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DIVERSITY AND REACH OF PENN STATE EXTENSION PROGRAMS AND EFFECT OF BROKERAGE AND NETWORK POSITION ON EXTENSION PROGRAM OUTCOMES THROUGH SOCIAL NETWORK ANALYSIS (SNA)

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by

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ABSTRACT

This study was designed to understand the diversity and reach of Cooperative Extension programs in Pennsylvania delivered by Penn State Extension and the influence of network variables (brokerage and centrality) on program outcomes (program business performance and demand for the program) using Social Network Analysis (SNA).

The study was conducted at Penn State Extension (PSE), the outreach wing of the College of Agricultural Sciences at the Pennsylvania State University. The population for this study consisted of all the programs offered by Penn State Extension and the program stakeholders. The sampling method used for this study was a 'census' of all programs and their stakeholders. The study utilized the SNA methodology and ex-post facto research design. The independent variables used in the study were the network variables, which included five types of brokers (liaison, gatekeeper, representative, itinerant, and coordinator), and degree centrality of Extension programs. There were two dependent variables, change in program business performance and change in demand for the programs. The independent variables were analyzed using UCINET 6 and network maps were drawn using NetDraw's spring embedding algorithm. Data were analyzed using the Statistical Package for Social Sciences (SPSS 21). Binary logistic regression was used to test the hypotheses. The study had four hypotheses regarding influence of network variables (degree centrality, gatekeeper brokerage, consultant brokerage, and liaison brokerage) on Extension program outcomes (program business performance and demand for the programs).

Results showed that network of Penn State Extension is widespread and programs are well connected to stakeholders in the form of number of stakeholders and connections of programs to

stakeholders. Analysis using backward Wald binary logistic regression revealed that all the independent variables together (degree centrality, gatekeeper brokerage, consultant brokerage, and liaison brokerage) were statistically significant in predicting the business performance of programs but were unable to significantly explain the change in demand for the programs. Only degree centrality statistically predicted the change in business performance of programs but it had no relationship with demand for Extension programs. None of the other variables significantly predicted the change in business performance or demand for the programs.

Overall, it can be concluded that, SNA is useful to understand the outreach of Extension and in understanding various outcomes of Extension programs. Based on the findings of the study, it is recommended that emphasis be placed to encourage collaboration among various programs, a need for systematic and accurate data collection and management that provides reliable data for all Extension activities. Further, it is recommended that future research be conducted by using the egocentric network to understand the all actors involved in Penn State Extension.

Key Words: Social Network Analysis (SNA), Cooperative Extension, Reach, Programs, Stakeholders, Brokerage, Degree Centrality

TABLE OF CONTENTS

LIST OF TABLES

TABLES Page

LIST OF FIGURES

FIGURES Page

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CHAPTER 1

INTRODUCTION

Cooperative Extension System (CES):

Extension has a long history of delivering programs to clientele. In the last 100 years, Cooperative Extension System (CES) has gained the reputation as the most effective technology diffusion organization along with being the largest non-formal adult education organization in the world (Franz & Towson, 2008; Rogers, 1992). CES personnel have a very good understanding of the current problems and issues and they strive to provide appropriate solutions for communities to prosper and individuals to live better. According to Mincemoyer, Perkins and Lillehoj (2004), CES is a community based organization in US which addresses societal issues through direct connection with research expertise available in the land grant universities.

CES in land grant universities functions by offering various non-formal, non-credit educational programs in areas such as agricultural crop production, economic and community development, animal production, family and consumer sciences, 4-H and youth development, nutrition, diet and health and conservation of environment and natural resources (Franz & Townson, 2008; NIFA, n.d.). CES addresses the complex issues facing society in rural, urban and suburban areas through the above mentioned educational programs with grass roots level involvement in problems/issues identification for individuals, community organizations and overall communities. Typically CES maintains local offices in most of the nation's 3000 counties and with the help of thousands of extension educators and specialists across the United States (Bull, Cote, Warner, & McKinnie, 2004; NIFA, n.d.; Rasmussen, 1989).

CES in the last 100 years has addressed various issues and crises in local communities, such as serving as a catalyst for improvement of crop productivity, helping communities to withstand local issues such as regional droughts and local economic depressions to national crisis of great depression and both world wars (Cartwright, Case, Gallagher, & Hathaway, 2002; Rasmussen, 1989).

In the past 20 plus years many trends has affected the CES. These include change in clientele demographics and target audiences, migration of a predominate rural population to cities, reduction in number of farms and farm population, mismatch between collaboration of research and Extension, new technologies, and the way Extension has been funded. But CES sustained or adapted to these changes and this year (2014) CES celebrated its 100th Anniversary (Ilvento, 1997; Peters, Franz, 2012). Now, to be sustainable for the next 100 years CES personnel should be receptive to adapting to change, accepting new technologies, and developing new financial partners. To be sustainable CES personnel have to consider the needs of undeserved audiences in suburban and urban areas (Bull, et al., 2004; Calvin, 2010).

Penn State Extension:

Penn State Extension (PSE) housed in College of Agricultural Sciences had served the communities and businesses in the commonwealth of Pennsylvania in various ways through its unbiased, science-based educational programs developed using relevant and appropriate research findings. Over these years " demonstrations of new technology, farming methods, environmental stewardship and management practices, leadership skills, home management skills, healthy living skills, citizenship, and youth development have helped farmers remain profitable, communities remain economically, politically, and socially viable, families remain

economically, emotionally, and physically healthy, and children develop into productive citizens" (Calvin 2010, p. 9). On the 100th anniversary, Dr. Calvin (Director of PSE) said, "We need to adapt to changing demands and not simply live off the legacy of the last 100 years" (Calvin, 2014, pp. 16).

Technology in Extension:

There has been great advancement in the development and use of technology in the last two decades. Knowledge disseminated through technology has become the central focus of a global economy, specifically to CES; as it is the organization which transfers research based knowledge from land grant universities to the general public to address the societal issues (Albright, 2000; Gregg & Irani, 2004; Green, 2012; Guenthner & Swan, 2011).

In 2008, 35% of adults in the US had an account on various social networking sites compared to only 5% in 2005, and this trend is growing at a very fast pace as exhibited by Facebook which had 300 million unique users in 2009. This trend is not prevalent only in urban and suburban areas but also in rural areas. High speed internet access in rural areas increased by 22% from 2008 to 2009 (Corbett, 2009; Horrigan, 2009; Lenhart, 2009). This growing trend in use of technology by CES stakeholders is presenting both challenges and opportunities for Extension educators and administrators (Diem, Hino, Marting, & Meisenbach, 2011; Green, 2012; Guenthner, & Swan, 2011).

A number of studies have been conducted related to the use of technology by Extension educators and Extension clientele, successful use of technology by Extension professionals and readiness of Extension to adopt new technologies (Diem et al., 2011; Green, 2012; Gregg &

Irani, 2004; Guenthner & Swan, 2011; West, 2007). The general consensus from these studies suggests the following:

- Top technologies used by Extension stakeholders mainly farmers were email, text messaging, digital photos, YouTube and Wii.
- Extension agents have embraced information technology in their job responsibilities with expanded use of e-mail, presentation software, and word processing. These were the highest used technologies by them.
- Technology is a powerful, affordable, easy to use and reliable method to conduct program evaluation more efficiently and easily.
- Technology can be successfully utilized by Extension educators to enhance their outreach capabilities to thousands of stakeholders across US with research based information.
- Time, money and training were identified as key barriers to technology adoption by Extension educators along with fear of losing traditional audiences due to using technology and new methods of program delivery.

In an environment of deep budget cuts, tight funding and shifts in demographics in US, CES has to embrace the use of technology in conducting their routine activities in order to do more with limited resources, reach larger numbers of clientele, serve new audiences and showcase the public value of its programs to stakeholders through new program evaluation methods such as Social Network Analysis (SNA).

Role of Social Network Analysis:

Social Network Analysis (SNA) is a methodology which provides complementary visual and statistical components for analyzing the traits of actors and their relationships in a network.

Brass, Galaskiewicz, Greve & Tsai (2004) defined network "as a set of nodes and the set of ties representing some relationship, or lack of relationship, between the nodes" (p. 795). Nodes are the actors such as individuals, groups, subunits, and organizations and ties are the relationships between these various actors. The relationships can be friendship, advice, common membership to any institution or depend on the need of the study. According to network perspective, actors are embedded within the network of interconnected relationships which provides both opportunities and constraints on the behavior of actors. A holistic network approach also helps researchers to capture the functioning/interaction of any individual actor/unit within the network as a whole (Brass et al., 2004; Kilduff & Tsai, 2003).

SNA methodology has been widely utilized in disciplines such as sociology, business management and public health for understanding various individual or organizational outcomes (Springer & de Steiguer, 2011). SNA has been used in a diversity of applications, including analyzing roles of intra-firm networks and corporate business partnerships (Tsai & Ghoshal, 1998); and examining how ideas and information are transferred amongst a field of professionals, understanding the role of networks in various organizational outcomes (Brass et al., 2004). However, this methodology is still underused in agricultural and extension education and literature on SNA studies in agricultural and extension education is scarce.

Bartholomay, Chazdon, Marczak and Walker (2011) conducted a study to examine the outreach of University of Minnesota (UM) Extension to organizations outside UM. They utilized the SNA as the methodology to understand the outreach of UM. They found that the outreach network of UM Extension was both broad in its reach and strong in its connection. They concluded that SNA has great potential to describe and understand the Extension outreach. Springer and De Steiguer (2011) also concluded that SNA has much to offer for Extension professionals and

specifically the visual and statistical elements in SNA. In another study, Roberts, Murphy and Edgar (2010) using SNA methodology recommended that teacher educators have to understand the social networks of student teachers for better learner to learner interaction.

Significance or the Need for the Study:

According to Extension Committee on Organization and Policy (ECOP), Cooperative Extension System (CES) is regarded as the "best kept secret" by the land grant universities. They found that only 3% of total population knows about Extension and in that population less than 30% of agricultural population knows about CES (Calvin, 2012). Over the past few decades there has been a shift in demographics in suburban and urban areas across the US and in Pennsylvania which led to a decreasing proportion of the population staying in rural areas and less than 2% of the population engaged in agriculture (Calvin, 2012; Franz & Townson, 2008; Ilvento, 1997; Peters & Franz, 2012). In addition, there have been deep budget cuts, complex accountability and staffing structures, widely varying programs and delivery methods and increasing anti-intellectual and anti-governmental sentiments (Peters & Franz, 2012). These factors have contributed to CES personnel being in a defensive position across the US and Pennsylvania (Calvin, 2010; Calvin, 2012; Franz & Townson, 2008; Ilvento, 1997).

Reorganization of Extension:

In 2007, to meet the needs of new and traditional stakeholders and sustain the organization in times of tight funding structures, the Cooperative Extension in the College of Agricultural Sciences at the Pennsylvania State University entered a process called "Reframing." As a result of this reframing, Cooperative Extension was divided into 19 Natural Work Groups (NWGs) delivering 81 state Extension programs. These 81 state programs were regarded as the major

educational efforts by Cooperative Extension to address the key issues faced by the residents of Pennsylvania. Prior to reframing in 2007, Cooperative Extension delivered 700 different programs (Calvin, 2010).

With the University Core Council's recommendations for improvement in the organization and operation of the College of Agricultural Sciences and Cooperative Extension amidst budget cuts for Cooperative Extension in FY2011-12, Cooperative Extension underwent another restructuring in 2011. Cooperative Extension adopted a new "business model" and renamed itself "Penn State Extension (PSE)" to improve its visibility in communities of Pennsylvania as one organization offering different educational programs to address societal issues rather than being known by varied education programs such as 4-H and Master Gardner's (Calvin, 2012).

Based on the recommendation and input from within the PSE and from stakeholders of PSE, five statements were developed to characterize the attributes of PSE:

- A *unified, agile* organization *focused* on *strategic areas* of excellence
- With a *team approach* to research and educational program development and delivery
- *Distributed* through a *county-based presence* addressing local needs
- In collaboration with diverse, statewide *partnerships*
- Providing stakeholders with *university access* to *research-based information* through *high quality, consistent* educational programs delivered using *diverse technologies and formats* (Calvin, 2012, The New Extension, pp.2).

In the new PSE, leadership at 67 counties in Pennsylvania was consolidated into 19 Districts and two urban counties. Each of the district directors in the new system were responsible for 2-5 counties and have the sole responsibility of leadership and management of PSE at the county

level with no personal obligation for specific Extension program development and delivery. At the same time the new PSE was reorganized into 11 Penn State Extension Teams replacing the earlier 19 Natural Work Groups. These 11 teams are responsible for educational program development and delivery within 11 Program Priority Initiatives (PPIs) to address the issues faced by the residents in Pennsylvania. These 11 teams have to work collaboratively to deliver the educational programs that satisfy 11 PPIs. These teams have to deliver a minimum of two programs each to satisfy PPIs and may deliver additional programs if there exists a clear need by stakeholders that were not addressed by these11 priority areas. This effort reduced the total number of programs offered by PSE to 20-30 as compared to 82 programs in the previous model. The program development and delivery for 11 teams are supervised by the seven program leaders across the state. The 11 teams under the new PSE model are:

- Dairy
- Poultry
- Equine
- Livestock
- Field and Forage Crops
- Renewable Natural Resources
- Horticulture
- Family and Consumer Sciences
- Food Safety and Health
- 4-H Youth Development
- Ag Entrepreneurship, Economic and Community Development

Recently (2014), a 12th team was added to the PSE called *Veterinary*. The 11 priority areas for PSE are:

- Animal Welfare and Environments
- Water

- Food Safety and Processing
- Sustainable Agricultural Businesses
- Pest Prediction/Response
- STEM Education and Positive Youth Development
- Rural Safety and Health
- Gas Drilling (Marcellus Shale and other gas fields)
- Bio-based On-Farm Energy Production and Use
- Childhood Obesity
- Green Infrastructure (Calvin, 2012)

The new PSE serves the citizens in 67 counties across the Commonwealth of Pennsylvania with the network of 175 county based Extension educators and 74 subject matter specialists. See Figure 1.

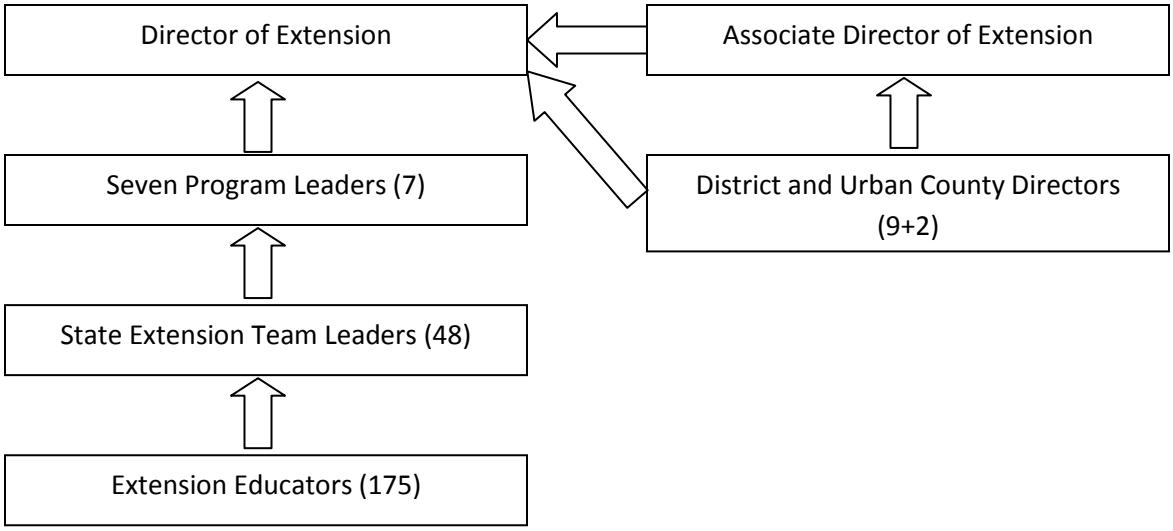

Figure 1. Organization and Reporting Structure of Penn State Extension

Three years have passed since the implementation of this new business model, but no efforts have been made to understand the reach and networks of new PSE programs across Pennsylvania

and how successful PSE is in adaptation of its new business model, to current funding requirements and in addressing the issues faced by the citizens of Pennsylvania. Thus, this study was designed to determine the diversity and reach of PSE.

Purpose and Objectives:

The purpose of this study was to understand the diversity and reach of Cooperative Extension programs in Pennsylvania delivered by Penn State Extension and the influence of various network variables (Brokerage and Centrality) on two program outcomes (program business performance and demand for the program) through Social Network Analysis (SNA). Specific objectives of the study were to:

1. Develop a holistic network map of programs and program stakeholders to understand the diversity and reach of Extension programs in Pennsylvania.
2. Examine the influence of five types of brokerage (liaison, itinerant, gatekeeper, representative, and coordinator) and degree centrality on Extension program business performance.
3. Examine the influence of five types of brokerage (liaison, itinerant, gatekeeper, representative, and coordinator) and degree centrality on demand for Extension programs.

Hypotheses/ Research Questions:

The following four hypotheses guided the study:

Hypothesis 1: For all five types of brokerage (liaison, itinerant, gatekeeper, representative and coordinator), programs which control the flow of information and resources between pairs of other programs are hypothesized to have higher business performance than the programs that do not control the flow of information and resources.

Hypothesis 2: The higher the degree centrality of the program, greater would be its business performance.

Hypothesis 3: For all five types of brokerage (liaison, itinerant, gatekeeper, representative and coordinator), programs which control the flow of information and resources between pairs of other programs are hypothesized to have greater demand among stakeholders than the programs that do not control the flow of information and resources.

Hypothesis 4: The higher the degree centrality of the program the greater would be its demand among the stakeholders.

Assumptions:

One of the major assumptions of the study was that if a program is occupying any of the five type of brokerage (liaison, itinerant, gatekeeper, representative, and coordinator) position in the network and with higher values for the degree centrality then that program will perform better in the business and has more demand from the stakeholders of CES in Pennsylvania.

Limitations:

One of the limitations of the study was that the data for the two dependent variables, program business performance and demand for the program, was collected through secondary data provided by Extension administration. The researcher, based on a brief review of major activities in each program, segregated the data for both dependent variables into 60 program areas. Another limitation of the study was considering the increase/change in both dependent variables from year 2011-12 to 2013-14, and year 2013-14 was not completed, so the researcher used the latest available data for business performance measured by grants and developmental funding

till 15th March and assumed that this represents the overall number of grants and contracts for the year 2013-14. Demand of the program was operationally measured by face-to-face direct contacts of the program. The researcher was unable to get the complete data for the year 2013-14, so the researcher used the available data for three years (2010-11, 2011-12 and 2012-13) and using this three year data, the researcher projected the data for the year 2013-14. Regarding data for the independent variables, the researcher relied on program leaders and state extension team leaders to provide the list of programs and the program stakeholders. Based on their input, the researcher drew the complete network of PSE and calculated the other independent variables of the study.

The number of cases in the study is exactly equal to the minimum number of cases required for the binary logistic regression, which also may have affected the results. Caution should be used in interpreting the results of the study, as results are applicable to PSE and as such cannot be generalized beyond Pennsylvania.

Operational Definitions:

Extension program: A program is defined as a set of orchestrated educational experiences purposefully selected to address a locally identified need or issue of broad public concern (Rennekamp, 1995).

The researcher created the following criteria to define a program to be included in the study:

- Conducted throughout the Commonwealth of Pennsylvania
- The program is in operation for a minimum of three years
- A major initiative of each specific state Extension team, such as Master Gardeners, Dining with Diabetes, Better Kid care

- Workshops, webinars and courses were not considered as a program.

*Stakeholders***:** Stakeholders are who have direct or indirect vested interest in the Extension program. Researcher included both direct and indirect stakeholders.

Brokerage: Is the extent to which a program links otherwise with unconnected other programs.

Liaison broker: It is a type of brokerage relation in which two unconnected programs and broker program occupy the three different separate teams, i.e., program which is acting as a broker, the program which is being brokered by the broker and program for which broker is doing brokering.

Itinerant broker: It is a type of brokerage in which two unconnected programs may belong to same team while the broker program belongs to a different team.

Gatekeeper broker: It is the kind of brokerage in which the broker program and one of the unconnected programs belongs to same team and the other unconnected program belongs to different team. The broker program is the controller for incoming information to its team and it has to decide whether to grant access of this information to its team or not.

Representative broker: It is the kind of brokerage in which the broker program and one of the unconnected programs belongs to same team and the other unconnected program belongs to different team. In this, a broker program of the team represents the complete team and negotiates to outside unconnected program teams on behalf of its team.

Coordinator broker: It is a kind of brokerage in which all three programs belong to the same team and the brokerage relationship is completely internal to the group.

Centrality: It is operationally defined as how a program is central in the network compared to other programs.

Degree centrality: It is the number of direct ties a program has with other programs in the complete network of Extension programs offered by PSE.

Business performance of Extension program: Business performance of an Extension program refers to the total amount of grants and developmental funding received for that specific program. Additional revenue sources such as fees, sale of publications and other sources of funding were not included in calculation of business performance of Extension programs.

Demand for the Extension program: The number of direct face-to-face contacts for each program.

Organization of Thesis:

This thesis is divided into six chapters. The first chapter, "Introduction," describes the history of CES, Penn State Extension, and use of technology in Extension, importance of SNA, and purpose and limitations of the study. The second chapter, "Review of Literature," provides an overview of literature reviewed as per objectives of the study. Chapter three, "Methodology," provides a description of how, from whom and what data were collected for the study and how the collected data was analyzed. Chapter four "Results," presents the major findings of the study by objectives. Chapter five "Conclusions and Recommendations," discusses the findings, its practical significance and suggestions for future research.

Chapter six, application of SNA to international agriculture and education settings (in this case, India), is a fulfillment for the dual title degree program in International Agriculture and Development (INTAD). Consequently, a detailed review of the application of SNA to Indian agricultural Extension is discussed.

CHAPTER 2

REVIEW OF LITERATURE

The purpose of this study was to understand the diversity and reach of Cooperative Extension programs in Pennsylvania delivered by Penn State Extension and the influence of various network variables (Brokerage and Centrality) on two program outcomes (program business performance and demand for the program) through Social Network Analysis (SNA). Specific objectives of the study were to:

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3. Examine the influence of five types of brokerage (liaison, itinerant, gatekeeper, representative, and coordinator) and degree centrality on demand for Extension programs.

The researcher found that there is limited literature related to application of Social Network Analysis (SNA) in agricultural and extension education and specifically to Cooperative Extension Service (CES) to examine the reach of Extension programs in the communities and to evaluate the Extension programs using social network perspective. Therefore, the researcher has attempted to present select literature available related to the profession of agricultural and extension education, but mostly relied on the studies completed in business management, public health and sociology professions.

This chapter is divided into three broad areas: (1) use of SNA and study of various network characteristics, (2) brokerage in general and specifically five types of brokerage and its effect on program/organization/individual business performance and demand of program/product/organization, (3) centrality in general and specifically degree centrality and its effect on program/organization/individual business performance and demand of program/product/organization.

Use of SNA and Study of Various Network Characteristics:

The societal structure described using interaction between members of society or networking among organizations can be best understood as network of relations, therefore SNA can be described as a useful tool to define and describe different organizations and for assessing the impact of various organizational structures (Zack, 2000). SNA can be defined by relations between individuals or group of individuals or organizations and defines society as constituted of networks made up of relationship or ties between actors or nodes (Williams, 2005). The arrangement these ties assume is defined as the 'Social Structure,' which means way individual actor act in the network is not only defined by the personal attributes of actor but also influenced by pattern of relations in which the actor is embedded (Vera & Schupp, 2006). Based on the level or focus of analysis, nodes in the network may represent different entities such as individuals, groups of individuals, technology, the entire organization, or even countries that mean whatever being the unit of analysis for the researcher form the unit/organization being studied (Zack, 2000). Relationship or ties defines the flow of resources between the nodes/actors which can be material or non-material (Wasserman & Faust, 1994) and these "resources might include social support, emotional support, companionship, time, information, expertise, money, business transactions, shared activity, and so on." (Williams, 2005, p. 22). The relationship

between two nodes/actors can be either informal means based on trust or formal means the relationship is bounded by formal contract (Provan, Fish, & Sydow, 2007). Wasserman and Faust (1994) proposed four theoretical propositions to define SNA:

- Actors in all social systems are interdependent, not independent.
- Actors are related through links that channel information, affection, and other resources.
- The structure of those relations both constrains and facilitates action.
- The patterns of relations among actors define economic, political and social structures (p. 4).

SNA perspective which includes both method and theory, restricts studying the individual relationship in isolation from the network which the individual is the part, that's why 'dyad,' or relationship between two individuals/actors is the building blocks of the network study (Borgatti & Everett, 1997; Williams, 2005). In traditional social sciences the data set would be a person-by-attribute matrix, where individual is the point of study and individual attributes of the individual were the variables. But in network studies, the data set would be person-by-person matrix, which is recording the single variable (dyadic attribute) among a set of actors (Borgatti & Everett, 1997).

In a network, all nodes are not connected to every other node, which in turn differentiates one network with other networks. Some clusters in a network are densely knit, where most of the nodes are connected to each other, while others are loosely knit and both clusters are connected via sparsely connected areas called bridges (Williams, 2005). Resources that are shared across

nodes through are finite and that make these resources scarce, which in turn produce the hierarchy structure in the previous neutral network. This hierarchy in the network in turn describes the feature that some nodes in the network are central while others are peripheral. The resources attenuates as they travel from one node to another, which in turn influences the accessibility of resources by various nodes in the network based on their position in the network as central or peripheral (Williams, 2005).

SNA originally started as a descriptive way of representing the networks graphically, gradually evolved from a technique to represent the networks graphically to a methodology with various explanatory powers by analyzing the data on social relations through relational data analysis (Butts, 2008; Gould, 2003; Vera, & Schupp, 2006).

Depending on the level of analysis, the networks can be dealt in two ways: egocentric and whole network. The 'egocentric' approach deals with the role of individual actor with respect to the characteristics of networks in which that individual is embedded, whereas the 'whole network' approach considers the structure of entire network in describing certain organizational outcomes or social phenomenon (Borgatti & Everett, 1997; Butts, 2008; Vera & Schupp, 2006).One challenge for researchers in describing SNA data was to define network boundary (Butts, 2008).

In understanding the various phenomenon in social sciences, SNA can be applied in five major themes: "the structure and functioning of organizations; genealogies of knowledge formation and transmission; the operationalization of social capital concepts; the diffusion of information and innovation; and the regulation of social networks" (Vera & Schupp, 2006, p. 410). The current study falls into first theme that the structure and functioning of organizations.

Over the years, studying the network variables has become an important approach in understanding various organizational outcomes (Brass, et al., 2004; Stevenson & Greenberg, 2000). In the past decades, researchers have studied various network variables that included network centrality (Freeman, 1979), centralization, structural holes (Burt, 1992), brokerage (Gould & Fernandz, 1989), social capital (Putnam, 1993), strength of weak ties (Grannovater, 1973), clique analysis and structural equivalence (Borgati & Everett, 1992) and others.

In the following paragraphs, studies from other disciplines that had numerous applications of SNA are presented. For each of the studies, description of how the SNA was used to understand various social phenomenon using network sociograms and other related network characteristics is presented.

In the discipline of agricultural and extension education, Bartholomay et al. (2011) conducted a study to understand the outreach of Minnesota Extension to organizations which were external to the University of Minnesota. They assumed that networks play an essential role in how and where extension carries out its outreach activities. To prove this, they designed a survey which consisted of questions on depth of connections between UM Extension and organizations external to UM, who initiated the connection and perceived importance of Extension's contribution to the organization. As a need for full participation of staff in networks studies, data on above mentioned measures was collected from all Extension staff members, including civil services and part-time through a web-based survey. A total of 96% Extension Staff responded to the survey. To describe the depth of relationship, the authors used traditional statistical methods and to draw the outreach network of UM Extension, researchers utilized the UCINET 6 and NetDraw software.

The findings revealed that UM Extension's networking with external organizations were mostly made up of partnership (43.1%) and substantive information (22. 4%). The network maps of UM Extension revealed that its network were widely distributed, but the whole network was split in two parts with youth development and family development programs on the left side and other programs and central Extension were on the right side of the split. Network map also revealed that UM Extension had broad outreach to government departments and other related organizations.

The authors concluded that UM Extension was both deeply and broadly connected to the organizations external to UM. There were some smaller networks in the whole network map of UM Extension representing that some organizations were unique to specific program or cluster of program areas. Overall, the authors suggested a bright future for the use of SNA in Extension evaluation agenda and concluded that SNA has the great potential to improve reporting, increase internal collaboration and assess the outreach efforts of organizations such as Extension (Bartholomay et al., 2011).

Another study conducted by Springer and De Steiguer (2011) used SNA to understand the networks of collaborative watershed initiative. In this study, the authors concluded that SNA methodology can provide new insights into watershed and other forms of collaborative initiatives for natural resource management. They also concluded that SNA has much to offer for Extension professionals and specifically the visual and statistical elements in SNA which provide extra insight into characteristics of groups.

Roberts, Murphy and Edgar (2010) conducted a study to explore the social interactions between the student teachers during the student teaching experience. They found that every student

teacher have interacted with their peers during their teaching experience. However, they interacted with a small percentage of their peers on a weekly basis. Another finding was that student teachers most frequently used the telephone or face-to-face modes to interact with their peers. They recommended that teacher educators have to understand the social networks of student teachers for better learner to learner interaction which in turn increase the overall learning of student teachers during their teaching experience.

Rhoades, Thomas and Davis (2009) conducted a study in Ohio to understand the social networking among 4-H youth and the way the youths use the social networking sites to share information about 4-H and Extension. They found that youth are using social networking sites to share information about the 4-H clubs and projects, but Extension educators had created a limited number of pages for youths to network with each other.

The SNA was used by Lauber, Decker and Knuth (2008) to understand the collaborative, community-based natural resource conservation and development in the communities. They used the multiple case study approach, and selected three communities where community based projects were successful. Data was collected from 8-10 individuals in each community through semi-structured interviews. The questions were based on who were the key stakeholders in the success of the project and what roles had been played by interactions between the stakeholders. Researchers used NetDraw software to draw the stakeholders' interaction network maps.

Based on the coding of interviews, researchers found five reasons for interaction between the stakeholders, which were: exchange of ideas, knowledge dissemination, getting funds and other tangible resources and exerting influence. Among all the reasons for interaction, exchange of ideas was highest. Overall, authors concluded that SNA provides a unique way to understand the

interaction between stakeholders and success of community-based natural resource management projects.

Mandarano (2009) conducted a study to demonstrate the value of SNA in evaluation of effectiveness of collaborative planning in the development of social capital by use of new and improved inter-organizational networks. The researcher used the case study approach and collected data using both interviews and surveys. Data was analyzed using UCINET 6 software and researchers used similarities, hierarchical clustering, density, and circle graph and centrality applications.

The results of similarity application in UCINET showed that organizations within habitat group are linked based on common interests. Among all the networks, resource exchange network had the highest density of 95%, while the fund exchange network had the lowest density of 46%. The results also showed that availability and accessibility of resources impacted the formation of new relationships. Researchers concluded that SNA helped in identification of new relationships formed among participants due to common interests they shared, which in turn improved the social capital.

Hawe and Ghali (2008) used SNA to understand the social structure of high school staff and teachers to promote the health intervention in the school. Data for the study was collected from teachers and staff using in-depth interviews. Data was analyzed using UCINET 6 software and researchers used network density and network centralization application of the software.

They found that principal and vice principals were most central in the network and support staffs were most peripheral in the advice-seeking network of the school. The density in the network was highest for knowing the person by name (66%). Based on these results they concluded that

SNA offers a unique opportunity for identification of key persons and social connections in the network which in turn helps in successful implementation of health intervention.

Fowler, Christakis, Steptoe, Roux (2009) used SNA to understand the spread of happiness in the large social network of Framingham heart study. They found that people's happiness in the network depends on their connection to other people in the network who were happy and concluded that SNA offers a unique methodology in understanding the spread of happiness.

Pow, Gayen, Elliott, and Raeside (2012), explored the application of SNA in the nursing profession. They found that SNA provides a simple and easy method in understanding the interactions between nurses and patients and how these interactions can help in understanding the various health outcomes of the patients.

Brokerage and its Effect on Program/Organization/Individual Business Performance and Demand of Program/Product/Organization:

Brokerage:

Brokerage refers to the occupancy of structural position by an actor in the network which links/connects otherwise unconnected actors and mediates the flow of information and resources between those unconnected actors (See Figure 2) or trade on gaps in the social structure (Burt, 1992; Gould & Fernandez, 1989; Fernandez & Gould, 1994; Stovel & Shaw, 2013). The broker represented with black (solid) circle occupies the gap in otherwise unconnected two actors represented with white (hollow) circle. In more formal terms brokerage can be defined as the process of connecting actors in a system of social, economic and political relations in order to access valued information and resources (Stovel, Golub, & Milgrom, 2011).

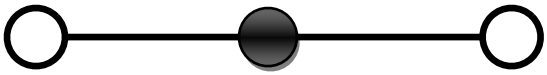

Figure 2. An example of brokerage process adapted from Stovel and Shaw (2013)

According to Stovel and Shaw (2013), the vital characteristics/properties of brokerage were "(*a*) they bridge a gap in social structure and (*b*) they help goods, information, opportunities, or knowledge flow across that gap (p.141)." Brokerage is the only mechanism through which isolated/unconnected individuals can interact economically, politically, and socially (Stovel & Shaw, 2013).

Actors with higher brokerage gain more access to information and resources because they were likely to access heterogeneous and non-redundant information (Burt, 1992; Yin, Wu, & Tsai, 2012) then the actors with low or no brokerage. According to Burt, occupancy of brokerage position provides an actor the control benefits because having the higher brokerage position the actor can manipulate the negotiation between unconnected actors. With the information, resources and control benefits, the actors with higher brokerage become more influential and perform well in the business compared to firms with lower brokerage (Fernandez & Gould, 1994; Stovel and Shaw, 2013; Stovel et al., 2011). In the individual network actors with high brokerage capabilities are able to do more innovations at the organization (Hargadon & Sutton, 1997), get the job more easily (Granovatter, 1973), get promotions more quickly (Burt, 1992) and more successful in their careers (Podolny & Baron, 1997).

In order to provide empirical support to the fact that network position of brokers provides them competitive advantage and it is persistent, Ryall and Sorenson (2007) conducted a study using biform game methodology. They found that brokers can exploit the advantage and sustain their position only when; a) there were no substitute for the position of broker or the value they create,

b) brokerage occurs at more than two actors, and c) brokers were not stuck at their intermediary position and can leave that anytime time when they require.

Gould and Fernandez (1989) introduced the concept of brokerage typology that further categorizes the brokerage. They identified five structurally different types of brokers or five types of brokerage relations on the basis of information flow and partitioning of actors into non overlapping groups.

The five distinct types of brokers were liaison, itinerant, coordinator; gatekeeper and representative (see Figure 3). The first type "*Liaison*" is a brokerage relation in which all three actors occupy different groups. One example for liaison brokerage is the negotiator who resolves the conflict between firm management and firm employees, other example can be the middleman between farmers and consumers (Gould &Fernandez, 1989; Fernandez & Gould, 1994).

The second type of brokerage is the "*itinerant,*" in which two unconnected actors may belong to same subgroup while the broker belongs to different group. The mediator in this kind of transaction is an outsider, so this type of brokerage is also called as "*Cosmopolitan*" or "*consultant*" broker. The best example for this kind of brokerage is the stockbroker, where brokerage firms are quite differentiated from their clients and according to stockbroker the buyer and seller make up an undifferentiated group (Gould &Fernandez, 1989; Fernandez & Gould, 1994).

The third type of brokerage is the "*coordinator,*" in which all three actors belong to the same group and the brokerage relationship is completely internal to the group. The example for this kind of brokerage is the Federal Reserve Bank, which act as a controller and a clearing house for all other banks in a country (Gould & Fernandez, 1989; Fernandez & Gould, 1994).

The fourth type of brokerage is "*gatekeeper*," it is the controller for incoming information to his/her group and he/she has to decide whether to grant access of this information to its group or not. An example to this kind of brokerage is the Census Bureau, which is responsible for gathering and processing the information and later distribution to other government organizations (Gould &Fernandez, 1989; Fernandez & Gould, 1994).

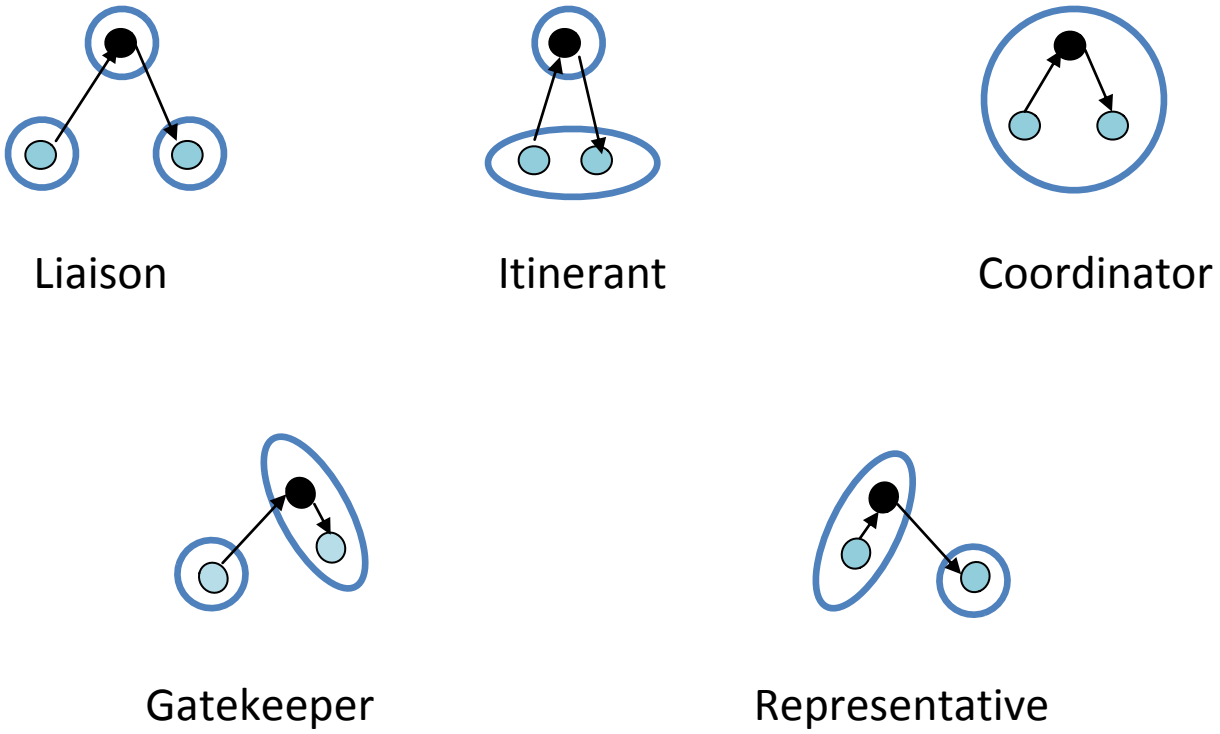

Figure 3. Different types of Brokerage Structures as adapted from Gould & Fernandez (1989)

The last type of brokerage is "*representative.*" In this, a member of the subgroup represents the complete group and negotiate to outside groups on behalf of his/her group. An example may be during the conflict between airline industry and government; American Airlines represent the

airlines group and negotiate with the government (Gould &Fernandez, 1989; Fernandez & Gould, 1994).

Gatekeeper and representative brokers perform the information processing and external representation and have clear-cut relevance to boundary spanning role and taking advantage of their positions (Gould &Fernandez, 1989; Fernandez & Gould, 1994).

Literature related to the application of brokerage is briefly described below:

Fernandez and Gould (1994) conducted a study to find the relationship between occupancy of brokerage position and influence in health policy domain. In this study researchers utilized the five kinds of brokerage (liaison, itinerant, gatekeeper, representative and coordinator) types proposed by Gould and Fernandez (1989). The five hypothesis of their study were:

> HYPOTHESIS 1 - For all five brokerage types, actors who control two- step paths between pairs of other actors are perceived as more influential, on average, than actors who do not.
>
> HYPOTHESIS 2 -Among government organizations, the relationship between influence and occupancy of liaison and itinerant brokerage positions will be attenuated by a tendency to take stands on policy events.
>
> HYPOTHESIS 3 -Among government organizations, the relationship between influence and occupancy of representative and gatekeeper brokerage positions will not be attenuated by a tendency to take stands on policy events.

> HYPOTHESIS 4 -For nongovernment organizations, the relationship between influence and liaison, gatekeeper, representative, and itinerant brokerage position will be unaffected by advocacy of specific policies.
>
> HYPOTHESIS 5 -Taking stands on policy events will contribute to the influence of coordinators, whether or not they are government organizations (p. 1461-1463).

Fernandez and Gould used the data from Laumann and Knoke's (1987) study on social structure of national energy and health policy domains. The dependent variable of the study was influence reputation, which was measured through each respondent's view on which actor was most influential in formulating the health policy. The data on communication flow was measured by researchers asking organizational informants to identify organizations with which their organization discusses health policy issues regularly. For calculation of values for five types of brokerage, researchers used partial brokerage scores and they used 15 common interest subgroups as the partitioning vectors. The moderating variable of the study was measured by analyzing which policy events each organization take public stand. This study used organization age and size as the control variables. In order to reduce the spurious relationship, percentage effort of each organization for health policy domain was also measured. Multiple regressions were used to prove the hypothesis.

In this study, Fernandez and Gould (1994) found the positive correlation between all five types of brokerage and highest correlation was between liaison and itinerant and among representative, gatekeeper and coordinator. All five types of brokerage were positively related to influence in health policy domain irrespective of governmental and non-governmental organizations, this

finding supported hypothesis 1 of the study. In the same way hypotheses 2, 3, 4, 5 were also supported by results of the study.

Overall Fernandez and Gould concluded that the governmental organizations remain influential when connecting disparate actors only when they remain neutral to specific health policy agendas.

In order to clarify that boundary spanning roles were not performed by one person, Friedman and Podolny (1992) conducted a longitudinal network study utilizing the network data for labor negotiations. They found that some individuals in the network broker ties towards their opponents (representative broker) while others had the broker ties from their opponents (gatekeeper brokers). They concluded that the role conflict for different individuals in negotiation networks must be analyzed differently both in form of concept and methodology and more options should be available to negotiator to better management of role conflicts.

Networks are dynamic and keep evolving with time (Gulati & Gargiulo, 1999). It is very hard to define the current organizational outcomes with existing network structure, as past network or 'network memory' also contributes to current outcomes (Soda, Usai & Zaheer, 2004). Soda et al. (2004) conducted a longitudinal study at the TV performance project firms in Italy to define the effect of network memory on current organizational outcomes. In their study, they considered current TV project performance as dependent variable and past and current internal closure (defines how connected were the specialists in project and mutually shares trust, knowledge and routines) and past and current structural holes (it is a gap in the network and actors embedded in networks rich in structural holes will gain capacity to utilize their position for personal advantage by acting as a broker (Burt, 1992). To avoid the effect of external factors on dependent variable,

researchers controlled size of project, average age of networks, and current project centrality (past research indicated effect of network centrality on performance of organization (Tsai & Ghoshal, 1998). Upon analyzing the multiple regression results researchers found that past network closure among network members affect the current organization performance in a curvilinear fashion and current structural holes enhanced the performance of organization compared to past structural holes. Overall, researchers concluded that social capital contained in the network in the form of closure sustained over time while social capital in form of structural holes decayed over time.

Upon reviewing the vast literature on brokerage, Täube (2004) found that brokerage concept is well discussed and classified and operationalized into five types on brokerage based on their affiliation to various subgroups but little effort have been made to assess the social capital associated to these different types of brokers due to their position in the network. Täube designed an instrument to capture the social capital associated with the liaison, itinerant, gatekeeper, representative and coordinator brokerage roles.

In order to assess the benefits hold by gatekeeper brokers in innovator networks, Graf and Krüger (2011) conducted a SNA study utilizing the patent data. Upon deeply studying the internal and external contacts of gatekeepers using multiple regressions, researchers found that gatekeepers were unable to extract all the benefits associated with their position and gatekeeper provides some sort of public benefits along with their personal benefits in the innovation networks.

The findings of Graf and Krüger (2011) were further supported by Graf (2011), where researcher expanded the previous study. In this study Graf found that for gatekeepers in order to reap the

competitive advantage of their position, their absorptive capacity (absorption of new knowledge from external actors and diffusion to local actors in its subgroup) was more vital than the size (large actor have more linkages) of the gatekeeper. Graf also found that gatekeeper role was mainly served by public research organizations compared to private organizations.

In order to understand the technology brokering in a product development firm, Hargadon and Sutton (1997) conducted an ethnography study at IDEO, the largest product design consulting firm in US. Upon analysis of data, researchers found that IDEO simultaneously worked with multiple industries on development of various products. Having the opportunity of working with many industries, the designers at IDEO exploited the benefits of their network position by developing new products for one industry using the existing technology from other industry. Researchers concluded that network position blended with organizational memory of IDEO designers helped them to become technology broker and develop new and innovative products.

Oke, Idiagbon-Oke, and Walumbwa, (2008) found the deficiency in literature regarding the impact of power (both personal and positional) associated with the broker position on ties strength in horizontal network and outcomes of new product development firms. To fill this deficiency they conducted a survey research with 13 networks comprised of 42 organizations. Based on the results of structural equation modeling they concluded that relationship between use of power by brokers and outcomes of new product development firms was completely mediated by strength of ties among horizontal network members.

Technology brokers catalyze the innovation process in an organization, but despite their catalyzing process they found difficulty in embedding inside the networks as network members had difficulty to grasp the value to work done by technology brokers (Klerkx & Leeuwis, 2009).

Even after wide research on network brokers, little research have been conducted on physiological antecedents of network brokers (Oh & Kilduff, 2008). In order to understand these physiological antecedents, Oh and Kilduff (2008) conducted a study on Korean entrepreneurs in Canadian urban areas. They found that, persons with high self-monitoring tended to become direct brokers in Korean community by connecting unconnected direct acquaintances. Those with high self-monitoring also exhibit the indirect brokerage and establish ties to important network members outside the Korean community. By these results they concluded that there was ripple effect of self-monitoring on social structure and personality relates to brokers at different levels of the network.

Using the typology proposed by Gould and Fernandez (1989), a very few research studies have been conducted in the past and they considered the macro-level consequences of particular form of brokerage. For example, studies done by Friedman and Podolny (1992) analyzing the labor negotiations; Gould & Fernandez (1994) analyzed the health policy domain. Recently, Hillmann (2008) utilized this framework to understand the state building efforts in the colonial Vermont. Studies to date on network variables have made substantial contributions in conceptualizing the idea of brokerage both theoretically and empirically, but limited studies have been conducted to explore the brokerage typology (Gould &Fernandez, 1989) and its effect on various organizational outcomes.

Centrality in general and specifically Degree Centrality and its Effect on Program/Organization/Individual Business Performance and Demand of Program/Product/Organization:

Centrality:

Centrality is one of the most studied variables in the network literature across the disciplines (Brass & Burkhardt, 1992; Brass et al., 2004; Powell, Koput, Smith-Doerr, & Owen-Smith, 1999; Sparrowe, Liden, Wayne, & Kraimer, 2001). Centrality refers to the extent to which an actor occupies a central position in the network when compared to other actors in the network. The centrality in a network can be conceptualized and analyzed in a variety of ways, but Freeman (1979) summarized three measures of centrality: *Degree, Closeness and Betweenness*.

Degree Centrality: degree is the number of nodes that a focal node is connected to and it measures the direct involvement of the focal node in the network. This measure is most simple and calculated by just counting the number of links to or from an actor to other actors in the network. In simple words degree centrality can be defined as the number of direct ties an actor has. The reason for its simplicity is that for its calculation the local network around the focal node needs to be considered. In the directed network data the degree centrality can be segregated into in-degree and out-degree. The in-degree defines the number of ties coming from outside to the focal node and this measure is an indicator of prestige of the focal node. The out-degree can be defined as the number of ties going outside from the focal node; this measure is an indicator of influence of the focal node. The degree centrality measure represents the number of alternatives available with an actor and availability of more alternatives means more access to information, less dependency on others and more power.

Assumptions: major assumption for degree centrality is that it considers only the direct connections/links to the focal node and considers just the one point reach in network from the focal actor compared to the whole network.

Limitations: one of the major limitations is that it considers only the direct connections to the focal actor and ignores the rest of the whole network means focal actor can reach to a vast number of other actors indirectly but the assumption of direct connection restricts its reach. One actor might have high degree centrality, but those to which it connects might be rather disconnected from network as a whole. In this case, although the actor is central but it is central only in a local neighborhood. Degree centrality is also dependent on the network size: small network means less alternative and large network means more alternatives. (Freeman, 1979; Opsahl, Agneessens, & Skvoretz, 2010; Chan, & Liebowitz, 2006; Borgatti, 2005).

Closeness centrality: this centrality measure considers the centrality of the focal actor based on how close it is to other actors in the network and how fast focal actor has the capability to spread the information to other actors in the network. This measure considers both direct and indirect links of an actor and is calculated by summing up the path lengths of the shortest paths (geodesics) from the focal point to all other points. This measure can be interpreted to represent efficiency (how an actor reaches other actor in the shortest steps) or independence (being close to all other actors, focal actor needs to be less dependent on others for access to information and resources).

Assumptions: this measure considers only the shortest path (geodesic) with which the focal actor is connected to others in the whole network and this measure only works with in the connected network (no isolates) and distance between two unconnected points is considered as infinite.

Limitations: one of the major limitations for closeness centrality is that it lacks its applicability to networks which have the disconnected or isolate actors. Another limitation is that it only considers the shortest paths, but what about the other paths through which the focal actor can reach to other actors in the network (Freeman, 1979; Opsahl, Agneessens, & Skvoretz, 2010; Chan, & Liebowitz, 2006; Borgatti, 2005).

Betweenness Centrality: this measure represents the extent to which an actor falls in between pairs of other actors on the shortest paths (geodesics) connecting them and can funnel the flow of information between the actors it is connecting. The betweenness centrality for an actor is measured by the frequency with which it falls between pairs of other actors on the shortest (geodesic) path connecting them. This measure represents the potential control of an actor over other actors. Actor at an intermediary position, which connects otherwise unconnected can have greater access to information, resources and can utilize its position for its personal benefits.

Assumptions: this measure only considers an actor as central when it falls on the shortest path which connects the pair of other actors. This measure considers the whole network and can be utilized in a network with disconnected actors which are a limitation for closeness centrality.

Limitations: one of the major limitations of this measure is that it only considers the shortest path, but in a network it is not possible that information can flow only through the shortest path, but it can take the other paths also (Freeman, 1979; Opsahl, Agneessens, & Skvoretz, 2010; Chan, & Liebowitz, 2006; Borgatti, 2005; Newman, 2005).

The other alternative centrality or network measures that relax the assumptions or address the limitations of above three mentioned centrality measures are *eigenvector centrality* and *flow betweenness centrality*.

Eigenvector centrality: this measure considers the centrality of the actors with whom the focal actor is connected. This means that an actor that has a high eigenvector score is one which is connected or adjacent to actors which have the highest degree centrality. Suppose actor A has an influence on actor B and actor B have influence on many other actors, then actor A would be the most influential according to eigenvector centrality. Unlike degree centrality, which weights every contact equally, the eigenvector weights contacts according to their centralities. Eigenvector centrality overcomes the limitation of degree centrality as it considers both direct and indirect connections to the focal actor and considers the whole network, but not the local network like degree centrality (Borgatti, 2005; Bonacich, 2007).

Flow betweenness centrality: this centrality measure relaxes the assumptions of betweenness and closeness centrality i.e. shortest path. Flow betweenness (Freeman et al., 1991) counts all paths that carry information when a maximum flow is pumped between each pair of vertices. Flow betweenness considers the paths other than the shortest path for maximum flow of information, but that information still needs to "know" the ideal route (or one of the ideal routes) from each source to each target, in order to realize the maximum flow.

This measure overcomes the limitations of betweenness and closeness centrality but still it is not the holistic measure, as information can flow through any path, not just the ideal path or shortest path and this can be considered as the limitation of this measure (Newman, 2005).

Centrality of an actor in the network provides various advantages to the actor such as getting a job (Granovatter, 1973), promotions and early career growth (Burt, 1992; Podolny & Barron, 1997), more number of new innovations (Hargadon & Sutton, 1997; Ibara, 1993), better performance in the job (Brass, 1981), creation of new values and achievement of organization

goals (Tsai & Ghoshal, 1998), more availability of power (Brass, 1984), influence on various decisions of other actors (Friedkin, 1993), and better performance of organization (Powell et al.,1999; Tsai, 2001).

Below mentioned are the few detailed studies which describe the application of centrality in various sectors to understand various outcomes of individual and organizations.

In order to assess the effect of central network position on business organization innovation capacity and performance, Tsai (2001) conducted a social network study at two large multinational corporations. The dependent variables of the study were business unit innovation capacity and performance of business unit, the independent variables were absorptive capacity of business unit (ability of organization to assimilate and replicate the new knowledge learned from organizations outside its network (Cohen & Levinthal, 1990) and network position (degree centrality). The control variables used in the study were size of business unit, local competition and past capacity to innovate and past business performance. Upon analyzing the results of hierarchical regression, Tsai found that business unit's degree centrality in the inter-organizational network did not contribute to its better business performance but positively related to innovation at business unit. On the other hand, business units with higher absorptive capacity are going to perform better in the business and effect of degree centrality on business performance was mediated by absorptive capacity of the organization. He also found that effect of degree centrality and absorptive capacity on business performance was not mediated by innovation capacity of business unit. The reasons given by Tsai for no significant association between degree centrality and business performance were costs for maintaining the central position outweighed the benefits of degree centrality and the organization lacked capacity to

absorb and apply the new knowledge gained through its central position. Tsai suggested further research to investigate the net effect of network position on business performance.

Powell et al. (1999) conducted another study in the biotech industry to examine the effect of network centrality (eigenvector) in an inter-organizational network on performance (number of patent, growth in size and more revenue from sales) of organization. Researchers collected data for 388 biotechnology firms over a period of ten years through archival data sets. Results from regression model indicated that centrality was a determining factor for performance of the biotech firms.

Sparrowe et al. (2001) conducted a study at five different organizations to define the effect of centrality (degree), network density (average number of ties for each group member) and network centralization (extent to which network is dominated by few individuals) in a work group on the individual and group performance. Based on the results of multiple regressions, researchers found positive relationship between advice network centrality (degree) and individual performance whereas network centralization at group level was negatively associated with group performance. They found no relationship between advice network density and group performance. The researchers also found negative relationship between density of hindrance networks and group performance.

Baldwin, Bedell, and Johnson (1997) conducted a study to analyze the effect of network centrality in the network of master of business administration (M.B.A.) students on attitudinal and performance outcomes of students. The results of structural equation model indicated that centrality in the communication and friendship network had affected both the attitude and final grades of the students.

Freeman, Roeder, and Mulholland (1980) in their MIT experiment research study found centrality as an important factor that influences leadership and efficiency in a small network but network density also turned out relevant influencing factor.

Brass and Burkhardt (1992) conducted a study at a newspaper publishing company to empirically explore the relationship between power and centrality of actors in an organization. Results of hierarchical regression indicated that centrality of actor in a network irrespective of types of centrality (degree, closeness and betweenness) and point of reference were positively associated with power in an organization.

Brass and Burkhardt (1993) conducted another study at a government bureaucratic organization to explore the relationship between power in organization (central structural position) and use of power by actors through behavior tactics in the network. Results of multiple regressions revealed that individual's network centrality (degree, closeness and betweenness) and level in the organizational hierarchy were significantly related to perception of other actors in the network about the power of central actor in the network.

Centrality of a single business unit in a social interaction network of multiple business units was found positively related to perceived trustworthiness of single business unit in the whole network and extent to which single business unit matches its vision with multiple business units organization as a whole (Tsai & Ghoshal, 1998).

Summary:

Social Network Analysis (SNA) offers a unique methodology to describe and measure the Cooperative Extension outreach. This methodology has been widely used for decades in disciplines such as sociology, business management and public health for understanding various individual or organizational outcomes (Springer & De Steiguer, 2011). SNA has also been used in a diversity of applications, including analyzing roles of intra-firm networks and corporate business partnerships (Tsai & Ghoshal, 1998), examining how ideas and information are transferred amongst a field of professionals, understanding the role of networks in various organizational outcomes (Brass et al.,2004). However, the use of SNA is limited in Cooperative Extension programs. SNA studies can be done considering two different but complementary perspectives: the analysis of the individual actor level (egocentric) and the analysis of the whole network (structure) level.

SNA as a methodology provides complementary visual and statistical components for analyzing the traits of actors and their relationships. Network studies utilizing various network variables such as centrality (informs how actors are central in a network compared to other actors) and brokerage (extent to which actor links otherwise unconnected actors) are able to define various characteristics of an organization. With the information, resources and control benefits, the actors with higher brokerage become more influential and perform well in the business compared to firms with lower brokerage. In the individual network actors with high brokerage capabilities are able to more innovations at the organization, get the job more easily, get promotions more quickly, and more successful in their careers. Gould and Fernandez (1989) introduced the concept of brokerage typology that further categorizes the brokerage into five types of brokerage relations on the basis of information flow and partitioning of actors into non overlapping groups.

Centrality of an actor in the network provides various advantages to the actor such as getting a job, promotions and early career growth, more number of new innovations, better performance in the job, creation of new values and achievement of organization goals, more availability of power, influence on various decisions of other actors, and better performance of organization.

SNA has great potential for use in Extension to understand all the actors involved in Extension and how they are connected with each other. SNA is a valuable tool to use for accountability and reporting, assessing internal collaboration, revenue/resource generation and in carrying out impact studies.

CHAPTER 3

METHODOLOGY

This chapter outlines the materials and methods used in this study and divided into five sections: 1) population and sample; 2) research design; 3) variables included in the study and data collection; 4) data analysis and interpretation.

The purpose of this study was to understand the diversity and reach of Cooperative Extension programs in Pennsylvania delivered by Penn State Extension and the influence of various network variables (Brokerage and Centrality) on two program outcomes (program business performance and demand for the program) through Social Network Analysis (SNA). Specific objectives of the study were to:

1. Develop a holistic network map of programs and program stakeholders to understand the diversity and reach of Extension programs in Pennsylvania.
2. Examine the influence of five types of brokerage (liaison, itinerant, gatekeeper, representative, and coordinator) and degree centrality on Extension program business performance.
3. Examine the influence of five types of brokerage (liaison, itinerant, gatekeeper, representative, and coordinator) and degree centrality on demand for Extension programs.

Hypotheses/ Research Questions:

The following four hypotheses guided the study:

Hypothesis 1: For all five types of brokerage (liaison, itinerant, gatekeeper, representative and coordinator), programs which control the flow of information and resources between pairs of

other programs are hypothesized to have higher business performance than the programs that do not control the flow of information and resources.

Hypothesis 2: The higher the degree centrality of the program, greater would be its business performance.

Hypothesis 3: For all five types of brokerage (liaison, itinerant, gatekeeper, representative and coordinator), programs which control the flow of information and resources between pairs of other programs are hypothesized to have greater demand among stakeholders than the programs that do not control the flow of information and resources.

Hypothesis 4: The higher the degree centrality of the program the greater would be its demand among the stakeholders (See Figure 4).

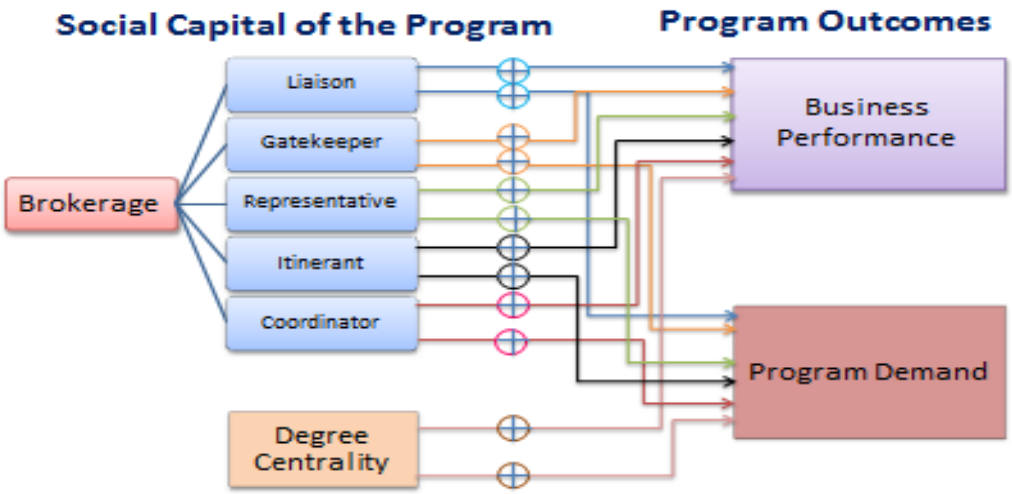

Figure 4. Conceptual Framework of the Study

Population and Sample:

This research was conducted with the cooperation of Penn State Extension (PSE), the outreach component of the College of Agricultural Sciences at the Pennsylvania State University. One site sampling scheme is very common in the network studies. By selecting a single site, the boundary of network can be easily defined (e.g. Krackhardt, 1988). By considering the single wing of the College of Agricultural Sciences, it is easy to assess the effect of various network variables on the program outcomes (Tsai & Ghoshal, 1998).

One of the requirements for the SNA studies is near to 100% response rate for its surveys and SNA won't rely on sampling because it requires full participation to draw the full network (Bartholomay et al., 2011). To fulfill this requirement and get the complete data to draw networks, it was decided to use the secondary data which was readily available and included the list of all the Penn State Extension programs and their stakeholders.

The population for this study consisted of all programs offered by Penn State Extension and the respective stakeholders. The sampling method used for this study was a 'census' meaning all the programs and the respective stakeholders were used for this study.

Research Design:

This study utilized the SNA methodology and ex-post facto research design. According to Bartholomay et al. (2011), SNA offers a unique methodology to describe and measure the Cooperative Extension outreach. SNA is a methodology which provides complementary visual and statistical components for analyzing the traits of actors and their relationships (Kilduff & Tsai, 2003). SNA studies can be done considering two different but complementary perspectives:

the analysis of the individual actor level and the analysis of the whole network (structure) level. The current study analyzed the Penn State Extension program networks at the structure level.

In ex-post facto or after the fact design, the research starts after the effect has already occurred. In this design, the researcher examines the dependent variables of the study first, and then explores retrospectively to define the possible cause for the effect or the relationship between dependent and independent variables. In this design, the researcher cannot manipulate the independent variables as they have naturally occurred in the past. This design is used as a substitute to true experimental design to study the cause and effect when the effect has already occurred (Silva, 2010).

In the current study, the dependent variables, demand for the Extension program and program business performance have already occurred and later network variables were used to define the current dependent variables.

The major threats identified by researcher with ex-post facto design include non-manipulation of independent variables, effect of extraneous variables and measurement error. To overcome the measurement error and the problem of faulty and incomplete data, the secondary data was used to collect data on independent and dependent variables.

Variables Included in the Study and Data Collection:

Independent Variables:

The independent variables in the current study were the network variables, which included five types of brokers (liaison, gatekeeper, representative, itinerant, and coordinator), and degree centrality of the Extension programs.

Data for independent variables were collected by listing various programs offered by Penn State Extension and their stakeholders. This list was first collected from all the seven State Program Leaders (SPLs) and later from 48 State Extension Team Leaders (SETLs) and the director of Penn State Extension. The rationale for collecting data at two levels of SPLs and SETLs was to improve the validity of the data and to reduce bias. Personal meeting and communication with all the SPLs, SETLs and the director was done to make them aware of the purpose and objectives of the study. Data for the list of programs and their stakeholders was collected using a survey. Within one week of meeting with SPLs and SETLs, program identity questionnaire (SurveyMonkey link) was emailed to all the 7 SPLs and 48 SETLs.

Data from a list of programs and program stakeholders was input to UCINET 6; a user-friendly SNA package for analysis of social network data (Borgatti, Everett, & Freeman, 2002). This would be a two mode data, as the nodes were the programs and tie between the two programs was the shared stakeholders. First, based on the information on various programs and their stakeholders the two mode matrix was created where the programs were listed in rows and stakeholders were listed in the columns and if the program had affiliation to specific stakeholders, then it was dummy coded as 1 and if not then coded as 0. The data analysis of 2-mode data is challenging and to conduct further analysis, it needs to be converted into one mode data. The 2-mode data was converted into one mode data through the ‘affiliation’ process in the UCINET 6. The one mode data was used to calculate the value of degree centrality through UCINET 6. To calculate the score for various brokerage types, the one mode data was divided into 12 subgroups based on consideration of 12 teams for PSE. By making the 12 subgroups out of all the available 60 programs, the five different types of brokerage scores were calculated through the UCINET 6.

Dependent Variables:

There were two dependent variables for the study: change in program business performance and change in demand for each program. For both the dependent variables, the data were collected in two stages, the first stage consisted of base line data for the year 2011-12 (the year Penn State Extension adopted the new business model), and then the data for year 2013-14, and difference between the baseline and current year would be treated as the value of these two dependent variables.

The program business performance was operationally defined as the number of grants and developmental funding (gifts) received by all the programs. The data for this variable was collected in the form of secondary data. The grants office in the College of Agricultural Sciences provided the list of all the grants and developmental funding received for financial years 2011-12 and 2013-14 (till March 15, 2014) by Penn State Extension. As of March 15, 2014, the 2013-14 financial year was not fully completed but the researcher assumed that by March 15, most of the grants and developmental were received by Penn State Extension. Upon receipt of the complete data sets in the form of grants and developmental funding for financial years, 2011-12 and 2013-14, the researcher based on brief review of major activities in each program, segregated the complete list into 60 distinct programs. Upon segregation of data into 60 programs for both years, the researcher calculated the change in business performance between year 2013-14 and 2011-12. This final value of change in business performance provided data for first dependent variable, program business performance.

The second dependent variable demand for programs was operationally defined as the number of participants who attended each of the 60 programs face-to-face. The data for this variable

collected in the form of secondary data as the number of participants who attended various educational activities offered by Penn State Extension for years 2010-11, 2011-12 and 2012-13. The rationale for collecting data for three years was that data for year 2013-14 was not available and to project the data, researcher utilized the data from the past three years.

The data projection for the year 2013-14 was done utilizing the "exponential smoothing method." This is one of the most popular methods for data projection. This is a kind of averaging method with use of weights and these weights decrease exponentially for older years, meaning highest weight to current year and lowest weight to previous year. Unlike average method, this method also utilizes all the available data points (Ravindran, & Warsing Jr, 2012).

> "Under this method, given demands D1, D2,…., Dn, the forecast for period (n+1) is given by
>
> $F_{n+1}= \alpha D_n+ \alpha (1-\alpha) Dn_{-1}+ \alpha (1-\alpha)^2 D_{n-2}+\ldots..$ (2.3)
>
> Where α is between 0 and 1 and is called the smoothing constant. Note that $\alpha \rangle \alpha (1-\alpha) \rangle \alpha (1-\alpha)^2 \rangle \ldots$
>
> Thus, the most recent demand is given the highest weight α and the weights are decreased by a factor (1-α) as the data gets older.
>
> Equation 2.3 can be rewritten as follows:
>
> $F_{n+1} = \alpha D_n + (1-\alpha) [\alpha D_{n-1}+ \alpha(1-\alpha) D_{n-2} + \alpha(1-\alpha)^2 D_{n-3}\ldots\ldots]$
>
> $F_{n+1} = \alpha D_n + (1-\alpha) F_n$ (2.4)

> Thus, the forecast for period (n+1) uses the forecast for period n and the actual demand for period n. The value of α is generally chosen between 0.1 and 0.4. In other words, the weights assigned to the actual demand are less than that of the forecasted demand, the reason being, the actual demands fluctuate a lot, while the forecast has smoothed the fluctuations." (Ravindran, & Warsing Jr, 2012, p.38)

In this study the researcher used 0.2 as the value of α. Upon projecting the data for year 2013-14, and using the available data from year 2011-12, the researcher based on brief review of major activities in each program segregated the complete list into 60 distinct programs. Very extreme outliers in the data were not included in the study. Upon segregation of data into 60 programs for both years, the researcher calculated the change in demand for the program between year 2013-14 and 2011-12. This final value of change in demand for the program provided data for the second dependent variable, demand for the program.

This study was approved by the Institutional Review Board (IRB) for involvement of human subjects with PSU IRB # 45329 (See Appendix A).

Data Analysis and Interpretation:

Social Network Analysis (SNA) studies are different than traditional social science studies, as in traditional social science studies we consider the attributes of a single individual as our variables but in SNA social relations were considered (Wellman & Berkowitz, 1988). In other words, the traditional social sciences studies considers the attributes on an individual (monadic attributes) but SNA studies rely on the attribute of pairs of individuals (dyadic attributes) (Borgatti & Everett, 1997). In traditional social sciences studies, the data set would be a person-by-attribute matrix, where persons were the cases and the individual attributes were the variables. But in

network studies, the data set would be person-by-person matrix, which is recording the single variable (dyadic attribute) among a set of actors (Borgatti & Everett, 1997). Network research is amenable to multiple levels of analysis and can integrate quantitative, qualitative and graphical data, which allows for more thorough and in-depth analysis of the data. At the same time network maps generated by SNA provides a degree of realism, which normally lacks in traditional research (Kilduff & Tsai, 2003)

In normal SNA studies, the data sets are one mode meaning that the relationship/tie between the individual actors would be a direct relationship, such as two actors tied to each other through friendship relationships. The other form of relationship between the actors would be the indirect relationship which is considered as two mode data, where the two actors are not connected directly but tie exist between the two actors through affiliation to a common group, considered as the duality of the actor or group (Breiger, 1974).

In this study based on two mode matrix of programs and their stakeholders, the whole network map of programs and their stakeholders was drawn using Netdraw (Borgatti, 2002). Based on network maps various characteristics of PSE network were described. At the same time after converting the two mode matrix into single mode (programs to programs connected through common stakeholders) through "affiliation" process in UCINET, independent variables of the study; degree centrality and five types of brokerage were calculated.

Data were analyzed using the Statistical Package for Social Sciences (SPSS 21). Binary logistic regression was used to test the hypotheses in which dependent variables were dichotomous. In this study the use of binary logistic regression represent basic exploration or preliminary analysis wherein multiple independent variables are used to explain change in demand for the programs

and business performance of programs. The purpose was to explore simultaneously the influence of independent variables rather than to infer to a larger pool of programs.

Logistic regression is an alternative to multiple regression where the dependent variable is nominal or categorical in place of continuous variable (Mertler & Vannatta, 2010). In this study, the dependent variables; change in program business performance and change in demand for the program were dichotomized into programs with change (from 2011-12 to 2013-14) in both dependent variables were negative (decrease in from 2011-12 to 2013-14) and programs with change (from 2011-12 to 2013-14) for both dependent variables were positive (increase from 2011-12 to 2013-14). The rationale for using the logistic regression in place of linear regression was: first the linearity assumption of linear multiple regression was not satisfied by current data and second, there were limited number of cases (60 programs). The number of cases in the study is exactly equal to the minimum number of cases required for the binary logistic regression. All the assumptions of binary logistic regression were checked and data satisfied all the assumptions, except for high correlation (r=0.997) between two independent variables: *gatekeeper and representative broker*, which is also called multicollinearity. To overcome the issue of multicollinearity and meet the assumptions of binary logistic regression, the *representative broker* variable was removed from analysis. The reason why *gatekeeper broker* was used and *representative broker* was not included in analysis was that *gatekeeper broker* had the highest correlation to the dependent variables compared to the *representative broker* variable. Another independent variable, *coordinator broker* was also not included in the analysis because during the calculation of five types of brokers, the value for coordinator broker was zero for all the 60 programs. In final model of logistic regression, out of the six independent variables (*liaison, gatekeeper, representative, itinerant, and coordinator brokers and degree centrality*) only four

variables (*liaison, gatekeeper, and itinerant brokers and degree centrality*) were used. Descriptive statistics, such as frequencies and percentages was also used to describe the independent and dependent variables.

CHAPTER 4

RESULTS AND FINDINGS

This chapter presents the results of the study and is organized into three sections based on the objectives of the study: section one presents the various network maps of Penn State Extension and description of various characteristics related to reach of Penn State Extension; section two describes the results related to influence of five types of brokerage (*liaison, gatekeeper, representative, itinerant, and coordinator brokers*) and *degree centrality* on Program Business Performance; and the third section presents the effect of five types of brokerage (*liaison, gatekeeper, representative, itinerant, and coordinator brokers*) and *degree centrality* on Demand for Extension Programs.

The purpose of this study was to understand the diversity and reach of Cooperative Extension programs in Pennsylvania delivered by Penn State Extension and the influence of various network variables (Brokerage and Centrality) on two program outcomes (program business performance and demand for the program) through Social Network Analysis (SNA). Specific objectives of the study were to:

1. Develop a holistic network map of programs and program stakeholders to understand the diversity and reach of Extension programs in Pennsylvania.
2. Examine the influence of five types of brokerage (liaison, itinerant, gatekeeper, representative, and coordinator) and degree centrality on Extension program business performance.
3. Examine the influence of five types of brokerage (liaison, itinerant, gatekeeper, representative, and coordinator) and degree centrality on demand for Extension programs.

Objective 1: Develop a holistic network map of programs and program stakeholders to understand the diversity and reach of Extension programs in Pennsylvania

Upon analysis of results from degree centrality measure of UCINET, it was found that the top three programs which had the highest degree centrality were: forest products and services (19.887), integrated crop production practices (19.718), and diary business management (19.548) and the three programs which had the lowest degree centrality were: PA farm safety and health quiz bowl contest (3.107), farm transitions (3.729), and meat and poultry processing (5.311). See Table 1.

Table 1

List of Programs and Values of Degree Centrality for each Program

Programs	Degree Centrality
Ag Entrepreneurship, Economic and Community Development Team	
Ag Business Management	9.774
Economic & Community Development	8.362
Marcellus Shale	8.362
Entrepreneurship	9.435
Dairy Team	
Dairy Business Management	19.548
Dairy Human Resource & Team Management	11.525
Dairy Nutrient & Feed Management	14.068
Equine Team	
Equine Environmental Stewardship	12.768
Equine Health and Well-Being	8.418
Livestock Team	
Livestock Production Efficiency	15.367
Poultry Team	

Poultry Health and Management	11.751
Family and Consumer Science Team	
Better Kid Care	11.921
PROSPER	11.412
Intergenerational Programs	8.249
Health Insurance and Personal Finance Literacy	8.305
Food Safety and Health Team	
Dining with Diabetes	10.621
Expanded Food & Nutrition Education program	8.814
PA Nutrition Education Tracks (SNAP-ED)	9.718
Eat Healthy, Be Active	5.650
StrongWomen/Growing Stronger	10.734
Everybody Walks in Pennsylvania	6.328
Food Safety training for producers	8.192
Food Safety training for processors	6.102
Food Safety for Retail Manager	7.288
Food Safety for Consumers	8.249
Dairy Processing	5.876
Meat and Poultry Processing	5.311
Wine Quality	6.780
Veterinary Team	
Mastitis & milk quality	9.774
Bovine Hoof Health	8.249
(Dairy) Beef Quality Assurance and prudent antimicrobial use	7.175
Animal health & welfare	11.751
Dairy Production Medicine Certificate Program	6.271
Animal Nutrition & Metabolic Disease	10.395
4-H and Youth Development Team	
4-H and Youth Development	12.938
Field and Forage Crops Team	
Integrated Crop Production Practices	19.718
Nutrient and manure management	18.418
Pests (insect, disease and plant) Monitoring and Management	17.062
Soil	17.740
Renewable Natural Resources Team	
Forest Products and Services	19.887
Managing Community and Urban Natural Resources	16.667
PA Woodland Owners Education Network	9.492

Safe Drinking Water	11.525
Sustaining PA's Forests Private forest landowners	10.621
Watershed Education	15.085
PA Farm Safety & Health Quiz Bowl Contest	3.107
Safe Tractor & Machinery Operation program	10.508
Safety & Health Management	7.119
Manure Storage Safety	6.102
Renewable Energy	11.638
Horticulture Team	
Tree Fruit Production Practices	15.989
Retooling the Pennsylvania Tree Fruit Industry with Innovative Technologies	13.898
Farm Transitions	3.729
Selection, and Evaluation of New/Novel and Traditionally Grown Specialty Crop Cultivars	13.729
Monitoring, prediction, and management of pests, beneficial and pollinators	10.96
Best Management Practices for Soil, Water, and Nutrient Management	11.13
Greenhouse and Nursery Production	10.226
Landscape Business Management	12.825
Turf grass Management	12.768
Master Gardener Program	9.153

Analysis of degree centrality for 12 teams revealed that top three teams with the highest degree centrality were: renewable natural resources (40.264), horticulture (35.178), and field and forage crops (26.588). See Table 2.

Table 2

List of Teams and Values of Degree Centrality for each Team

Teams	Degree Centrality
Renewable natural resources	40.264
Horticulture	35.178
Field and forage crops	26.588
Food safety and health	25.613
Dairy	16.627
Family and consumer science	15.547
Ag Entrepreneurship, economic and community development	15.283
Veterinary	13.096
Equine	9.091
Livestock	7.167
4-H and Youth Development	6.034
Poultry	5.481

Analysis of five brokerage types based on partition vector of 12 teams revealed that none of the programs occupied the coordinator broker position in the network indicating the value for coordinator brokerage was zero for all programs. Top three programs which had the highest *gatekeeper brokerage* values were: safe drinking water (4.816), manure storage safety (4.816), and best management practices for soil, water, and nutrient management (1.751); the top three programs which had the highest values for *representative brokerage* were similar to *gatekeeper brokerage*: safe drinking water (4.816), manure storage safety (4.816), and best management practices for soil, water, and nutrient management (1.751); the top three programs with highest *consultant brokerage* values were: dairy human resource and team management, food safety for consumers (3.853), intergenerational programs (2.408), and everybody walks in Pennsylvania (2.408); regarding *liaison brokerage* the highest brokerage values was same for 31 programs. See Table 3.

Table 3

List of Programs and Values of Different Brokerage types for Each Program

Programs	Coordinator Brokerage	Gatekeeper Brokerage	Representative Brokerage	Consultant Brokerage	Liaison Brokerage
Ag Entrepreneurship, Economic and Community Development Team					
Ag Business Management	0	0	0	0	1.491
Economic & Community Development	0	0	0	0	0
Marcellus Shale	0	0	0	0	0
Entrepreneurship	0	0	0	0	1.491
Dairy Team					
Dairy Business Management	0	0	0	0	1.491
Dairy Human Resource & Team Management	0	0	0	9.632	0
Dairy Nutrient & Feed Management	0	0	0	0	0
Equine Team					
Equine Environmental Stewardship	0	0	0	0	1.491
Equine Health and Well-Being	0	0	0	0	1.491
Livestock Team					
Livestock Production Efficiency	0	0	0	0	1.491
Poultry Team					
Poultry Health and Management	0	0	0	0	1.491
Family and Consumer Science Team					
Better Kid Care	0	0	0	0	1.491
PROSPER	0	0	0	0	1.491
Intergenerational Programs	0	0	0	2.408	1.118
Health Insurance and Personal Finance Literacy	0	0	0	0	0

Food Safety and Health Team					
Dining with Diabetes	0	0	0	0	1.491
Expanded Food & Nutrition Education program	0	0	0	0.917	1.349
PA Nutrition Education Tracks (SNAP-ED)	0	0	0	0.917	1.349
Eat Healthy, Be Active	0	0	0	0	0
StrongWomen/Growing Stronger	0	0	0	0	1.491
Everybody Walks in Pennsylvania	0	0	0	2.408	1.118
Food Safety training for producers	0	0	0	0	1.491
Food Safety training for processors	0	0	0	0	1.491
Food Safety for Retail Manager	0	0	0	0	1.491
Food Safety for Consumers	0	0	0	3.853	0.894
Dairy Processing	0	0	0	0	0
Meat and Poultry Processing	0	0	0	0	1.491
Wine Quality	0	0	0	0	1.491
Veterinary Team					
Mastitis & milk quality	0	0	0	1.376	1.278
Bovine Hoof Health	0	0	0	0.602	1.397
(Dairy) Beef Quality Assurance and prudent antimicrobial use	0	0	0	1.07	1.325
Animal health & welfare	0	0	0	0.963	1.341
Dairy Production Medicine Certificate Program	0	0	0	1.204	1.304
Animal Nutrition & Metabolic Disease	0	0	0	1.926	1.192
4-H and Youth Development Team					
4-H and Youth Development	0	0	0	0	1.491
Field and Forage Crops Team					
Integrated Crop	0	0	0	0	1.491

Production Practices					
Nutrient and manure management	0	0	0	0	1.491
Pests (insect, disease and plant) Monitoring and Management	0	0	0	0	1.491
Soil	0	0	0	0	1.491
Renewable Natural Resources Team					
Forest Products and Services	0	0	0	0	1.491
Managing Community and Urban Natural Resources	0	0	0	0	0
PA Woodland Owners Education Network	0	0.843	0.843	0	1.23
Safe Drinking Water	0	4.816	4.816	0	0
Sustaining PA's Forests					
Private forest landowners	0	0	0	0	1.491
Watershed Education	0	0	0	0	0
PA Farm Safety & Health Quiz Bowl Contest	0	1.643	1.643	0	0.982
Safe Tractor & Machinery Operation program	0	0	0	0	1.491
Safety & Health Management	0	0.838	0.838	0	1.231
Manure Storage Safety	0	4.816	4.186	0	0
Renewable Energy	0	0	0	0	1.491
Horticulture Team					
Tree Fruit Production Practices	0	0	0	0	1.491
Retooling the Pennsylvania Tree Fruit Industry with Innovative Technologies	0	0	0	0	1.491
Farm Transitions	0	0	0	0	0
Selection, and Evaluation of New/Novel and Traditionally Grown Specialty Crop	0	0	0	0	1.491

Cultivars					
Monitoring, prediction, and management of pests, beneficial and pollinators	0	0	0	0	1.491
Best Management Practices for Soil, Water, and Nutrient Management	0	1.751	1.751	0	0.949
Greenhouse and Nursery Production	0	0.301	0.301	0	1.397
Landscape Business Management	0	0	0	0	1.491
Turf grass Management	0	0	0	0	1.491
Master Gardener Program	0	0	0	0	0

Network maps are very powerful empirical tools to reveal the outreach of any organization in the community (Bartholomay et al., 2011). These network maps not only reveal the outreach of organizations but also exhibits which programs have the common stakeholders. The complete network map of Penn State Extension drawn with NetDraw's spring embedding algorithm revealed the following (the green circles represents the programs and blue circles represents the stakeholders and arrows in pink represent the connection between the program and stakeholders):

- Penn State Extension network consists of 60 programs and 293 stakeholders in total associated with these programs; one program is associated to multiple stakeholders, with a maximum of 52 stakeholders associated to livestock production efficiency program and a minimum associated with to farm transitions program (5). On an average, each program is associated to 19.18 stakeholders (SD=9.80).
- The network centralization (network concentrated by few individuals with high degree centrality) for PSE network was 9.46%. This indicates that PSE network is decentralized and not dominated by few programs.

- The PSE network was widely distributed and has the wide reach among stakeholders. Overall, the network was segmented indicating a clear division in the network which was divided into two halves. The right side of network consisted of animal related and renewable natural resources programs while the left side consisted of programs related to plants and safety and health management of consumers (See Figure 5).

- Upon further analysis of the network, one can see that complete network was divided into four clusters, named A, B, C, and D. Cluster A consisted of programs related to veterinary and dairy; cluster B consists of programs related to plants science, mainly horticulture and field crops production; cluster C consists of program mainly related to food safety and health of consumers but this cluster also consisted of master gardener program; and finally the cluster D consisted of programs related to renewable natural resources and economic and community development. Programs in each cluster have more number of stakeholders in common compared to other programs (see Figure 5).
- Programs which are located at the center of the network not associated to any cluster are managing community and urban natural resources and ag. business management.
- Some programs were isolated from the network which included food safety, 4-H and youth development, equine health and wellbeing and livestock production efficiency, indicating that these programs have specific stakeholders (See Figure 5).

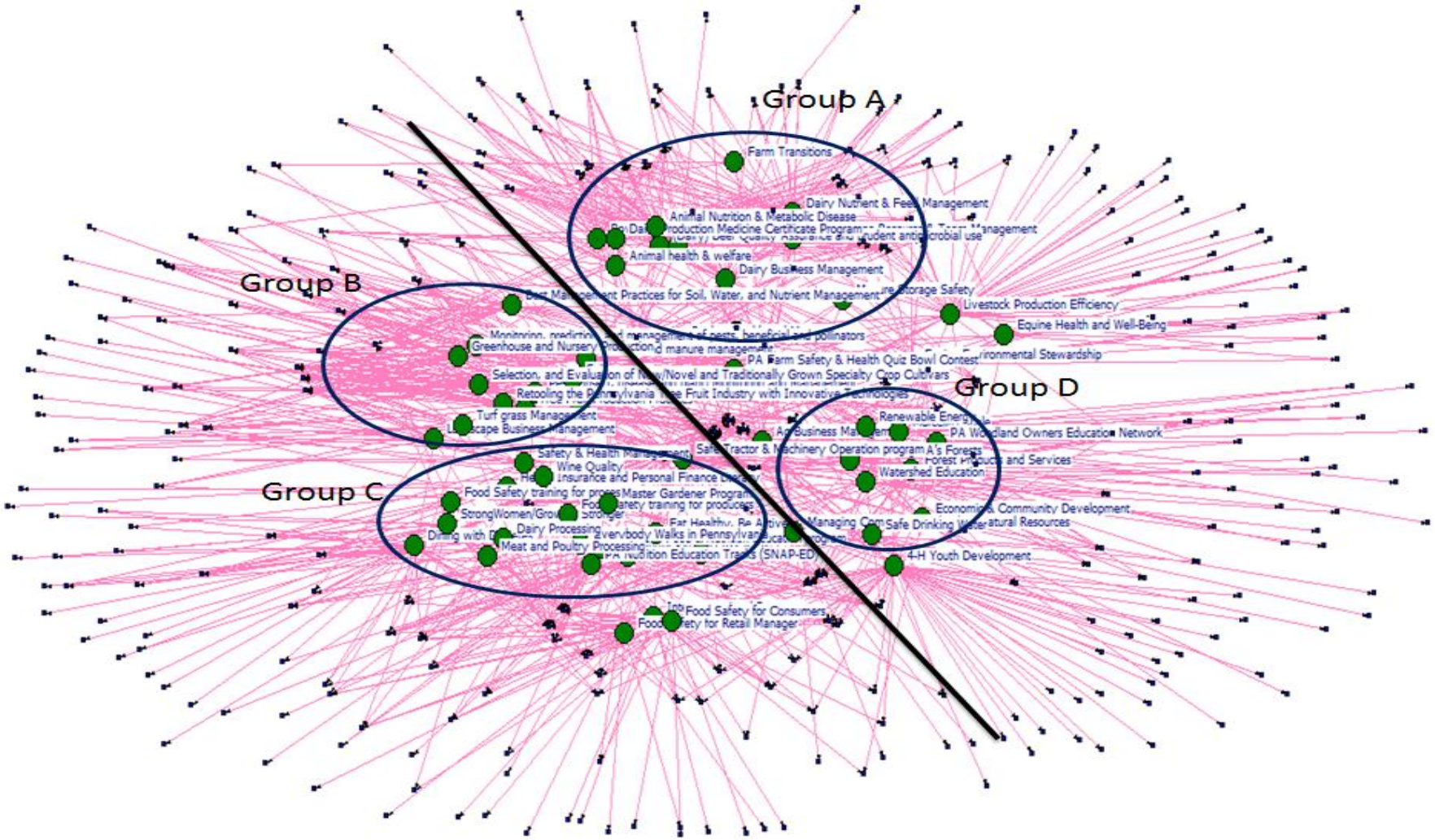

Figure 5. Overall Network of Penn State Extension (Programs and their Stakeholders)

For an in-depth understanding of the networks of PSE, the network was further simplified into network of programs and government stakeholders. As a result, there were 33 government stakeholders. Overall, programs were well connected to government stakeholders indicating that programs were receiving information and educational resources from local, state and federal governments. This network also had the four clusters similar to the whole network, but it had few isolate programs which were not connected to any stakeholders such as farm transitions, manure storage safety and safe tractor and machinery operation programs (See Figure 6).

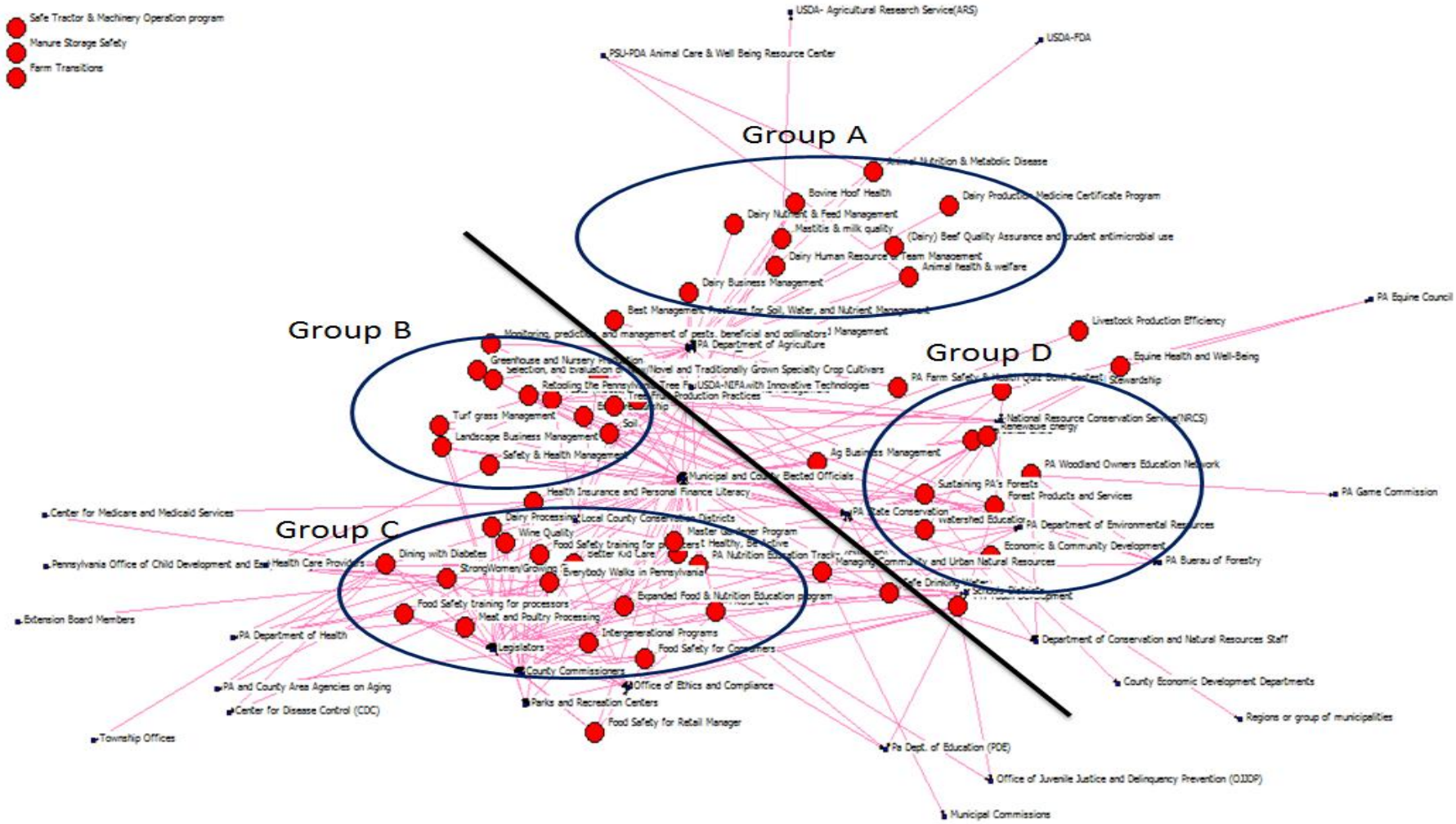

Figure 6. Overall Network of Penn State Extension (Programs and their Government Stakeholders)

Another way of examining networks of PSE is drawing just the networks of the entire 60 programs where the connection between two programs is the common stakeholders. Using the affiliation process in UCINET, the single mode matrix was generated which was later used to draw the network map with the help of Netdraw's spring embedding algorithm. This network map revealed that all 60 programs were well connected to each other and the overall network is very dense suggesting more number of connections between the programs and the stakeholders. See Figure 7.

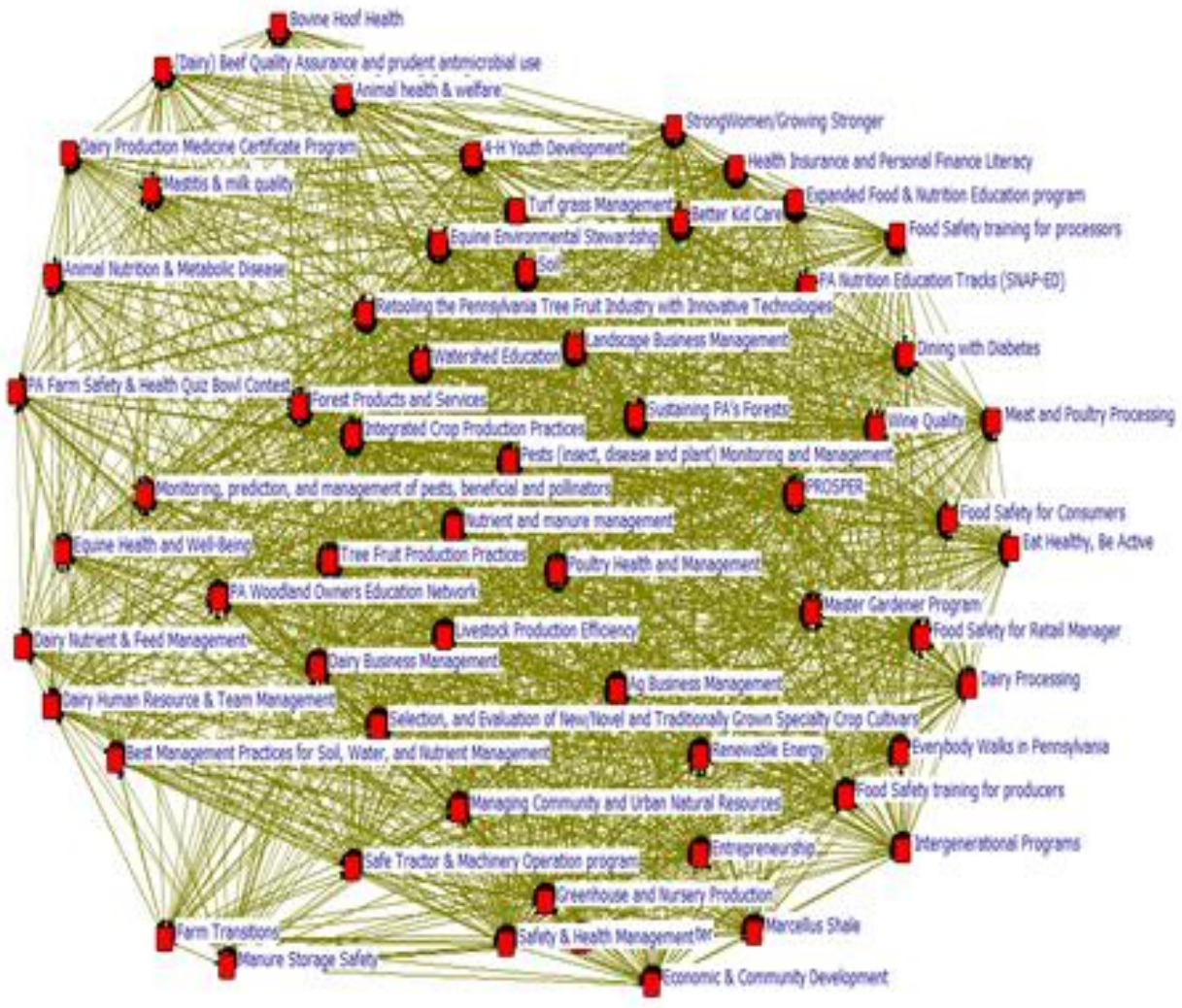

Figure 7. Overall Program Network

The PSE networks were also analyzed by segregating the programs into 12 teams and then drawing the network of teams and stakeholders. The red circles represent the teams and very small blue circles represent the stakeholders. The teams were represented with different circle sizes, where bigger size indicating the more number of connections that teams have with the stakeholders. The map reveals the following (See Figure 8):

- Teams to stakeholder's network are very widespread, and therefore well connected to various stakeholders.
- Similar to programs to stakeholder's network, this network (teams) is also clearly divided into two parts.
- Further analysis of this network shows two clusters A and B. Cluster A consisted of all animal related teams while cluster B contained all plant and natural resources related teams.
- Some teams were isolates, such as 4-H and youth development, livestock indicating that they have specialized stakeholders (see Figure 8).

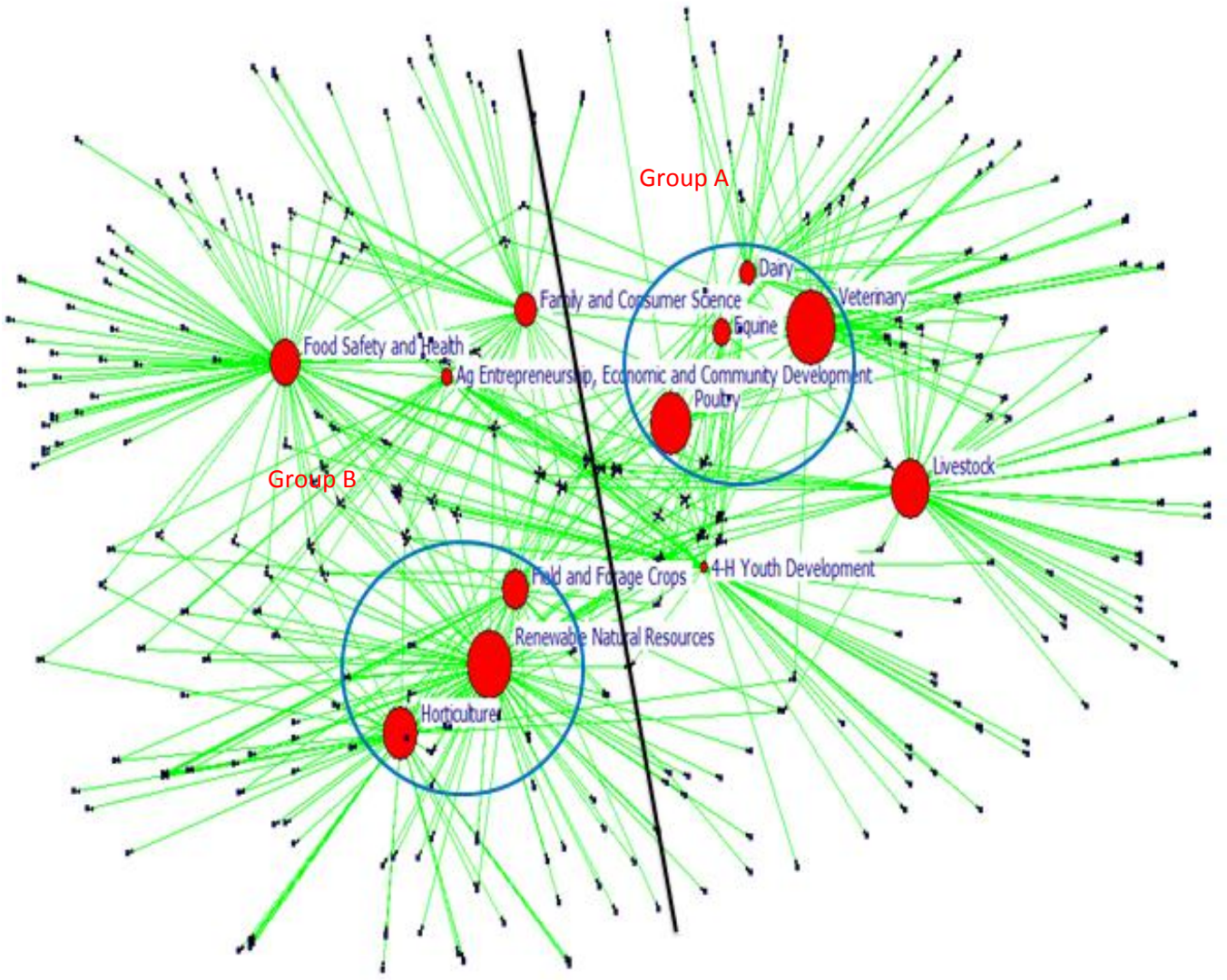

Figure 8. Overall Network of Penn State Extension (Teams and their Stakeholders)

Objective 2: Examine the influence of five types of brokerage (liaison, itinerant, gatekeeper, representative, and coordinator) and degree centrality on Extension program business performance

After analyzing the data for all 60 programs, the top three programs which had the highest increase in business performance (measured by amount of grant money and developmental funding (gifts) from year 2011-12 to 2013-14 were: Renewable energy ($2,461,131), Forest

Products and Services ($1,866,390), and Safety and Health Management ($1,546,814). The top three programs which had the highest decrease in business performance from year 2011-12 to 2013-14 were: Nutrient and Manure Management (-$17,612,400), Integrated Crop Production Practices (-$11,095,727), and Pests (insects, disease and plant) Monitoring and Management (-$3,304,924). See Table 4 for detailed description of change in business performance for each program.

Table 4

Increase in grants and contracts (Business Performance)

Programs	Total grants and developmental funding amount ($) for year 2011-12	Total grants and developmental funding amount ($) for year 2013-14	Difference/increase between 2011-12 to 2013-14 ($)
Ag Entrepreneurship, Economic and Community Development Team			
Ag Business Management	940,272	540,593	-399,679
Economic & Community Development	1,694,382	1,481,961	-212,421
Marcellus Shale	752,451	1,066,678	314,227
Entrepreneurship	509,629	21,000	-488,629
Dairy Team			
Dairy Business Management	3,011,726	595,200	-2,416,526
Dairy Human Resource & Team Management	2,500	16,171	13,671
Dairy Nutrient & Feed Management	935,305	1,025,632	90,327
Equine Team			
Equine Environmental Stewardship	3,700	1,100	-2,600
Equine Health and Well-Being	0	0	0

Livestock Team			
Livestock Production Efficiency	509,696	48,266	-461,430
Poultry Team			
Poultry Health and Management	798,352	26,000	-772,352
Family and Consumer Science Team			
Better Kid Care	1,816,533	1,057,576	-758,957
PROSPER	456,554	616,324	159,770
Intergenerational Programs	94,693	41,319	-53,374
Health Insurance and Personal Finance Literacy	30,000	165,000	135,000
Food Safety and Health Team			
Dining with Diabetes	43,232	59,068	15,836
Expanded Food & Nutrition Education program	37,220	18,895	-18,325
PA Nutrition Education Tracks (SNAP-ED)	0	0	0
Eat Healthy, Be Active	12,000	0	-12,000
StrongWomen/Growing Stronger	102,964	572,932	469,968
Everybody Walks in Pennsylvania	0	0	0
Food Safety training for producers	114,744	55,000	-59,744
Food Safety training for processors	0	0	0
Food Safety for Retail Manager	10,000	0	-10,000
Food Safety for Consumers	0	0	0
Dairy Processing	0	0	0
Meat and Poultry Processing	0	0	0
Wine Quality	0	0	0
Veterinary Team			
Mastitis & milk quality	23,154	12,337	-10,817
Bovine Hoof Health	0	0	0
(Dairy) Beef Quality	19,500	0	-19,500

Assurance and prudent antimicrobial use			
Animal health & welfare	39,394	91,200	51,806
Dairy Production Medicine Certificate Program	0	0	0
Animal Nutrition & Metabolic Disease	0	31,993	31,993
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4-H and Youth Development Team			
4-H and Youth Development	779,203	302,620	-476,583
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Field and Forage Crops Team			
Integrated Crop Production Practices	13,039,613	1,943,886	-11,095,727
Nutrient and manure management	17,704,471	92,071	-17,612,400
Pests (insect, disease and plant) Monitoring and Management	4,846,728	1,541,804	-3,304,924
Soil	14,551	0	-14,551
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Renewable Natural Resources Team			
Forest Products and Services	134,010	2,000,400	1,866,390
Managing Community and Urban Natural Resources	2,648,117	3,071,187	423,070
PA Woodland Owners Education Network	1,089,294	1,088,250	-1,044
Safe Drinking Water	0	0	0
Sustaining PA’s Forests Private forest landowners	1,242,000	1,086,881	-155,119
Watershed Education	2,878,672	700,000	-2,178,672
PA Farm Safety & Health Quiz Bowl Contest	0	0	0
Safe Tractor & Machinery Operation program	333,678	521,563	187,885
Safety & Health Management	1,295,408	2,842,222	1,546,814
Manure Storage Safety	177,199	447,577	270,378
Renewable Energy	4,138,369	6,599,500	2,461,131

Horticulture Team			
Tree Fruit Production Practices	35,500	66,500	31,000
Retooling the Pennsylvania Tree Fruit Industry with Innovative Technologies	1,435,662	1,413,112	-22,550
Farm Transitions	0	0	0
Selection, and Evaluation of New/Novel and Traditionally Grown Specialty Crop Cultivars	399,358	56,698	-342,660
Monitoring, prediction, and management of pests, beneficial and pollinators	5,769,346	2,872,195	-2,897,151
Best Management Practices for Soil, Water, and Nutrient Management	118,997	8,046	-110,951
Greenhouse and Nursery Production	19,249	43,536	24,287
Landscape Business Management	10,000	0	-10,000
Turf grass Management	203,011	16,780	-186,231
Master Gardener Program	300,200	0	-300,200
Total	70,570,637	34,259,073	

A backward Wald binary logistic regression was performed using four independent variables (degree centrality, gatekeeper brokerage, consultant brokerage, and liaison brokerage) to ascertain whether they significantly predicted/explained the change (increase or decrease) in business performance of programs from year 2011-12 to 2013-14. A test of the full model (inclusive of all independent variables) against a constant only model was statistically significant, χ^2 (4, N=60) = 10.432, p =0.034, indicating that the predictors (degree centrality, gatekeeper brokerage, consultant brokerage, and liaison brokerage) were statistically significant

in predicting/explaining change in business performance of programs) (see Table 5). The model correctly classified 66.7% of programs for negative change and 60.0% for positive change in business performance with an overall correct classification rate of 63.3% (see Table 6). Wald statistics indicated that none of the four variables individually predicted the change in business performance of the programs but collectively they were significant predictors (see Table 5). The researcher then developed the most parsimonious model using backward Wald logistic regression.

A backward Wald logistic model with degree centrality was significantly different from full model, χ^2 (1, N=60) = 6.307, p =0.012 (see Table 5). Wald statistics confirmed that degree centrality significantly predicted the change in business performance of the programs. However, the odds ratio for degree centrality showed that the odds that programs had a positive change decreased by 16.3% with a single unit increase in degree centrality (see Table 5). Thus, degree centrality has some influence in distinguishing between which programs have the positive change and which programs have the negative change in business performance, but the distinction is not strong as the odds ratio is only 0.837. Results presented above partially supported the hypotheses 1 and 2 of the study, as all together, four predictors predicted the change in business performance of programs but individually only degree centrality was a significant predictor.

Table 5

Logistic Regression Analysis of Change in Program's Business Performance Status as a function of Degree Centrality and Brokerage Measures (n=60)

Variable	B	SE B	Wald	p	Exp B	95% CI for Exp B	
						Lower	Upper
Step 1 (complete model with all independent variables)							
Degree Centrality	-0.141	0.081	3.013	0.083	0.869	0.741	1.018
Gatekeeper Brokerage	0.400	0.475	0.707	0.400	1.491	0.588	3.785
Consultant Brokerage	0.360	0.361	0.999	0.318	1.434	0.707	2.908
Liaison Brokerage	-0.441	0.514	0.736	0.391	0.644	0.235	1.761
Constant	1.772	1.043	2.888	0.089	5.884	-	-
Model Summary (Omnibus Tests): Chi-square=10.432; 2-Log Likelihood = 72.746; df =4; p =0.034; Nagelkerke R^2 =0.213, Cox and Snell R^2= 0.160							
Step 4 (model with one independent variable)							
Degree Centrality	-0.178	0.077	5.409	0.020	0.837	0.720	0.972
Constant	1.902	0.852	4.796	0.026	6.697	-	-
Model Summary (Omnibus Tests): Chi-square=6.307; 2-Log Likelihood = 76.871; df =1; p =0.012; Nagelkerke R^2 =0.133, Cox and Snell R^2= 0.100							

Table 6

The Observed and Predicted frequencies for Change in Program's Business Performance Status by Logistic Regression with the cutoff of 0.50

Observed (step 1: complete model)	Predicted		% Correct
	Negative Change	Positive Change	
Negative Change (30)	20	10	66.7
Positive Change (30)	12	18	60.0
Overall % Correct			63.3
Step 4 (only one independent variable, Degree Centrality included)			
Negative Change (30)	17	13	56.7
Positive Change (30)	10	20	66.7
Overall % Correct			61.7

Objective 3: Examine the influence of five types of brokerage (liaison, itinerant, gatekeeper, representative, and coordinator) and degree centrality on demand for the Extension programs

After analyzing the data for all 60 programs, the top three programs which had the highest increase in program demand (measured by number of participants who attended each of the 60 programs face-to-face) from year 2011-12 to 2013-14 among stakeholders were: PROSPER (17,709), Equine Environmental Stewardship (11,945), and Marcellus Shale (7,223). The top three programs which had the highest decrease in demand for the program from year 2011-12 to 2013-14 were: Equine Health and Well-being (-23,905), Master Gardner Program (-5,496), and Dairy Business Management (-5,316). See Table 7 for detailed description of change in demand for each program.

Table 7

Direct contact for the Programs

Programs	Direct Number of contacts for 2010-11	Direct Number of contacts for 2011-12	Direct Number of contacts for 2012-13	Direct Number of contacts for 2013-14*	Increase from 2011-12 to 2013-14*
Ag Entrepreneurship, Economic and Community Development Team					
Ag Business Management	2,139	101	11,617	4,978	4,877
Economic & Community Development	17,622	14,298	4,386	11,617	-2,681
Marcellus Shale	59,426	27,650	21,533	34,873	7,223
Entrepreneurship	16,894	8,335	848	8,116	-219
Dairy Team					
Dairy Business Management	8,653	14,226	4,374	8,910	-5,316
Dairy Human Resource & Team Management	1,054	416	2,423	1,350	934
Dairy Nutrient & Feed	1,276	609	2,835	1,633	1,024

Management					
Equine Team					
Equine Environmental Stewardship	36,379	3,080	8,475	15,025	11,945
Equine Health and Well-Being	594	36,338	647	12,433	-23,905
Livestock Team					
Livestock Production Efficiency	7,049	7,716	4,773	6,426	-1,290
Poultry Team					
Poultry Health and Management	12,969	5,503	4,030	7,187	1,684
Family and Consumer Science Team					
Better Kid Care	21,091	13,970	7,647	13,753	-217
PROSPER	15,866	11,055	54,954	28,764	17,709
Intergenerational Programs	870	173	3,243	1,519	1,346
Health Insurance and Personal Finance Literacy	3,480	415	0	1,177	762
Food Safety and Health Team					
Dining with Diabetes	8,582	3,880	5,792	5,993	2,113
Expanded Food & Nutrition Education program	791	3,028	6,728	3,731	703
PA Nutrition Education Tracks (SNAP-ED)	5,318	6,213	15,086	9,235	3,022
Eat Healthy, Be Active	0	209	195	141	-68
StrongWomen/Growing Stronger	59,297	44,098	38,950	46,729	2,631
Everybody Walks in Pennsylvania	0	0	0	0	0
Food Safety training for producers	2,491	1,387	1,760	1,855	468
Food Safety training for processors	1,041	1,958	394	1,104	-854
Food Safety for Retail Manager	5,266	4,727	3,543	4,449	-278
Food Safety for Consumers	7,041	3,149	2,310	4,000	851
Dairy Processing	0	0	57	21	21

Meat and Poultry Processing	0	0	12	4	4
Wine Quality	0	0	125	46	46
Veterinary Team					
Mastitis & milk quality	57	0	107	57	57
Bovine Hoof Health	47	0	0	14	14
(Dairy) Beef Quality Assurance and prudent antimicrobial use	809	0	1,252	706	706
Animal health & welfare	2,065	569	4,615	2,516	1,947
Dairy Production Medicine Certificate Program	0	0	0	0	0
Animal Nutrition & Metabolic Disease	0	0	706	262	262
4-H and Youth Development Team					
4-H and Youth Development	249441	193144	149416	193750	606
Field and Forage Crops Team					
Integrated Crop Production Practices	27284	19604	10111	18379	-1,225
Nutrient and manure management	1,837	4,604	829	2,378	-2,226
Pests (insect, disease and plant) Monitoring and Management	13,735	10,962	14,901	13,250	2,288
Soil	3,604	3,422	2,378	3,089	-333
Renewable Natural Resources Team					
Forest Products and Services	406	7,537	318	2,731	4,806
Managing Community and Urban Natural Resources	10,374	5,261	10,112	8,586	3,325
PA Woodland Owners Education Network	2,948	5,760	7,477	5,557	-203
Safe Drinking Water	7,522	5,896	4,024	5,688	-208
Sustaining PA's Forests Private forest landowners	11,235	4,084	4,543	6,390	2,306
Watershed Education	7,051	6,078	8,751	7,359	1,281
PA Farm Safety & Health Quiz Bowl Contest	259	2,032	342	876	-1,156

Safe Tractor & Machinery Operation program	8,408	11,676	2,302	7,225	-4,451
Safety & Health Management	38,820	24,562	13,339	24,660	98
Manure Storage Safety	789	886	2,229	1,355	469
Renewable Energy	3,528	2,826	1,464	2,531	-295
Horticulture Team					
Tree Fruit Production Practices	3,099	1,899	11,603	5,854	3,955
Retooling the Pennsylvania Tree Fruit Industry with Innovative Technologies	4,765	7,019	5,596	5,818	-1,201
Farm Transitions	23	569	27	205	-364
Selection, and Evaluation of New/Novel and Traditionally Grown Specialty Crop Cultivars	2,066	1,813	866	1,538	-275
Monitoring, prediction, and management of pests, beneficial and pollinators	15,493	17,144	14,817	15,788	-1,356
Best Management Practices for Soil, Water, and Nutrient Management	4,463	5,233	4,269	4,646	-587
Greenhouse and Nursery Production	5,808	4,536	2,715	4,241	-295
Landscape Business Management	6,401	359	580	2,245	1,886
Turf grass Management	7,205	4,449	2,574	4,577	128
Master Gardener Program	47,556	35,976	11,819	30,480	-5,496
Total	782,287	600,434	500,819	617,823	

Note: * represents the projected values

A backward Wald binary logistic regression was performed on three independent variables of the study (degree centrality, gatekeeper brokerage, and liaison brokerage), to ascertain whether they significantly predicted the change (increase or decrease) in demand of the program from year 2011-12 to 2013-14. Only three independent variables were used because of an issue with the

values for consultant brokerage. For those programs coded a zero (0) on the dependent variable demand for the program, they exhibited a constant for the variable consultant brokerage. Inclusion of consultant brokerage in the model led to an unstable model; therefore consultant brokerage was not included.

The results of logistic regression for demand for the programs are summarized in Table 8. Neither the full model nor the reduced model was statistically significant.

Table 8

Logistic Regression Analysis of Change in Demand for the Program Status as a function of Degree Centrality and Brokerage Measures (n=60)

Variable	B	SE B	Wald	p	Exp B	95% CI for Exp B	
						Lower	Upper
Step 1 (complete model with all independent variables)							
Degree Centrality	-0.088	0.071	1.553	0.213	0.915	0.797	1.052
Gatekeeper Brokerage	-0.389	0.333	1.361	0.243	0.678	0.353	1.302
Liaison Brokerage	-0.279	0.506	0.303	0.582	0.757	0.280	2.041
Constant	1.702	0.950	3.210	0.073	5.483	-	-
Model Summary (Omnibus Tests): Chi-square=3.042; 2-Log Likelihood = 78.461; df =3; p =0.385; Nagelkerke R^2 =0.067, Cox and Snell R^2= 0.049							
Step 3 (model with one independent variable)							
Degree Centrality	-0.082	0.068	1.460	0.227	0.921	0.806	1.052
Constant	1.226	0.787	2.428	0.119	3.408	-	-
Model Summary (Omnibus Tests): Chi-square=1.498; 2-Log Likelihood = 80.005; df =1; p =0.221; Nagelkerke R^2 =0.033, Cox and Snell R^2= 0.025							

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter summarizes the findings of the study, draws conclusions and provides a discussion for each objective. In addition, overall recommendations and implications are presented for Extension administrators, program reporting and accountability and for further research.

Purpose and Objectives:

The purpose of this study was to understand the diversity and reach of Cooperative Extension programs in Pennsylvania delivered by Penn State Extension and the influence of various network variables (Brokerage and Centrality) on two program outcomes (program business performance and demand for the program) through Social Network Analysis (SNA). Specific objectives of the study were to:

1. Develop a holistic network map of programs and program stakeholders to understand the diversity and reach of Extension programs in Pennsylvania.
2. Examine the influence of five types of brokerage (liaison, itinerant, gatekeeper, representative, and coordinator) and degree centrality on Extension program business performance.
3. Examine the influence of five types of brokerage (liaison, itinerant, gatekeeper, representative, and coordinator) and degree centrality on demand for Extension programs.

Hypotheses/ Research Questions:

The following four hypotheses guided the study:

Hypothesis 1: For all five types of brokerage (liaison, itinerant, gatekeeper, representative and coordinator), programs which control the flow of information and resources between pairs of other programs are hypothesized to have higher business performance than the programs that do not control the flow of information and resources.

Hypothesis 2: The higher the degree centrality of the program, greater would be its business performance.

Hypothesis 3: For all five types of brokerage (liaison, itinerant, gatekeeper, representative and coordinator), programs which control the flow of information and resources between pairs of other programs are hypothesized to have greater demand among stakeholders than the programs that do not control the flow of information and resources.

Hypothesis 4: The higher the degree centrality of the program the greater would be its demand among the stakeholders.

Summary of Study Procedures:

This research was conducted with the cooperation of Penn State Extension (PSE), the outreach component of the College of Agricultural Sciences at the Pennsylvania State University. The population for this study consisted of all the programs offered by PSE and the respective stakeholders. The sampling method used for this study was a ‘census’ meaning all the programs and the respective stakeholders were used for this study. The study utilized SNA methodology and ex-post facto research design.

The independent variables in the study were the network variables, which included five types of brokers (liaison, gatekeeper, representative, itinerant, and coordinator), and degree centrality of Extension programs.

Data for independent variables was collected for various programs offered by PSE and the program stakeholders from all the seven State Program Leaders (SPLs), 48 State Extension Team Leaders (SETLs) and the director of Penn State Extension through an electronic questionnaire using SurveyMonkey. Data from a list of programs and program stakeholders was entered into UCINET 6; a user-friendly SNA package for analysis of social network data (Borgatti, Everett, & Freeman, 2002). Based on two mode matrix of programs and their stakeholders, the complete network map of programs and the stakeholders was drawn using Netdraw (Borgatti, 2002). Using network maps, characteristics of PSE network were also described. After converting the two mode matrix into single mode (programs to programs connected through common stakeholders) through the "affiliation" process in UCINET, the independent variables, degree centrality and five types of brokerage were calculated.

There were two dependent variables for the study, which included change in program business performance and change in demand for each program. For both the dependent variables, the data were collected in two stages. In the first stage existing base line data for the year 2011-12 (the year PSE adopted the new business model), and then the data for year 2013-14 were collected. The difference between the baseline and current year (2013-2014) was treated as the change value for these two dependent variables. The dependent variable, program business performance was operationally defined as the number of grants and developmental funding (gifts) received by all the programs. Additional revenue sources such as fees, sale of publications and other sources of funding were not included in calculation of business performance of Extension programs. The

data for this variable was collected from the database maintained in the grants and contracts office.

The second dependent variable, demand for programs was operationally defined as the number of participants who attended each of the 60 programs, face-to-face. The data for this variable was collected using the contact information for number of participants who attended various educational programs offered by Penn State Extension for years 2010-11, 2011-12 and 2012-13. The rationale for collecting data for three years was that data for year 2013-14 was not available and to project the data, the researcher utilized the data from past three years. The data projection for the year 2013-14 was completed utilizing the "exponential smoothing method."

Data were analyzed using the Statistical Package for Social Sciences (SPSS 21). Binary logistic regression was used to test the hypotheses. The dependent variables (change in program business performance and change in demand for the program) were dichotomized into programs with negative change (from 2011-12 to 2013-14) or programs with positive change. All the assumptions of binary logistic regression were checked and data satisfied all the assumptions, except for a very high correlation (r=0.997) between two independent variables: *gatekeeper and representative broker*, a strong indicator of potential multicollinearity problems. To overcome the issue of multicollinearity (in this case almost an issue of singularity) and reduce potential problems of multicollinearity, the *representative broker* variable was removed from the analysis. Another independent variable, *coordinator broker* was also not included in the analysis because during the calculation of five types of brokers, the value for coordinator broker was zero (a constant) for all the 60 programs. In the final binary logistic regression analysis, out of the six independent variables in the study (*liaison, gatekeeper, representative, itinerant, and coordinator brokers and degree centrality*), only four variables (*liaison, gatekeeper, and*

itinerant brokers and degree centrality) were used. The study also used descriptive statistics, such as frequencies and percentages to describe the independent and dependent variables.

Summary of Results:

For each objective of the study, findings are presented first, followed by conclusion and discussion.

Objective 1: Develop a holistic network map of programs and program stakeholders to understand the diversity and reach of Extension programs in Pennsylvania

Findings: Findings related to degree centrality of programs revealed that the top three programs with the highest degree centrality were: forest products and services, integrated crop production practices, and dairy business management. On the other hand, the programs with the lowest degree centrality were PA farm safety and health quiz bowl contest, farm transitions, and meat and poultry processing. Among Extension program teams, the highest degree centrality was recorded for renewable natural resources, followed by horticulture and field and forage crops.

Based on findings of the study none of the programs occupied the coordinator brokerage position, while safe drinking water, manure storage safety, and best management practices for soil, water, and nutrient management programs occupied the highest brokerage positions for both representative and gatekeeper brokerage. Regarding consultant brokerage, the programs which utilized their position most were dairy human resource and team management, food safety for consumers, intergenerational programs, and everybody walks in Pennsylvania program. Finally, for liaison brokerage, 31 programs had the same brokerage values which indicated that they had the same potential to broker unconnected programs.

Penn State Extension offered 60 programs which were connected to 293 stakeholders, with an average of 19.18 (SD=9.80) stakeholders per program (maximum=52, minimum=5). The entire network map of programs to stakeholders revealed that whole network of PSE is widespread. The network was divided in two parts and further analysis revealed that the entire network contained four clusters A, B, C, and D. The programs which are part of a cluster have more in common compared to other programs. There were few programs that were in the center of the network such as managing community and urban natural resources and ag business management and few programs were isolates such as programs related to food safety, 4-H and youth development, equine health and wellbeing and livestock production efficiency. These programs being isolates represent the specificity of stakeholders and have less in common with other programs. The network was further simplified by just keeping the government stakeholders, such as government agencies that were the primary funding sources for programs. Upon simplification, the network characteristics were similar to the original network, but there were few isolates which were not connected to any stakeholders -- farm transitions, manure storage safety and safe tractor and machinery operation program.

PSE networks were further studied by a different perspective by explaining just programs to programs network where the connection between two programs was common stakeholders. This network shows that programs were well connected and the network was very dense (See Figure 7).

The PSE network was further simplified by condensing the 60 programs into 12 teams. The team to stakeholder's network was also very widespread. This network was also divided into two parts and had two clusters A and B. Some teams were isolates representing their specificity to stakeholders such as 4-H and youth development and livestock.

Conclusions: Based on the degree centrality results for programs it was concluded that programs in natural resources, dairy and plant sciences were more connected to various other programs. Programs in these areas have a number of alternatives available, and these programs can utilize these alternatives for being more successful in organizational outcomes such as business performance. The programs with lowest degree centrality values had limited connections and limited resources available to them. In order to perform better, either they need to develop more connections and collaborations with other programs or get merged with other larger programs in their area of activity.

From the brokerage results, it was concluded that none of the programs acted as a coordinator or local within group broker, indicating that all the programs for each team were well connected and there were no gaps. Programs such as safe drinking water, manure storage safety, and best management practices for soil, water, and nutrient management had the highest values for both representative and gatekeeper brokerages suggesting that these programs controlled the flow of information with in their teams. Both brokerage types-- representative and gatekeeper—for all the programs were very highly related to each other ($r=0.997$). While many of the programs hold liaison brokerage indicating that these programs were able to access the non-redundant information from other two programs.

Analyzing the network maps of programs and their stakeholders it was concluded that the PSE network is widely distributed and has extensive reach in the community by connections to various stakeholders. The network consists of some clusters, and in examining the clusters it was concluded that programs in these clusters have more in common. Efforts should be made for greater collaboration between programs in each cluster that may be lacking in the current network. The presence of some isolates (programs related to food safety, 4-H and youth

development, equine health and wellbeing and livestock production efficiency) in the whole network suggests that they are niche areas and are less connected to stakeholders of other programs because of their distinctiveness in their goals and objectives or unique program areas. Similar conclusions were made for programs to government stakeholders. However, for isolates (farm transitions, manure storage safety and safe tractor and machinery operation programs) in programs to government stakeholders' network, efforts should be made to increase their connections to government agencies which may ultimately contribute to better performance.

The teams and stakeholders' network are also very much consistent with programs and stakeholder's network. Similar conclusions were drawn as for teams and stakeholders' network.

Overall it can be concluded that, SNA has much to offer in order to understand the outreach of extension and in understanding various outcomes for PSE programs. The work of Extension is largely dependent on the relationships with stakeholders, so SNA should be frequently utilized by Extension to understand the dynamic outreach network to better serve target audiences. Overall, SNA will be important in the future as Extension looks for alternative ways to utilize the limited resources more efficiently.

Discussion: There are very limited studies which utilized SNA to understand the outreach of Extension. The findings of the study were consistent with Bartholomay et al. (2011), who applied SNA in a Minnesota Extension study. They found that the reach of programs in the network was very wide, and the Minnesota complete network was divided into two parts with existence of three clusters in the network. These results are consistent with the current study, but the only difference found was that in the Minnesota study, master gardener programs was located in the center of the network with no association to any cluster while in the current study master

gardener program was part of a cluster named ‘C’ (See Figure 5). This difference can be explained by the fact that different states have different structures for Extension and different association of various programs to different groups. Another difference was that in the University of Minnesota Extension study, the 4-H program was part of the cluster that comprised family and consumer science but in the current study 4-H and youth development was found to be an isolate. A plausible reason for this difference is that 4-H and youth development programs are different in the two states. For example, University of Minnesota has a center for youth development, while it is not the case in Pennsylvania. In Pennsylvania, the administrative structure has undergone several changes during the past decade.

The conclusions of Bartholomay et al. (2011) and Springer & de Steiguer (2011) studies support the conclusions from the current study that SNA provides valuable information for understanding Extension outreach and various outcomes of Extension programs and for identification of greater internal collaboration among programs.

Objective 2: Examine the influence of five types of brokerage (liaison, itinerant, gatekeeper, representative, and coordinator) and degree centrality on Extension program business performance

Findings: Findings of the study revealed that the top three programs which had a positive change in business performance were: renewable energy, forest products and services, and safety and health management. The three programs with highest negative change in business performance were: nutrient and manure management, integrated crop production practices, and pests (insects, disease and plant) monitoring and management.

Analysis of backward Wald binary logistic regression revealed that full model containing all the independent variables (degree centrality, gatekeeper brokerage, consultant brokerage, and liaison brokerage) was statistically significant compared to the constant only model. But Wald statistics indicated that none of the four predictors as a collective group were significantly affecting the business performance. A reduced model with only degree centrality was found statistically significant ($p < .05$) and Wald statistics revealed that degree centrality significantly affected the business performance of programs. Degree centrality was mainly associated with negative change in business performance of programs.

Conclusions: Based on the findings for objective 2, it was concluded that programs under the renewable natural resources team are performing better compared to others by securing a greater number of grants over the years. This trend can be attributed to the fact that funding agencies and formula funding are emphasizing sustenance of nature by investing more in renewable energy sources. The highest decrease in program business performance occurred in the field and forage crops teams. This may imply that research on crop development is less emphasized by funding agencies as farmers in US are able to produce enough food to feed the US population and beyond.

The results of backward Wald logistic regression revealed that all kinds of brokerage types in association with degree centrality significantly predicted/explained the change in business performance. However, individually, only degree centrality explained a relatively small portion of the change. Programs holding a brokerage position can only explain the change in business performance in association with degree centrality. This implies that in addition to acting as a broker, program also needs to have more connections to other programs in the network. But the programs which have the higher degree centrality are going to see little decrease in business

performance. The possible reasons for these findings could be attributed to the fact that the programs holding the brokerage positions have low absorptive capacity. This means that they were unable to utilize benefits associated (information and resources) with their position, and that made these programs to establish extra contacts as degree centrality, which predicted the change in business performance. Another possible reason for such results would be the presence of measurement error (inconsistent format of data collection, data availability, and poor data quality) relative to both independent and dependent variables.

Discussion: The findings achieved in this study are very much consistent with Tsai (2001) where he found that higher centrality of a business unit in an inter-organizational network did not contribute to the business performance of the unit. Tsai concluded that costs of maintaining the central position outweighed the benefits associated with central position and organization in central position had poor absorptive capacity. On the other hand, a study by Soda et al. (2004) found that current structural holes (a gap in the network or lack of connection between actors which can be utilized by an actor for its personal benefit) in the network along with past network closure (more connectedness among actors in the network) enhanced the performance of an organization. These findings are consistent with the current study findings that different types of brokerage positions (structural holes) along with degree centrality (closure) affect the business performance of the programs. Graf and Krüger (2011) in their study found that gatekeeper brokers in the innovation network were unable to extract complete benefits associated with their position due to their poor absorptive capacity in the network. These findings also support the findings achieved in this study that five types of brokers were unable to predict the reliable change in business performance of the programs because programs occupying these network

positions were unable to utilize all the benefits associated with their position besides their poor absorptive capacities.

Powell et al. (1999) findings contradict the findings of this study. They found that centrality in an inter-organizational network is a determining factor for better performance in biotech firms. Plausible reason could be the use of eigenvector centrality by Powell et al., which is more powerful compared to degree centrality. Further it should be noted here that degree centrality only considers the number of direct contacts, whereas eigenvector centrality considers the centrality of direct contacts. On the other hand, Sparrowe et al. (2001) found that higher degree centrality of an individual in an advice network was positively associated with individual performance. The reason why Powell et al. and Sparrowe et al. findings are not similar to the findings of the current study is because the current study considered the business performance of programs (groups of individuals) not as single individuals and degree centrality considered the availability of all resources not just the information. It must be noted that outcomes of the network vary with type of network, for example network of individuals and network of organizations have different outcomes.

Objective 3: Examine the influence of five types of brokerage (liaison, itinerant, gatekeeper, representative, and coordinator) and degree centrality on demand for the Extension programs

Findings: The number of participants who attended the 60 face-to-face programs, from 2011-12 to 2013-14 revealed that the top three programs which had the highest change in demand for the program were PROSPER, equine environmental stewardship and Marcellus shale. The top three programs which had the highest negative change in demand for programs were equine health and wellbeing, master gardeners, and dairy business management.

The findings of backward Wald binary logistic regression revealed that the complete model inclusive of all independent variables (degree centrality, gatekeeper brokerage, consultant brokerage, and liaison brokerage) was not statistically significant compared to constant only model. The variables as a collective group were not able to significantly explain changes in demand for the programs.

Conclusions: Based on the findings, it can be concluded that programs dealing with issues like early child care and environmental damage due to drilling of natural gas in Pennsylvania (Marcellus shale) have become more important (popular) and attracted an increasing number of people. Marcellus shale, which was earlier a small program, has grown exponentially in the past few years due to its potential long-term effect on the lives of Pennsylvania residents. Whereas highest decrease in demand for programs such as equine health and wellbeing, master gardeners program and dairy business management could be attributed to less interest of people in horses, and the increase in growth of master gardener in past years has peaked. It should be noted that the demand for programs was measured by face-to-face attendance of audiences to the programs only; however, in recent years, online delivery methods are an increasing trend in Extension. Therefore, programs attracting fewer audiences should consider offering programs through online delivery methods due to increased use of social media sites.

The results of backward Wald logistic regression suggests that none of the five type of brokerage positions and degree centrality predicted/explained the change in demand for the program. The reason why none of the five types of brokerage and degree centrality explained the change in demand for the programs may be poor absorptive capacity of programs to use the new information. Additionally, the increasing trend to reach people via online programs than face-to-face should be considered. As indicated previously, data quality is also a concern.

Discussion: The researcher found limited literature which supports the findings of current study. The reason for such findings would be poor data quality, bias in selection of indicators for measuring the change in demand for the programs, increasing trend to reach people via online programs than face-to-face, and lack of available data for number of people reached by online programs.

The findings of the current study were not similar to the conclusion achieved in Hargadon and Sutton (1997) study that network position in association with network memory (information and resources provided by past networks) leads to production of new innovative products. These new innovative products ultimately lead to more demand of product in the market. The reason why current study hasn't supported these findings could be the use of network memory in Hargadon and Sutton (1997) study compared to five types of brokerage in the current study. Network memory means contacts in the past which in turn enhance the demand for the product, but five types of brokerage positions provides competitive advantage but plays no role in increasing demand of new product and stakeholders.

Soh (2003) found that more number of repeated partners and high network centrality of firm influenced the performance/demand of firms' new product in the market. The findings of Soh's study were also not supported by the results of current study. The reason may be the inclusion of five types of brokerage variables with degree centrality and poor data quality.

Based on the findings, conclusions and discussions achieved in this study, recommendations and implications were offered for Extension administration, accountability and reporting and future research.

Recommendation for Extension administration

- The results of the study should be communicated to the entire PSE system for better collaboration among programs in the time of tight funding and scarce resources.
- There is a need for a centralized data management system for Extension to better plan and document outcomes of extension programs in a systematic manner.
- Administrators should encourage collaborative work among programs such as joint grant writing, conducting programs together where there are common stakeholders considering the various clusters found in the study.

Recommendation for accountability and reporting

- In order to improve the reporting and accountability, key evaluation and outcome data from all the programs should be collected through a standard data collection format that is common across programs. Such format should not only help reporting both federal and state mandates but also help in systematically evaluating all Extension programs.
- Extension professionals need to use innovative methods of evaluation, including SNA, which provides a clear picture of about reach of Extension among stakeholders. Networks have to be analyzed periodically to assess change, improve internal collaboration, share information and resources among programs in order to better serve the communities and address the issues facing society more efficiently.

Recommendation for further research

- Future researchers should examine egocentric network compared to structural network by contacting every individual involved in PSE work for getting the list of programs and whom they are serving.
- Researchers should try to include some control variables such as age of programs, past performance, network memory, other forms of revenue sources that defines business performance of programs other than grants and gifts and area of operation to better understand predictors of business performance and program demand.
- Further study is needed to understand how the programs receive/secure grants and use new ways to reach the target audiences by studying the advice network of the entire individuals in PSE.

CHAPTER 6

INTAD Extra Chapter

This chapter, application of SNA to international agriculture and education settings (in this case, India), is a fulfillment for the dual title degree program in International Agriculture and Development (INTAD). Consequently, a detailed review of the application of SNA to Indian agricultural Extension is discussed.

Using SNA as a framework, an approach for developing a SNA Education Program was proposed. Specifically, the following questions guided the approach.

a) Who is going to be the audience for the proposed program? What information is needed about the audience prior to developing and implementing the SNA education program
b) What methods will help obtain this information?
c) What potential challenges one may encounter in reaching the audience?
d) What goals and objectives will guide the program?
e) What strategies are needed to develop, implement and evaluate this program?
f) What will indicate to justify that the program is sustainable today as well as in the future?
g) And finally, what other critical questions that might help or hinder the program and how these questions will be addressed?

A logic model specifying the sequence of actions which describe what the program will be and do will be discussed. Identify key components of the logic model-- the inputs, outputs, expected impact, assumptions, and external factors will guide the development, implementation, and outcomes of *SNA Education Program.*

Introduction:

India is a vast country with varied agro-ecological situations and farmers with unequal resource base operate under these situations. India has 53.11% of arable land with 53.97% of the population is economically active in agriculture (Qamar & Swanson, 2013). Farmers in India are widely dispersed that makes them hard to reach and different farmers have different information needs. Extension promoted agricultural productivity, sustainable resource base, transmission of new technologies, and agricultural development, but links between research, Extension and farmers in India is inadequate and uncoordinated (Ferroni & Zhou, 2012). Farmers now work with various information sources to tap on the markets and new available technologies and inputs to provide good quality products to consumers (Ferroni & Zhou, 2012). The most important source of information to farmers is other progressive farmers (16.8%), input dealers (13.2%), radio (9.4%) and TV (7%). Extension workers as source of information is very limited (5.8%). Krishi Vighyan Kendra run by Indian Council of Agricultural Research (ICAR) is mere 0.6% (Adhiguru et al., 2009). All different providers of Extension just reach to 40% of total farmers in the country and typically advantage goes to large growers (Ferroni & Zhou, 2012).

Extension has disproportionately benefited large farmers and neglected small and marginal farmers and underrepresented population. Considering this, central and state governments are working toward making Extension "pluralistic" and new thinking for Extension are decentralization, outsourcing, cost-recovery, involvement of private sector and non-governmental organizations (NGOs), and use of information communication technologies (Adhiguru, Birthal, & Ganesh Kumar, 2009; Ferroni & Zhou, 2012). Extension in India is inadequately funded with limited availability of Extension agents characterized by lack of motivation, competence, performance and accountability (Anderson, 2007). In public sector Extension, the evaluation and accountability of various Extension

programs and projects offered by Extension is very limited and there is a dire need for experimentation, documentation, replication and scaling up what works with Extension to fulfill the diverse needs of agricultural producers (Ferroni & Zhou, 2012). The problem is compounded by the fact that the farm holdings in the country are shrinking in size, production costs are rising, and the resource drain from the farm sector is mounting in recent decades (Planning Commission, 2005). By the year 2020, India need to reach a production level of about 296.6 MT of food grains respectively from the present production level of 206.39 MT (Planning Commission, 2005). The projected production must emanate from improved resource productivity. Over the years, manpower and a shortage of funding have adversely affected the performance of public sector agricultural extension services. In India there are about 120 million farm holdings and the number is growing year by year. If it is proposed to provide one village extension worker for every 800-1000 farm families, then the requirement of field level extension workers is estimated to be about 1.3-1.5 million, against the present availability of only about 0.1 million workers. Presently no state government can provide the required number of field level workers, as it is cost prohibitive. The fund allocation for extension activities under extension reform was very meager (Planning Commission, 2005).

Considering the need for increased accountability in Extension and to increase their reach in the farming community across various economic statuses of farmers (small, medium or large), evaluation is very much required for Extension system. It is very hard to visualize the reach and penetration of Extension in the farming community, studying the networks of Extension personals and farming community is a very good proposition to understand the reach of Extension. According to Bartholomay, et al. (2011) Social Network Analysis (SNA) offers a unique method for describing and measuring Extension outreach. SNA is a methodology which provides complementary visual and statistical components for analyzing the traits of actors and their relationships (Kilduff & Tsai,

2003). This methodology has been widely used for decades in disciplines such as sociology, business management and public health for understanding various individual or organizational outcomes (Springer & de Steiguer, 2011). SNA has also been used in a diversity of applications, including analyzing the roles of intra-firm networks and corporate business partnerships (Tsai & Ghoshal, 1998), examining how ideas and information are transferred amongst a field of professionals, understanding the role of networks in various organizational outcomes (Brass et al.,2004). However, the use of SNA does not exist in Indian Extension.

Considering this, an SNA education program is designed for all the extension educators, administrators and various departments to utilize this method in their evaluation efforts. This will help understand the reach of Extension in the farming community and to identify constraints that hinder their efforts.

Goals and Objectives:

The goal of this program is to educate the Extension educators and Extension administrators of different public agencies involved in agricultural Extension about the importance of SNA in understanding the diversity and reach of Extension in the farming community with the help of visual network maps of extension personals and their connection to farming community. Looking at the visual network maps and relationship of various network variables to various Extension outcomes, find out what constraints limiting the reach of Extension and by what ways Extension can increase its penetration in the farming community to help farmers to increase their production and income.

Specific objectives of this program are:

1. During the months of November and December, 2014, 60% of Extension educators associated with various public institutions will participate in the SNA education workshop

that will be held at UAS, Bangalore, Dharwad and Raichur from 9am-5pm, measured by analyzing the enrollment forms of the workshop.

2. Extension educators associated with public institutions in Karnataka state will increase their awareness and knowledge about the importance of SNA in understanding their reach in the farming community by 50% after completion of a series of workshops measured by pre and posttest.
3. Six months after completion of SNA education program workshop, 40% of Extension educators associated with public institutions in Karnataka state out of the total who attended the workshop will integrate the SNA methodology in their work to understand their reach in the farming community assessed through personal interview and analyzing the official records at the Extension administration.
4. One year after completion of SNA education program workshop, 70% of Extension educators associated with public institutions in Karnataka state out of those who integrated SNA methodologies with their work life after two months will complete an initial assessment of their reach in the community and come out with the network maps, possible constraints to their reach and ways to overcome these constraints. The objective will be measured by reviewing the reports and network maps developed by the target audiences and observation of how the results from the study are utilized in their accountability for their reach in the farming community.

Program: "SNA Education program for Karnataka state Extension education unit" Logic Model
Situation: Only 5.8% of total information about new technologies, inputs and other resources that goes to farmers comes from Extension educators and accountability of Extension work is very limited in Karnataka state and across the whole country, India.

Inputs	Outputs		Outcomes – Impact		
	Activities	*Participation*	*Short*	*Medium*	*Long*
Program coordinators Extension educators Volunteers Agriculture colleges administration Auditoriums Money Time Flyers Booklets Videos PowerPoint presentation SNA software Computers and projectors SNA testing lab Fact sheets Magazine articles Posters Snacks	Program curriculum Two day workshop Different lectures with help of various media tools like power point, flyers. Method demonstration lab regarding usage of SNA methodology Group discussion Success stories	Extension educators associated with all the public institutions involved in agricultural Extension Administrators of all these public institutions Three agricultural universities(UAS, Bangalore, Dharwad and Riachur) Representatives from state department of agriculture and cooperation Software experts in SNA	50% Increase in knowledge of Extension educators and administrators who attended the two day workshop regarding usage of SNA methodology to assess their reach in the farming community After two months 40% of total who attended the workshop will incorporate will integrate the SNA methodology in their work life and start a project to assess their reach in farming community through SNA.	Eight months after completion of the workshop 70% of those who initiated project to assess their reach in farming community through SNA will complete the evaluation process and come out with network maps and report. At the same time these participants also know about barriers to their reach and ways overcome that.	Inclusion of SNA methodology is mandated in Karnataka state Extension accountability system and all Extension educators utilize this methodology to assess barrier to their reach and within five years they become the primary source of information to the farming community.

Assumptions
Workshop on SNA education will increase the competence and evaluation skills of Extension educators and administrators

External Factors

Poor motivation, lack of funding for evaluation activities, lack of one apex body that control Extension activities across the state

Figure 9. "SNA Education Program for Karnataka State Extension Education Unit" Logic Model

Target audiences of the program:

Due to the presence of varied agro-ecological conditions, varied income, land holdings and resource level of farmers, and different departments managing agricultural sector/activities in India, agricultural Extension is done by a variety of public, private and non-governmental organizations. Due to the extensive dissemination of Extension education dissemination by different organizations, the SNA education program will consider only the public institutions involved in agricultural Extension in the state of Karnataka, India. The target audiences for this program would be all the Extension educators and administrators at the various public institutions in Karnataka state which are mentioned below.

- Karnataka State Department of Agriculture (DOA): this department is responsible for agricultural Extension in the state. Specifically, in the department, Directorate of Extension looks after the agricultural Extension. Extension educators from this department take the new technology to the farmers. This department is also responsible for the implementation of one of the important district level agriculture Extension model i.e. ATMA (Agriculture Technology Management Agency). ATMA is a registered society of key stakeholders (farmers, development departments, NGOs, input dealers, mass media, agribusiness companies, farmer organizations etc.) involved in sustainable agricultural development at the district level.

- Indian Council of Agricultural Research (ICAR): it is the apex body which looks after the agricultural research and education across the country. It comprises of 99 ICAR institutes and 53 state agricultural universities spread across India. Its Extension education division carries out Extension activities across all the states of the country. State of Karnataka has 4 agriculture and horticulture universities and a number of ICAR institutes.

- Agricultural Extension Division of ICAR: this division performs Extension activities through 631 Krishi Vigyan Kendras (KVKs) and 44 Agricultural Technology Information Centers (ATIC) across the country and Karnataka also have the KVKs and ATIC.

- State Agricultural Universities: Karnataka state has 4 agricultural and horticultural universities. In these universities, Directorate of Extension carries out the limited Agricultural Extension activities across the state. These universities also work in collaboration with the Agricultural Extension Division of ICAR.

- National Institute of Agricultural Extension Management (MANAGE): it is an autonomous established by the Government of India to assist central and state governments to help improve their pluralistic Extension systems by bringing positive changes in policies, programs and personal skills. This institute offers various trainings and offer one year diploma to agricultural input dealers and responsible for implementation of the Agri-Clinics and Agri. Business Centers Schemes across India.

- State Agricultural Management and Extension Training Institutes (SAMETI): it is present in every state and conducts training courses on new agricultural technologies, extension management, gender issues, extension reform and new information technologies.

- Commodity boards: every state has specific commodity boards which carry out Extension in the state related to that specific commodity. Karnataka state has the Central Silk Board, Coffee Board, Tobacco Board, and Cashew Export Promotion Council.

- Raitha Sampark Kendra (RSK): It is a Karnataka state specific organization, which is founded with the goal to decentralize the Extension and provide Extension services to the farmers at the Hobli level (Planning commission, 2005).

What needs to be known about target audiences before the development and implementation of the SNA education program?

The first thing to be known by the programmer before developing and implementing a new program is to understand the local context. That means before the development of the program the programmer will understand the agricultural Extension system in the state of Karnataka, how different public agricultural Extension organizations function, what is the level of relationship between the extension educators and farmers, what are the ways in which extension programs are disseminated to farmers, and how these organizations carry out the accountability for different programs, where the accountability records are stored and how the results of the these accountability results are incorporated into future programs.

Specific things to be known about the target audiences before the development and implementation of the SNA education program are: personal interest and motivation towards new methods to improve program accountability, education level, prior trainings in the area of program SNA and program evaluation, their competencies, reception to new technologies, desire to change, how proactive they are to technology change, and their understanding that they are responsible to serve the farming community.

How the information about target audiences needs to be collected?

Information about the specific things to be known about the different target audiences and answers to questions mentioned above will be collected through conducting a needs assessment in Karnataka state with SNA education as the concentration of needs assessment. During needs assessment, focus group interviews will be conducted across the state with Extension educators

and administrators of different public organizations, interview with the key informants and visiting different organizations.

Potential challenges to reach the target audiences:

The main challenges to reach the target audiences are: different work schedules for different organizations, geographically distant locations for different target audiences, support from administration and state government, personal interest of target audiences to meet the programmer regarding the SNA education program, development of SNA education benefit message (that how it helps them in their work life) in a way that is best understood by all the target audiences and at last lack of trust and buy in.

Strategies for Program Development:

After understanding the local situation and based on the results of the needs assessment, the SNA education program will be designed. Based on the local needs of the target audiences two-day workshops will be developed, which will be delivered during the month of November and December, 2014 at the UAS Bangalore, UAS Dharwad and UAS, Raichur in separate sessions. Bangalore, Dharwad and Raichur are the three main locations to cover the target audiences across the state. At the same time, programmer will develop the curriculum and educational material for the workshop, such as a PowerPoint presentation, poster gallery, live examples of hypothetical network maps and practical lab where participants can execute what they learnt during the workshop. The programmer will write the goals and objectives of the program, develop the logic model to guide the program and develop the time frame for the program. At the same time ways to evaluate the program are decided and indicators to assess the program success are formalized.

Strategies for program implementation:

Once the location and day of the workshop id decided, curriculum, educational materials, and the program will be advertised among all the stakeholders and efforts will be done to raise their interest to attend the program. Later workshops will be conducted by the programmer with the assistance of stakeholders at the three agricultural universities and the Department of Agriculture.

Strategies for program evaluation:

For the evaluation of the SNA education program, the following procedures will be followed: first the evaluation plan will be developed based on the objectives of the program; second, the use of Rockwell and Bennett (2004) TOPS model to guide the evaluation process. Third, indicators to assess the success of the program will be identified. Both formative and summative evaluations will be used for program improvement and assess the outcomes of the program. Just after completion of the workshops, a feedback form will be provided to participants to assess their reaction on the quality of the program and ways to improve the program. Pre and posttest questionnaire will be developed to assess the change in the knowledge of participants regarding SNA. Three months after the conclusion of workshops, personal interviews and review of various records will be done to assess the integration of SNA concept by the target audiences in their evaluation of Extension activities. In the long-term, after one year, the participants who utilized SNA to assess their reach of the farming community will be surveyed by assessing the reports of results and visual network maps.

Ways to increase the sustainability of the program today as well as in the future:

Major constraint to the sustainability of any program are: lack of funding, lack of motivation, especially to use the SNA methodology, lack of support from the administrators and colleagues, and lack of practical application of program to real life situations.

These constraints to the sustainability of SNA program will be overcome by providing incentive to target audiences who incorporate this methodology in their work life, a success story can be used to demonstrate: 1) the practical usage of the program and ways in which SNA methodology helped the successful extension educator, 2) to assess his/her reach in the farming community and ability, 3) to identify barriers and opportunities to increase their reach in the community, 4) being useful for accountability of Extension funding to support these efforts from state and central government and 5) proper support should be offered from administrators. Extension educators who are using this methodology should be encouraged to train their colleagues in the organization so that use of SNA methodology becomes self-sustainable.

What other critical questions that might hinder the program and how to overcome them?

Other critical questions that hinders the program are: lack of experts in the SNA methodology, lack of competencies and resources available with various extension educators to carry out evaluation using this methodology, lack of common governing body for Extension that guides Extension across the state not the different organizations with the different accountability requirements, and lack of interest among Extension educators to carry out the systematic evaluation as most of them view evaluation as their own personal evaluation.

Ways to overcome the above mentioned questions, are to start a program development and evaluation center at the state level with experts in program development, evaluation and SNA

methodology. Such a center will help in providing training to the Extension educators, inclusion of courses related to SNA and program evaluation in the B.Sc. agriculture curriculum to increase expertise in advanced methods of evaluation such as SNA. All the Extension offices should be equipped with proper resources and computers with all the required software packages to carry out the data analysis. There should be a common administrative department at the state level, which looks after all the Extension activities across the state and have common accountability procedures for the entire Extension organizations.

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APPENDIX A

PENNSTATE

Vice President for Research
Office for Research Protections

The Pennsylvania State University
The 330 Building, Suite 205

Phone : (814) 865-1775
Fax: (814) 863-8699
Email : orprotections@psu.edu
Web : www.research.psu.edu/orp

Date: March 11, 2014

From: The Office for Research Protections - FWA#: FWA00001534
Courtney A. Whetzel, Compliance Coordinator

To: Anil Kumar Chaudhary

Re: Determination of Exemption

IRB Protocol ID: 45329

Follow-up Date: March 10, 2019

Title of Protocol: Diversity and Reach of Cooperative Extension Programs and Effect of Brokerage and Network Position on Extension Program Outcomes through Social Network Analysis (SNA)

The Office for Research Protections (ORP) has received and reviewed the above referenced eSubmission application. It has been determined that your research is exempt from IRB initial and ongoing review, as currently described in the application. You may begin your research. The category within the federal regulations under which your research is exempt is:

45 CFR 46.101(b)(2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

Given that the IRB is not involved in the initial and ongoing review of this research, it is the investigator's responsibility to review IRB Policy III "Exempt Review Process and Determination" which outlines:

- What it means to be exempt and how determinations are made
- What changes to the research protocol are and are not required to be reported to the ORP
- Ongoing actions post-exemption determination including addressing problems and complaints, reporting closed research to the ORP and research audits
- What occurs at the time of follow-up

Please do not hesitate to contact the Office for Research Protections (ORP) if you have any questions or concerns. Thank you for your continued efforts in protecting human participants in research.

This correspondence should be maintained with your research records.

APPENDIX B

Initial Survey Electronic Mail

Date: Wednesday, April 2, 2014

Dear Program Leaders and State Extension Team Leaders,

I am working on my MS thesis titled "Diversity and Reach of Cooperative Extension Programs and Effect of Brokerage and Network Position on Extension Program Outcomes through Social Network Analysis (SNA)."

My research involves two parts: first part is to draw the network of all the programs offered by Penn State Extension across the Commonwealth of Pennsylvania and their stakeholders. Data on list of all programs and their stakeholders will be collected from all the program leaders and state Extension team leaders. Refer to question # 1 in the survey.

Second part of my research is to assess the effect of network variables: centrality and brokerage on Extension program outcomes: program business performance, demand for the program and program identity. For this part of the research, most of the data is secondary except for program identity variable. For program identity data will be collected from all program leaders and state Extension team leaders. Refer to question # 2 in the survey.

While answering the program identity question, please consider the complete program area if you are a program leader; and if you are state Extension team leader, please consider all the programs coming under state Extension team.

This study is approved by the Institutional Review Board of Penn State for use of human subjects. PSU IRB # 45329.

Please, complete this survey by 12th April, 2014. If you have any questions, please contact me. We truly appreciate your time and assistance in the conduct of this research.

Thank you very much for completing this survey.

Here is a link to the survey:
https://www.surveymonkey.com/s.aspx

This link is uniquely tied to this survey and your email address. Please do not forward this message.

Please note: If you do not wish to receive further emails from us, please click the link below, and you will be automatically removed from our mailing list.
https://www.surveymonkey.com/optout.aspx

Yours Sincerely
Anil Kumar Chaudhary
Graduate Assistant
009 Ferguson Building
Department of Agricultural Economics, Sociology and Education
Penn State University
Email id: auk259@psu.edu
Phone # 814-441-6209

Remainder Electronic Mails

Date: Thursday, April 10, 2014

Dear Program Leaders and State Extension Team Leaders,

One week ago, I sent you a survey regarding my MS thesis titled "Diversity and Reach of Cooperative Extension Programs and Effect of Brokerage and Network Position on Extension Program Outcomes through Social Network Analysis (SNA)." As of today, I have not received your completed survey.

Could you please take a few minutes from your busy schedule to complete the survey? Your responses are valuable to my efforts in drawing the network of all the programs offered by Penn State Extension across the Commonwealth of Pennsylvania and their stakeholders and later analyzing the effect of network variables: centrality and brokerage on Extension program outcomes: program business performance, demand for the program and program identity.

While answering the program identity question, please consider the complete program area if you are a program leader; and if you are state Extension team leader, please consider all the programs coming under state Extension team.

This study is approved by the Institutional Review Board of Penn State for use of human subjects. PSU IRB # 45329.

Here is a link to the survey:
https://www.surveymonkey.com/s.aspx
Please complete the survey and return it by April 15, 2014.

Thank you again for your time and cooperation. If you have further questions, please contact me (auk259@psu.edu or 814-441-6209). Best wishes.

Sincerely,

Anil Kumar Chaudhary
Graduate Assistant
009 Ferguson Building
Department of Agricultural Economics, Sociology and Education
Penn State University
Email id: auk259@psu.edu
Phone # 814-441-6209

Please note: If you do not wish to receive further emails from us, please click the link below, and you will be automatically removed from our mailing list.
https://www.surveymonkey.com/optout.aspx

Date: Wednesday, April 16, 2014

Dear Program Leaders and State Extension Team Leaders,

I request you please spare 10 minutes from your busy schedule to complete my survey. Without your response I cannot complete my MS thesis.

Two week ago, I sent you a survey regarding my MS thesis titled "Diversity and Reach of Cooperative

Extension Programs and Effect of Brokerage and Network Position on Extension Program Outcomes through Social Network Analysis (SNA)." As of today, I have not received your completed survey.

Could you please take a few minutes from your busy schedule to complete the survey? I need to complete my MS thesis and your responses are valuable to my efforts in drawing the network of all the programs offered by Penn State Extension across the Commonwealth of Pennsylvania and their stakeholders and later analyzing the effect of network variables: centrality and brokerage on Extension program outcomes: program business performance, demand for the program and program identity.

While answering the program identity question, please consider the complete program area if you are a program leader; and if you are state Extension team leader, please consider all the programs coming under state Extension team.

This study is approved by the Institutional Review Board of Penn State for use of human subjects. PSU IRB # 45329.

Here is a link to the survey:
https://www.surveymonkey.com/s.aspx
Please complete the survey and return it by April 18, 2014. Please respond to my survey.

Thank you again for your time and cooperation. If you have further questions, please contact me (auk259@psu.edu or 814-441-6209). Best wishes.

Sincerely,

Anil Kumar Chaudhary
Graduate Assistant
009 Ferguson Building
Department of Agricultural Economics, Sociology and Education
Penn State University
Email id: auk259@psu.edu
Phone # 814-441-6209

Please note: If you do not wish to receive further emails from us, please click the link below, and you will be automatically removed from our mailing list.
https://www.surveymonkey.com/optout.aspx

APPENDIX C

List of Major Programs and their Stakeholders

1. Please list the major programs offered by your specific program area in which you are either a program leader or state Extension team leader. You can list upto a maximum of 20 programs. For each identified program, please list the key stakeholders (provide as many as possible) seperated by commas in the box provided below each identified program.

The researchers created the following criteria to define a program to be included in the study:

- **Conducted throughout the Commonwealth of Pennsylvania**
- **The program in operation for a minimum of three years**
- **A major initiative by each specific state Extension team, such as Master Gardeners, Dining with Diabetes**
- **Workshops, webinars and courses are not considered as a program**

Program 1

Stakeholders for Program 1

Program 2

Stakeholders for Program 2

Program 3

Stakeholders for Program 3

Program 4

Stakeholders for Program 4

Program 5

Stakeholders for Program 5

Program 6

Stakeholders for Program 6

Program 7

Stakeholders for Program 7

Program 8

Stakeholders for Program 8

Program 9

Stakeholders for Program 9	
Program 10	
Stakeholders for Program 10	
Program 11	
Stakeholders for Program 11	
Program 12	
Stakeholders for Program 12	
Program 13	
Stakeholders for Program 13	
Program 14	
Stakeholders for Program 14	
Program 15	
Stakeholders for Program 15	
Program 16	
Stakeholders for Program 16	
Program 17	
Stakeholders for Program 17	
Program 18	
Stakeholders for Program 18	
Program 19	
Stakeholders for Program 19	
Program 20	
Stakeholders for Program 20	

Measurement of Program Identity (Perceived)

2. The following statements relate to the perceptions of Cooperative Extension program identity.

Identity refers to attributes which are most central, enduring, and distinctive characteristics of a program. With the help of these three aspects, program management team is able to answer " who are we as a program?"

Please indicate the degree to which you agree or disagree with the statements relative to program identity. Use the scale 1-5, where 1= Strongly Disagree and 5= Strongly Agree.

Over the past three years (2011-12 to 2013-14), our program:

	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
has maintained its unique identity for what it was created/developed.	○	○	○	○	○
has maintained its vision.	○	○	○	○	○
has involved with various stakeholders who haven't changed its identity.	○	○	○	○	○
has maintained its central attributes.	○	○	○	○	○
has maintained its distinctive attributes.	○	○	○	○	○
has maintained its practices.	○	○	○	○	○
has maintained its commitment to people it intended to serve.	○	○	○	○	○
has involved with other programs that haven't changed its initial/intended identity.	○	○	○	○	○
interdisciplinary colloboration haven't changed its identity.	○	○	○	○	○
identity has remained the same even after reorganization of Extension.	○	○	○	○	○

Demographics

3. What is your title?

▼

4. Your highest education level

5. What is your gender?

6. Your experience in working with extension ___ years.

7. Comments

Thank you for completing this survey

APPENDIX D

State Extension Teams	Educational Material Distribution		
	2013-14	2012-13	2011-12
Dairy	1,326	1,854	3,384
Equine	17,458	10,852	17,204
Poultry	25,428	37,566	33,509
Livestock	17,656	16,961	20,959
Field and Forage Crops	25,241	68,536	49,314
Horticulture	75,515	68,244	89,234
Renewable Natural Resources	53,359	83,744	88,724
Ag Entrepreneurship, Economic and Community Development	13,734	43,378	52,984
Family and Consumer Science	21,467	31,254	25,873
Food Safety and Health	214,424	157,444	168,578
4-H Youth Development	88,314	83,953	60,727
Veterinary	0	0	0
Total	553,922	603,786	610,490

State Extension Teams	Number of visits on websites (2013-14)	Total Time On Site (hours) (2013-14)	Unique Page views (2013-14)
Dairy	222,801	10,157	371,891
Equine	48,808	2,917	72,852
Poultry	31,751	1,386	53,471
Livestock	39,755	1,593	71,301
Field and Forage Crops	615,141	18,412	885,610
Horticulture	488,830	21,059	948,439
Renewable Natural Resources	335,189	12,715	531,964
Ag Entrepreneurship, Economic and Community Development	315,357	14,287	636,204
Family and Consumer Science	223,246	54,862	453,083
Food Safety and Health	340,088	9,900	482,716
4-H Youth Development	108,495	8,181	410,000
Veterinary	0	0	0
Total	2,769,461	155,469	4,917,531

Government Stakeholders:

Sr. No.	Name of the Stakeholder
1	County Economic Development Departments
2	Regions or Groups of Municipalities
3	PA Department of Agriculture (PDA)
4	National Resource Conservation Service (NRCS)
5	PA Department of Environmental Protection (DEP)
6	PA Equine Council
7	PA State Conservation Commission
8	School Districts
9	USDA-NIFA
10	Centre for Disease Control (CDC)
11	Pennsylvania Office of Child Development and Early Learning
12	Health Care Providers
13	Center for Medicare and Medicaid Services
14	PA Department of Health
15	PA and County area Agencies on Aging
16	Township Offices
17	Extension Board Members
18	Parks and Recreation Centers
19	USDA: Agriculture Research Service (ARS)
20	USDA-FDA
21	PSU-PDA Animal Care
22	PA Department of Education (PDE)
23	Office of Ethics and Compliance
24	County Commissioners
25	Office of Juvenile and Delinquency Protection (OJJDP)
26	Local County Conservation Districts
27	PA Department of Environmental Resources
28	Legislators
29	Municipal and County Elected Officials**
30	Municipal Commissions
31	Department of Conservation and Natural Resources Staff
32	PA Bureau of Forestry
33	PA Game Commission

Note. ** Most Central Stakeholder