

Social Network Analysis: A Methodology for Exploring Diversity and Reach Among Extension Programs and Stakeholders

Abstract

Social network analysis (SNA) is a methodology that provides complementary visual and statistical components for analyzing the traits and relationships of actors in a network. We conducted a study to develop a whole-network map of programs and their stakeholders to understand the diversity and reach of Extension programs in Pennsylvania. We concluded that the Penn State Extension network is widely distributed and has extensive reach in the community and that there exist a few program clusters (programs serving common stakeholders) and isolates (niche programs). Overall, SNA has much to offer in fostering understanding of the outreach of Extension and various outcomes of Extension programs.

Keywords: [social network analysis \(SNA\)](#), [Cooperative Extension](#), [Extension programs](#), [Extension stakeholders](#), [reach](#)

Anil Kumar Chaudhary
Assistant Professor
auk259@psu.edu

Rama Radhakrishna
Professor
brr100@psu.edu

Department of
Agricultural
Economics, Sociology,
and Education
The Pennsylvania
State University
University Park,
Pennsylvania

Introduction

Over the past few decades, several trends have affected the Cooperative Extension System. These trends include demographic shifts in suburban and urban areas, deep budget cuts, increasing complexity of funding, changing staffing and accountability structures, and varied programs and delivery methods (Calvin, 2012; Franz & Townson, 2008; Ilvento, 1997; Peters & Franz, 2012). Collectively, these trends have brought both challenges and opportunities to Extension. Extension professionals have embraced the use of technology to reach large numbers of audiences, including new audiences (Diem, Hino, Martin, & Meisenbach, 2011; Green, 2012). Extension professionals have made attempts to showcase the public value of their programs by writing impact statements, showing economic benefits achieved from programs (Diem, 2003; O'Neill & Richardson, 1999), and using new program evaluation approaches, such as social network analysis (SNA) (Bartholomay, Chazdon, Marczak, & Walker, 2011; Springer & de Steiguer, 2011).

SNA is a methodology that provides complementary visual and statistical components for use in analyzing the traits of actors and their relationships in a network (Borgatti, Everett, & Johnson, 2013; Kumar Chaudhary & Warner, 2015; Scott & Carrington, 2011). SNA has been widely used in disciplines such as sociology, business management, and public health for understanding various individual or organizational outcomes (Springer & de

Steiguer, 2011). However, this methodology is still underused in agricultural and extension education, and literature on SNA use is scarce (Kumar Chaudhary, 2014). Bartholomay et al. (2011) used SNA as a methodology for examining the outreach of University of Minnesota (UM) Extension to organizations outside UM. They found that the outreach network of UM Extension was both broad in its reach and strong in its connections, and they concluded that SNA has great potential for helping Extension professionals describe and understand Extension's outreach (Bartholomay et al., 2011). Springer and de Steiguer (2011) also concluded that SNA has much to offer for Extension professionals, specifically the visual and statistical elements of SNA.

In response to Pennsylvania State University Core Council recommendations for improvement in the organization and operation of the College of Agricultural Sciences and Cooperative Extension as well as budget cuts for Cooperative Extension in financial year 2011–2012, Penn State Cooperative Extension went through a major restructuring in 2011 (Calvin, 2012). Penn State Cooperative Extension adopted a new "business model" so that communities in Pennsylvania would recognize it as one organization offering different educational programs to address societal issues rather than perceive its varied education programs, such as 4-H and the master gardener program, as individual, unconnected entities (Calvin, 2012). Several years have passed since the implementation of the new business model, but no efforts have been made to understand the reach and networks of new Penn State Cooperative Extension programs across Pennsylvania.

Purpose and Objective

We undertook a study to use SNA to determine the diversity and reach of Cooperative Extension programs delivered by Penn State Extension. Our specific objective was to develop a whole-network map of programs and their stakeholders to understand the diversity and reach of Extension programs in Pennsylvania.

Methodology

We conducted our descriptive cross-sectional research in spring 2014 with the cooperation of Penn State Extension, the outreach component of the College of Agricultural Sciences at The Pennsylvania State University. The population for the study consisted of all the programs offered by Penn State Extension and the respective stakeholders. For the study, an Extension program was conceptualized as a program that was conducted throughout Pennsylvania and had been in operation for a minimum of 3 years (Kumar Chaudhary, 2014). Major initiatives of each specific state Extension team, such as the Penn State Extension Master Gardeners program, were considered programs. Workshops, webinars, and courses were not considered programs. Stakeholders were conceptualized as those who had direct or indirect vested interest in an Extension program. We included both direct stakeholders (those directly served by a program, such as farmers) and indirect stakeholders (e.g., the Pennsylvania Department of Agriculture). A census of all the programs and the respective stakeholders was used as the source of data for the study.

We used SNA methodology. As explained earlier, SNA provides complementary visual and statistical components researchers use to analyze the traits and relationships of a network's actors (Borgatti et al., 2013; Kumar Chaudhary & Warner, 2015; Scott & Carrington, 2011). Brass, Galaskiewicz, Greve, and Tsai (2004) defined a 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 network's actors, such as individuals (e.g., an Extension educator), groups (e.g., the educators at an Extension office), subunits, and organizations (e.g., Penn State Extension), and ties are relationships (e.g., friendship, communication) between the actors (Borgatti et al., 2013). In a social network, actors are embedded in the network of interconnected relationships, a scenario that provides both opportunities

for and constraints on the behavior of the actors (Brass et al., 2004; Kilduff & Tsai, 2003). SNA allows researchers to combine fundamental social science theories and diagnostic methods (statistical procedures) with the production of intuitive visual network maps to explore the characteristics of certain network members (e.g., Extension programs) and their common affiliations with other network members (e.g., stakeholders) (Borgatti et al., 2013; Kumar Chaudhary, 2014; Scott & Carrington, 2011; Springer & de Steiguer, 2011).

Using SurveyMonkey, we collected data on various programs offered by Penn State Extension and their associated stakeholders from all seven state program leaders, 48 state Extension team leaders, and the director of Penn State Extension. To increase the trustworthiness of data collected, we cross-verified the list of programs and their stakeholders with available information on the Penn State Extension website.

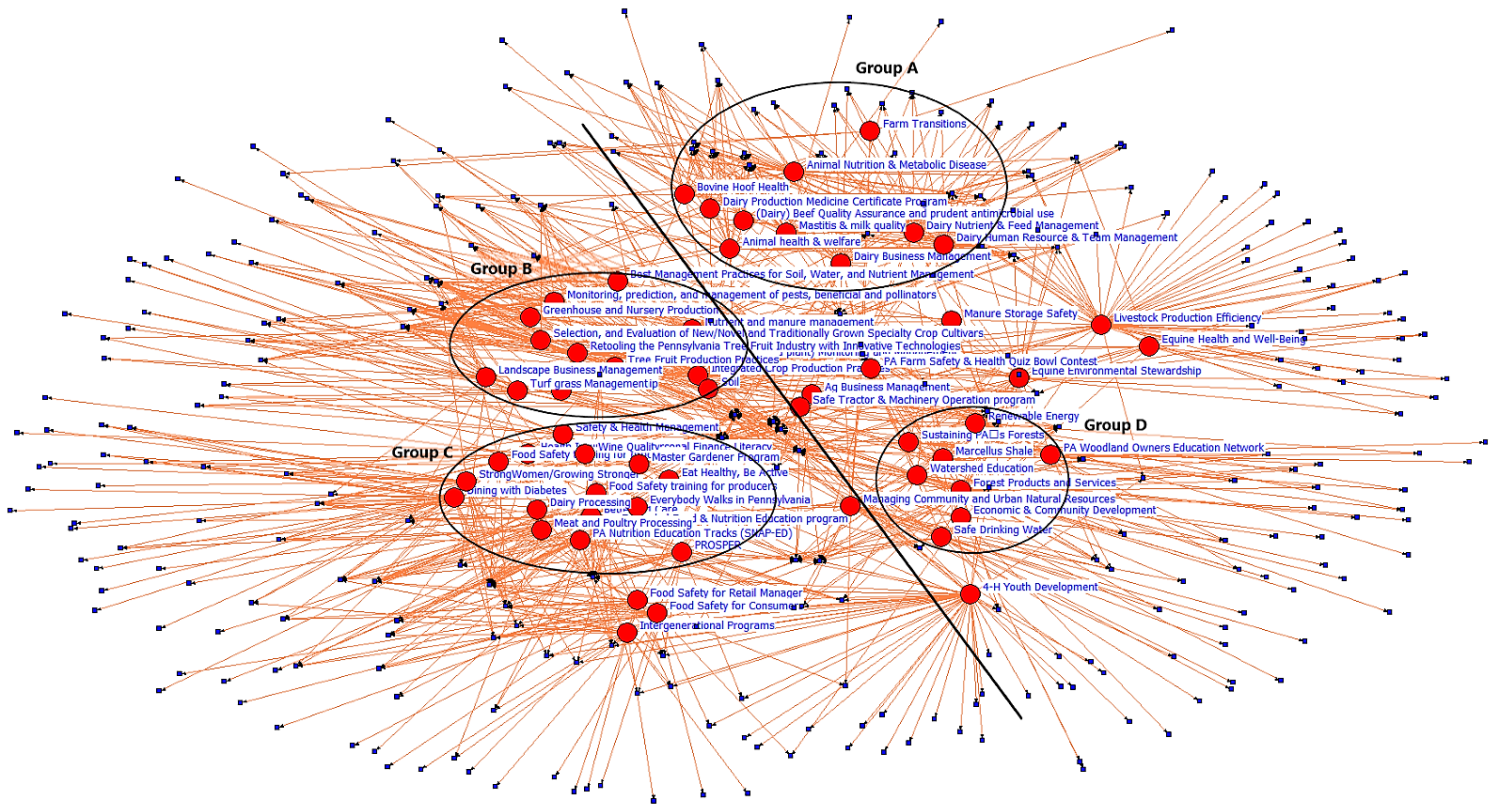
After collection and cross-validation of data from the various sources, we developed a composite list of all the programs and their stakeholders. Later, we used Microsoft Excel 2010 to create a two-mode matrix in which all the programs were listed as row headings and all the stakeholders were listed as column headings. A program was dummy coded as 1 if it had an affiliation with a specific stakeholder and 0 if it had no affiliation (Kumar Chaudhary, 2014). This two-mode matrix of programs and stakeholders was later entered in UCINET 6, a user-friendly SNA package for analysis of social network data (Borgatti, Everett, & Freeman, 2002). In UCINET, the two-mode matrix was translated to (a) two modes of data, one mode being the programs and the other mode being the stakeholders, and (b) ties, the associations of programs with specific stakeholders. On the basis of the translated data, the complete network map of Penn State Extension programs and stakeholders was drawn through the use of the spring-embedding algorithm of NetDraw (the network map drawing tool of the UCINET package) (Borgatti, 2002). The spring-embedding algorithm places actors on the network map relative to their relationships or connections, thereby exhibiting the juxtaposition of programs to one another and to the stakeholders (Borgatti et al., 2013). Using the Penn State Extension complete network map and additional, more specific network maps, we described characteristics of Penn State Extension.

Results

As noted previously, network mapping can be a powerful empirical tool for revealing the outreach of an organization in a community (Bartholomay et al., 2011). Furthermore, network maps not only reveal the outreach of an organization but also exhibit which of the organization's programs have common stakeholders (Borgatti et al., 2013). The Penn State Extension complete network map drawn via NetDraw's spring-embedding algorithm is presented in Figure 1.

Figure 1.

Overall Network of Penn State Extension (Programs and Their Stakeholders)



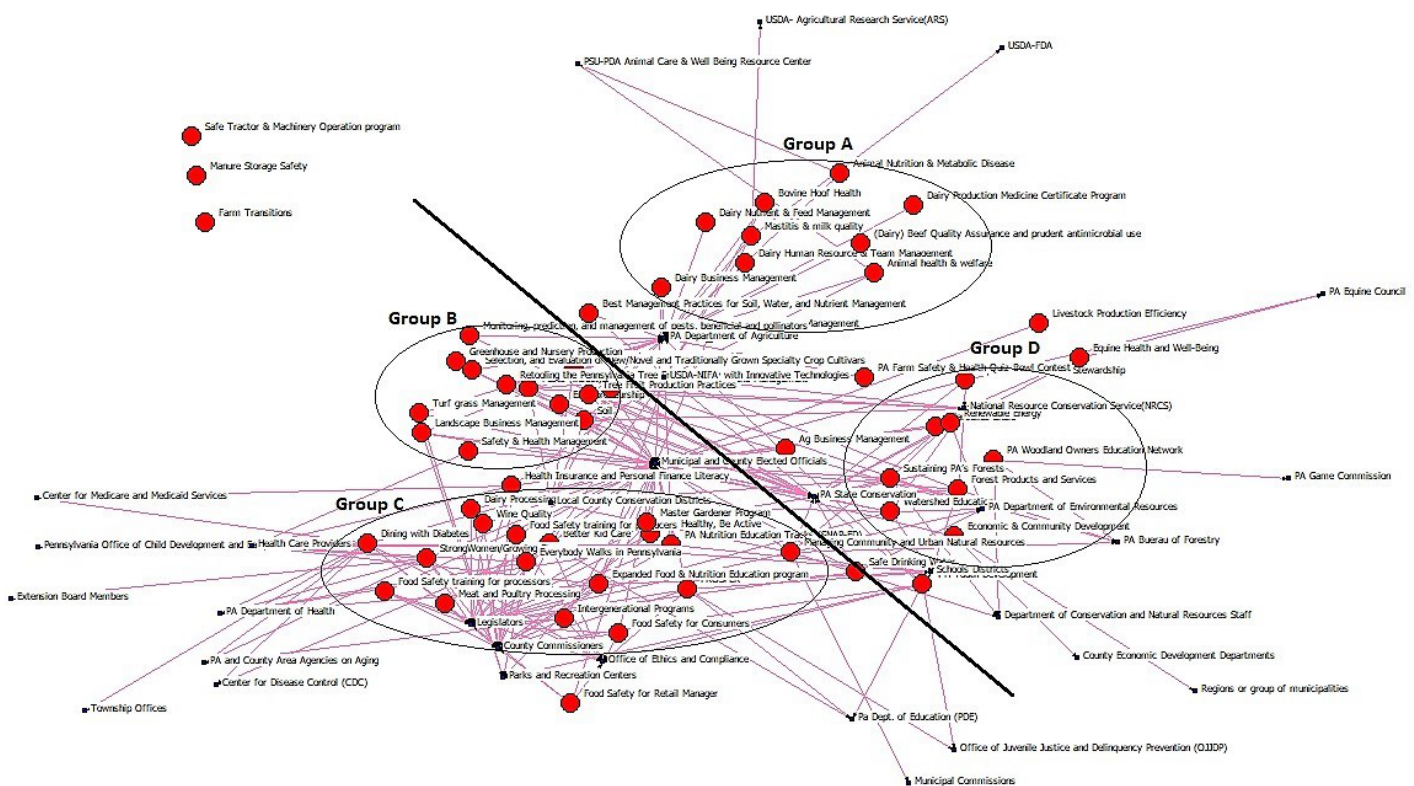
Note. The red circles represent programs, the very small blue squares represent stakeholders, and the orange lines represent connections between programs and stakeholders. (The diagonal black line and the ovals and labels indicating groupings were added during data interpretation. [Click here](#) to view the image file directly.)

Analysis of the Penn State Extension complete network map revealed the following information:

- In all, the Penn State Extension network consisted of 60 programs and 299 stakeholders. Each program was associated with multiple stakeholders, with the maximum number of stakeholders (52) associated with the Livestock Production Efficiency program and the minimum number (5) associated with the Farm Transitions program. On average, programs were associated with 19.18 stakeholders ($SD = 9.80$). This shows that the Penn State Extension network was widely distributed and had wide reach among the stakeholders. In addition, programs and stakeholders were widely spread as viewed in the network map.
- Visual inspection of the network after execution of NetDraw's spring-embedding algorithm indicated that the network could be segmented into two halves, as indicated by the diagonal black line in Figure 1. One half of the network consisted mainly of programs related to animals, natural resources and community and economic development, and the other half consisted mainly of programs related to plants and the safety and health of consumers.
- The network also could be divided into four clusters, or groups, lettered A, B, C, and D in Figure 1. Cluster A included programs related to veterinary science and dairy science; cluster B consisted of programs related to plant sciences, mainly horticulture and field crop production; cluster C included programs related mainly to food safety and health of consumers; and cluster D consisted of programs related to renewable natural resources and community and economic development. In general, a program has more stakeholders in

- Some programs, including certain food safety programs, intergenerational programs, 4-H Youth Development, Equine Health and Well-Being, and Livestock Production Efficiency, were isolated from the clusters, indicating that these programs have specific stakeholders.

Network of Penn State Extension Programs and Their Government Stakeholders



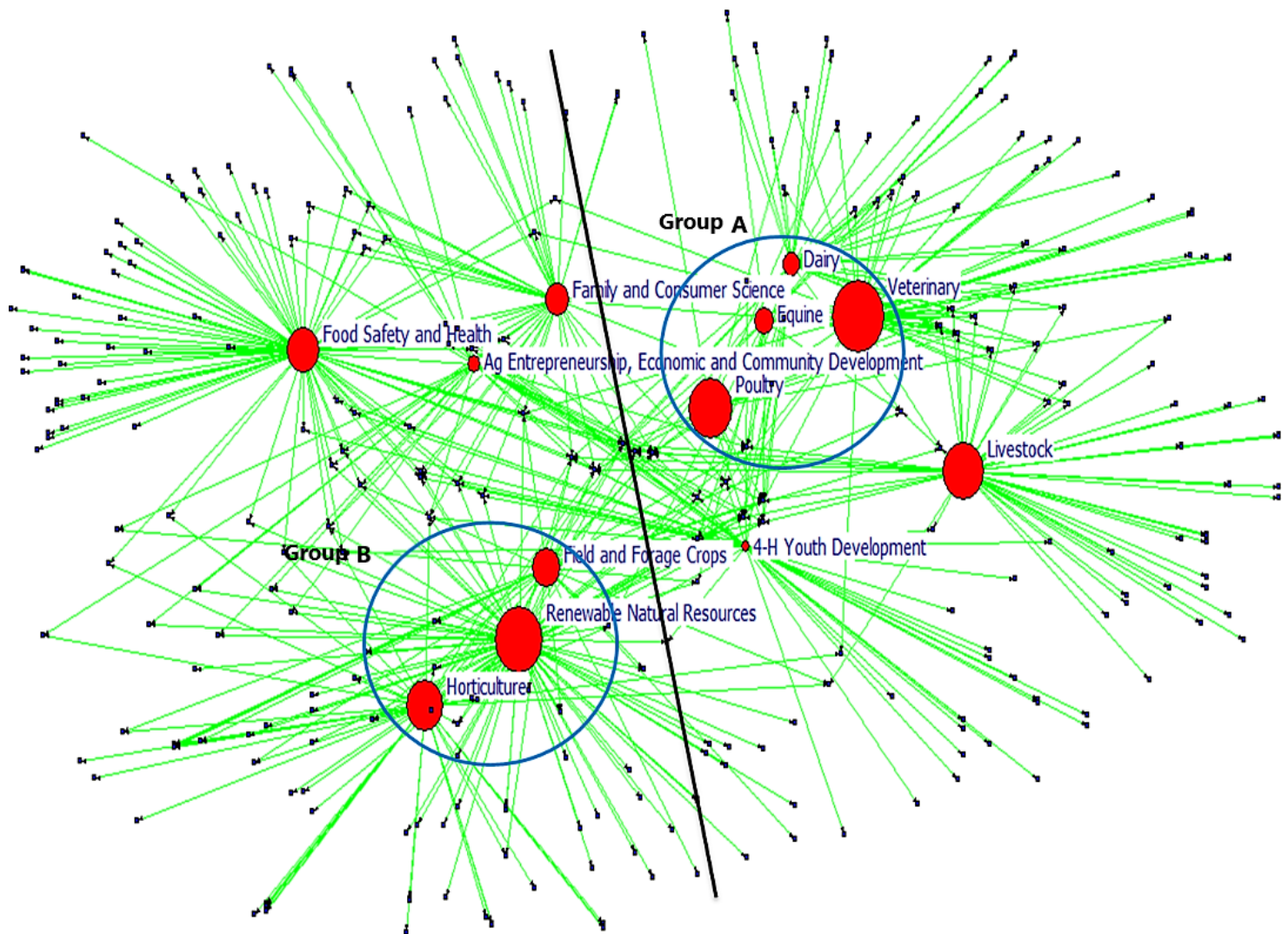
Analysis of the map of programs and their government stakeholders revealed the following information:

- Out of a total of 299 stakeholders, 33 were government stakeholders.
- Overall, programs were well connected to government stakeholders, indicating that program staff were exchanging knowledge and information with local, state, and federal governments.
- Like the whole network, this network also had four clusters of programs, and it had a few isolates that were not connected to any government stakeholders (Farm Transitions, Manure Storage Safety, and Safe Tractor and Machinery Operation).

We also analyzed Penn State Extension networks by segregating the programs into 12 teams (as the new business model of Penn State Extension administratively operated by grouping 60 programs into 12 teams) and then developed a map showing the network of those teams and their stakeholders (Figure 3). On the map, the teams are represented by different circle sizes, with a bigger size indicating a higher number of connections with stakeholders.

Figure 3.

Network of Penn State Extension Teams and Their Stakeholders



Note. The red circles represent teams, with differences in circle size representing differences in number of connections with stakeholders; the very small blue squares represent stakeholders; and the green lines represent connections between teams and stakeholders. (The diagonal black line and the circles and labels indicating groupings were added during data interpretation. [Click here](#) to view the image file directly.)

Analysis of the map of teams and their stakeholders revealed the following information:

- The network was spatially widely dispersed, and teams were well connected to various stakeholders.
- The network comprised two clusters: A and B. Cluster A consisted of teams involved with animal-related programs, and cluster B consisted of teams involved with plant sciences and natural resources. As with the clustering shown in the complete network map, the clustering indicates that teams that were part of a cluster served similar stakeholders.
- Some teams, such as 4-H Youth Development and Livestock, were isolates, indicating that they had specialized stakeholders.

Conclusions

It is advised that readers use caution in interpreting our study as the findings are applicable only to Penn State Extension. However, the study's methodology and findings have implications for Extension organizations across the United States. By analyzing the network maps of programs and their stakeholders, we concluded that the Penn State Extension network is widely distributed and has extensive reach in the community because it has connections to a vast array of stakeholders, and, on average, a high number of stakeholders were associated with the programs. We noted that the complete network map indicated some clusters. A close examination of these clusters revealed that programs in the clusters have commonalities and serve similar stakeholders. Need exists for collaborative efforts among programs in each cluster that may be lacking currently. The presence of some isolates in the network suggests that these programs represent niche areas and are less connected to stakeholders of other programs because of their distinctiveness in their goals and objectives or unique program areas. We reached similar conclusions for the network of programs and government stakeholders. However, the existence of isolates in this network is cause for concern. Efforts should be made to increase these programs' connections to government agencies, perhaps ultimately guiding them to receive more funds and new information, which in turn might lead to more stakeholder connections and better performance. Additionally, we found the network of teams and stakeholders to be consistent with the complete network of programs and stakeholders. In the network of teams and stakeholders, teams related to plant sciences formed a cluster, and teams related to animal sciences formed a cluster, with the teams in each cluster serving similar stakeholders, addressing related subject matter topics, and attracting similar audiences. Teams providing specific programs, such as 4-H Youth Development, have specific target audiences to reach, thereby resulting in their unique locations in the network. Overall, our study provided evidence that SNA can be successfully used to obtain insight on diversity and reach of Extension programs delivered by an Extension organization.

Recommendations and Implications

To keep up with trends affecting Extension, Extension administrators, program evaluators, educators, specialists,

and staff must use new approaches to evaluation. One such approach is SNA, which provides a clear picture of Extension's reach among stakeholders. Because Extension survives on relationships with stakeholders, it is important that Extension professionals study their networks of relationships with stakeholders at regular intervals and keep track of changes in those networks so that they may improve internal collaboration, more successfully share information and resources to better serve their target audiences, and more efficiently address the issues facing society. The results of SNA studies also can be communicated to program coordinators, administrators of state Extension systems, and others to encourage broader collaboration and understanding in times of tight funding and limited resources. Moreover, Extension professionals can easily conduct studies such as the one reported here because most of the data needed are secondary data, such as a listing of programs and their respective stakeholders.

Some specific implications of SNA for Extension center on resource generation, impact reporting, and internal collaboration.

- *Resource generation.* A network map is a snapshot of existing connections between programs and their stakeholders. In an era of declining public funding, certain types of network maps, such as our map showing the network of programs and government stakeholders, can be used to identify information relevant to the generation of resources. For example, by examining a network of programs and funding agencies, Extension professionals could identify which programs have better collaboration with funding agencies and which have the highest levels of available grant and extramural funds. Such information could be used to identify success factors that could then be applied to generate resources for underperforming programs.
- *Impact reporting.* As it is often said that one picture is worth a thousand words, Extension administrators could present network maps showing their Extension programs and the stakeholders they reach to better convince funding agencies or legislators of the importance of their work. These network maps could complement other indicators in Extension reporting.
- *Internal collaboration.* Network maps developed using SNA can assist Extension professionals in identifying which programs have more or less in common with respect to their outreach. Such information could be used for enhancing collaboration, coordination, sharing of resources and information, and mutual learning among Extension program personnel. For example, on the basis of clusters identified during an analysis, Extension administrators could encourage collaboration among applicable program personnel, including efforts such as participating in joint grant writing and conducting programs together for common stakeholders.

Despite its contributions, our study has some limitations. First, data for stakeholders served by Penn State Extension programs were collected from Penn State Extension administrators, and there may be some bias in their response. Second, even though we undertook an effort to reduce potential bias in administrator response by cross-verifying data with the Penn State Extension website, the website may not have been current and, therefore, the data on stakeholders served may not have been accurate. Although our study had these limitations, we see value in our findings, given existing constraints of time and funding. To obtain a more holistic picture of an Extension network, researchers should conduct an in-depth study in which they interview Extension professionals individually to identify whom they are serving directly or indirectly in terms of investment of their official time before drawing the network of programs and stakeholders. Also, researchers could use multiple data validation procedures, including but not limited to validation from stakeholders served and observations of program delivery, to improve the accuracy of the data collected.

The work of Extension is largely dependent on relationships with stakeholders, so SNA should be used frequently by Extension professionals to improve their understanding of dynamic outreach networks and, accordingly, better serve target audiences. Our findings mirror those from studies by Bartholomay et al. (2011) and Springer and de Steiguer (2011), which suggest that SNA provides valuable information not only for understanding Extension outreach and various outcomes for Extension programs but also for identifying the potential for greater internal collaboration across programs and/or program teams. Overall, SNA can serve as an important tool in the future as Extension professionals look for alternative ways to use limited resources more efficiently.

References

- Bartholomay, T., Chazdon, S., Marczak, M. S., & Walker, K. C. (2011). Mapping Extension's networks: Using social network analysis to explore Extension's outreach. *Journal of Extension*, 49(6), Article 6FEA9. Available at: <http://www.joe.org/joe/2011december/a9.php>
- Borgatti, S. P. (2002). NetDraw visualization software. Cambridge, MA: Analytic Technologies.
- Borgatti, S. P., Everett, M. G., & Freeman, L. C. (2002). UCINET for Windows: Software for social network analysis. Harvard, MA: Analytic Technologies.
- Borgatti, S. P., Everett, M. G., & Johnson, J. C. (2013). Analyzing social networks. London, UK: Sage.
- Brass, D. J., Galaskiewicz, J., Greve, H. R., & Tsai, W. (2004). Taking stock of networks and organizations: A multilevel perspective. *Academy of Management Journal*, 47(6), 795–817.
- Calvin, D. (2012). Extension update to university faculty senate report. Retrieved from <http://extension.psu.edu/about/reports/extension-update-to-university-faculty-senate-report/view>
- Diem, K. G. (2003). Program development in a political world—It's all about impact. *Journal of Extension*, 41(1), Article 1FEA6. Available at: <http://www.joe.org/joe/2003february/a6.php>
- Diem, K. G., Hino, J., Martin, D., & Meisenbach, T. (2011). Is Extension ready to adopt technology for delivering programs and reaching new audiences? *Journal of Extension*, 49(6), Article 6FEA1. Available at: <http://www.joe.org/joe/2011december/a1.php>
- Franz, N., & Townson, L. (2008). The nature of complex organizations: The case of Cooperative Extension. *New Directions for Evaluation*, 2008(120), 5–14. doi:10.1002/ev.272
- Green, S. (2012). Extension online: Utilizing technology to enhance educational outreach. *Journal of Extension*, 50(5), Article 5TOT4. Available at: <http://www.joe.org/joe/2012october/tt4.php>
- Ilvento, T. W. (1997). Expanding the role and function of the Cooperative Extension System in the university setting. Paper presented at the meeting of NAREA, Sturbridge, MA.
- Kilduff, M., & Tsai, W. (2003). *Social networks and organizations*. Thousand Oaks, CA: Sage.
- Kumar Chaudhary, A. (2014). Diversity and reach of Penn State Extension programs and effect of brokerage and network position on Extension program outcomes through social network analysis (SNA) (Unpublished masters' thesis). Retrieved from https://etda.libraries.psu.edu/files/final_submissions/9964
- Kumar Chaudhary, A., & Warner, L. A. (2015). Introduction to social network research: Application of social

network analysis in Extension (AEC534/ WC196). Retrieved from

<http://edis.ifas.ufl.edu/pdffiles/WC/WC19600.pdf>

O'Neill, B., & Richardson, J. (1999). Cost-benefit impact statements: A tool for Extension accountability. *Journal of Extension*, 37(4), Article 4TOT3. Available at: <http://www.joe.org/joe/1999august/tt3.php>

Peters, S., & Franz, N. K. (2012). Stories and storytelling in Extension work. *Journal of Extension*, 50(4), Article 4FEA1. Available at: <http://www.joe.org/joe/2012august/a1.php>

Scott, J., & Carrington, P. J. (2011). *The Sage handbook of social network analysis*. London, UK: SAGE Publications.

Springer, A. C., & de Steiguer, J. E. (2011). Social network analysis: A tool to improve understanding of collaborative management groups. *Journal of Extension*, 49(6), Article 6RIB7. Available at: <http://www.joe.org/joe/2011december/rb7.php>

Copyright © by Extension Journal, Inc. ISSN 1077-5315. Articles appearing in the Journal become the property of the Journal. Single copies of articles may be reproduced in electronic or print form for use in educational or training activities. Inclusion of articles in other publications, electronic sources, or systematic large-scale distribution may be done only with prior electronic or written permission of the Journal Editorial Office, joe-ed@joe.org.

If you have difficulties viewing or printing this page, please contact [JOE Technical Support](#)