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Who Talks to Whom in African Agricultural Research Information Networks?

The Malawi Case

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ABSTRACT

The sector-wide approach currently dominates as the strategy for developing the agricultural sector of many African countries. Although it is recognized that agricultural research plays a vital role in ensuring success of sectorwide agricultural development strategies, there has been little or no effort to explicitly link the research strategies of the National Agricultural Research System (NARS) in African countries to the research agenda that is articulated in sectorwide agricultural development strategies. This study fills that gap by analyzing the readiness of Malawi's NARS to respond to the research needs of the national agricultural sector development strategy, namely the Agriculture Sector Wide Approach (ASWAp) program. Results of a social network analysis demonstrate that public agricultural research departments play a central coordinating role in facilitating information sharing, with other actors remaining on the periphery. However, that analysis also shows the important role other actors play in relaying information to a wider network of stakeholders. These secondary information pathways can play a crucial role in ensuring successful implementation of the national agricultural research agenda. Policymakers and managers of public research programs are called upon to integrate other research actors into the mainstream national agricultural research information network. This is vital as other research actors are, at the global level, increasingly taking up a greater role in financing and disseminating research and research results, and in enhancing the scaling up and out of new agricultural technologies.

Keywords: social network analysis, sector-wide approach, Framework for African Agricultural Productivity, National Agricultural Research System (NARS)

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1. INTRODUCTION

A paradigm shift occurred globally in agricultural research systems in the early 1990s consisting of changes in research financing and institutional arrangements and a greater role for actors not traditionally involved in public research (Byerlee 1998; Pardey et al. 2006). In Africa, agricultural research was further transformed with the adoption of the Framework for African Agricultural Productivity (FAAP) by African governments in the early part of the new millennium (FARA 2006). The FAAP provides for increased funding for subregional organizations and national research programs and greater involvement of nontraditional research partners in scaling up activities to support agricultural research. In addition, the FAAP hinges on a pluralistic approach to ensure wider dissemination and greater uptake of best-bet technologies. A framework specific to the African context was essential as the emerging global agricultural research paradigm was not able to respond fully to the continent's diverse social, economic, and biophysical conditions (Sumberg 2005).

In many African countries, the principles of the FAAP have been woven into existing national agricultural research programs. The FAAP's vision has thus been manifested in practice as part of a broader agricultural sector strategy, and in recent years as part of countries' Comprehensive Africa Agricultural Development Programme (CAADP) compacts. Scholars agree that agricultural research plays a vital role in ensuring the success of national agricultural sector development strategies (Rajalahti, Woelcke, and Pehu 2005; Alston, Beddow, and Pardey 2009). Assessments of sectorwide applications in developing countries have demonstrated that successful cases are those with well-targeted research that feeds into the policy process (Brown et al. 2001; Foster, Brown, and Naschold 2001; Global Donor Platform for Rural Development 2007; Campbell 2011). Such well-targeted research allows for ongoing adjustments of the strategy framework. The Forum for Agricultural Research in Africa (FARA) led the development of the Framework for African Agricultural Productivity (FAAP). The framework addresses the challenges of CAADP Pillar IV in that it aims to strengthen agricultural knowledge systems and technologies for adoption by farmers (FAAP 2006).

Furthermore, successful sectorwide strategic frameworks can be developed only if there is a clear understanding of the diverse social and economic conditions of the rural majority (Norton and Bird 1998). This can be achieved through robust qualitative and quantitative research. Despite this, we find no evidence in the literature of efforts to explicitly link the research strategies of National Agricultural Research Systems (NARS) in African countries to the research agenda that is articulated in national agricultural sector development strategies. In addition, there have been no studies to assess the readiness of African countries' NARSs to respond to national agricultural sector development strategies.

This study therefore aims to fill that gap. We assess the readiness of Malawi's NARS to respond to the national agricultural research agenda. Malawi's vision for the agricultural sector is articulated in the Agriculture Sector Wide Approach (ASWAp). ASWAp aims to support priority activities that increase agricultural productivity, reduce hunger, enable people access to nutritious foods, increase the contribution of agroprocessing to economic growth, and conserve the natural resource base. The policy directly supports Malawi's growth and development strategy objective of reducing poverty and transforming the economy from one based on importing and consuming to one based on manufacturing and exporting. This study therefore analyzes the responsiveness of Malawi's NARS to ASWAp. Insights from the study are of primary interest to research organizations throughout the continent where potential for innovation, creativity, and personal expertise can be pooled to create synergies and cooperation. The study contributes greatly toward knowledge needed for continuing the transformation of African agricultural research and aligning African agricultural research vision and practice with the emerging global agricultural research paradigm.

In the next section we present a description of the methodology used in the study; this is followed by the results and discussion section. Section 4 provides a conclusion and lessons learned.

2. METHODOLOGY

The study focuses on actors in the Malawian NARS. Malawi's NARS consists of a wide array of actors, including a public agricultural research department that has several research stations throughout the country, agricultural academic institutions, semiautonomous research institutions, private companies, and international agricultural research institutions. Although the new paradigm in African agricultural research calls for greater involvement of a diversity of research actors, the public sector remains central to the successful implementation of national agricultural research strategies (Spielman and von Grebmer 2006). The study therefore includes a sample of several research units and sections within the public agricultural research department as they each have separate core functions and mandates.

Other research institutions sampled include Consultative Group on International Agricultural Research (CGIAR) centers operating in Malawi, private seed companies and seed industry associations, farmers' organizations, academia, as well as other types of research institutions. Table 2.1 shows the organizations sampled. Relational data pertaining to the nature and extent of interactions, contacts, and meetings were collected from key informants in each organization using a semistructured limited-choice questionnaire. Not all organizations contacted for the purpose of the study provided sufficient information to allow their inclusion in the analysis.

Table 2.1—Organizations included in the social network analysis of Malawi's NARS

Type of organization	Name of organization
Government—research	1. Department of Agricultural Research Services (DARS) a. Horticulture b. Livestock and Pastures c. Farm Power and Machinery Engineering d. Plant Protection and Quarantine Services e. Technical Services f. Maize Breeding (Maize Commodity Research Group) g. Soils and Chemistry
Consultative Group on International Agricultural Research (CGIAR)	2. International Potato Center (CIP) 3. International Center for Tropical Agriculture (CIAT) 4. International Agroforestry Center (ICRAF) 5. International Food Policy Research Institute (IFPRI)
Private seed companies	6. Chemicals and Marketing Co./Pioneer 7. Monsanto Malawi Ltd. 8. SeedCo 9. Pannar Seed 10. Demeter Seed
Farmer organizations/industry associations	11. Seed Traders Association of Malawi (STAM) 12. Association of Smallholder Seed Multiplication Action Group (ASSMAG) 13. Agricultural Input Suppliers Association of Malawi (AISAM)
Academia	14. Natural Resources College (NRC)
Other research	15. Agricultural Research and Extension Trust (ARET)

Source: Authors' compilation.

The study employs *social network analysis* (SNA) to analyze the data. Social network analysis is a tool to analyze structural patterns of social relationships and provides measures to identify and analyze networks within and between organizations (Knoke and Yang 2007, 2008; Scott 1987). It helps to identify information pathways, brokers, and gatekeepers, and it supports processes of knowledge sharing within and between organizations. In social network analysis, the *density* of a network refers to the proportion of ties (or relationships between actors) expressed as a percentage of all possible ties in that network. The denser the network, the higher the number of potential ties present. The network density gives insight about the speed at which information diffuses among the network actors.

When looking at individual members within the network, the analyses in this study include the following basic measures:

- Size: size of ego network (number of other actors with which ties exist). An ego is an individual focal node or actor and can be a person, group or organization. A network is the set of nodes or actors who are connected to a focal node or actor. An ego network is the "neighborhood" (within one step) of a single node or actor, and is formed by selecting a single node/actor and all the other actors/nodes connected to the focal node/actor.
- Ties: number of directed ties
- Pairs: number of ordered pairs
- Density: ties divided by pairs

Reach efficiency is the number of nodes (other actors) within two links divided by size. It measures the number of actors within *friend-of-a-friend* distance and is concerned with how much secondary contact is gained through each unit of primary contact. If reach efficiency is high, then the actor is successful in reaching a wider audience through each primary contact. If the primary contacts have few secondary contacts that the first actor does not have, then reach efficiency is low.

Key indicators that give insights into power and influence of individual actors or members are called *centrality measures,* and we focus on two: *closeness* and *betweenness.* Closeness centrality is the sum of the distance of a member to all other members in the network. It determines a member's integration within a network (Knoke and Yang 2007, 2008; Scott 1987). Higher closeness centrality indicates greater autonomy of a member. The member is able to reach out—that is, it is "close" to many other members. Low closeness centrality indicates higher individual member dependency on other members. Betweenness centrality measures how often a node lies along the shortest path between two other nodes. High betweenness centrality helps identify knowledge brokers and gatekeepers (Knoke and Yang 2007, 2008; Scott 1987).

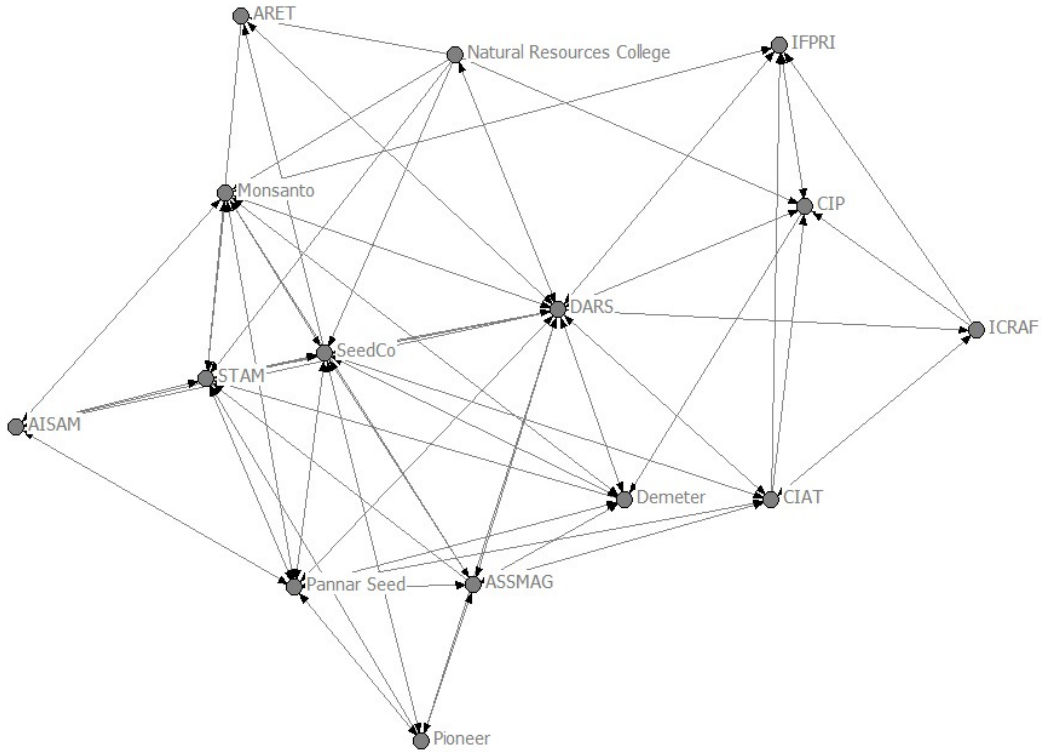
The *means* for *information sending* and *receiving* give insight into which network members act as sources and brokers or facilitators of information. Actors with higher means for information sending are a source of information and can have influence as a supplier of information. Actors with high means for information receiving receive a lot of information and may exercise influence and power as brokers or facilitators of information, depending on which other actors they receive information from. Coupled with other measures, these measures help identify influential members in the network.

3. RESULTS AND DISCUSSION

The Department of Agricultural Research Services as a Single Entity

Although sections within the Department of Agricultural Research Services (DARS) were interviewed separately, the first set of results we present (Figure 3.1) shows the DARS as a single organization. This is done to illustrate its central position in the Malawian agricultural network. In this scenario, if any organization had interaction with any DARS section, it is presented as an interaction with the "DARS." This analysis includes 15 different actors, and Table 3.1 presents various measures of the network and individual actors within the network.

Figure 3.1—Malawi's agricultural information network (DARS as a single entity)



Source: Author calculations using data collected from the 'ASWAp Operationalization and Research Capacity Strengthening in Malawi' project.

Table 3.1—Ego network measures for Malawi's agricultural information network (DARS as a single entity)

Actor	Size	Ties	Pairs	Density	Reach efficiency	Between-ness	Closeness	Mean	
								Info. Sending	Info. receiving
DARS	14	65	182	35.7	14.6	40.4	100.0	1.000	1.000
CIP	6	14	30	46.7	32.6	8.3	63.6	0.214	0.357
IFPRI	5	12	20	60.0	35.0	10.0	60.9	0.214	0.357
ICRAF	4	10	12	83.3	43.7	0.0	58.3	0.286	0.143
CIAT	7	22	42	52.4	24.6	14.3	66.7	0.500	0.357
Seed Co.	11	55	110	50.	16.7	12.1	82.4	0.714	0.714
Monsanto	9	41	72	56.9	18.7	13.2	73.7	0.571	0.643
Pannar	9	47	72	65.3	18.4	9.8	73.7	0.643	0.643
Pioneer	5	19	20	95.0	26.9	0.0	60.9	0.357	0.214
Demeter	7	31	42	73.8	20.9	5.9	66.7	0.429	0.429
ASSMAG	8	42	56	75.0	19.4	3.5	70.0	0.500	0.500
AISAM	5	20	20	100.0	26.4	0.0	60.9	0.357	0.286
STAM	10	53	90	58.9	17.9	2.2	77.8	0.286	0.714
ARET	4	10	12	83.3	34.1	0.0	58.3	0.143	0.214
NRC	6	18	30	60.0	25.9	0.0	63.6	0.429	0.071
Social network analysis network density: 44.3 percent									

Source: Authors' estimation using Ucinet.

Notes: Ucinet is a Windows software package that was developed for the analysis of social network data.

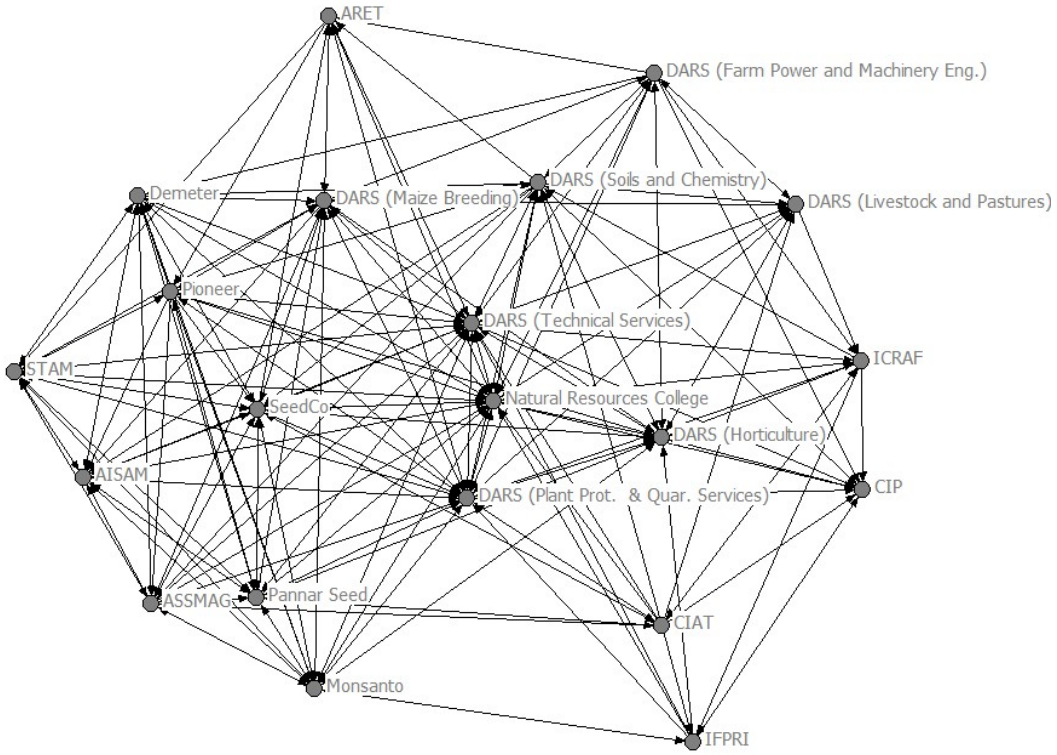
With the DARS presented as a single entity (Figure 3.1), we see that the network has a density of 44.3 percent, or the proportion of ties present out of all *possible* ties. The central location of the DARS in the network is apparent, and as expected the measures in Table 3.1 indicate its importance, power, and influence within the network. The size of its ego network and number of ties, combined with high levels of betweenness and closeness and high information sending and receiving means, all confirm that the DARS occupies an influential position within Malawi's agricultural research information network. Note, however, that its reach efficiency is relatively low compared with that of other actors within the network, indicating that its reach beyond primary points of contact is relatively low.

Other influential actors, as indicated by high information sending and receiving means and a high level of closeness, include SeedCo, Monsanto, and Pannar Seed. One can also see that some CGIAR centers have relatively low means for information sending and receiving and, as indicated by their position in the network, lie on the periphery of the network. This is also the case for some private-sector companies and industry associations. However, at the same time, we see that the CGIAR centers have relatively high reach efficiency measures, indicating the importance of secondary contacts in their networks.

DARS Sections as Separate Entities

Despite the central position the DARS occupies in Malawi's agricultural information network when presented as a single entity, it does not reflect reality in that interaction between other actors takes place with *individual* sections of the DARS, not the DARS as a whole. Therefore, the main focus of the SNA is on interactions with individual DARS sections (listed in Table 1), the results of which we present in Figure 3.2 and Table 3.2.

Figure 3.2—Malawi's agricultural information network (DARS as separate entities)



Source: Author calculations using data collected from the 'ASWAp Operationalization and Research Capacity Strengthening in Malawi' project.

Table 3.2—Ego network measures for Malawi's agricultural information network (DARS as separate entities)

Actor	Size	Ties	Pairs	Density	Reach efficiency	Between-ness	Closeness	Mean	
								Info. sending	Info. receiving
DARS									
Horticulture	14	101	182	55.5	10.3	7.7	76.9	0.500	0.700
Livestock and Pastures	9	55	72	76.4	14.5	1.7	64.5	0.350	0.400
Farm Power and Machinery Eng.	11	75	110	68.2	12.8	1.5	68.9	0.500	0.300
Plant Prot. and Quar. Services	20	187	380	49.2	7.8	11.3	100.0	0.900	0.950
Technical Services	20	189	380	49.7	7.8	9.2	100.0	0.750	1.000
Maize Breeding	16	152	240	63.3	8.9	4.7	83.3	0.750	0.600
Soils and Chemistry	16	128	240	53.3	9.3	8.1	83.3	0.700	0.500
Other actors									
CIP	9	51	72	70.8	15.4	5.8	64.5	0.200	0.450
IFPRI	8	41	56	73.2	17.1	3.6	62.5	0.300	0.200
ICRAF	10	64	90	71.1	14.5	6.0	66.7	0.400	0.300
CIAT	11	62	110	56.4	13.1	7.3	68.9	0.550	0.250
SeedCo	15	139	210	66.2	9.3	3.8	80.0	0.650	0.650
Monsanto	13	108	156	69.2	10.5	13.4	74.1	0.650	0.600
Pannar	13	115	156	73.7	10.4	3.9	74.1	0.600	0.500
Pioneer	14	137	182	75.3	9.7	1.1	76.9	0.550	0.300
Demeter	13	114	156	73.1	10.3	2.2	74.1	0.500	0.600
ASSMAG	13	117	156	75.0	10.3	2.1	74.1	0.550	0.500
AISAM	12	109	132	82.6	10.8	0.6	71.4	0.400	0.500
STAM	12	102	132	77.3	11.2	3.7	71.4	0.550	0.600
ARET	9	57	72	79.2	13.9	2.2	64.5	0.300	0.350
NRC	20	194	380	51.1	7.8	4.4	100.0	0.550	0.950
Social network analysis network density: 53.3 percent									

Source: Authors' estimation using Ucinet.

Notes: Ucinet is a Windows software package that was developed for the analysis of social network data.

When separate DARS sections are presented as individual entities, the picture changes substantially. At a glance, one can see the increased density of the network, which is confirmed by the network density of 53.3 percent. It is also readily apparent which DARS sections play a more central role within the network—namely, Plant Protection and Quarantine Services and Technical Services, and to a lesser degree Maize Breeding, Soils and Chemistry, and Horticulture. We also see that the Natural Resources College has moved to a more central position within the network. However, we still see that many CGIAR centers, private-sector companies, and industry associations remain on the periphery of the network.

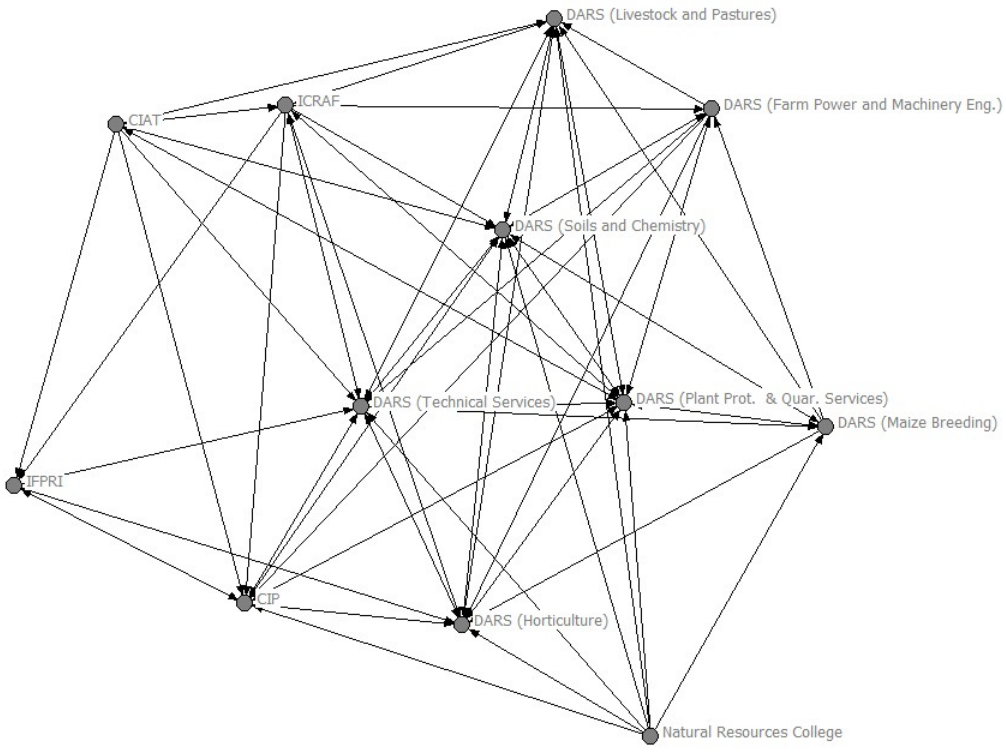
An examination of Table 3.2 confirms the influential roles of the aforementioned DARS sections (Plant Protection and Quarantine Services, Technical Services, Maize Breeding, Soils and Chemistry, and Horticulture). Plant Protection and Quarantine Services and Technical Services have very high means for both information sending and receiving, and high levels of closeness and betweenness, indicating influential roles in information exchange. The same measures for the other three sections are also relatively high and indicate their importance in the network. Private seed companies (SeedCo, Monsanto, and Pannar Seed) continue to occupy positions of relative influence and power, as indicated by relatively high means of information sending and receiving, closeness, and betweenness. We also see that the Natural Resources College occupies a significantly more important position in this example, particularly as a receiver of information and with a high level of closeness. Relatively low means for information sending and receiving for CGIAR centers, private-sector companies, and industry associations confirm their relatively less influential and powerful positions within the network.

Another interesting characteristic of this analysis is the relatively low levels of reach efficiency for some of the DARS sections (for example, Plant Protection and Quarantine Services, Technical Services, Maize Breeding, and Soils and Chemistry) and other organizations (for example, the Natural Resources College) that otherwise have strong indications of influence, suggesting that their networks are not very strong beyond primary points of contact. At the same time, CGIAR centers have relatively high levels of reach efficiency, suggesting that they rely on friend-of-a-friend connections to send and receive information.

Social Network Analysis without the Private Sector

Finally, we look at the Malawian agricultural research information network *without* private-sector companies and industry associations, leaving only the DARS sections, CGIAR centers, and academia. The results are presented in Figure 3.3 and Table 3.3. As in the preceding analyses, we see the important role that some of the DARS sections—namely, Plant Protection and Quarantine Services and Technical Services, and to a lesser degree Horticulture—play. The network density increases to 58.3 percent. However, we see that the CGIAR centers remain on the periphery of the network, even more so in some cases. The Natural Resources College has also shifted from a more central position to one on the extreme periphery of the network. Of note are the means for information receiving for the CGIAR centers and the Natural Resources College. With the exception of the International Potato Center, they remain very low, and the mean for the Natural Resources College has dropped to zero.

Figure 3.3—Malawi's agricultural information network (without the private sector)



Source: Author calculations using data collected from the 'ASWAp Operationalization and Research Capacity Strengthening in Malawi' project.

Table 3.3—Ego network measures for Malawi's agricultural information network (without the private sector)

Actor	Size	Ties	Pairs	Density	Reach Efficiency	Between-ness	Closeness	Mean	
								Info. sending	Info. receiving
DARS									
Horticulture	10	52	90	57.8	12.9	4.9	91.7	0.545	0.909
Livestock and Pastures	9	46	72	63.9	13.9	1.2	84.6	0.455	0.818
Farm Power and Machinery Eng.	8	45	56	80.4	14.7	1.6	78.6	0.636	0.364
Plant Prot. and Quar. Services	10	52	90	57.8	12.6	13.6	91.7	0.818	0.909
Technical Services	11	59	110	53.6	12.1	7.3	100.0	0.636	1.000
Maize Breeding	7	32	42	76.2	16.9	1.6	73.3	0.545	0.364
Soils and Chemistry	10	55	90	61.1	12.6	5.0	91.7	0.545	0.909
Other actors									
CIP	9	41	72	56.9	14.3	6.3	84.6	0.455	0.727
IFPRI	5	15	20	75.0	23.9	1.3	64.7	0.273	0.273
ICRAF	9	46	72	63.9	13.9	10.7	84.6	0.818	0.545
CIAT	7	29	42	69.1	17.5	1.2	73.3	0.636	0.182
NRC	7	35	42	83.3	16.7	0.0	73.3	0.636	0.000
Social network analysis network density: 58.3 percent									

Source: Authors' estimation using Ucinet.

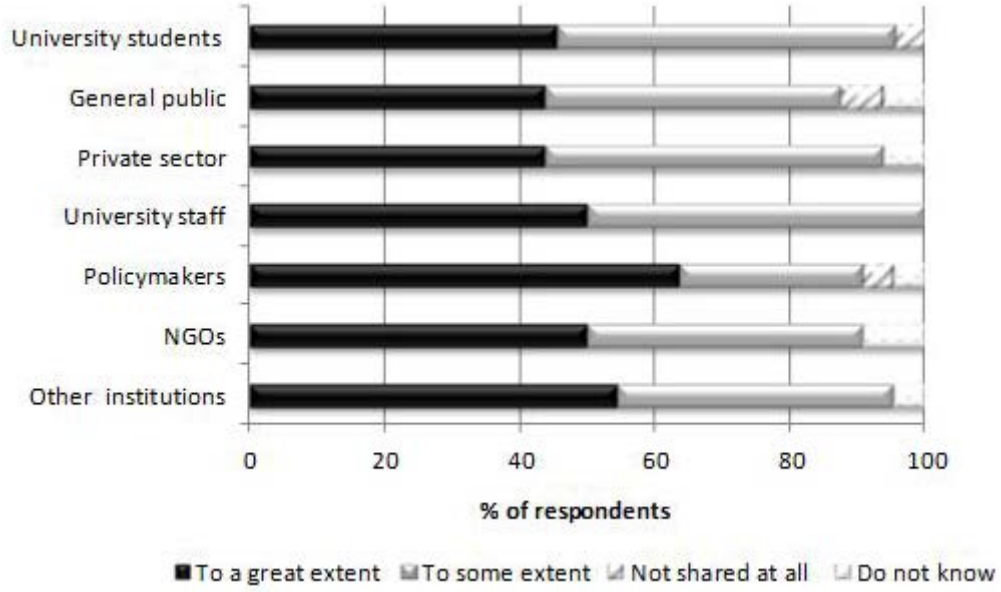
Notes: Ucinet is a Windows software package that was developed for the analysis of social network data.

Due to the deliberate elimination of some of the actors, the results of this analysis are necessarily skewed. Nevertheless, they suggest that the private-sector companies and industry associations play an important role, through secondary contacts, in bringing CGIAR centers and academia closer to the center of the network by facilitating information sharing with the DARS sections.

This assessment demonstrates that the DARS is a central coordinating body and facilitator of information sharing in Malawi's NARS. However, it also shows the important role other actors play in relaying information to a wider network of stakeholders. These secondary information pathways can play a crucial role. The analysis further illustrates that key stakeholders (CGIAR centers, the private sector, industry associations) remain on the periphery of the network. These findings provide much insight for policymakers and managers of agricultural research programs. This is because lack of information sharing is a threat to the successful implementation of national agricultural sector development strategies such as ASWAp in Malawi.

Differences in information sharing by different actors in Malawi's NARS are further confirmed by descriptive analysis. Figure 3.4 shows that in general the NARS actors share agricultural research information with a wide variety of stakeholders that includes university staff and students, policymakers, nongovernmental organizations (NGOs), other private-sector entities, and the general public, as well as other (research) institutions. Second, the results demonstrate that the extent of information sharing varies. From Figure 3.4 it can be seen that at least half and sometimes more of the NARS actors share information *to a great extent* with policymakers (63.6 percent), other (research) institutions (54.4 percent), and university staff (50 percent), respectively. In addition fairly large proportions of actors sampled said they share information *to a great extent* with the private sector (43.8 percent), the general public (43.8 percent), and university students (45.5 percent), respectively.

Figure 3.4—Extent of agricultural research information sharing with stakeholders



Source: Author calculations using data collected from the 'ASWAp Operationalization and Research Capacity Strengthening in Malawi' project (2012).

Half of all the respondents said they share research information *to a lesser extent* with the private sector and university staff. A fairly large proportion of respondents reported they share information with NGOs (40.9 percent), other (research) institutions (40.9 percent), and the general public (43.8 percent) *to some extent,* respectively. Third, Figure 3.4 further shows that although the majority of respondents share information on agricultural research with a wide variety of stakeholders in the country, some actors in the NARS do not share any information with some stakeholders in the sector. A small proportion of respondents said they share *no information* with policymakers (4.5 percent), the general public (6.2 percent), and university students (4.5 percent), respectively. Actors that share no agricultural research information with policymakers, the general public, or university students are mainly those under the DARS and private seed companies. About 20 percent of all private seed companies sampled reported sharing no agricultural research information with the general public, whereas an equal percentage of 11.1 percent in sections under the DARS stated that they do not share any agricultural research information with either policymakers or university students.

The statistical significance of the findings shown in Figure 3.4 was tested using the Kruskal-Wallis one-way analysis of variance by rank statistic. The results in Table 3.4 show that the Kruskal-Wallis test statistic for information sharing with policymakers was statistically significant at the 5 percent level of confidence (Kruskal-Wallis test statistic = 0.021 < 0.05). This provides evidence that the extent to which agricultural research information is shared with policymakers differs between different types of NARS actors—with some types of actors sharing agricultural research information to a larger or lesser extent than others, and other types of actors not sharing any information at all with policymakers.

Table 3.4—Differences in information sharing with different stakeholders between Malawian NARS actors

Stakeholder	Kruskal-Wallis statistic
Other research institutions	0.129
Nongovernmental organizations	0.120
Policymakers	0.021*
University staff	0.354
Private sector	0.098
General public	0.065
University students	0.67

Source: Author calculations.
Note: * Significant at the 5% level of confidence.

This analysis dovetails with the findings of the SNA about the importance of full participation of all stakeholders in the agricultural sector. ASWAp is a sectorwide strategy for Malawi's agricultural sector. Thus, its success hinges on the full participation of all stakeholders in the agricultural sector. Therefore the finding that some agricultural research actors do not share information with some parts of the sector poses a threat to its successful implementation. In Malawi, specifically, it threatens the ability of the country's agricultural research sector to respond to the ASWAp focal research areas. The way forward to ensure that actors in Malawi's NARS can respond to the ASWAp focal research areas will entail developing an information and communication strategy for agricultural research. Such a strategy should ensure that different actors in agricultural research are enabled to share information with all stakeholders in the sector, with specific focus on improving the capacity of the different types of research actors to communicate with and effectively inform policymakers.

4. CONCLUSION AND LESSONS LEARNED

The social network analysis demonstrates that although several units under the public agriculture research department play important roles in Malawi's agricultural research information network, there is scope for improvement to increase the efficiency of information exchange and contribute to implementation of the country's sectorwide strategy for agricultural development. Furthermore, there is evidence that many important players in the system are not fully integrated into the network, such as the CGIAR centers, private-sector companies, industry associations, and other academic institutions. Many of those players are somewhat cut off from the public agricultural research department and rely on their own networks (primary *and* secondary contacts) to send and receive information. Although the networks of some of those players are not as broad as those of the public department, in many cases reach deeper and further through the network due to reach efficiency or reliance on *friend-of-a-friend* information flows.

We can draw lessons for other African countries that have similar agricultural development strategies and similar national research systems. First, it is important that the private sector and other nontraditional research actors are brought into the mainstream research agenda. This is imperative if national agricultural research agendas that are part of the broader agricultural sector development strategy are to be fulfilled. This is because nontraditional research actors play an important role in relaying information to a wider network of stakeholders. These secondary information pathways can play a crucial role. This can be achieved through the development of national information and communication strategies for agricultural research systems. Such strategies should not only specifically focus on improving communication and information sharing in the sector, but also be geared to build capacity of different players in agricultural research to communicate effectively with policymakers. Strategies to improve information sharing and communication include joint work planning for supporting implementation of sector strategies, regular review meetings with government to evaluate what each agency is doing, and collaborative research.

Finally, if agricultural sector development strategies in Africa are to be implemented efficiently, government needs to take a supportive role and facilitate linkages. It might be necessary to establish a liaison office, such as an Agricultural Sector Strategy Partnerships and Liaison Office, responsible for research partnerships and linkages. Such an office's main role would be to support partnerships and collaboration for agricultural sector strategy implementation and make sure that there is an environment for CGIAR centers and other research institutes to collaborate with both public and private institutions, including NGOs. This office would be responsible for supporting the harmonization of the sector strategy components of all research plans and monitoring, evaluation, and impact assessment. It is important that the Ministry of Agriculture and Food Security include the private sector in sector strategy development activities to benefit from that sector's specific experience and knowledge and to access its own information networks. This would help institutions collaborate and share information, and facilitate linkages between the private sector and CGIAR center and government researchers. Although different institutions might have their specific work plans, for the sector strategy development activities, there is a need for institutions partnering on a specific development theme to develop clear work plans coordinated by the government through the suggested Sector Strategy Partnerships and Liaison Office.

Further research is needed to determine the key barriers to effective information sharing, as well as the staff capacity gaps and training needs and the institutional capacity and resource constraints. This assessment should feed into the development of a collective agricultural research strategic plan. The success of the collective agricultural strategic plan should be measured by how well it feeds into and responds to the national agricultural sector development agenda as well as other national-level development strategies. Its success should also be measured by how well the collective agricultural research plan is able to link and guide the operations of all agricultural stakeholders in the country and its ability to remain on track in the face of external and internal shocks. Hence, a comprehensive system for monitoring and evaluating the implementation of the collective strategic plan needs to be established at the onset.

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