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•• Briefing Paper

A Social Network Approach to Research Systems for Sustainable Agricultural Development: Results from a Study of Kenya, Ghana, and Kerala

By Wesley Shrum

abstract

The nature and frequency of linkages in developing country research systems has long been a concern of policymakers and research managers for several reasons. One is that research in science and technology requires collaborative relationships as well as effective communication. Another is that the material and informational resources on which research depends often lie outside the organizations in which projects are conducted. A science and technology *system* may be viewed as a set of people, organizations, and linkages that connect them.

This paper describes a *social network approach* to such systems, taking into account the primary sectors involved in agriculture and natural resource management. It outlines a methodology for producing an inventory of the set of relationships that actually occur rather than purely formal linkages that may or may not have consequences. It describes the kinds of information sources that may be generated through such a technique. Summary results are presented from a study of 137 organizations involved in agriculture and natural resource management in Kenya, Ghana, and Kerala. These include state research institutes, universities, and non-governmental organizations.

Results of the pilot study are presented on (1) internal organizational linkages, (2) external organizational linkages, and (3) perceptions on the role of linkages in improving research capacity. These suggest that Indian researchers operate in less bureaucratic and more cooperative organizational settings than Africans, who tend to supervise larger numbers of staff than they can work closely with. Priorities for capacity building that are significant for researchers themselves are examined. Improving links with extension, with international research organizations, and with policy makers are viewed as important, while workshops, travel, and electronic communications are seen as less important to improving capacity. That is, networking is viewed as more useful than simple communication. Although many believe that universities and national research institutes are insular, these results show that relations between organizations are predominantly between sectors, rather than within sectors. Finally, NGOs view the contributions of national research institutes highly, suggested that opportunities for

future collaboration may be more obtainable than often thought.

Introduction

Research systems in the developing world are exceedingly complex. Owing to their smaller resource base and need for external support, the research process in less developed countries involves more interdependencies than in industrialized countries. In agricultural and environmental research there are not only state research institutes and universities, but also international, private, and nongovernmental organizations, each playing a role in the process of research and utilization.

This complexity renders it difficult to produce an overview of the components of the research system within a given region or country. In consequence, studies of NARS in context are extremely rare. A well-developed methodology exists for producing qualitative reviews of the research program within state-sponsored research institutes. However, there remains a need for a means of systematically describing the components of research systems within a national and international context.

The pilot project discussed here seeks to develop such a methodology for describing and analyzing research systems based on a social network approach to social systems. Based on interviews with a sample of scientists and managers in three systems (Kenya, Ghana, and the State of Kerala in India), this briefing paper describes the implementation of the study and preliminary results on linkages between research organizations.

Social Networks

The idea of networks is most familiar as a form of regional research collaboration. However, during the past 25 years an approach to social systems analysis based on the concept of "social networks" has emerged and flourished. A social system—including systems of knowledge creation, diffusion, and utilization—is characterized empirically as a social network (Wasserman and Faust). A social network is a set of actors and the ties between them. "Actors" in this approach may be individuals or organizations. "Relationships" (linkages, ties) may be any type of association between actors.

In the social network approach, the performance (effectiveness, efficiency) of a system is viewed as a product of the nature and variety of relationships that link actors. There is no "one best form" for a successful system. One of the axioms of a network approach is that the *absence* of relationships is often as important to the functioning (or non-functioning) of a social system as their presence. Describing a social system is seen as a problem of mapping the social relationships that characterize the network, either from the standpoint of a particular actor in the system (i.e., a particular scientist or research institutute) or in a more holistic way (i.e., a national agricultural research system). The first step is to conduct an inventory of linkages such as described here.

Several principles drawn from network theory shaped the development of the study:

- At any given point in time, actors with varying resources are embedded in a complex framework of relations.
- Relationships between organizations may be indicated by ties between people.
- These ties provide certain opportunities and increase the likelihood of certain outcomes, while making others less likely.
- Relationships are interdependent, such that changes in one may have consequences for others.
- Current relationships are the outcome of a historical process that leaves actors with a unique history of relationships, only some of which are active at any one time.
- Information about resources, relationships, and behavior circulates within the network, continually producing knowledge about practices as well as reputations.

Moreover, the study employed the central methodological insight of the social network approach: *important information about the role of an actor in the system is often best obtained through asking other actors.*

Methodology: The Network Inventory

Describing a national system requires information about (1) national research institutes, (2) universities within which agricultural research is conducted, (3) private enterprises, and (4) the international research context of IARCs and donor organizations. With the emergence of agro-ecological approaches and increasing importance of on-farm, adaptive research, (5) non-governmental organizations must be included as well.

A network inventory of system performance faces two immediate issues: the identification of actors and the collection of information about their relationships. First, how can such a diverse set of actors be identified? A combination of bibliographic search and consultative methods can be employed.

One useful though incomplete method of compiling a list of research organizations is an on-line bibliographic search. This has an important advantage: productivity indicators are yielded as a by-product of the same method that generates names of organizations and people. Electronic searches may be conducted through modem links with commercial vendors who provide access to hundreds of publicly available databases. We utilized seventeen international databases (including general sources such as SCISEARCH and field-specific databases such as CAB, AGRIS, and AGRICOLA) to search for all items in the fields of agricultural and environmental research originating in Ghana, Kenya, or Kerala. All records of articles, reports, books, etc., for the years 1992-1993 were extracted. The information for each record was converted into a relational database that can be sorted by organization, department, author, and title (including abstracts).

Such a bibliographic search also yields important information on publications and reports about these regions that are published by scientists in developed countries. The results show that Kenyan researchers have the highest international visibility of the three locations and Kenya

generates the highest level of international research attention. Kerala has the lowest visibility even with better qualified researchers and much higher productivity in domestic journals. In all, bibliographic search methodology was generally *adequate for the identification of key research institutions within a country but* ***not*** *for the identification of individual scientists*. Further, the work of NGOs is not reflected to any significant degree.

Hence, a second method, based on interviews with knowledgeable respondents, was required to create a pool of NGOs. This allowed the incorporation of NGOs in the sample according to (1) the number of nominations received by a variety of sources, (2) their degree of interest or involvement in research and (3) a focus on agriculture, natural resources, and/or environmental issues.

This process of identification is crucial to a network inventory of organizations and linkages. Two lists of organizations are generated with this method. First, a relatively comprehensive group of organizations is needed to represent each state research system. This is used to create a structured format for detailed questions about linkages. Of course, a fully comprehensive list would be impossibly long, but we sought to be relatively inclusive in generating a list of the most important organizations in agriculture, natural resources management, and environment work.

Next, a subset of the comprehensive list was designed to form the basis for the sample of organizations to be interviewed. This consisted of a smaller list of organizations in four sectors: national research institutes, university departments, non-governmental organizations, and international organizations. (Private firms were not interviewed for this study.) In cases where we could not interview all actors in a given sector (as with university departments), productivity rankings generated by the bibliographic search were used to select the organizations. NGOs were selected based on their interest in agriculture/environment, and the research process.

A team of three interviewers spent one month in each location conducting both unstructured and structured interviews. The number of interviews per organization ranged from one to five and was proportional to the size of each organization (e.g., fewer interviews were conducted at small NGOs, more at large national institutes). In all, interviews were conducted with 53 national research institutes, 48 academic departments, 31 NGOs, and 5 international organizations.[1] With the cooperation of the director of each organization, we targeted mid-career researchers. We sought to divide our interviews between those whose names appeared in the international databases and those whose did not. A special effort was made to interview women researchers, who constitute 25% of the sample.

Information Sources

A network inventory is not a statement of formal programs or agreements between organizations.

[1] International organizations were all located in Kenya.

Indeed, it is recognized in the management literature that collaborative institutional linkages are not equivalent to actual collaborations between scientists. Statements about linkages that "ought" to exist, even in developed countries, are often formal programs that do not reflect what occurs on the ground. The generation of useful information for farmers and producers is the outcome of a set of *actual* relationships between people and organizations, not formal programs. So the next questions are how such an inventory can be obtained and what information does it generate?

The relational inventory can be seen as an "interview within an interview." It was accomplished in a three step process here, but can be tailored to various measurement needs and can be more or less complex. Respondents are asked to report their own ties with other organizations, the nature of these ties, and their assessment of the contributions (see Table 1 for a sample). Researchers were presented with the comprehensive list of organizations for their country and asked about their relationships. That is, starting with a set of "contact organizations" with whom linkages *could* have occurred, people were asked to name those with which they actually *did* occur within the past five years.[2] Next, just for those organizations with which they had some contact, they are asked to describe the specific types of relations from a list of eight types of tie. Finally, they were asked to "assess the contribution to agriculture and natural resource management" for each organization with whose work they were familiar. In addition to the printed list of contact organizations, respondents added the names of additional contacts that were not on the list.

Table 1. Illustrative section of international organizations from network inventory.

ORGANIZATION	YES **Some Relation in past 5 years**	WHAT KIND OF RELATION? received or gave funds, collaborative project, personal friend, worked there, research or training visit, information exchange, material exchange, attended workshop or conference	ASSESSMENT VG=Very Good G= Good F=Fair P=Poor
ICRAF Int Coun Res in Agroforestry			
WARDA West Africa Rice Develop Assoc			
ICRISAT Int Crop Res Inst Semi-Arid Tropic			
IITA Int Inst Tropical Agriculture (Nigeria)			
ILRAD Int Lab for Res on Animal Diseases			
ICLARM Int Cent Living Aquatic Res Mgmt			
CIFOR Cent. Int Forestry Res (Indonesia)			

[2] For Kenya, there were 168 organizations listed; for Kerala, 192; for Ghana, 193. Note that the international organizations (62) are the same for each location. In all 96% of these contact organizations were linked at least once to individuals in our sample.

IRRI Int Rice Research Institute			

This combination of interview and inventory yields the following information sources:

(1) *A survey of people*. A standard (questionnaire) survey of 293 researchers and their relationships.

(2) *A database of Person-Organization relations*. A set of 7221 records that summarize relations between individuals and organizations in terms of reported links.

(3) *A database of Organization-Organization relations.* A set of 5103 records that summarize unique relations between organizations. Such information can be used to produce graphic representations of the research system. For example, Figure 1 depicts the relations among the national research institutes in Ghana using a simply network graphics package (Krackhardt et al.). Stronger relations are represented by smaller distances between institutes.

(4) *A survey of Respondent organizations*. Summary information on 137 organizations whose members (at least one per organization) were interviewed directly and their relationships.

(5) *A database of Contact organizations*. Information on 411 organizations that were *linked with* our survey respondents. Since we did not contact all of these organizations directly, such information is less detailed than the survey of Respondent organizations, but still provides a perspective on the organizational contexts within which national systems operate. For example, the CGIAR centers are an important part of this context and their relations with scientists in Kenya, Ghana, and Kerala may be assessed with this method.

Results

A sample of findings obtained from analyzing the above information sources illustrates the kind of descriptive information yielded by this method. Findings from the conventional survey analysis are presented first, followed by network results.

Communication in organizational context

Research, regardless of sector, is a collective activity shaped by organizational context. How much research activity is actually reported by the typical individual? The average number of weekly hours worked by all respondents was 51, with 30 hours spent on research. The question of "weekly hours worked" is sensitive because many scientists are holding more than one job, but we specified "as a professional" here. Country differences are not large but differences between sectors are significant. University scientists typically work longer hours overall, but because of their teaching responsibilities, they spend less time on research (only 23 hours per week on research compared with 33 hours per week for institute personnel). Surprisingly, NGO

respondents claimed 26 research hours per week—that is, *more* than academic researchers.[3] A country comparison shows that while African NGO researchers spent about the same amount of time on research as university scientists, Indians spent 32 hours per week. Thus, the greater involvement in research by NGOs is primarily due to Keralan respondents.
Scientists and technicians work cooperatively to produce results, but such contexts are bureaucratic to the extent that the activities of researchers and technicians are supervised by others. Indicators were developed by asking respondents how many workers in various categories they supervise as well as the number of people with whom they work closely within their own organization. Results are presented in Table 2 for professional scientists and technicians.

Table 2 Average Number of Organizational Colleagues & Subordinates by Country

	Kenya	Ghana	Kerala
1) Professional colleagues	6.33	5.9	8.63
2) Professionals supervised	4.6	1.8	1.55
3) Difference between 1& 2	1.73	4.07	7.12
4) Technician colleagues	5.34	6.24	4.99
5) Technicians supervised	8	5.9	3.14
6) Difference between 4 & 5	-2.66	0.27	1.85

Overall, researchers supervise about 2-3 professionals and 5-6 technicians. However, the average number of professionals and technicians supervised is much higher for Kenyan scientists than for those in Ghana or Kerala. Even restricting the sample to scientists from national institutes, Kenyan researchers supervise nearly twice as many professionals as Ghanaians and over twice as many as Keralites. In fact, for all categories of personnel except students, Kenyans have a larger supervisory role.

[3] It should be noted that we left this question open to interpretation--whatever the respondent considered to be research was so counted. Further, we selectively sought to interview NGO personnel involved in the research process. So this finding should be qualified to say that among NGO respondents who had research responsibilities at all, many spend more time on research than some university scientists.

The importance of this difference is not apparent without a second measure of communication—the number of persons in each group with whom researchers work closely (defined as those with whom projects are discussed on a regular basis). "Working closely with" is not the same as "supervising." One may supervise many people, but not work closely with them. Similarly, one may work closely with many people, whether one is a supervisor or not.

Overall, respondents worked with seven other professionals (about three times the number supervised) and over five technicians or field workers (about the same as the number supervised). But Indian scientists report working closely with nearly nine other scientists while Africans work with only six. Taking the difference between the two indicators shows the extent to which a researcher works closely with those s/he does not supervise and indicates the extent of collaboration that does not simply result from formal, hierarchical relations.

The use of the this new variable makes the difference between countries clearer. As shown in Table 2, Keralites work closely with significantly more organizational colleagues than Kenyans or Ghanaians. Indian respondents, for example, work with over seven scientists they do not supervise, while Kenyans work with only one or two (row 3). African scientists do not typically work closely with others than those they supervise. While Kenyan researchers actually supervise more technicians and field workers than they work closely with, Keralites work with more technicians and field workers than they actually supervise (row 6). Narrowing the subset of researchers to university or national institute contexts, this finding holds. It strongly suggests that Indian researchers operate in less bureaucratic and more cooperative organizational settings than Africans. The span of control for Kenyan scientists may be too large: if so, there is unused capacity or such low levels of subordinate training exist as to constitute a questionable use of resources.

Perceived Needs of the Research System

The literature on capacity building rarely takes into account the opinions of researchers in developing countries. A major objective of the study was to determine the needs of the research system from the viewpoint of the people most closely involved in its operation--the scientists. From a policy perspective, this analysis represents the "demand side" of capacity building.

The first approach was to ask respondents to *rate* the importance of twenty factors that are widely discussed in the literature on capacity building. Factors are listed in decreasing order of priority in Table 3.

Table 3. Rated importance of twenty factors in capacity building
(1) Providing operating funds for field and lab work
(2) Expanding and improving libraries
(3) Improving communication between researchers and extension
(4) Improving links with international research organizations

(5) Establishing research plans and priorities for programs

(6) Improving management of research resources
(7) Improving management of research programme
(8) Maintaining the physical infrastructure
(9) Including users in the process of setting research priorities
(10) Improving communication with policy makers

(11) Increasing salaries and improving conditions for researchers
(12) Providing funds for workshops between institutions
(13) Providing funds for travel
(14) Creating electronic communication networks within the country

(15) Creating international electronic communication networks

(16) Building new facilities
(17) Sending nationals abroad for training
(18) Hiring more researchers
(19) Hiring more technicians & support staff
(20) Increasing the number of university staff

The second approach to assessing needs of the research system was to ask respondents to rank a smaller subset of factors. Six broad categories were presented and ranked from one to six, forcing the choices between areas rather than allowing each to be rated equally important. Average rankings for all respondents are as follows, with low scores indicating high priority:

Table 4. Ranking of six areas of capacity building.

2.41	Setting research plans and priorities
2.56	Salaries
3.17	Management
3.34	Operating budget
4.36	Training budget
5.12	Communication budget (including travel)

These forced choice rankings show that the operating budget, although first in the ratings, is not considered the most important factor for the improvement of the research system. Though most everyone appreciates that operating funds are an important problem, setting research plans and priorities is generally considered the most important factor for improving the research system with salaries close behind. These rankings tell us much about the ways researchers perceive the problems in the research system. "Setting plans and priorities" is seen as more important than

"management." Researchers do not feel that adequate general guidance has been provided by policy makers and senior planners. They believe the research system is unfairly criticized for slow progress or irrelevance when in fact the process of priority setting has failed. The low ranking for training is consistent with the generally low rating observed for nearly all of the human resource development factors in the preceding section.

Communication and networking factors are complex because in terms of average ratings they are distributed throughout the list, while in terms of comparative ranking the entire group is last (less than ten percent of the sample ranks it among the top three factors). A view expressed by a few respondents was that *too much* time is spent communicating. With donor missions, training and coordination workshops, and numerous gatherings both within and outside the organization, researchers fill their days with superfluous and time-consuming meetings. This is not likely to be the case, however, with the bench level scientists we generally interviewed. University researchers, more than those in other sectors, were more likely to rank communication important, while researchers at international organizations rank communication the lowest—perhaps since they have access to excellent communication technologies themselves.

The message here is that researchers are relatively discriminating with respect to the different varieties of networking and communication. They are not inclined to think that more resources should be poured into communciation simply for the sake of communication. Rather, it depends on the specific kinds of linkage.

(1) The research-extension linkage is considered important by virtually everyone. Keeping in mind that we interviewed few respondents who were involved in extension alongside local research (NGOs) this finding is quite important. Kenyans are most likely (95% say it is "very important") while Keralans are least likely (74%) to rate this connection highly. Sectoral differences are not large. International organizations and NGOs, with national laboratories close behind, believe it is very important to improve this type of communication, but 80% of university respondents do as well.

(2) It is generally felt that only countries with some research capacity of their own can benefit from collaboration with IARCs and regional research institutes (Jain, 1990, p. 40). The data here show that in terms of their rated importance to improving the research system, links with international research organizations are highly valued. Neither country nor sector makes much difference to the rating here--though respondents at international organizations themselves are slightly less likely to say this kind of linkage is "very important" while university researchers rate it very highly. These differences are small and lend credence to the idea that international research centers are generally viewed very positively.

(3) Communication with policy makers was rated moderately important, tenth on the list of factors. There are large country differences here, with Kenyans more likely than Keralans to view its improvement as a priority. Sectoral differences are also important. International organizations and NGOs are more likely to see improving communciation with policy makers as a priority, with universities next and national institutes least likely.

The final group of communication and networking items deals with the *means* of communication, receiving relatively low average ratings, just ahead of the human resource factors. The set of two items pertaining to meeting and movement is followed by a pair pertaining to electronic communication, specifically distinguishing between domestic and external linkages. Electronic communication--using PC-based phone and computer links, are widely perceived as cutting edge communication technologies, but researchers in developing countries were not extremely optimistic about their capacity to improve the research system, a view borne out in our qualitative interviews as well. However, there were important differences by country and sector.

For both domestic and external networks, Keralans rate electronic communications more important than either African location. Fewer are interested in international electronic networks than in internal networks. For the country at the lowest level of development, international electronic communication networks are not perceived as a critical need for the research system. University researchers are more likely than those in other sectors to rate both domestic and external networks highly. International researchers have a relatively low opinion of the degree to which electronic communication will improve national research systems.

It is understandable that university researchers perceive electronic communication as an important means of keeping in touch with colleagues. However, one might suspect that if electronic communication networks were an unalloyed benefit, then researchers at international centers, who are the only people in our sample to have regular access to such technology, would rate them more highly. In fact more than one third said it was not so important or not at all important. Although we did not ask for an explicit ranking of electronic communication, it is significant that the item on "creating international electronic communication networks" received the lowest rating of any of the seven items on communication and networking. Paraphrasing what one researcher said, "it'll be another white elephant. The donors will come in and try to establish electronic links, then leave and not support the system. It's not that important."

In sum improving links with extension, with international research organizations, and with policy makers are viewed as important, while workshops, travel, and electronic communications are seen as less important to improving capacity. A simple hypothesis can account for these clusterings in the communication ratings: group linkages are perceived as more important than mechanisms of linkage in building the research system, or again, *networking is viewed as more useful than communication*. Each of the specific groups we asked about--extension, international research centers, and policy makers--were seen as important, while traditional means of creating linkage such as workshops and cutting edge technologies involving electronic communication were seen as less significant.

Person-Organization Linkages

As participants and researchers well know, there are committees that never meet, and programs

that exist on paper with scarcely any consequence. "Formal" relationships do not necessarily translate into "actual" ties relevant to the research process. At one level, research capacity can be viewed as consisting of the set of people, organizations, and resources available within the research system, together with the set of relationships that bind them. We sought to learn the extent of relationships that were present both nationally and internationally, what kinds of actual linkages were most common, and how they varied by sector.

The first feature to be noted about the three systems studied is that there is no obvious relationship between the development of the system and the sheer frequency number of reported relationships. For instance, though we conducted more interviews in Kerala, there were fewer total relationships than in Ghana and Kenya.

To what extent does the set of linkages constituting the research system involve various sectors? This question can be examined by asking how many relationships are reported *to* different kinds of organizations. In all, over one third of reported ties (36%) are to state research institutes. Least active is the private sector, with 5% of all linkages. International organizations received one quarter of the ties, followed by university departments (16%). Nongovernmental organizations are reported as recipients of 11% of the total.

With this information we can compare the sector of each respondent to the sector of the contact organization and estimate the extent to which linkages exist between sectors. Given the widespread belief that organizations within an institution such as universities or national research institutes are insular, it may come as a surprise that *inter-organizational relations are predominantly intersectoral.* In fact, two thirds of all reported relationships are to organizations in other sectors. This is true regardless of which sector or country is reporting the linkage. University researchers—reputed to be residents in an "ivory tower"—are actually *more* likely than others to have contacts with organizations outside their sector.

The inventory method required that after establishing whether any type of contact exists between with a particular organization, each reported relation is described in terms of eight types of relation: funding, collaboration, friendship, work, visits, information flows, materials exchange, and workshops or conferences. In general, it will be the case that the more frequent the tie type, the "weaker" is that type of relationship, and conversely, the less frequent the tie type, the "stronger" the relationship.

Table 5 shows that friendship and the exchange of information or assistance are more common than other types. They occur in almost half of all relationships, followed by exchange of more tangible objects such as materials or reports. Less common are collaborations, visitations involving research or training, and conferences or workshops. Working directly with an organization and relationships involving funding are the least common, since they are relatively strong linkages.[4]

[4] "Other" tie types constitute 9% of all reported linkages. Note that percentages do not sum to 100% because each linkage may involve more than one type of tie.

Table 5: Frequency of Linkage in Research Systems	% of Total Links
Personal friend	45%
Gave/requested information or research assistance	45%
Borrowed/lent materials, samples, papers, reports	29%
Collaborative project	24%
Research or training visit	20%
Attended workshop or conference there	16%
Received or provided funds	11%
Worked there	4%

The number of linkages tells us more when it is combined with information on sector and reputation. Relations that are common for some components of the research system are rare for others, a condition that indicates the kind of research environment within which these components operate. For instance, respondents from international organizations were about twice as likely to be involved in funding relations than other sectors and more likely to be involved in collaborative projects as well as visits and workshops. Among national sectors, however, it is NGOs that report the most collaboration as well as the most frequent information exchange. NGOs also report greater emphasis on workshops and conferences than do universities and national institutes. University researchers are least likely to report relationships involving collaboration, exchanges, and workshops. National institute personnel are more likely than other sectors to report friendships.

The issue of friendship is significant. It should not be viewed as an indicator of cronyism or an impediment to a high performing research system. This issue can be examined indirectly by asking the following question: Does the presence of friendships with another organization lead to a biased assessment of that organization? The assessments of those who reported friendships were compared with those who did not. In fact, of *all forms of relationship tested, friendship is the least likely to be associated with biased assessments*. That is, having friends in another organization leads to a more accurate view of that organization's operation, including its problems and constraints along with its innovations and success. If one simply attends a workshop, it may appear that an organization is making important contributions to agriculture—if one has a friend there, its activities may be viewed in a more realistic light.

Relations between Research Sectors

How strong are the linkages between sectors in the research system? Do such linkages depend on the level of development of the country? How does each sector view the contributions of other sectors? To answer these questions, we recall the central methodological insight of the network approach. The best way to measure and evaluate the linkages of a particular organization within a research system is *not* to ask members of the target organization, which may be biased or inaccurate in various ways, but to collect the information from others in the research system. This method was used to assemble information on the 131 national organizations in our sample, in order to calculate the number of linkages *to* each organization, as reported by all other organizations.

Table 6 shows the average number of ties reported to organizations in each sector for each of the three locations. The last column shows the average number of ties to all organizations in each sector, while the last row shows the average number of ties to all organizations in each location.[5]

Table 6. Average number of organizational links by country and sector

	Kerala	Kenya	Ghana	Average Sectoral ties
National	17.95	17.94	17	17.68
University	14.32	12.42	11.56	12.89
NGO	8.0	13.17	7.06	8.45
Average Country ties	15.06	15.15	11.57	13.78

Organizations in both Kerala and Kenya have significantly more linkages than those in Ghana, a difference that may reflect more integrated research systems. Otherwise, what is most striking about organizational linkages are the differences between sectors, which are relatively large. In all locations, national institutes have more ties than other sectors, and their number is relatively consistent across locations. University departments have more links than NGOs, with the exception of Kenya. Kenyan NGOs average slightly more links to other organizations than do university departments, and substantially more linkages than do NGOs in Kerala and Ghana.

Average numbers of links within the research system, such as shown in Table 6, are especially important when they are viewed in the context of an evaluative process. Reputation, as we have used it here, is the *contribution to agriculture and natural resource management*, as viewed by

[5] International organizations have more contacts than national sectors, but of course their linkages may be reported by respondents in all locations.

other constituents of the system. Only individuals that have some kind of tie to an organization are allowed to assess it. These assessments are used to generate evaluations for each organization by averaging. It is outside the scope of this briefing to present evaluations for individual organizations. Instead, we illustrate the method by presenting differences in reputation for different sectors and countries.

Evaluations given to organizations in Ghana, Kerala, and Kenya are quite similar. This is not the case with sector—indeed, there are fairly large differences between the rated performance of the international sector and other sectors, with university departments rated above state institutes, followed by NGOs, private firms, and ministries.[6] National research institutes are, in all three cases, rated below universities and above NGOs in terms of their contribution to agriculture and natural resource management. It would be easy to conclude that such a ranking justifies a simple policy of resource provision to high performing sectors. However, since assessments of the contribution of these sectors differ by country, we must exercise a *caution against speaking of overall sectoral evaluations*. To give just two examples, Kenyans—who are most familiar with international organizations given their visible presence in Nairobi—rank international organizations lower than Ghanaians and Keralites. There, university departments are viewed as having made a greater contribution to agriculture and natural resource management. Ministries, viewed least favorably in both African countries, are seen as having greater impact in Kerala than NGOs or private enterprises.

National institutes, universities, and NGOs all have a role to play in the research systems of developing countries. It is well known that they often disagree on such issues as the role of basic research, the extent and nature of collaborative projects, and their relative influence on the direction and pace of knowledge relevant to sustainable development. In particular, it is often thought that their views of each other can help or hinder the process of development. We can examine these views by averaging the ratings given by sectors to other sectors. A high rating shows that a particular group views the contribution of another group highly—sometimes more highly than they rate their own group.

Because state institutes and universities comprise the "traditional NARS," they have been placed together in the upper left corner of Table 7. Combined results are presented for all three locations. In general, we expected researchers to give the highest ratings to other organizations in their own sector. While university researchers do give the highest ratings to other universities, this is not true for all sectors. State research institutes rate university contributions slightly higher than they do their own, while they rate the work of international organizations most highly. In fact, international organizations are most highly rated by all except the academic sector, which gives equally high marks to the private sector.

Much has been said about the views of NGOs relative to the state and the university system. Table 7 shows that while national researchers have a relatively low opinion of NGOs (as well as

[6] Private enterprises and ministries were rated but not interviewed.

their own Ministries), it is not shared. In fact, NGOs and state institutes have remarkably *dissimilar* perceptions of each other. After international organizations, NGOs rate the contributions of the state institutes most highly. They rate the contributions of their own sector significantly below the state while they assess university work at about the same level as their own.[7]

Table 7. Average assessments of organizational sectors

	Univ	State	NGO	Inter	Private	Ministries
University	3.27	3.14	2.97	3.09	3.09	2.73
State	3.07	3.06	2.97	3.27	2.95	2.97
NGO	2.99	3.15	3.01	3.25	2.77	2.82
International	2.93	2.88	2.87	3.12	2.7	2.61

Conclusion

The social network approach has been used in a wide variety of social scientific applications but is underutilized in the study of research systems in less developed countries. The importance of having a means of generating systematic information about research systems is particularly apparent during the renewal of the CGIAR, which stresses partnership with and incorporation of NARS priorities, as well as relationships with NGOs. Through its focus on actors as both organizations and individuals, and its treatment of linkages between actors, a social network approach will often be preferred for the study of national research systems in agriculture and natural research management. Through its systematic methodology for producing an inventory, it is ideal for assessing the set of relationships that actually occur, rather than purely formal linkages. The data generated range from the standard survey of individuals, to files of individual-organization links, to summary information on organizational embeddedness and reputation.

Summary results from a study of organizations in agriculture and natural resource management in Kenya, Ghana, and Kerala were presented for state research institutes, universities, and non-governmental organizations. It was shown that Indian research institutes tend to be less bureaucratic and more cooperative than African institutes, whose structural features are such that scientists tend to supervise larger numbers of staff than they can work with closely. Priorities for capacity building were examined in terms of those needs that are significant for researchers themselves. Important elements were improved links with extension, with international research

[7] Of course, we must keep in mind that individuals did not rate their own organizations.

organizations, and with policy makers. Enhancement of workshops, travel, and electronic communications were viewed as less important to improving capacity. This finding may be summarized in the maxim that networking is more useful than simple communication. Although there is a common belief that universities and national research institutes are insular, the results above show that relations between organizations are predominantly *between sectors*, rather than within sectors.

Finally, the results on rated contribution cast doubt on any simple formulae regarding the potential for collaboration between state institutes and NGOs. The fact is that NGOs rate state research organizations highly, and often expressed the desire to work more closely with them. However, staff scientists at national research institutes frequently view NGOs as poorly trained and highly localized in their concerns, which accounts in part for the relatively low esteem in which state institutes hold NGO contributions. If these asymmetric perceptions are not recognized and taken into account, there is scant possibility they will be bridged in future programs.

References

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About the study

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