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Science and Story in Developing Countries:

The Emergence of Nongovernmental Organizations in Agricultural Research

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Abstract

Given the importance of social location to research practice, a particularly compelling problem for social studies of science is how research activities emerge in a new sector. Nongovernmental organizations (NGOs) in less developed countries are initiating research, often in a style of 'alternative' agriculture. I account for this development using concepts from semiotic and structural network approaches. While many studies stress linkages as the key to technoscientific organization, delinking is especially important to the emergence of a new research sector in the Third World. Stories of participation, indigenous knowledge and greening allowed NGOs to capitalize on local relationships and tap external resources by offering the technological alternative of 'organics'. But such institutions are also buffeted by the opportunities and constraints of resources imported from outside. This development is illustrated by the case of Shamba, an NGO whose research involvements illustrate the promise and pitfalls of both locality and linkages.

In western Kenya there is a school for farmers, one of many in the developing world. Shamba Agricultural Center is not one of the better known sites in the country, though it is near the Kitum Cave, famous as a possible source of Ebola virus. Most tourists bypass such areas in favor of wildlife parks and climbing peaks. The fluster over Ebola is an extreme counterpoint to the uplifting work of Shamba, an unassuming cluster of workers and students whose business is to tell stories and produce practices. These stories and practices are a style of technology recognizable as organic farming. Odd, that this small school should be the recipient of a research grant that few centers in Kenya can match, one quarter million dollars from a large, international Foundation. Shamba illustrates a new and increasingly important phenomenon in the developing world, a non-governmental organization involved in research. I will argue that locality, linkages, and the style of organics are responsible for this shift.

Non-governmental organizations (NGOs) are not new on the international scene, but their impact as recipients and channels of development aid, as well as their involvement in research activities, is no longer possible to ignore. They represent a far point in the intensely complex research institutions of the developing world, one that stretches from the Rockefeller Foundation and the Consultative Group for International Agricultural Research to a small NGO interested in the role of women in agriculture. It was modeled--that is to say, carried by European colonists and, later, development specialists--on distinctive organizational patterns drawn from the developed world. However, to imagine that research in the Third World is a simple reflection of the organization in disciplines, specialties and problem areas that characterize U.S. and European science is a mistake. Science in the developing world exhibits a rich and varied social

organization of its own.[i]

In the first part of this essay, the context of agricultural development is introduced and framed by three problems for STS in less developed countries. While the 'network' concept offers the greatest promise for the analysis of research institutions in the developing world, elements of both structural and semiotic network approaches must be combined. In the second part, the major actors and technological regimes are outlined, together with key trends that led to the 'failure' of linkages that opened a space for research activities by NGOs. In the third, the story of Shamba is told to illustrate the consequences of the new linkages, participative research programs and resource complexities that are common in developing countries. The splitting and proliferation of organizational entities shows how the flexibility of new technological regimes can lead to changes in social organization without significant shifts in research or technological practice.

Knowledge, Networks and Change

Agriculture is not the oldest, but rather the most venerable technology known to humans. What is striking from the standpoint of contemporary studies of technoscience is its near perfect embodiment of the 'seamless web' of social, technical, economic and political dimensions.[ii] Even committed technicists are quick to admit that agricultural technology consists of, in Bijker's coinage, 'sociotechnical ensembles' of a heterogeneous nature.[iii] Though these ensembles are black-boxed into machines that seem obdurate and fully stabilized in the industrialized growing of the developed world, few are tempted to analyze agriculture in less developed countries as an unproblematic application of technology. Rainfall, soil, animals, chemicals, organic matter,

tools and seeds interact with knowledge and social organization to generate the most basic of production outputs: sustenance and risk.

Indigenous knowledge and traditional social organization have, of course, provided these outputs for ten millennia. There is no inherent reason that alternative, technoscientific knowledge must be developed and disseminated, embodied in machines and materials, distributed as certified practices. Not only do non-Western cultures possess stores of knowledge and practices pertaining to cultivation, but they engage in its innovative development, a kind of 'informal R&D'.[iv] Not just knowledge, but new knowledge has characterized agricultural technology since the horticultural era.[v] Yet globalization of agricultural research has proceeded apace, producing knowledge claims that often replace or supplement indigenous knowledge. Even when nations are too small and resource poor to support fully generalized research institutes, they are encouraged to fund scientific staff strictly to adapt and disseminate knowledge from elsewhere. The first problem for any constructivist analysis is, How do indigenous and scientific knowledge claims interact?

Growers themselves did not decide to erect--and may not even know about--the massive network of international research centers, university departments and national research institutes devoted to their difficulties. They are more likely to be familiar with extension agencies operated by the state and the services offered by 'grassroots' NGOs. Professional staff in research organizations--even those heavily involved with teaching--are faced with continual shortages of funds though they are continually asked to produce new and relevant knowledge for various constituencies. The second problem: How such a diverse array of actors is connected?

Agricultural technology--even under the expanded definition that includes fisheries,

forestry and livestock together with crops--involves growth and harvesting. To grow more, or grow it with fewer resources, or without adverse effects are all legitimate goals--and this leaves out what for many are the critical issues of opportunities for growth and distribution. Hence, technological change is multifaceted and contentious, with machines often playing small role in the process. The third problem is, How can technological change--much less 'progress'--be characterized in such a complex sociotechnical field?

Localism and Globalization

These three issues--the interaction of scientific and indigenous knowledge, linkages and change--may be interpreted as separable aspects of the problem of locality, a theme that has long dominated STS. Shapin, in a recent review of the sociology of scientific knowledge, sums up two decades of work as depicting in detail 'the ways in which the making, maintaining and modification of scientific knowledge is a local and a mundane affair'.[vi] Three of the most significant 'localist' arguments have been developed in the context of Western scientific development, but tailor to less developed countries with little alteration. (1) Knowledge-making is a mundane matter that can be explained by ordinary forms of social interaction. (2) Since plausibility does not inhere in knowledge claims, processes of persuasion, credibility and doubt are of paramount importance. (3) As knowledge is not unproblematically transferred from one actor to another through formal rules and recipes, principles of re-location must be identified, whether embodied in people or artefacts.

These localist arguments center on the physical situatedness of knowledge-making. As attention has been laboriously deflected from the narrative of scientific universality, 'topical

contextures' have assumed a central role.[vii] What traits, that is, characterize the knowledge claims produced in specific laboratories? What marks do specific fields and regions leave on statements and machines? What signatures do research schools or nations inscribe on their intellectual products? Now that there is relative consensus on the situatedness of knowledge, studies of science and technology seek to go beyond understanding what that implies--the subject of the current science wars--to a theory of how it operates.

If knowledge is situated rather than universal, the problem of relocation at once dominates theoretical and empirical interest--the problem of how knowledge travels. Technological knowledge is incorporated in artefacts, practices and actors. It has been widely assumed that if one could only trace the pathways of these entities, a satisfying account of technological change would be forthcoming. Tremendous strides have been taken in this direction, but there is far to go, particularly in the context of developing areas.

Structural and Semiotic Networks

The initial breakthrough may be attributed to the concept of a 'network'. Now widely used in virtually every social scientific field--either as metaphor or method--it gained currency in STS through the work of Mullins, Crane, Callon and Latour. Representing quite different views of technoscientific knowledge, these traditions fall into what have been called 'social network' and 'actor network' approaches, or, alternatively, 'structural' and 'semiotic' approaches.[viii]

The structural approach originated with British social anthropologists J.A. Barnes and Clyde Mitchell, but was used, even in the 1950s, to study the diffusion of technical innovations.[ix] In the sociology of science, it was widely employed in the 1970s, primarily to study the

emergence and development of scientific communities.[x] Such an interest was motivated by both Kuhnian and Mertonian considerations, elaborating the structural differences in patterns of coauthorship, apprenticeship and citations that accompanied shifts in problem foci, paradigm development and intellectual consensus. While these internalist studies became more sophisticated in their linkage of intellectual and social factors, a separate stream of studies developed a tradition of research on adoption of new technology.[xi] Much of this was conducted in less developed countries, given the extensive interest in mapping the diffusion of artefacts such as birth control devices and hybrid seed varieties.

Semiotic treatments of the network idea gained popularity in the mid-1980s, appealing to the dominant constructivist sensibilities that had employed it a decade earlier, but with important differences from the structural network view.[xii] First, and most important, it sought to go beyond the boundaries of academic science, to 'follow scientists and engineers through society', addressing the problem of how knowledge travels.[xiii] Second, it did not view propositions or artefacts as unproblematic, but as aspects of technoscience with varying degrees of stability, which sometimes became obligatory passage points within networks of other actors through a combination of technical and rhetorical means. To that end, 'translation' has served as a fruitful way of describing what happens to knowledge claims when they leave home, with somewhat less baggage than 'application', 'transfer', 'adoption', or 'adaptation'. Finally, passage points and their ties were taken to consist in an assemblage of human and nonhuman actors. The ontological distinctions among quasi-objects and quasi-humans are abolished in favor of the more general analytic vocabulary of semiotics that recognizes 'actants' in a text, where the latter can be understood as ranging from manuscripts to social settings.

Structural and semiotic approaches agree that networks of linked entities are the basic constituents of the technoscientific realm, but neither is without difficulties. The structural approach, because of its focus on the measurement of relations, has employed an overly restrictive view of social actors, operating at personal, organizational, or national 'levels of analysis'.[xiv] The major debate where global technoscience is concerned has been whether it consists fundamentally in (1) a system of individual researchers who form scientific specialities, regional systems and a world system of science or (2) a system of organizations, including multinational corporations and national governments.[xv]

But to reduce the character of the social actor to this narrow range of possibilities is to ignore the vast array of other groups, committees, projects, programs, oversight bodies, councils and other social formations that affect the course of technoscience. Moreover, the idea of 'levels of analysis' has bound observers to overlook significant connections between different kinds of actors. Links between actors taken to operate at different analytical 'levels', e.g., persons and organizations, are ignored. For an approach whose strength is often taken to be the measurement and analysis of relations between actors, there remain serious problems with the conceptualizaton of these entities as well as the treatment of their interactions.

The semiotic approach overcomes these difficulties through abrogation, but at great cost. Actants consist of a heterogenous ensemble of artefacts and people, animals and things--brought together in networks of variable potency through the operations of enrolment and translation. There is a seductive integrity to the framework, just as in a structural approach that relies on the notion of 'levels'. Allowance for connections among diverse kinds of actants is unlimited, owing to the abolition of constructed boundaries among types of actors and spheres of action. This

accomplishment owes much to the focus on the establishment of rhetorical ties among entities and is not a consequence of the new ontology of actants, which has not generally been seen as plausible--or even widely understood--outside its locus of origin. Increased tolerance for entities eventuates in a relative inability to understand the kinds of connections that exist between them. Curiously, for an approach whose strength is the comprehensive idea of an actor network, the actors are too heterogeneous for their linkages to make sense.

The merits and vigor of both structural and semiotic perspectives seem clear, but ought not blind us to their limitations. The interaction of scientific and indigenous knowledge, the structure and operation of connections between entities, and the appropriate characterization of technological change are not adequately treated by either, nor has there been a convincing attempt at integration. While the structural perspective has traditionally given precedence to the detailed treatment of linkages, their analytical manipulation, and their effects on outcomes, its focus on quantitative characterizations has vastly outstripped the ability of models to provide convincing explanations of knowledge production and transmission.[xvi] In short, it is precise with respect to network, but weak in regard to story. While the actor network perspective is better equipped for the task of accounting for the interaction of forms of knowledge, it principally provides a descriptive vocabulary for actors and their relations.[xvii] In short, it is strong on story, but weak on network.

The following section addresses those aspects of locality formulated above: the ways indigenous and scientific knowledge claims interact and the connectedness of arrays of actors as well as technoscientific change. Knowledge, linkage and change are presented as products of the relationship between networks and stories. First, the primary research formations are outlined,

together with a brief account of the technological style associated with the Green Revolution. Next, technology transfer is interpreted in terms of alternative accounts of locality, as extension 'fails' and new linkage solutions are sought. The explanation for the emergence of non-governmental research organizations follows.

Locality, Globalization and Sustainability

At the present time, developing countries afford an unusual opportunity to witness the emergence of a new research sector in formation. This phenomenon is the advent of research in non-governmental organizations. The inertia of social organization--that is, the institutionalized pattern of scientific actors and ties--tends to resist new entrants into the research field. An account of institutional innovation incorporates new identities by means of network ties and stories, since embedding[xviii] into preexisting networks is the condition for change. In the case of NGOs, embeddedness in research formations arises through 'alternative agriculture', that is, 'organics' as a technological style.

Research organizations for export crops and commodities provide the foundation for technoscience in Africa, Asia and Latin America. Many institutes were devoted to common problems, organized on a regional basis, sometimes with a network of substations, such as the West African Cocoa Research Institute in Ghana. But post-colonial institutional development began in earnest with the proliferation of universities, governmental research institutes and the international network of institutes that eventually became the Consultative Group for International Agricultural Research (CGIAR) in 1971. Today, the primary organizational entities may be described as 'sectors' characterized by different forms of organizational structure

and functioning: academic departments, state institutes, international agencies, private firms and nongovernmental organizations.

One way of viewing sectors is as guides to typical structures within which various kinds of research activities take place, performed by social actors facing different types of constraints. Academic departments consist of a loosely coupled grouping of researchers, without coordination between research projects. A never-ending stream of students intersects a professorate with ties to developed country institutions, often those where individuals received--or are receiving--postgraduate training. Laboratories and fieldwork are poorly funded. Research time often gives way to secondary employment. One of the most common complaints about university science in LDCs is that professors are oriented to irrelevant problems areas or specialties because of their strong ties to scientists in developed countries.[xix]

Government research institutes are generally embedded in an elaborate formal structure (semi-autonomous research councils, ministries, university-based systems of experiment stations) that includes linkages to Extension Services with the goal of providing technology to users. In contrast with academic departments, relationships within a national system are common, both between institutes and with other sectors. Knowledge claims are oriented towards relevance as a value. State institutes are sited in the political world of ministries, producers for export and development interests. Small institutes may be isolated by their remoteness and lack of communications technology. But the differentiation of a national research organization into a set smaller formations distinctive in research focus or geographical coverage results in a set of institutes that jockey for prestige, resources and often survival. Knowledge claims and practices for agriculture (always) and natural resources (recently) are the subject of contracts and

counterparts.[xx] What makes claims and practices 'scientific' is their association with scientific institutions.[xxi] In agriculture one of the clearest forms of association--is the production of 'Recommended Practices' by experiment stations. These 'officially' sanctioned formulations are based on research, certified by committees and become objects of transmission by extension. For a half century, most formulations have been related in terms of a particular technological pattern.

The 'Green Revolution', named long before the most recent environmental movement, is a style.[xxii] Its fluidity is expressed in a variety of characterizations, beginning with two major themes: increasing agricultural productivity and the modernization of agricultural technology. Such style requires provenance, a story told in terms of need (increasing populations in LDCs and low agricultural productivity), support (Rockefeller and Ford Foundations), crops (maize, wheat and rice), research (international agricultural research centers), and adoption (extension agents and contact farmers).

Central to this argument is that Green Revolution style emerged in opposition to traditional style, the result of agricultural practices built up over the centuries, adapted to low population densities. At the center of research were new varieties of seed, developed from crossing existing varieties, with higher yield and rapid maturity, permitting more than one crop to be grown each year.[xxiii] Such modern varieties were highly responsive to fertilizer and, indeed, were anything but a stand-alone artefact. Designed and offered as part of a technological regime, high yielding varieties (HYVs) were associated with a 'package' of practices. Fertilizers were required, but also crop protection inputs such as pesticides, herbicides and fungicides. Owing to short growing seasons and high cropping intensities, a closely regulated water supply

was frequently essential to the achievement of yields, as well as high levels of mechanization.

The knowledge claims and practices were research-based technology. Often the breeding projects for HYVs were based in international research institutes of the CGIAR, the largest and most visible organizations in the global research network. Credited for averting mass famine in India during the 1960s, the growth era of international agricultural research spanned the decade of the 1970s, as the number of centers increased from 4 to 13 and support for the institutes increased fourfold.[xxiv] At the same time, all but the smallest developing countries took advantage of high levels of international aid to promote growth in the two sectors indicated above. First, they began to develop systems of national research institutes. Second, they increased the number and size of universities, adding rapidly to the mix of institutions in just those social spaces where science and technology were previously 'transferred', from knowledge claims and practices produced abroad.[xxv]

The growth in technoscientific institutions accompanied aid but required legitimation in the form of stories.[xxvi] Money, capital improvement projects, and new organizations must be incorporated in a recognizable social framework. That account involved the rejection of the simple 'transfer and adoption' framework, and the widespread acceptance of the need for strategic and adaptive research, of the need for local capabilities to undertake such research. 'Local' in this sense meant 'national', the establishment of scientific organizations within geopolitical boundaries. While the development of research capacity in a country was viewed as one of the many requirements of modernization, 'pure' scientific research was never valued widely in LDCs, though it was promoted by a minority of scientists with Western educations.[xxvii] The central question asked by policy makers, planners and system managers involved the impact

of research on development. To what extent are research outputs used by producers? What percentage of land was planted with HYVs? Were recommendations of experiment stations widely adopted? How widely did stories and practices disperse throughout LDCs? These questions return us to an older meaning of 'local'--not a country, but a place where people live.

Embedding and Decoupling of Extension

Universities and research institutes were not the only forms drawn from developed countries. The university land grant system of the U.S. was often taken as an organizational model, in particular the 'cooperative extension services' created to disseminate research results to farmers. Extension services became common in LDCs, whether affiliated with state universities (as in India), separate divisions within Ministries of Agriculture (as in much of Africa), or otherwise lodged within agricultural institutions. The central idea was to translate scientific knowledge claims into producer practices. Linking the output of research projects to the behavior of farmers was to be the function of special organizational units, the extension providers. Such translation requires strenuous efforts and substantial resources under the best of circumstances: the relatively few commercial farmers, sophisticated research institutes and wealthy private enterprises characteristic of developed countries. It is a significant challenge indeed where peasant farmers are many, research formations are new, and resources for extension are few.

By the 1980s, with widespread problems in the agricultural sector, a story began to circulate within the development community that technology transfer had 'failed', resulting in poor linkages between researchers and farmers. Failure--recognized production deficiencies--is

important as a social construction, clearing space for new institutions and new configurations of old relationships.[xxviii] But failure in extension is a special kind of failure. Extension is a social formation with the explicit goal of linking social actors, as implied in the linear model of agricultural modernization and explicit in the term 'technology transfer' . The failure of linkage need not be told as a failure of the entities whose function is to provide the link. It can equally well be construed as a failure of either end of the link, or some combination of these. That is, since 'transfer' is a directional relation, senders as well as recipients may be implicated.

In the case of extension, only two of the three possible actors were targeted, before responsibility spilled out to state and donors. Poor performance by extension services was often blamed on insufficient training and staffing, or bureaucratic difficulties, or structural problems, or inadequate transportation and salaries. It was also attributed to the research component of the system, having 'nothing to extend'. In contrast to earlier story lines involving 'conservatism' and 'tradition' as impediments, by the late 1980s it was exceedingly rare to blame farmers for their failure to adopt.[xxix]

In many cases, new varieties of seed diffused among users without extension services playing any major role. Further, private and public agricultural supply companies began to distribute inputs for commercial sale and possessed superior resources for reaching the larger farmers who could afford their products. The creation of institutions that specialize in linkage is not without consequences for technoscience. They are an elaboration of social organization that sets in motion struggles for control by the newly created entities, struggles that always entail more than the transfer of technology to farmers. Subject Matter Specialists and Village Level Workers are participants in a network where social status is negotiated just as surely and

importantly as the relevance of knowledge claims for transmittal. Because of the relatively higher prestige of knowledge producers with cosmopolitan ties, researchers engage in mobilization processes leading them to view interaction with extensionists as unproductive. In turn they are seen as 'patronizing', as working in ivory towers, by extensionists who can claim to understand the local constraints of production in practical terms.

As the 'failure' of extension circulated, new mechanisms were sought. In Latin America, many countries eliminated extension services entirely.[xxx] More visibly, a new Training and Visit ('T & V') system was promoted by the World Bank during the 1980s. The T&V system was meant to strip away nonessential activities, so that the delivery of messages could be the focus of extension, rather than supplying credit and inputs to farmers. But training, which involves new forms of social interaction such as meetings of village extensionists with researchers and/or subject matter specialists, is easier to achieve than paring of the old forms. As a review of 24 completed projects showed, this element of T&V was least often followed.[xxxi] In India, the new system, a project of the federal government, was overlaid on a stable network of relations, competing with the Community Development Program in seeking to reduce the importance of village level workers. These were generalists who provided a range of services, supported by local political elites who brought legal actions against the new specialists. The tradeoff for promoting technology transfer that focused on the delivery of scientific messages was conflict--obtaining the support of other actors as well as demands for performance that were difficult to meet.

Perhaps the best illustration of the process, the unending possibilities for the proliferation of organizational entities, is the recommendation that special linkage units be created to integrate

agricultural research and technology transfer.[xxxii] Note that since the function of extension is to provide recommendations to producers, it is already, in principle, a 'special linkage unit'. Now that extension has become embedded in the network so fully that performance problems are treated as though it were a primary production unit, then it may indeed be said to require linking by virtue of some new linkage unit. Of course, were this new unit to be construed as having failed, it would be possible to install yet another linkage formation. And so on.[xxxiii]

Resources and linkages, the overtly 'social' causes of decoupling, have an epistemological counterpart, a space to be filled by progressively more specific claims of relevance. Agricultural practice is epistemologically decoupled from research. Ecological localization, unlike social organization, does have a principled termination point at the level of the individual farm, field or plot--the living space of people.[xxxiv] Agricultural research, by contrast, formulates and seeks to answer questions at some level of generality to legitimate public funds and scientific effort. Therefore, a 'relevance gap' is always available in principle as a discursive resource for technology arenas. Institutions that select technology have only to define a narrower scope of practice to reduce or evade applicability--at minimum, to render it problematic. In the case of agriculture, a version of this was internalized within agricultural research organizations as Farming Systems Research, which critiqued traditional commodity-oriented science. More important, the external organizational population was augmented with the founding of voluntary action associations independent of--and often hostile to--government.

The practitial break in this case is easy enough to show even for agriculture in developed countries. Research sometimes veers toward 'pure' rather than 'applied' problems. The design of studies may be flawed. Recommendations may increase productivity, but without cost

effectiveness. The varieties or treatments used in research may not be locally available. The objectives of research, increasing the yield of a particular commodity, may not correspond to the farmer's aims of profitability. The limited applicability of most agricultural research is even justified by the standards of conventional experimental science: since plots are not randomly selected from a population but chosen for availability and convenience, the results are not generalizable with known probabilities. But for practice, the fundamental issue is the mismatch of locality: research results are interpretable only in terms of averages, while the farmer makes decisions about a particular field.[xxxv]

Non-Governmental Organizations and Research

The failure of extension created a space for the non-governmental organizations that gained visibility in the 1980s. As a sector, NGOs are more difficult to describe than universities or state research institutes owing to their extreme heterogeneity. Indeed, their commonality is defined as negation, by 'non'. They include peasant cooperatives, church-based farmer training centers, clinics, private voluntary groups of professionals, evangelical service centers, networks of village associations, retired scientists promoting environmental causes, multi-million dollar international foundations with local affiliates, paper organizations that are registered primarily to attract donor funds, and spinoffs of state institutes whose membership is tied to established political parties.[xxxvi] Though such diversity is widely recognized, the conclusion that they are not a 'sector' in the usual sense is not drawn. NGOs spring from a variety of other entities and are not a sector until they begin to compete and strive for recognition, which allows other organizations to perceive them as similar.[xxxvii]

Of course, service and voluntary associations are not of recent origin. Some, such as those sponsored by the Catholic and Protestant churches, have colonial roots. The inclusion of such a diversity of organizational arrangements as an important new sector in the 1980s had many sources and consequences.[xxxviii] Dissatisfaction with state policies and agencies, both ideological and managerial, was important in the shift. One effect was to redirect aid flows. Alternative targets for development aid by multilateral and bilateral groups were preferred as a response to the 'failure' of the official research and extension framework.

Agriculture was one of many areas to experience growth in the number of NGOs, though most NGOs were not founded to deal specifically or exclusively with agriculture. Larger NGOs--some founded as relief agencies, some with an environmental focus--expanded operations to include agricultural assistance that would help clients raise incomes and become self-sufficient without undermining the natural resource base. Small formations, staffed by one or a few people, appeared throughout the developing world, offering training for producers, working with communities, indigenous peoples and the rural poor. Many use organizational skills acquired in government, as structural adjustment left state workers unemployed. Excluding groups whose goal was to influence national policy, most NGOs operate in a single area or region. Their range is a narrow locality--a group of villages, a single community, even a group of farmers. In truth, it is difficult to see how formations with small size and limited resources could do otherwise.[xxxix] This feature conjoins an organizational form with a new story set involving participation and sustainability. It is not that NGOs have exploited concern with the environment and the rhetoric of democratization, but rather that the themes have ripened jointly with the emergence of nongovernmentals as a newly recognized sector in development.

NGOs operate in a narrow locality, but so do scientific teams. Science derives its authority from universalistic knowledge claims based on embeddedness within institutions such as university research groups and professional associations of scientists. Rural developmental NGOs promote embeddedness in community formations. Their authority is local, where the meaning of 'local' is much closer to 'community' than to 'national'. In the absence of other organizations that could represent a given population,[xl] NGOs often monopolize localities, particularly since activities are based on claims to employ 'participatory' methods involving close ties to growers. Small and resource poor, highlighting the value of development over profit, NGOs began to accrue authority that was 'moral' rather than scientific. As NGOs developed a reputation for participatory methods, their organizational activities could be accounted as 'bottom up' rather than the 'top down' state-supported development that had failed.[xli]

Participatory methods imply not only the 'validity' of local preference, but also the importance of indigenous knowledge.[xlii] NGOs become arenas for technological selection as they develop agricultural programs. First, indigenous growing practices were readily available as a stylistic resource. Second, these practices were often considered sustainable, or ecologically proper by environmental networks that were active in developed countries.[xliii] They did not require machines. They did not require modern cultivars. Most important, they did not require high levels of 'chemical' inputs.[xliv] Of course, indigenous people could not have known it, but they practiced 'alternative agriculture'.

Alternative agriculture emerged as a technological style in opposition to the Green Revolution regime, a profile of practices recognizable by all actors in international agricultural development. Also called 'sustainable', 'biointensive', 'low-input', 'ecological' or 'reduced-

chemical' agriculture, the older term 'organic' was applied to forms of practice that had previously been Traditional.[xlv] Indigenous practices could readily be characterized as 'green' because of their resemblance to alternative agriculture in developed countries. Donor agencies with environmental priorities discovered common interests with nongovernmental organizations whose primary resource was not expertise or dispersion but their embeddedness in specific localities.[xlvi]

Nothing in the account thus far has implicated research as opposed to provision of services, but the explanation of research as an activity of NGOs follows. The new technological style of alternative agriculture emerged problematically. Traditional agriculture might be organic--but still deficient. If indigenous practices actually are alternative agriculture, then peasant farmers in the developing world are the experts, not educated representatives of Northern donors and NGOs. If traditional is organic, it would make better sense to send Northern farmers there to learn from these experts, or to become apprentices in NGOs than to promote the dispersion of practices from research communities elsewhere.[xlvii]

But such transformation and reordering would be inconsistent with technoscientific support. Donors, institutes and universities are components of scientific institutions that compel the linking of stories into research formations.[xlviii] For NGOs, embedding in state and donor networks--as well as increasing interconnections between entities that came to be 'like' one another--facilitated both organics as style and the new form of legitimation, that is, the development of research themes and linkages. A consistent solution is to grant growers knowledge without expertise, identify NGOs as a replacement for extension, and establish research within NGOs or linkages to other research institutions. Indigenous practices may be

verified by research, which can also contribute to their modification. Practices are dispersed and supplemented with ideas from alternative agriculture in developed countries, but here the issue of locality is always available for NGOs. Will this practice be suitable for these growers? In principle, all knowledge claims must be verified locally. Since NGOs are local representatives, NGOs must conduct and validate research.

Since association with research practice makes knowledge scientific, research need not necessarily be performed within NGO boundaries. Research conducted in collaboration with institutes or universities, adaptations of experiments, on-farm experimentation with NGO assistance is sufficient. Such practices enable the identification of NGOs as legitimate linking formations, through their dual connection to local communities and scientific institutions. The 'participation' that dignified indigenous knowledge soon comports with technoscience as a condition for its persistence. Some connection with research is required, lest technology become unmanageable in its diversity or smooth into traditional stories.

A Kenyan Case

The above account does a great deal to simplify the complex growth of a new research sector. The case of Shamba, with which this essay began, reveals the intricacies of the contextualized process. In sub-Saharan Africa, NGOs have been especially important during the past twenty years. Kenya, once the darling of the international donor community because of its overtly pro-Western policies, has experienced a radical loss of support during the 1990s owing to widespread perceptions of government corruption and mismanagement of funds. With a feeble policy orientation towards the rural poor, but a strong state presence in these areas, the Kenyan

government exhibits a negative attitude towards NGOs. Control over the policy agenda is exercised by powerful tribal groups that often regard NGOs--especially those with foreign ties--with suspicion.[xlix]

In the 1990s, aid agency support was suspended or withheld to stimulate state reform. The number of NGOs has grown with consequences for the mix of organizational entities entering the competition for research funds. The following case involves the rapid acquisition, development and disintegration of research activity within an NGO. Yet that disintegration did not lead to a reduction of activity within the NGO sector, owing to the structural fluidity of locally-based institutions. The production of organized knowledge claims in developing countries is not simply a matter of organizations adding research functions, as corporations add a laboratory or universities hire staff to begin an interdisciplinary program. Localized research activities are extended through splitting and propagation rather than organizational growth.

Shamba was originally a colonial school in Trans Nzoia district, part of the White Highlands that made Kenya desirable.[1] The area is considered the 'grain belt' of Kenya owing to its high agricultural potential. Rainfall is fairly high and reliable, the topography generally flat, with fertile soils. Since fundraising in Western countries typically depends on images of food shortages and impoverished peasants, such an area is not an obvious choice for a nongovernmental agency devoted to farmer training and demonstrations of increased productivity through organic agricultural style. Though the school has moved to a nearby town of about 60,000, its forty acre property and buildings are now part of Shamba Agricultural Centre, the first NGO to focus on alternative agriculture in Kenya.

Trans Nzoia District was known for the cultivation of maize and dairy farming in

relatively large farms carved out by white settlers. Even in the colonial era the problems of farmers were a focus of attention. Researchers sought to help settlers increase yields and maintain fertility on land that was abundant but quickly lost soil nutrients owing to high drainage. The research station near Shamba is one of the oldest in Kenya. After Independence most of the large farms were bought by Africans. Some were purchased by groups of individuals, some were subdivided, and some were purchased by the government, though few of these remain. Farm ownership is currently 'dualistic' with large farms occupying 60% of the agricultural area and many small farms of five acres or less.[li]

The Shamba program was designed in an era where growth and migration to high potential areas had dramatically increased population density in Kenya. By the late 1970s, Green Revolution practices had already diffused widely. Their spread was particularly evident in areas of high potential such as Trans Nzoia. Hybrid maize was used by the majority of farmers, tractors were readily available for hire, and fertilizer subsidies enabled growers to achieve high productivity. However, the area was dependent on rainfall. In the early 1980s, draught and the economic liberalization that reduced government subsidies led to increasing difficulties for smallholders who could ill afford the inputs necessary to achieve high yields.

Shamba Agricultural Centre was founded in 1984 through a coalition of individuals that shared a recognition of the problems facing resource-poor farmers and a commitment to organic agricultural practices. First, there were Kenyan supporters who provided funds from their personal holdings. These individuals played a major role part on the Governing Board and continued to donate funds in exchange for influence in Centre activities. Second, there was support from a North American foundation, also a consistent donor over the years. A

representative of the foundation--at the time a strong advocate of solar energy--came to Nairobi in 1981 for a UN-sponsored conference on 'New and Renewable Sources of Energy'. Convinced by nationals and development experts that Western-style utilization of solar energy was not the greatest need for Africa, particularly in the wake of a three-year drought, she assisted locals in providing funds to found a nonprofit organization in the Mount Elgon area. Some argued against this choice of location: a center for farmer training ought to be located in a less fertile area since farmers are more impressed with high productivity in an area with low potential. But a colonial teacher from the school prevailed and the Centre was established in the highland area.

The guiding idea was to provide training for small farmers in biointensive agriculture with minimal use of external inputs such as fertilizer and pesticides. But the stories and practices that were promoted by Shamba were not the indigenous practices of productive peasant farmers. By now the smallholders who populated the area were either migrants or several generations removed from those who occupied the land prior to colonial times.[lii] In the early 1980s the organic alternative to Green Revolution agriculture had begun the transition to less developed countries by deemphasizing the negative health consequences of chemicals. Instead, the primary rationale focused on (1) the need for new approaches to farming; (2) the opportunity to harness the full potential of organic resources in a context of limited land, water and vegetation; and (3) the reduction of dependence on expensive external inputs provided by the state and donors. 'Self-reliance' and 'sustainability' increasingly entered the vocabulary of justification. Before the end of its first decade, attuned to new frameworks of gender and inclusivity, Shamba adopted Participatory Rural Appraisal, required that applicants 'demonstrate a strong commitment to community-based self-help groups', and sought to enroll equal numbers

of women in its training program.

Not only was the rationale for the organic style adopted, but the practices themselves were often brought from elsewhere. For more than two thirds of its technological recommendations, Shamba depended on an organic farming group in California. Its leader was a charismatic individual, himself a disciple of an Englishman with whom he worked to create a 'Garden of Eden' using simple, organic methods of farming. Key elements of practice involved double digging, the use of compost for fertilizer and diagonal offset spacing to maximize plant populations, increase yield and maintain soil fertility. The formal training program initiated in 1986 involved two components. The first was an eighteen month program for secondary school graduates, emphasizing 'hands-on-training' and an internship as an extension agent with local NGOs or community groups. The internship was important in establishing visibility and linkages, as Shamba students were placed with such NGOs as Oxfam and World Neighbors as well as community-based organizations. Second, one week farmer workshops were designed for individuals or organized community groups.[liii]

By the early 1990s, the center was organizing workshops at the rate of twenty per year, providing lodging and board for a standard class of fifteen farmers. Shamba was flourishing. The staff had expanded to several dozen. The Centre began to offer workshops for recruits in NGOs and government agencies, spreading the gospel of organic farming, and serving as a model for the formation of new groups throughout the country. Demand had grown to such an extent that in 1992 a three month Biointensive Agriculture short course was offered for professionals in agricultural extension, environmental protection and soil conservation. Its demonstration potential might have been greater in a semi-arid location. But as donors began to

scrub the corridors of state corruption by switching their emphasis to NGOs, it did not hurt that a visit to Shamba involved a trip to a lush, tropical environment at the foot of Mt. Elgon, lodging at an old colonial club with golf and tennis.

The staff and trustees conducted an evaluation of the program in 1992. While the primary donors had not changed and the primary activity remained the training of farmers, the time seemed ripe for expansion. What had changed since the founding of Shamba was the (1) diffusion of organics as a global and immediately recognizable technological style,[liv] (2) the increasing NGO activity in the developing world--there were now more than three dozen NGOs working in the area of sustainable agriculture in Kenya, and (3) the shift in donor funding from states to NGOs, particularly in countries where the government was perceived as corrupt and inefficient.[lv] This shift, as indicated earlier, was not confined to large multilateral and bilateral donors such as the World Bank, IMF, and USAID, but to the foundations that are often held responsible for the development of the original Green Revolution technology. Shamba produced a strategic plan that now included an Extension/Outreach Program, a Publications Development Program, and for the first time, an Adaptive Research Program.

Following negotiations with the donor, Shamba received its first large infusion of resources from outside its original sponsors.[lvi] The purpose of the three year grant was to 'strengthen the Centre to respond effectively to the needs of communities pertaining to agricultural resource management'. Such a grant was doubly welcome, since income from the training courses did not suffice to provide for the staff and upkeep of the center and the donor grant was a clear signal of legitimacy.[lvii] This was particularly important in a period of donor movement towards NGOs and away from corrupt and inefficient national governments.

Although relatively distant from Nairobi, there was every sign that the oldest organic farming group in Kenya had an advantage over the upstarts and was well positioned to take a leadership role in the NGO collaborative networks that began to dot the landscape.[lviii] Because of its experience and the nature of its relations with farmers, Shamba was asked to organize seminars on sustainable agriculture and participatory research with the national agricultural research institutes and other NGOs. Indeed, from all appearances, Shamba had arrived.

The donor grant of $221,000 was channeled directly to a bank account in the city nearest the NGO. By direct funding of this type the donor could bypass the Ministry of Finance altogether. The grant enabled the Centre to purchase equipment,[lix] to expand its training in extension and development methodologies, and to begin a publication program of promotional brochures, a newsletter, hand-outs, training curriculum, posters and crop production handbook. Such activities, while extensive, were not themselves unique. More important, for the first time Shamba began to engage in research activities.

In 1993, with the help of two untrained research assistants, a former volunteer worker undertook a research program that would be the envy of any scientist at a governmental research station. Projects were abundant, represented a mix of on-farm and on-station research, and were targeted toward needs articulated by farmers themselves. Not only did Shamba organizers seek the direct participation of clients in the design of the research program, but they encouraged the production of knowledge by farmers. Shamba had trained sufficient numbers of farmers that a week long advanced workshop could be held for farmers that had already been through the course in biointensive agriculture and were utilizing organic techniques.[lx] This advanced workshop was viewed as particularly successful because 'when such farmers were taught the

principles underlying different soil fertility management practices...they went on to experiment with what they had learned on their own farms'. In short, the Shamba adaptive research program was a model of an NGO research effort closely tied to identified farmer needs.

By the end of its second year the Adaptive Research section focused on two major areas: (1) alternative fertilization techniques in maize fields and (2) verification trials for the kinds of sustainable agricultural practices that were being taught in training seminars by Shamba and other NGOs (these included biopesticides as well as the use of plant and manure teas). Importantly, for both the NGO and the funding agency, these areas had been identified by the farmers themselves through Participatory Rural Appraisals.[lxi] They collaborated with four farmer groups, the nearby Agricultural Research Institute, and an NGO in Central Province. During 1994 alone, on-station research was conducted in compost and manure tea, soil improving legumes and legume/grain mixtures as green manures for maize production. Verification trials begun in 1993 were continued, using bio-pesticides for the control of late blight in tomatoes and maize stalk borer. New trials were implemented for the nutrient content of plant teas, and the effect of frequent turning on the nutrient content of compost. At the same time the section began on-farm research with over 80 farmers. These included members of a women's group (composting for maize production), with additional farmer groups for soil improving legumes, verification trials on the effect of digging depth and spacing on cabbage production, and a project on crop adaptability trials in West Pokot in collaboration with a church group.

Of five major objectives in the Adaptive Research proposal, four did not involve specific projects--after all, the staff consisted of one technically trained individual--but rather linkages:

with the nearby agricultural research station, with relevant NGOs to gather data in different agro-ecological zones, with another group in a city several hours away that targeted women farmers, and, of course, with the Shamba farmers themselves. But many of these linkages involved commitments by other groups that were little more than speculative. Expenses, overcommitments, infrastructural difficulties and bids for influence render it far easier to undertake Memoranda of Understanding, Networks and Plans than to engage in the ephemeral loosening of organizational boundaries that joint projects require. In the words of a program officer for an international agency:

> People here talk all the time about conflict resolution, but they don't actually get together around the table and resolve their differences--they just go off and form a new NGO. Within six months I had a dozen [NGOs] in my office, all wanting funds to write a manual on biointensive agriculture. I told them, even if a few of you can get together, we can talk. Not one of them ever came back. Finally, we had to get [an organization] from outside to bring together a workshop for the NGOs and do it.

Results come in two forms: new stories and the changes in the social formations that produce them. In the case of Shamba, organizational shifts dwarfed those that might have been produced in the practices they sought to disseminate to smallholders. As indicated above, the research actually conducted was typically agronomic in character and did not examine socio-economic issues of small farmers or bio-intensive agriculture per se.[lxii] Studies were justified by the twin arguments that farmers wanted answers to certain major problems--identified in participatory fashion--and that many of the recommendations in the package of biointensive agriculture practices had never been tested.[lxiii]

Double digging, the practice of turning over the earth at two or more times the depth of conventional tilling, was one of the key elements of the biointensive production package promoted in California and taught regularly both at Shamba and other Kenyan NGOs.[lxiv] Shamba staff and farmers who used the technique noticed that the most common variety of hybrid maize grew to a height of three meters and lodged. Equally important was the frequent complaint from farmers that double digging just involved too much work.[lxv] An experiment with sukuma wiki (collards), the most popular vegetable crop in Kenya, showed that double digging was at least four to twelve times as labor intensive as traditionally hoed plots with no significant increase in yield.[lxvi] The Shamba report notes that

> If land were not a limiting factor, these results suggest that the best results, for the least amount of labour, may be obtained by planting collards with compost using conventional row crop spacing...Many of the soils in Kenya are well drained and double digging may not offer substantial benefits in such soils. In fact, double digging, if not combined with close spacing of plants and adequate application of compost, might even have some negative effects, such as increasing the erosion potential of the soil and causing organic matter to be oxidized more rapidly. (1996, 32)

The research program at Shamba was not ideological in character--evidence could be brought to bear one way or the other on the practices that were advocated. In such a small organization, one might not expect a great deal of difficulty in the transfer of knowledge from one individual to another. The adoption of knowledge production as well crop production as an organizational activity meant that certain commitments were rendered problematic. The research and extension coordinators began to discuss the findings. But the improvement of soil fertility--

a value central to organic style--was not shared by the clientele:

> In the past two years of interacting with over 80 farmers through our on-farm research efforts, we have learned that farmers are not interested in growing crops during the main rainy periods purely for purpose of improving soil fertility. Farmers' selection of possible soil fertility experiments has clearly demonstrated that useful products for people or animals is their number one priority, with soil improvement being perceived as a subsidiary or secondary benefit.

Not only were many of the recommendations unsupported, but the publications promised in the grant application failed to materialize. Indeed, one of the chief issues for publications and outreach was that so many research trials were undertaken that little reporting of results was accomplished. Without trained assistants, the coordinator spent a great deal of time on research activities. In the words of the Publications Coordinator, 'the major challenge that the department has faced so far is a lack of new and original materials to work with'. For the director who would subsequently take over the program, there were 'pathetically very little of these accomplishments published'. The promised materials on the curriculum, a crop production handbook, and a resource book for extension workers were not produced. Documentation dating from the time of the centre's first training continued to be reused.

For the Adaptive Research section, however, the plethora of trials and the leaky roof of the composting shed that confounded the experiment on turning frequency, were not the most serious problems. In the developing context of Kenya, unemployment, corruption, and inefficiency are endemic. The attempt to circumvent the government sector is beset with a related set of problems. In the words of one donor representative, herself an African:

> You know NGOs in Kenya. They have low credibility. Anyone can start one. Just go and register with the government NGO office and start collecting money--or at least that's what they think. They have little ability to manage and account for funds.

Such views have proliferated with the growth of a nongovernmental sector that had been created not simply by 'need' but in large part by the donors themselves.

In developing country research, the network of social relations in which centres and institutes are embedded begins to encroach on operations as soon as an external link with a donor is established. Shamba's network did not originate with the grant, but the new flow of funds caused boundary difficulties for the organization and increasing impact from the surrounding context. First, the direct funding that was meant to bypass the official thievery of funds that typically begin their journey at the Ministry of Finance, was unable to solve this problem. The first transfer of funds in 1993 employed foreign exchange certificates that were stolen immediately after collection from the bank. Amounting to Ksh. 650,000 (US$18,571), the certificates were reported stolen and cancelled by the Central Bank. Though replacements were offered, the certificates were dissolved as financial instruments before this occurred..[lxvii] Next, the high inflation rate and the dramatic fluctuation of Kenyan currency from 30 Ksh. to 80 Ksh. per dollar after liberalization reduced the real value of the grant in 1993. Third, the Macintosh computer used for publications was stolen in early 1994 from a Nairobi hotel. Finally, the fate of the new vehicle purchased for farmer visits is emblematic. Resources that find their way into a local context of relative deprivation are difficult to monopolize for their intended uses. As described by one informant:

> I didn't find out until one of the vehicles broke down that they had been using it as a

matatu.[lxviii] The one we bought at the beginning had so many kilometers on it. They blame the drivers for this, but no one was taking responsibility for what was happening with the money.

Under these circumstances, the donor threatened action and the director who had negotiated the grant resigned midway through the second year. Shamba's financial audit for the period was found deficient owing to poor accounting procedures. For several years the management of funds had been in disarray, with unpaid bills and taxes owed. The governing board had not attempted to engage in any active oversight role. Shortfalls required the shift of funds between budget categories. Savings were generated in project monitoring, evaluation and publications. Staff numbers were reduced. Staff training and farmer workshops suffered the largest cuts. A new director was appointed to identify and rectify the Centre's accounts. As cuts were required and scrutiny increased, conflict with the staff rose to such levels that members sought new ways to communicate with funding agencies. Predictably, the new director was widely disliked and left before the end of his second year.[lxix] But the most important consequence for the research program at Shamba was that six members of the research and extension sections resigned as the primary grant was ending to form a new NGO on the other side of town.[lxx]

In short, under the dire conditions facing the centre, as salary funds were exhausted but before the grant was finished, a new nonprofit, nongovernmental organization was registered in March 1996 under the Non-Governmental Coordination Act. The research coordinator and technical assistants, together with members of the Extension-Outreach staff withdrew, negotiated new funding support with an alternative donor, and began to 'research, develop, and promote

ecologically sound and economically viable technologies for the sustainable utilization and management of agricultural resources for small holder farms'. Within two years the new Adaptive Research Program had worked with 54 'farmer collaborators' in on-farm field trials. As at Shamba, the farmers helped to select the topics and work through the design, implementation and evaluation of the trials.

The new director of Shamba, a former teacher at the centre, was now in charge of righting the accounts as well as damage control. Pressed for a report from the donor, he was unable to obtain details about the activities of the Adaptive Research Section. In the absence of reports or publications, what was left was the oral report of the researcher who, in the time honoured fashion of scientists, departed with the original data. Without data, without training in analytical skills, and only the briefest of synopses on which to rely, the final report of the series of experiments on the control of late blight in tomatoes suggests his sense of futility with an asterisk: '*The bottom line for now is that if you want to grow tomatoes during the rainy season, you have to be prepared to spray them with fungicides if you want to harvest any fruits'.

Were stories--or changes in stories--produced as a result of the extensive program of research? It is impossible to say. Though trainers may report that the results of research are incorporated in the practices of the farmers themselves, there is no evidence on which to base such a conclusion. New training manuals have not been produced. What is salient in the present context is that the number of NGOs in Kenya continues to grow. The primary mechanism for this growth is splitting and proliferation. The number of registered NGOs in Kenya increased from 124 in 1975 to approximately 500 in 1990. At that time, NGOs received aid from donor government agencies abroad at approximately $35 million annually (about 18% of donor aid to

Kenya), while NGOs from abroad provided approximately 30-40% of all development funding.[lxxi] By the end of the decade in which these events unfolded it was estimated that there were approximately 1000 registered NGOs and seven times as many operating without registration.

The consequence of donor linkage for Shamba was not growth and development. It was not the expected emergence of an ongoing organizational research program, an increase in donor funding or the enhancement of Shamba's standing in the NGO community. Instead, an immediate glut of adaptive research studies, the absence of documentary traces and resource difficulties that are standard in the national context led to splitting and reproduction of organizational identities. One might say, of course, that Shamba's research program was a complete failure. But that would be a misguided interpretation. Research is no longer conducted at Shamba, but it is likely to be revived, it has spawned new entities, and farmers themselves are said to experiment more systematically than before.[lxxii]

Conclusion

Two central lessons emerge from the case of Shamba, involving the nature of its research and the importance of linkages. The first follows from the character of the research conducted, which was basically agronomic. While the topics may have been selected through participative processes, entry into the global framework of technoscientific institutions occurs more readily when old forms are employed, when consensual practices are adopted, when paradigms are readily understood by others who may provide funds or partnerships in research. The research activities themselves were not novel, even as they were transferred to a new sector to become

part of a different story line.

The second lesson is that it is a mistake to fall in love with linkages. Almost every sector in the developing world--including donors, states, national research institutes, universities and NGOs--assumes that linkages are beneficial for organizational and systemic functioning. The general reason is held to be that increased productivity results from access to the resources, personnel and expertise of other entities. Linkages are just as likely to result in decreased productivity, chaos and organizational disaster. Here we witness the failure of a research program within an NGO, but not within the NGO sector. Organizational growth did not occur, but the reproduction of an organizational form. The close linkages to community that are attractive for donors seeking to promote local development are efficient in drawing the new resources of NGOs into the lives of its people, but not in ways the donor desires.

The explanation for the emergence of new identities in international agricultural research relies on the shifting mix of basic social formations, as NGOs with little formal representation have increasingly assumed functions formerly held by agencies of the state. What is less often recognized is that this framework depends on the widespread circulation of stories--not until indigenous knowledge was linked to organics did a style (alternative agriculture) emerge.

Stories are important in every aspect of social organization, often accompanied by practices. Often the stories are told about risk and ways to ameliorate risk. Sometimes they are told about production and ways to increase it. In still others, risk and productivity are related directly. But stories always circulate within the amorphous regimen of institutions and social formations that constitute a network. The spread of stories through networks, and the practices that accompany them, is the essence of social organization as well as the key to understanding

the relationship between science, technology and development.

I began with the assumption that some version of the network concept is essential to an account of contemporary technoscience, given the relative consensus that has emerged on the importance of locality and dispersion to technological practice. The account here combines features of both semiotic and structural uses of the network concept with the notion that the dispersion of organizational forms is promoted by the spread of stories about styles of practice. The nations of the Third World may be undeveloped with respect to most indicators, and their research institutions may be underfunded, but they are intricate and generally stable. Such institutions are linked in formations that comprise effective social organizations for preventing change. We have seen one instance in which this resistance was overcome. Opportunities for new research entities emerged from this fluidity. NGOs with fluid structures and dense local connections have entered the mix.

One of the central aims of this essay was to exhibit the complexity of research organization in LDCs. Indeed, it might well be argued that technoscience exhibits greater complexity here because of the dependencies that are developed for science to exist at all. This account emphasizes social organization as the representation of place within networks and deemphasizes rules. 'Levels' or 'scales' that differ grossly in resources and spread must be smoothed into compatibility, laced with recognizable features and strung together in a hierarchy. So it is that a simple structure such as an NGO without credentialed expertise or systematic training in scientific methodology can tap the resources of international donors and enter scientific research networks. Formal organization, that is, an Organizational Chart together with handbooks of procedure, is useful as a declaration of identity, but it is not the only such

declaration. That virtually all of the persisting identities in developing country technoscience are formal organizations obscures rather than reveals the basic structure.

Research projects that consist of new entities or collaborations of old ones are constantly formed and dissolved, causing reverberations without fundamental alteration to resilient patterns. One might imagine that the resource deficits characteristic of developing countries make them pervious to incursions. That is accurate, but the consequence is small change. It would be a mistake to characterize the events at Shamba as progress that resulted from increased ties to international donor agencies. When such linkages generate resources that attract local interests, they activate pre-existing local ties. The flexible organizational patterns characteristic of NGOs are insufficient to keep resources flowing within organizational bounds in the predictable ways that are desired by managers and policy makers. Of course, donors hope that resources will benefit local communities. They object to their lack of control over the specific beneficiaries.

In agriculture, a subsistence farm and a research group are both production units.[lxxiii] The inhibiting effect of social organization on production means that the absence of linkages is just as important as their presence. If every foray by a team of experts resulted in reallocation of resources, priorities and relevancies, no research would get done. If every new practice was actually tried by farmers, little food would be grown. But most important, if every technological recommendation by the research system had to be tested in each locality--no matter how small--no practice or seed variety would ever get recommended. Put differently, there would be nothing but on-farm research.

This leaves a puzzle regarding the relationship between knowledge and social practice. If the goodness of research lies in its applicability, relevance stories must be generated for the local

context. There are different ways of accomplishing this. Once, experimental treatments were applied and contrasted with nearby control plots, illustrating to farmers the effects of an 'already proven' treatment in a demonstration. Today, treatments may be examined in relation to controls to determine 'yet to be proven' effects for a given locality--that is, with a particular configuration of soil, rainfall, chemical and biological material. Such an activity is a matter of applied research. As locality concerns become paramount, what was formerly the practice of demonstration will disappear in favor of research, as Shamba and other NGOs become the arbiters of technological effectiveness.[lxxiv]

NOTES

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i. Research in less developed countries continues to be neglected by mainstream science and technology studies in spite of the existence of a heterogeneous body of literature spanning a variety of fields. For an overview, see Wesley Shrum and Yehouda Shenhav, 'Science and Technology in Less Developed Countries', Sheila Jasanoff, Gerald Markle, James Peterson and Trevor Pinch (eds.), Handbook of Science, Technology, and Society (Newbury Park, CA: Sage, 1995). In the past ten years, three of 366 published articles in Social Studies of Science and Science, Technology, and Human Values have dealt with agriculture in LDCs.

ii. Lawrence Busch, William B. Lacy, Jeffrey Burkhardt and Laura R. Lacy, Plants, Power, and Profit: Social, Economic, and Ethical Consequences of the New Biotechnologies (Cambridge: Blackwell, 1991). Agricultural research in developing countries also displays the characteristic and complex features of 'Mode 2' research, including knowledge produced in the context of application, transdisciplinarity, organizational diversity, social accountability and reflexivity. Michael Gibbons, Camille Limoges, Helga Nowotny, Simon Schwartzman, Peter Scott and Martin Trow, The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies (London and Thousand Oaks: Sage, 1994).

iii. Wiebe Bijker, Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change

(Cambridge, Mass.: MIT Press, 1995).

iv. See Stephen Biggs, 'Informal R&D', Ceres, Vol.13 (1980), 23-26; Stephen Biggs and Edward Clay, 'Sources of Innovation in Agricultural Technology', World Development ,Vol. 9 (1981), 321-36; Robert Chambers, 'Origins and Practice of Participatory Rural Appraisal', World Development,Vol. 22 (1994), 953-69.

v. Paul Richards has argued that peasant enterprise (intercropping and shifting cultivation) has produced agricultural revolutions. See his Indigenous Agricultural Revolution: Ecology and Food Production in West Africa (Boulder: Westview Press, 1985).

vi. Steven Shapin, 'Here and Everywhere: Sociology of Scientific Knowledge', Annual Review of Sociology, Vol. 21 (1995), 304.

vii. Michael Lynch, 'Laboratory Space and the Technological Complex: An Investigation of Topical Contextures', Science in Context, Vol. 4 (1991), 51-78.

viii. Classic references include Nicholas Mullins, 'The Development of a Scientific Specialty: The Phage Group and the Origins of Molecular Biology', Minerva, Vol.10 (1972), 51-82; Diana Crane, Invisible Colleges: Diffusion of Knowledge in Scientific Communities (Chicago: University of Chicago Press, 1972); Michel Callon, 'The Sociology of an Actor-Network: The Case of the Electric Vehicle', in Michel Callon, John Law and Arie Rip (eds.), Mapping the Dynamics of Science and Technology: Sociology of Science in the Real World (London: Macmillan, 1986), 19-34; Bruno Latour, Science in Action: How to Follow Scientists and Engineers Through Society, (Cambridge, MA.: Harvard University Press, 1987). The semiotic

approach is more often known as 'actor network' theory, but American structuralists also use this term. See Ronald Burt, Towards a Structural Theory of Action: Network Models of Social Structure, Perceptions, and Action, (New York: Academic Press, 1982). Even to call the Mullins/Crane approach 'structural' is to court confusion, since Francophone structuralism bears less resemblance to the Anglophone version than the latter does to semiotic network theory.

ix. J.A. Barnes, 'Class and Committees in a Norwegian Island Parish', Human Relations Vol. 7 (1954), 39-58; Clyde Mitchell, 'Social Networks', Annual Review of Anthropology Vol. 3 (1974), 279-99; James S. Coleman, E. Katz and H. Menzel, 'The Diffusion of an Innovation Among Physicians', Sociometry Vol. 20 (1957), 253-70.

x. David Edge and Michael Mulkay, Astronomy Transformed: The Emergence of Radio Astronomy in Britain (New York: Wiley, 1976). Michael Mulkay, N. Gilbert and S. Woolgar, 'Problem Areas and Research Networks in Science', Sociology, Vol. 9 (1975), 187-203.

xi. E.M. Rogers and D.L. Kincaid, Communication Networks: Toward a New Paradigm for Research (New York: Macmillan, 1981).

xii. H.M. Collins and R.G. Harrison, 'Building a TEA Laser: the Caprices of Communication', Social Studies of Science, Vol. 5 (1975), 441-50.

xiii. Latour, op. cit. note 8.

xiv. W. Shrum and Nicholas Mullins, 'Network analysis in the study of science and technology', in Anthony van Raan (ed.), Handbook of Quantitative Studies in Science and Technology

(Elsevier Science Publishers, 1988), 107-43.

xv. For an approach based on individual scientists, see Thomas Schott, 'The World Scientific Community: Globality and Globalisation', Minerva, Vol. 29 (1991), 440-62. For an approach based on organizations, see W. Shrum and C. Bankston, 'Organizational and Geopolitical Approaches to International Science and Technology Networks', Knowledge and Policy, Vol. 6 (1993), 119-133.

xvi. For a review of these analytical and methodological techniques, see Stanley Wasserman and Katherine Faust, Social Network Analysis: Methods and Applications (Cambridge: Cambridge University Press, 1994).

xvii. Shapin, op. cit. note 6; Olga Amsterdamska, 'Surely You're Joking, Monsieur Latour!', Science, Technology, and Human Values, Vol. 15 (1990), 495-504.

xviii. 'Embedding' refers to the process of establishing relationships with social actors, particularly in the sense of entering into a preexisting network or pattern of ties, while 'decoupling' is the converse. 'Embeddedness' simply indicates such a state of connectedness.

xix. Research substantiating this is absent, and what empirical evidence does exist points in the opposite direction. Wesley Shrum and Patricia Campion, 'Are Scientists in Developing Countries Isolated?' Science, Technology, and Society, forthcoming.

xx. 'Contracts' is perhaps too general a term for a planned study that may be part of a larger program of research. 'Counterparts' is used in reference to a practice whereby bilateral or

multilateral donors fund a developed country research project only if it engages the services of 'nationals' in the conduct of the study.

xxi. This association ranges from the 'merely' rhetorical--as in the case of an outright lie--to a 'proven' claim, that is, a representation of nature based on theory or multiple research studies that garners the assent of all members of the scientific community. These extremes are rare: incorporation, controversy and dissensus are more common. What is now more often appreciated within STS are the relatively mobile forms of association.

xxii. The Green Revolution is widely recognized as a kind of pattern or technological structuring. What I call a 'style' has also been conceptualized as a technological regime, paradigm, or trajectory. For a review of these concepts, see Rene Kemp, 'Technology and the Transition to Environmental Sustainability: The Problem of Technological Regime Shifts', Futures, Vol. 26 (1994), 1023-46.

xxiii. Jack Kloppenburg, First the Seed: The Political Economy of Plant Biotechnology (Cambridge: Cambridge University Press, 1988).

xxiv. The period from 1973 to 1981 has been called the 'golden era' because of a confluence of factors leading to massive increases in support for agriculture in LDCs. L.S. Hardin, 'Whence International Agricultural Research', Food Policy Vol. 19 (1994), 561-67.

xxv. This process occurred so rapidly and with such force that a special CGIAR center was founded specifically with the aim of promoting policy and management practices for these new systems. The International Service for National Agricultural Research (ISNAR) was founded in

1980.

xxvi. Throughout this essay, the concept of 'story' is employed in Bijker's sense (Bijker, op. cit. note 3).

xxvii. 'Basic' research, responsive to the problem direction of the specialty community, has never been central to either national priorities or a majority of scientists in developing countries, contrary to the views of both scholars and activists.

xxviii. The importance of 'failure' has been well documented by actor network theorists, for both artefacts and social actors.

xxix. The farmer, in the words of one widely accepted account, came first. See Robert Chambers, Arnold Pacy and Lori Ann Thrupp (eds.), Farmer First: Farmer Innovation and Agricultural Research (London: Intermediate Technology Publications, 1989).

xxx. David Kaimowitz, 'The Role of Nongovernmental Organizations in Agricultural Research and Technology Transfer in Latin America', World Development, Vol. 21 (1993), 1139-50.

xxxi. D. J. Gustafson, 'Developing Sustainable Institutions: Lessons from Cross-Case Analysis of 24 Agricultural Extension Programmes', Public Administration and Development, Vol. 14 (1994), 121-34.

xxxii. Thomas Eponou, 'Integrating Agricultural Research and Technology Transfer', Public Administration and Development, Vol. 13 (1993), 307-18.

xxxiii. There is a parallel to this kind of regress in court determinations to exclude or include scientific testimony. The U.S. Supreme Court has ruled that judges may act as 'gatekeepers' to exclude expert testimony. However, in order to determine whether certain experts should be including in the trial formation, it has been suggested that other (court-appointed) experts be called, for example in pretrial hearings.

xxxiv. This is not to claim that plots cannot be divided infinitely--of course they can--but that ecological localization is a social construct based on ownership and agency.

xxxv. Although most of these 'inapplicability' arguments are well known, I find most convincing the case of a farmer in the developed world. Frederick Suppe, the eminent philosopher, also operates a commercial forage and livestock farm in Virginia. When he sought to determine when to combine legumes with grasses in his pastures and hay fields, he began with a course in forage crop production. Of course, he had access to the most recent textbooks in the field. He followed the literature on red clover and reproduction rates in sheep, tracking down studies from Australia and New Zealand, asking farmers in his area, and attending extension short courses. Probing these agents for references, he discovered another literature on grassland agriculture, but nowhere did he find a specific study directly relevant to his own situation. That is, a comprehensive search of both formal and informal sources that would be impossible for a subsistence farmer in the Third World, did not yield even a probabilistic expectation for his own particular situation. See F. Suppe, 'The Limited Applicability of Agricultural Research', Agriculture and Human Values, Vol. 4 (1987), 4-14.

xxxvi. In what follows, I restrict the term NGOs to the midrange of possible uses. Excluded are large international organizations (e.g., CARE, World Vision) and membership organizations (e.g., a farmer's association). The focus on nonmembership organizations is common, because they are typically staffed by professionals who are socially distinct from the clients they serve.

xxxvii. Theorization of NGOs, that is, their definition as part of a common social category, was significant. Without it, 'the real diversity of social life is likely to seem as meaningful as... parallelism' (David Strang and John W. Meyer, 'Institutional Conditions for Diffusion', Theory and Society, Vol. 22 (1993), 492.

xxxviii. John Farrington and Anthony Bebbington, Reluctant Partners? Nongovernmental Organizations, the State, and Sustainable Agricultural Development (London: Routledge, 1993).

xxxix. Although an NGO may provide services to one locality, in areas where NGOs have proliferated, this is no inherent limitation for the reach of the sector. Kaimowitz has estimated 15% of the rural population may be served by NGOs in Honduras, which is not dissimilar for estimates in other Latin American countries (op. cit. note 30).

xl. NGOs are sometimes characterized by territorial behavior when faced with the prospect of other NGOs on their turf.

xli. Chambers, op. cit. note 4.

xlii. The 'validity' of preference is contrasted with the 'importance' of knowledge. Allowing its significance does not grant it truth value, which is central to the argument that follows, because it

maintains the regulatory role of scientific organizations.

xliii. This is not to suggest anything about their actual sustainability, which depends in large part on the definition of sustainability employed. (See J.A. Dixon and L.A. Fallon, 'The Concept of Sustainability: Origins, Extensions, and Usefulness for Policy', Society and Natural Resources, Vol. 2 (1989), 73-84.) Indeed, many NGOs seek to stop excessive use of indigenous practices that produce, for example, rapid soil erosion and deforestation. Still, the argument is that practices that have persisted over long periods have by that fact proven themselves sustainable, if not overemployed.

xliv. In their study of the relationship between conventional and alternative agriculture paradigms, John Allen and Kevin Bernhardt showed the largest difference involved whether farmers should use natural fertilizers and production methods or synthetic fertilizers and pesticides ('Farming Practices and Adherence to an Alternative/Conventional Farming Paradigm', Rural Sociology, Vol. 60 (1995), 297-309).

xlv. William Lockeretz and Molly Anderson argue that 'organics' may be preferable owing to its origin in the idea that the farm should be understood as a system rather than its specifically anti-chemical connotation. See their Agricultural Research Alternatives (Lincoln: University of Nebraska Press, 1993). The diversity among alternatives to Green Revolution style is much less significant than their common opposition to that style, which is what is meant by saying that styles are defined by contrast.

xlvi. Sheila Jasanoff provides an overview of the origin of such international communities in

response to perceived environmental threats but her account holds generally ('Seven Forms of Ambiguity', Presented to the British Association for the History of Science. Edinburgh, Scotland.1996).

xlvii. One trope common among organic agricultural practitioners is that the principles are ancient, dating 4000 years ago to China or 2000 years ago to Greece, and hence appropriate to a natural relationship between a community and its ecosystem.

xlviii. Note that, consistent with positivist doctrine, the origin of stories does not matter so long as they embed back into research formations.

xlix. Farrington and Bebbington, op. cit. note 38, 54-5.

l. Names and details have been altered to protect the anonymity of the organizations involved. All quotations below are from unpublished project reports and interviews with participants. The name employed here--'Shamba'--denotes a rural home place, with highly positive connotations for Kenyans, and does not sufficiently reflect the colonial origins of the location.

li. Foeken and Tellegen, in their survey of large farms and households in the district, use a 'nearest neighbor' survey technique to show that non-laborers are better off than farm laborers, whether the latter are residents on the large farms or seasonal (non-resident). Journal of Peasant Studies, 24 (1997), 296-313.

lii. The land had been primarily controlled by pastoral peoples.

liii. The short course for farmers proved more important in the eventual operation of the Centre

owing to its duration and cost. The eighteen month course did not attract large numbers of students. Discussions with a Kenyan university to upgrade it to a Certificate course were subsequently the subject of a dispute between the California group and the Centre that led to a temporary cessation of funds from abroad. In the words of one observer, 'He has never to my knowledge set foot in the place, and yet he is turning the funds on and off like a tap'.

liv. The International Federation of Organic Agriculture Movements (IFOAM) maintains a membership of 750 organizations in 103 countries.

lv. In standard developmental discourse, this is known as funding civil society directly in order to empower it to act as a catalyst to good governance.

lvi. The importance of external donors cannot be overemphasized. Using the Kenyan case of opposition by a coalition of NGOs to the government registration act, Ndegwa effectively illustrates the process by which NGOs oppose the government through the mobilization of collective resources and alliances with oppositional political parties, but even in this case alliances with donors, involving threats to withdraw resources were ultimately the most effective. Stephen N. Ndegwa, 'Civil Society and Political Change in Africa: The Case of Non-Governmental Organizations in Kenya', International Journal of Comparative Politics, Vol. 35 (1994), 19-36.

lvii. In light of the events that followed, it is important to note that the donor was not wholly unaware of potential problems with accounting systems at the Centre. Such problems are well known, indeed endemic, among NGOs in most parts of Africa. Funding is viewed as an

investment in improving an organization with high potential.

lviii. The most important of these in Kenya was the Organic Matter Management Network (OMMN), formed in November of 1993 to promote on-farm research by bringing together NGOs and research institutes. Task forces were funded by Ford and Rockefeller to promote networking, but the group quickly disintegrated.

lix. The principal equipment, in keeping with the need to travel to farmers fields, included two Suzuki 4WD vehicles and a motorbike.

lx. It was even proposed to focus future courses on advanced training and leave the training of new groups to the Local Outreach Programme.

lxi. This technique was then being recognized as characteristic of NGOs and evidence of their commitment to localities (Chambers, op. cit. note 4).

lxii. This account of research results is drawn from the annual reports produced by the centre.

lxiii. It should not be inferred from this account of Adaptive Research at Shamba that the training program was in any way misguided or that its impact on farmers was not positive. One of the most important aspects of training is the use of biointensive agriculture for gardens that provide both food and income for households. Since opportunities to earn income from non-agricultural wage labour were declining during the 1980s, and since agricultural labourers (both resident and non-resident) are generally disadvantaged relative to non-labourers (Foeken and Tellegen, op. cit. note 51), this aspect of the training is particularly useful.

lxiv. The technology itself is often said to be of African origin, which was one of its selling points in California.

lxv. If there is any one feature of the biointensive agriculture heavily promoted in developing countries that is widely recognized and widely ignored, it is that biointensive practices are also labor intensive. This feature is never lost on farmers.

lxvi. The experiment reported was actually conducted in the last year of the grant as a student practicum, just as the research coordinator was leaving. Double digging trials were continued at the new location, with no reported effect on yield.

lxvii. Most Kenyans, confronted with this story of financial theft and mismanagement, express no surprise whatsoever, assume that the director himself made away with the funds, that the accounts were cooked, and that it would be naive and foolish to believe otherwise. However, such an assumption is unwarranted, since there are several other entities that may plausibly have acquired the funds. What is important about this initial transfer of funds is that it was, for practical purposes, both the beginning and the end--at least temporarily--of the research program at Shamba.

lxviii. *Matatus* are the most common means of transportation in Kenya, privately owned and operated vehicles that travel on unpublished but regular routes.

lxix. A new director who enters an organization in a situation of financial chaos, under pressure to restructure and professionalize, often experiences difficulties with the previous staff, who feel that they are being blamed for problems that are actually diffuse.

lxx. Adaptive research continues, funded by a new donor in this new NGO. Both of the former Shamba directors now work for NGOs, one of which is new.

lxxi. Alan Fowler, 'The Role of NGOs in Changing State-Society Relations: Perspectives from East and Southern Africa', Development Policy Review,Vol. 9 (1991), 53-84; Ndegwa, op. cit. note 56.

lxxii. This development is in itself worthy of close attention. In other developing countries, 'local agricultural research communities' consisting of farmers have been organized, such as those established by Jacqueline Ashby of the International Centre for Tropical Agriculture.

lxxiii. A true subsistence farmer, or the Unabomber's virtuous twin, does not need Society but they are few.

lxxiv. A brief characterization of a research program that is ideological in character is one that can only involve demonstrations.