No-Till Networks in Developing Countries

Javier Ekboir, Institutional Learning and Change Initiative (ILAC)

SYNOPSIS

This profile summarizes lessons from the networks that arose to develop no-till technology. The most innovative aspects of the networks were their composition and the ways in which they operated. Partners and research and extension approaches varied, but in all successful cases, a flexible innovation network emerged in which farmers' participation was important. Innovation brokers and catalytic agents played critical roles. Effective networks explored organizational innovations until they found approaches appropriate to local conditions; they also explored different approaches to organize the generation and diffusion of the technical innovation. The composition of innovation networks changed as the innovation process matured and new challenges emerged. Parallel innovation efforts contributed to the effectiveness of innovation, including efforts by public organizations that gave their employees scope to explore new ideas.

CONTEXT

In the 1970s, intensification of agriculture after the Green Revolution created severe soil erosion in many temperate and tropical countries. At the same time, grain prices started to fall due to rapid production increases. Reacting to these problems, farmers and researchers in many countries started to explore more sustainable, profitable technologies.

For centuries, farmers plowed the soil to favor water infiltration and control weeds. In the 1960s, the chemical company, Imperial Chemical Industries (ICI), developed a herbicide for which there was little demand, but the company decided that it could create a market for the product if chemical weed control could effectively replace plowing.[1] At the time, ICI was not trying to create a more sustainable or profitable technological package; it was just seeking to sell a product in which it had invested substantial resources and for which there was little use.[2] After the first successful experiments with no-till,[3] ICI realized that a new agricultural paradigm was needed. To develop it, ICI set up a research team that eventually settled in southern Brazil in 1970. The team leader recognized that for the herbicide to be of any use, new agronomic techniques, new weed management approaches, and new equipment were required. Knowing that ICI did not have all the capabilities to develop the components, the team leader looked for partners. Soon, the network included a state research institute, the Wheat Research Center of the Brazilian Agricultural Research Corporation (Empresa Brasileira de Pesquisa Agropecuária, EMBRAPA), a factory for planting equipment, progressive farmers, and the ICI team. Once the package was developed, farmer organizations diffused it.

A similar process (although with other partners) occurred in Argentina, Bolivia, and Paraguay. In all cases, the technology diffused very rapidly in the 1990s, thanks to the efforts of very effective no-till farmer associations, the technology's benefits, and favorable economic conditions. During the same period, no-till diffused to a few other countries as well. No-till programs have now been identified in more than 60 other countries, but adoption has been negligible (Ekboir 2002) because no-till methods require considerable adaptation to local conditions. No-till was used on an estimated 100 million hectares worldwide in 2005, mostly in the United States, Brazil, Argentina, Canada, Australia, Paraguay, and China. Bangladesh, Ghana, India, Nepal, and Pakistan accounted for a relatively small area because no-till is used by large numbers of small farmers (Derpsch 2010).

OBJECTIVES AND DESCRIPTION

No-till was developed and diffused by networks that included several public and private agents such as pioneer

farmers, agrochemical firms, equipment manufacturers, and sometimes researchers and public extension agents. The networks had varied origins. Some were started by private companies, others by public researchers, farmers, or public programs. Massive diffusion occurred only where networks that developed strong learning capabilities and effective interactions emerged. When no-till packages were developed with traditional experimental methods or diffusion was organized through conventional approaches, adoption was minimal.

Although the partners and research and extension approaches varied, a common factor in all successful cases was the emergence of a flexible innovation network in which farmers' participation was important (Ekboir 2002). The uniqueness of no-till processes is exemplified by the Ghanaian experience. To date, Ghana is the only country where a no-till package was adapted for small-scale farmers but not for large-scale farmers (box 1.23). Table 1.4 shows the partners and defining factors of some successful networks.

THE INNOVATIVE ELEMENT

The main innovation was the emergence and evolution of new organizations—innovation networks that involved different partners, including public and private researchers, farmers, equipment manufacturers, extension agents, and agrochemical companies—that generated, adapted, and diffused no-till techniques. To reach their objectives, the networks innovated in three domains:

- *Organizational.* New modes of interaction among different actors in the AIS emerged, as well as new approaches to research and extension.
- *Equipment.* New planters, sprayers, and combines enabled the consolidation of an innovative agricultural equipment industry.
- *Agricultural practices.* New practices were devised for planting and fertilization, weed control, management of soil cover, crop rotations that span several production cycles, and harvesting.

Box 1.23 Development of No-Till for Ghana's Small-Scale Farmers

For centuries, Ghanaian farmers used traditional slash-and-burn agriculture, which is equivalent to no-till without mulch. Slash-and-burn was sustainable when abundant land allowed farmers to leave the exhausted plots fallow for many years. Demographic pressure in the second half of the twentieth century forced farmers to shorten or abandon fallows and made slash-and-burn unsustainable. In the 1980s, research to adapt no-till with mulch as a sustainable alternative to slash-and-burn was initiated by the Crops Research Institute in Kumasi in conjunction with the International Maize and Wheat Improvement Center. Farmers did not adopt the package, because it was difficult to plant with a stick through the thick cover of plant residues in the field. In the 1990s, the importer of glyphosate (a herbicide), the Crops Research Institute, and Sasakawa–Global 2000 formed a partnership. Monsanto, trying to emulate its success in Brazil, later joined the partnership. The partners' key action was to fund the doctoral dissertation of a highly motivated soil scientist. As part of his research, he worked with innovative farmers to develop a weed and mulch management system that small-scale farmers could use and organized a successful extension program that motivated and provided resources to public extension agents. The package was disseminated to farmers in Ghana's forest, transition, and Guinea savannah zones and rapidly adopted. In 2005, no-till was used by an estimated 300,000 small-scale farmers.

Unlike other countries, in Ghana the no-till package responded to small-scale farmers' needs. Adoption was facilitated by the low-input agricultural practices that already prevailed and the fact that few farmers had animals (other than some chickens). There was no need to develop no-till planters, which were major obstacles in other countries where no-till was introduced, because crops were planted with a stick or cutlass (machete). The lack of equipment proved to be a limitation on widespread adoption among large-scale and mechanized farmers, however, because they needed suitable machinery to adopt the technology.

Source: Ekboir, Boa, and Dankyi 2002.

Table 1.4 Factors That Influenced the Performance of Four Successful No-Till Networks

Argentina	Brazil	Paraguay	India
Actors that at some point participated in the network			
– Innovative and committed farmers – Argentine researchers willing to interact with farmers – Innovative equipment manufacturers – Farmer organizations – Universities – Foreign researchers – Agrochemical companies – International research centers	– Innovative and committed farmers – Brazilian researchers willing to interact with farmers – Innovative equipment manufacturers – State research institutes – Farmer organizations – Foreign researchers – Agrochemical companies – International cooperation agencies	– Innovative and committed farmers – Farmer organizations – International research centers – International cooperation agencies	– Innovative and committed farmers – Innovative equipment manufacturers – International research centers – State universities
Modes of interaction			
– Active interactions between researchers, equipment manufacturers, and farmers in the development phase – Initial mild support from agrochemical companies, which became very strong when the leading firm recognized the market potential – Effective no-till farmer association organized diffusion programs	– Strong support from agrochemical companies – Active interactions between researchers, equipment manufacturers, and farmers – Effective no-till farmer association organized diffusion programs – Alliances of several partners developed and diffused packages adapted to small-scale farmers' needs and resources	– Strong links between Paraguayan and Brazilian farmers – Support from international cooperation agencies – Support from an international research center – Effective no-till farmer association organized diffusion programs	– Strong support from an international research center and state universities – Exchange of prototypes between Bolivian and Indian artisans enabled the development of efficient planters – Active interactions between international researchers, equipment manufacturers, and farmers – Traditional extension services worked with researchers
Factors that triggered the development of no-till networks			
– Curiosity-driven research – Severe soil compaction	– Severe soil erosion – A private firm willing to develop a market for a new product	– Farmers were aware of the economic and environmental benefits of no-till	– An international research center had experience with no-till in rain-fed areas and was willing to experiment in irrigated crops – Severe weed infestation that could be controlled easily with no-till
Socioeconomic and environmental factors that facilitated the generation and diffusion of no-till			
– Well-developed commercial agriculture – No-till's economic benefits – Research institutes that allowed researchers to conduct curiosity-driven research – Widespread use of custom operators for planting and harvesting – Macroeconomic policies reduced the profitability of grain production	– Well-developed commercial agriculture – No-till's economic benefits – Research institutes that allowed researchers to conduct curiosity-driven research	– Well-developed commercial agriculture – Previous experience with no-till	– No-till's economic benefits – Affordability of planters – Existence of market for planting services

Source: Author.

BENEFITS, IMPACT, AND EXPERIENCE

In all countries listed in table 1.5, except China, no-till was adopted mainly by large- and medium-scale commercial farmers. Among countries that have adopted no-till but do not appear in table 1.5, India, Pakistan, Bangladesh, Nepal, and Ghana together account for 1.9 million hectares under the technology. As noted, this relatively small area is deceiving in the sense that no-till is used by very large numbers of small-scale farmers. No-till practices are expanding in South Africa, Venezuela, New Zealand, France, Chile, Mexico, and Colombia and are in the early stages of adoption in other countries (Derpsch 2010).

Table 1.5 Use of No-Till in Select Countries, 2007–08

Country	Area under no-till (hectares), 2007–08
United States	26,593,000
Brazil	25,502,000
Argentina	19,719,000
Canada	13,481,000
Australia	12,000,000
Paraguay	2,400,000
China	1,330,000
Kazakhstan	1,200,000
Bolivia	706,000
Uruguay	672,000
Spain	650,000

Source: Derpsch 2010.

No-till had several important impacts on the AIS:

- New linkages developed among actors of the AIS and with foreign sources of technical information.
- New business models developed. For example, contracting planting and harvesting in South America and India allowed more efficient use of specialized equipment.
- New research methods were developed, accelerating the generation of the no-till package.
- New approaches were developed to disseminate the package.
- Some researchers and extension agents changed the way they interacted with other actors in the AIS.
- Farmer organizations developed capabilities for effectively exploring alternative technical and organizational solutions.
- Existing research and extension capabilities were used more effectively.
- Effective farmer organizations with strong innovation capabilities emerged.

LESSONS LEARNED AND ISSUES FOR WIDER APPLICATION

Effective networks explore different organizational innovations until they find approaches appropriate to local conditions. "Research" networks adapted the package to local conditions and "extension" networks diffused it; these networks interacted assiduously, and some actors (especially innovative famers) participated in both of them. The most innovative aspects of the process were the composition of the networks and the ways in which they operated (box 1.3 in the module overview). Innovation brokers and catalytic agents played critical roles in the exploration (TN 2 in this module and module 3, TN 4). Appropriate resources should be provided to pay for their services and for the trial of organizational innovations.

Effective networks explore different approaches to organize the generation and diffusion of the technical innovation. In the case of no-till, the research networks used participatory, on-farm research approaches, whereas the extension networks used a larger range of instruments, including self-help groups, demonstration days and plots, conventions, publications, radio and television programs, sales forces of agrochemical and equipment companies, and farmer-to-farmer communication. In the development of complex innovations like no-till, flexible approaches for research, financing, and evaluation should be used.

The composition of innovation networks changes as the process matures and new challenges emerge. No-till networks started as small teams and incorporated new members as the innovation process evolved. Despite this commonality, in each country (or even regions within countries) different processes led to the emergence of effective innovation networks. For example, in southern Brazil the catalytic agent was a private firm (ICI), but later, farmer organizations were the key actors in diffusing no-till among commercial farmers. In Argentina and northern Brazil, a group of researchers and farmers developed the package, but a coalition of innovative farmers and agrochemical companies diffused it. In Bolivia and Paraguay, commercial farmers led the process, but private firms joined the networks after no-till was widely adopted. Innovation projects should recognize the changing needs of innovation networks and

facilitate the incorporation of partners that possess assets the network needs and the withdrawal of partners that no longer contribute to the common effort. In other words, when promoting the creation of an innovation network, it is important to (1) search for willing partners, (2) empower them to decide on the best strategies to achieve the goals, and (3) encourage them to identify constantly what resources and information they lack and who can supply them. Innovation projects should contemplate resources for these search activities.

Effective innovation networks use adaptive management to facilitate collective action. When setting up a project to foster innovation, it is important to use participatory methods that help to create trust among potential partners, develop approaches adapted to local conditions, and use an adaptive management approach. In other words, prepare a project plan, implement it, periodically assess its implementation (at most yearly, but at shorter intervals in the first two years) to identify emerging problems and opportunities, and adjust the plans in response to the information collected.

Parallel efforts are necessary for effective innovation. Different approaches were used to generate the no-till packages and to create the networks that developed and diffused them. Each approach responded to local human and social resources and institutional constraints, but distant groups interacted among themselves. The effectiveness of innovation teams depends on the individuals that participate in them, their interactions, the resources they command, their learning strategies, external constraints, and unforeseen factors. It is impossible to know in advance how effective an innovation team will be; therefore, an effective innovation policy is to have more than one team working on the same innovation (Huffman and Just 2000). There are no precise methods to determine how many teams should be created. The number depends on several factors, including the quality of the individuals involved, the resources they command, the nature of the problem (for example, whether it is a major innovation or a minor adjustment), and the institutional environment in which they operate. To facilitate learning, however, the teams should interact assiduously among themselves.

Public organizations have to allow innovative employees to explore new ideas. The public research institutes in South America initially did not recognize the value of no-till, but they allowed individual researchers to explore new ideas. This approach contrasts with current trends in the management of research, which require projects to be clearly defined before they are implemented. To increase the contribution of public researchers, extension agents, and project managers in innovation processes, it is necessary to offer incentives that favor exploration, calculated risks, and participation in innovation networks (see TN 2).