Linkages
Discussion
Paper
No. 1

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Institutional Linkages for Different Types of Agricultural Technologies: Rice in the Eastern Plains of Colombia

by

Luis Alfonso Agudelo and David Kaimowitz

October 1989

International Service for National Agricultural Research

INTRODUCTION TO THE ISNAR STUDY ON THE LINKS BETWEEN AGRICULTURAL RESEARCH AND TECHNOLOGY TRANSFER IN DEVELOPING COUNTRIES

David Kaimowitz
Study Leader

In 1987, the International Service for National Agricultural Research (ISNAR) initiated a major international comparative study on the links between agricultural research and technology transfer in developing countries. Like other ISNAR studies, this study was developed in response to requests from agricultural research managers for advice in this area. It is being carried out with the support of the Governments of Italy and the Federal Republic of Germany and the Rockefeller Foundation.

The objective of the study is to identify ways to strengthen the links between agricultural research and technology transfer systems in order to improve:

(a) the relevance of research efforts through a better flow of information about farmers' needs for the research systems;
(b) the transfer of technology to agricultural producers and other users of agricultural technologies.

Why the Study was Initiated

Many sources have noted the problem of poor links between research and technology transfer in developing countries:

"Bridging the gap between research and extension is the most serious institutional problem in developing an effective research and extension system." World Bank, 1985

"Weak linkages between the research and extension functions were identified as constraints to using the research in 16 (out of 20) of the projects evaluated." United States Agency for International Development (USAID), 1982

"All the 12 countries (in which research projects were evaluated) had difficulties of communication between research institutions and extension agencies." Food and Agriculture Organization (FAO), 1984

The serious consequences of this problem is effectively summed up in the following statement by a leading international expert in the field, Monteze Snyder: "The poor interorganizational relations between the extension agency and the research organization almost guarantee that research results will not reach farmers, and if they do, farmers will not be able to use them." Despite this situation, however, no major international study has been dedicated specifically to this issue. While there are a few good evaluation reports and academic studies in individual countries, much of what has been written about research-technology transfer links has been general or anecdotal. The results of the practical attempts which have been made to improve links have been disappointing.

A systematic study is needed to provide a set of simple, but not simplistic, suggestions on how research-technology transfer links can be improved in different situations.

Operational Strategy and Products

The study is to be conducted over a four-year period and has been divided into three stages. The first stage consists of a literature review, the development of a conceptual framework and case study guidelines, the production of 'theme papers' (*see page iii*) and pilot case study activities in Colombia. The second stage involves carrying out case studies in six additional countries — Costa Rica, Côte d'Ivoire, the Dominican Republic, Nigeria, the Philippines and Tanzania. In each of these countries the studies will concentrate on specific subsets of the national research and

technology transfer systems. They will also document the links which were involved in the generation and transfer of a small number of specific new agricultural technologies. In the third stage, the various materials which have been developed will be synthesized into one set of concrete applicable guidelines.

Ultimately, four types of documents will be published as part of this special series of papers on research-technology transfer links:

1. *Theme papers* on key linkage-related topics. These have been written by specially commissioned international experts in the field.

2. *Discussion papers* which analyse one or a few major issues emanating from the case studies. About 15 such papers are expected to be produced, written by the case study researchers. They will focus on the most outstanding features of the links observed in the cases and draw clear conclusions about them for practical use by managers.

3. *Synthesis papers* which present the lessons emerging from the case studies. These are being written by ISNAR staff.

4. *Guidelines* on how to design and manage the links between agricultural research and technology transfer for policy makers and managers concerned with the two activities. These will also be written by ISNAR staff, with input from the case study researchers, managers of national systems, and others.

We expect the theme papers to be published during 1989. Most of the discussion papers will be published during the following year and the synthesis papers and guidelines will probably be available in early 1991. Individual copies of all these papers will be available from ISNAR upon request, at the discretion of ISNAR.

LIST OF THEME PAPERS
IN THE SPECIAL ISNAR LINKAGE SERIES
(forthcoming in 1989)

A Conceptual Framework for Studying the Links between Agricultural Research and Technology Transfer in Developing Countries
D. Kaimowitz, M. Snyder and P. Engel

The Agricultural Research-Technology Transfer Interface: A Knowledge Systems Perspective
N. Röling

Private Sector Agricultural Research and Technology Transfer Links in Developing Countries
C. Pray and R. Echeverría

The Political Economy of the Development and Transfer of Agricultural Technologies
H. Sims and D. Leonard

The Implications of On-Farm Client-Oriented Research for the Relationships between Research and Extension
P. Ewell

Intergroup Relationships in Institutional Agricultural Technology Systems
P. Bennell

The Effect of Changes in State Policy and Organization on Agricultural Research and Extension Links: A Latin American Perspective
R. Martínez Nogueira

Interorganizational Relationships between Agricultural Research Institutions and Extension Agencies
J. T. Kang (tentative)

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INSTITUTIONAL LINKAGES FOR DIFFERENT TYPES OF AGRICULTURAL TECHNOLOGIES: RICE IN THE EASTERN PLAINS OF COLOMBIA

Luis Alfonso Agudelo and David Kaimowitz

Summary

Four rice technologies from the Eastern Plains (Llanos Orientales) of Colombia are used to show that the generation and transfer of different types of technologies require distinct institutional configurations and linkages. As rice growers technological needs have shifted, the institutions serving them have also had to evolve. This has been facilitated by the flexibility of the Rice Growers Federation (Fedearroz) and strong inter-institutional coordination between Fedearroz, the International Center for Tropical Agriculture (CIAT), and the Colombian Agricultural Institute (ICA).

Introduction

There is a large and growing literature about institutional mechanisms for improving the coordination between agricultural research and technology transfer activities in developing countries (Cernea et al., 1985; Samy, 1988; Snyder, 1986). Most of it, however, is so general that it gives the impression that the same institutional mechanisms are appropriate for all technologies. The implicit message is that whether one looks at a new crop variety, a livestock vaccine, or a new recommendation for fertilizer use, the same basic set of actors, activities, and linkage mechanisms will be involved.

Such simplifications are misleading. In reality, different types of technology require different linkages. One set of linkage mechanisms will not be adequate for institutions that deal with a wide variety of technology types. Moreover, as new technological issues become dominant, research and technology transfer institutions are forced to adapt in order to adequately address them. This implies there is a need for a certain degree of flexibility if these institutions are to sustain their effectiveness over time.

This paper uses the case of rice technologies for the Eastern Plains of Colombia to demonstrate these two points. In that case the first major technological improvements made were based on varieties and machinery directly imported from abroad. The only necessary actors were importers, distributors, and seed multipliers.

Later, new high-yielding varieties, bred specifically for Colombian conditions, became important. These required additional actors and close coordination between those with access to international sources of germplasm, plant breeders, agronomists carrying out regional trials, seed multipliers, individual private agronomists, and farmers.

Along with the new varieties came a major increase in chemical fertilizer use. Here soils researchers relied largely on publications and seminars to disseminate their specific research results, with little success. Still, private chemical distributors effectively promoted a generalized increase in fertilizer sales.

Most recently, researchers have sought to reduce production costs by lowering pesticide usage. These technologies have proven difficult to transfer because they suffer from the same problems found in the fertilizer case, without the benefit of commercial promotion by private input distributors and agronomists.

Over time, the Colombian Rice Growers Federation's willingness and ability to adjust its structure and mandate has helped make it possible to meet the new technological challenges and institutional bottlenecks that have arisen. Were it not for this flexibility, on various occasions an institutional vacuum could have developed that might have greatly hindered the technological change process.

The paper is divided into six sections. The first provides basic information on rice production in the Eastern Plains

of Colombia and the institutions relevant to our story. Then, there are sections on the institutional experiences with imported varieties, nationally bred varieties, fertilizer recommendations, and pesticide-use reduction. The conclusions concentrate on the implications of the Colombian experience for other developing countries.

1. The Context

Rice is a staple food in the Colombian diet. After coffee, it is the country's second most important crop (IADB, 1979).

The country's three principal rice-producing areas are the central region, the coastal region, and the Eastern Plains. The latter was the last major rice region to develop; it currently produces about one-quarter of the national output.

Typically, rice growers in the region are medium-sized commercial farmers with some 50-100 hectares under cultivation. Almost all use agricultural machinery and make heavy use of agrochemicals. Slightly more than half of the region's rice acreage is irrigated.

Poor soils are the region's most important limiting factor for rice. The soils tend to be acidic, low in organic matter, high in aluminum, and generally infertile (Villarruel et al. 1987).

The principal actors concerned with rice technology for commercial growers in the region are: the International Center for Tropical Agriculture (CIAT), the Colombian Agricultural Institute (ICA), the Colombian Rice Growers Federation (Fedearroz), private agrochemical distributors, private seed multipliers, and individual private agronomists. Other institutions also play a role, but these are of secondary importance.

CIAT is an international agricultural research center (IARC) based in Colombia. Its rice program has a mandate to carry out rice research applicable to all of Latin America and the Caribbean. Two of the program's experiment stations are located in the Eastern Plains.

ICA is Colombia's public agricultural research institute. It also has an experiment station in the Eastern Plains. In addition to its rice research activities, ICA has a regional office charged with supervising the technical assistance provided by private agronomists and is responsible for regulations concerning input production and distribution.

For its part, Fedearroz is a national growers' association concerned with all aspects of rice production and marketing. The Federation's Technical Subdivision is heavily involved in adaptive research and disseminating technical information among private agronomists and growers. The Federation multiplies rice seed and sells agrochemicals.

The seed and agrochemicals companies produce and distribute agricultural inputs and are important sources of technical information, both for the agronomists and the growers.

Finally, as part of a government-supervised credit program, rice growers are required to contract the services of private independent agronomists to provide them with technical assistance. Approximately 300 agronomists are licensed to provide technical assistance to rice growers in the region, but only around 100 actually do so in any given season. Generally the agronomists visit the grower several times during the season, mostly after the crop is already established.

2. Borrowing Technology from Abroad

Fedearroz was created in 1947 to pressure the Colombian government for more favorable policies towards rice producers. Although technological issues were not its central concern, by 1954 the Federation had become interested enough in these aspects to initiate a substantial effort to identify, import, multiply and distribute improved rice varieties from the United States.

Various varieties were tried and one, Bluebonnet-50, became a major success. By 1966, 90% of the country's rice area was being planted with this variety (Fedearroz, 1985). This occurred entirely through simple trial and error, with no elaborate research efforts. The activities were undertaken on a purely commercial basis, with minimal coordination between Fedearroz and other agencies. Although there had been some rice research in Colombia as early as 1928, little, if anything, had come from it.

Similar stories could be told about agricultural machinery and agrochemicals. These were largely borrowed technologies, disseminated strictly on a commercial basis, with little relation to national research.

3. Research-Generated Varieties

Despite its commercial success, Bluebonnet-50 had several significant defects. It was susceptible to Colombia's major rice diseases -blast and piricularia- and had rather low yield potential. Thus, the need to develop national varieties, adapted to local conditions, soon became apparent.

A national rice research program was created in 1957 that concentrated on breeding for higher yields and resistance to blast (Hertford et al. 1977). Soon after, Fedearroz began providing individual technical assistance. A formal contract was signed in which the rice research program agreed to be responsible for breeding and Fedearroz for extension, seed multiplication, and distribution. The two institutions had joint responsibility for carrying out regional variety trials and trials under semi-commercial conditions. They also shared responsibility for determining the agronomic recommendations appropriate for a new variety. The first Colombian-bred variety was released under this agreement in 1963.

Coordination between ICA and Fedearroz became even stronger after 1963. The government established a levy on rice sales to finance Fedearroz's activities, and a new coordination agreement was signed. Fedearroz agreed to provide general technical assistance to rice growers and to disseminate ICA's research results. At one point Fedearroz had 22 agronomists in the Eastern Plains providing direct technical assistance to growers.

A number of concrete mechanisms facilitated the coordination between the two institutions. ICA provided training to the Fedearroz agronomists. Fedearroz seconded agronomists to work full-time in ICA's rice research program. Annual joint planning meetings were held to set priorities and assign responsibilities. Discussions about whether a new variety should be released were held at another set of national and regional meetings. Fedearroz's magazine, **Arroz**, popularized and disseminated ICA's research results.

In the years that followed there were changes, but the basic pattern of coordination remained. In 1966 the breeders began to focus on dwarf varieties and added high grain-to-straw ratios and resistance to lodging to their major breeding objectives (ibid:88). This led to the "green revolution" in rice in Colombia.

The creation of CIAT in 1967 converted the bilateral relationship between ICA and Fedearroz into a triangle. Since that time, all three organizations have had formal agreements with each other, which are periodically updated. (Each organization's basic responsibilities are presented in figure one.)

Figure 1

Institutional Responsibilities for Steps in Obtaining New Rice Varieties

Steps	*Responsibility*
Germplasm Evaluation	CIAT-ICA
Crosses and Evaluation of Early Segregating Generations (F2, F3, F4)	CIAT-ICA
↓	
Yield Trials	ICA
↓	
Regional Trials	ICA-Fedearroz
↓	
Develop Agronomic Recommendations for the Variety	ICA-Fedearroz
↓	
Semi-Commercial Trials	ICA-Fedearroz
↓	
Evaluate whether Variety Should be Released	ICA-CIAT-Fedearroz
↓	
Release New Variety	ICA

In the 1970s ICA began to have problems with high turnover in its professional staff and delays in funding for operational costs. To keep these from disrupting the entire system, Fedearroz assigned more agronomists to assist the program. Later CIAT initiated a rotating fund financed out of the sale of basic seed to reduce ICA's liquidity problems.

Around the same time Fedearroz stopped providing direct technical assistance to growers. As the growers' technical needs became more sophisticated and the number of private agronomists available to provide assistance grew in response to the creation of public-supervised credit programs, Fedearroz increasingly took on the role of liaison between the rice researchers and the private agronomists.

The number of private seed multipliers and distributors increased. These suppliers became an important channel for a two-way flow of information about new varieties between breeders and the private agronomists and growers.

The results of these efforts were impressive. Yields rose rapidly and are now among the highest in Latin America. (See table one). High internal rates of return were obtained on the investments from rice breeding (Hertford et al. 1977). Since 1967, a new rice variety has been released on average once every two years. This is

important, since the varieties' disease and pest resistance tends to break down over time. Recently, varieties have been released specifically for the infertile soils of the Eastern Plains.

Table 1

Rice Yields in Colombia, 1961-1984
(Tons/Hectare)

1961-1965	1.98
1966-1970	2.55
1971-1975	4.03
1976-1980	4.24
1980-1984	4.48

Source: Fedearroz (1985)

Effective linkages have developed between all the major actors. Each organization is clear about its specific responsibilities. These responsibilities have been formalized, and the whole breeding and dissemination process has become a regular routine. Fedearroz's seed division and the private seed multipliers have done a good job promoting new varieties among producers and, until recently, producers have been required to plant these varieties in order to obtain subsidized public credit.

Informal communication has also been important. The performance of different varieties is a topic of constant discussion in the rice-growing regions, and the relevant characteristics of promising strains are usually well known through word-of-mouth long before they are officially released. Informal contacts with seed multipliers, agronomists, and growers frequently provide the breeders with crucial information on disease outbreaks and signs of break-downs in disease resistance.

In contrast, formal communication channels, such as publications and seminars, seem to play a relatively minor role.

4. Fertilizers and Soil Amendments

The case of fertilizers and special soil amendments is quite different. Unlike with varieties, there is little close coordination, standardization of activities, and clear assignment of responsibilities. It is also less clear that the results of informal communication have been positive.

Most of the soils research has been done by ICA. Relatively little has been coordinated through the official agreements between the three organizations. Within ICA, soils and rice breeding are separate programs. The formal flow of information between the two programs is inadequate. Informal information exchanges partially make up for this, but these are irregular and somewhat haphazard.

The organizations disagree about recommendations, and there is no established forum for reaching agreement on these issues. ICA recommends applying phosphoric fertilizer at or before planting. Fedearroz and CIAT recommend a later application. Private companies actively promote various liquid and foliar fertilizers despite recommendations by ICA against their use.

The soils researchers do actively disseminate their results. There are more seminars, courses, field days, and publications about soils-related issues than about new varieties.

Nonetheless, the overall relationship between soils research and the private agronomists has been weak. Many research articles are written in scientific language and published in small irregular journals. Attendence by private agronomists at events presenting research results is often poor.

Weak coordination with Fedearroz about soils issues means that Fedearroz is less likely to actively promote ICA recommendations in this area. The ICA regional office charged with supervising and training the private agronomists lacks resources for this purpose.

Unlike the seed distributors, who reinforce the technical recommendations from research, the private fertilizer companies promote a large and confusing array of products and many times openly diverge from ICA recommendations. It is difficult for ICA to compete with these companies, which have much greater resources available for promotional activities.

Thanks to heavy promotion and clear economic benefits, overall fertilizer use grew rapidly and is presently quite high. In many cases, however, the specific fertilizer mixes and amendments used and their level, date, and form of application are different from those recommended by researchers. While many growers use fertilizers at unprofitably high levels, the use of amendments to decrease soil acidity is probably lower than would be desirable. In general terms, the overall outcome may have been acceptable; but the existing institutional arrangements and linkages clearly have not permitted much technological fine-tuning.

5. Pesticide Usage Reduction

Although Colombia's rice yields are among the highest in Latin America, so are the costs of production. The country is already basically self-sufficient in rice and per capita consumption is static. Thus, to continue expanding production at historic rates it must export; but with its current costs, Colombia cannot compete on the world market. In addition, yield increases have leveled off in recent years, and yields may be near the maximum levels currently obtainable. Yet price rises for inputs have kept per-hectare production costs rising steadily.

In 1985 CIAT conducted a detailed study of production costs for most major Latin American rice production regions (CIAT, 1986:53). The results were discussed at an international rice meeting later that year, attended by both ICA and Fedearroz. At that meeting the high Colombian costs came under particular scrutiny.

Out of these discussions came a tripartite cost-reduction plan for Colombia. The major areas identified for savings were in seeding rates, weed control, and disease and pest management (CIAT, 1987: 15).

For pest management, the most important recommendation was the application of pesticides only when critical economic threshold levels of pest damage have been reached. It was estimated that this change alone could save growers U.S. $ 20 million annually.

In the Eastern Plains the plan was initiated at a broadly attended meeting sponsored jointly by CIAT, Fedearroz, and ICA. Four projects were undertaken as part of the plan, and all three organizations were assigned specific individuals to work on them.

The plan's pest management component relies mostly on demonstration plots and didactic manuals to communicate its message. Courses, talks, and leaflets are also used. ICA's regional director has taken a particular interest and has tried to use the regional technical-assistance office to actively involve the private agronomists and identify growers willing to host demonstration plots.

Despite the plan's great clarity, economic benefits, and high levels of inter-institutional coordination, however, acceptance by the private agronomists and growers has been weak. This is partly due to the weak coordination between researchers and the private agronomists. In addition, although the private pesticide companies have, in principal, accepted the plan, there are clearly strong incentives for each individual dealer to maximize pesticide sales. These dealers exercise a strong influence on both the private agronomists and the growers.

Even if the private agronomists had supported the new approach and were adequately trained about its implementation, their mode of operation would have limited their ability to effectively promote it. Integrated pest management requires a different technology transfer approach then preventive pest control. Each grower must be trained in the skills necessary to evaluate the levels of damage caused by pests and decide when a given response is appropriate. The private technical-assistance operations are not set up to provide such training; they find it easier and more profitable to make occasional visits and recommend pesticide applications. Since the input companies and private agronomists themselves are not convinced of the new practices, growers are reluctant to take the risks involved in adopting the new techniques.

This situation has led Fedearroz to rethink its technology transfer strategy. It is considering initiating a program to directly promote the national cost-control plan among growers. Fedearroz originally had stopped providing direct technical assistance because private agronomists were available to do the job. But with the new technologies, the institutional arrangements that worked well for varieties, and more or less acceptably for increasing the use of fertilizers, have proven inadequate. Thus, once again, Fedearroz may step in to fill the vacuum.

6. Implications for Other Developing Countries

Commercial rice growers in Colombia and the institutions that support them have greater access to resources than is typically the case in developing countries. Nevertheless, their experience provides relevant lessons for all those seeking to improve the management of the technological change process.

Effective agricultural research and technology transfer institutions, and mechanisms for coordination between them, cannot be designed without paying special attention to the specific types of technologies they will focus on.

Different arrangements are required to directly borrow technology from abroad than to develop it locally. A system that works perfectly well in promoting increased input sales may be poorly suited to make more efficient use of a given set of inputs. Information about certain technologies can be disseminated effectively through informal communication channels. Others require formal training and informational materials. Strong coordination between institutions on one topic does not necessarily imply similar coordination in other areas.

There is currently a proliferation of general models with claims for wide applicability. Perhaps the most controversial is the Training and Visit system of extension. Its proponents have advocated the same type of extension institution and linkages between research and extension for practically all situations (Benor and Harrison, 1977). Other examples include farming systems research, the land-grant university system, and private research and extension. Each of these is appropriate for certain types of technologies in certain situations. But none has the universal relevance that is sometimes implied.

This point is particularly important at the present because it is time to move beyond new annual crop varieties as the classic example of technological change in agriculture. The great success of the high yielding varieties associated with the "green revolution" and the emphasis of most public agricultural research institutions on plant breeding have led most writers on these topics to use varieties as the implicit prototype in their discussions.

This focus, however, may have blinded them to many of the institutional issues raised by other types of technologies, which are becoming increasingly important.

Byerlee (1987) argues persuasively that where crops have already gone through the green revolution, as has rice in Colombia, significant improvements will probably have to come through localized changes in cropping patterns and agronomic practices and a more efficient use of inputs. But as we have seen, such changes present institutional difficulties quite different from those found with new commercial varieties.

In more traditional agricultural areas livestock, post-harvest technologies, agro-forestry, and environemental issues are becoming increasingly important themes for research and technology transfer. But here again, the issues they raise are so unique that research and technology transfer paradigms based on the variety experience are as likely to mislead as enlighten (Scherr, 1988).

Officials in the ministries of agriculture and foreign donors must give close attention to the organizational implications of the changing mandates of agricultural research and technology transfer institutions. Different institutional bottlenecks will become important as new technological issues arise and the overall organizational environment evolves.

In Colombia it was principally Fedearroz that took the initiative. When the private sector was still weak Fedearroz took responsibility for commercial seed imports. Later, when no one else could effectively do the job, it accepted the task of providing direct technical assistance.

As ICA's research capacity became weaker and the private capacity for technical assistance became stronger, it moved out of direct technical assistance and gave more attention to adaptive research and serving as a liaison between research and technology transfer. Finally, when the private agronomists proved incapable of forcefully promoting cost reduction, the Federation considered taking this task on directly.

In most developing countries there are no private institutions to play this role. Public institutions rarely have the resources to take on responsibilities outside their official mandate and are extremely reluctant to give up their monopoly over tasks that are within it. Thus, it is left to ministry officials and foreign donors to actively manage and make adjustments in the agricultural technology system as a whole.

Footnotes

1. Luis Alfonso Agudelo is a researcher at the Colombian Agricultural Institute (ICA), and David Kaimowitz is a research officer at the International Service for National Agricultural Research (ISNAR) in the Netherlands. This paper is part of a much larger comparative study of the relationship between agricultural research and technology transfer currently being conducted by ISNAR. The authors gratefully acknowledge the financial support of the governments of Italy and the Federal Republic of Germany, and the Rockefeller Foundation in this study and the excellent collaboration received from ICA, Fedearroz, and CIAT. All errors, of course, are the sole responsibility of the authors.

2. A notable exception in this regard is Swanson et al. (1988).

3. Small peasant rice producers in the Eastern Plains are served largely through rural development programs. This paper looks only at the services for commercial growers, who are predominant in the region.

4. Another factor in Fedearroz's decision to dismantle its technical assistance service in 1970 was internal labor disputes. How important this factor was, however, is unclear.

5. In some cases this may reflect rational decision-making by growers. Optimal fertilizer recommendations, unlike new varieties, are quite sensitive to changes in economic parameters, and there has been relatively little economic analysis on this topic in the region. There is a consensus among soils researchers, however, that many growers' current fertilization and soil amendment practices could be greatly improved.

6. The under-utilization of soil additives for raising the PH level, which provide much of their benefits only in the .nedium term, may be partially due to land tenure considerations, since some 70% of the rice area in the region is rented under insecure contracts.

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