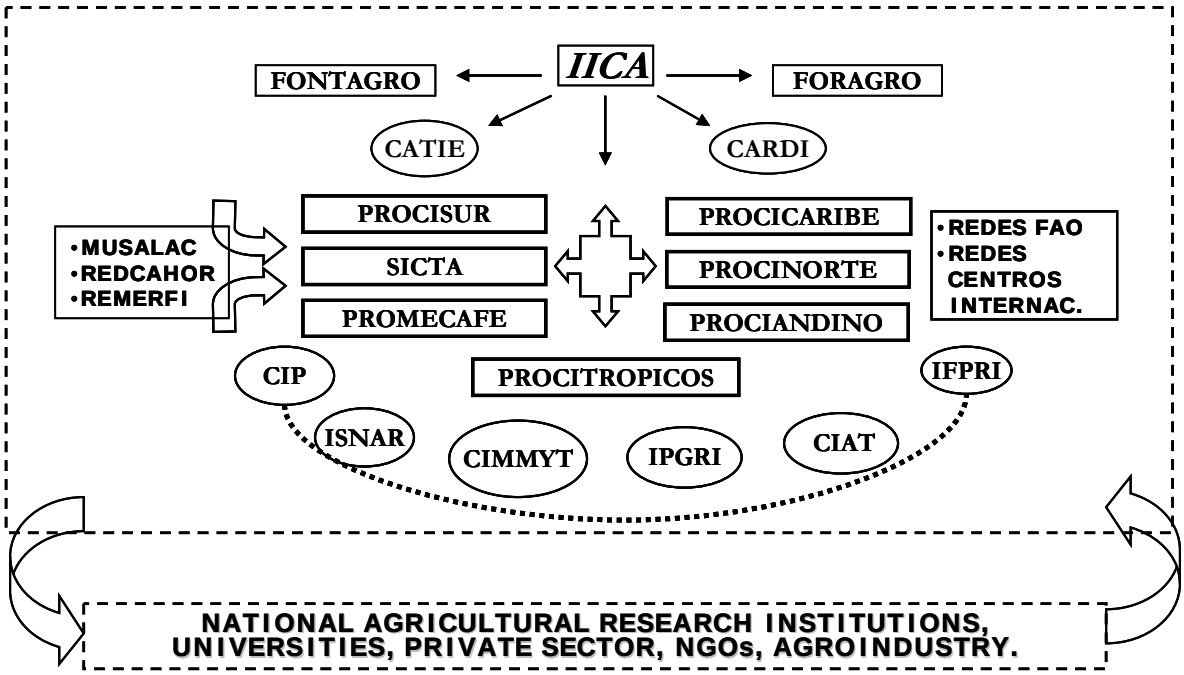
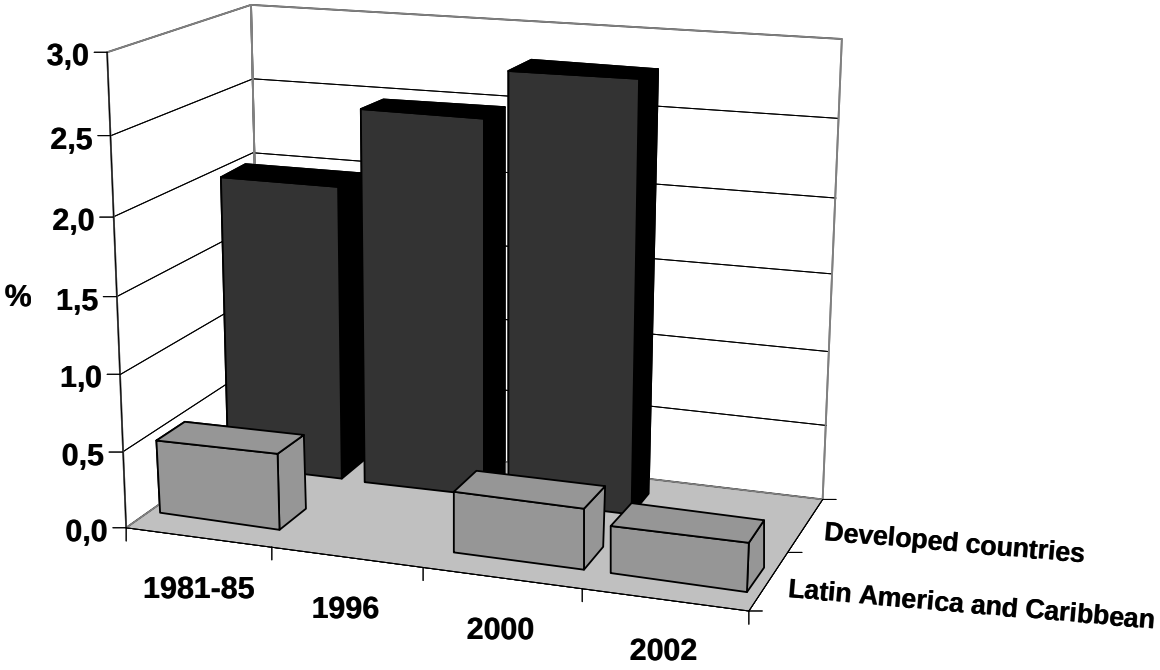
LAC Chapter 2 Figures

Figure 2.1 Regional Agricultural Technology Innovation System for the Americas



Source: Ardila 2006

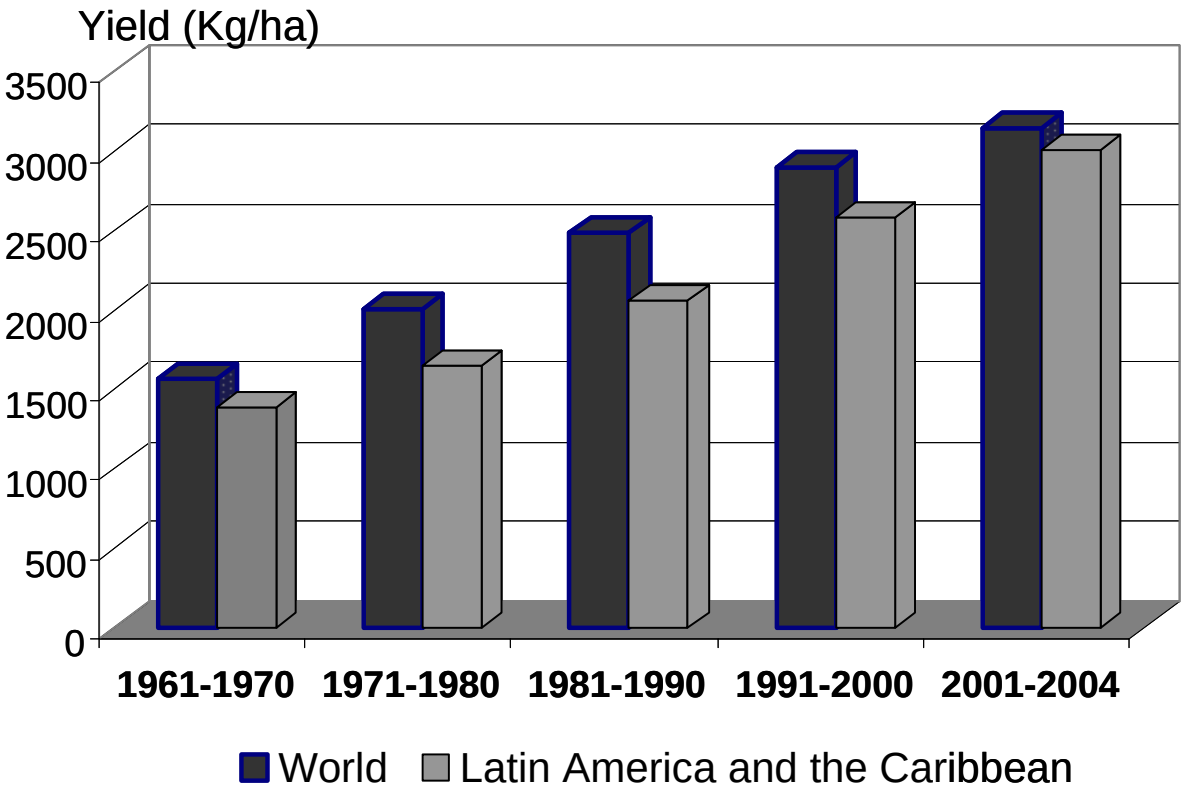
Figure 2.2 Evolution of the intensity[1] of public agricultural research in Latin America and the Caribbean compared to developed countries.



Source: Ardila 2006.

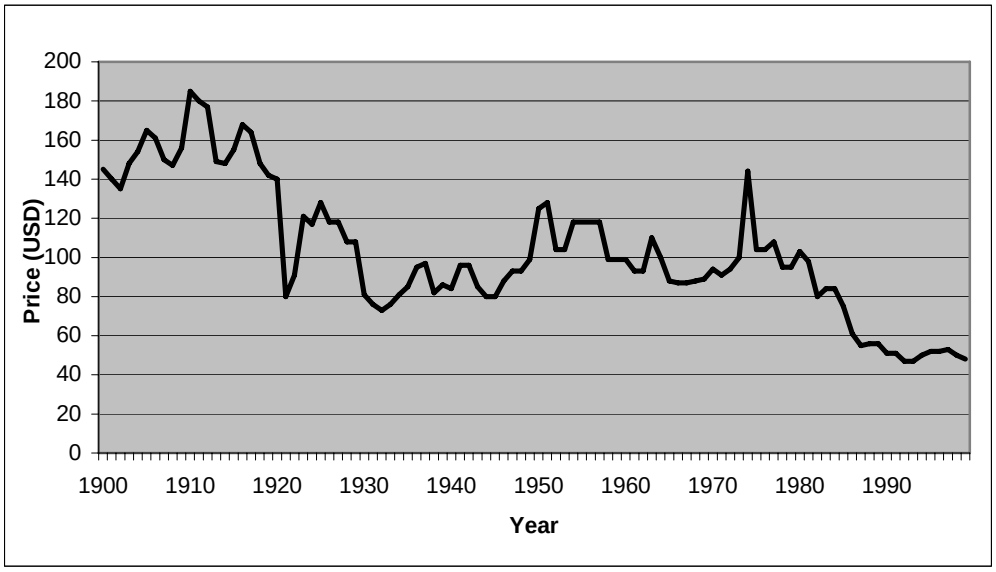
(1) Intensity measured as the relation between investment in Agricultural I&D and the Agricultural Gross Domestic Product in percentage.

Figure 2.3 Trends in the median yields of food crops in LAC and the world, 1961-2004



Source Ardila 2006

Figure 2.4 Historical trends of average prices of primaries commodities (Weighted average prices in real dollars)



Source: Authors elaboration base on World Bank data. Global Commodity Markets. A Comprehensive Review and Price Forecast. Enero 2000, Nº 20306

Table 2.1 Problems common to NARIs in LAC (Most outstanding examples)

(a) Limited inter - institutional collaboration
Mutual antagonism and lack of cooperation between the institutions in charge of agricultural research and universities and university faculties involved in agriculture.
Ineffectual links between plant and livestock research.
Insufficient use of socio-economic disciplines.
Research on production and on-farm systems relegated to isolated, separate organizational units. Insufficient support for the concept that researchers should carry out research on-farm from a production systems perspective.
Ineffective linkages between research and extension activities.
Limited interaction and linkages between public and private bodies engaged in agricultural research.
Insufficient participation of producers in the definition of research agendas and the evaluation of results.
Dispersion of agricultural research over a large number of ministries and other agencies.
Excessive intra-institutional fractioning, with researchers and other team members spread over too many small experimental stations or scientific fields, leading to the lack of a critical mass for the efficient use of infrastructure and proper supervision, tutoring, and collaboration.
(b) Resource problems
Severe lack of resources.
Allocation of resources by crop, system, product or research area that do not reflect national priorities and the needs of producers.
Diluted distribution of scarce resources among a large number of crops or research areas without the necessary setting of priorities.
Inappropriate balance of resources (the greatest percentage of budgets is assigned to paying for salaries, leaving insufficient resources for operations).
A resource allocation process that is too centralized.
Excessive dependence on resources from externally financed projects for the acquisition of equipment and vehicles.
Inefficient use of costly equipment and specialized infrastructure due to their dispersion and fractioning, aggravated by ineffectual linkages.
Budgetary allocation guided more by experimental station than by research area.
Budgets are more a compilation of “requests” than tools for the effective allocation of resources.
(c) Organizational and managerial weaknesses
Hierarchical organizational structures and attitudes instead of “flatter” structures linked to a more collegiate management style more conducive to scientific innovation.
Insufficient delegation of authority.
Purchase of inputs that is subject to complex and slow bureaucratic procedures.
Lack of management information (information systems).

Inappropriate procedures for the preparation and revision of budgets.
Inadequate research planning and follow-up.
(d) Organizational and personnel weaknesses
Hierarchical organizational structures and attitudes, instead of "flatter" structures linked to a more collegiate management style that is more conducive to scientific innovation.
Insufficient delegation of authority.
Lack or weaknesses in assessing individual performance.
Promotion based on seniority rather than on merit.
Heads of institutions or units not chosen on the basis on their administrative performance.
Inadequate training regarding leadership, administration, and management.
Lack of incentives.
Lack of flexibility in civil service regulations regarding the administration of human resources dedicated to agricultural research.

Source: Nickel, J., in Bonte-Friedheim, C. and K. Sheridan (eds). 1996. *The Globalization of Science. The Place of Agricultural Research.* The Hague. International Service for National Agricultural Research (ISNAR). The Netherlands.

Table 2.2 Factors that condition AKST's potential for developing more productive, sustainable and equitable systems

Type of factor	**Description**
Political	Lack of linkages between AKST systems and public policies – macroeconomic, commercial, financial, environmental, and related to access to markets, education, and information. Lack of policies to promote and support AKST. Lack of vision on the strategic role of the sector. **Regulatory insecurity.**
Institutional	Lack of cooperation in national, regional and international AKST networks. Lack of strategic plans and AKST participation in the same. Ageing of scientists and technicians and lack of human-resource policies within the system. Lack of balance in human resources with regard to interdisciplinary, intercultural, and gender issues. Lack of linkages between research and technology transfer.
Economic	Reduction of public investment in AKST. Insufficient private investment in AKST.
Social	Lack of acknowledgement of the importance and impact of AKST among the general population (reflected in little public investment in AKST). Lack of participation of social actors in defining the agenda and management of AKST Systems.

Source: Authors elaboration

Table 2.3 Most important impacts of AKST Systems in Latin America

Aspects	***Positive Impacts***	***Negative impacts and Risks***
Productive	• Improvement in crop and animal production yields by surface and water quantity, mainly in conventional production systems. • Development of new varieties and races that are resistant to diseases and adapted to different agro-ecological conditions. • Development of safer and higher-quality products. • Generation of new agricultural technologies.	• Loss of agro-biodiversity. • Loss of soil fertility. • Loss of productive systems' resilience. • Negative impacts on health due to lack of hygiene and on-the-job safety.
Economic	• Reduction in production costs. • Reduction in food prices, particularly for basic food items. • Increase in the income and profits of conventional farmers. • Increase in countries' GDP and exports. • Access to new markets for traditional, indigenous, and agro-ecological farmers.	• Reductions in employment. . • Migration. • Concentration of profits. • Lower incomes for traditional or indigenous farmers.
Ecological	• Soil and water conservation in some production systems. • Generation of less polluting agrochemicals.	• Loss of agro-biodiversity and wildlife biodiversity. • Contamination of water and soils by agrochemicals. • Contributions to climate change.
Social	• Improvements in the social conditions of conventional and agro-ecological producers.	• Little impact on the social conditions of traditional and indigenous producers. • A devaluation of local knowledge.

Source: Authors elaboration

Table 2.4 Evolution of the AKST agenda in Latin America and the Caribbean over the last 50 years

AKST Dimension	*Until the 1980s*	*Currently*
Main AKST objectives	• Increasing production and productivity. • Increasing the food supply.	• Increasing production and productivity. • Increasing the food supply. • Ensuring food security. . • Conserving natural resources and providing environmental services. • Alleviating poverty. • Mitigating the impact of climate change and natural disasters. • Incorporating local knowledge. .
Issues researched	• Production aspects: genetic improvement, fertilization and soil management, pest and disease management and control, agricultural machinery, animal and plant health.	• Production aspects: genetic improvement, fertilization and soil management, waste management, pest and disease management and control, agricultural machinery, animal and plant health. • Biotechnology and biosafety. • Postharvest treatment. • Environmental services valuation. • Agro-biodiversity and wildlife biodiversity conservation. • Impact of production on natural resources (water, soil, biodiversity). • Value added to the production chain. • Socioeconomic and anthropological issues. • Environmental-, ecological-, and natural- resource economics issues.
Technological tools used	• Animal and plant genetic improvement. • Crop and livestock technologies. • Soil management and conservation. • Water management and conservation.	• Advanced animal and plant genetic improvement. . • Biotechnology and genetic engineering. • Crop and livestock technologies. • Precision farming methods. • Soil management and conservation. • Water management and conservation. • Information and communications technology. • Participatory methods. • Nanotechnology. • Aquaculture.
Dimensions assessed	• Agronomic.	• Agronomic. • Environmental and ecological. • Social. • Anthropological. • Economic (environmental and ecological). • Cultural. • Policy-related.
Main focus of AKST research	• Personal consumption and food self-sufficiency. • Agro-exports of commodities and other products.	• Personal consumption and food self-sufficiency. • Agro-exports of commodities and other products (including fruit, garden greens, and handicrafts). • Products with value added.

		• Non-agricultural products and services. • Biofuels.
Main AKST customers	• Conventional producers (in medium- to large-scale organizations). • Agro-industries.	• Conventional producers. • Agro-industries. • Agro-ecological producers. • Traditional/indigenous producers. • Women farmers.
Sectors included	• The primary sector.	• The primary sector . • The secondary sector and other stages of productive and service chains. • The non-rural sector.
Places where AKST activities take place	• Experimental stations.	• Experimental stations. • Demonstration farms. • Producers' farms and small farms. • Watersheds. • Non-rural milieus.
Legal nature of AKST institutions	• Centralized. • Mainly public, with a high degree of autonomy. • With little participation from NGOs.	• Decentralized. • Para-statal. • Public corporations run according to private law. • Public research centers. • Greater participation of the private sector in appropriable technologies. • Greater participation of small producers' NGOs.
Participation of civil society	• Low.	• Growing: moderate to high.
Valuation and incorporation of local knowledge in AKST	• Low.	• Growing.

Source: Authors elaboration

Table 2.5 Impact Assessments of Agricultural Research in Different LAC Countries

Authors	Countries	Products/Levels	Rates of Return* (%)
Ayer & Schuh (1972)	Brazil	Cotton	77
Fonseca (1976)	Brazil	Coffee	23-26
Moricochi (1980)	Brazil	Citrus	28-78
Ávila (1981)	Brazil	Irrigated rice	87-119
Cruz & Ávila (1983)	Brazil	Aggregate	20 -38
Roessing (1984)	Brazil	Soy	45-62
Monteiro (1985)	Brazil	Cacao	61-79
Barbosa, Cruz & Ávila (1988)	Brazil	Aggregate	34-41
Teixeira *et al.* (1989)	Brazil	Aggregate	43
Gonçalves, Souza & Rezende (1989)	Brazil	Rice	85-95
Evenson & Ávila (1995)	Brazil	Wheat Soy Maize Rice	40 58 37 40
Oliveira & Santos (1997)	Brazil	Aggregate	24
Almeida, Ávila & Wetzel (2000)	Brazil	Soy	69
Almeida & Yokoyama (2001)	Brazil	Rice	93-115
Barletta (1971)	Mexico	Wheat Potato Maize Other crops	74-104 69 26-59 54-82
Himes (1972)	Peru	Maize	65
Ardila (1973)	Colombia	Rice	58
Montes (1973)	Colombia	Soy	79
Peña (1976)	Colombia	Potato	68
Scobie & Posada (1977)	Colombia	Rice	87
Pazols (1981)	Chile	Rice	16-94
Yrarrazaval R. 91982)	Chile	Wheat Maize	21-28 36-34
Martinez (1983)	Panama	Maize	47-325
Norton (1987)	Peru	Beans Maize Potato Rice Wheat	14-24 10-31 22-48 17-44 18-36
Mendoza (1987)	Ecuador	Potato Rice Soy Palm oil	28 44 17 32
Scobie (1988)	Honduras	Fruits, nuts Other crops	16-93 17-76
Cordomi (1989)(**)	Argentina	Aggregate	41
Echeverria (1989)	Uruguay	Rice	52
Evenson & Cruz (1989b)	PROCISUR Southern Cone Region	Wheat Maize Soy	110 191 179
Ruiz de Londoño (1990)	Peru / Colombia	Beans	15-29
Traxler (1990)	Mexico	Wheat	22-24
Pino (1991)	Ecuador	Wheat Potato Maize Beans	29 29 3 5
Palomino & Echeverria (1991)	Ecuador	Rice	34
Taxler (1992)	Mexico	Wheat	15-23
Cruz & Ávila (1992)	Andean Region	Aggregate	245
Vivas, Zuluaga & Castro (1992)	Colombia	Sugarcane	13
Racines (1992)	Ecuador	Palm oil Soy	32 35
Palomino & Norton (1992)	Ecuador	Flint Maize	54
Byerlee (1994)	Latin America / Caribbean Mexico	Wheat Wheat	81 53
Cap (1994)	Argentina	Beef cattle Milk Maize Potato Wheat	74 55 77 69 67

		Other crops	54-59
Macagno (1994)	Argentina	Maize Wheat Other crops	47 32 34
Pena (1994)	Argentina	Potato	53-61
Romano, Bermeo & Torregrosa (1994)	Colombia	Sorghum	70
Byerlee (1995)	Latin America	Wheat	82
Fonseca (1996)	Peru	Potato	26
Ortiz (1996)	Peru	Potato	30
Farfan (1999)	Colombia	Coffee	21-31
Manzano (1999)	Ecuador	Rice	58
Amores (1999)	Ecuador	Cacao	31

Source: Adapted from Días Ávila, Antonio Flavio *et. al.* (2006) "Agricultural Productivity in Latin America and the Caribbean and Sources of Growth."

(*) Internal rates of return, except in the cases indicated with (**) which are estimates of the marginal internal rates of return

Table 2.6 Growth Rates of Agricultural Production in Different Regions of LAC during the Period 1962-2001 (annual %)

Regions	**Crops**			**Livestock**			**Average Growth**		
	1962/1981	1982/2001	Average	1962/1981	1982/2001	Average	1962/1981	1982/2001	Average
Southern Cone	2.79%	2.98%	2.89%	1.74%	2.95%	2.34%	2.27%	2.96%	2.62%
Andean	2.43%	2.65%	2.54%	3.95%	2.92%	3.44%	3.19%	2.79%	2.99%
Central America	3.60%	1.32%	2.46%	4.35%	2.84%	3.59%	3.97%	2.08%	3.03%
Caribbean	1.20%	-0.71%	0.24%	2.78%	0.77%	1.78%	1.99%	0.03%	1.01%
Averages	2.55%	1.57%	2.06%	3.56%	2.38%	2.97%	3.05%	1.98%	2.51%

Source: Días Ávila, *et al.* (2006) "Agricultural Productivity in Latin America and the Caribbean and Sources of Growth.

Table 2.7 World and LAC: Indicators of public and private R&D activities around 1995

(a) Expenditure in agricultural research and development (millions of dollars at 1993 rates)

	Developing World		Developed World	World Total
	LAC	TOTAL		
Public	1,947	11,469	10,215	21,684
Private	91	672	10,829	11,511
Total	2,038	12,141	21,044	33,194

(b) Intensity ratio of agricultural research (percentage)

	Developing World		Developed World	World Total
	LAC	TOTAL		
Public	0.98	0.62	2.64	1.04
Private	0.01	0.04	2.80	0.61
Total	0.99	0.66	5.43	1.65

Source: Pardey and Bemtema (2001)

Table 2.8 Global investment in Research & Development in selected countries (in billions of international 2000 dollars and in percentage)*

Selected countries / regions	Amount Total 1995	2000	Participation 1995	Total (%) 2000
Developed Countries (23)	461,4	574,0	82,1	78,5
- EE.UU.	196,4	263,0	35,0	36,0
- Japan	90,0	99,5	16,0	13,6
Developing countries (141)	100,3	157,0	17,9	21,5
Asia Pacific (26)				
- China	19,5	48,2	3,5	6,6
- India	11,7	20,7	2,1	2,8
LAC (32)	17,2	21,2	3,1	2,9
- Brazil	9,8	12,4	1,7	1,7
World Total	561,6	730,9	100	100

Source: Pardey, Philip, N. Beintema, 2006. Agricultural Research: A Growing Global Divide?. IFPRI. Washington. August
(*) Local currency converted to international dollars using the Purchasing Power Parity index (PPP).

Box 2.1 Synthesis: Assessment of the *Patronatos* that support AKST – Experiences in Mexico

The *Patronatos* are civil society organizations that support agricultural or livestock research in Mexico. They are led and financed to varying degrees by farmers, the main users of the products and services generated by publicly funded agricultural research institutions. They are an example of synergy between civil society and government, within what is known as “participation and/or social monitoring of innovation”, which helps to ensure an appropriate correlation between the AKST System agenda and users’ needs, and contributes to transparency and accountability.

The *Patronatos* offer the following advantages: they provide moral, political and economic support to specific research and technology transfer projects of interest to their members; they promote positive synergies between the federal institutions responsible for research and civil society (producers and agro-entrepreneurs) as well as the users of the products and services generated, such as improved seeds, vaccines, and technological know-how and innovations. They ensure that agricultural research projects meet the interests of the productive sector. In addition, they facilitate and promote the early and rapid adoption by farmers of innovations.

The Mexican federal government, through INIFAP, covers salaries and part of the operating and investment costs, which are complemented by the *Patronatos’* own contributions. In times of financial crisis, this helps to reduce or mitigate government budget cuts and ensure the continuity of the research projects under execution.

Although their effectiveness varies, other advantages offered by the *Patronatos* are setting research priorities based on real needs; encouraging researchers to generate results that are applicable in real agroecological and economic conditions; establishing permanent communications between researchers and farmers; enhancing the credibility and acceptance of the technology generated; taking advantage of the experience and vision of farmers; administering resources more efficiently and promptly; building consensus; diversifying the sources of financing; and reducing political influence in decision-making.

Most *Patronatos* have been established by groups of organized market-oriented farmers with medium to large-scale operations. Small subsistence-oriented farmers with few resources and little organization have not participated.

The *Patronatos’* performance has been variable, with notable examples of effectiveness, efficiency, and continuity over several decades, and also failures due to interference by federal or state governments; the use of the *Patronato* and its resources for party politics; conflicts of interest in the management of resources, and the improper use of the *Patronatos’* products (improved seeds, services, etc) for personal benefit.

The *Patronatos’* success or failure reflects the degree of organization, education, and civic responsibility of the farmers and local officials involved, and is expressed in their solidarity on issues of community interest, as well as in joint responsibility, synergy and respect between society and the government. It would be useful to study the development,

operation and performance of these institutions, since they constitute a first step in a strategy of “participatory innovation development” and are an example of “social monitoring of innovation”.

Box 2.2 Examples of linkages between the Consultative Group on International Agricultural Research (CGIAR) and civil society in Latin America

The scientists who work at the 15 CGIAR centers collaborate closely with a broad spectrum of civil society groups. These include farmers, producers' associations, and community organizations. Participatory research is a way of ensuring that the results of CGIAR's research efforts rapidly reach small farmers with limited resources so they can use them to improve their quality of life and livelihoods. The examples described below offer a brief synthesis of the participatory research projects currently under implementation and other programs that foster important linkages with civil society.

Local Agricultural Research Committees (CIALs) — In these committees, coordinated by the International Center for Tropical Agriculture (CIAT), farmers express their views on the development and evaluation of agricultural technologies. Researchers benefit from the feedback provided by farmers. Farmers, in turn, are encouraged to evaluate new options for increasing agricultural productivity and improving the management of natural resources. Currently, 249 local committees are active in eight Latin American countries. The benefits of this initiative range from increased local capacity in formal research methods and improved local planning and management skills to a greater availability of improved seed, not to mention food security. For example, in Cauca, Colombia, over 80% of farmers from the village of Pescador have adopted a bean variety recommended by the local committee. CIAT has estimated a 78% rate of return on investments to implement the CIALs approach (www.ciat.cgiar.org).

Learning partnerships for agribusiness development in Latin America — CIAT, in association with CARE, Catholic Relief Services and other institutions, is creating "learning partnerships" in Central America. These innovative partnerships are made up of research and development organizations that jointly design and implement strategies and interventions aimed at building local capacity in specific geographical areas. Members of these partnerships, including farmers, jointly analyze the strategies to determine which ones work. The lessons learnt are applied and generate new learning cycles. In Nicaragua, thanks to this participatory learning process, an agribusinesses initiative that began in one municipality is now being applied in 10 others (www.ciat.cgiar.org).

Combating bacterial wilt in the Andean region. CIP scientists have developed an inexpensive detection kit that can be used in an organized seed system to eliminate infected potato seed before it reaches farmers' fields. Although crop rotation can help eliminate the pathogen from the potato fields, the recommended method – abandoning potato cultivation for a few years – is not an economically or socially viable option for thousands of poor farmers who depend on the tuber for their income and nutrition. With CIP's participation, farmer/researcher groups have identified a promising solution that enables farmers working in highly infested soils to sanitize their fields in 9-17 months by planting three successive non-solanaceous horticultural crops with high market value (e.g. onion, leek, or cabbage), or two successive food crops such as lupine, sweet potato, or *arracacha* (an Andean root crop) after the potato harvest. Using this method, farmers were able to recover their fields for potato production in a short time – and also managed to triple their potato yields (www.cipotato.org).

CIMMYT and the Agricultural Research and Experimentation Board *(Patronato)* of the State of Sonora — In the Yaqui Valley in Sonora, located in North-western Mexico, a group of private farmers and the *Patronato* have donated a new sprinkler- and drip-irrigation system to CIMMYT that will help scientists avoid water wastage and better manage this valuable resource in a dry zone. The system will directly benefit farmers in the Yaqui Valley who produce wheat, maize, and other crops. *Patronato* leaders work on a voluntary basis and make sure that the organization only invests in research efforts aimed at minimizing the obstacles to agricultural production (www.cimmyt.org).

Self Help International, a non-governmental organization based in the United States, is promoting quality maize with high protein content in Nicaragua. This new and more nutritious variety of maize, developed by CIMMYT, is helping to reduce malnutrition in a community located in the southern tip of Lake Nicaragua (near Costa Rica) that has the second highest maternal mortality rate in the world. After Hurricane Mitch, Self Help International, in collaboration with CGIAR,, established an innovative seed bank program, giving farmers a bag of seed to be paid back later with two bags of seed

that in turn would be distributed to other farmers, allowing them to benefit from the new technology. By December 2002, more than 7,000 farmers were planting the new maize seed (www.cimmyt.org).

Consortium for the Sustainable Development of the Andean Eco-region (CONDESAN) — The consortium works with the Water and Food Challenge Program for Andean Region Watersheds. CONDESAN provides support to this program by creating links between research networks, and providing its infrastructure and experience, in order to contribute to the efficient execution of research activities. By combining the program with other regional initiatives, CONDESAN prevents duplication of efforts while promoting complementary aspects and fostering synergies. The main purpose of this collaborative effort is to promote an eco-regional approach to meet development challenges in the Andean region.

Conserving agricultural biodiversity. Cassava, maize, beans, potato, and sweet potato are Latin America's leading crops. The Center for Advanced Research and Studies of the National Polytechnic Institute (CINVESTAV) brings together the main national research programs and the CGIAR centers in order to promote conservation activities throughout the region. The International Plant Genetic Resources Institute (IPGRI), for example, has implemented an international cooperation project in nine countries to strengthen basic science for *in situ* conservation of cultivated plants and to incorporate agricultural biodiversity into agricultural development strategies. Similarly, the Latin American and Caribbean Consortium to Support Cassava Research and Development (CLAYUCA) works to increase cassava production and expand marketing opportunities for poor farmers throughout Latin America (www.ipgri.cgiar.org).

Box 2.3 Civil society's role in supporting the AKST System – the case of the *Produce* Foundations, Mexico

According to a recent assessment (Eckboir *et al.* 2006), the *Produce* Foundations have been a highly significant institutional innovation in Mexico. In their ten-year history, the *Produce* Foundations have promoted links between the federal and state political authorities, on the one hand, and rural production sectors on the other, to support the transformation of public research organizations and influence the design and implementation of agricultural policies, including scientific, technological, and innovation policies for the rural milieu. New channels of interaction have also opened up between federal and state authorities, on the one hand, and groups of commercial agricultural producers on the other.

Mostly, these impacts did not originate in the activities for which the Foundations were established – that is, administering competitive funds for agricultural research and extension – but on actions the Foundations themselves started to engage in as they evolved.

The growth of the Foundations was made possible by the presence of a group of highly motivated and innovative individuals (Eckboir *et al.* 2006). They did not work only for the Foundations but also for the federal government and several state governments. Acknowledging the central role of such individuals is crucial for the design of policies and programs. Frequently a great deal of attention is paid to building organizations and regulations, while their effectiveness often depends on the people who are involved in the administration and operation of those organizations. (Eckboir *et al.* 2006.)

The Foundations have had a significant impact because they have developed effective learning mechanisms. Initially, research priorities and the selection of projects to be financed were determined in an *ad hoc* manner. Currently, the Foundations use structured methods to identify priorities and have adopted a clear division of tasks between the state levels, on the one hand, and regional and national levels on the other. They have also established new contractual mechanisms to transfer resources to researchers and providers of agricultural services.

By contrast, aspects related to extension have not received sufficient attention and until now remain one of the weaker aspects of the Foundations' work. For this reason, extension services are another area of opportunity.

According to Eckboir *et al.* 2006, the future recognition of the *Produce* Foundations will largely depend on their capacity to continue offering valuable elements for the consolidation of the agricultural innovation system and for the transformation of agricultural research organizations into more efficient and effective institutions in generating or identifying products and services to support innovation in the production processes.

Diversifying their funding sources and encouraging increased contributions of resources from state governments and from the users themselves for innovation projects of mutual interest is another short-term challenge facing the *Produce* Foundations.

Box 2.4 A pro-poor AKST System agenda for LAC

Reducing poverty and its negative impacts has been of secondary importance to the AKST System agenda in LAC. The primary goal has been to boost productivity in order to increase the food supply and reduce food prices – and to increase the productivity of agricultural, forestry, fishery, and aquaculture export commodities.

Agricultural research policies often do not mention poverty relief among their specific goals. The incentives system for researchers does not encourage their interest in this issue (Gunasena 2003). A current and growing challenge facing governments, public AKST System organizations and civil society is to define, sponsor, and execute a research agenda to help the poor — with their active participation, It would be aimed at developing products and services accessible to poor populations whose use may serve to decrease or mitigate the negative effects of poverty.

Does AKST have the potential to generate knowledge and innovations that will contribute to reduce or mitigate the negative effects poverty on nutrition, health, energy use, and the degradation of natural resources? These are factors that influence the development of human capital, in terms of health, life expectancy, education, empowerment, organization, recreation, development, and well-being.

According to Nickel (1989), “Obviously, agricultural research *per se* cannot solve all social problems and inequalities.” However, as he suggests, “Research policies and strategies may be designed in such a way as to direct the benefits toward relieving poverty.” It is also possible to “develop technologies that will give a comparative advantage to farmers with limited resources and to poor consumers.”

Both Nickel (1989) and Gunasena (2003) agree that a pro-poor research agenda should focus on product-systems of interest to the poor, and on the zones where they are concentrated such as barren highlands, the semiarid tropics, and marginal lands. Although these areas are extensive, their limited ecophysical conditions mean that the poor will not benefit unless research is focused on the natural resources available in the region they inhabit. Research should be designed to find ways of helping the poor to emerge from poverty.

The technologies most likely to succeed in these marginal areas are those associated with mixed livestock and agroforestry production systems, with improvements in deferred grazing, cover crops, etc., which are more in tune with the agroecological farming system (Gunasena 2003).

Science and technology policies to support the poor should promote the development of plots or farms in ways that do not require them to purchase more external inputs. A challenge facing AKST is to develop technologies that require little capital and low energy and can be used by small farmers with few resources. (Dialo, 2005; Pretty and Hine 2001).

A pro-poor AKST System agenda should aim to optimize integrated pest control and promote strategies to increase the organic matter content in the soil, improve the efficiency of fertilizers through biological nitrogen fixation, or develop technological innovations to conserve genetic resources. (FAO 2005).

In short, according to Gunasena (2003), “The second green revolution – for poor peasant farmers on marginal lands — should not be a copy of the first. It should seek environmental sustainability [and] low-cost inputs and better yields on small plots, and should reduce risks to a minimum. It should focus less on crops and more on systems, and on finding ways to diversify production and use the different resources available.”

Biotechnology and the poor. New developments in molecular biology offer opportunities for researching and resolving problems that affect developing countries, such as the increase in water scarcity. The development of drought-tolerant and salt-tolerant crops would be of value, as would genetic improvement to develop tolerance or resistance to pests and diseases.

However, it is unlikely that biotechnology and nanotechnology’s potential will be used to solve these problems. Substantial investments would be required in laboratories, equipment, and highly specialized human resources, as well as financial resources to pay for royalties for access to and use of patented genes and processes. Small farmers with few resources — the potential users of such innovations, products, and services — have very limited purchasing power. Because biotechnology research is mainly concentrated in the private sector, large biotechnology companies focus on

crops and livestock products that enjoy a large market. The users of these biotechnology products and innovations are large-scale producers with significant purchasing power.

Accordingly, basic research aimed at understanding the mechanisms and problems that affect crops grown by small farmers in developing countries will not receive financial backing. For this reason, it is essential that the international community create a trust fund to finance the use of frontier knowledge and advanced methodologies to address major problems affecting the poor in developing countries.

Financing a pro-poor agenda will test the solidarity between the public and private sectors, both at the country level and at the regional level, for instance in Central America and the Caribbean, throughout the entire region, and globally. And the primary responsibility for generating public goods (products and services) and making these available falls on governments.