CHAPTER 6

Sustaining Innovation in the Latin America and Caribbean Rice Sector

*Luis R. Sanint**

Introduction

The chapter is divided into four sections. It first presents a broad picture of technological and social developments over the twentieth century, stressing the effects of population increase. A quick review follows of major technological innovations that conferred on agriculture a protagonist role by avoiding hunger mainly through increased efficiency. The Fund for Latin America and the Caribbean Irrigated Rice (FLAR) is then presented. FLAR, created in 1995, is a new international model for the rice sector. Its role in sustaining and scaling out innovations is also explained. Finally, some conclusions are drawn.

Population Dynamics in the Twentieth Century

The twentieth century was characterized by rapid change in response to the enormous challenges that emerged from unprecedented increases in human population, which more than tripled to surpass the 6 billion mark by the year 2000. In the last 40 years, the population has doubled from 3 to 6 billion people. By the middle of the century, there were serious doubts that mankind could meet the exponential growth in population with food supplies that grew at linear rates. Books, such as "Famine 1975" (Paddock, 1968), "Too Many" (Borgstrom, 1969), or forecasts by the Club of Rome had a Malthusian flavor (Meadows et al., 1972). Yet technological advances took mankind from the horse to the airplane, from the telegraph to the cellular phone and to satellite communications, from the cash register to computers and beyond, from organic fertilizers and pesticides to powerful, specific chemicals that controlled insects, pathogens, and weeds. As a result of these and many other innovations, and the intertwined synergisms that resulted, agriculture performed at unexpected levels to slash the negative predictions and allow for abundant food supplies.

* Executive Director for the Fund for Latin America and the Caribbean Irrigated Rice (FLAR), Cali, Colombia.

The so-called century of the masses saw deep changes in the way societies organized and governed themselves. Amidst technological progress, there was war, poverty, and the exclusion of millions of people, mostly in the name of progress. Social Darwinism has overshadowed humanitarian approaches. The survival of the fittest was taken to extremes through market-oriented philosophies that minimized the value of the person in favor of economic ideologies. Big challenges still remain as to how to put the economy at the service of the people and not the other way around, and how to avoid hunger in a world of plenty. While there are enough provisions to feed everyone on the planet, nearly 800 million people go to bed with an empty stomach and hundreds of children die every day from malnutrition. Many other forms of organization (e.g., labor unions, farmer associations, and political parties) accompanied the rise of democracy in all corners of the world. Several nations achieved independence, and countries formed economic blocks. By the end of the century, capitalism turned the free market into a dogma, the norm, the infallible truth, the only alternative, especially in western countries.

In Latin America, political parties remain weak, and farmer associations lack the power to articulate their needs and defend their interests in an effective manner. Countries do not form cohesive blocks, and Mercado Común del Sur (MERCOSUR) and Comunidad Andina de Naciones (CAN) have lost power and effectiveness over recent years. However, rice producers have had relatively strong confederations and have been supporting research and development (R&D) very actively thorough strategic alliances within and outside their countries. The century brought awareness of the need to look for alliances: Labor unions, producer associations, political parties, economic blocks, corporate conglomerates, etc.

The governability of the growing masses is at the heart of most social and economic problems. Deeper questions also remain unanswered: How to conciliate the interests of the masses with those of powerful, small groups with huge lobbying capacity; and how to defend culture and the innermost traditions from the charge of superficial market-oriented dogmas. The attack on rural traditions and ancestral forms of life in the name of capitalism and progress represents an enormous challenge to rural communities everywhere.

Agricultural Performance and Innovations

Agriculture was a protagonist in the past century, not only for what it accomplished, but for the issues it avoided and the way in which it did so: Through efficiency and productivity, avoiding hunger. Granted that the intensive new practices put great strain on the cultivated areas and on the environment, and that the challenge to reduce the damages is a paramount task still at hand. Yet, progress “with its bark and its pits” has been beneficial to the natural resource base. Higher efficiency has helped

preserve huge new areas that would have been disturbed in the absence of higher yields, and would have led to higher damage, higher costs, and more expensive food at lower levels of supplies.

At the heart of these events were the advances in the biological sciences, with new varieties that produce with higher and more stable yields, and new chemical inputs, as well as impressive inventions in mechanical engineering. Opportunely, these technological and scientific advances become mixed and combined with impressive efficiency to allow for rapid gains in agricultural productivity. Yield increases in the three main cereals (rice [*Oryza sativa* L.], maize [*Zea mays* L.], and wheat [*Triticum sativum* Lam.]) surpassed population growth rates (Table 1).

Table 1. Annual rates of growth (%) for cereals, worldwide, 1961-99[a].

	Rice	Wheat	Maize
Production	2.5	2.5	2.9
Yield	2.0	2.3	2.1
Area	0.5	0.2	0.8

a. The rate of growth of the world population in 1961-99 was 1.75% per year.
SOURCE: FAOSTAT, 2001.

Rice production stagnated in the first half of the century to boom after 1960 (Table 2). The creation of international centers, such as the International Rice Research Institute (IRRI), the International Maize and Wheat Improvement Center (CIMMYT, the Spanish acronym), the International Institute of Tropical Agriculture (IITA), and the International Center for Tropical Agriculture (CIAT, the Spanish acronym), fostered by visionaries like George Harrar and Forrester Hills (from the Rockefeller and Ford Foundations), was a pivotal event that helped catalyze a wealth of knowledge into concrete shared efforts with a specific commodity approach (Chandler, 1992).

Table 2. Rice in the world: Production, area, and yield, 1900-2000.

Year	Production	Area	Yield
1900	148	84	1.8
1950	151	94	1.6
2000	598	154	3.9

SOURCES: Efferson, 1958; FAOSTAT, 2002.

In Latin America, rice became one of the basic food staples due to expanded production, more notably during the first half of the century. Based on mechanization schemes and strong government support, rice became a preferred pioneer crop in the frontiers of the Brazilian Cerrados and the Colombian, Venezuelan, and Bolivian savannas, as well as in forest margins throughout the region. Annual per capita consumption of

rice went from less than 9 kg in the 1920s to 20 kg by the 1940s (mainly because of a jump in production from 1.0 to 8.0 million tons of paddy rice), and currently is around 30 kg (Sanint and Gutiérrez, 2001). In absolute terms, however, the large increase occurred in the past four decades, when paddy rice production tripled, from 8.0 million tons in 1960 to about 24.0 million tons by the end of the century.

Fund for Latin America and the Caribbean Irrigated Rice (FLAR): Sustaining Innovation in the Rice Sector

Central to these accomplishments in technological innovations and impact, several institutional developments can be highlighted:

- The progressive involvement of the private sector in rice research and extension, through formal associations that consolidated strategic alliances with public institutions, both national and international.
- A linkage by the region through CIAT to the world's premier source of rice germplasm (IRRI).
- The development of a strong, regionally relevant, rice improvement program in the 1970s and 1980s through a productive partnership of CIAT, the Federación Nacional de Arroceros de Colombia (FEDEARROZ), and the Colombian Institute of Agriculture and Livestock (ICA).
- The close cooperation between CIAT's regional rice program, national programs, and producers in major rice producing countries of Latin America and the Caribbean (LAC).

While the upstream linkage to IRRI was a valuable component of this three-part improvement model, high-quality downstream activities at the country level, frequently involving cooperation between public programs of research and extension with private producer organizations, were key to locally relevant adaptive efforts. Through research, extension, and training, the new knowledge was capitalized to accelerate and expand the spread of improved germplasm, complementary cultural practices, and related institutional and policy developments. Even though the investment commitments made by the private and public sectors throughout the past 3 decades were of major proportions, attractive (even unprecedented) returns have been gained.

When CIAT signaled a change in strategies, by the late 1980s, and decided to give higher emphasis to natural resource management research at a time of decreasing funds, it was clear that support for rice research would diminish. By the end of 1993, the announcement of a sharp decline in support from CIAT's core resources to its rice program caused alarm mainly because of the high dependence that the region had developed on that international center as a model to sustain innovations, particularly in germplasm research.

Fostered by CIAT, the initiative to create a self-relying research effort based on financial contributions from the private sector was well received among several producer associations in the region (Colombia, Venezuela, Brazil, and Uruguay). Several of these associations had already voiced support for a mechanism such as the one proposed by CIAT since the center announced its shift from irrigated to upland rice research in 1990. Conversations to create the producer-based mechanism began in 1994, when CIAT hired two consultants for the task: One to assemble it in terms of rules, regulations, and terms of agreement among founding members, and the other to contribute in the process of identifying a research agenda that would be agreeable to all parties involved. In January 1995, CIAT's Director General, along with representatives from six organizations, took the torch of innovation and signed the Heads of Agreement for FLAR. The six others involved were:

(1) FEDEARROZ (Colombia),
(2) Instituto Rio Grande de Arroz (IRGA), Rio Grande do Sul, Brazil,
(3) Asociación de Productores de Semilla Certificada de los Llanos Occidentales (APROSCELLO), Venezuela,
(4) Fondo Nacional de Investigaciones Agropecuarias (FONAIAP), Venezuela,
(5) Instituto Nacional de Investigacíon Agraria (INIA), Uruguay, and
(6) Instituto Interamericano de Cooperación para la Agricultura (IICA), Chile.

By 2002, thirteen countries had contributed resources to FLAR and, by the end of this same year, 10 were still actively involved. They represent 56% of total and 62% of irrigated rice production in LAC.

FLAR's vision statement reflects its essence: "An inclusive model, headed by the private sector, to ensure stable resources for sustaining innovations that enhance the quality of life in the rice sector of Latin America". Its main mission is to meet the needs of its partners to achieve the stated vision. The FLAR partners govern the fund through administrative and technical committees, where all of them are represented with right to voice and vote, and equal powers.

FLAR was created to:

- Avoid duplications of efforts,
- Maintain efficient use of the resources available for research,
- Achieve effectiveness through clear mandates, high quality staff, and active involvement from partners,
- Rely on the relative strengths from each partner to take advantage of specialization for specific tasks, and
- Maintain an international scope.

Total financial contributions during 1995-2002 reached US$3.8 million. In the 10 countries, alliances include producer organizations in 80% of the cases, millers in 60%, seed producers in 30%, and the public sector in 50% (Table 3).

Table 3. Strategic alliances within the Fund for Latin America and the Caribbean Irrigated Rice (FLAR) members, by sector of activity.

Partner[a]	Producer	Miller	Seed	Public
Bolivia (CONARROZ)	x	x		x
Brazil (IRGA)	x			
Colombia (FEDEARROZ)	x			
Costa Rica (SENUMISA)		x	x	
Cuba (IIA)				x
Guatemala (ARROZGUA)	x	x		
Nicaragua (ANAR)	x	x		
Panama (FEDAGPA)	x			x
Uruguay (INIA)	x	x	x	x
Venezuela (FUNDARROZ)	x	x	x	x
Colombia (CIAT)				x

a. CONARROZ = Consejo Nacional Arrocero; IRGA = Instituto Rio Grande de Arroz; FEDEARROZ = Federación Nacional de Arroceros de Colombia; SENUMISA = Semillas de Nuevo Milenio S.A.; IIA = Instituto de Investigaciones Agrícolas; ARROZGUA = Asociación Guatemalteca del Arroz; ANAR = Asociación Nacional de Arroceros; FEDAGPA = Federación de Productores de Arroz de Panamá; INIA = Instituto Nacional de Investigacíon Agraria; FUNDARROZ = Fundación Nacional de Arroz; CIAT = Centro Internacional de Agricultura Tropical.

The main research objectives were defined from its inception:

- Maintain access to the elite rice material of the world and store it in a germplasm bank;
- Characterize all the material for yield, for its tolerance and resistance to the major constraints in the region (blast, *hoja blanca* virus and its vector *sogata* [*Tagosodes orizicola*], secondary diseases, cold, iron toxicity, straighthead), and for quality aspects, cooking, and milling;
- Select progenitors and make crosses to produce varieties with superior traits and yield performance;
- Facilitate improvements in integrated crop management; and
- Perform postharvest studies to improve milling efficiency and offer better products to the markets.

FLAR provides a mechanism for collective action in which countries join forces and share the cost for rice R&D. The founders of FLAR were among the strongest countries in terms of organization, production, and R&D infrastructure. Joining efforts is essential for most countries in LAC, because few have adequate resources and personnel to support the required effort in rice R&D. However, several of the countries that can

benefit most from FLAR have not developed the means for securing finances to maintain their participation in FLAR. Examples are Ecuador, Peru, and the Dominican Republic. This most immediate problem has been an objective since the creation of FLAR and is reflected in its vision statement. The subsequent step will be to assist the grower associations in strengthening their R&D agendas. Finally, most of the associations require assistance in strengthening the technical expertise within the national association or affiliated organizations.

FLAR is the most suitable organization for addressing the needs of the rice producing countries of LAC, particularly the small, resource-deficient countries. External assistance to FLAR from the international donor community will enable the organization to provide the previously described assistance to its member-countries. In 2002, the Common Fund for Commodities (CFC) approved a grant of close to one million dollars to implement a crop management project over 3 years in Venezuela and southern Brazil. These activities will subsequently be sustained through membership fees. National associations can sustain their membership via revenues generated by a production check-off and other innovative means of finance, such as sale of germplasm and royalties.

An overview of recent accomplishments in breeding

Over the years, the breeding program has been refining its strategies as members become more involved, diversified, and sophisticated, and as FLAR governance becomes more capable of self-assessment, which is where true learning begins. Besides the original quest for higher yields, better cooking quality, and resistance to major diseases (blast and rhizoctonia), the program now includes tolerance to *sogata* and *hoja blanca* (in the tropics), as well as cold and straighthead (in the temperate region). Milling quality is also an important objective. FLAR selects elite lines every year and forms nurseries for the tropics and the temperate zone (Vivero de Observación del FLAR [VIOFLAR]) that are evaluated by members for their specific micro environments.

This year, FLAR has a set of 640 promising F_4 lines for the tropics that will be shipped to members in 2003. The best 100 lines, in terms of yield, out-yield the checks by over 10% and the elite 20 lines out-yield them by more than 20% (Table 4). For the temperate region, there is a set of F_2 lines that showed significant tolerance to cold.

The superior performance of the new lines obeys a redirection in the breeding strategy. For many years, and after the development of IR-8 at IRRI by Dr. Peter Jennings and his collaborators (Chandler, 1992), the main objective was to tame the new yield potential and make it more stable by adding new sources of tolerance to biotic and abiotic constraints. Three decades later, there were lines with good resistance to blast, *hoja blanca* virus, *sogata*, and other diseases, but the yield potential remained

stagnant. The current strategy, led by the team of breeders at FLAR, coordinated by Dr. Jennings himself, recalls the emphasis on yields by bringing in objectives of plant type, vigor, stay green, tillering capacity, etc. Other changes included new fields at CIAT, higher rates and earlier applications of nitrogen, and triple crosses. The result was the set of lines already depicted that also carry very good cooking and milling quality characteristics. For the temperate region, the challenge is to blend the yield potential of the tropical lines with cold tolerance.

Table 4. Yield of elite lines of the Fund for Latin America and the Caribbean Irrigated Rice (FLAR), Palmira, Colombia, 2002.

Advanced lines	Yield (t/ha)
Total (640)[a]	6.9
100 highest yielding	9.0
20 highest yielding	9.9
Checks:	
FEDEARROZ 50	8.1
ORYZICA 1	8.2

a. Candidates for Vivero de Observación del FLAR (VIOFLAR) 2003.

Scaling out

Scaling out is understood in this chapter as the replication, dissemination, and adaptation (across space and time) of technologies or practices. To help research "deliver the goods" for many of the world's poor over a large area and in a timely manner, Harrington et al. (2001) suggest a problem-solving approach that facilitates the scaling out of relevant agricultural practices. They propose seven ways to foster scaling out:

(1) Develop more attractive practices and technologies through participatory research;
(2) Balance supply-driven approaches with resource user demands;
(3) Use feedback to redefine the research agenda;
(4) Encourage support groups and networks for information sharing;
(5) Facilitate negotiation among stakeholders;
(6) Inform policy change and institutional development, and
(7) Make sensible use of information management tools, including models and geographic information systems (GIS).

The structure of FLAR reflects these seven requirements, because it is a participatory mechanism that uses demand-driven signals to define a research agenda that is the product of negotiations and dissemination of information among networks of collaborators. As FLAR enters into crop management activities, its research domain expands, and its capacity to scale out increases.

The CFC Project

The CFC functions under the frame of the United Nations. It favors projects that have a commodity approach. FLAR, under the aegis of CIAT, requested assistance for strengthening crop management and technology transfer for irrigated rice production. The project will be implemented in Venezuela (states of Portuguesa and Guárico) and Brazil (state of Rio Grande do Sul). There, national rice farmer organizations are already established and FLAR, in collaboration with its national counterparts, has conducted diagnostic studies to identify areas requiring improvements. Together, these two sites account for an annual production of nearly 6 million tons of paddy rice, which represents nearly 30% of all rice production in the region. In both locations, yields are relatively low, averaging only 4.4 t/ha in Venezuela and less than 5.5 t/ha in southern Brazil, both of which are far below the genetic potential of available varieties. The purpose of the project is to establish on-farm research and technology transfer programs that will introduce and extend to growers improved crop management practices, resulting in increased yields and more competitive production. Small-scale growers will be the primary beneficiaries of increased technical assistance provided by grower associations, because they have limited access to existing technologies and other forms of assistance.

The total cost of the project is US$1.5 million, and CFC will contribute US$975,000 in the form of a grant. Counterpart funds will be provided by IRGA in Brazil, Fundación Nacional de Arroz (FUNDARROZ) in Venezuela, and FLAR. The duration of the project is 3 years (March 2003 to February 2006).

The project goal is to increase productivity of irrigated rice in two strategically located countries, resulting in improved market competitiveness. The project objective is to strengthen the capacity of national grower associations to identify and transfer yield-enhancing crop management practices that narrow the yield gap in irrigated rice. The two countries included in the proposal are representative of tropical and temperate ecologies. The improved crop management practices and experience in organizing farmer-financed technology transfer programs will subsequently be extended to other FLAR-member countries within each ecological zone. Adoption of improved crop management practices will narrow the yield gap, increase on-farm incomes, and permit more sustainable production.

The project has several activities:

(1) Diagnosis and baseline data: It is critical to start with representative samples and units and to have a clear notion of the initial states-of-the-art, in order to identify adoption of the new practices and measure impact.

(2) Identification of entry points: These must be attractive and well focused. For example, applications of urea throughout Latin America are done in wet fields or even in flooded fields, seed densities are high, and seed quality is low, pesticide applications are heavily biased by sales promotions from input dealers, etc.
(3) With the initial information, trials are planned and on-farm trials are installed.
(4) Farmer groups and leaders are identified: One of the premises of the project is that extension works best when done from farmer to farmer. Technical extension personnel are also involved in the project activities, but they are usually reluctant to assimilate simple, new practices without doing extensive tests by themselves. Farmers are more pragmatic.
(5) Measure adoption and impact: Careful follow-up of adopters with thorough evaluation of management practices, costs, and implications for efficiency will be done to measure the impact of the project.
(6) Regional and national integration: The project serves as a platform to integrate other FLAR members as well as countries not affiliated to FLAR that are CFC members (such as Ecuador, Peru, and the Dominican Republic). At the country level, it aims at leaving in place fully active networks of collaborators.

FLAR and CIAT

FLAR represents a unique mechanism for its partners to tackle common objectives and reach farmers throughout the region. For CIAT, it offers a platform that facilitates the scaling out of innovations in a rather inexpensive and efficient manner. FLAR members represent over 50% of rice production in LAC. The emphasis on flooded rice environments targets over 80% of rice production in the region. Most of the remaining 20% is in the Brazilian Cerrados, where the Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA) has a well-funded and well-staffed program for that system. How much CIAT should devote of its own resources to complement FLAR's efforts to sustain innovation in the flooded ecosystems of the region is a strategic issue for CIAT. Currently, the center puts a substantial emphasis on supplying technologies in non-FLAR domains and to non-FLAR members. From the perspective of FLAR, CIAT can play a major role in bringing non-FLAR members into FLAR, and in complementing FLAR efforts for flooded environments. This would give increased leverage to FLAR's current capacity as a prime vehicle for scaling out and sustaining innovation in the rice sector of LAC.

Conclusions

The twentieth century brought immense material progress to mankind. The Malthusian concerns that exponential population growth was going to outrun linear growth in food production were slashed by the impressive performance of agriculture. Governability of the rapidly expanding masses

is at the heart of the emergent social and economic challenges. A deeper question also remains unanswered: How to conciliate the interests of these masses with those of powerful, small groups with huge lobbying capacity. The attack on rural traditions and ancestral forms of life in the name of capitalism, progress, and globalization represented an enormous challenge to rural communities everywhere by the end of the twentieth century. Producers' associations have been a powerful response to the issue of governability, and of innovation and diffusion of new technologies. A myriad of impressive technological advances and their respective synergisms allowed annual rates in productivity to surpass population growth. Progress, "with its bark and its pits", has been beneficial to the natural resource base as area harvested barely grew at the time that cereal production was quadrupled.

While, at the world level, rice production stagnated in the first half of the century, in LAC it grew relatively quickly, as rice became a preferred pioneer crop in the frontiers of the Brazilian Cerrados and the Colombian, Venezuelan, and Bolivian savannas, as well as in forest margins throughout the region. These early settlements took advantage of the new advances in mechanization. By the 1970s, the new semi-dwarf rice varieties arrived in farmers' fields and flooded rice production gradually replaced upland rice areas. The IRRI and CIAT centers became the prime sources of new germplasm and the hub for international efforts in the field of technology generation and innovations for the rice sector. By the 1990s, CIAT signaled its intention to diminish its support to the rice program. Rice producer associations from Colombia, Venezuela, Brazil, and Uruguay reacted to this situation and, together with CIAT, took the torch of innovation and created FLAR in 1995. By 2002, thirteen countries have contributed funds to this novel mechanism and the program is now growing from a primarily germplasm-based effort into crop management and postharvest activities as well. With the approval from CFC of a grant for US$975,000 for 3 years that represents an increase of 70% of the incomes from fees, FLAR's resource base is well consolidated and it emerges as a viable and stable international model to sustain innovations for the rice sector of Latin America.

References

Borgstrom, G. 1969. Too many: A study of earth's biological limitations. MacMillan Publishing Company, NY, USA. 368 p.

Chandler, R. 1992. An adventure in applied science: A history of the International Rice Research Institute. IRRI, Manila, PH. 233 p.

Efferson, J.N. 1958. The production and marketing of rice. Louisiana State University, Baton Rouge, MS, USA. 534 p.

FAOSTAT (Food and Agriculture Organization Statistics). 2001. FAO statistical databases. Available in: http://apps.fao.org

FAOSTAT (Food and Agriculture Organization Statistics). 2002. FAO statistical databases. Available in: http://apps.fao.org

Harrington, L.; White, J.; Grace, P.; Hodson, D.; Hartkamp, A.D.; Vaughan, C.; Meisner, C. 2001. Delivering the goods: Scaling out results of natural resource management research. Cons. Ecol. 5(2):19. [online] Available in: http://www.consecol.org/vol5/iss2/art19

Meadows, D.H.; Meadows, D.L.; Randers, J.; Behrens, W.W. III. 1972. The limits to growth: A report for the club of Rome's project on the predicament of mankind. Potomac Associates, WA, USA. 205 p.

Paddock, W. 1968. Famine 1975! America's decision: Who will survive? Little Brown & Co., NY, USA. 276 p.

Sanint, L.R.; Gutiérrez, N. 2001. Arroz siglo XX y agricultura siglo XXI: Un enfoque del negocio desde América Latina. Paper presented at the II International Rice Congress, Porto Alegre, Brazil, August 20-23. [online] Available in: http://www.flar.org