RICE PRODUCTION AND TRADE

IN LATIN AMERICA

CHALLENGES TOWARDS THE FUTURE[1]

Edgardo R. Moscardi[2]

Paper prepared for the 9th. International Rice Conference for Latin America and the Caribbean, March 21-25, 1994, Goiania, Brazil.

IICA's Representative in Colombia, Ciudad Universitaria, Carrera 30, Calle 45. Ap. Aéreo 14592. Bogotá, Colombia

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1. INTRODUCTION AND SUMMARY

This paper presents some thoughts on the future regarding rice production and trade in Latin America. It starts with a brief analysis of the socio-economic environment of recent years, and its impact on agriculture as a whole, where rice production in many countries has suffered together with other crops due to the combined effect of a sudden withdrawal of protective measures and the ensueing fall in profitability, dumping of international prices and the low dollar exchange rate. Although increased compe-titiveness, defined as the capability for the domestic production of a country to improve its internal or external market share, involves several components, the only genuine improvement dimension (from the irreversibility standpoint) has to do with comparative advantages, where technological change, as a cost reduction factor, is an essential component.

Emphasis is made on the importance of rice as a staple food for our region, and on the accomplishments in productivity, comparable to those of Asia. Mention is made of the fact that, excepting Brazil, close to 80% of the Latin American production corresponds to the irrigated rice ecosystem. There are also indications that, given the present and future importance of this ecosystem in Asia, international research efforts will concentrate in that region, and Latin America must be able to capture "spillings" from those investments with the maximum possible effeciency.

Regarding the marketing aspect, the two well known rice characteristics are

discussed, i.e., the reduction in real prices as a long term trend, and the instabilitity in world prices, as the main aspects to be considered. Emphasis is made on the fact that technological progress is the only variable capable of maintaining coipetitiveness and buffering the impact of unfavorable terms of trade, given the long term fall in product prices. As to the variability, resulting mainly from the low marketing/production ratio for rice, the idea of regional agricultural products stock exchanges is proposed as a mechanism to promote trade and prevent, to a certain extent, the ups and downs in international prices.

The following section presents the basic parameters for Latin America to be able to respond to the challenges posed by the production increases required for the future. Our region has a major potential for expanding areas under irrigation, however, this demands significant investments that must compete with other social impact opportunities in our countries.

Yield gains are seen as the main source for increasing rice production, thus the importance of discussing the organization of regional rice research as a basic aspect to be studied. This analysis is undertaken in the final section of this document, where a draft profile of such an organization is presented combining those national and international strengths which may most effectively contribute to the technological progress in rice for our region.

2. THE FRAMEWORK OF ECONOMIC TRENDS FOR LATIN AMERICA AND THEIR IMPACT ON AGRICULTURE

Adjustment programs and concommitant regional integration processes are undoubtedly the two major economic topics for discussion as to their impact on Latin American agriculture. For our region, these programs may be analyzed in three stages (Piñeiro M., 1993).

The first stage involved dealing with the symptoms of the economic crisis of the 80's, also knows as "the lost decade". From the formal viewpoint, the crisis was unleashed by problems resulting from the foreing debt and the incapability of some countries to service it. However, inflation was the main symptom giving rise to the economic policies implemented. The instruments used in this first stage were the restrictive management of the monetary policy and a delibeiraite effort to control the fiscal deficit as the main cause of inflation. Policies were aimed mainly at controlling public expenditure and, therefore Government intervention.

Against this background, the first adjustment stage had no major impact on Latin American agriculture which withstood recessionist policies quite well.

The second stage consisted in tackling the structural causes of the crisis of the 80's, causes steming from closed markets responsible for many agricultural and industrial productive sector inefficiencies, not only from the standards and service provision but from the productive structure viewpoint. More open economies and

regional integration, tax levying, and the beginning of privatizations and deregulations of the State, as a whole, were the main tools.

This second stage had a definite negative impact on agriculture because it meant, on the one hand, the disprotection of some production subsectors and, on the other, the weakening of some public services for agriculture such as technical assistance and credit.

Trade liberation and integration programs (the Andean Pact, G-3, Mercosur, and bilateral agreements) have progressed at different rates in each country. Tariff reduction was extended to the agricultural sector and, in some countries, the price band mechanism was adopted as a stabilization and protection instrument of the agricultural sector. In some instances, the implementation of these programs coincided, in addition, with a streengthening of the baalance of paymenst and, therefore, with an accumulation of international reserves giving rice to the revaluation of local currencies.

The impact of these measures on the agricultural sector was quite evident. When the aperture began, the major price distortions were seen in agricultural products, especially in oil seeds, cereals, and milk, as a results of the large subsidies granted by developed countries. In this scene of distortions and unfair competition, the scant protection margin provided by **price bands** was not sufficient to

compensate the sector. In the meantime, export sectors (mainly coffee and cotton) were affected first by the fall in international prices and second by the actual revaluation.

The different Latin American countries have different interpretations and concerns regarding the impact and the seriousness of its consequences in this second stage of the adjustment on the agricultural sector. Aspects related to the increase in rural poverty, the depletion of natural resources, and the development of truly competitive productions have brought about different types of reactions regarding agricultural policies in these countries. Mexico and Colombia seem to be moving towards and integral, sectorial agricultural policy. These are, no doubt, two countries where the agricultural sector has played a major role in the social aspect and where sectorial policy is considered as a requirement to sustain the political model and the model of the aperture of the economy. In other countries, as Chile and Argentina for instance, the response has been different, and there some policies on investmets infrastructure have been launched, for example irrigation, and of social programs for the agricultural sector, which not necessarily guarantee the basic accumulation required for a sustained and equitable growth process.

The third adjustment stage, also know as the "post-adjustment" stage, has as its main objective the search for long term or structural competitiveness. This process involves two main instruments; sectorial economic restructuring, as a continuation of

global restructuring, and the final determination of the role of the public sector. The structural competitiveness objetive relates to investments in universitity and graduate education areas, in communication and transportation systems, and in the development of technological infrastructure, among others.

For agriculture, there are in this stage both opportunities and challenges to enter regional and international markets and become once again an important economic growth sector. Basic questions regarding this stage deal with aspects related to the following: Which are the agricultural and comodity sectors which are the most competitive at long term? What transition programs are required for sectors and/or regions that have experienced and will continue to experience difficulties? How to improve political and social processes to provide security to investments in agricultural sectors, among others?

The aperture and integration of the economy have presented new challenges for the agriculture of the countries of the region. Many sectors found out that being "efficient" they were not competitive at an international scale and they were affected by the importation of foreign goods. Agricultural and livestock competitiveness involves the following three major components:

(1) **Comparative costs or relative efficiency**. Which is known in economics as "comparative advantages".

Production costs, strongly influenced by cost reduction technologies.

Marketing and transportation costs, strongly influenced by the road, port, and communications infrastructure.

(2) **Rates of exchange**, as a basic aspect of the macroeconomic policy.

(3) **Agricultural and trade policies**, both national and foreign.

3. RICE PRODUCTION FRAMEWORK

Asia produces and consumes over 90% of the world rice production, with 8 countries generating close to 80% of the production of that region.

Total rice production increase in Latin America forecasted for the year 2030, is less than half the present rice production in Indonesia. At world level, rice is mainly an Asian phenomenon, with Asia being the continent with the highest concentration of poor population in the world (See Table 1), and where rice provides over 60% total calories in the diets of some countries.

In Panama, a country where rice is the main staple food, in terms of calories, in Latin America, that contribution represents 33%.

In our region, in spite of beeing a relative new crop in the died, rice has shown a remarcable increase in consumption, going from 14 kg per capita for the 1924-28 period, to 45 kg for 1988-90. World consumption per capita is 97 kg per year. Although rice is a relatively more important component in the diet of the poorest sectors, its overall consumption increases with per capita income indicating that there is still a positive income elasticity in the region. The fact that the income elasticity for rice and other staples tends to fall as per capita income increases is well-known. It is to be expected that for some high per capita income and fast development countries, as Japan, Taiwan, Singapore, and Malaysia, in Asia, there will be negative elasticities by the end of this century. This phenomenon will also be seen, most

certainly, in some Latin American countries.

Comparing average rice production in the 1966-68 and 1988-90 periods, this grew up in Latin America at a 2.8% annual rate, with a 1.7% yield increase component, and an additional 1.1 planted area increase component. This global behavior is similar to that seen in Asia, although in that region, the yield increase component was 2.3% per year.

Regarding Latin American rice production ecosystems, the typical favorable or under irrigation, and less favorable or up land soil environments are found. Excepting Brazil, over two thirds of the rice crop land for the 1988-90 period were grown under irrigation. Including Brazil, only one third of the area is under irrigation. As to production, figures are the following: Excluding Brazil, 78% production comes from irrigated areas; including Brazil, this ratio falls to 60%.

Table 2 indicates the variability in yield both between and within ecosystems for countries in the region growing over 150,000 hectares of rice. In up-land rice, there are environments with no water restrictions and good soils, where rice germoplasm developed for irrigation behaves quite well. This is the case of Colombia, while the up-land rice in Brazil has other characteristics and problems reflected in the relatively low yields obtained.

TABLE 1. PRESENT AND FORECASTED POOR POPULATION DISTRIBUTION AT WORLD SCALE

	Poor population (In millions)[3]		% Poor population in each región		% Poor population over world total	
REGION	1985	2000	1985	2000	1985	2000
Subsaharan Africa	184	304	48	50	13	27
Wana	60	89	31	31	6	8
South Asia	532	511	52	37	51	46
Southeast and East Asia	182	73	13	4	17	7
Latin America	87	126	22	25	8	11
Europe	5	4	7	6	1	0
TOTAL	1051	1107	31	24	100	100

FUENTE: WORLD BANK (1992)

[3] Assuming a US$350 income poverty line in 1985.

TABLE 2. AREA AND YIELD FOR LATIN AMERICAN COUNTRIES WITH OVER 150,000 HECTARES OF RICE

COUNTRY	TOTAL AREA (000 has)	ECOSYSTEM (000 has)		RENDIMIENTO (Ton/Ha)	
		IRRIGAT	UP LAND	IRRIGAT	UP LAND
BRAZIL	5.052	960	4.090	4.80	1.34
COLOMBIA	462	308	154	4.90	3.15
CUBA	166	166	-	3.06	-
ECUADOR	275	147	128	3.65	2.00
PERU	206	166	40	5.64	3.12
TOTAL	6.161	1.747	4.414	4.41	2.40

SOURCE: Trends in CIAT Commodities, 1992 Working Document No.111, CIAT, Colombia.

all countries. Given that prices are marginally determined, a market as low internationally as 5% for rice is enough for prices to be transmitted. With products not internationally traded, the commodity price reduction mechanism is that of "factor price equalization" (Mundlak, Y., 1993)

The low trade/production ratio seen for rice is probably the main cause for world price instability, as the second trait mentioned. Rice imports from of countries are more the result of shortages or lack of sufficient production than of the opportunity cost of producing it domestically or importing it. Consequently, the international rice market is a residual market, explaining price instability. A similar behavior is seen in some exporting countries that export in the event of surplus production beyond domestic consumption needs, being forced to export small quantities, often at a loss, either due to internal cost or to differences between prices paid to growers and international market prices.

Table 3 shows, for the 1990-94 period, international rice trade for the major importing and exporting countries and for Latin America as a whole. It can be seen that, during recent years, our region has maintained a production deficit of close to one million tons per year.

GRAFICO N°1. U.S. #2/4 vs. THAI 100B RICE PRICES

August 1991 to Present (Nov. 1993)

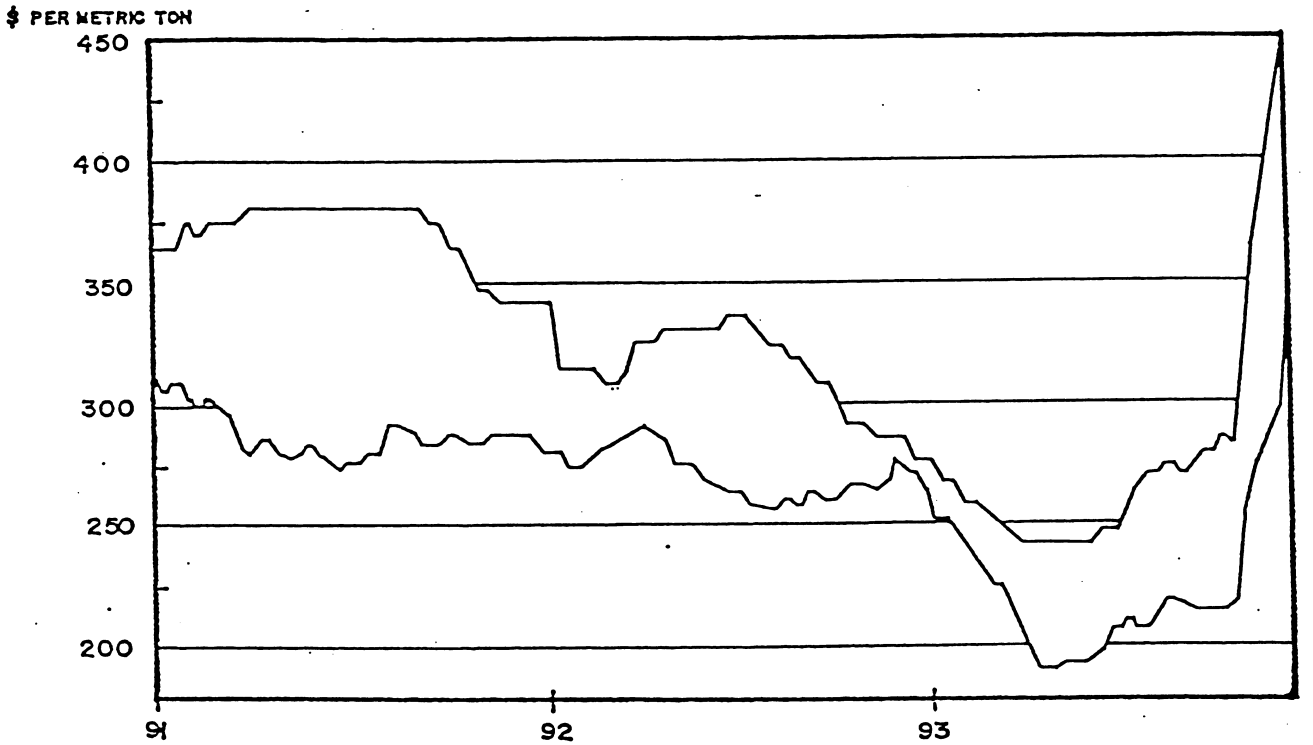


TABLE 3. EXPORTS AND IMPORTS FOR THE 1990-1994 PERIOD (000 Tons)

EXPORTER	90	91	92	93	94
Thailand	3.938	3.988	4.776	4.300	4.600
U.S.A	2.420	2.197	2.106	2.500	2.800
Viet Nam	1.670	1.048	1.914	1.900	2.000
Argentina	53	75	250	175	170
Uruguay	288	260	300	350	400
WORLD TOTAL	11.661	12.009	14.037	13.933	15.375
IMPORTER					
Japan	11	34	17	220	1.800
Taiwan	850	585	950	1.050	750
EC-12	500	481	463	575	625
Brazil	493	776	450	480	545
Cuba	238	264	136	200	250
Haití	112	103	136	140	140
México	148	173	385	400	400
Perú	233	340	325	220	300
Jamaica	75	69	79	75	75

SOURCE: WORLD GRAIN SITUATION AND OUTLOOK, USDA Circular Series, FE 11-93.

5. CHALLENGES RELATED TO RICE PRODUCTION AND MARKETING IN LATIN AMERICA

Challenges for our region are found in both rice production and rice marketing. As to production, the basic question is how to meet demands projected for the future. This requires defining investment strategies in both production research and infrastructure. Forcasted rice demand in Latin America has been estimated at a 2.4% annual growth rate for the 1987-2005 period and at 1.3% for the 2005-2030 (Scobie, G. et al, 1993).

This means for the year 2030 a total projected demand of close to 40 million tons which, compared to present production - of 18 million tons - means more than double that amount. Increases in cultivated area and yield to attain that production have been estimated as follows:

	86-88 (current)	2030 (indicative levels)
AREA (million has)	7.9	9.1
YIELD (tons/ha)	2.3	4.3
PRODUCTION (million tons)	18.4	38.8

SOURCE: Scobie, G., et al, 1993.

In turn, estimated yield growth ceilings to attain that 4.3 ton per hectare average at the level of each ecosystem for Latin America are the following:

ECOSYSTEM	86 88 (Ton/ha)		2030 (Ton/ha)	
	Current Yield	Ceiling	Ceiling	Obtain able yield
IRRIGATION	4.0	9.5	13.0	8.5
FAVORABLE UP-LAND	2.5	7.0	8.0	3.4
UNFAVORABLE UP-LAND	1.2	4.5	5.0	2.0

SOURCE: Scobie, G., et al,1993

The estimated expansion in cultivated area (1.2 million hectares) to attain total projected production is shared approximately as follows: 200,000 hectares under irrigation, 200,000 hectares in favorable up-land rice, and 800,000 in unfavorable up-land rice.

Only 11% of the projected production increase would come from the additional cultivated area, with which most of the effort would concentrate in increasing yields or intensifying production in presently cultivated areas.

In spite of these estimates regarding feasible sources for projected production increases there is still room for discussion, especially regarding the potential area for production under irrigation in our region. Although for some authors, expansion of the

area under irrigation to meet future food demand is quite improbable (Crosson and Anderson, 1992), expansion potential in Latin America is quite significant as indicated by the following estimates:

	CURRENT IRRGATED AREA (000 has)	POTENTIAL IRRIGATION (000 has)	POTENTIAL INCREASE (%)
Mexico and Central America	7.035	2.865	41
South America	9.200	20.000	217

SOURCE: WORLD BANK/UNDP, 1990.

Investments required both to develop new areas for cultivation under irrigation and to rehabilitate other areas, or maintain the present ones efficient, will have to be analyzed vis-a-vis other social investment opportunities in our countries. The intensification of production in fragile ecosystems or marginal environments also involves major challenges in terms of research costs and natural resources sustainability.

Challenges for marketing are national, inter-regional and international. At the level of each country, thre are few modern and effecient marketing systems available, and some are undergoing critical transformation in view of the withdrawal of the

Government from this field. The private sector is probably called to play a major role in this regard, especially through growers associations that may act to improve terms of trade, marketing services, and purchase and sales support. The Colombian Rice-Growers Association (FEDEARROZ) for example, presently absorbs 17% of the national production through the three mills owned by FEDEARROZ in different areas of the country.

With more open economies, there is the need for greater specialization among countries, and it is quite improbable that any of them will seek selfsufficiency in food production. Latin America has at preent, as a region, a 1 million ton annual rice production deficit. The surplus export criterion, or the criterion to buy in the case of eventual falls in domestic rice production in some countries affets the growers income and international price stability. The creation of agricultural products stock exchanges in each country, looking afterwards to a higher level organization allowing trading among at regional and/or international level, has been proposed as a means to minimize these problems (Lizarazo, L.J., 1993).

6. RICE RESEARCH INVESTMENTS IN LATIN AMERICA

Technological progress has been emphasized as the top priority for future food production increases. For the specific case of rice, it acquires special significance this being the main staple of the poorest sectors of world population. The estimated increase in ceiling yields, and the efforts to close gaps between present and potential productivity levels, demand a sustained and efficient investment in generation and use of technology for the case of rice.

In the section on the rice market framework, herein, reference was made to the unfavorable terms of trade our countries are faced with as a result of the fall in international prices for the products of this sector. It was also said that, at long term, the major cause for the fall in actual food prices is the rate of global technological change in agriculture. Why should we then emcourage technological progress if it damages agriculture as a result of the fall in prices? Basically because the return on investment of technological innovations are positive. Farmers increase agricultural and livestock production despite the reduction in actual prices because new technologies make that additional production profitable. If new technologies are not generated and incorporated into the production process, competitiveness decreases and a given country is in desadvantage. Thus producers, and finally countries, are forced to become updated, and technological change is transmitted. If a country or region has a high technological change rate (and, therefore, a constant improvement in the

profitability of the resources used), higher than that seen at the international level, that country or region could benefit even with unfavorable terms of trade.

The economic adjustment processes undergone by our countries have also impacted research infrastructures promoting the search for more efficient schemes with increasing participation of the private sector. Rice research in Latin America is a combination of national and international efforts. All of the 25 rice producing countries have developed a certain research capability for this cereal, organized in some type of National Program. Additionally, there are different growers associations, private corporations, universities and NGOs contributing in one way or another to rice research (Cuevas, F., 1991). Finally, there is international research that reaches our region through CIAT and IRRI, that has had the well known impact all over the world.

The basic question that has been descuissed in recent years has to do with a better organization and partnership for a more efficient use of scarce resources, and of national and international rice research capabilities for a greater impact in production.

Following are some thoughts on the international and national research systems as an input to the process of rethinking the rice research scheme in our region.

6.1 CGIAI sponsored research

The CGIAI system allocates approximateely 39 million dollars per year for rice research conducted at IRRI, WARDA, CIAT, and IITA. This accounts for approximately 6% total resources invested by developing countries in rice research. Table 4 shows world distribution of total population, the poor population, the rice production, CGIAR investments, and intensity of rice research in each of the major regions. If the needs of China are added to those of the rest of Asia, it is evident that present CGIAI fund allocation for that region is just enough. What is more striking is the allocation to the African Sub-Sahara region, both because of the allocated funds percentage and because of the intensity of research, widely surpassing expectations, given the characteristics of that region.

TABLE 4. DISTRIBUTION BY REGIONS FOR SOMEM RELEVANT VARIABLES AND CGIAI ALLOCATION FOR 991

	POPULATION DISTRIBUTION %	POOR POPULATION DISTRIBUTION %	RICE PRODUCTION DISTRIBUTION %	CCIAI'S RICE INVESTMENT %	CCIAI'S INTERNATIONAL RICE INVESTMENT (US$Cents/Ton)
ASIA (Excluding China)	40	53	56	65.6	10.3
CHINA	29	19	38	-	-
S.S.A.	12	16	2	29.4	104.6
LAC	11	6	4	10.7	22.2
WANA	8	5	1	2.3	18.6

SOURCE: Scobie G., et al, 1993.

Scobie's paper does not imply of course that research investments should be uniform thoughout the different regions. Differences can stem from many factors such as: variability in production systems, environmental impacts, the extent to which research

in a given region generates results that can be applied in another region, past investments, and success probability, among others. But differences in research investment as large as those lead to suspect inefficient allocation with a net loss for global rice production, as concluded in the paper in reference. The Technical Advisory Committee (TAC), a specialized GCIAI support group, has already recommended a moderate increment of priorities for Asia and the subsequent reduction in the African Sahara. Within this scheme, a relative increase in fund allocation for rice research in Latin America is not to be expected but rather the oposite, which is already a fact given the restricted financial conditions at the GCIAI level.

The other interesting discussion to take into consideration, aside from the regional balance, is the balance of funds' allocation among ecosystems. Acording to world demand projections, close to 80% of required increases in rice production should come from the system under irrigation and 20% from up-land rice systems. However, at world level, the GCIAI allocates over 50% of research resources to up-land rice.

Table 5 shows the resource allocation of the GCIAI per region, ecosystem, and center for 1991. For Latin America, at least until 1991, almost 60% of the US$4.2 million was allocated for research in rice under irrigation. Recently, with the cuts and reallocations, there has been a relative and absolute reduction in GCIAI research resources for irrigation rice in Latin America.

This reallocation of GCIAI funds to less favorable environments deserves further discussion given the rice production structure of our region where, excluding Brazil, close to 80% of the product comes from irrigation rice on the one hand, and, given future perspectives of expanding the irrigation area, on the other hand.

Four arguments are usually raised in support of a reallocation of research resources from more favorable to less favorable environments (Byerlee, D. and Morris, M., 1993):

(i) Returns on research in marginal environments may now be higher than in favorable ones due to the fact that the increase in yields on investments in favorable environments are declining.

(ii) A large percentage of the population depends on unfavorable environments for their survival, and the population increase pressure forces migration to those areas.

(iii) Inhabitants of marginal environments are oftentimes the poorest of the population groups; therefore, an increase in research resources towards those areas is justified on the basis of equity.

(iv) Many marginal environments are characterized by the fragility of their resource base; thus, special effforts are needed to develop production technologies

that will support or improve that resource base at long term.

This paper does not intend to reach any conclusions as to the rationality of resource allocation at the GCIAI level. In this type of international research efforts, research priorities and the subsequent allocation of resources are highly influenced by the donor community and the developing countries' NARS that have not traditionally had great bearing in these decisions. From the viewpoint of research policy design, in addition to what has been said, it should be born in mind that, for each specific region, the research investment level for marginal environments must be consistent with: (a) the value of production in those environments, (b) the number and relative level of poverty of the inhabitants of those areas, and c) the probability of success of the technological progress for the accomplishment of a sustainable production.

Undoubtedly, marginal environments deserve attention, in this case, regarding the allocation of research resources, but their importance must be seen in perspective, given the far greater significance of favorable environments.

TABLE 5. GCIAI CENTRAL BUDGET ALLOCATION FOR RICE RESEARCH PER REGION, ECOSYSTEM AND CENTER (1991 US$ milllons)

REGION	ECOSYSTEM	CENTER				TOTAL
		IRRI	CIAT	IITA	WARDA	
ASIA	Irrig. Fav. up land	10.30				10.30
	Unfav. up land	7.00				7.00
	Pits	5.20				5.20
	SUBTOTAL	3.30				3.30
		25.80	-	-	-	25.80
S.S.A.	Irrig. Fav. up land	0.75		-	2.35	3.10
	Unfav. up land	0.30		0.11	1.54	1.95
	Pits	0.35		0.11	1.95	2.41
	SUBTOTAL	0.10		-	0.87	0.97
		1.50	-	0.22	6.71	8.43
LAC	Irrig. Fav. up land	0.90	1.60			2.50
	Unfav. up land	0.30	0.55			0.85
	SUBTOTAL	0.30	0.55			0.85
		1.50	2.70		-	4.20
WANA	Irrig.	0.90	-	-	-	0.90
TOTAL		29.70	2.70	0.22	6.71	39.33

SOURCE: Scobie, G., et al, 1993.

6.2 Research in National Programs

In this regard, discussion evolves around the possibilities of attaining greater efficiency for rice research in Latin America.

As has been said, each of the 25 rice producing countries in Latin America has a certain capability in rice research, although only five of them grow more than 150,000 hectares. These capabilities are distributed among genetic improvement, crop protection and management for rice production. The following discussion will be centered in the genetic improvement scope.

Graphs 2 and 3 show, for the 1986-90 period, the percentage of improved wheat, rice, and maize varieties now grown in developing countries which: (a) come from crossings conducted in international GCIAI centers and (b) come from crossings conducted by national programs but from parents originated in international centers. Petterns for each crop differ, but the important aspect is the comparison of those behaviors with what could be expected according to different hypothesis. For instance, in the hypothesis that NARS could eventually replace international research in genetic rice improvement, the percentage of varieties based on crossings conducted by international centers would be expected to decrease with time. This is in fact the case with rice given that he percentage has fallen from 28% for the 66-70 period to 11% for the 86-90 period. With the same hypothesis, the percentage of varieties resulting from crossings conducted by NARS, even with germoplasm or materials available in international centers, will be expected to increse with time. Graph 3 shows that, for rice, this is the case from the 66-70 period to the 76-80 period but then this percentage tends to fall indicating a loss of strength of NARS either due to decreased financing and or human resources or due to inefficiencies of NARS themselves in genetic improvement.

It would be premature to draw any final conclusion from this analysis. First of all, because there are probably marked differences in the way in which NARS use the technology developed in international centers, and secondly because a difference would have to be established between improved varieties for different ecosystems.

Nevertheless, some lines of analysis towards the future can be drawn. The attached model proposes different research schemes for rice with two scenarios and two assumptions in relation with the existence of efficiency gains with more centralized improvement programs. The model is only useful to discuss strategies and their implications, and does not pretend to be a decision making guide.

The most realistic assumption would appear to be that in which international centers have less resources than in the past and/or a different research agenda. For example CIAT towards the solution of specific rice problems (white leaf, pericularia) and IRRI with emphasis in raising irrigation rice yield ceilings in Asia, but with

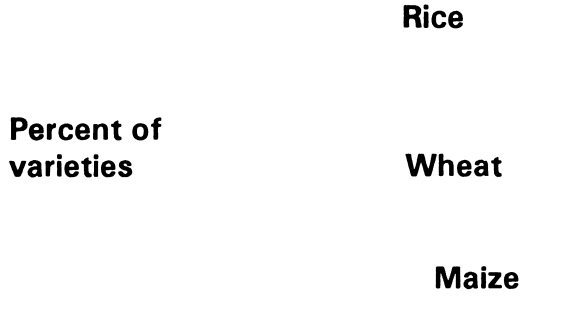
significant spillings for Latin America. Assuming some efficiency gains, with more centralized improvement programs, the indicated strategy would appear to be a consolidation of national improvement programs with one or two countries taking the bulk of the responsibility for genetic improvement, in close cooperation with the IRRI, and an efficient regional test network. In the case that most of the materials produced for the irrigation rice ecosystem will behave reasonably well for favorable up-land rice conditions, the research for unfavorable up-land rice would still be pending. With Brazil as the major Latin American country in this last ecosystem, the bulk of up-land rice research should be organized there, with certain technical and financial support from CIAT and IRRI, and a regional test network for those countries where this ecosystem is relevant. The private sector would play a major role both in the partial financing of the research work as in the setting up of networks such as the INGER.

Most certainly, a regional entity for rice research, such as the one proposed, requires further discussion as to its many implications. In spite of recent integration efforts, political limits still exist between nations, as well as concerns regarding food safety and technological dependency. Whatever the case, the globalization of the economy and the pressures to improve competitiveness demand the greatest possible efficiency for technological progress in order to improve the global rate of technical change and mitigate the unfavorable terms of trade that the agricultural sectors of our countries are faced with.

A more efficient regional model for genetic improvement in rice would allow countries to allocate more resources to management and crop protection. For crops such as rice, where considerable technical progress has already been attained, there are technologies available to improve productivity but these are far more data and skill intensive, and more site specific than the original technologies of the first period of the Green Revolution. In the so called "Post-Green Revolution", the aim is more that of improving technical efficiency and obtaining higher yields without increasing input use but through a more coordinated and timely use of them and with the least possible harm for the environment and the natural resources base.

GRAFICO 2. Percent of all varieties in developing countries based on IARC crosses, 1966-90

GRAFICO 3. Percent of varieties in developing countries based on NARS´s crosses with IARC parent, 1966-90



SOURCE: **Byerlee, D. and Bohn A., Are There Economies of Scale in Wheat Breeding?. CIMMYT, México, Miscelaneus Paper.**

GRAFICO No. 2 Percent of all varieties in developing countries based on IARC crosses, 1966-90

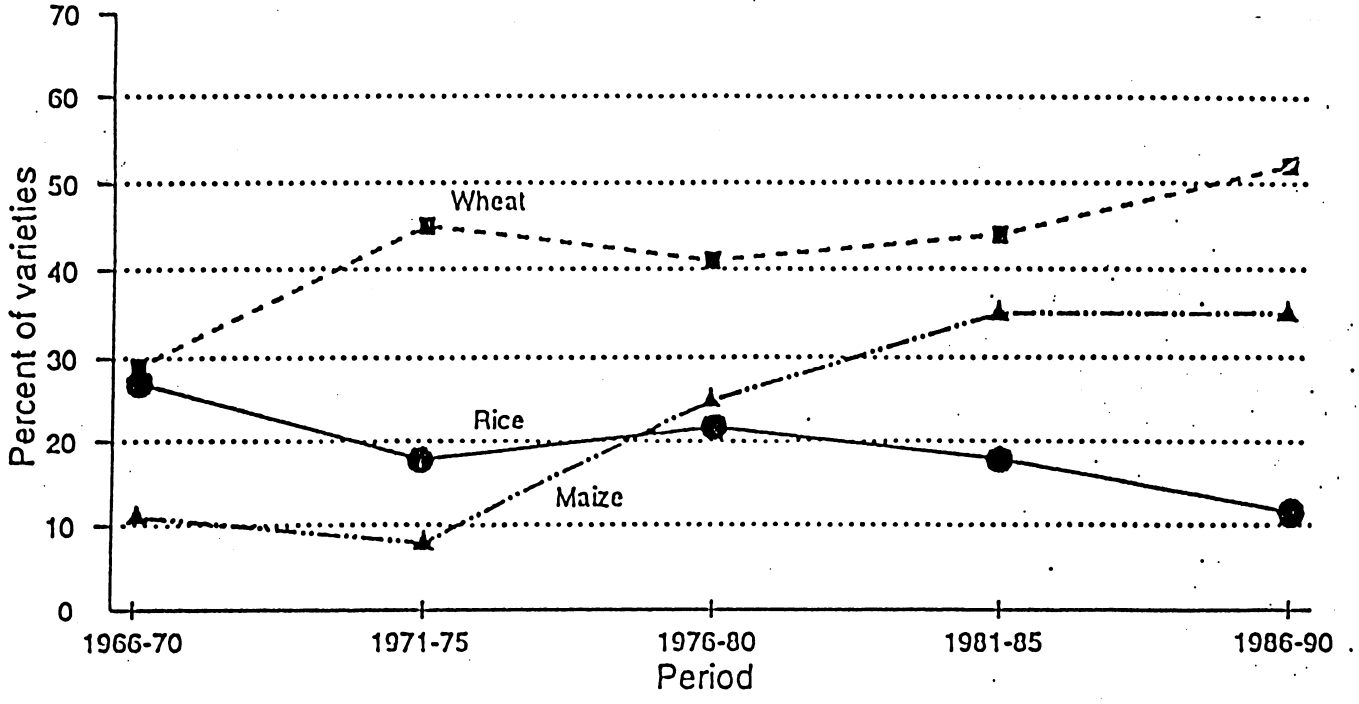
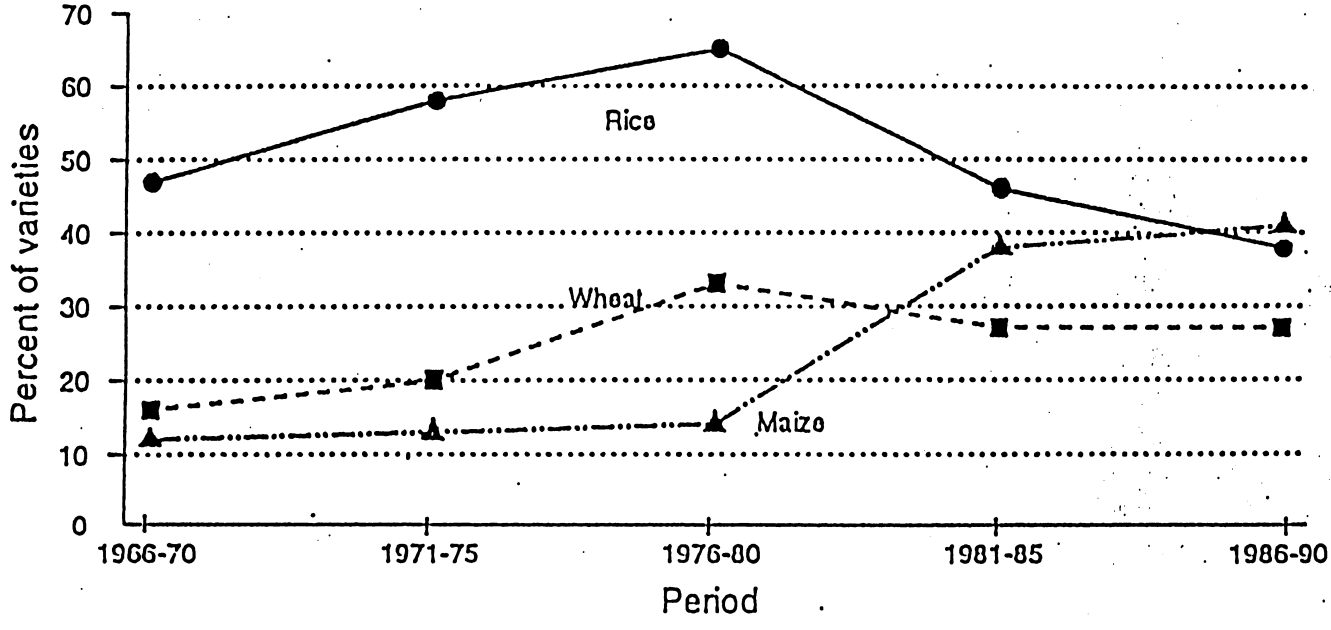


GRAFICO No. 3 Percent of varieties in developing countries based on NARS's crosses with IARC parent, 1966-90



FUENTE: Byerlee, D. and Bohn A., Are There Economies of Scale in Wheat Breeding?. CIMMYT, México, Miscelaneus Paper.

MODEL FOR REGIONAL ORGANIZATION IN RICE RESEARCH WITH TWO SCENARIOS AND TWO ASSUMPTIONS

A. SCENARIO WITH IARCs (the most likely)

A.1 With efficiency gains due to centralized improvement programs.

Strategy: Centralized improvement in international centers with key test sites in different countries.

A.2 With no efficiency gains

Strategy: Joint efforts of IARCS and NARS with varieties coming from crossings conducted in both types of institutions.

B. SCENARIO WITHOUT IARCs

B.1 With efficiency gains by centralized improvement programs.

Strategy: Consolidation and racionalization of existing NARS in some kind of centralized regional programs and test sites.

B.2 With no efficiency gains.

Strategy: Each NARS has its own crossing program, with exchange of materials among countries through established networks.

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