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IICA

INTER-AMERICAN INSTITUTE FOR COOPERATION ON AGRICULTURE
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AGRICULTURAL MODERNIZATION AND RESOURCE DETERIORATION IN LATIN AMERICA

Jorge A. Torres Zorrilla

45 October, 1994
PROGRAM PAPERS SERIES

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WHAT IS IICA?

The Inter-American Institute for Cooperation on Agriculture (IICA) is the specialized agency for agriculture of the inter-American system. The Institute was founded on October 7, 1942, when the Council of Directors of the Pan American Union approved the creation of the Inter-American Institute of Agricultural Sciences, to be headquartered in Costa Rica.

IICA was founded as an institution for agricultural research and graduate training in tropical agriculture. In response to changing needs in the Americas, the Institute gradually evolved into an agency for technical cooperation in the field of agriculture. These changes were officially recognized through the ratification of a new Convention on December 8, 1980. The Institute's purposes under the new Convention are to encourage, facilitate and support cooperation among its Member States so as to promote agricultural development and rural well-being.

The Member States participate directly in the Inter-American Board of Agriculture (IABA) and the Executive Committee, the Institute's governing bodies, which issue the policy guidelines executed by the General Directorate. Today, IICA has a geographic reach that allows it to respond to needs for technical cooperation in the countries, through its Technical Cooperation Agencies and five Regional Centers, which coordinate the implementation of strategies tailored to the needs of each region.

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The 1994-1998 Medium Term Plan (MTP) provides the strategic framework for orienting IICA's actions during this four-year period. **Its general objective is to support the efforts of the Member States in achieving sustainable agricultural development, within the framework of hemispheric integration and as a contribution to human development in rural areas.** The Institute's work is aimed at making changes in three aspects of agriculture: production, trade and institutions, using an integrated approach to development which is based on sustainability, equity and competitiveness. IICA carries out its technical activities in four Areas of Concentration: Socioeconomic Policies, Trade and Investments; Science and Technology, Natural Resources and Agricultural Production; Agricultural Health; and Sustainable Rural Development. IICA's actions receive support from two Specialized Services: Training, Education and Communications; and Information, Documentation and Informatics.

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FOREWORD

Agricultural modernization has been recognized as one of the most effective means of reactivating the economies of developing countries, especially in light of the multiplier effects that result from linking agriculture to other production and service sectors. Several case studies conducted in the region showed how agricultural modernization has generated foreign exchange, employment, and demand for factors produced by the industrial sector, and given rise to new services to meet the needs of the production system. In all these cases, the modernization process was undertaken in order to increase participation in highly dynamic national and international markets.

These successful production processes have, in some cases, lasted 20 years or more. Nevertheless, concerns have arisen regarding their impact on natural resources and their sustainability. In some cases, such as soybean production in Brazil and shrimp harvesting in Ecuador, both forests and mangroves were destroyed. In other cases, production has involved a technological pattern that has led to depletion of the soil, as in the case of grain in Argentina. In still others, production will have medium-term effects on the quality of aquifers, as in the cases of fruit in Chile and flowers in Colombia.

In none of the cases was there a drastic deterioration of productivity or a significant loss of competitiveness. Nevertheless, in each case there are indications that negative effects are already being felt. This gives rise to three considerations: First, policies could have been established many years ago, but were not; this resulted in conditions that promoted modernization but gave no consideration to the conservation of natural resources. Second, policies could be established today to try to slow the deterioration of resources without reducing significantly the competitiveness of enterprises. Third, the modernization processes studied have provided many valuable lessons, one of

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them being that modernization should be encouraged within a framework of policies that incorporate the objectives of competitiveness and sustainability.

Carlos Pomareda
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SUMMARY

Fundamental aspects of the new economic strategies in the Latin American region are openness, economic liberalization, deregulation of domestic markets, strengthening of the private sector, and minimizing of state intervention. The new trends seem to imply a specialization of Latin American economies according to their natural comparative advantages, that is, further specialization in those products that use more intensively the region's more abundant resources. It is advanced here that the region's most abundant factor is natural resources, in view of its enormous land, water, and forest resources, as well as its great biological diversity.

The prospects for rapid increase in exports in Latin America in the years ahead are clear. There is already an export boom taking place in some countries, such as Mexico and Chile. The thesis here is that this export boom will extend to most countries in the region by the end of the decade, generating a massive outflow of natural resource-based goods to world markets. The most important sectors contributing to the export drive will be agriculture, forestry, and fisheries.

The projected export boom and modernization will be expected to have environmental impacts because these processes imply a more intensive use of natural resources, of industrial inputs, and of existing capital stock; because the modernization process is associated with a greater scale of production and new investment projects, these in turn will have additional effects on natural resources previously not used and the environment. There is therefore a clear danger of resource deterioration and ecological damage.

There is evidence that resource deterioration is already taking place, as shown by several case studies made by IICA on agricultural modernization in Latin America. But we have seen only the tip of the iceberg. More ecological damage may be expected from a massive effort of export-oriented agricultural modernization to satisfy worldwide demand.

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However, there is a clear contradiction between policies and objectives. On one side, incentives are given for export expansion at any cost, while on the other, a new natural resource conservation policy is being advanced. This simply restates the contradiction between short-run urgencies and long-run sustainability.

This document presents concrete evidence that resource deterioration is taking place in the most dynamic subsectors of the agricultural sector in Latin American countries. First, the most successful experiences of agricultural modernization are described in Chapter 2. Then, the environmental assessment of these export-oriented modernization processes is presented in Chapter 3. Finally, the need for alternative policies to ensure natural resource conservation, environmental enhancement, and a sustainable and competitive agriculture are discussed in Chapter 4.

Agricultural modernization in Latin America

Chapter 2 discusses the modernization of selected agricultural subsectors of some Latin American countries. A modernization process is identified by sustained increases of productivity and net income at the enterprise level, without the existence of significant protection on behalf of the State being a necessary condition. In order to determine the factors contributing to the modernization process, IICA organized a series of eight selected case studies: grain in Argentina, soybean in Brazil, flowers in Colombia, dairy products in Costa Rica, fruit in Chile, poultry in Peru, shrimp in Ecuador, and vegetables in Mexico. However, the study on Peru was dropped because the focus of the analysis is export-oriented modernization; a new case study, citrus in Brazil, was included.

The case studies include a description of the dynamics of each process, through indicators such as production, productivity, and number of participant

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enterprises. The basic modernization factors considered were policies, markets, technology, and organization and management.

A basic conclusion of the analysis was that modernization should be interpreted primarily as managerial enterprise modernization and development of human capital. Other conclusions allowed classification of the eight experiences in four different categories:

a. Modernization of traditional commodity exports, such as grain in Argentina and soybean in Brazil.

b. Modernization of products with high income elasticity, such as Chilean fruit, and Mexican vegetables.

c. Development of new products of a sumptuous nature oriented to satisfy external demand, such as flowers in Colombia and shrimp in Ecuador.

d. Modernization of products basically oriented to domestic markets, such as dairy products in Costa Rica and poultry in Peru.

Resource deterioration in Latin America

Chapter 3 documents the impacts on natural resources brought about by the economic performance of the selected agricultural subsectors discussed in Chapter 2.

The environmental assessment of the case studies considers two components:

- Identification and description of activities with greater potential to produce environmental impacts.

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- Concise evaluation of the environmental impacts generated.

The environmental assessment identified some common impacts on natural resources and the environment, allowing classification of the case studies in four different categories:

a. Modernization processes with strong effects on deforestation (soybean in Brazil and livestock in Costa Rica).

b. Modernization processes with greater impact on basic agricultural resources (soil deterioration for grain in Argentina and water depletion for flowers in Colombia).

c. Modernization processes resulting in chemical pollution (Chilean fruit, Mexican vegetables, and Brazilian citrus).

d. Modernization processes with strong impacts on wetlands, such as shrimp in Ecuador.

Natural resources and public policy

In Chapter 4, it is suggested that the solution to the environmental problems of agricultural modernization is not to reverse new trends in export policy, but to face these problems directly. If most environmental problems originate from some economic distortion (externalities or common-property resources), the proper instruments must be used to resolve these distortions.

The environmental impacts associated with agricultural modernization involve important economic aspects, most importantly those related to input prices. The case studies showed that there are market limitations that provide private economic incentives to overexploit natural resources and that create

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disincentives for protection. These include low value assigned to ecological capital, strong distortions between private and social benefits and costs, and a high market-defined discount rate.

Modernized private enterprise is motivated by an explicit objective of profit maximization. Unless the enterprise is convinced that natural resource deterioration affects profits, environmental protection plans will have low priority. Whenever the impacts refer to common-property resources, private enterprise will try to avoid any responsibility.

Government policies must then promote conservation of natural resources, on behalf of society. The policies should be conducive to private firms internalizing of externalities. The basic policy instruments most appropriate to induce sustainable agricultural development are the following:

a. Macroeconomic policies: A consistent real exchange rate policy will make sustainable agricultural investment projects more profitable and the use of imported agrochemicals less profitable; a low real interest rate policy will make long-term investments more profitable; a low and flat tariff policy will make sustainable agricultural investment more profitable.

b. Sectorial policies: Liberalization of food prices will make agriculture more profitable, thus promoting conservation; a high price for irrigation water will induce a more efficient use of water; elimination of subsidies on fertilizers and pesticides will induce their prudent use; granting of land titles to small farmers will go a long way toward making conservation investments more secure and profitable.

c. Social policies and government programs: Public and private education will help to raise environmental awareness and consciousness. Actions, measures, and controls by government will avoid or minimize environmental impacts in the following areas: ecosystems (forests,

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wetlands, biodiversity); water pollution; human health; soil deterioration; and social conflicts.

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RESUMEN

Algunos aspectos fundamentales de la nueva estrategia económica de Latinoamérica son la apertura, y la liberalización económica, la desregulación de mercados, la revalorización del sector privado y la minimización de la intervención estatal. Las nuevas tendencias implicarán una especialización de las economías de Latinoamérica de acuerdo con sus ventajas comparativas naturales, esto es, una mayor especialización en productos cuya elaboración requiere el uso de los recursos más abundantes de la región. Se ha planteado que el factor más abundante en la región son los recursos naturales, en vista de sus enormes *stocks* de tierras, aguas y forestas y a la gran diversidad biológica que posee.

Las perspectivas de que en el futuro cercano se de un rápido incremento de las exportaciones de Latinoamérica son claras. Ya hay un *boom* exportador en algunos países como México y Chile. La tesis es que este *boom* exportador se extenderá a la mayoría de países de la región a fines de la década, lo que generá un flujo masivo de bienes producidos con base en el uso intensivo de recursos naturales. Los sectores más importantes de esta tendencia exportadora serán el agrícola, el forestal y el pesquero.

Se espera que el *boom* exportador y su correspondiente modernización tengan impactos ambientales, pues estos procesos implican un uso más intensivo de recursos naturales, de insumos industriales y del capital existente. Debido a que el proceso de modernización se asocia a una mayor escala de producción y a nuevos proyectos de inversión, estos a su vez, tendrán efectos adicionales sobre los recursos naturales no usados y sobre el ambiente. Hay, por lo tanto, un claro riesgo de deterioro de recursos y de daño ecológico.

Ya hay evidencias que los recursos naturales se están deteriornando, como ha sido demostrado por varios estudios de caso sobre modernización agrícola en Latinoamérica realizados por el IICA. Pero ellos sólo muestran la punta del *iceberg*. Puede esperarse mayor daño ecológico proveniente de un esfuerzo masivo de modernización agrícola orientado a la exportación para satisfacer

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una demanda mundial. Hay, sin embargo, una clara contradicción entre las políticas y los objetivos. Por una parte, se dan incentivos para expandir la exportación, pero, por otra parte, se plantea una nueva política de conservación de recursos naturales. Esto simplemente expresa la contradicción clásica entre las urgencias de corto plazo y la sostenibilidad de largo plazo.

Este documento presenta evidencia concreta de que se está dando un deterioro de recursos en los subsectores más dinámicos de la agricultura de Latinoamérica. En el capítulo 2 se discuten las más exitosas experiencias de modernización agrícola. Luego, en el Capítulo 3 se presenta la evaluación de impacto ambiental de estos procesos de modernización exportadora. Finalmente, la necesidad de que haya políticas alternativas para asegurar la conservación de los recursos naturales y el medio ambiente y la urgencia de una agricultura sostenible y competitiva se discuten en el capítulo 4.

Modernización agrícola en Latinoamérica

En el capítulo 2 se discute la modernización de subsectores agrícolas de algunos países latinoamericanos. Un proceso de modernización se define por un incremento sostenido de la productividad y de los ingresos de un determinado sector, sin que sea una condición necesaria la existencia de una significativa protección por parte del Estado. Para determinar los factores que contribuyen al proceso de modernización, el IICA organizó una serie de ocho estudios de caso: granos en Argentina, soya en Brasil, flores en Colombia, productos lácteos en Costa Rica, frutas en Chile, pollos en Perú, camarones en Ecuador y hortalizas en México. Sin embargo, el estudio en Perú fue excluido, pues el foco de este análisis es la modernización exportadora, por lo que se incluyó un nuevo estudio de caso: cítricos en Brasil.

Los estudios de caso incluyen una descripción de la dinámica de cada proceso, a través de indicadores tales como la producción, la productividad y

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el número de empresas participantes. Los factores básicos de modernización considerados fueron políticas, mercados, tecnología, y organización y administración.

Una conclusión fundamental del análisis fue que la modernización debe interpretarse primordialmente como modernización de la administración empresarial y como desarrollo de capital humano. Otras conclusiones permiten clasificar las ocho experiencias en cuatro diferentes categorías:

a. Modernización de exportaciones tradicionales, tales como granos en Argentina y soya en Brasil.

b. Modernización de productos de alta elasticidad de ingreso, tales como frutas en Chile y hortalizas en México.

c. Desarrollo de nuevos productos suntuarios orientados a satisfacer demandas externas, tales como flores en Colombia y camarones en Ecuador.

d. Modernización de productos básicamente orientados al mercado interno, tal como productos lácteos en Costa Rica y pollos en Perú.

Deterioro de recursos en Latinoamérica

El Capítulo 3 documenta los impactos sobre los recursos naturales producidos por la actividad económica en los subsectores agrícolas discutidos en el Capítulo 2.

La evaluación del impacto ambiental de los estudios de caso considera dos componentes:

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- Identificación y descripción de las actividades con mayor potencial para producir impactos ambientales.

- Evaluación concisa de los impactos ambientales generados.

La evaluación del impacto ambiental condujo a la identificación de algunos impactos comunes sobre los recursos naturales y el medio ambiente, lo que permitió clasificar los estudios de caso en cuatro diferentes categorías:

a. Procesos de modernización con fuertes efectos de deforestación (soya en Brasil y ganadería en Costa Rica).

b. Procesos de modernización con mayor impacto sobre recursos agrícolas básicos (deterioro de suelos para granos en Argentina y agotamiento del recurso agua para flores en Colombia)

c. Procesos de modernización cuyo mayor efecto fue la contaminación química (frutas en Chile, hortalizas en México y cítricos en Brasil).

d. Procesos de modernización con fuertes impactos sobre manglares, tal como la explotación de camarones en Ecuador.

Recursos naturales y políticas de gobierno

En el Capítulo 4 se sugiere que la solución a los problemas ambientales de la modernización agrícola no es revertir la nueva tendencia de las políticas orientadas a la exportación, sino enfrentar los problemas de manera directa. Si la mayoría de los problemas ambientales se originan en distorsiones económicas (externalidades o recursos de propiedad común), los instrumentos apropiados deben usarse para resolver esas distorsiones.

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Los impactos ambientales asociados a la modernización agrícola incluyen aspectos económicos importantes, especialmente los relacionados con los precios de insumos. Los estudios de caso mostraron que hay limitaciones de mercado que otorgan incentivos económicos privados para la sobre-explotación de recursos naturales y crean desincentivos para la protección, tales como bajo valor asignado al capital ecológico, fuertes distorsiones entre beneficios y costos privados y sociales, y una alta tasa de descuento social.

La empresa privada modernizada es motivada por el objetivo explícito de maximizar las utilidades. A menos que la empresa esté convencida de que el deterioro de recursos naturales afecta sus utilidades, los planes de protección ambiental tendrán poca prioridad. Cuando los impactos se refieren a recursos de propiedad común, la empresa privada tratará de evitar cualquier responsabilidad.

Las políticas gubernamentales deben, entonces, en nombre de la sanidad, promover la conservación de recursos naturales. Las políticas deben conducir a la internalización de las externalidades por las firmas privadas. Los instrumentos básicos de política más apropiados para inducir un desarrollo agrícola sostenido son los siguientes:

a. Políticas macroeconómicas: Una política consistente sobre la taza real de cambio hará más rentables los proyectos de inversión agrícola sostenible y menos rentable el uso de agroquímicos importados; una política de bajas tasas de interés hará más rentables las inversiones de largo plazo; una política de aranceles bajos y uniformes hará más rentables las inversiones agrícolas sostenibles.

b. Políticas sectoriales: La liberalización de precios agrícolas hará a la agricultura más rentable, promoverá la conservación; un alto precio para el agua de riego inducirá a un uso másss eficiente del agua; la eliminación de los subsidios a los fertilizantes y plaguicidas fomentará su uso prudente; la

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titulación de tierras para los pequeños agricultores hará que la inversión en conservación sea más segura y rentable.

c. Políticas sociales y programás gubernamentales: La educación pública y la privada ayudarán a la concienciación ambiental. Las acciones, medidas y controles del Gobierno evitarán o minimizarán los impactos ambientales en las siguientes áreas: defensa de ecosistemas (bosques, siste costeros, biodiversidad), control de la contaminación del agua, protección de la salud humana, control del deterioro de lod suelos y prevención de conflictos sociales.

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INTRODUCTION

The central thesis

Fundamental aspects of the new economic strategies and policies in the countries of the Latin American and Caribbean (LAC) region are openness to international flows of goods, services, capital, and technology; economic liberalization; and deregulation of domestic markets.

Governments of all countries in the region today are promoting economic growth by strengthening the role of the private sector and the market system, as well as limiting state intervention to those areas essential for a stable macroeconomic foundation, a good investment climate, and an adequate infrastructure.

These new policy trends seem to imply a respecialization of LAC economies according to the natural comparative advantages of the region in the medium term. Following standard economic theory, this would in turn mean a further specialization in those products that use more intensively the region's most abundant resources. It is advanced here that the region is not relatively abundant in capital or labor; the region's most abundant factor is natural resources, in view of its enormous land, water, and forest resources, as well as its great biological diversity.

Even if the prospects for rapid development of LAC economies in the years ahead seem unclear, it is proposed here that the prospects for rapid increase in exports are a lot more certain. There is already an export boom taking place in some LAC countries, such as Mexico and Chile. It may be shown, furthermore, that this export boom is clearly founded on sales of natural resource-based commodities.

The thesis here is that this export boom will extend to most countries in the region by the end of the decade, generating a massive outflow of natural resource-based goods to world markets.

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The most important sectors that will contribute to the export drive are agriculture, forestry, fisheries, and mining. The new export orientation would imply modernization efforts in these sectoral activities. This modernization process is going to take on new dimensions since it will take place within the new context of commercial openness in an increasingly interdependent world, facing worldwide demand levels.

The projected export boom and modernization efforts will be expected to have some environmental impacts mainly for two reasons. First, these processes generally imply a more intensive use of natural resources, of industrial inputs, and of existing capital stock. Second, the modernization process is associated with development of new investment projects, which in turn have additional effects on natural resources not previously used and on the environment.

Modernization for the agricultural sector may imply a more intensive use of land and water, expansion of the agricultural frontier at the expense of forests, and wider use of agrochemicals and machinery. This is helped by present-day policies that provide incentives for valuation of natural resources at private prices that are null or extremely low.

There is, therefore, a clear danger of resource deterioration and great ecological damage. This is aggravated by the fragility of the region's tropical ecosystem, the present high deforestation rates, and the high level of soil erosion affecting watershed basins.

Furthermore, the increasing world demand, particularly in the developed economies, for commodities such as wood products and quality seafood may continue to be a driving force behind deforestation and resource degradation; these processes will be difficult to reverse unless the pattern of demand changes or the appropriate actions and policies are taken.

The evidence of resource deterioration

There is evidence that resource deterioration is already taking place. Several case studies on agricultural modernization in Latin America made by the Inter-American Institute for Cooperation on Agriculture (IICA), show clearly that there has been no explicit effort by the private sector or through public policy to conserve resources.

It is particularly troublesome that the great success in increasing grain output in Argentina is at present eroding soil; that the great advances in

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shrimp production in Ecuador are destroying thousands of hectares of the mangrove ecosystem; that the use of chemical pesticides in Chile and Mexico has been dangerously increased to preserve sanitary conditions of fruit and vegetables; that the agricultural frontier in Brazil has been expanding for soybean production at the expense of Amazonian forests and biological diversity; and that cut flower production in Bogota's Savanna is causing a significant depletion of the water table.

But we have seen only the tip of the iceberg. More ecological damage, at a higher pace and with new dimensions, may be expected in the years to come from a massive effort at export-oriented agricultural modernization to satisfy worldwide demand levels.

Resource deterioration in the LAC region is particularly acute with regard to land, since large amounts of forests with poor lathyritic soils are currently being converted into pastures, farmland, and cities. The rapid rate of deforestation has drawn worldwide attention, particularly in the Amazon basin. Agricultural technicians have noted that production in lathyritic soils has more in common with mining than typical agricultural production. This is because yields from lathyritic pasture have been shown to deteriorate quickly after the initial deforestation, which leads to soil erosion, siltation of water resources, and siltation of prime fishery areas.

The above tendencies toward overexploitation of natural resources explain why the issue of sustainability and resource conservation has become a focus of attention in the LAC region. However, there is a clear contradiction between policies and objectives. On one side, incentives are given for export expansion and a more intensive use of natural resources, while on the other, a new environmental and natural resource conservation policy is being advanced. This simply restates the contradiction between the short-term urgencies of the region's economies and the long-term sustainability problem affecting the structure of production.

Furthermore, this contradiction between policies and objectives also seems to be implied in the activities of the financial multilateral organizations in the region. Both the World Bank and the Inter-American Development Bank are currently financing structural adjustment loans that have as a condition policies that foster economic liberalization and provide export incentives. Although both banks express a concern for environmental issues, it is clear that first priority is given to "get-the-prices-right" policies. The requirement of environmental assessments on activities financed by the banks seems to be at present only an intent to save face.

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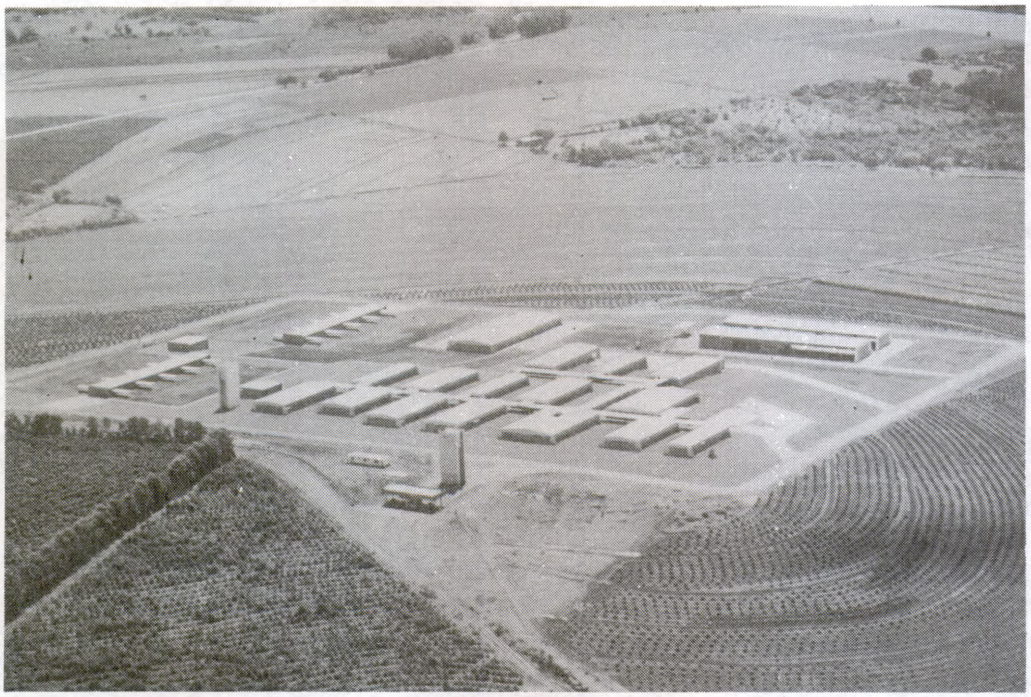

Soybean agroindustrial complex in Brasil and Shrimps in Ecuador.

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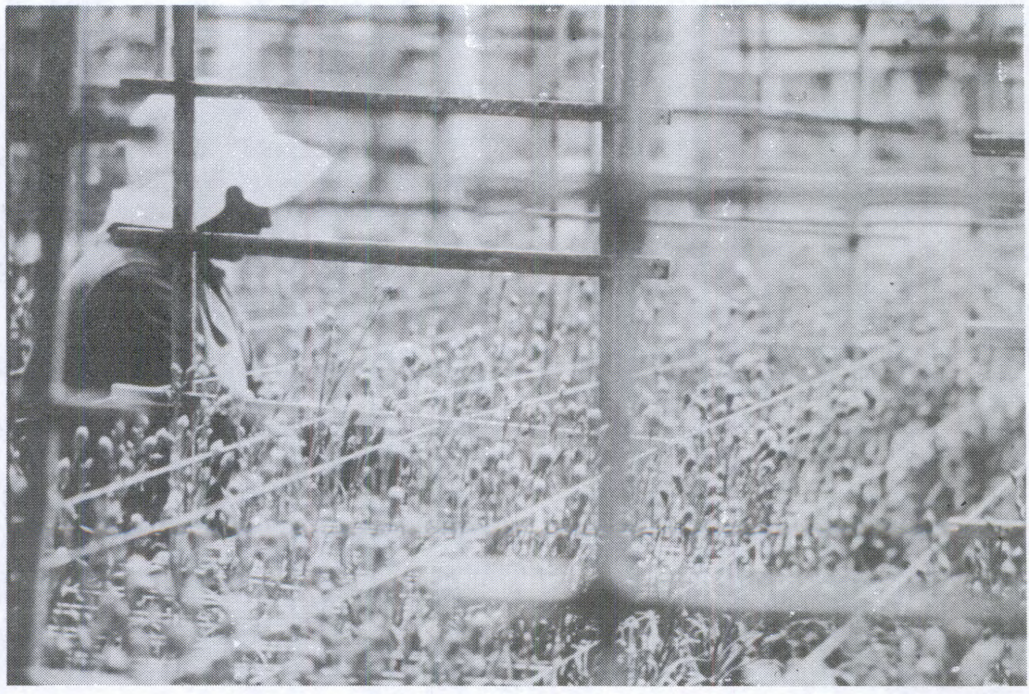

Grapes in Chile and Flowers in Bogota

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Grain Exports in Argentina

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What to do?

First, there is need for independent research to prove or reject the above thesis of a strong trend toward a massive export drive and resource deterioration. There is need for an objective environmental assessment of present situation and trends. There is also a need for a baseline analysis of the natural resource stocks in the LAC region.

Second, if the above thesis is accepted, there is need for a concrete proposal on policies and strategies for alternatives that will ensure natural resource conservation and enhancement of the environment. This proposal should consider the role for the state, private sectors, multilateral organizations, and NGOs (nongovernmental organizations), as well as the use of subsidies and taxes to promote sustainable development and resource conservation. Price policies will be particularly important to assure that prices on natural resources (soils, forests, water) and agrochemicals are sufficiently high to promote prudent use.

Third, there is need to incorporate a better assessment of the future and a systemic approach in development strategies for LAC natural resource sectors, rectifying present tendencies that promote short-run profits instead of long-run social welfare.

This study presents concrete evidence of the fact that natural resource deterioration is already taking place in the most dynamic subsectors of the agricultural sector in Latin American countries. First, the most successful experiences in agricultural modernization are described in Chapter 2. Then, an environmental assessment of these export-oriented modernization processes is presented in Chapter 3. Finally, the most important components for an alternative strategy of sustainable and competitive agricultural modernization are discussed in Chapter 4.

The study should help with the discussion on the scope of win-win strategies that would yield efficient economic growth while minimizing the social cost of natural resource use and environmental degradation. The relevant question is How much depletion-degradation may be justified in order to achieve poverty alleviation and economic growth? (Roe 1992). The fact that resources are being depleted may not be bad in itself; one may think of the new export orientation of LAC countries as being a better situation than before, because shifting resources to agriculture and natural resource activities may take away resources from other activities with higher incidence of pollution and depletion (e.g., heavy industry).

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Some arguments are being advanced that outward orientation and liberalization may achieve economic growth and also resolve environmental degradation. First, inward-oriented policies imply undervaluation of natural resource assets, conducive to their overexploitation. Second, outward orientation increases the profitability of agricultural firms and their willingness to accept policies that save on natural resources. Third, policy reform tends to open an economy to information and new technology that can save on the use of environmental resources. Fourth, decreasing fiscal deficits is also good for the environment because resources can be liberated for monitoring environmental degradation and for investment in pro-environment education (Roe 1992).

Review of literature

Currently, a great amount of research being done on the issue of trade and environment, although most of it is at the theoretical and general level. That research is mostly outside the agricultural domain and focuses on industrial issues such as the global reallocation of "dirty" industries from the developed countries to Third World countries (Low 1991). Other problems being studied concern commercial policies to compensate for the fact that external diseconomies are treated differently by various countries (Low 1991).

Regarding the more specific issue of agricultural trade and the environment, the literature is still scanty. A short review of the recent related literature follows.

Regarding general issues of agriculture and the environment, Hanley (1991) presents an economic analysis of external costs and benefits of farming, arguing that modern commercial agriculture, while producing enormous profits, often has large negative effects on the environment, such as soil erosion, aquifer and surface water pollution, and reduction of local biodiversity. Chapman and Barker (1991) discuss resource depletion and the sustainability of developing country agriculture. Heady (1982) already presented trade-offs among soil conservation, energy use, exports, and environmental quality, while Myers (1986) studied economics and ecology in trade. Finally, Scott (1986) discusses the issues of endangered species, habitat destruction, and environmental degradation brought about by native plant trade.

Regarding depletion of forest resources, Richards and Tucker (1988) present the problem of world deforestation in the twentieth century. They examine the debate on forest-environment issues through a long-term historical perspective;

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they focus on forests in the developing and the developed world and linkages with the global timber trade. Contributions specifically discuss deforestation in southern Brazil, southern Mount Kenya, and colonial forest conflicts; the impact of German colonial rule on Togo forests; deforestation and desertification in the arid Sahel region of Africa; the British Empire and India's forest resources; agricultural expansion and forest depletion in Thailand; exports of tropical hardwoods in the twentieth century; the North America-Japan timber trade; Tasmanian forestry; the death and rebirth of the U.S. forest, and perspectives on deforestation in the former USSR.

West (1987) describes from a regional-anthropological perspective the problem of the "burning bush" in Bolivia, that is, the exploitation of native shrubs for fuel and its consequences in environmental degradation and land use strategies in the Andes.

On the issue of pollution, Zilberman et al. (1991) discuss the economics of pesticide use and regulation. They advance the argument that pesticides enhance agricultural productivity but that environment and health side effects justify government regulation. Bans on pesticide use are the principal regulatory device in the USA and their economic impacts depend on availability of substitutes, supply conditions, and research and development (R&D); without substitutes, pesticide bans result in reduced production levels and higher prices, income loss to consumers, and income redistribution among agricultural producers. Pesticide-use fees are shown to be more efficient than outright pesticide bans as a mechanism to obtain environmental goals. Also, Lichtenberg and Zilberman (1987) propose regulation to avoid environmental and human health risks from agricultural residuals causing pollution.

Regarding the environment and public policy, Chambers, Doering, and Schmitz (1982) studied the subsidy component of U.S. agricultural exports. The paper raises the question of whether or not the USA indeed gains from trade, by determining the "full cost" of exports —not merely the private costs of the producer— but considering factors such as input subsidies and soil erosion.

Just and Bockstael (1991) examine commodity-resource policies in agriculture. Contributions focus on joint formulation and sequential coordination of these policies in the USA; state regulations for agricultural chemical use; effects of commodity programs on resources and the environment; the redistribution of income through commodity and resource policy; joint management of buffer stocks for water and commodities; effects of feedgrain and wheat programs on water depletion in Nebraska; water policy effects on production; trade-offs between agricultural and chemical

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policies; best management practices versus socially optimal practices; agriculture and fisheries; agricultural policies and health regulation; and air pollution and agriculture. Johnson, Wolcott, and Aradhyula (1990) also discussed the opportunities and trade-offs of coordinating agricultural and environmental policies. Finally, Stonich (1991) presents issues of equity, environment, and natural resource management in designing policies for promotion of nontraditional agricultural exports in Honduras.

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2

AGRICULTURAL MODERNIZATION IN LATIN AMERICA

Introduction

A modernization process is identified as one through which sustained increases of productivity and net income at the enterprise level are attained, without as a necessary condition the existence of significative protection on behalf of the state. The modernization process should be interpreted as the development of enterprise capability to increase production under conditions of risk in the market of products and factors and under conditions of change in technology. In the present political and social context, it is desirable that agricultural modernization be attained within a framework of equity, that is to say, that it also contribute to a better income distribution and to the conservation of society's natural resource stocks.

Equitable agricultural modernization has been proposed as one of the main elements for an agricultural development strategy in Latin America and the Caribbean (IICA 1991a). It is thus important to know the factors that contribute to the agricultural modernization process. This motivated IICA in 1989 to organize a series of studies to understand those facilitating factors of the modernization process. The following factors were proposed to be taken under consideration: economic incentive policies, local and external markets, technology, and organization and management (IICA 1990).

The studies also focused on the multiplier effects of the modernization process. This analysis was made considering the direct effects on employment and income, the indirect backward linkages (inputs and service industry), and the indirect forward linkages (agroindustries, transport, services) (IICA 1991b). Another stage of the studies was the evaluation of environmental effects associated with the modernization process.

The conceptual and methodological framework of IICA's research on modernization was original and different from typical economic analysis, concentrating on the important interaction among the proposed factors of modernization. Even though financing should have also been proposed as a

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facilitating factor in the methodology, it was evident that the question of financing always arose when speaking about policies, technology, and markets.

The studies took place in eight countries, emphasizing a subsector that showed evidence of sustainable growth through several years and was associate with a modernization process. The eight selected case studies were grain in Argentina, soybean in Brazil, flowers in Colombia, dairy products in Costa Rica, fruit in Chile, poultry in Peru, shrimp in Ecuador, and vegetables in Mexico. It must be emphasized that the success achieved by the production units and by the agriculture-agribusiness system was not exempt from the economic difficulties, the policy changes, the market instability, and the frequent technology innovations that characterized the 1980s. All cases were successful in attaining a sustained growth because the production units and the system developed the capacity to grow, adapting to the circumstances (see Table 1).

Table 1. Agricultural modernization in eight Latin American countries: Dynamism of production and export (average annual growth).

	Production Growth			Export Growth
Subsector	Subsector	Agriculture (1970-87)	Economy	(1981-88)
Fruit (Chile)	12.2%	3.3%	2.2%	17.7%
Vegetables (Mexico)	5.1%	2.8%	1.1%	5.6%
Grain (Argentina)	3.9%	1.7%	-0.7%	10.3%
Poultry (Peru)	6.7%	0.9%	0.7%	-----
Dairy (Costa Rica)	3.7%	2.3%	2.0%	-----
Soybean (Brazil)	15.0%	3.9%	2.7%	16.0%
Flowers (Colombia)	18.3%	3.4%	4.0%	18.3%
Shrimp (Ecuador)	18.8%	3.0%	2.1%	24.9%

Source: IICA 1990.

The case studies first considered the dynamics of the modernization process through indicators showing how the subsector was modernized. These indicators included production, productivity, real net income by area unit or by enterprise, and number of participating enterprises.

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The basic elements and factors of the modernization process considered in the case studies were the following:

Policies: Included a description of the policies followed, both sectorial and global, and of the indicators reflecting the application of such policies. A reference to the subject of policy stability was made when deemed necessary.

Markets: Examined the market characteristics and the practices followed to open and keep new markets.

Technology: Identified technological elements decisive in the process of reaching modernization and growth of the subsector.

Organization and Management: Analyzed how organizations related to generation of demand, credit and commercialization cooperatives, and consortiums or groups played a role in effectively achieving political and economic protection through lobbying mechanisms. Examined the notion of enterprise within the subsector and the existing managerial skills decisive for success in modern agriculture.

One conclusion of this analysis was the identification of elements explaining the modernization process, within the framework of the proposed determining factors.

A first analysis of the elements all eight case studies had in common shows that modernization should be interpreted primarily as managerial modernization in the enterprises and the economic agents within the specific subsectors.

Further, the eight experiences of agricultural modernization can be classified in four different categories:

a. Modernization of traditional commodity exports, such as grain in Argentina and soybean in Brazil.

b. Modernization of products with high income elasticity, such as Chilean fruit and Mexican vegetables.

c. Development of new luxury products oriented toward satisfying external demand, such as flowers in Colombia and shrimp in Ecuador.

d. Modernization of products basically oriented to domestic markets, such as dairy products in Costa Rica and poultry in Peru.

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The hypothesis advanced was that there were factors alongside managerial modernization that also explained the development of the four process categories above mentioned. Thus, for grain in Argentina and soybean in Brazil (traditional commodity exports), technological development and great productivity increases were probably the determining elements of modernization. In the cases of Chile and Mexico (products with high elasticity), government dynamism and economic policies supported the managerial modernization of these subsectors. Finally, in the case of Colombia and Ecuador (new products of sumptuary nature), market dynamism seems to have been the determining factor in explaining the development of these subsectors.

This chapter presents a summary of the above-mentioned case studies of agricultural modernization in LAC countries according to the proposed classification. First, grain in Argentina and soybean in Brazil are discussed, followed by fruit in Chile and vegetables in Mexico, and flowers in Colombia and shrimp in Ecuador. The Peru study is not presented here because it was confined to supplying the domestic market, and the focus of the present analysis is export-oriented modernization and its impact on natural resources. Next, an extension of the Costa Rica study incorporating the development of all livestock activities is presented and, finally, a new case study of agricultural modernization in citrus in Brazil is included in the analysis.

Modernization of grain in Argentina

The grain subsector in Argentina

The agricultural sector has a significant role in the Argentinean economy because of its special importance in the Gross Domestic Product (GDP), in export, in food supply, and in fiscal revenues. Agriculture's share in the GDP has been around 15% in the last decade, but gets as high as 36% if the agroindustrial complex and related services are considered. The processing of meats, cereals, sugar, dairy products, cotton, edible oils, wines, and agricultural machinery are the most important activities of the industrial sector. Agricultural exports represented 60%-68% of the total between 1972 and 1987; grain exports made up over 90% of agricultural exports and around 50% of total exports.

Crops are the principal activity in agriculture with 62.5% of the sectorial GDP; livestock represents 34.5%; and fishing-forestry account for only 3%. This sector shows great heterogeneity due to the large extension of the country and the variety of natural resources, but the pampa region, a great plain of 45

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million hectares, dominates. This region accounts for around 75% of agricultural production, forming over 85% of the cultivated area of Argentina and producing 75% of bovines. Pampa agriculture specializes in cereals and oil seeds, producing 95% of the domestic output of wheat, maize, sorghum, soybean and sunflower.

Grain (cereal and oil seed) is the most important production of Argentinean agriculture, accounting for 40% of agricultural output and 63% of total crops in 1985-87. In the period 1960-85, the production of grain experienced sustained growth, which originated in the modernization of the productive process and in the parallel growth of services and a marketing infrastructure. The volume of production tripled in that period (Figure 1).

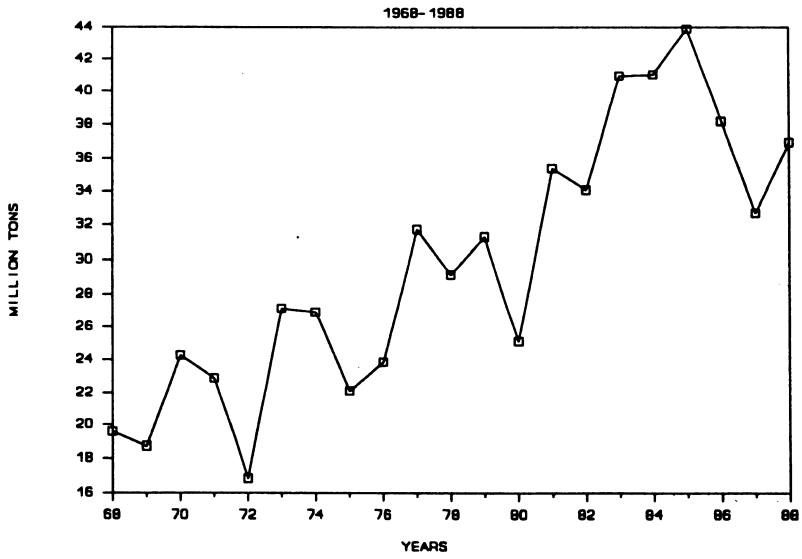

Figure 1. Grain production in Argentina.

The growing production of pampa agriculture allowed Argentina to recuperate its position in world trade between 1960 and 1985, reaching a production record of 44 million tons in 1985. However, due to a drastic fall in international prices, Argentinean grain production fell to 38 and then 33 million tons in 1986 and 1987. The 1988 drought in the Northern countries raised international prices, but Argentina could not take advantage of this new

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situation, due to the impact of the adjustment policy and a domestic drought, that allowed production of only 25 million tons in the 1988-89 season.

Fundamental to the modernization of Argentinean grain production was the incorporation of technology changes; while the cultivated land area grew 41.7% during the period, the productivity of land grew by 153.8%. Since variation in productivity depends primarily on technological change, it can be assumed that technology accounts for approximately 80% of the increase in output. Modernization had a significant impact on the economy: the increase in production raised exports by an equal amount, since population growth is low and per capita consumption is stable. In 20 years, the export volume of cereal grew by 185% and that of oil by 240%, while the value in constant dollars grew by 126% and 138% respectively. The share of both groups went from 38.5% to 47.8% of total exports.

The impact of technological innovation on agricultural productivity created increases in grain profit rates that contrasted with the fall in livestock profit rates. A substitution of crops for livestock followed: it is estimated that land use for livestock production decreased 11% between 1950 and 1985. Technological change influenced grain agriculture specialization in five products: wheat, maize, sorghum, soybean and sunflower. This raised their share in grain production from 78% to 95% between 1960 and 1985. Also notable was the continuous increase in oil seed; the share of the soybean-sunflower-flax group in grain production went from 15% to 47% between 1967 and 1987. This change had important consequences on soils and on storage, transport, and shipping because of the different physical characteristics of the marketed products.

The modernization process

Modernization resulted from transformations in production, marketing, and processing, but the core of the process was the transformation of production techniques. The evolution of pampa agriculture from 1950 may be divided into four stages: dissemination of agricultural techniques, agricultural mechanization, improvement of seeds, and use of agrochemicals.

The first stage, agricultural techniques, was characterized by research and extension of better agricultural practices that were primarily developed by the public sector through the creation of the *Instituto Nacional de Tecnología Agropecuaria* (INTA) in 1956. The private sector also participated in R&D in agricultural techniques through the *Consorcios Regionales de Experimentación Agrícola* (CREA), established in 1959.

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The second stage, agricultural mechanization, consisted of the spread of use of tractors and mechanical harvest. The mechanization of the pampa region accelerated in the 1950s, and was completed in the 1960s; growth of the stock continued in the 1970s, both in number and power. The latest trends reflect the diffusion of units over 100 HP (horsepower) with technical innovations similar to the units used in countries with advanced agriculture. Production of harvesters in the country dates from long ago, but technological transformation and diffusion also occurred in the 1960s.

Mechanization was promoted by a policy with a double objective: protection of domestic production of agricultural machinery, and promotion of demand for these capital goods. Protection policies included tariff exemptions on materials and equipment for production, subsidies for domestic production, production quotas by firm, sale tax exemption, tax cuts for profits reinvested in certain equipment, and restrictions on importing tractors. Demand for tractors was encouraged through tax cuts on profits reinvested in certain equipment in agricultural enterprises (up to 100% of the value of the machinery) in 1955-73, and subsidized long-term credits in 1963-77.

The third stage consisted of diffusion of improved seeds: hybrids in the case of maize-sorghum-sunflower, and varieties of "Mexican" germplasm for wheat. The massive incorporation of new varieties took place in the 1970s. In the case of hybrids, development was confined to the public sector at the beginning, but there was a rapid decrease in public sector participation in the 1970s. Establishment of the "closed pedigree" in 1959 allowed private agents complete secrecy concerning production of hybrids, which implied protection for hybrid R&D by private enterprise and a "biological copyright" for private appropriation of the returns generated by the innovation. Diffusion of hybrid seeds was rapidly reflected in productivity increases and made mechanization more profitable.

The introduction of Mexican germplasm for wheat started in 1972. The research on adaptation was carried out by INTA and CIMMYT (*Centro Internacional de Mejoramiento Maíz y Trigo*) in the first years. Later, the private sector share in development of autogamous plants was promoted by the 1978 "seed law," which protected creation of new genetic knowledge through plant breeders, rights. The new varieties provided a significant increase in yields, but other characteristics were also important: short cycle and response-to-fertilizer capability. Short cycle varieties allowed double-crop systems, thus contributing to the rapid diffusion of the wheat-soybean crop in the pampa region, substituting maize and livestock.

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Simultaneously, there was an explosive growth in soybean. Practically unknown until 1960, the development of a technological package made up of selected varieties according to agroecological regions, agronomic recommendations, inoculants, herbicides, and specific agricultural implements, was the reason for its rapid adoption. The public sector started the research on adaptation of North American varieties in 1960; in 1970 the *Comisión Permanente para Fomento de Cultivo de Soya* was created, made up of the public sector and private industry. Finally, another technological breakthrough in pampa agriculture was the development of sunflower hybrids, which, through higher yields and higher oil efficiency, has turned sunflower into an important alternative.

The fourth stage, growing application of agrochemicals, was initiated in the mid-1970s. The new preemergency and postemergency herbicides have been particularly important for perennial weed control (e.g., sorghum from Alepo). Soybean, in particular, could not be grown without the new agrochemicals. The private sector has taken over the importing, formulation, and distribution of these chemicals, helped by low-duty policies. Fertilizer use has incremented in wheat, encouraged by a policy of favorable prices. In 1984, the government established the *Subprograma Nacional de Fertilizantes*, regulating importing by the State, distribution by cooperatives, and a new payment system of barter for grain; as a result, consumption expanded rapidly, increasing fivefold in the years 1983-86.

Macroeconomic and sectorial policies

Macroeconomic policies adopted in the 1950s were influenced by CEPAL's (*Comisión Económica para América Latina*) ideas. Their most notable aspects were import substitution industries, considerable State intervention, agricultural sector role confined to provider of food and funds, and eventual compensation to agricultural sector for economic surplus extraction.

The principal macroeconomic tools were the exchange rate and tax policy. The exchange rate was officially defined, and was periodically updated by devaluations, with a strong tendency toward overvaluation of the Argentinean peso.

Export taxes have been a traditional tool of fiscal policy. Taxes collected by the *Tesoro Nacional* were mostly indirect, and export taxes represented 63% of them, thus becoming the most important source of revenue. Therefore, agricultural export taxes have become an instrument of an industrial development strategy based on lower relative prices for agriculture and on the

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transfer of economic surplus. Surplus extraction was partially compensated by tax cuts on agricultural machinery investment, fertilizer-pesticide expenses, seed sale profits, and value added tax.

Treatment of inputs also followed the industrial protection policies: imports of agricultural machinery and other items were prohibited or subject to high tariffs. This allowed the development of a local industry but with a low level of competitivity. This meant higher costs for agricultural producers.

Despite this clearly biased-against-export exchange rate and tax policy, production and export of grain experienced sustained growth. This paradox is explained by the fact that agricultural benefits grew significantly because of technological innovation. Obviously, actual profit rates and expansion of production were less than they could have been with the right policies.

Credit policy also operated as a compensation factor: real interest rates for cereal and oilseed production were negative between 1960 and 1977. Likewise, the agricultural sector share in the total credit was greater than its GDP participation. The sector was additionally favored with a high number of official banks supplying credit to the sector. Moreover, external resources were used for special programs such as agricultural mechanization and help for small producers (funds from the Inter-American Development Bank), and silos and elevators in grain production areas (United States Agency for International Development --USAID).

Regarding pricing policy, the price received by exporters was always less than the international price, due to the overvaluated exchange rate and the export tax. The price received by producers depended additionally on marketing costs and margins. Through the *Junta Nacional de Granos* and the guaranteed price policy, the state has managed to secure the producer price and the internal wheat supply. The *Junta* would buy all the offered cereal at the guaranteed price, thereby protecting the producer, who confronts unfair competition with an export sector that is heavily concentrated. In general, the price trend resulting from variations in international markets and domestic policies has been toward price depression.

Marketing of grain

The marketing system facilitated transformation and modernization of production. The first facilitating factor aiding in this process was the commodity characteristic of grain; that is, a good with a well-developed international market, and which is not identified with brands. The grain

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market is sufficiently large in relation to Argentinean production that Argentina does not influence price formation. The second facilitating factor was the organization of the domestic market. Since 1930 several mechanisms have developed: arbitrage entities, guarantee systems, official classification systems, and laboratories of grain quality analysis and of industrial quality. In quality control matters, the *Junta Nacional de Granos* established marketing standards, which are compulsory for the internal market and which determine grades and price premiums and discounts. All production is negotiated on this basis, activating operations and introducing security in negotiations.

The third factor was the degree of competition in the market, since the weight of the big enterprises was balanced by the *Junta Nacional de Granos* and the cooperatives. In addition, the *Bolsas de Cereales* (marketing boards) in the locations where grain production is concentrated allowed formation of a competitive market with great number of suppliers and demanders. Publishing of *Bolsa* prices contributes to price formation in further stages. In turn, the *Junta de Granos*, by fixing the guaranteed price, sets a floor for the market price.

The fourth facilitating factor was the favorable evolution of international demand and prices during the 1970s, which coincided with the period of modernization of grain production. Likewise, U.S. agricultural legislation up to 1985 favored surplus Argentinean exports by fixing price floors. Given the greater Argentinean production efficiency, price discounts in relation to the North American "floor" assured a market for Argentina's exportable surplus. Thus, the Argentinean share in international markets grew between 1960 and 1985. The growth of protectionist policies in the EEC and USA, the U.S. agricultural legislation change in 1985, and the virtual commercial war between these two economic powers caused the international grain price crisis in 1985. Given the dimension of the price fall, the productivity increase in Argentina was not enough to offset these events and production fell sharply in 1986 and 1987.

Sector expansion was accompanied by transformations in the marketing system. In-bulk harvesting was incorporated for grain handling, doubling labor productivity. Likewise, since the 1950s, policy incentives for domestic truck production had been implemented and the truck stock for grain transportation grew in number, capacity, and power. At the same time, the roadway system was expanded. Truck transport services were added to railroad services, with a resulting cost reduction in transportation of 50% in real terms between 1960 and 1988. Also, construction of storage installations was greatly increased in the 1970s. In summary, the old marketing system, characterized by grain handling in bags, transport by railroad, and storage in

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ports, was transformed into a new system of moving in-bulk harvests, transporting by truck, and storing in intermediate installations and private port installations.

Organization of production

Changes in the organization of production are observed at various levels: new social forms of production organization, intersectorial linkages, firm-level organization, and producer organizations.

Social forms of production organization in the pampa region have transformed particularly with regard to land distribution and kind of tenancy. A small deconcentration in land distribution was brought about: family enterprises and medium-sized capitalist enterprises absorbed growing proportions of land and output and, at the same time, the number of and land area for very-small and very-big enterprises was reduced. Regarding types of tenancy, traditional leasing disappeared in the 1960s and a new form of leasing, characterized by one-year contracts paid with a percent of harvest, was developed.

New contractors have upgraded machinery and applied modern technology (improved seeds, herbicides); they look for maximum profit for the year and for this reason they make use of the most efficient production techniques. Two basic types of contractors were found: the family enterprise (local producers leasing additional land) and the contracting enterprise (without land but possessing capital, machinery, and professional human resources).

Regarding intersectorial relations, backward and forward linkages in the production process of grain were increased or created during modernization. Development of the providing industry strengthened substantially the agriculture-industry linkage: no inputs are produced in the rural area today. Everything affecting input prices (exchange rate policy, tariffs, industrial policies, petroleum prices) affects the agricultural sector, and everything affecting agricultural production levels (climate, tax policy, credit) affects the demand for providing industries. At the level of processing industry, greater production of oilseed stimulated growth of the edible oils and balanced feed industries; 75% of soybean and 95% of sunflower harvested are processed within the country. Agriculture and the providing and processing industries require services (transport, storage, ports, financing), demand for which has increased alongside agricultural production.

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Technological change has had impacts on agricultural firms in terms of an increase in long-term profitability. Innovations brought about greater harvest security, derived from the greater availability of machinery and greater defense capability implicit in the new seeds and pesticides: agricultural risk diminished considerably. At the same time, increases in input use (fuels, improved seeds, pesticides, fertilizers) incremented total expenses considerably and also the need for financing. Likewise, technological modernization brought some undesirable aspects in terms of soil conservation: the process of substituting agriculture for livestock activity and the adoption of double-crop schemes led to continuous agricultural use of soil and to the loss of the traditional mixed-use systems appropriate for maintaining physical and chemical soil structure.

Farm management has become complex and dependent on factors outside the farm; new requirements for information and economic analysis instruments have emerged. INTA and some producers have provided services in the area of rural administration. It is important to note that the average agricultural producer has modernized only at the production level, with overall organization lagging behind. For instance, some services that in other countries are provided by the same producer (grain drying, storage, and transport), are the province of others in Argentina.

The principal function of producer organizations in the modernization process has been defense of their interests. In the case of small and medium-sized producers, unions (grouped in the *Federación Agraria Argentina*) and cooperatives have tried to mitigate their situation of relative disadvantage vis-à-vis the marketing and financial system. The cooperative movement, which dates from long ago, grew to aid small producers in confronting the power of grain exporters. This movement grew to nowadays include powerful industrial enterprises (edible oils, dairy), providing services such as input sales and up-to-harvest financing, consequently contributing to the incorporation of producers in the expansion process.

In summary, it is possible to classify modernization factors in three categories: decisive, facilitating, and discouraging. The principal decisive factor was, no doubt, a sustained process of generation and incorporation of technology. The facilitating factors were favorable market conditions, making an external market promotion policy unnecessary; the property and tenency structure of the land, without minifarms and with predominantly family enterprises and medium-sized capitalist farms; policies of trucking development, road investment programs, and incentives for private shipping, which facilitated adequate mobilization of harvests at decreasing costs. Among the discouraging factors was the macroeconomic policy, with lower

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prices received by producers as a result of the exchange rate and tax policy, which affected profitability.

Modernization of soybean in Brazil

The modernization process

The recent history of Brazilian agriculture is marked by its integration with the industrial-financial sector and the modernization of its technical base. In the modern and dynamic agricultural sector, the profound economic-technological-social transformation in production, distribution, and processing of soybean stands out. The following factors, among others, are connected to this modernization process: increase in urban demand, growth of external trade, economic policy, technological innovation, availability of frontier land, and development of an industrial sector that provides a means of production for agriculture.

This section discusses the decisive factors in the modernization of soybean production in Brazil. Since the soybean complex is an integrated subsector, one must also consider the dynamics of inputs, machinery and agricultural implements, soybean milling, and human and animal food. This section presents a brief historical overview and then discusses the dynamics of the soybean modernization process, policies that have benefited the subsector, technology for grain production, market characteristics, organizations connected to the subsector, and management of the production units.

Brazil has been an important world actor in the soybean market since the 1970s. That participation, explained in great part by the modernization process that soybean production underwent, is made viable by the fact that Brazilian soybean production enters the market in the between-harvest period of U.S. soybean, and by the greater content of oil and protein in Brazil's grain. Soybean modernization is also connected to other important factors, such as agricultural research.

Brazil has opted for exporting soybean derivatives (cake and oil) instead of simple grain, looking for processing value added and ensuring full utilization of the internal mill capacity. The power of the soybean agribusiness in Brazil is revealed when one notes that its exports are greater than U.S. exports, even though in soybean grain production, Brazil is still behind U.S. production.

Brazil's soybean agribusiness complex is made up of a succession of activities ("soybean chain"), including production of capital goods for

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agriculture, input industries (pesticides-fertilizers), financing, grain production itself, harvest, storage, transport, transformation, and distribution. The dynamics of Brazilian agriculture is now linked to the actions of agricultural-industrial complexes, suggesting that the principal forces of change in agriculture are located outside the sector. Agriculture's intersectorial relations explain in great part the transformation of its organization and technical base.

Brazilian soybean production had moderate growth in 1960-68, a strong increase in 1969-77 (the "boom" period), and reached a volume of over 18 million tons in 1986 (Figure 2). The climatic adversities of 1978-79 and the pricing and financial problems of the 1980s affected production in the period 1978-88.

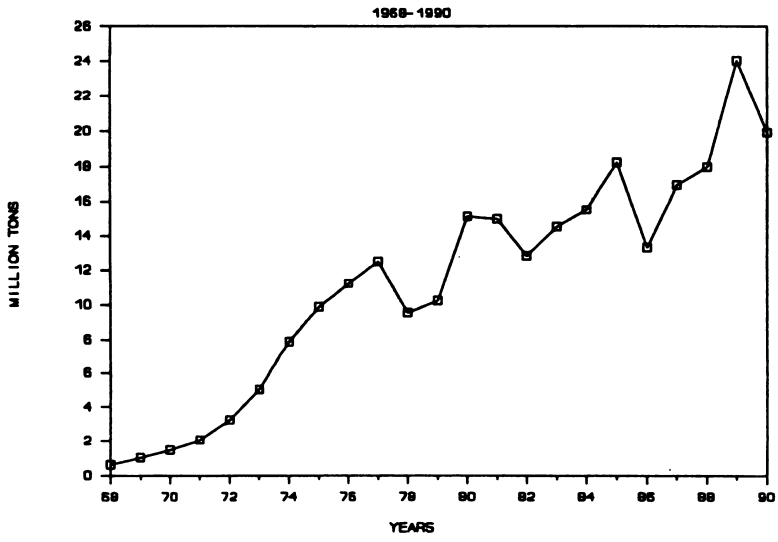

Figure 2. Soybean production in Brazil.

Soybean expansion in Brazil is reflected in the growth of harvested area and in productivity; a strong correlation exists between the evolution of production and the harvested area, and this relation is greater when the effect of climatic adversities is eliminated. The harvest area for soybean registered a continuous expansion during 1960-80, but a major fall occurred in 1981-83 due to the reduction in cultivated area in the traditional region (Rio Grande do Sul, Santa Catarina, Parana and Sao Paulo). This reduction is explained by the great decapitalization of producers (due to the negative relation between costs

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and prices) and by greater incentives placed on maize production. The reactivation of growth in cultivated area since 1984 has occurred due to the extraordinary performance of the central/western region, which contrasts with the trend toward reduction in the traditional region.

The rise of the central/western region as a new soybean production center is explained by the sudden appearance of new varieties originating from agricultural research units, and by the overcoming of problems of disease, plague, low levels of seed germination, technological deficiency, and financial-infrastructure shortcomings through research, financial, and regional development projects.

A great part of the soybean area is farmed with machinery. In the traditional region of cultivation, mechanization is present in all production phases: soil preparation, seeding, harvest, and processing. In the traditional region more than half of the country's stock of tractors is concentrated. A considerable part of this stock is part of the technical base of soybean production. Growing mechanization in the central/western region is demonstrated by the great increase in the number of tractors in 1975-80.

Another modernization indicator is the productivity level. Noticeable is its relatively elevated initial level and its general growth trend over the whole period. When the technical-scientific studies on soybean were initiated in Brazil, the research process globally had already achieved a high degree of transferable technological results in the biological, mechanical and physical/chemical areas. These products were rapidly transferred to the farm level, including sophisticated technologies comparable to those in developed countries. Growing productivity during the 1960-88 period, especially after 1968, resulted from national research and rural extension efforts.

Decisive factors of modernization

A set of factors are connected to Brazil's soybean modernization. Besides the stimulus of international markets, some favorable conditions for crop expansion should be considered: the existence of varieties from central and southern USA that were easily adapted to Brazil's southern region; cultivation of soybean in succession with wheat, thus taking advantage of the same area, fertilizers, machinery, equipment, storage facilities, and labor; greater available capital to the producer as a result of the official wheat self-sufficiency policy; the possibility of total mechanization of production; expansion of the national agricultural industry; the growth of urbanization that demands more edible oils to replace animal grease; the intense role of cooperatives in the process of

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production, marketing, and industrialization; and technology generation adaptable to different regions.

Macroeconomic policies

The Brazilian development model of the 1980s was based on export promotion with the goal of increasing trade surpluses to cover the financial costs of the external debt. In that context, the agricultural and agribusiness sectors have played a role of great importance.

Openness to exports was initiated in Brazil in 1964 with a series of incentives that were reflected in exchange rate adjustments and fiscal and credit measures. The 1965 tax reform was a decisive frame for that new policy and in the same year the National Rural Credit System was created, which was to play an important role in soybean modernization. Fiscal policy was strengthened as an instrument for export stimulus in 1968, and in 1969 the manufactured products export subsidy system was created, aiming to diversify the country's exports. The incentives were not aimed at primary exports such as soybean, but at manufactured goods.

Macroeconomic policies have benefited the input and agricultural equipment domestic industry and the soybean processing sector. These policies have promoted installation and growth of those industries through import tariffs and subsidized credit. For the milling industry, the policies have diminished the price of the internally produced raw material (soybean), have facilitated installation with subsidized credits, and have allowed duty-free grain imports ("drawback" system) with the objectives of reducing unused capacity and increasing incoming external resources. These policies have favored establishment and development of an important agribusiness center, and the growing utilization of the primary products. The policies have been concerned with supplying the internal market, promoting the use of soybeancake by the domestic feed industry, making grains available for the milling industry, and satisfying the domestic demand for soybean oil.

The exchange rate overvaluation in some periods affected not only exports of soybean and derivatives, but also domestic grain producers; it was a decisive factor in the negative rates of effective protection for soybean during 1977-83. Even when huge devaluations were adopted, the soybean sector was denied the benefits due to the simultaneous imposition of special export taxes. On the other hand, the exchange rate policy made the imported inputs artificially cheap.

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Sectorial policies

The sectorial policy of most importance for soybean is rural credit, an important factor in Brazilian agricultural modernization and in the soybean production boom of the 1970s. The agricultural sector had, up until 1982, a great availability of subsidized credit, and a considerable part of that credit was used by the soybean complex. A strong reduction in rural credit resources, for cost financing as well as for investment-marketing, occurred later, coinciding with the retraction of the principal bank for agriculture, *Banco do Brazil.* Credit loss in the 1980s was greater among small producers due to the increase in bank requirements for credit concessions. The credit policy had especially stimulated fertilizer use through negative interest rates.

On the other hand, minimum price policies for soybean did not set internal prices since these were fixed by the international market. In fact, minimum soybean prices have been lower than the actual prices received by producers.

Technological aspects of production

The international market and the internal processing sectors, by demanding quality and homogeneity, have imposed on soybean producers the use of a technological profile that has transformed the technical base of soybean production.

The technical-scientific development of U.S. soybean had a considerable influence on technological development in Brazil's traditional region of cultivation. Soybean production in Brazil has benefited intensively from the U.S. technical-scientific legacy. The usual hypothesis is that the modest soybean productivity growth in Brazil is explained by that legacy, which places Brazilian soybean production at a very high initial level.

This hypothesis must be better analyzed. In fact, soybean production in Brazil started by importing U.S. species appropriate for production at latitude 30°-35°; this is why soybean was introduced in Brazil through its southernmost state, Rio Grande do Sul (located between 27° and 33° south latitude). However, since 1980 new varieties with long juvenile periods started to develop in Brazil, which made the crop feasible in other regions of the country located in low-latitude tropical areas where economic production was previously impossible with the original varieties. These new varieties with long juvenile periods diminished the crop's dependency on daytime sunlight (photoperiod). With previous varieties, the tropical region's short days would imply precocious flowering and small development. This initial hypothesis

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must be revised, therefore, because crops with long juvenile periods represented a distinct technological development and the Brazilian soybean agronomic research was, in fact, an intellectual breakthrough.

The vigorous expansion of soybean in nontraditional areas of Brazil has made the total production less subject to localized climatic problems. Research centers have recently oriented their efforts toward prevention of damage from drought. They have also developed more tolerant varieties ("Doko") and new techniques for soil correction (use of carbonate and calcium sulphate) in order to obtain a deeper radicle system.

In any case, the growth curve of Brazil's soybean productivity presents a weak positive tendency, in particular when it is compared to the production expansion curve (productivity grows from 1200 kg/ha in 1960 to 1717 kg/ha in 1988).

Scientific-technological soybean research has been taken over by the private enterprises connected to the soybean complex and by the public sector. Biological technologies, even though they were also developed by private initiative, have received great pushes from government agencies. Mechanical and physical-chemical technologies have been better developed in the private industrial sector.

The subsector market

The market has been a facilitating and decisive factor in the modernization process; the external market was an important initial factor in the process.

Soybean is an intermediate demand product, and only after processing becomes part of the human diet. Basic products are extracted from soybean for use in an ample range of industrialized foods. The consumer is not always aware that he or she is consuming soybean when acquiring products such as oil, ham, bacon, sausage, hamburger, pork, poultry, beef, pasta, and many others.

Due to the great milling capacity in Brazil, built in the 1970s, grain supply to the internal market has been maintained. This proves the success of policies for structuring an industrial soybean processing center. The marked growth in milling capacity is explained by the establishment in 1978 of credit lines for establishment of industrial plants. These had the major attraction of negative real interest rates. Disparity between milling capacity and internal grain

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supply for milling has generated a number of responses, such as importing soybean by means of "draw back" systems.

Brazilian exports of soybean and soycake have gone mainly to Europe, though sales to Japan grew from 1985. Exports of oil (gross and refined) followed an eastern route (especially Iran and India).

Soybean oil faces today a strong potential competitor in African palm oil; large palm plantations in Asia's tropical regions are currently being developed. The African palm, after an eight-year growth period, has a production capacity of approximately 8000 kg/ha/year for several consecutive decades. On the contrary, soybean is an annual crop producing around 400 kg/ha of oil per harvest.

The common belief that Brazilian soybean is an export crop has concealed its growing internal importance. The soybean complex has reinforced intersectorial relations, has generated new organizations (processing industries and cooperatives), and has consolidated as a principal supplier of edible oil and as a fundamental protein component in animal feed (pork, poultry, bovines).

Organization and management

The soybean complex is made up of multiple persons and organizations, including means-of-production industries, agricultural producers, transformation industries, traders, and researchers. In conjunction with this complex, a production-transformation-distribution model exists that is gradually growing stronger and that has brought the subsector toward a growing production of food items, animal proteins, and edible oil.

Soybean expansion in Brazil is also connected to the explosive urban growth, which creates new relationships between social agents, alterations in consumption patterns, and strengthening of new economic agents such as the processing and trade enterprises.

The cooperatives also play an important role in the transformation of rural areas. They differ from private enterprises in that they do not have profit objectives and their principal function is providing services to their associates. The soybean cooperatives have facilitated provision of indispensable agricultural inputs, technical assistance, storage, marketing, and industrialization. The majority of producers prefer to deliver their output to

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the cooperative system; direct delivery of soybean to industry is done mainly by big producers.

Soybean is the crop that has most adopted modern technology, which is due in part to the activism of internal research institutions. This institutions efficiently provide a considerable stock of technology to producers. Producers' administrative capability has been demonstrated from soybeans' introduction in the south, where the double crop wheat-soybean has become an efficient agricultural venture, because of its maximum use of soil. The excellent combination of legumes (soybeans) with grain (wheat) contributes to minimize soil erosion. Administrative capability may be also demonstrated by the low production costs: Brazilian soybean is more efficient than the U.S. soybean in terms of farm production costs.

In conclusion, without questioning the importance of external markets, this section presents agricultural research, growth of the processing sectors, and economic policies as the decisive factors in soybean modernization in Brazil.

Modernization of fruit in Chile

The objective of this section is to characterize the elements that helped in the modernization of fruit production in Chile. The analysis is based on the period 1976-87, coinciding with the boom period, although in discussing policy changes some references will be made to previous periods.

The temperate-climate fruit production in Chile has special physical conditions and its production is off-season with respect to the northern hemisphere. The principal indicators show that between 1970 and 1987, planted area grew from 60 to 150 thousand hectares, production from 500 thousand to 1.5 million tons, and exports from US$12 to 527 million, today representing over 80% of all agricultural exports (Figure 3).

Macroeconomic and sectorial policies

Monetary policy

Chile has lived through a long inflationary period reaching three-digit levels in 1972-76, principally explained by monetary expansion to finance fiscal deficits. From 1974, a new monetary policy, oriented to reduce inflation and create an environment of price stability, was initiated. That policy favored fruit, since economic agents could estimate the profitability of fruit investment

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with a degree of security; thus, when inflation stabilized in 1983-87, it coincided with the annual increase in area of fruit plantation.

During the period 1979-82, overvaluation of the currency favored imports over exports, negatively affecting the subsector, although at the same time the policy helped the subsector through new foreign investment. At the moment of external crisis, the subsector found itself deeply in debt and benefited from reprogramming of production debts. The subsequent adjustment program and the reduction of aggregate demand did not affect the subsector because the exchange rate incentives more than compensated for the negative effects.

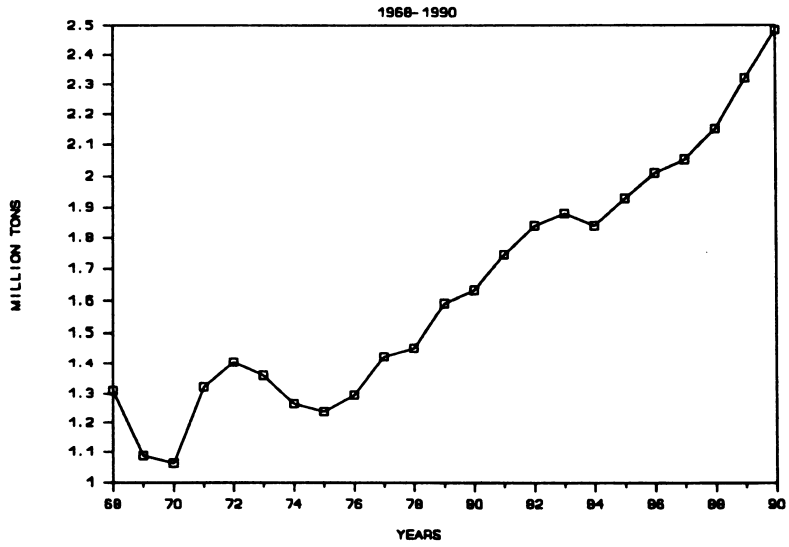

Figure 3. Fruit production in Chile.

Financial policy

The period of controlled and selective credit with low or negative interest rates, which ended in 1975, benefited agriculture moderately. However, the questioning of private enterprise, the agrarian reform, and an exchange rate overvaluation policy took out any motivation by the agricultural private sector to invest in fruit.

In the period of deregulation and financial liberalization (1976-82), the subsector was more favored, especially those big- and medium-sized producers that could engage in foreign debt, due to the lower real interest rates on

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foreign currency debts. Also, with the return of financial regulation policies (1983-87), the subsector again benefited from debt renegotiation programs and from the increase in profitability due to the adjustment policies. Fruit had no problem capturing internal credit, displacing other activities (milk-beef and crops, except wheat and sugar beet). The deciding element was the change in credit policy, which allowed the inclusion of irrigation systems and infrastructure as loan guarantees.

During this period, a free and competitive market with equal treatment of foreign investment and domestic capital was strengthened. Alongside market liberalization, state institutions such as CORFO (*Corporación de Fomento*) and *Banco del Estado de Chile* lost importance in fruit financing relative to commercial banks. After the crisis, CORFO returned to fruit financing, but with external resources from the Inter-American Development Bank.

There seem to be no limitations at present with regard to financing for increases in planted area. However, it appears that the negative experience with dollar debts has led agricultural producers to reinvest their export revenues to expand their business or look for alternatives to the traditional financial system.

Exchange rate policy

The exchange rate policy has been one of the decisive factors in the Chilean fruit boom, creating incentives for the expansion of exportable fruits, especially table grapes, carozos, apples, pears, and others for which the internal market is very limited.

During the 1976-87 period, three phases may be distinguished. The first phase, creation of profitability, was linked to the new 1975-79 exchange rate policy that allowed competition in the international market causing revenues to increase by a greater proportion than costs. This generated profits, great expectations, business expansion, and an increase in fruit plantations. The second phase, the 1979-82 profitability reduction period, was characterized by revaluation and a fixed exchange rate; benefits decreased because of fixed revenues and internal costs subject to moderate inflation. Fortunately, good prices and not-so-severe quality requirements allowed the exportation of a high percentage of the production. The third phase, one of increase in profitability, was determined by the 1983-87 exchange rate policy designed to overcome the external crisis, which established an extraordinary incentive to export through a high real exchange rate that greatly favored fruit. In response, in 1983-87 the average annual growth of fruit area was 9,300 hectares.

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Fiscal policy

The 1976-87 tax regulations established as the base for income tax the presumed rent, which definitely favored the subsector. In addition, the territorial tax rate was only 2% annually. Finally, specific taxes on wine production have cut that activity back and have shifted soils to export fruit (table grapes).

Direct public expenditure on the agricultural sector lessened in the period 1976-87. However, the subsector has benefited indirectly from roadway development, expansion and adaptation of seaports and airports, rural electrification and telephone development, debt reprogramming, and direct subsidies for private irrigation works.

Tariff policy

Tariff policy did not benefit the subsector before 1974, since tariffs were high and affected the import cost component of production (pesticides, hormones, machinery). In contrast, the new low and flat tariffs benefited the subsector, by diminishing the relative profitability of other lines of production. Application of the new tariff policy together with the exchange rate policy (devaluation) meant that in practice the profitability of the subsector was increased. The new tariff policy also allowed reciprocity in international trade and facilitated market diversification.

Price policy

Before 1974, traditional price fixing at low profitability levels for agricultural producers encouraged them to look for alternatives, especially those with free market prices; first plantations of peaches, plums, apples, and table grapes were developed during that period.

With price stability in the later period, fruit investment was further favored since investors could have a clearer vision of the expected benefits. The development of competitive markets in other areas also helped, such as the creation of land and water markets.

Employment and wage policy

The export fruit trade requires a great quantity of labor, especially in some products like table grapes. This labor is needed at the farm level as well as the packing level, and during very short periods, in particular during the harvest and conditioning of fruits. Employment and wage policy is critical in business

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success. Labor costs have been favorable to the subsector, given rural seasonal unemployment and relatively low wages. This situation is even more important when compared to wages in competitor countries (New Zealand, Australia, USA), which may be 20 times higher in dollars. An important aspect has been the institutional framework, centered in a new labor code that creates labor discipline and makes it practically impossible to strike. The new labor system has stabilized the farm-packing-transport-shipping process chain, essential to business success.

Export promotion

Export policy had four favorable elements: export cost reduction, risk reduction, export process facilitation, and opening of markets. Export cost was diminished by payment postponement and return on custom duties on capital goods destined for exportable goods production, and also by a 10% FOB value reimbursement on small exports. Facilitation of the export process was achieved through institutional reforms in the central bank, *Servicio Agrícola y Ganadero* (SAG), *Servicio Nacional de Aduanas*, and *Tesorería General*. With the aim of reducing risks, the *Fondo de Garantía a Exportadores* was implemented and the warrants system to exporters was extended. The state played a role in market opening through PROCHILE (*Promoción de Exportación Chilena*) with commercial offices in Asia, Europe, North and South America, and all over the country.

In conclusion, policies have achieved results by facilitating development of private enterprise, providing high profitability, and consolidating the comparative advantage. Profitability was made effective through a high real exchange rate, low and flat tariffs, abundant and low-cost credit, a flexible labor market, low tax rates on presumed rent, and direct subsidies and public investment in infrastructure. The comparative advantage was consolidated through the outward development policy, external trade facilitation, export promotion by PROCHILE, and agreements within GATT to obtain reciprocity against protectionist measures.

Research and technology

Research on fruit was initiated by the *Sociedad Nacional de Agricultura* (SNA) and was reinforced by several universities and the *Instituto Nacional de Investigación Agropecuaria* (INIA) in the 1960s. Special mention should be made of the program between the *Universidad de Chile* and the University of California, which trained the professionals who produced CORFO's Fruit Development Plan in 1968.

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Fruit research in the 1970s was directed toward introduction and adaptation of species and varieties; development of new systems for plant handling; introduction of rooting patterns; management of pests and diseases; quarantine problems; and pesticide residual detection. Other indicators of research orientation were subjects addressed by graduate theses at the national universities, where the issues were production, postharvest, agrochemicals, agribusiness, phytosanitation, economics, and propagation.

The technology generated and adapted in the research centers was adapted by the producers thanks to public and private efforts. INIA was basically devoted to developing and promoting species and varieties for the outermost areas of the country, providing fruit producers with new alternatives and production techniques and management, and training agricultural engineers and technicians.

From 1976, *Fundación Chile*, with state and International Telegraph and Telephone funds, participated in diffusion of new technology by means of seminars and publications. Fruit experts from California and New Zealand participated in these seminars on production, postharvest, and agribusiness. The *Fundación* established a pilot plant with experimental lines, created firms and enterprises that were later handed over to the private sector with the respective technical assistance, and introduced new technologies such as frozen fruits, principally for blackberries and strawberries.

CORFO was the first institution with the idea that Chile should become a fruit exporting country and, with the Ministry of Agriculture, made in 1961 the first official land register on fruit. The Fruit Development Plan, which was later implemented, was based on that basic information. The plan stressed change in farm management, introduction of new varieties, and help for nurseries, packing, and freezing. The plan recognized that the infrastructure (cold, packing, agribusiness) was insufficient to manage large volumes, and the so-called Fruit Centrals were built. Between 1965 and 1979, 30 cold-storage plants, 30 packing plants, and 3 dehydrating plants were built with credit from CORFO. The institution continues to this day its policy of assistance to fruit through credit and research in the form of agreements with the *Universidad de Chile, Universidad Católica*, and the INIA.

Private sector research concentrated on the adaptation of foreign technology to domestic climatic conditions, with a special role for big enterprises. Technology came principally from California and New Zealand; examples are postharvest techniques such as fast cold, and remote-sensor and controlled-atmosphere cold chambers. On the production side, irrigation technology stands out, such as drop and microaspersor irrigation, harvest forecasts, high-

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density planting, and variety-species diversification. The *Asociación de Exportadores de Chile* (ASOEX) is concerned today with safeguarding fruit quality through a quality verification program and a laboratory to work on control of the Mediterranean fruit fly, which is Japan's basic requisite for entry of grapes to its territory.

Markets

Chilean fruits have been geared toward fresh fruit markets. Favorable conditions in these markets and the high competitivity achieved by Chilean producers has allowed a high level of growth in production and has furthered a great number of associated investments, such as roads, bridges, and communications in the public sector, and packing, cold-storage plants, and fruit fumigation rooms in the private sector. The fruit subsector stands out as one of the more dynamic of the economy and as an important development area and foreign revenue source.

High profitability has coincided with a great expansion in exports; thus, in 1987 fresh fruit represented 87% of agricultural exports and 10% of total exports. Factors contributing to this expansion are the unmet off-season demand in the USA and EEC, and the commercial efforts of producers and exporters, assisted by marketing action by PROCHILE.

Table grapes and apples together represented 79% of fresh fruit exports in 1987 and that share has been stable. The U.S. market has increased purchasing volume by 4.6 times during this period while the EEC market has increased by over 20 times. Although a greater rigidity in some markets may be observed for apples, its expansion is notable in Europe, USA, and the Far East. The best example of Chile's export effort is the penetration of the Japanese market in the late 1980s.

An important element in fruit producers' strategy has been the incorporation of new species and high variety differentiation. While in 1978 around 17 export species were registered, they exceeded 20 in 1986; the situation is clearer in the case of varieties exported, which went from 59 to 190 varieties. The risk-aversion commercial attitude of Chilean producers is demonstrated here through their offering of a more ample basket of fresh fruits. The variety expansion has brought with it a change in seasonality of sales; peak-times vary and the total sales period in each year is extended. In table grapes the external sales period went from 5 months to almost 10 months, and similar situations are observed in apples, pears, peaches, nectarine, and plums.

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The important increase in external sales volume, especially to the USA, has been accompanied by moderate price decreases in destination markets. However, sales values have not deteriorated, but on the contrary, a sustained trend is observed. European currency revaluation has favored a deterioration, but prices have responded to aspects of quality more than to volume; the adjustment in variety no doubt played an important role.

Organization of producers and exporters and enterprise development

Organization of fruit producers

Organization of agricultural entrepreneurs in Chile has a long history. The most important institution, the SNA, gets interested in fruit when relevant. Another related institution is the ASOEX, in existence since the 1970s. Given the subsector development and the weak negotiating position of the producers, the *Federación de Productores de Frutas* (FEDEFRUTA) was born in 1985. FEDEFRUTA looked for an official relationship with the domestic and international institutions and its objectives were to improve market information and fruit promotion abroad, and to design a private fruit development program centered on quality. FEDEFRUTA started with 128 producers and today has over 1100.

Organization of exporters

This period has also been characterized by better organization of exporting agents who, with public sector help, have overcome free trade barriers in some markets. Export enterprises have been capable of managing much greater volumes of exported fruit, without restricting entry of new firms. On the contrary, the concentration of firms that existed at the beginning of the 1980s has been lowered by a proliferation of small- and medium-sized enterprises. A group of foreign firms entered the business in the early 1980s and contributed effectively to external sales expansion.

ASOEX is the institution representing fruit exporters. The board of directors is made up of 14 enterprises, which account for 90% of export earnings. Its principal actions have been to defend domestic exports from competition by other countries of the southern hemisphere and to confront protectionist measures by consuming countries. Thus, in the USA, ASOEX brought about the formation of the Chilean fruit importers association, coordinated advertising of fresh fruits, cooperated in opening a Chilean consulate in Philadelphia—principal destination port of Chilean fruit—participated with the

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Food and Drug Administration and the Environment Protection Agency in a study on sulphur anhydride generators —used to conserve fruit during transport. ASOEX participated directly in the opening of the Japanese market through compliance with quality and sanitary requirements. In the EEC, it coordinated the position of the Chilean fruit sector in defining the import licenses of Chilean apples. It coordinates with the Ministers of Agriculture, Economy, Promotion and Reconstruction, Transport, and Communications, PROCHILE, and the National External Trade Commission. It has a technical department with projects on fruit quality verification, methyl bromide fumigation, and fruit pesticide residual control.

Since 1981 ASOEX has been concerned with quality norms for export fruit. ASOEX's specification techniques for pears, apples, and table grapes were used as the Official Chilean Norm for these three species. In 1985 ASOEX implemented an experimental program for fruit shipments that from 1986 was the basis of the Quality Verification Program. The program had a national scope with only one parameter, maturity, affecting four varieties of table grapes: Thompson seedless, Flame seedless, Perlette, and Ribier. The program was later extended in terms of parameters and markets: berry diameter evaluation and grapes destined for Japan, Europe, and the USA were included. During the period 1987-88, the quality program established norms with respect to the caliber of plums and nectarines for export to the USA.

The Official Chilean Norm No. 1549 established the terminology and the general requisites for fruit and vegetables. The norm included compliance requirements for fruit; pesticide tolerances; packing conditions; and printed labels with information on quality, variety, caliber, packing date, and net content. The technical norms and quality regulation of the Chilean Official Norm apply to persimmons, cherries, plums, apricots, peaches, nectarines, strawberries, kiwis, apples, lemons, melons, pears, prickly pears, and table grapes.

Fruit producers

From the technical point of view, considering climate-soil resources, there is not one Chilean fruit sector but an aggregate of distinct fruit regions that differ, even within valleys of a same region, due to the great latitudinal extension of the country. From the entrepreneurial point of view, there are, however, similar situations that allow a degree of generalization. The entrepreneurs have a high school education, they are middle-aged (40-50 years old), are involved in other activities besides fruit, a high percentage has entrepreneurial experience in another sector (mining, industry, trade), most are newcomers to the business, they have a great capacity to make use of

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technologies and foreign experiences, they consider themselves in permanent training on technological aspects and management, they have knowledge of macroeconomic policies such as exchange rate and labor policies, they agree with the liberal economic policy applied since 1974, and they have a cautious attitude toward credit risks. In addition, they participate in associations, their desire to stay in business is associated directly with its profitability, they do not have the attachment of traditional farmers to the activity, they are democratic entrepreneurs who make subordinates participate, they look for creativity in personnel, they believe in delegating production functions, but not financial or commercial functions.

Fruit enterprises

Available technology is good and is provided by enterprises and groups of specialists. The financial resources come from the financial system, and the service of refrigeration and packing is in large part provided by the exporter. Enterprises have enough machinery, communications are good, and almost all have radios and cellular telephones.

Transport service for inputs and products is contracted. In terms of organization, division of labor is by product, the enterprise does not consider one department more important than others but that all act within a system. Enterprises have a high degree of delegation and controlled targets, almost all have financial budget control, most incorporate annual records, supervisor/ personnel relations are adequate, and executives coordinate by means of a plan. The surveyed enterprises had a sufficient level of personnel management, low numbers of resignations and firings, and temporary personnel who would return year after year. Executives are selected by reference and there is room for promotion, there is good internal communication, and decision-making is of a "programmed" type.

Marketing enterprises

Management efficiency of these units was evaluated by the following indicators: export volume, geographical scope, price level, and negotiation with producers.

The number of fresh fruit exporting enterprises has greatly increased while the exported volume has increased by 262%. That situation runs parallel to a low concentration in exports by enterprises. This is favorable to fruit producers since the situation allows a greater number of options, improving their bargaining position. The efficiency of the exporting enterprises is expressed in their capability of reaching a greater number of countries: they

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presently export successfully to the Near and Far East, besides expanding sales to Europe and North America. That efficiency is also expressed in negotiating ability, reflected in the fact that while sales volumes have increased greatly, prices have descended by a noticeably lower proportion.

Exporting enterprises have built a great number of conditioning and storage installations in all national fruit regions, supplying a sure and efficient service to fruit management after harvest. In their negotiations with fruit producers, the enterprises use different modalities such as production contracts with free consignation, production contracts with guaranteed minimum price, and medium-run production contracts.

Modernization of vegetables in Mexico

Vegetables for export in Mexico

Vegetable exports are very important in Mexico's agricultural trade, providing 44% of foreign exchange inflows from the agricultural sector in 1987-89. However, harvested area of these vegetables reached 273 thousand hectares, representing only 1.4% of the total harvested area.

Tomato, onion, pumpkin, melon, and watermelon make up more than 70% of the harvested area of vegetables, which shows the high concentration in a small number of products. On the other hand, production of tomato, onion, cucumber, melon, and watermelon represent more than 80% of total volume. Tomato is the principal product, with an average share of 45%, increasing in the 1970-85 period from 923 thousand tons to 1.6 million tons. The destined-for-export vegetable production was on average 32% of total production and the rest was absorbed by the internal market. The volume of external sales of vegetables for export increased by 136% in 1970-87, growing from 757 thousand to 1.8 million tons. Export value increased significantly by 270% in the period, with strong increases in 1977, 1983, and 1986 and a major fall in 1982.

There exists an inverse relation between volume and value of exports, which allows appreciation of the great vulnerability in international prices of these products. Thus, in 1986 a volume of 1.4 million tons meant foreign exchange inflows of 655 million dollars, while in 1987, in spite of a 400 thousand ton increase in export volume, its value diminished to 601 million dollars.

Some considerations follow from the analysis: first, the generation of a high share of agricultural exports from only a small percentage of area places this

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activity at a very high profitability level in relation to other crops. Second, the evolution of output volume and harvested area shows that the production has increased mainly through higher productivity (Figure 4). Yields have increased throughout the period: in 1970 average yield was 10.7 tons/ha while in 1980 it was 14.6 tons/ha. Third, a high concentration of production and export in a few crops is observed.

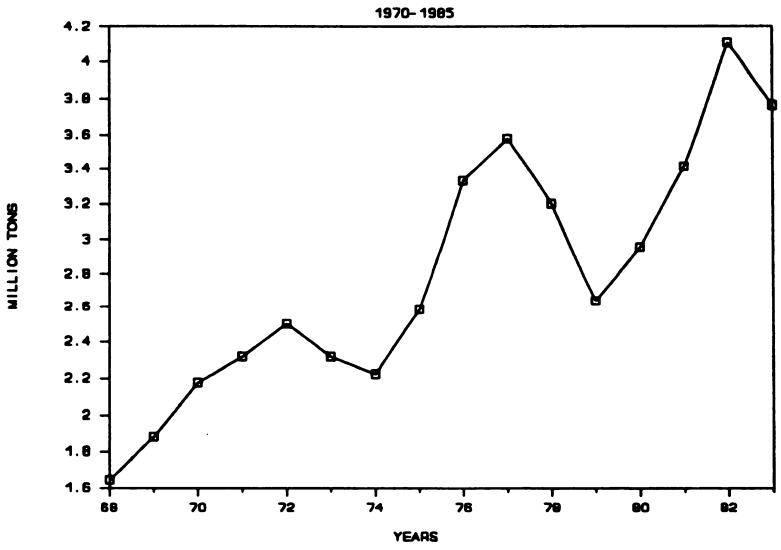

Figure 4. Vegetable production in Mexico.

It is to be noted that the great investments in the state of Sinaloa (northeastern Mexico) brought about important changes in employment and induced transformation of agriculture into a highly technical and diversified commercial agriculture. There, the vegetable activity has found optimum conditions for development, using only irrigation land, mechanization and modern and efficient production techniques, and basic inputs (domestic and imported) such as fertilizers, pesticides, and improved seeds. For all this, yields are much higher than national averages, transforming Sinaloa State into the most important producer of tomato, cucumber, pumpkin, runner bean, aubergine, pea, melon, and watermelon.

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Macro and sectorial economic policies

Up until 1972 the agriculture of vegetables for export had a rapid growth in technology and increase in yields, but faced a pro-industry economic policy and exchange overvaluation.

In 1972-80 the search for food self-sufficiency weakened agricultural exports. This policy increased internal prices for agriculture, incremented direct participation by the state, and provided assistance in input supply, credit, insurance, marketing, and investments in irrigation. However, the response of producers was insufficient, imports grew, and self-sufficiency in basic grains was lost. Public investment in agriculture grew but it could not offset the stagnation of private investment. Rural society continued its transformation process into an urban society, it built an economic infrastructure, it continued advancement toward an intermediate level of industrial development, and it absorbed some characteristic expressions of modernization. A new way of channelling resources towards agriculture emerged at the end of the 1970s in the form of subsidies through the national system of agricultural credit: explicit subsidies through interest rates and insurance costs, and implicit subsidies through operation costs.

The 1982 crisis brought a new situation, characterized by retraction of per capita income, deterioration of the real wage, and accumulated external debt. The new policy froze the prices of the principal agricultural products, increased the financial resources directed toward the sector as compensation, created the *Sistema Alimentario Mexicano* (SAM) that tried to raise guaranteed prices, increased the public investment, and lowered the export taxes. The persistent overvaluation of the Mexican peso created unfavorable conditions for production and export. The crisis brought to light the existing disequilibrium and agricultural development lost its dynamics. Society was unable to absorb the labor force, unemployment increased, and the financial trends affected on the price level.

The new government defined a stabilization policy that included fiscal adjustments, increases in public sector prices, decreases in subsidies to the agricultural sector, export promotion and trade balance equilibrium, elimination of exchange overvaluation, and liberalization of external trade. With the admission of Mexico to GATT, tariffs were substituted for import licenses and a 50% maximum tariff was strengthed. Finally, the wage policy was key in the strategy against inflation and produced a very large fall in the real wage with accompanying great social unrest. The real wage lost 45% of its buying power and, in 1986, it was equivalent to 87% of that of 1970. The income concentration, which was already very acute at the beginning of the

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decade, increased even more in 1981-86, wage participation in national income decreased from 45% to 32%, and inflation reached a record three-digit level in 1986. Private and public investment registered very low levels. The crisis affected equally the rural population, and the wage component of *campesino* income was also decreased. These circumstances joined unfavorable climatic conditions and the unfavorable evolution of the guaranteed prices to reinforce the spread of the crisis in rural areas.

Exchange rate policy

From 1982 the exchange rate policy had the objective of promoting exports through an attractive exchange level that acted as stimulus to external sales. This policy benefited vegetable exports: in 1982-84 exports increased by 16% annually and in 1985-87 the increase was almost 60% per year. From 1982 to 1987 exports went from US$230 to 601 million. Note that in the first period, 1982-84, the exchange rate was controlled and the distortions with respect to the free market rate were still very big.

However, if the U.S. import statistics were analyzed, it would be clear that export sales of vegetables were much larger than those recorded by Mexican exporters. This means that the exchange rate controls and the implied distortions propitiated subvaluation of export. A study by the *Unión Nacional de Productores de Hortalizas* (UNPH) in 1983 revealed that the expenses and sales commissions of exporters, which represent unreported foreign exchange, increased strongly during these years. When the distortions in the exchange rate disappeared in 1985, official exports increased substantially.

Tax policy

Taxes affecting the subsector were the import tax on inputs and the export tax. There exist other federal taxes that do not apply to agricultural producers, such as the income tax, value-added tax, and diverse state and municipal taxes.

Exports of vegetables have been taxed during different periods. The fiscal revenues derived from vegetable exports for the period 1970-88 reached US$350 million, averaging US$22 million annually. The export tax rates had a decreasing trend.

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Subsidies

In 1970-82, the policy was one of compensation to the agricultural sector by means of subsidies and public sector prices. The most important subsidies were the financial subsidy, and those on fertilizers, fuels, and water.

In 1982-88, the new stabilization policy included a substantial reduction in subsidies. Hikes in agricultural interest rates were initiated in 1983, leveling them with bank costs in 1985. From 1985, the subsidy on fertilizer prices was annulled and price increases on electricity and fuels were in effect.

Financial policy

Policy objectives during the 1970-87 period were increasing agricultural production, capitalizing production units, helping small agricultural producers, and promoting basic products.

Credits to Mexican agriculture came from the development banks and from the commercial banks. Bank credit figures show that the production sector most hurt by credit contraction in the 1980s was agriculture. Agricultural credit decreased by 40% in constant 1970 pesos between 1982 and 1986; in 1981 the sector obtained 10.8% of total credit and in 1986 only 4.5%.

Undoubtedly, it has been objective of the federal government to promote agricultural production, especially to achieve food self-sufficiency in basic products (maize, beans, soybeans). Although this self-sufficiency need not run totally contrary to Mexico's competition in external markets with products such as vegetables, which have high economic density and comparative advantages, vegetable producers have faced a situation of expensive and scarce credit for production and export.

Financing of agricultural exports has been reduced in the period 1977-82 from 1103 million to 804 million 1978 pesos, and the share of the total has been only 7.2%. The FIRA *(Fideicomisos Instituidos en Relación con la Reforma Agraria)* credit for exports has concentrated on coffee, cotton, bovines, porcine, and vegetables; approximately 80% went for coffee, the share of vegetables being minimal.

The *Banco Nacional de Comercio Exterior* mainly handled two financing lines: export and preexport. From the first line, among vegetables and fruits, credit was offered only to strawberries, channeling most resources to coffee and cotton. Up until 1982, preexport credits were directed toward financing

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storage and working capital; almost 90% of preexport resources up until 1982 had been channeled to cotton and coffee, and in lesser amounts to cocoa, tobacco, honey, and peas. In 1983-87, exportable agricultural production was given new impulse, especially cotton, cocoa, concentrated juices, and packed vegetables. A new credit line was opened for external sales to nontraditional markets and some vegetables were helped through this action (cucumber, chili pepper, garlic, broccoli, cauliflower, onion, pumpkin).

Vegetable exports have grown and strengthened thanks to foreign capital. Mexican vegetable producers have been considered internally as high-income producers, which has severely restricted bank financing. This situation encouraged producers to commit their output to foreign distributors, moving them into financing and commercial dependency.

Another way of financing vegetable production is the so-called "Agriculture by Contract" system used by the big agribusiness firms that contract the producer, defining the type and quality of the product. A contract establishes the firm's commitment to supply the producer credit and technical assistance, and to buy his output.

Technological policy

The basic thrust of Mexico's technological development policy has been the search for higher yields in basic products. Research and dissemination have varied considerably. First, techniques for improved seeds and low input requirements were developed, but in later stages, highly intensive inputs and capital technologies were searched for. Technological development also implied different uses of production factors: while peasant agriculture used techniques demanding a greater use of family labor, agricultural firms intensified use of capital and inputs, obtaining a greater productivity from labor and land.

Technological research in official institutions was dedicated exclusively to achieving greater productivity from basic grains in response to food self-sufficiency principles, and the federal government directed resources to research, technical assistance, and training for grain producers.

Vegetable technology has remained in the hands of producers' own organizations; the State has made only scant efforts with tomato and onion. Notwithstanding, export agriculture has been able to incorporate technical innovations, use improved seeds and agrochemicals, and achieve the highest degree of mechanization.

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Inputs

The process of modernization was initiated through investments in irrigation infrastructure. It implied an intensive use of inputs in the production process, and a change toward greater articulation with the economic process at the national level.

Vegetable producers have developed a production process significantly different from that of traditional agriculture: they produce typically exportable products and use irrigation, mechanization, and modern inputs. They benefited the most from the input subsidy policy, since they worked with these modern inputs.

However, intensive input use has not implied parallel increases in agricultural production. This is explained by at least two factors: a subsidy policy that did not promote production but only provided partial compensation for falling real agricultural prices; and the misuse of inputs due to lack of adequate training.

Research and adaptation of technology

The greatest technological advancement in the vegetable subsector was found in natural resource management, inputs, genetic advances, and use of pesticides.

Regarding harnessing and handling of water, technology has been oriented toward water control and conduction toward reservoir storage for later use in planted areas. For this purpose, harnessing and storage borders, lister furrows, and rain harnessing microbasins were built.

Regarding soil and water conservation, the technology focused on controlling drainage. The methods employed were wide-narrow base terraces, adding manure to improve humidity retention by soil, use of green fertilizers, sorting crops in alternate strips, and use of plastics to collect water and avoid evaporation.

Research on vegetables and fruit has concentrated on citrus, banana, mango, avocado, papaya, pineapple, guava, tomato, chili, watermelon, melon, garlic, onion and pumpkin. Research addressed genetic improvement technology, improved yields, soil fertility, harvest and postharvest, and plagues. Assistance has been given by the *Instituto Nacional de Investigación Forestal y Agrícola* (INIFAP). The private sector has made some efforts in research and

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technical development promotion through the *Confederación Nacional de Productores de Hortalizas* (UNPH).

The INIFAP reinforced work on plagues and disease control, hybrid development, virus-resistant varieties, and genetic improvement. Also, assistance was given for adapting plastic-use technology, microtunnels, and solarium technology. Regarding biotechnology research in Mexico, it is estimated that there are over 200 research projects in 33 public centers and universities and in three private centers.

Investment as factor in technical progress

Agricultural sector investment in 1960-84 concentrated on livestock and machinery; both categories made up over 80% of sector investment although machinery became the most important line. Technological change investments thus concentrated on machinery and implements.

It is also important to underline the technological advance regarding plant sanitation. In order to reduce the phytosanitary risk, programs have been established to inspect, diagnose, and control plagues and diseases that may be introduced into the country. Achievements include the quarantine export treatment, improving and updating of the pesticides manual, and the eradication of the Mediterranean fruit fly from the national territory (the principal sanitary limitation on Mexican vegetable exports). Additionally, acceptable chemical procedures for specific plague control have been strengthened. Finally, Sonora State was declared a plague-free zone, especially in terms of the Mediterranean fruit fly, eliminating the need for fumigating vegetables for export.

External markets

The USA and the other developed countries changed their consumption patterns in the 1980s, substituting natural products for processed foods, and opening ample possibilities for Mexico to increase sales of frozen legumes, vegetables, and fruits. Accordingly, 90% of Mexican vegetable sales have been to the U.S. market, 6% to the Canadian market, and the rest to markets in Europe and Japan. Because of nearness and buying capacity, it is expected that the USA will continue to be the principal market for Mexico.

The Canadian market is also important for Mexico; however, U.S. broker intervention as a triangulating element limits Mexican possibilities in the

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Canadian market. In addition, there are other problems associated with the Canadian quality norm that conflict with the U.S.-Mexico border review, and the high air freight costs. Exports have not done well in the European market, the problem being lack of knowledge of that market. The Western European market represents 360 million people, 320 million in the European Economic Community alone, with a high income level. It constitutes a great market but with strong competition from ex-colonies and Israel.

The Mexican vegetable producer has allocated great resources and effort to the production phase and has left distributors and brokers in charge of marketing. For many producers, the external marketing process is a black box, the producer ignores what happens and only gets liquidations for his shipments.

Marketing of Mexican vegetables varies a lot. There is the integrated way in which the distributor and the producer together decide the varieties, the timing, the packing, the product presentation, and the joint-risk financing. There is also the other way in which the producer decides independently what to produce, and at harvest time sends his or her output to the market, leaving her or himself at the mercy of market conditions and brokers.

Lack of commercial innovation in Mexican vegetable marketing has encouraged competition by other producing countries with better products and commercial practices. The Mexican producer already knows that the competition will continue making efforts to displace him or her, that the price differential between other suppliers and Mexico may disappear, that Florida's frosts are not benefiting her or him as before, that new providers are capturing markets, and that he or she is being constantly threatened by compensatory duties, by unfavorable changes in U.S. legislation, and by discrediting campaigns over quality and toxic residues. Furthermore, U.S. tariffs on Mexican imports have been at times outrageously high: 35% ad valorem on cantaloupe, 20% on watermelon, and 25% on broccoli. However, the possibilities of the U.S. market are still enormous since Mexican exports produce off-season with respect to domestic production, and they may be helped by current trade negotiations (NAFTA).

Quality control

Quality norms in Mexico are compulsory in very few cases and they function as an element in price determination. The USA, on the other hand, through the American Marketing Service (AMS) of the Department of Agriculture (USDA), applies a compulsory mechanism to products that are

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considered to be necessary to protect, which is known as "marketing orders." This measure guards the economic interests of a certain production sector of the U.S. economy and may impact negatively on imports.

It is clear that there should be quality norms and requirements to protect consumer health and well-being, such as pesticide residual limits, brands, and content declaration. However, administrative norms in U.S. legislation establish trade barriers disguised as phytosanitary norms, through arbitrary changes in quality norms, size, branding, tolerances, or inspection systems. This constitutes a constant threat to development of Mexican vegetable exports.

Producer organizations

Entrepreneurial agriculture in Mexico specialized gradually in labor-intensive and high-profit crops. This agriculture is located in the northern part of the country, within the states with greatest capitalist development and great labor demand: Sinaloa, Sonora, Tamaulipas, Baja California Norte, Coahuila, and Chihuahua. In those regions, agricultural entrepreneur organizations are stronger and aim to promote and develop their economic activities and negotiate adequate policy conditions. Today, these organizations have assumed a national character, their functions are diverse (political, corporative, and service), and they represent local, regional, and state interests.

The most representative organization of exportable vegetable producers is the *Unión Nacional de Productores de Hortalizas* (UNPH). This organization grouped 24 regional agricultural unions and 238 local agricultural associations in 1987. It has its own export regulations, which implies that its members are subject to obligations and sanctions and to the application of minimum norms regarding quality, packing, inspection, and marketing.

The *Confederación de Asociaciones Agrícolas de Sinaloa* (CAADES) may be considered the prototype of a regional organization. It groups nine associations of regional character and has great influence in actions and policies of the agricultural sector at the local level. Together with government representatives, it participates in the permanent commission for research and agricultural experimentation and in the phytosanitary protection of Sinaloa State.

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Modernization of flowers in Colombia

The flower subsector

Flowers in Colombia is a successful case of a modern production activity within the agricultural sector that develops backward and forward linkages and that provides evidence of a new entrepreneurial class that reacts to market signals and opportunities through massive investment. Expansion of the activity in Colombia created some international trade problems derived from protectionism in developed markets, which offers both challenges for future growth and lessons for other experiences.

In 1965, the North American Edgar Wells foresaw the possibility of cultivating flowers in Bogota's Savanna, given its ecological and economic conditions: altitude between 2000-3000 meters, temperature between 13°-26°C, adequate light and humidity, proximity to the airport, appropriate input supply (domestic or imported), and ample labor supply, especially female. Greenhouse production technology and cold room conservation were brought from abroad and adapted to local climatic conditions.

As a luxury good, it was natural that the principal market would be the developed countries, especially the USA because of its nearness. High product perishability made airplanes the only viable transport mode. The idea was sold to the local bourgeoisie and foreign investors, and a critical mass of investment-production and institutional support was developed both in Colombia and in the principal foreign destination, Miami. The *Asociación de Floricultores* (ASOCOFLORES) was then established as a strong association of producers that brought government attention, and organized and defended their commercial and legal interest in external markets.

The Colombian flower economy had a first stage of development that ran up to 1973, when output and export grew very rapidly, reaching 5.6 thousand tons and US$9.7 million respectively. An expansion period followed, until 1980, when production grew at a 26% annual rate and export almost 33%, reaching 37.4 thousand tons and US$101.4 million. A more stable growth phase followed next, and continues to the present, with production growing at an annual average rate of 11.8%, reaching 87 thousand tons, and exports expanding 8.3% annually, recording US$204.8 million in 1983 (Figure 5).

The types of flowers most produced and exported are carnations (41% of total export value in 1987), roses (22%), pompons (19%) and others such as chrysanthemums, daisies, mini carnations, estatice, gypsophila, gerbera, astromelia, irises, and orchids. The productive life of a carnation cutting is

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approximately two years and that of a rose cutting up to eight years. The first cut or planting occurs at six to seven months of life and it is repeated every three to six months, with peaks approximately every six months. Carnation planting occurs principally in the months of June, August, and October, so that harvest coincides with the consumption peaks in consumer markets, a procedure that is repeated for other types of flowers.

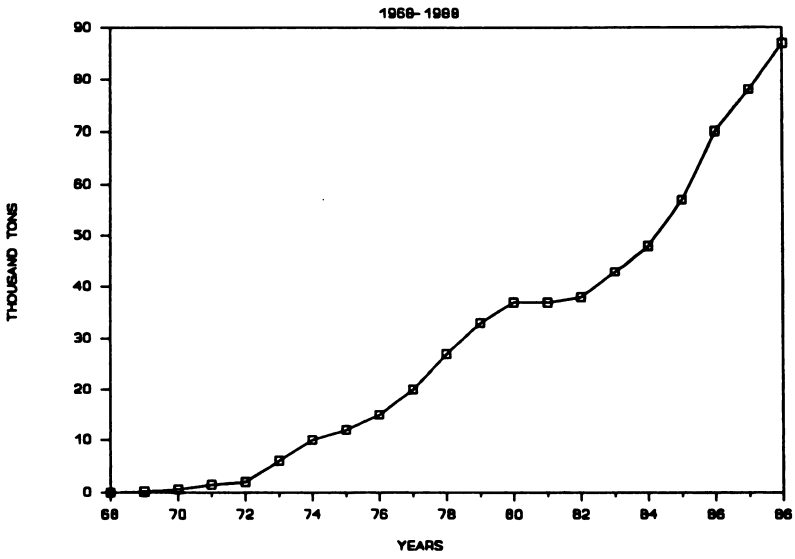

Figure 5. Flower production in Colombia.

More than 200 firms cultivate approximately 2000 hectares of flowers in Colombia, the great majority located in Bogota's Savanna (90% of production), and in the zones of Rionegro, Ceja, Antioquia, and Piendamo. FLORAMERICA, the largest firm, with Colombian capital, cultivates nearly 200 hectares in diverse places of the country with different types of flowers. The average firm has 6-8 hectares and the minimum economically profitable scale seems to be 3-4 hectares.

Production costs are high and technology is complex. Greenhouses, cuttings, irrigation systems, chemicals, labor, packing, and cold conservation systems are needed. Fixed investment is estimated at US$100 thousand/ha, which includes greenhouse construction, cold equipment, and irrigation wells. Variable costs are from US$120 thousand to 240 thousand/ha annually, including labor for plant handling (50%), cost and planting of cuttings (20%), and postharvest costs (18%), principally packing in carton boxes. Productivity

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is about 2.4 million carnations/ha, 500 thousand bunches of pompons/ha, and 1.3 million roses or chrysanthemums/ha.

Flower crops employ between 16 laborers (pompons and roses) to 30 laborers (carnations) yearly per hectare. The subsector employs nearly 65 thousand workers, principally women, who receive wages of US$65 million annually.

Greenhouse and equipment technology and irrigation techniques have been improved locally. The demand for equipment, materials, and technology has allowed local development of an industry of goods and services. The basic research allowed domestic development of good quality cuttings; recently Dutch firms associated with local firms to develop bulbs and mother-plant cultivation.

The external market

The principal market is the USA because of its proximity to Colombia, followed far behind by the EEC. The bigger firms, some of foreign-Colombian mixed capital, have direct commercial connections to the USA. Small firms, on the other hand, operate by means of exporting agents, some of whom are linked to U.S. importers and wholesalers located in Miami; the usual sales commission is near 15%.

Every buyer market has consumption peaks during special holidays. In the USA, these dates are St. Valentine's Day (February 14), St. Patrick's Day (March 7), Easter (variable), Mother's Day (second Sunday of May) and Christmas (December 25). Wholesale prices follow demand seasons, oscillating from US$1/kg in July to US$10/kg in February/March. However, the U.S. market is changing rapidly and the off-peak demand is growing significantly.

A packed box for export weighs between 12 and 18 kg, depending on the flower. Every 15 kg box contains 600 carnations in 50-60 branches of 10-12 sprouts, wrapped in plastic and conserved against excess humidity. A Jumbo 747 cargo plane transports up to 6000 boxes of carnations. In export peaks, 20-30 flights daily leave Bogota with flowers, and the normal flow is 5-6 flights. Air freights on average are to Miami US$0.65/kg, to London US$1.86/kg, and to Tokyo US$3.25/kg. Freight costs are an important part of the CIF price and transport cost is thus a limiting barrier for Colombian flowers in the European and Japanese markets.

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Colombia is second in the world in terms of flower exports, trailing only Holland. The European market, besides having more competitors, is more demanding (phytosanitary certification) and more protected, with 24% tariff in summer and 17% in winter over CIF prices. The natural market of Colombia is the USA and Canada, so the size of the U.S. market and its protectionist trends will limit future expansion of Colombian flowers, even if diversification efforts lead to the conquering of markets such as Japan and Switzerland. International competition seems to be increasing lately, notably from Israel and Spain, who have better conditions in the EEC market, and from Thailand, with better access to Japan. However, the world market shows expansion although prices have been decreasing since 1982.

The U.S. market is more accessible and less protected, with an 8% tariff on FOB prices. Notwithstanding, the growing Colombian penetration has already provoked protectionist reactions of U.S. producers. Thus, the USA has applied the following norms to Colombian exports: GATT Safeguard Clause against all imported flowers in 1977 and against Colombia specifically in 1979; Compensatory Duties, threatening to charge between 8.9% and 3.5% FOB in 1982; the Antidumping law with an 8.7% tax in 1986, later reduced to 4.4%. The legal and lobbying costs of ASOCOLFLORES in USA reach US$2 million yearly, money that could be used, together with contributions from U.S. flower producers, to promote consumption, with better results for both parties.

However, Colombia continues to benefit from the General System of Preferences of the EEC for carnations and of the USA for all flowers. With the USA there is an agreement by which flower producers do not have total access to Colombian export subsidies.

Policies

Colombian flower production did have specific government help at the beginning, but only after a critical mass of investment, production, and export had been created. Then, a Department of Floriculture within the Faculty of Agronomy of the *Universidad Nacional* was created, and basic and applied research was promoted, principally regarding production of cuttings and new varieties. To this first nucleus, large firms with their own groups of researchers were added later. Afterwards, the *Servicio Nacional de Aprendizaje* (SENA) got involved with training programs for semispecialized labor and management.

PROEXPO (*Promoción de Exportaciones*) started providing credit from 1970 for fixed investment and working capital. From 1972 to 1982, PROEXPO

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financed working capital up to 90% of export value on a six-month term (1972-78) and two-year term (1979) at a 19% annual rate (average bank rate in 1983 was 36% annually). For investment capital, PROEXPO started to provide credit in 1974 for 2-6 year terms at variable rates, with a minimum 25%.

Flowers also benefited from export tax incentives, such as the CAT (Tax Credit Certificate), CERT (Tax Reimbursement Certificate), and *Plan Vallejo*.

Plan Vallejo was the first stimulus for operation and consisted of exemptions from import licenses, import deposits, and import tariffs on raw materials, intermediate products, and equipment used in any production destined to export. By facilitating and making imported input cheap, the plan made the production of exportables viable, reducing costs and providing international competitivity. This allowed large-scale commercial production of flowers which, at the initial stages, was very dependent on equipment, machinery, and imported inputs, such as plastics, cuttings, fertilizers, pesticides, compressors, and tubes. Today the plan is not so important, because demand for those inputs created an impulse for domestic production, which adapted the technology embodied in imports. Presently, in accordance with the Agreement of Suspension of Compensatory Duties with the USA, Colombian flowers do not benefit from *Plan Vallejo*.

CATs were tax-exempt negotiable titles received by exporters as a percentage of external sales. They were fixed initially at 15% of FOB value, but in 1974 that percentage was reduced and some criteria were added. In 1982, CATs were replaced by CERTs, a new incentive conceptualized as indirect tax reimbursements, so that they would be acceptable within GATT norms. CAT and CERT benefits for flower exports changed in response to protectionist pressures from the USA. Colombia eliminated the CERT for flower exports to the North American market in 1985 and fixed the incentive at 9% of FOB value for other markets.

In any case, the economy of flowers benefited from the export incentive that favored diversification and growth of minor exports. Decree 444 of 1967 eliminated the multiple exchange rates, promoting exports and marking the beginning of openness of the Colombian economy. That strategy was based not only on the above-mentioned incentives (PROEXPO, CAT, CERT, *Plan Vallejo*) but, more importantly, on a consistent policy of currency devaluation.

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Perspectives and problems

Growth of Colombian flower exports today has tended toward stabilization and has lost momentum because of specific limitations within its principal market (USA), such as saturation, competition, and protectionism. That perspective may change only if exports from the principal competitor (Holland) were to be drastically reduced, or if Colombia were to achieve a breakthrough that would mean a clearly new advantageous position in world supply, such as the creation and imposition of new species or varieties or a technological advance that would drastically reduce Colombian production costs.

However, there are still some options for reducing costs and increasing exportable production or profits, such as to reduce air freight costs; to build cold rooms and special terminals at Bogota and Miami airports; to reduce production costs of cuttings and mother plants; and to reduce import costs of packing cartons, fertilizers, insecticides, and greenhouse plastic.

One option is business expansion to other countries such as Costa Rica, Ecuador, or the Dominican Republic, taking advantage of the economic incentives that those countries give to production for export: lower input costs, imports, and labor, and easy access to the U.S. market. In fact, some Colombian firms are already following that road. Another option is association with U.S. producers for promotion and advertising in order to give impulse to sales in the USA market far beyond recent trends, which would diminish resistance of U.S. producers to Colombian competition.

Modernization of shrimp in Ecuador

Shrimp mariculture in Ecuador was developed beginning in the 1970s. The production area grew continuously from 12.6 thousand hectares in 1980 to 118.7 thousand in 1988. Shrimp production went from 4.5 thousand tons in 1975, to 10 thousand in 1980, and 65 thousand in 1988 (Figure 6). Most of that production was destined to external markets and exports grew from 2.2 thousand tons in 1975, to 8.1 thousand in 1980, and 52.5 thousand in 1988. Shrimp exports are today second in foreign exchange in Ecuador, preceded only by petroleum. Export value grew from US$14.2 million in 1975, to US$56.9 million in 1980 and US$387 million in 1988. Participation in total exports reached 18% in 1988.

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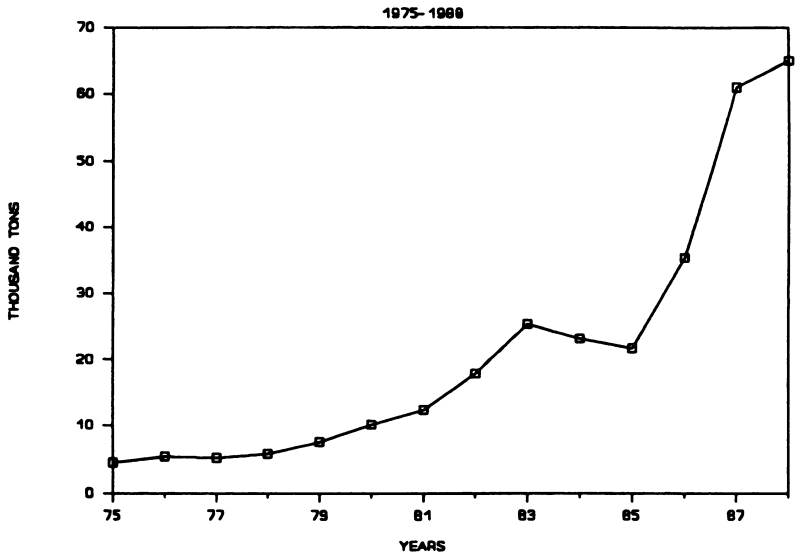

Figure 6. Shrimp production in Ecuador.

The external market

World production of shrimp comes from fishing and cultivation in ponds. In 1988, the fishing production was 1.55 million tons, while the cultivation in ponds reached 450 thousand tons. However, in the period 1985-88 fishing production increased by 29% while cultivation production had greater growth, 108%. The most important countries in shrimp fishing in 1985 were China and India (15% each), followed by Indonesia, Thailand, and Taiwan. The most important countries in shrimp cultivation in 1988 were China (22%), Ecuador (16%), Taiwan (11%), and Indonesia (11%). Ecuador is the second largest producer of pond shrimp, but its participation in fishing is very small; in all, Ecuador produces 4.6% of the world total in shrimp, even though it cultivates 16% of all pond shrimp.

World consumption of shrimp is around 2 million tons; the U.S. market consumes 320 thousand tons or 16% of the total, reaching a per capita consumption of 1.3 kg/year. The U.S. demand grew at an annual rate of 8.5% in 1980-88 and it is possible that in the future this consumption trend will be maintained. The USA is very dependent on imports, which represent 73% of the total demand, and the principal suppliers are Brazil, China, Ecuador, Mexico, Panama, Thailand, and Taiwan. Ecuador's sales to the U.S. market were 50 thousand tons in 1988.

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Japan is the other big world buyer since her production supplies only 16% of total demand. Shrimp per capita consumption in Japan is 1.8 kg/year and her principal suppliers are the Asian producing countries. West Europe satisfies its demand for cold-water species from the North Atlantic; the hot-water shrimp demand is limited today, but may become an important market in the future.

Marketing

Shrimp transport from the ponds to the packing plants is mainly by boat, given the lack of roads in Ecuador. The big shrimp farms have their own packing plants but the medium-sized and small producers sell their output to the packing plants. In the packing plants the shrimp is cleaned, beheaded, classified, packed, and frozen; from every 100 lbs. of shrimp, 65-70 lbs. of shrimp tails are obtained.

Transport of shrimp to the U.S. market is by ship, using 40-thousand-lb. wagons with freezing capacity. In the destination port the wagon is taken to the storage area without being disturbed at intermediate points. The trip takes six days from Ecuador to Miami and from there the cargo is transferred to New York and other markets.

The principal export market is the USA; until now Ecuadorian exports have entered that market without restrictions, complying with demanding quality norms. Exports are made by about 120 authorized private firms; the 14 largest firms represent 67% of exports in 1987.

The international price for shrimp grew significantly between 1950 and 1970 (500% in real terms). In recent years, the CIF price (Gulf price) has not fluctuated much, tending to an equilibrium, varying from US$10 to 12 thousand per ton. The U.S. price generally decreases in the summer-fall season, when fishing in the Gulf of Mexico increases.

Policies

The most important domestic policies that affected the development of the shrimp subsector in Ecuador were the exchange rate policy, the tax policy, and the credit policy.

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Exchange rate policy

Historically, there has been a trend in LAC countries and Ecuador, in particular, of following a policy of overvalued national currencies. This situation changed in the second part of the 1980s, even though real exchange rate increases in Ecuador were given a little later than in other countries of the region. This change favored exports in general, and shrimp exports in particular.

Fiscal policy

There was no export tax for shrimp in the period. Moreover, to partially compensate for overvaluation of the sucre, a Tax Credit Certificate for nontraditional exports was created in 1979, but was later suppressed in 1986.

Credit Policy

There has been easy access to financing from the Central Bank of Ecuador, the *Banco Nacional de Fomento*, the *Corporación Financiera Nacional*, and private banks, with preferential interest rates. The Central Bank operated through financial funds, production rediscounts, promotion bonds, advances on exports, export promotion funds, and integral project credit lines.

Production

The most important production factors affecting the development of the shrimp subsector in Ecuador were land, mangroves, water, labor, capital, larvae, and industrial inputs.

Land

In 1988, 119 thousand hectares of ponds were reported, but it was estimated that only 61 thousand were incorporated into production. These ponds have been built in state-property beach zones (granted under 10-year concessions) and also in agriculture-suitable highlands.

Mangroves

The mangrove, more than a plant or a forest, is an ecosystem with an enormous variety of fowl, mammals, reptiles, crustaceans, fungi, bacteria, and protozoa. The mangrove is a transition zone between land and sea, resists waves, holds sediments, diminishes the sea's erosive action, and creates soils

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with access to the ocean. CLIRSEN (Center for Outlining Resources with Remote Sensors) reported a mangrove reduction from 204 thousand hectares to 170 thousand hectares between 1969 and 1987, representing a 16% deforestation rate. Even though the use of mangroves for shrimp farms is not profitable in the long run, because only 75% of total production is recuperated and the soil acidifies, illegal mangrove deforestation continues at present.

Water

The Gulf of Guayaquil's water is of high quality for shrimp cultivation due to salinity, temperature, and pH, even though growing levels of insecticides, heavy metals, and sewage water residuals from Guayaquil and other cities have been found. Other factors that affect water quality are the "red tide," algae, and seaweeds, which diminish the oxygen content of the ponds.

Labor force

It was estimated that 64 thousand persons worked directly in shrimp activity in 1988. To that, laborers working in fishing and transport of larvae, who might reach 120 thousand people, must be added.

Capital goods

There existed in Ecuador in 1988, 1422 shrimp farms, 75 packing plants, 55 laboratories, and 120 exporting firms. Total investment was estimated at US$1600 million. Considering a total area of 120 thousand hectares, this total investment implies an average of US$13.8 thousand per hectare. Pond construction may represent 68% of total investment. Land moving machinery is important because the ponds must be rebuilt every four years. The pumping equipment is imported, although pipes are domestically produced. Given the incipient road infrastructure, fluvial transport is used for moving materials, equipment, inputs, and shrimp production.

Larvae

Capture of postlarvae or seeds is made along the whole Ecuadorian coast. Seeds are marketed by intermediate traders who buy larvae from fishers and transport them in oxygenated-seawater plastic tanks. The supply of natural larvae has lately lessened considerably, moving Ecuador toward a prohibition of exports and restrictions on capture. To overcome this problem, construction of laboratories has been promoted. However, larvae from laboratories is not totally accepted; many producers consider that the larvae are less vigorous, have a greater mortality rate, and grow at a lower rate.

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Balanced feed and fertilizers

Balanced feed complements the shrimp's natural diet, based on phytozooplankton. Knowledge of shrimp nutritional needs is insufficient at present, which affects the quality of balanced feed. Ponds are also fertilized with urea or phosphates to assure phytoplankton growth.

Technology and production systems

New technology, adopted by the shrimp farms of superior technical level, has been generated in Ecuador. In these farms, the water quality (temperature, turbidity, pH, oxygen) is controlled, fertilizers and balanced feed are used, and a permanent control of the biomass is made. But there still are many backward firms for which the shrimp mortality is 40%-60% and the yields are low.

There are three production systems in Ecuador: extensive, semiextensive, and semiintensive mariculture. The extensive system uses ponds with water and larvae from tides, density is low, feeding depends on natural phytoplankton, no fertilizers or balanced feed are used, and average yield is 600 lbs./ha. The semiextensive system uses designed ponds with areas up to 20 hectares, larvae from nurseries with controlled handling and that are later transferred to bigger ponds, pumps for water renovation, fertilizers, balanced feed, and the average yield is 1195 lbs./ha. The semiintensive system uses laboratory larvae in greater proportion, ponds receive high levels of supplementary feed, a permanent technical control is maintained, and average yield is 2200 lbs./ha.

Modernization of dairy-livestock in Costa Rica

Livestock development in Costa Rica

Until 1980, beef cattle production for the export market used to be an attractive investment for Central America as a whole, and for Costa Rica in particular. Commercial beef consumers in the USA (the hamburger chains) had seen Central America as an attractive nearby source of inexpensive meat. National and international interest groups, as a result, cooperated to create incentives for cattle expansion in Costa Rica and Central America for the past three decades.

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Livestock and ranching expansion have contributed to the process of conversion of tropical forest to pastures in Costa Rica. The deforestation-ranching process went smoothly up until the late 1970s, when the real price of beef decreased and the profitability of cattle ranching was lessened. The new situation implied a reorientation of livestock production from beef production to a dual-purpose activity of beef and milk. Accordingly, Costa Rica's beef exports increased steadily up until 1978, decreased substantially in 1980-83, and recuperated after that.

The process of modernization of dairy-livestock activities in Costa Rica should be seen within this context and should be interpreted as a reconversion of the traditional livestock activity to adapt to new market situations.

The dairy subsector in Costa Rica

Production, consumption, and productivity

Dairy production in Costa Rica has two independent stages: (1) production of fluid milk at the farm level where biological and phytosanitary factors are predominant. At this stage, two alternative processes coexist: production in milk-specialized livestock, and production in dual-purpose livestock (beef and milk); (2) processing of pasteurized milk and derivatives, where agribusiness capacity and technological innovation are important factors.

Milk production in Costa Rica is destined almost totally to domestic consumption. A self-sufficiency policy applied in the past decades implied a significant decrease in imports until now they are almost totally eliminated.

Milk is the second most important food commodity in per capita consumption (eggs being the first). Milk per capita consumption increased continuously until 1982, experienced a large decrease in 1982-83, and had a partial recovery in later years. The high consumption level has been in part a result of government programs of milk distribution implemented with donations and with local purchases by the government; the program suspended internal purchase from 1984, causing a fall in domestic consumption and an excess supply.

During 1967-80, milk production grew at an annual average rate of 5.6%. Between 1973-80, this growth was accompanied by high milk prices, increases in processing capacity, and an actual reduction of per-animal yield (explained by the start of dual-purpose livestock activity).

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A substantial fall in milk and dairy industry production happened in 1980-83, as a result of the contraction process of the economy. To offset the crisis, in 1982 the National Plan for Dairy Promotion was implemented, with the objective of developing the activity in lower zones of the country through new and more-efficient production processes, creation of gathering points near regions of production, and important increases in producer prices. The program contributed to growth that reached over 8% in 1984, through significant increase in yields and lowering of transport costs. That same year a milk oversupply was observed as a result of the greater output and the reduction of direct purchases of state programs. The excess supply has led to a search for external markets for dairy products.

The economic crisis of the 1980s brought with it the fall of agricultural real wages and increases in the cost of balanced feed, fertilizers, and pesticides. These changes in relative prices, together with the lessening of profitability of the milk activity, have led to a revision of technological practices in use.

Regarding perspectives for the 1990s, the dairy sector reached the limits of its growth possibilities in the internal market in 1985. In recent years, the efforts have been directed toward searching for new markets, and dairy products are already a dynamic component of nontraditional exports.

The prices of the principal world producers continue to be very much lower than Costa Rican prices. This results from greater production efficiency, but also reflects subsidies in those countries, which have created overproduction and dumping on the international market. It is important to note that once freight, insurance, and the moderate tariff are added, the difference between the domestic and the external price is notably reduced.

Some Central American countries have a domestic price for fluid milk above that of Costa Rica but existing tariffs limit those sales. Dairy exports in the last few years were destined to other nearby markets such as Panama, Colombia, the Dominican Republic, and the Caribbean.

Production structure and modernization at the agricultural level

The accelerated expansion of output clearly reflects a process of modernization in the subsector (Figure 7). This expansion also results from the significant increase in number of production units due to the conversion from beef livestock to dual-purpose livestock.

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During 1967-78 the productivity per animal was low compared to that in Europe and the USA, and there was no significant improvement. Only in the 1980s did productivity increase significantly due to technological improvements and technical assistance to producers. Today there is a high degree of mechanization in the milk-specialized production but technology is inefficient in dual-purpose production.

The Agricultural Censuses of 1973 and 1983 showed a significant increase in the number of livestock operations, from 44 to 52 thousand. The greatest increase was in milk and dual-purpose operations, which together represented only 20% in 1973 and reached 67% in 1983. The change was induced by the low profitability of beef livestock. Also, a significant increase in the number of heads of livestock in the country was reported, from 1.7 to 2.05 million between 1973 and 1983. The growth was greater in the dairy herd stock, with an increase in dairy cows and dual-purpose animals.

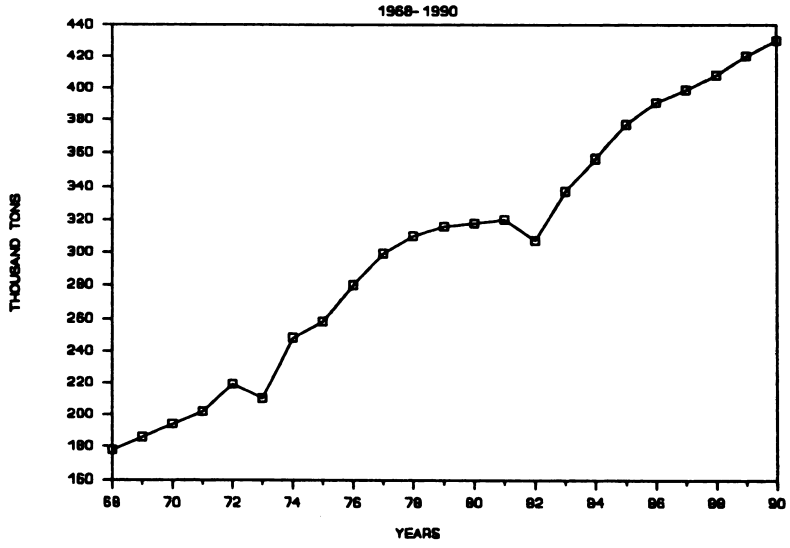

Figure 7. Milk production in Costa Rica.

Production structure and modernization in the dairy industry

A high level of vertical integration exists in the subsector, and it uses cooperative arrangements. With this system, the dairy industry guarantees itself the principal input at low cost and distributes the profits of the industry

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to its associates. However, 50% of fluid milk is not processed today due to lack of gathering points and to high transport costs to processing plants.

In contrast to the large number of milk producers, the dairy industry is concentrated in a few enterprises. Excess industrial capacity exists, which is paradoxical considering that 50% of fluid milk is not processed. The expansion of that capacity took place in the 1970s: in the early 1970s only one processing plant of large size was in operation, together with a number of small enterprises. Today, four large processing enterprises coexist (three of them cooperatives), and at the same time many small enterprises have proliferated. However, at the present time the biggest enterprise controls 80% of the market (*Cooperativa Dos Pinos*). The limiting factor for the expansion of the number of dairy enterprises is the size of the market. Domestic output is orientated toward internal consumption only, which for a long time made the operation of more than one processing firm impossible.

Pasteurized milk is not profitable for the industry given the domestic policy of fixing its price to the consumer. The industry has to offset these adverse effects by means of changes in the prices of derivatives. The dairy products market operates as a monopoly one with the *Cooperativa Dos Pinos* acting as price fixer.

The fixed costs for entering the market are high: the investment in plant and equipment is significant and results in a high financing burden for new enterprises. The high financing costs have also impeded the adoption of a more efficient technology. The technological diagnosis of the subsector clearly showed a high degree of equipment deterioration and obsolescence and inadequacy of technology.

The most recent aspect of modernization of the sector has been the diversification and incorporation of technological improvements that extend the durability of the products. These processes have been slow. Only in the 1980s were the new technical processes of ultra high temperature (U.H.T.) and of vacuum packing (Tetrabrick) adopted, which have improved the durability of the product and favored the expansion of exports, in particular to the countries of the Caribbean.

Economic policy and the dairy subsector

The economic situation and policy management have been conditioning factors of the modernization process and its prospects. During 1960-88 the evolution of the dairy sector reflected the economic evolution of the country

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with the same three periods: accelerated expansion until 1980, stagnation until 1983, and recovery until the present. The subsector has been influenced by the economic conditions and the economic and sectorial policies of each period.

The strong expansion of the dairy sector until 1980 is explained by the development of production zones near the consumption markets, which brought reduction of processing and transport costs; by introduction of new, appropriate production areas; by improvements in the industrial infrastructure through expanded capacity of processing plants; by changes in industrial production with marked expansion of derivatives; and by demand expansion through population growth and real income increases. During this period the sustained growth and the economic stability of the country clearly favored the modernization process, facilitating the incorporation of new technological processes.

The period 1980-83 clearly illustrates the nexus between the milk activity, the economic situation, and the management of economic policies. During these years the stagnation of the subsector was the result of the fall in real income of the population; the inflationary process caused by the monetary, exchange rate, and fiscal policy applied during the external debt crisis; the significant increase in production costs; and the fall of the real producer price as a result of the adjustment policy in the agricultural sector. The overall result was a fall in profitability, a reduction in the availability of credit, and a higher interest rate, which deteriorated milk operations and hurt the financial situation of the industry.

Since 1983, a recovery of the activity has taken place, reflected in the 7.5% annual increase in production levels. This expansion has been influenced by promotion of production through the Back-to-the-Land Program and the National Milk Production Program; the incorporation of new milk areas in low zones by transformation of beef livestock operations to dual-purpose (given the readjustment in milk price and the fall of the beef price); and improvements in producer prices.

Commercial policy

Imports of milk have not been subject to tariffs during the greater part of the period, although nontariff barriers have been applied. However, tariffs on inputs and raw materials for dairy products do exist. Two studies on effective protection indicate that in 1980 and in 1986, the implicit protection level on dairy products was over 50%, and the effective protection was around 30% (this adjustment is due to currency overvaluation that makes imports cheap).

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Import and export restrictions have been added to tariffs since 1979. These restrictions mean in practice a total prohibition on imports and donations of dairy products, which form part of a policy of self-sufficiency in milk. Since that year, previous authorization from the *Ministerio de Economía, Industria y Comercio* is required to import powdered milk and from the *Consejo Nacional de Producción* to import dairy products. Export licenses are also required, for the purpose of avoiding a situation in which a favorable international price would channel domestic production abroad without fulfilling the minimal internal consumption demand. However, the structural adjustment program is changing these regulations at present.

Exchange rate policy

Up to 1981, the exchange rate policy in Costa Rica was characterized by a currency overvaluation that led to artificially cheap imports. From 1982, a flexible exchange rate was adopted leading to currency undervaluation and increasing the cost of imports. This affected the input cost for the dairy sector, particularly fertilizers, pesticides, and the industry's import component. This contributed to a fall in profitability and further deterioration of milk operations. Even though the currency undervaluation made exports more attractive, the dairy sector in Costa Rica was not competitive at the international level. However, continuation of the flexible exchange policy gave incentives to exports and the dairy activity began an intensive search for external markets.

Price policy in the dairy sector

The price fixing policy has directly affected the subsector since 1973. Within this system, only fluid milk prices are regulated, leaving the prices of other dairy products to supply-and-demand conditions. Price fixing reflects clearly the stages of the production process: minimum producer prices are established (first stage) and then maximum consumer prices are fixed (second stage). This scheme regulates the margin going to processing.

Price controls were oriented toward promotion of production and protection of the consumer. The minimum producer price was highly influenced by the bargaining power of producers, processors, and government officials. Since 1979, the main objective has been to regulate consumer price increases, given raises in inputs and wages, without damaging the producer. Today, price fixing is based on estimated production costs of a "model farm" that reflects a desired degree of efficiency. From these model costs, a 30% margin to the

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producer is added, a 20% margin to the industry is given, and a 10% margin to retailers is assigned, thus reaching the maximum consumer price.

In 1978-79, the average price obtained by producers was above the minimum fixed price for fluid milk. However, since 1980 fixed prices were above average producer prices, which is explained by a milk supply increase coming from a shift to dual-purpose livestock.

Credit policy

The share of livestock in agricultural financing has varied between 24% and 36% in the past. Credit in real terms increased between 1975 and 1980, reaching a record in 1982-83, but with a reduction since 1984. Even though the livestock sector gets a significant proportion of credit in Costa Rica, the greater part of these resources is oriented to beef and dual-purpose operations and the proportion for milk activity is relatively low. This may be due to the fact that the activity generates a continuous flow of output and resources for milk producers. In addition, part of the costs of balanced feed, vitamins, fertilizers, and pesticides are financed by the producer cooperatives.

Up until 1980 subsidized credit to small producers was the only relevant program for milk. Between 1979 and 1984 the Central Bank implemented agricultural credit programs, which were discontinued in 1985 due to monetary restrictions. From 1985, high interest rates were added to reduced availability; today preferential credit is available only for beef or dual-purpose livestock.

Technology and technical assistance in the dairy subsector

Before the 1970s, the only technological program directed to the dairy sector was improvement of herd stocks and technical assistance on phytosanitary control. Since then, concrete efforts to influence the efficiency and capacity of the subsector have been made: the Dairy Modules Program, the National Milk Production Program, and the Genetic Improvement Program. Technical assistance today is oriented to promotion of greater yields and cost reduction through herd stock improvement and better use of pastures and forages.

Technological practices at the agricultural producer level

Milk farms in Costa Rica are classified in milk-specialized, highland operations, and intermediate-low zone, dual-purpose operations.

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Biological practices. Highland operations use European races, especially holstein, jersey, and guernsey, with two daily milkings and sale of calves immediately after birth. Intermediate and low zones have a combination of milk cows and dual-purpose livestock, with the races Brown Swiss, jersey, holstein, and zebu-type livestock. In dual-purpose operations, cows are milked once a day with assistance from the calf.

Chemical practices. Fertilization of pastures was a widespread technological practice in milk operations up until 1978, with excellent results. This practice decreased due to higher fertilizer prices from 1978. At present, fertilization of pastures is uncommon; rather, the use of herbicides for weed control has increased as a result of wage increases.

Feeding systems. Feeding in livestock operations varies by zone and by specialization. In the highland zones, more balanced feed is used, and in low zones, the feed is based on forage and mineral supplements. In milk-specialized operations the consumption of balanced feed, medicines, vaccines, and veterinarian services represents 70% of the total production cost. Since balanced feed has a high import component, production costs for milk farms have recently increased significantly, and improved production techniques using feed substitutes and forages are needed.

Reproduction and handling of stock. Artificial insemination controlled mating, control of impregnation, and interval between parturitions are the practices used in specialized milk farms. Artificial insemination is used in highland farms in ever greater numbers; in medium-low zones this practice is restricted to the production units with higher yield and efficiency. For handling of stock, most operations use the common practices of animal sanity (internal and external parasite removal, vaccination). The mastitis test is performed regularly in milk operations.

Technological practices in the industry

Technology and equipment. The technology and equipment used in the dairy industry are imported. The 1985 technological diagnosis showed that much of the equipment is old and producing suboptimal results, particularly that for freezing and cleaning. Also, processing capacity in several production stages is underutilized.

The technological diagnosis also showed that qualified personnel is limited and the imported technology generally has not been adapted to local conditions. The possibilities of adaptation of technology are limited, because

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the country's machinery industry is not capable of adapting precision equipment such as pasteurizers, centrifuges, and homogenizers.

Other restrictions within the dairy industry today are the impossibility of preserving milk by drying methods or by sterilization in most processing enterprises, excessive manual handling during the stages of filling and sealing ice cream cartons, and economic restrictions on acquiring modern equipment.

Quality control. Quality control of raw materials and finished products is done basically in terms of chemical and microbiological aspects. However, the equipment in some enterprises is not appropriate for complying with the requisites of hygiene and quality control.

Institutional organization and entrepreneurial strategy

The structure of public and private organizations in the dairy sector is well developed in Costa Rica. Thus, producer cooperatives are in charge of organization of production, processing, and marketing of the products. The government and other institutions coordinate and implement technical assistance and transfer-adoption-improvement of technology (*Ministerio de Agricultura*, universities, international agencies) and dictate policy guidelines (*Ministerio de Economía, Consejo Nacional de Producción*). Finally, the milk producer associations act as pressure channels for safeguarding the interests of their associates.

Even though the dairy industry does not carry out technological research regarding equipment, market research for new product development is done by the large enterprises. The principal recommendations for technological policy and strategy were to satisfy the need for greater entrepreneurial aggressiveness in sales, mainly of derivatives, with a better use of capacity, development of new production technologies for derivatives through automatization of some processes and equipment modernization, and the decentralization of production, especially for cheeses.

Modernization of citrus in Brazil

The citrus complex

The citrus complex in Brazil is part of a select group of activities that, during the economic crisis of the 1980s, managed to maintain a pattern of great movement. Exports of frozen concentrated orange juice (FCOJ) increased from US$339 million in 1980 to US$1 billion in 1989. The Brazilian citrus complex

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is responsible for 85% of FCOJ world trade. Ninety-eight percent of Brazilian production of orange juice is exported and 881 thousand hectares are cultivated with oranges, the largest citrus cultivation in the world.

The impressive growth in planted area in Brazil during the 1980s illustrates the anti-cyclic behavior of the citrus activity (Rascunho 1992). This growth of area reflects investment in citrus, which is estimated at US$3 thousand per hectare. Since the growth in area was 306 thousand hectares, investments in the sector must have reached a value near US$1 billion for the 1980s.

The Brazilian production of oranges is estimated at 260 million boxes in 1990, with 81.8% originating in Sao Paulo. Since 90% of the industrial citrus capacity is also located in Sao Paulo, it can be said that the citrus complex responds to a specific regional reality.

The citrus complex must be understood as an agribusiness complex made up of three basic subsystems:

a. a subsystem of provision of inputs (machinery, implements, fertilizers, etc.)
b. a subsystem of citrus production
c. a subsystem of industrial processing of oranges, that is, an industry of concentrated and frozen juice, which includes the distribution and marketing network

The first subsystem is made up of multinational enterprises. Citrus, even though it uses chemical inputs intensively (76% of 1980 harvested area used pesticides and 91% used fertilizers), as well as tractors and implements, represents only a small part of the market. Thus, for the pesticide industry, demand from the citrus area represents only 10% of global sales.

The citrus complex second subsystem is made up of nearly 40 thousand rural producers, most of them landowners (96%). The distribution of citrus producers in terms of size and their respective shares in production is presented in Table 2.

The greatest proportion of orange production comes from small and medium-sized producers (57%). When all farms up to 500 hectares are considered, 88% of production is accounted for. A tendency toward concentration in orange production may be observed, since in 1960 farms up to 10 hectares represented 51% of the total farms.

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Table 2. Distribution of Brazilian citrus producers by size and participation in production.

Area (has)	Number of citrus producers	% producers	% production
<10	10799	27	7
10-99	23822	59	50
100-500	5563	14	31
>500	44	0	12
Total	40228	100	100

Source: Rascunho 1992.

This process of increase in size is a consequence of the requirements of production by the juice industry. A selection process favoring medium-sized and large producers was generated, because of their lower operation costs due to economies of scale. This tendency provokes concern because of its social consequences but seems to be irreversible. Furthermore, the leading firms in juice processing are studying the possibilities of having their own orange plantation projects, looking for a significant degree of self-sufficiency, which is becoming a key element in competition.

The third subsystem is made up of 16 FCOJ processing firms. The industrial activity is definitively the most dynamic part of the citrus complex, not only because it generates the greatest proportion of the economic surplus, but because it is the principal agent that guarantees continuous expansion of participation in external markets, which is the key factor in the whole growth process of the citrus complex.

Origin and evolution of the citrus complex

Orange planting goes back to the colonial period in Brazil. Initially, Rio de Janeiro State was the principal producer. However, the rapid growth of orange planting in Sao Paulo State made it the principal producer in 1957. This growth was generated by economic factors, with conditions of soil, climate, precipitation, temperature variations, and topography making Sao Paulo the most propitious region for planting citrus. These conditions influence coloration, acidity, sweetness, and maturation period, all of which make fruit most suited to FCOJ production.

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Until 1960, the demand for oranges was associated with the urbanization process in Brazil. Its growth was based on a substitution process for coffee: the continuing overproduction of coffee promoted a search for suitable alternatives. But only in 1989 did orange juice exports surpass coffee exports, placing oranges second in agricultural exports, behind only the soybean complex.

Sao Paulo orange production was already important and dynamic in the 1930s and 1940s. However, a brutal plague of *tristeza* developed in the 1940s, decimating the orange trees, extinguishing the citrus trade, and causing an unprecedented retraction.

Sao Paulo orange production recuperated in the 1950s on a more technical basis, with new, more-resistant varieties such as pera, valencia, natal, lima, hamlim. The rapid expansion of the crop (Figure 8) attracted large orange marketing firms such as Golwin, Cocozza, Citrobrasil, and Fischer. Yields increased greatly during this period and citrus was established as a modernized activity incorporating agricultural machinery, fertilizers, pesticides, and so on.

There is no doubt that citrus was attractive because of the high prices for oranges. At the end of the 1950s, the orange was the crop with greatest return per hectare.

By the mid-1960s, the first juice processing industries emerged, when Sao Paulo production was reaching 24.4 million boxes of oranges per harvest, making industrial investment viable. From the implantation of the juice industry, the dynamics of the citrus activity reached new dimensions, becoming more dependent on the volumes demanded by the juice industry, which has been connected from its very origin to the international market. After five years of industry growth (between 1963 and 1968), Brazilian FCOJ production reached 30 thousand tons, bypassing in record time North American juice production.

Citrus production thus became subordinated to the agroindustry, changing the marketing structure of oranges to a situation in which, at the time of blossoming, industry anticipates buying of farm production.

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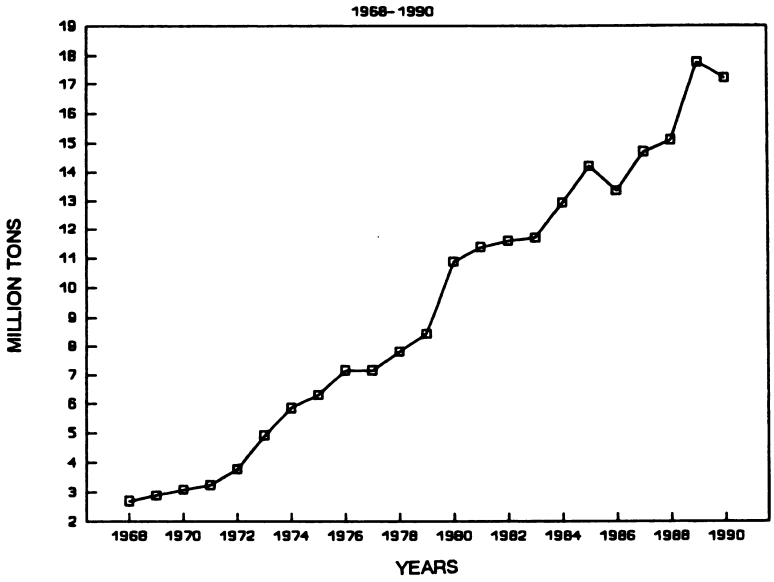

Figure 8. Orange production in Brazil.

The industry of concentrated orange juice

The location of the juice industry had, necessarily, to be near the zone of production of the raw material, because of transport costs. The industries foresaw opportunities in the international market for orange juice because of climatic problems affecting the North American production (frosts in Florida in 1962-63).

The Brazilian orange juice industry initiated with a production capacity near 10 thousand tons/year in the mid-1960s, which grew to 47 thousand tons/year in 1970, implying a 36% annual growth. This intense growth continued in the subsequent period and the production capacity reached 240 thousand tons/year in 1976 and 585 thousand tons/year in 1980, with an average annual growth of 28% in the 1970s. Expansion was slower in the 1980s, but very significant, reaching approximately 1.2 million tons/year of FCOJ production capacity in 1989-90, —which doubled the capacity in that decade. No doubt this high-growth performance of capacity and exports (Figure 9) had an anti-cyclic character in relation to the global economy.

There are four leading firms in orange juice production: Citrosuco Paulista, Sucocitrico Cutrale, Cargill Citros, and Frutesp. These four enterprises own 84% of the sector's industrial capacity, and were responsible for 71% of

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national exports in 1988, reaching sales of US$814 million. The two main firms are ranked among the 20 greatest exporting firms in Brazil. They are also the firms with greatest unused capacity, and are financial partners.

Table 3 shows that in spite of the high concentration of the industry (84% of capacity in four firms), there has been a tendency toward deconcentration in exports: "other" firms increased their participation from 11% to 24% in 1983-88.

Recently there have been new, large investments in the sector. The Votorantim group established the Citrovita firm and entered the citrus complex through a US$200 million investment concentrated on three fronts: a 10 thousand hectare orange plantation during 1989-92 in Itapetininga/SP, development in 1994 of an industrial plant in the same state with a 50 thousand ton/year FCOJ capacity, and development of another industrial plant with a 35 thousand ton/year capacity in another area. This new investment will strengthen the trend toward deconcentration.

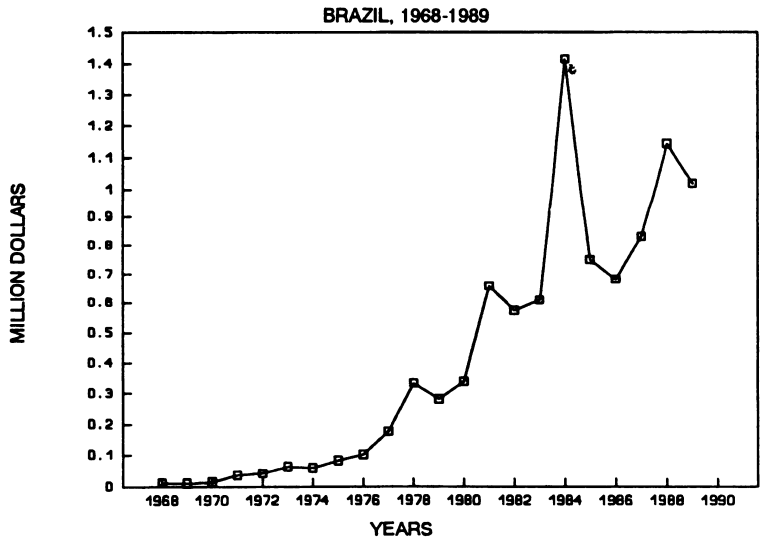

Figure 9. Export value of concentrated orange juice.

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Table 3. Frozen concentrated orange juice industries.

Industries	Capacity (million boxes)	Participation in exports 1983	1988
Citrosuco	100	39	30
Cutrale	86	33	27
Cargill	42.6	10	9
Frutesp	32.4	7	10
Others	50.5	11	24
Total	311.5	100	100

Source: Rascunho 1992.

The leading industries feel the increase in competitive pressure and they are responding through the extension and development of new marketing channels in new potential markets (EEC and Japan), the development of port terminals, and the search for new frontiers and market diversification.

Although the three major firms are controlled by domestic capital, they have solid associations with foreign enterprises. Cutrale, for instance, has an exclusive contract with Coca Cola for orange juice distribution in the U.S. market.

In summary, the citrus complex is highly concentrated: 16 firms with the leading four responsible for 84% of capacity. This corresponds to a processing capacity of 311.5 million 40.8-kg boxes per 180 days of harvest. Since 260 boxes are needed to produce a ton of FCOJ, the production capacity in terms of 65°-Brix concentration juice is 1.2 million tons. The value of a 30 thousand ton industrial plant reaches US$35 million, so the assets of the citrus industrial complex approach US$1.2 billion.

Since the FCOJ is a homogeneous product, competition through product differentiation is not possible. Actual competition is found in the following elements: (a) availability of capital due to high demand for financing funds, given the periodic advances to producers for fruit purchasing; (b) access to external marketing channels; (c) guaranteed provision of raw materials (oranges) both in volume and quality; (d) maintaining unused industrial capacity; (e) maintaining a sophisticated logistic system encompassing

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industrial plants, transport to port, port terminals in Brazil and abroad, and adequate ships for FCOJ transport.

Markets

The Brazilian citrus complex movement is strongly connected to the international market, since two-thirds of all orange production is destined to industries that, in turn, export 98% of the juice produced. On the other hand, it is important to consider that the world market is also affected by Brazil's businesses, since they represent 85% of FCOJ world trade. This power is reinforced by the fact that the USA, despite being the second largest world producer, is also the greatest importer.

Orange juice consumption is related to food demand patterns spread in postwar USA, when fast and practical food items were increasingly valued. Standardization of preferences, promoted by the media in modern consumer society, makes a growing supply feasible at ever-lower real costs. This happens because of cost reductions in processing, transport, and marketing. This process feeds back on itself, providing a continuous market expansion.

Immediately after World War II, world consumption of FCOJ was concentrated in USA. In Europe, juice consumption increased markedly in the 1960s and 1970s. In England, for instance, orange juice consumption per capita increased from 0.54 liter in 1970 to 4.76 liter in 1985. However, per capita consumption is greater in other European countries such as Germany, where it has lately reached 10.5 liters.

The principal FCOJ producers are Brazil (51%) and USA (40%), with an estimated world supply equaling 1.5 million tons in 1990. Some countries, such as Italy, Israel, Spain, Turkey, Pakistan, and Mexico, have tried to increase planted areas of oranges. However, for climatic reasons or for scarce availability of suitable areas, it is difficult to evaluate the extent of deconcentration of world production.

Brazil's participation in the world market was 30% in 1969, increasing to 60% in 1975, and reaching 85% today. Brazil enjoys a quasimonopoly situation in FCOJ trade. This situation was helped along by the four strong frosts in Florida's oranges (1981, 1983, 1985, 1989). The figure below presents a comparison between U.S. and Brazilian orange production.

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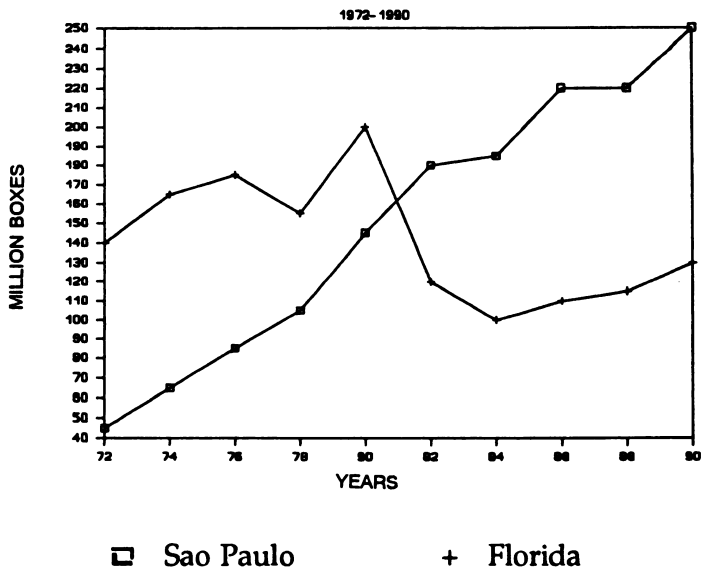

Figure 10. Orange production: Sao Paulo and Florida.

With an annual production of 650 thousand tons in 1983, the USA was the greatest FCOJ producer in the world when it was surpassed by Brazil. The strong frost in Florida in December 1989 produced an immediate increase of 60% in orange juice prices because of the expected 32% reduction in Florida's orange production. That expectation did not materialize, so imports from Brazil were lower than expected and prices tended to go back to previous levels.

FCOJ production in the USA has been relatively stagnant since the mid-1970s. However, new plantations, especially in Florida's southern region, were begun in recent years. It is estimated that there are 18 million trees not yet producing, equivalent to 34% of the total U.S. orange plantations. U.S. plantations today have 53 million trees, which compares to 183 million in Brazilian plantations.

The USA is the second largest world producer of FCOJ, with an estimated 450 thousand tons in 1990. But it is also the greatest importer in the world, with a total of 420 thousand tons. Consumption is therefore 870 thousand tons or 65% of the world total. This consumption level corresponds to a per capita demand equal to 27 liters/year of orange juice, also a world record.

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U.S. imports from Brazil averaged 94% of the total FCOJ imported during the period 1980-87. A slight tendency toward reduction of this quasimonopolistic position has been observed, with the share decreasing from 98% of the total imported in 1980 to 90.3% in 1987.

In the European market, the leading businesses are trying to create new access channels, particularly in Italy and Holland. Table 4 presents Brazilian exports according to the principal importing countries.

Fruit juice consumption, despite being stabilized in most European countries, still has potential for growth. Thus, between 1985 and 1987 European imports of orange juice grew 60%. It should be mentioned that England's FCOJ imports grew 350% between 1980 and 1989, reaching US$250 million. This growth must be attributed to food promotions favoring consumption of natural products.

Japan, Eastern Europe, USSR, and Asian NIC's are little explored markets. In any case, FCOJ import volumes for Japan and Korea grew 360% in 1989. Total FCOJ imports by Japan are only 40 thousand tons/year but it is expected that, after import barriers on concentrated juice are eliminated, Japan will absorb 200 thousand tons/year.

Table 4. Brazilian exports of FCOJ by destination countries (Porto de Santos).

Destination	1988 ThousTns	1988 %	1989 ThousTns	1989 Thous$	1989 %	1990 ThousTns	1990 Thous$	1990 %
USA	258	38.9	267	362	36.9	282	478	40.0
Canada	45	6.8	48	66	6.7	35	62	5.2
N.America	303	45.6	315	428	43.6	317	540	45.2
Holland	194	29.2	200	275	28.0	203	357	29.9
Belgium	104	15.7	105	151	15.4	92	147	12.3
Germany	17	2.6	17	24	2.4	28	43	3.6
France	1	0.2	1	1	0.1	1	1	0.1
Other EEC countries	11	1.7	9	12	1.2	8	13	1.1
EEC	327	49.2	332	463	47.1	332	561	47.0
Japan	9	1.4	25	35	3.6	26	46	3.9
S.Korea	0	0.0	15	20	2.0	12	20	1.7
Australia	7	1.1	6	9	0.9	1	2	0.2
Israel	2	0.3	5	7	0.7	5	9	0.8
Finland	2	0.3	3	5	0.5	3	5	0.4
Other dev. countries	14	2.1	10	15	1.5	6	11	0.9
Rest of countr.	34	5.1	64	91	9.3	53	93	7.8
Total	664	100.0	711	982	100.0	702	1194	100.0

Source: Rascunho 1992.

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Fruit juice consumption per capita in Japan reaches 25 liters/year, 50% being orange juice and 21% apple juice, distributed principally through a network of automatic machines. The growth in fruit juice consumption in Japan accelerated in the 1970s (544%), with moderate growth in the 1980s (35%). The habit of drinking orange juice is widespread in modern Japan. Even if per capita consumption did not increase, a simple growth of FCOJ's share of the wider natural juice market may represent an important direction for FCOJ growth.

Brazil's internal demand for FCOJ is not significant (20 thousand tons/year). Expansion of internal consumption is a strategic objective of the sector, not only for its effect on market expansion, but because it would be a demand generated in the same economic space where production takes place. Some industries are making efforts in this direction and consumer prices are close to US$1.40/liter in Tetrabrik packaging.

Organization and management

Competitiveness of Brazilian production has been based on the following set of factors: (a) adequate climatic conditions for citrus plantations, principally within 20° and 25° latitude; (b) low production costs principally for labor and land; (c) technologically modern industrial capacity; (d) technical-agronomic development; (e) well-structured production chain incorporating rural producers, industries, transport, and marketing.

The sources for cost advantages are related to economies of scale in production and marketing, technology, and access to raw materials. The process of expansion and modernization of Brazil's citrus complex shows great dynamics in its cost structure, especially regarding the logistics of transporting the final product.

Until 1982 juice was transported using barrels that, besides having handling difficulties, cost US$33 per unit (268 kg capacity) and were impossible to reuse. The transport cost with the new in-bulk system, using special ships and port terminals, may be less than half the cost of the barrel system, depending on the scale of operation. The necessary investment for the new structure is US$50 million and the economies of scale provided by this new method work fully when the 40 thousand ton mark is reached.

To evaluate competitiveness, Rascunho (1992) made a comparison between orange production costs in the two principal world producers, USA and Brazil. Regarding agricultural production, the average productivity in Brazil (403

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boxes/ha) is substantially lower than in the USA (754 boxes/ha). The difference in productivity between the two countries must take into account the fact that the irrigated area is 55% of total area in USA and only 5% in Brazil. However, new projects in Brazil have a significantly higher productivity of 1100 boxes/ha.

It was demonstrated that the necessary investment in orange plantations in Brazil –up to the time of commercial production in the fourth year– was only 20% of the corresponding investment in the USA. Regarding operational costs, it was shown that labor costs are triple in USA and machine operation double. The result is that the variable cost of a box of oranges in the USA is 50% greater than in Brazil, taking into account the different levels of productivity.

When new investments in the agricultural area are considered, the adopted technology leads to an expected productivity of 1100 boxes/ha. Once this performance is achieved, the cost of a box of oranges reaches $1.00 in Brazil, half the price of a box in the USA.

According to the analysis, the comparative advantages of Brazilian production are undeniable. Even if labor costs and machine operation costs in Brazil increase in the long run, the costs of chemical inputs may be reduced via a trade liberalization policy, thus maintaining the competitiveness of Brazilian production.

According to FAO (United Nations Food and Agriculture Organization) projections, the world citrus sector will face a period of decreasing prices as a consequence of supply growing at a greater pace than demand. For 1996, a minimum price of US$1.45 per box of oranges for the producer is projected; thereafter prices would increase, reaching US$2.02 in 1999. In any case, the projected minimum price will be greater than the variable cost (US$1.00/box) of Brazilian citrus projects of high efficiency. Naturally, if this minimum price level is maintained for many years, the profitability of these projects may be affected.

It should also be considered that competitiveness of the U.S. production is being helped by tariff barriers on the Brazilian product, which provide U.S. producers with an advantage of $2.00 per box. The question is whether U.S. society is willing to subsidize its producers to guarantee a viable citrus industry, and to what extent. In the context of a high fiscal deficit, the U.S. position in the GATT Uruguay Round has been to favor a reduction of tariff barriers.

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The disaster of the Uruguay Round in December 1990 served to prove that there is a rather large distance between the liberal discourse and the concrete position at the negotiating table. The agriculture of Brazil and the rest of Third World countries is affected by the fact that the market's invisible hand is not allowed to act in those areas where these countries have comparative advantages.

Finally, it may be proposed that the competitivity of Brazil in the production of FCOJ will be ever more dependent on the production efficiency of plantations and, in the field of industry, a reduction of transport costs and improvements in the production process.

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3

ENVIRONMENTAL RISKS OF AGRICULTURAL MODERNIZATION

Introduction

Agriculture in most LAC countries is one of the most important sectors of economic activity, in terms of generation of gross domestic product, foreign reserves, and employment for a high percentage of the population. This is a natural consequence of the great wealth and diversity of natural resources of LAC countries, together with their undeniable agricultural potential and comparative advantages in the production of natural resource-derived products.

However, a high rate of population growth, among other things, has compelled the countries of the region to use production strategies, particularly in traditional agriculture, based on overexploitation of the natural resource capital, a short-run option, less costly, and requiring lower social cooperation (Kirchner et al. 1984). This option has already caused a growing pressure on the environment, propitiating a vicious circle of rural poverty, overexploitation, degradation of natural resources, and, finally, greater poverty.

From this new situation, the urgent need for a new development strategy based on sustainable exploitation of natural resources is seen. Within this strategy, the modernization of traditional agriculture has been advanced as a central element. Agricultural modernization postulates an efficient exploitation of the potential advantages of LAC countries with respect to their human and natural resources, reactivation of the agricultural sector, generation of multiplier effects on the rest of the economy, and benefits for the large segments of the population affected by the economic crisis in the region. Moreover, it is recognized that this modernization process may produce only nonsustainable, sporadic benefits if it not generated within a framework of equity and natural resource conservation.

This last aspect has received attention only in recent years. There is now a felt need to discuss the long-term viability of the modernization process and to analyze its environmental impacts. The basic concept of sustainability implies achieving agricultural modernization in the LAC region while at the

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very least maintaining over time the base of natural resources. In fact, the environmental impacts of the modernization experience have not been evaluated, either regarding the ecological context or its implications for sustainability of the production process itself. Furthermore, it is proposed that in the modernization experiences of LAC countries there have been no explicit intentions on the part of the private sector to conserve natural resources, nor have there been incentives given through governmental policies.

The risks of ecological deterioration from LAC agricultural modernization processes are presented in this chapter. These are based on the case studies of the previous chapter, and the principal environmental impacts of agricultural modernization are analyzed. Measures, actions, controls, and policies for avoiding and mitigating the environmental damages will be proposed in the next chapter, as well as the need for modifications in the market economy's price system to incorporate the true dimension of natural resources.

Methodology

The case studies on agricultural modernization of Chapter 2 were chosen as representative cases regarding potential ecological risks: flowers in Colombia, fruit in Chile, vegetables in Mexico, shrimp in Ecuador, dairy-livestock in Costa Rica, grain in Argentina, and soybean and citrus in Brazil.

An analysis of the ecological deterioration risks in these case studies is presented in this chapter, considering the following two components:

a. An identification and description of activities with greatest importance in terms of their potential for producing significant environmental impacts.

b. A concise evaluation of the environmental impacts generated from the modernization processes.

The environmental assessment of LAC agricultural modernization experiences led to the identification of some common impacts on the environment and on natural resources. A first analysis of these common elements led to the classification of the experiences of agricultural modernization in four different categories:

a. Modernization processes with strong effects on deforestation, such as soybean in Brazil and livestock in Costa Rica.

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b. Modernization processes with greatest impact on basic agricultural resources, such as soil deterioration by Argentina's grain and water depletion by Colombia's flowers.

c. Modernization processes with greatest effects on chemical pollution, such as Chilean fruit, Mexican vegetables, and Brazilian citrus.

d. Modernization processes with strong impacts on wetlands, such as shrimp in Ecuador.

This chapter presents a summary of the environmental assessment for the case studies according to the above classification.

Environmental assessment of agricultural modernization

Soybean in Brazil

Activities

As stated above, from the 1970s Brazil has been one of the most important actors in the soybean world market. This presence has been facilitated by the supply of Brazilian production during the off-harvest period of U.S. soybean and by the greater content of oil and protein in Brazil's grain. Even though the Brazilian share in soybean world exports is relatively low, Brazilian exports of oil and soycake have proven a great influence on international markets and of great importance to the associated agroindustrial complex. Brazilian soybean production increased rapidly from 1969, reaching a volume of over 18 million tons in 1986.

The production activities of the soybean subsector in Brazil with greatest relevance to the environment are related to preparation of land, planting, cultivation practices, and harvest at the agricultural level; and milling and industrial production of edible oils at the agribusiness level.

Environmental impacts

One important factor of the growth process of Brazilian soybean has been the rapid evolution of the crop in the central/western region in the 1980s. The harvested area in this region and the traditional region are compared in Figure 11.

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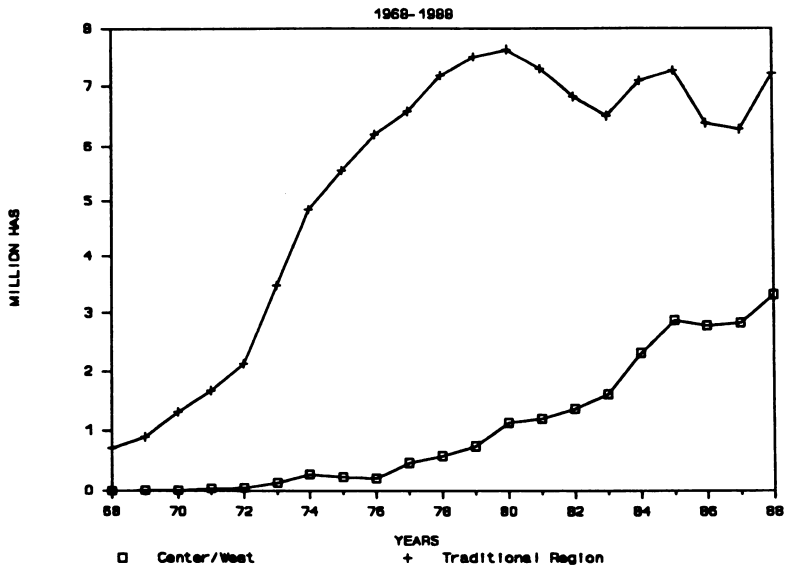

Figure 11. Planted area of soybean in Brazil.

The rapid growth of planted area in the central/western region contrasts with the decreasing trend in the crop's traditional region from 1980. However, the increase in planted area is not explained by soybean's substitution for other crops, but by an important agricultural border expansion based, partially at least, on deforestation south of the Amazonian basin.

The tropical forests of this region are highly vulnerable to serious and irreversible deterioration resulting from poorly planned agricultural activities. Direct and indirect impacts of deforestation and colonization of the tropical forest include loss of biodiversity, loss of fragile soils, fragmentation and loss of habitats, social and cultural conflicts with indigenous populations, and global climatic repercussions.

In addition, the use of agrochemicals and the growing industrial production of edible oils is causing as yet unknown effects on the quality of water of the surrounding region and long-term repercussions on the fauna.

Dairy-livestock in Costa Rica

Activities

Prior to beef and fluid milk production, in the cattle ranching phase, the most important processes were the clearing of the land, handling of soils, and

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handling of livestock. Clearing of land is related to the process of conversion of tropical forest to pasture land in Costa Rica. Regarding soil handling, the practices of irrigation and drainage, use of fertilizers, and production of pastures and grain-forage are considered. Backward linkages with fertilizer and pesticide demand can be distinguished in this phase. Regarding livestock handling, the selection of varieties, genetic improvement, and farm infrastructure are to be highlighted.

In the milk production phase, the use of balanced feed, pesticides (phytosanitary control), mechanization, and marketing arrangements are important. During this phase, backward linkages with the balanced feed industry and forward linkages with processing and marketing of fluid milk are developed.

The distribution and marketing of milk is the point of greatest interest in dairy sector modernization in Costa Rica, and the link of greatest importance in the production chain. The cooperative mechanism established between the principal processors and producers has been the most dynamic element in modernization and in propagation of its multiplier effects.

Environmental impacts

Livestock and ranching expansion has contributed—alongside other factors—to the process of conversion of tropical forest to pasture land in Costa Rica. Figure 12 shows the steady increase in the number of cattle in Costa Rica in the 1960s and 1970s, and the stabilizing in the late 1980s. Figure 13 shows the parallel increase in land used for pastures and the corresponding decrease in forest area.

The process of cattle ranching growth has been clearly described by Nations (in Collins and Painter 1986): "Although the causes of deforestation in Middle America are complex, the major forces of destruction can be narrowed to three: logging, colonization and export crop production. Usually the three factors work in tandem. Logging companies bulldoze roads through tropical forests to extract valuable hardwood trees; landless peasants use these roads to infiltrate into the area and colonize it for subsistence and cash crop agriculture; and finally, either the colonizing farmers themselves or a new group of capital intensive entrepreneurs clear what remains of the forest to produce monoculture cash crops (cotton, coffee, banana, cacao) or beef cattle."

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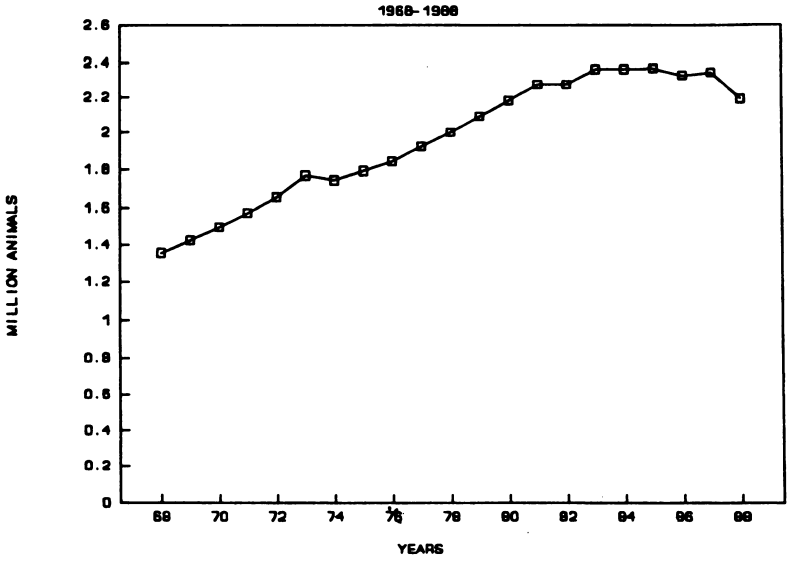

Figure 12. Cattle stock number in Costa Rica.

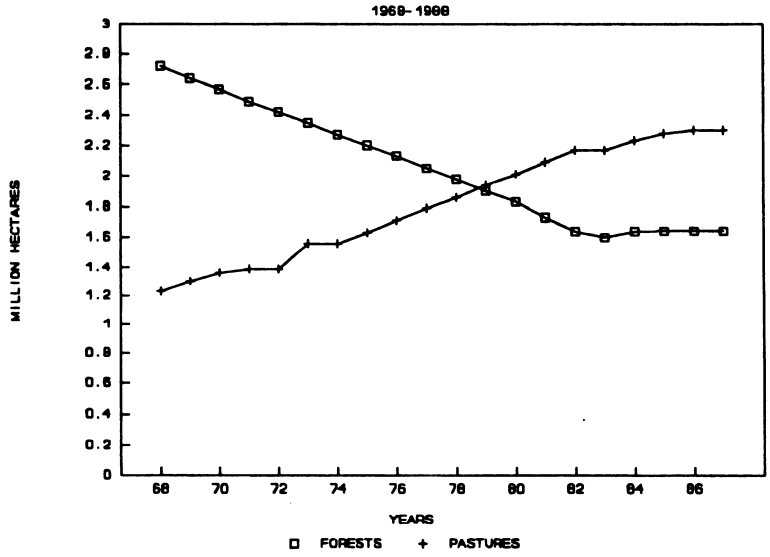

Figure 13. Forest and pasture area in Costa Rica.

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The deforestation-ranching process in Costa Rica proceeded up until the late 1970s, when the real price of beef decreased and the profitability of cattle ranching was lessened. The new situation brought about a reorientation of livestock from beef production to a dual-purpose activity of beef and milk production.

Livestock and ranching expansion in Costa Rica have thus contributed to the process of deforestation of the tropical rain forest. As stated above, this process follows a pattern of initial logging, subsequent colonization, and final clearing of the remaining forest for cattle ranching activity.

The dairy sector in Costa Rica has shown low negative environmental effects. More, it has been argued that the subsector modernization has somewhat influenced the decrease of deforestation through increasing the efficiency of livestock production. In addition, there is a tendency toward land rotation as a method for improving yields and reducing erosion problems. Even though consumption of fertilizers and pesticides has increased, no information on its true impact on environmental quality exists.

Industrialization of milk is a consolidated process, carried by 40 enterprises in Costa Rica that are registered with the Ministry of Health. Production is concentrated today on pasteurized milk, cheese, ice cream, and yogurt. The residual water discharges from these industrial processes may contain a high concentration of organic materials, solids, and greases. These discharges may have strong effects in terms of diminishing levels of oxygen in water, but this has not been quantified in Costa Rica.

Grain in Argentina

Activities

Production of grain in Argentina has four basic phases: handling of the soil, planting, growth, and harvest.

Two types of production agents may be distinguished in the subsector: owners managing the production directly, and lessees under a nontraditional arrangement, generally one-year leasing contracts with a stipulation to pay a percentage of the harvested volume. These contractors have their own machinery and use, in general, the best available technology, making themselves a very efficient means of modernization through extending a high level of technology to all leased farms.

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The production process is initiated by preparing the land with appropriate agricultural machinery. This creates a backward link between grain producers and the industries of machinery and inputs.

The phases of planting and growth require the use of pesticides. Subsector growth is associated with production modernization and crop area expansion. Changes in pesticides are therefore qualitative and quantitative. There have been changes in plagues (where insects were previously predominant), and the relative importance of various weeds has varied, with an increase in perennial weeds that are more costly to battle. Because of these situations, new chemical products, more efficient, strong, and concentrated but which may have great pollution risks, are in use today.

The generation of employment has decreased with machinery and new technology that is being used to harvest and with the change from bags to in-bulk handling of the product.

Environmental impacts

Grain production in Argentina grew significantly in the 1980s, especially soybean for export. The increase was possible because of a profound transformation of the traditional production systems, which consisted in rotating cattle grazing with cereal crops, with the livestock activity renovating soil fertility. This scheme was replaced by a continuous crop system —wheat, maize, and soybean— within a process of technological innovation that increased the productivity and profitability of these crops.

The new type of producer, the contractor, has been identified as an important factor in the modernization process. However, this mode of production has increased environmental problems, since the fallowing of land, recuperation of the soil, and implementation of conservation techniques were hindered.

Continuous production and intensification of land use have caused increasing soil degradation; loss of organic material, nitrogen, and phosphorus; and a moderate-to-severe erosion process in large extensions of the Argentinean pampa. The degradation reported forms a potential problem of incalculable repercussions. The increased use of fertilizers in the grain subsector may be a proxy variable in this process (Figure 14).

In particular, soybean development in Argentina is characterized by a growing reliance on agrochemicals, especially herbicides and fertilizers. The chemical fight against weeds has exceeded the mechanical one. In fact,

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soybean production could not take place without the new, imported agrochemicals. The evolution of the use of agrochemicals in the grain subsector is presented in Figure 15.

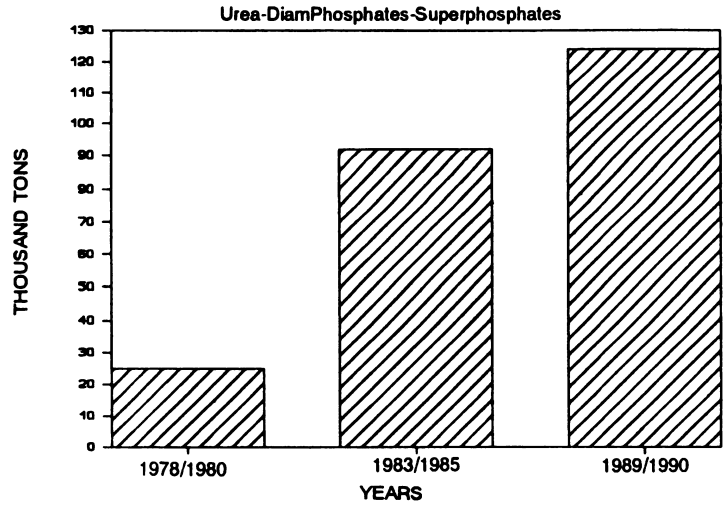

Figure 14. Fertilizer use for grain in Argentina.

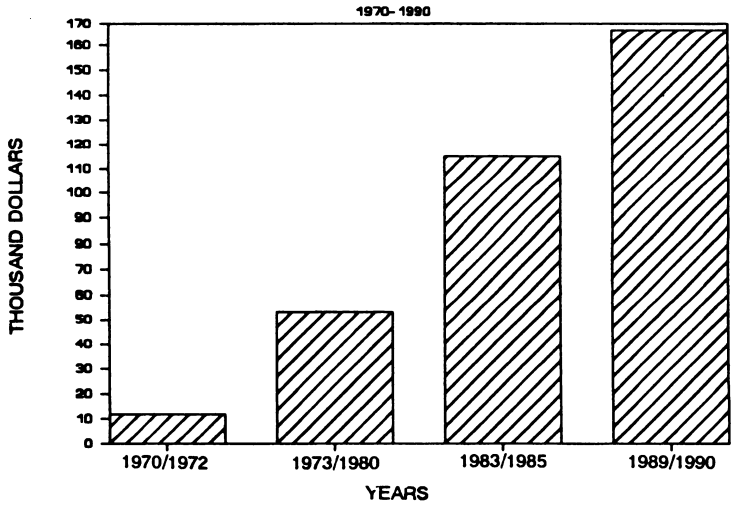

Figure 15. Pesticide use for grain in Argentina.

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The effects of intensive use of agrochemicals on the quality of water have not been evaluated; however, significant changes in environmental conditions are forecastable due to the growing dependence on these inputs.

Flowers in Colombia

Activities

Flower production has the following phases: preparation of land, preparation of garden "beds," planting and cultivation practices, and harvest. Within these phases, the activities of greatest environmental relevance are the following:

Preparation of land. Within this phase, the construction of irrigation systems and infrastructure (nurseries and greenhouses) constitute the principal activities with greatest environmental incidence. In general, the irrigation system requires the digging of deep wells and the use of sprinkling or drop systems; the greenhouses are built using wood or metal structures covered with plastic material with special technical specifications.

Preparation of garden "beds." Planting itself is done on "beds" or elevated strips of land; the soil is subject to a sterilization process using steam and chemical products.

Planting and cultivation practices. After planting, the cultivating practices include intensive use of irrigation water, and of fertilizers and pesticides for crop control. Likewise, pruning of the plants generates organic residuals.

Harvest. The intensive use of labor (especially women, who account for 65% of the labor in Bogota's Savanna), involves an important population group in the regional economy who have no alternative employment. Packing of the product requires use of chemical preservatives to conserve flowers during the transport process.

Postharvest. Total dismantling of the crop is needed after harvest for some types of flower, generating large quantities of organic residuals (possibly contaminated).

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Environmental impacts

Cultivation of flowers has caused major environmental repercussions in Bogota's Savanna.

The intensive use of water has caused a worrisome depletion in the level of the underground water table (Figure 16). This situation has already created conflicts in the use of water, affecting not only the flower producers and other farmers, but also the supply of water for human consumption in urban areas near areas of cultivation. The problem is aggravated by the fact that the water-bearing zones of the Savanna are being subjected to a deforestation process and urban expansion. In addition, a salinization of the soils of the Savanna is probable in the near future.

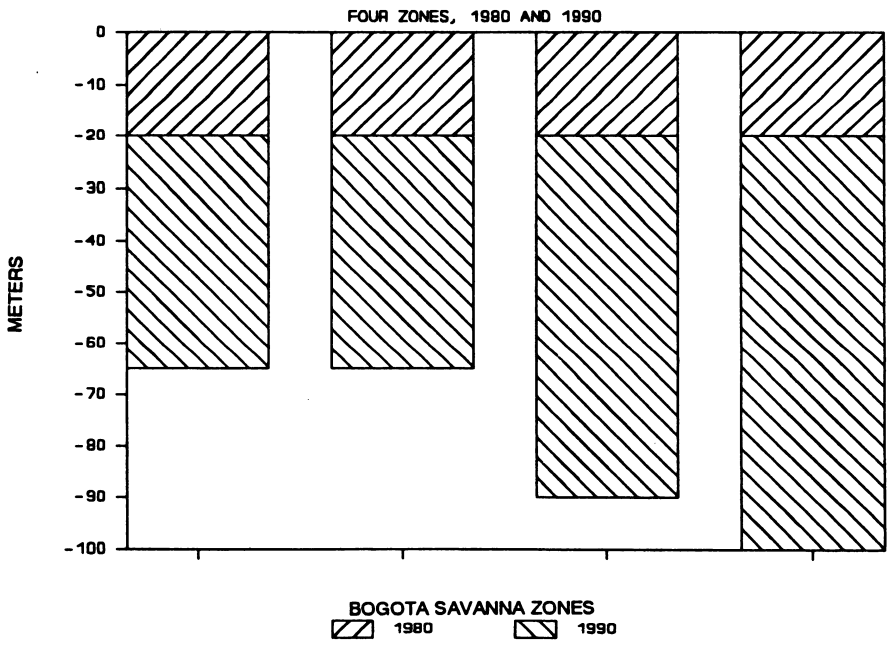

Figure 16. Underground water levels in Bogota.

Bogota's Savanna soils have a high agricultural potential and the zone was considered a basic source of food for the metropolitan area of Bogota. Utilization of these soils for flower crops changed the use of land, displacing traditional crops in the region.

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It is important to stress that the climatic and logistic conditions of Bogota's Savanna were greater influences on the development of the activity than the soil fertility itself; today the soil is used only as a substratum since the flower producer practically "produces" his or her own soil. The process of sterilization and adaptation of the soil modifies its structure and biological composition.

The use of agrochemicals and preserving compounds have polluted the ground water and also the surface water, even though the activity has made some efforts to reuse water. The effect of this pollution has not been quantified.

The use of a female labor force, with ages from 22 to 35 years, has raised serious concerns about exposure to toxic products. However, no cases of acute intoxication have been registered; chronic and cumulative effects of these toxic compounds are being studied at present.

The generation of jobs in the activity has already caused a large migratory process to the area, aggravating the precarious infrastructure of basic services. The issue of compensation to the rural population has not been resolved and is causing continuous frictions between the subsector and the surrounding communities. Due to the character of the primary activity —flowers do not pay municipal taxes— an additional situation of conflict has arisen. Finally, the construction of greenhouses and sheds has substantially modified the Savanna's landscape.

Fruit in Chile

Activities

The principal phases in fruit production are preparation of the land, planting, cultivation, and harvest. The most sensitive activities for the environment are presented below.

Preparation of land. The terrain must first be adapted and the most appropriate irrigation system established. It is important to know in advance the operation's water supply and its annual variation, the growing period of the species to be planted, and the legal situation of the resource. The needs for irrigation water of each fruit species must be known with precision and for every phenological stage.

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Then, deep plowing, raking, and subsoil breaking are carried out. Machinery and agricultural implements are employed for this; only scarce labor is demanded since the practice is totally mechanized.

The plantation also requires a basic infrastructure: a good quality fence to avoid destruction of young plants and stealing of the fruit, a house for the guard, storage area, and sheds for machinery and packing.

Planting. Pesticides and fungicides are commonly employed at planting time to avoid diseases in the root system and at pruning time in the upper part. In specific cases the soil is fumigated against fungi, bacteria, and nematodes.

Cultivation practices. After planting, essential activities for the successful development of the crop are carried out. Fertilization requires a soil fertility analysis and an appropriate mode for providing nutrients, which is linked with the irrigation system. Fertilizer is of nitrogen type; organic fertilizer is also used, especially in arid zones where soils have a low level of organic material. The labor is specialized and constantly supervised by technical personnel.

An ample range of specific herbicides are available today, but their inappropriate application may cause serious environmental damage. Manual control of weeds has become obsolete, especially by the availability of specific herbicides that destroy weeds above ground and at the root, but do not affect the foliage of the tree.

Harvest. This activity, together with the practices of pruning and arrangement of the fruit, requires seasonal laborers since demand is concentrated at one point in time. This labor must have the necessary requisites and experience.

Environmental impacts

The great number of jobs generated by the fruit sector —around 80,000 annual direct jobs, especially for women— have special importance. However, wage-earning female labor has brought with it situations of family disintegration and educational problems for the children.

The special character of fruit production and the absence of conservation practices has caused a deterioration of the soils. Even though this deterioration is not very significant in terms of erosion (low slope zones are

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used for fruits), salinization phenomena are found due to the irrigation systems used.

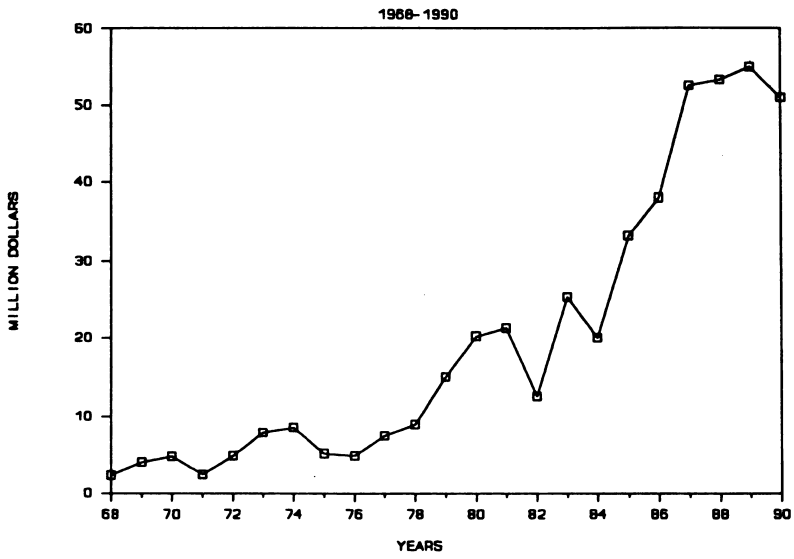

Figure 17. Imports of pesticides in Chile.

The increase in the use of pesticides is particularly notable. Imports of pesticides in Chile for the last 20 years in monetary terms are shown in Figure 17. Even though the environmental impacts of this great increase in pesticide use have not been evaluated, distortions in water and soil and as yet unknown effects on the fauna are presumed. At present, specific resistance to some plagues and pesticides has been developed, which, in turn, makes greater use of these inputs in the future somewhat foreseeable.

Vegetables in Mexico

Activities

As stated above, vegetables in Mexico are a highly commercial activity, using irrigation, land, machinery, improved seeds, and fertilizer-pesticide intensive techniques. They have become the major agricultural export, even though the harvested area represents only a minimal share of the total crop area. Tomato, onion, pumpkin, melon, and watermelon are the principal

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species and production has expanded in response to a growing demand from the U.S. market.

The principal phases in vegetable production and the most sensitive activities in terms of the environment are similar to the previous case of fruit in Chile: preparation of land, planting, cultivation practices, and harvest.

Environmental impacts

Fertilizers and herbicides are important in the cost structure of vegetables in Mexico. They represent 8% and 22% respectively of total cost. The fertilizers used by the subsector represent 8.5% of the total used by Mexican agriculture, but the pesticides represent over half of the national total (Torres-Zorrilla 1991).

Analysis of the demand for agrochemicals in Mexico concludes that pollution from use of pesticides (herbicides, insecticides, and fungicides) in vegetable production may be especially important in response to the stringent quality requirements of the U.S. market.

Aspects to consider in the environmental impact of pesticides are the pollution of water in basins and the repercussions on human health. Studies on pollution stemming from pesticides in Mexico's rural areas are in the first stages of implementation. As of today, it is not possible to quantify the actual magnitude of toxic residuals in the water. All that can be done is to document the present consumption level of carbamate and copper, which is currently 9 thousand tons of active ingredient per year and growing at rates between 7% and 15% per year (Figure 18).

However, regarding impacts on human health, dangerous levels of 14 pesticides are currently recorded in the maternal milk of Indian mothers in the state of Sonora (northwest of Mexico and close to Sinaloa), as reported by a study carried out by Monica Garcia and Maria Meza (1992). At least eight of these pesticides are included in a United Nations "black list" and are legally prohibited in Mexico. Among the pesticides being reported are DDT (producing cancer, mental retardation, hepatitis), lindane (cancer, sterility), heptachlor (cancer), aldrin (cancer, fetal damage), BHC, dieldrin, and endrin.

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Citrus in Brazil

Activities

Production of FCOJ in Brazil has three basic phases: initial investment in orange plantations, operational costs of growing and harvesting oranges, and industrial production of FCOJ.

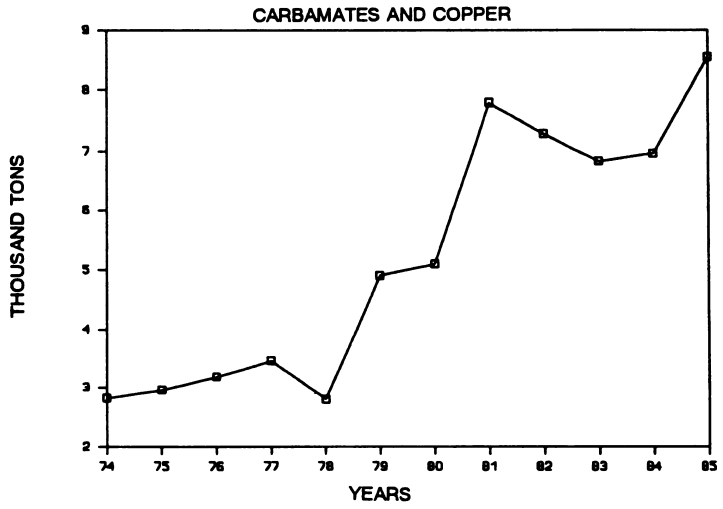

Figure 18. Pesticide consumption in Mexico, 1974-85.

Table 5 presents the necessary investment to plant a hectare of oranges in Brazil, up to the time of commercial production in the fourth year. The largest investment costs are the preparation of land and the planting of trees.

Table 5. Necessary investment in orange plantations in Brazil.

Item	US$/ha	%
Land	1741	50
Plantation	1414	41
Interest	127	4
Equipment	201	6
Total	3483	100

Source: Rascunho 1992.

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Table 6 presents the operational costs of maintaining one hectare of oranges in Brazil. Note that chemical inputs (pesticides and fertilizers) represent 67% of operational costs in Brazil. The largest item in operational costs is pesticides (36%) followed closely by fertilizers (32%).

Table 6. Structure of operational costs in Campinas, Brazil.

Item	US$/Box	%
Fertilizers	0.45	31.5
Pesticides	0.51	35.7
Mach. operation	0.23	16.1
Labor	0.09	6.3
Management	0.15	10.5
Total	1.43	100.0

Note: Productivity assumed: 750 boxes/ha.
Source: Rascunho 1992.

Environmental impacts

The use of chemical pesticides and fertilizers is notoriously high in orange plantations in Brazil, and growing fast. The statistics on total national consumption of pesticides in Brazil for the period 1981-88 are available and shown in Figure 19. It is estimated that 10% of the total is currently consumed by the citrus subsector.

Shrimp in Ecuador

Activities

Four principal phases are present in shrimp farm production: construction of infrastructure, handling of soils, planting, and growth and harvest.

Construction of Infrastructure. Once the location is defined, construction of infrastructure begins by clearing of weeds by tractor, burning of residuals, and leveling of land.

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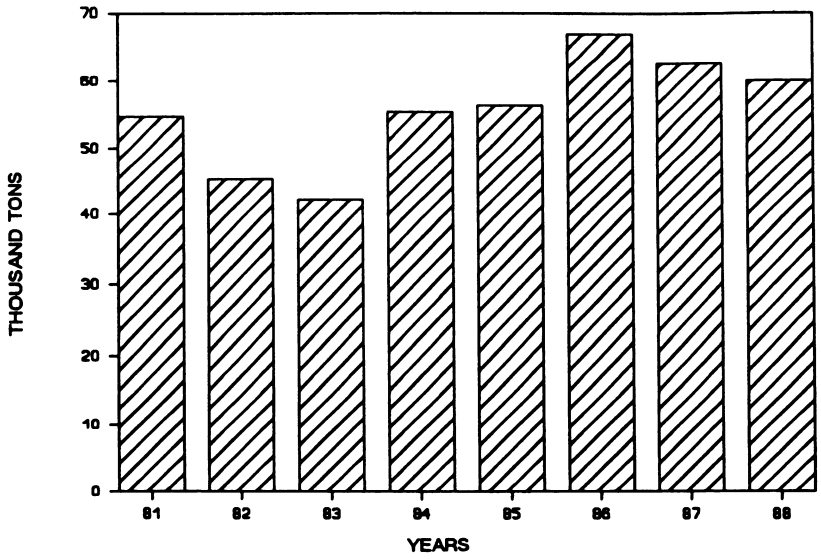

Figure 19. Pesticide consumption in Brazil, 1981-88.

Construction of associated infrastructure then proceeds with building walls and roads to form the borders of the pools for nurseries and farming; building of the principal adduction canal, which is also a water reservoir; and building of the principal drainage collector. Other construction is included here, such as the port —used for the fluvial transport of personnel, inputs, and the final product— which may be of wood or concrete. Also included is the pumping system structure, which is made of concrete within a filling that is protected from tides.

Handling of soils. The handling of soils requires permanent labor because after each harvest the terrain must be dried, lime and fertilizers must be added, and the pool must be filled with water for a new planting. Two or three harvests are made in one year depending on the intensity of production of the shrimp farm. The soil is plowed at the end of each year so that the deepest soil layers get oxygen.

Planting. Once the soil is prepared, the pool is filled with seawater and the planting proceeds; this is done using natural or laboratory larvae. The larvae are transported in special containers that are domestically produced. On the shrimp farm, these containers are received by specialized personnel and transferred to the nurseries using siphonlike tubes, watching that the larvae

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stay alive during the operation. It is a delicate manipulation that must be done by trained workers, who are generally permanent personnel of the shrimp farm.

Growth and harvest. During the growth phase, the following fundamental operations are carried out: transfer of shrimp from the nurseries to the growth pools, control by sampling of the basic biological parameters (density and average unit weight), complementary feeding according to density and age (weight) of the shrimp, and renewal of water.

For these cultivation practices an appropriate handling of water and an efficient drainage system are needed. Handling of water quality refers to such factors as temperature, salinity, pH, and phosphate content. These conditions vary throughout the year and care must be taken so that these variations are in a range compatible with shrimp survival. Monitoring pollution problems is also important since many shrimp farms throw their recycling water in the same estuary.

Another variable influencing the handling of water is the tides. In the extensive-production-system shrimp farms, the tides are used to introduce water in the pools and for indispensable renewal. In the semi-extensive and semi-intensive systems, the action of tides is complemented by pumping equipment, which allows improvement of the water renewal process.

Drainage consists of a collector canal of used water that has lost oxygen. Also, water from rain accumulates in the pools and must be drained through the same collector canal.

Harvest is done manually with fishing nets. Harvest is at night to avoid sun damage to the shrimp: a lamp is used to attract the shrimp, who follow the ray of light. Seasonal workers, in addition to the shrimp farm's permanent personnel, are used during this phase.

Environmental impacts

The environmental interactions of shrimp farming are complex and involve diverse elements of the environment. Mariculture development in Ecuador has involved the outright destruction of mangroves in an important area of the Pacific Coast. The reduction of mangrove area is shown in Figure 20. As a result, natural reproduction of shrimp has been reduced, as well as the availability of larvae for planting in pools. In 1985, around 40% of the pools were not used for this reason.

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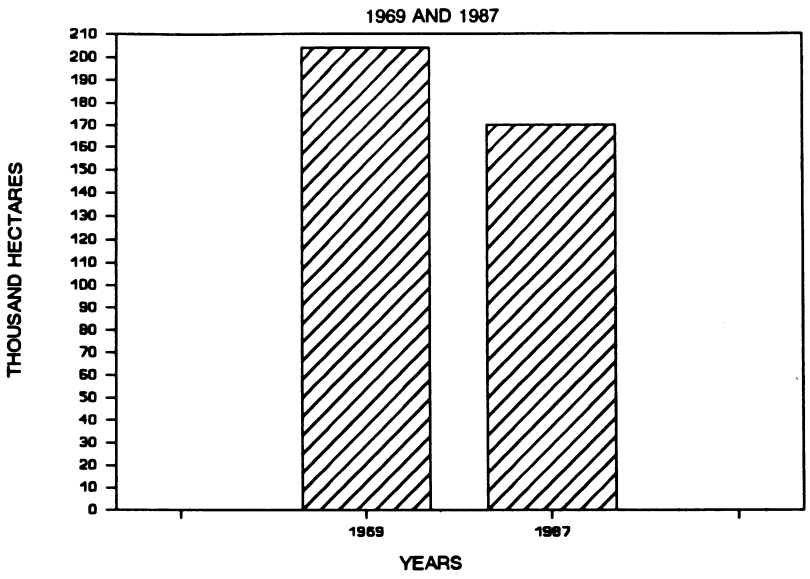

Figure 20. Mangrove area in Ecuador.

The wetlands, including the mangrove ecosystems, are production mechanisms that may play a decisive role in sustainable development strategies and have begun to be recognized internationally. Mangroves perform certain ecological functions (control of erosion), they generate products (fishing, wildlife), and have important attributes such as abundant biodiversity.

The consequences of the loss of these functions, products, and attributes on the Ecuadorian coastal ecosystem are difficult to quantify. No studies on the magnitude and importance of the environmental effects of shrimp development exist. Also, because productivity is unequal and the average is still low, it is difficult to quantify the incidence of changes in the ecosystem on the profitability of the investment.

The selective fishing of impregnated female shrimp for sale to laboratories has modified the pattern of traditional fishing in the region, deteriorating the ecosystem's natural productivity even more. Efforts to produce laboratory larvae of satisfactory quality have not been successful, this being a top priority for profitability of the subsector.

The discharge of residual water into the estuary is another factor affecting the ecosystem, disturbing the equilibrium of water nutrients and causing overfertilization and sanitary problems for the fauna.

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Shrimp production has damaged the poor rural population of the area since they are losing a high-value natural resource. Likewise, the migration induced by the shrimp bonanza has caused conflicts in the use and tenancy of land, the indiscriminate destruction of the mangrove, and the alteration of traditional patterns of fishing and agriculture.

Synthesis and final considerations

The most significant impacts may be grouped in the following categories, which summarize the principal environmental repercussions to be considered in the modernization process of LAC agriculture.

a. **Loss of ecosystems.** Increase in deforestation, loss and fragmentation of habitats, loss of ecosystems of high value (wetlands, tropical forest, mangroves), loss of biodiversity.

b. **Changes in water quality.** Pollution of surface and underground water by agrochemicals, discharges of fluid residuals, disposal of solid residuals.

c. **Conflicts in use of natural resources.** Conflicts in uses of land and uses of water.

d. **Health risks.** Potential danger for the health of workers and people in the area of influence through the handling and use of dangerous chemicals.

e. **Loss of soil resources.** Erosion, loss of soils, loss of nitrogen and phosphorus, salinization of soils.

f. **Social-economic-cultural conflicts.** Migration, disruptions of social and family patterns, displacement of population, marginality, increase in demand for basic services, conflicts with indigenous populations.

The interactions of the LAC agricultural modernization process with these environmental categories are presented in Table 7.

Agricultural modernization in LAC countries may become an important mechanism of a sustainable development strategy for the region. However, the modernization process may create conditions of environmental risk that have a large influence on the sustainability of projects. These risks need to be evaluated in relation to the ecological context and in relation to the long-term sustainability of production.

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Table 7. Environmental interactions of LAC agricultural modernization processes.

	Flowers Colombia	Fruit Chile	Vegtbls Mexico	Shrimp Ecuador	Dairy C.Rica	Grain Argentin	Soybean Brazil
Loss of ecosystems				*			*
Water quality changes	*	*	*	*	*	*	
Conflicts in natural res use	*			*			
Health risks	*	*	*				
Deterioration soil resources	*	*				*	*
Socio econ cultural conflicts	*	*		*		*	*

Design and implementation of public policies to move toward a sustainable agricultural modernization in LAC countries, considering equity and natural resource conservation, require a coordinated participation on the part of governments, development organizations, and the entrepreneurs themselves. These policies will be discussed in the next chapter.

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4

THE ENVIRONMENT AND PUBLIC POLICY

It should be clear from the beginning that the solution to the problem of environmental impacts of agricultural modernization is not to reverse the new trends in macroeconomic and sectorial policies, nor to reverse the export orientation of the economies. The optimal solution is to face these problems directly. If most environmental problems originate from some economic distortion, such as externalities or common-property resources, the proper instruments must be used to resolve these distortions at the sectorial or macroeconomic level. This should be the general guideline for the discussion.

There are two basic types of solution to environmental problems brought about by market distortions in economic activities: governmental policies and concrete actions. Both of these alternatives will be discussed in this chapter.

Limitations of market economies

Obviously, the environmental impacts associated with agricultural modernization involve very important economic aspects. One of the first issues that appears in the discussion is how much government control to apply to check environmental deterioration caused by the modernization process. Aspects to be considered are price policies, output and input prices, and their indirect impacts on production cost increases, profitability, and competitiveness in internal and external markets.

There are limitations in market economies that may make the incorporation of protection of natural resources and the environment in the development process difficult. These limitations have been discussed at large in the literature and they include very low or null value being assigned to ecological capital, private behavior based on the assumption that natural resources are limitless, and strong distortion between private and social benefits and costs. All three limitations provide private economic incentives to overexploit natural resources.

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To this general situation some intrinsic problems in LAC countries should be added. These are the economic crisis of the 1980s and the external debt problem, both of which have provoked the adoption of a strategy based on the "mining" of natural resources.

In addition, underdeveloped market economies have another structural handicap regarding incorporation of the concept of long-term sustainability of production. This comes from the fact that the market tends to define a high discount rate, which undervalues future income flows in favor of present flows. New alternatives to the price system should be looked for that reflect a true valuation of natural resources over time.

The role of private enterprise

The behavior of private enterprises, who are in charge of actual implementation of modernization projects, may vary in relation to the environment according to the type and size of the investment project and the country. The ideal private enterprise is an institution that coordinates the transformation of inputs (natural resources, land, labor, and capital) into outputs using the best available technology. This transformation is always motivated by an explicit objective of profit maximization. Unless the enterprise is convinced that lack of environment protection and natural resource conservation will affect their medium- or long-term profits, environmental protection plans will have very low priority and a low probability of succeeding.

Whenever the impacts refer to common property resources, private enterprise will try to avoid any responsibility in terms of costs for environmental protection. It is thus a responsibility of government to account for environmental costs in defense of society, and to implement an adequate environmental policy to regulate the use of common property natural resources by private enterprises. This environmental policy will imply measures of environmental protection such as rules, norms, and taxes.

The entrepreneur will direct efforts and innovations to implementation of environmental programs and natural resource conservation only if he or she is convinced of the need for the additional investment and that his or her own benefit is at stake. An environmentally friendly behavior, however, may be induced through appropriate incentives and public policies. Furthermore, the concern with natural resources and the environment could be seen, on the part of the entrepreneur, as a strategy for market participation and for creating good public image for the enterprise.

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The role of government

Governmental policies must promote the development and conservation of natural resources. The policies should be complemented with schemes that lead toward the internalization of externalities by private firms. Some policies that have been identified as most appropriate for moving toward sustainable agricultural development are discussed below (IICA 1991a). The basic instruments of policy, as well as the expected favorable impact on resource conservation and the environment, are listed. These policies should be examined in light of the central hypothesis and the findings of this study.

Macroeconomic policies

A consistent policy of exchange rate devaluation in real terms will have an expected impact of making sustainable agricultural investment projects more profitable and the use of imported inputs (primarily agrochemicals) less profitable. Also, a policy of low real interest rates will make long-term investments more profitable, thus helping sustainable projects.

A tariff policy of low and uniform duties ("flat" tariff), unbiased against primary activities, will make sustainable agricultural investment more profitable and, again, imported inputs less profitable.

Finally, application of environmental taxes by the government will provide much-needed resources to implement sustainable policies and programs.

Sectorial policies

A policy of continuing the present trends toward liberalizing food prices will help to make agriculture more profitable, creating incentives for not "mining" rural resources and promoting conservationist practices.

A credit policy that provides specific subsidies for financing sustainable practices in agriculture will have an impact on new investment in soil conservation, and investment in perennial, more sustainable, crops.

Likewise, a high price for irrigation water will encourage a more efficient use of water; and the elimination of subsidies on fertilizers and pesticides will encourage a more rational use of agrochemicals.

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Finally, a strategy of restricting road construction in specific areas, the Amazonian region for instance, will help to reduce present trends toward deforestation and colonization.

Legal framework

A policy of granting land titles to medium-sized and small farmers of the region will go a long way toward making long-term investments more secure and profitable, as well as encouraging a more environmentally friendly conduct by these producers.

The creation of more areas of protected reserves will assure a more rational use of land by society.

The issuing of "gene pool" legislation protecting copyrights will provide incentives for private investment in gene diversity. Likewise, the passing of more restrictive pesticide legislation will promote a prudent and rational use of these chemicals.

Finally, land market ordering will convey a more rational use of land.

Social policies

Public and private education will help to raise environmental awareness and consciousness among people from all population groups. A public policy oriented toward generation of job opportunities and employment will contribute to reduce antienvironmental activities in the rural areas.

Actions to avoid or minimize environmental impacts

Besides economic policies, there are concrete actions a government may take to deal with environmental problems brought about by market distortions in economic activities. The negative environmental impacts described in the previous chapter could have been greatly avoided if appropriate actions had been taken, on the part of the enterprises themselves or on the part of the government or society as a whole. A list of the actions, measures, and controls that could avoid, minimize, or compensate the identified environmental impacts are discussed in this section.

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The ecological risks of agricultural modernization, discussed in the previous chapter, may be divided in the following categories: (a) damage to ecosystems, (b) pollution, (c) danger to human health, (d) soil resource deterioration, and (e) social conflicts.

Regarding ecosystems, the principal environmental impacts are increase in deforestation; loss of habitats and high-value ecosystems such as wetlands, tropical forests, and mangroves; and loss of biodiversity. The actions proposed to deal with these damages are better agroecological zoning; creation of protected reserves; better control of natural resource use; and control of further colonization, especially regarding the opening of new roadways.

Regarding pollution, the most important impacts are pollution of surface water, pollution of underground water, discharges of residual water, and elimination of solid wastes. The proposed actions are regulation of use of pesticides, norms and controls for fluid residuals, recycling of solid wastes, rationalization of water use, and monitoring of water quality.

Regarding potential dangers to human health, the proposed actions are regulation of use of pesticides, biological control of plagues, and monitoring of health.

Regarding soil deterioration, the most important issues are erosion and loss of soils, loss of nitrogen and phosphorus, and salinization of soils. The proposed actions are crop rotation, use of conservation practices on soils, appropriate cultivation practices; and avoidance of overgrazing.

Finally, regarding social conflicts, the impacts are migration, disruption of social and family patterns, increased demand for basic services, and conflicts in use of land and water. The proposed actions are environmental education, social assistance, regional development planning, land market ordering, regulation of water use, and titles on land.

The role of development organizations

International organizations should require the inclusion of an environmental component in investment projects and sectorial programs to be financed by their resources. These should be compulsory and must include the following: environmental assessment of agricultural projects and sectorial programs, mechanisms to assure compliance by borrowing countries with requirements and environmental norms; dissemination of information on appropriate

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technologies, and dissemination of relevant experiences from different countries on the management of natural resources in agricultural projects.

The case of water depletion in Colombia

As an application, we present here a policy analysis concerning the case of water resources in Colombia. It was seen that intensive use of water in Bogota's Savanna has caused a depletion of the underground water table, creating conflicts among flower producers, other farmers, and urban areas. The problem is aggravated by the fact that the water-bearing zones of the Savanna are being subject to a deforestation process and urban expansion. Bogota's Savanna is becoming dry because limited water resources are not only being used for growing crops but also for homes and factories in the growing city of Bogota.

Every year the wells in Bogota's Savanna are getting deeper and every year more water is needed. Even though the groundwater may be replenished through precipitation, the stock resource may be in danger of exhaustion.

Specialists often prescribe as a "sustainable yield" a quantity of extracted flow that is equal to the average amount being replenished, so that the stock is never "mined." However, this does not account for the fact that values attached to water may change over time and a discount rate should address the optimum use over time. In addition, new sources of water may be developed in the long run.

A proposal for a socially desirable policy would have to consider the principles involved in the typical groundwater management model in the short-term. This will require implementing new, aggressive price policies for the resource. This social policy would also involve taking serious steps toward correcting the situation in the long run.

New price policies

Water prices will have to increase to promote a prudent use of water. If water prices increase enough, the demand for growing crops and for city use will certainly decrease. Since water is a common-property resource, the state has the authority to price it and/or tax it.

Today there is no price attached to underground water in Colombia. However, there is a cost for pumping the underground water, which is borne

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by farmers who own wells. Conceptually, farmers pump out water until the marginal cost equals the value of the marginal product of water in growing flowers or food (in the margin the marginal product value will be equal for all uses of water). The policy that has to be implemented is to estimate a tax on water that would increase the private marginal cost to make it equal to the social marginal cost of water.

One basic condition for optimum management of the resource would require that the marginal value of water, determined by the demand function, should be equated to the sum of unit pumping cost plus the scarcity rent on the water. This basic condition may be achieved by imposing a pumping tax equal to the scarcity rent.

Assume that a given percentage is found to be the tax that at present makes private costs equal social costs. (This value should be estimated from a management model to be developed.) It is proposed here that the revenues collected from this tax should provide the funds for developing a project that will solve the scarcity problem over the long run.

Bringing water to Bogota

Prices may achieve equilibrium in the short run by adjusting present demand levels to availability. However, the city of Bogota will grow and more food will be needed or more foreign exchange to import the food, increasing the need for more exports of cut flowers. The long-term solution will be to develop a project to move water into Bogota's Savanna from other basins. This project may require building a dam, a reservoir, and an aqueduct that will carry the water through pipelines, canals, and/or tunnels. A social cost-benefit analysis of this project will have to be made internalizing all external costs to the environment.

Alternatively, one may consider that at present there is a hydroelectric project being developed to provide energy for Bogota *(El Guavio)*. The proposed project of bringing water to Bogota could be formulated as an extension of this energy project and the social cost-benefit analysis of this irrigation and water-supplying project could be done accordingly.

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STATISTICAL APPENDIX

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Table 1. Agricultural modernization in Latin America: Production figures.

	Unit (tons)	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
CHL fruit	Million	1.3	1.1	1.1	1.3	1.4	1.4	1.3	1.2	1.3	1.4	1.5	1.6
CRI milk	Thousand	178	186	194	202	219	210	248	259	280	299	310	316
MEX vgtbls	Million			1.6	1.9	2.2	2.3	2.5	2.3	2.2	2.6	3.3	3.6
ARG grain	Million	19.6	18.7	24.3	22.9	16.8	27.1	26.9	22.1	23.8	31.7	29.2	31.3
BRA soybean	Million	0.7	1.1	1.5	2.1	3.2	5.0	7.9	9.9	11.2	12.5	9.5	10.2
COL flowrs	Thousand	0	0.2	0.7	1.5	2	6	10	12	15	20	27	33
ECU shrmp	Thousand							4.5	5.4	5.2	5.8	7.5	

	Unit (tons)	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
CHL fruit	Million	1.6	1.7	1.8	1.9	1.8	1.9	2.0	2.1	2.2	2.3	2.5
CRI milk	Thousand	318	320	307	337	357	377	391	399	408	420	430
MEX vgtbls	Million	3.2	2.6	3.0	3.4	4.1	3.8					
ARG grain	Million	25.1	35.4	34.1	40.9	41.0	43.9	38.2	32.7	37.0		
BRA soybean	Million	15.2	15.0	12.8	14.6	15.5	18.3	13.3	17.0	18.0	24.1	20.0
COL flowrs	Thousand	37	37	38	43	48	57	70	78	87		
ECU shrmp	Thousand	10.1	12.4	17.9	25.4	23.2	21.7	35.4	61	65		

Source: SIAPA, Program I, IICA.

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Table 2. Harvested area of soybean in Brazil, by region (million has).

	1968	1969	1970	1971	1972	1973	1974
MiddleWest Region	0.0	0.0	0.0	0.1	0.1	0.2	0.3
Traditnl Region	0.7	0.9	1.3	1.7	2.1	3.5	4.9
Total	0.7	0.9	1.3	1.7	2.2	3.6	5.1
	1975	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**
MiddleWest Region	0.3	0.2	0.5	0.6	0.8	1.1	1.2
Traditnl Region	5.6	6.2	6.6	7.2	7.5	7.6	7.3
Total	5.8	6.4	7.1	7.8	8.3	8.8	8.5
	1982	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**
MiddleWest Region	1.4	1.6	2.3	2.9	2.8	2.8	3.3
Traditnl Region	6.8	6.5	7.1	7.3	6.4	6.3	7.2
Total	8.2	8.1	9.4	10.2	9.2	9.1	10.5

Source: SIAPA, Program I, IICA.

Table 3. Cattle stock and land use in Costa Rica.

	1968	1969	1970	1971	1972	1973	1974
Cattle Stock(Mlln)	1.4	1.4	1.5	1.6	1.7	1.8	1.7
Pastures (Mlln has)	1.2	1.3	1.4	1.4	1.4	1.6	1.6
Forests (Mlln has)	2.7	2.6	2.6	2.5	2.4	2.4	2.3
	1975	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**
Cattle Stock(Mlln)	1.8	1.8	1.9	2.0	2.1	2.2	2.3
Pastures (Mlln has)	1.6	1.7	1.8	1.9	1.9	2.0	2.1
Forests (Mlln has)	2.2	2.1	2.1	2.0	1.9	1.8	1.7
	1982	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**
Cattle Stock(Mlln)	2.3	2.4	2.4	2.4	2.3	2.3	2.2
Pastures (Mlln has)	2.2	2.2	2.2	2.3	2.3	2.3	
Forests (Mlln has)	1.6	1.6	1.6	1.6	1.6	1.6	

Source: SIAPA, Program I, IICA.

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Table 4. Pesticide consumption in Mexico (thousand tons).

	1974	1975	1976	1977	1978	1979
Carbamate	2.4	2.5	2.7	2.9	1.8	3.2
CarbamateHrb	0.0	0.0	0.0	0.0	0.0	0.1
DithioCarbamate	0.4	0.5	0.5	0.5	1.0	0.7
Carbamates Tot	2.8	3.0	3.2	3.5	2.8	4.1
Copper	0.0	0.0	0.0	0.0	0.0	0.8
	1980	**1981**	**1982**	**1983**	**1984**	**1985**
Carbamates	2.1	2.2	2.1	1.7	1.5	1.2
CarbamateHrb	0.1	0.1	0.1	0.2	0.1	0.2
DithioCarbamate	1.3	3.8	3.4	3.3	3.7	4.1
Carbamates Tot	3.6	6.1	5.6	5.2	5.3	5.5
Copper	1.5	1.7	1.7	1.7	1.7	3.0

Source: SIAPA, Program I, IICA.

Table 5. Pesticide consumption in Brazil (thousand tons).

	1974	1975	1976	1977	1978	1979	1980	
OHerb ConsVol	15	22	24	14	17	17	25	
OInsec ConsVol	45	42	29	29	32	31	24	
OFungi ConsVol	40	14	17	18	13	20	25	
Total Consmptn	101	78	69	61	62	68	74	
	1981	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**
OHerb ConsVol	23	19	17	20	18	23	22	27
OInsec ConsVol	15	12	10	17	18	22	21	16
OFungi ConsVol	17	14	15	18	21	23	20	17
Total Consmptn	55	45	42	55	56	67	63	60

Source: SIAPA, Program I, IICA.

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Table 6. Imports of pesticides in Chile (million dollars).

	1968	1969	1970	1971	1972	1973	1974	
ImportsTotalVal	2.4	4.0	4.8	2.5	4.9	7.9	8.6	
	1975	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**
ImportsTotalVal	5.2	4.9	7.5	9.0	15.0	20.2	21.2	12.5
	1983	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
ImportsTotalVal	25.2	20.0	33.2	38.0	52.6	53.4	55	51

Source: SIAPA, Program I, IICA.

Table 7. Use of agrochemicals in the grain subsector in Argentina.

Year	Pesticides Thousand$	Fertilizers Urea	Diam.Phosphate	(ThousTons) Suprphosphates
1970-72	12			
1978-80	53	10	15	0
1983-85	115	38	54	0
1989-90	167	68	47	9

Source: Obstchatko 1991.

Table 8. Static levels of underground water in Bogota's Savanna.

Zone	Before 1980 mts	1990 mts
Subaioque	20	65
Boja	20	70
Madr	20	90
Facativa	20	100

Source: Quintero 1991.

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Table 9. Distribution of Brazilian citrus producers by size and participation in production.

Area (has)	Number of citrus producers	% producers	% production
<10	10,799	27	7
10-99	23,822	59	50
100-500	5,563	14	31
>500	44	0	12
Total	40,228	100	100

Source: Rascunho 1992.

Table 10. Frozen concentrated orange juice industries.

Industries	Capacity (million boxes)	Participation in exports 1983	1988
Citrosuco	100	39	30
Cutrale	86	33	27
Cargill	42.6	10	9
Frutesp	32.4	7	10
Others	50.5	11	24
Total	311.5	100	100

Source: Rascunho 1992.

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Table 11. Brazilian exports of FCOJ by destination country (Porto de Santos).

Destinatn	1988 ThousTns	1988 %	1989 ThousTns	1989 Thous$	1989 %	1990 ThousTns	1990 Thous$	1990 %
USA	258	38.9	267	362	36.9	282	478	40.0
Canada	45	6.8	48	66	6.7	35	62	5.2
N America	303	45.6	315	428	43.6	317	540	45.2
Holland	194	29.2	200	275	28.0	203	357	29.9
Belgium	104	15.7	105	151	15.4	92	147	12.3
Germany	17	2.6	17	24	2.4	28	43	3.6
France	1	0.2	1	1	0.1	1	1	0.1
Other EEC Countries	11	1.7	9	12	1.2	8	13	1.1
EEC	327	49.2	332	463	47.1	332	561	47.0
Japan	9	1.4	25	35	3.6	26	46	3.9
S. Korea	0	0.0	15	20	2.0	12	20	1.7
Australia	7	1.1	6	9	0.9	1	2	0.2
Israel	2	0.3	5	7	0.7	5	9	0.8
Finland	2	0.3	3	5	0.5	3	5	0.4
Other Devel. Countries	14	2.1	10	15	1.5	6	11	0.9
Rest of Countries	34	5.1	64	91	9.3	53	93	7.8
Total	664	100.0	711	982	100.0	702	1194	100.0

Source: Rascunho 1992.

Table 12. Necessary investment in orange plantations in Brazil.

Item	US$/ha	%
Land	1741	50
Plantation	1414	41
Interest	127	4
Equipment	201	6
Total	3483	100

Source: Rascunho 1992.

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Table 13. Structure of operational costs in Campinas, Brazil.

Item	US$/Box	%
Fertilizers	0.45	31.5
Pesticides	0.51	35.7
Mach. operation	0.23	16.1
Labor	0.09	6.3
Management	0.15	10.5
Total	1.43	100.0

Note: Productivity assumed: 750 boxes/ha.

Source: Rascunho 1992.

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The Agricultural Policy Analysis and Planning Program seeks to collaborate with LAC countries in defining and evaluating alternative strategies for agricultural development; contribute to improving the capacity for analysis and follow-up in the execution of agricultural policies; and strengthen the organization and management of national institutions charged with agricultural sector planning.

The Program stresses that agriculture, in the context of current international economic conditions, is a key element in the achievement of beneficial economic development. As the agricultural sector increasingly becomes an engine of economic growth, the careful formulation of appropriate sectoral policies takes on new importance.

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