4 Farmer and Industry Funding of Agricultural Research in Colombia

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Abstract

Introduction

Colombia, like most Latin American countries immediately after the Second World War, used the import-substitution approach to development. In the case of agricultural products for export, production was organized in plantations, using technology imported from abroad. Agronomic and mechanical practices were introduced and adapted, as well as some organizational and managerial methods. A typical example was banana production, managed by multinational companies. Later, during the early sixties, flower production and exports were organized in the same way, adapting foreign technology by investing domestic capital.

Food and raw material production for domestic use was divided among commercial producers who concentrated mainly on grains and cotton, and subsistence producers growing mainly potato, tubers and some horticultural species. Agricultural research for these two groups was largely financed and executed by the public sector. However, from the 1920s, several producer organizations have created special levys or levies on output to finance part of the research, mainly adaptive research. The trend toward farmer financial support to agricultural research, reached a peak around 1980.

Coffee was the first industry where farmer financing of research and development (R&D) was employed. In 1938 a coffee experimental station was established by the Coffee Growers Association. In 1948, cotton producers began to finance activities related to the introduction and testing of commercial varieties. In 1963, a special rice levy was approved by the Rice Grower Association to finance research and seed multiplication. Following the same model, the sugarcane industry began funding in 1967 a national sugar research station to combat a virus disease that was threatening local production. In 1985, the Cereal Producer Association (maize, wheat, barley) and the oil palm producers took the same approach followed by the flower, grape, and shrimp producers in the early 1990s. Table 1 summarizes information on the levy paid by producers, and the structure of each industry.

This chapter summarizes the most successful of these efforts by Colombian agricultural producers to finance research. Lessons learned from this experience are presented and some implications for the future explored.

The Cases

Coffee

Coffee producers concluded that the only way to capture an emerging international market was the consolidation of marketing in order to reduce transactions and transportation costs. A levy on exports, to be administered jointly by the national government and the producer association, was established in 1934. Revenues from this levy were used to promote production, through credit, to build marketing and export infrastructure, and to finance a coffee research station. The Colombia government delegated all responsibilities related to agricultural research, production promotion, and export market development to the Coffee Producers' Association (FEDECAFE).

The export levy is administered by the National Congress of Coffee Producers. An annual budget is approved, which includes an appropriation for research of around 12% of the revenues collected, although the amount varies from year to year, depending on coffee prices. However, in general, financial resources for research have been stable.

The resources allocated to research are administered by a Board of Directors formed by producer representatives from different coffee regions. Managers of the coffee research program present an annual work plan to the Board built around projects. Since 1990, the annual research program has been discussed and validated with municipal coffee regional committees, in order to respond to local demands.

Coffee research has concentrated on the development of agronomic practices designed to improve product quality, a variable considered as strategic in international markets. Later, producers recognized the risk of rust disease and assigned resources to breeding rust-resistant varieties. In both cases, researchers were successful and coffee research was taken as a model for other industries.

Although no comprehensive evaluation of investment in research by FEDECAFE has been made, the impact of research is demonstrated by the cases of coffee rust and the coffee berry borer. In Colombia, coffee is grown in areas with cool climates that favor rust development, which appeared for the first time in the Americas in 1970 in Brazil. To solve the problem of coffee rust, a resistant variety, 'Colombia', was developed and disseminated. Although rust reduced yields by 10-20% on local varieties, the improved variety 'Colombia' receiving no control yielded the same as local varieties treated with fungicide. The evolution of the disease and the rapid adoption of the improved variety with associated benefits is shown in Table 2 and Figure 1. The internal rate of return to the research investment varied between 12% and 31%, depending on the control method used.

The coffee berry borer, the major insect pest attacking coffee worldwide was detected in the Americas in 1913 in Brazil and has been causing serious problems in Colombia since its appearance in 1988 (Bustillo 1990). In 1999, the borer was found in 400 municipalities, encompassing 380,000 coffee farms

and 715,000 ha (Herrón 1998). The borer, in addition to reducing coffee production by destroying the bean, also causes fruit to fall, increases the proportion of grain broken during processing, and alters beverage flavor. Development of a resistant variety was not possible so FEDECAFE accepted, as policy, to develop and use an integrated pest management system that included the collection of borer-infested beans, spraying coffee trees with the fungus *Beauveria bassiana*, and releasing the beetle *Cephalonomia stephanoderis* to attack the borer. Insecticide applications were to be used according to established infestation levels that are determined through periodic samplings. This program required considerable training of extension workers to disseminate. While the program had considerable impact, adoption was incomplete due to the complex set of practices involved.

Rice

In 1963, rice producers followed the coffee model when a rice levy, collected at the mill gate, was established. A large percentage of the levy revenues was used to promote the use of improved varieties for irrigated rice, developed by the national research institution, now called CORPOICA, and the application of a technical package, based on the intensive use of fertilizers and other agrochemicals, to control emerging pests and diseases. Multinationals firms protected by import licenses and controls, assembled the technical package.

The rice levy is managed under a National Council which has equal representation from producers and government officials. The producer representatives are appointed by the Rice Producer Association and the government representatives are officials from the Ministry of Agriculture, the National Planning Agency and the National Treasury. The revenues from this levy are distributed among research, transfer of technology, and marketing. The Rice Producer Association must present an annual program and budget that allocates resources across activities according to the relative severity of technical problems at the farm level and marketing bottlenecks.

The Rice Producer Association has experimental sites in all the main producing regions. Local farmers are invited to identify the major local constraints and problems and to evaluate the results. Consequently, the rice research agenda is no longer structured to meet a single national objective, but to confront local problems.

The rice levy for research have been used to address three interrelated objectives. First, they financed an extensive network of trials to adapt and evaluate advanced lines developed in the public national rice program. This program was aimed at obtaining high yielding varieties, as well as incorporating resistance to major pests and diseases. Second, the rice levy financed the development of a technological package, based on the use of agrochemicals to control weeds, a major constraint to rice production in tropical areas. Third, it financed the establishment of a seed multiplication and distribution network.

The increased R&D made possible by the levy was a success story. Rice production increased threefold from 1963 to 1983, and the domestic market was satisfied with cheaper, high quality rice. Rice agronomic practices, irrigation and harvesting were mechanized. An input market developed to meet the

increasing demand for commercial inputs. National average yields jumped from 2.4 t/ha in 1963 to 4.2 t/ha in 1983. However, when domestic production exceeded domestic consumption, the national government was forced to implement subsidized market interventions, and domestic prices were tied to production costs. Since 1983 rice production in Colombia has been stable, with an annual growth rate similar to human population growth. Colombian rice producers have been able to compete in the national market, but not in the international markets.

With the collapse of the public-sector rice research program in the late 1980s, it was necessary to use part of the rice levy to finance more upstream research, in collaboration with several international rice research programs. In 1995, Colombia promoted the creation of a Latin American Irrigated Rice Research Fund (FLAR). This fund has allowed the continuation and strengthening of the irrigated rice research in the region. Nine Latin American countries make annual contributions to the fund, on the basis of their national rice production. In order to speed up the operations and improve efficiency, FLAR has adopted a strategic alliance with an administrative council governed by the International Center for Tropical Agriculture (CIAT). This alliance allows FLAR to use CIAT's research agenda, access to the international nurseries and to use the research facilities at CIAT headquarters.

After five years of operation FLAR is showing concrete results. In most countries new varieties have been delivered. These varieties are adapted to the biological and physical constraints of each country. Also, training has been a very important instrument to improve the managerial efficiency of all producers.

The impacts of the Colombian rice research program have been evaluated several times and in all cases the results have been positive. Indicators such as the internal rate of return showed that the investment was profitable both from the private and social points of view. These evaluations have also shown that both producers and consumers received positive benefits from the rapid technical change. However, subsistence-oriented upland rice producers, that were not able to adopt the new technology, suffered losses due to lower prices.

Sugar

The Colombian Sugarcane Research Center (CENICAÑA) was founded in 1977 to contribute to the development of the Colombian sugar industry. This center is financed through levy funds paid by the eleven sugar mills and 1,400 individual sugar producers who form the Colombian Association of Sugar Producers (ASOCAÑA). The annual budget allocated to CENICAÑA represents 0.55% of total sugar sales and has averaged about US$ 2.5 million per year during the 1977-97 year period. This budget has been increasing during the last five years as a result of the expansion in planted area (Table 3 and Figure 2). In addition, the percentage of total sales allocated to CENICAÑA is expected to increase to 0.70% during the next three years (CENICAÑA 1998).

The research agenda has been historically established by the owners of the sugar industry, represented by a board of trustees of 12 members (one for each of the eleven sugar mills and one representing the sugar producers). The backbone of the research agenda has been the development of improved varieties with increasing sugar content, earlier maturity, and resistance to economically important diseases. During the last 10 years, emphasis has also been placed on the development of varieties which defoliate and that are erect in order to facilitate mechanical harvesting (CENICAÑA 1998).

This research agenda has resulted in the introduction, validation, and development of several improved varieties which have significantly improved the performance of the sugar industry during the past 21 years, increasing productivity by 71%, reducing harvest time by 43%, and increasing sucrose content in

cane by more than 7% (Table 4). All these factors have made the industry more competitive, resulting in a 54% increase in planted area from 122,000 ha to 188,000 ha.

These changes in productivity as a result of research investment have produced important benefits to the industry which are estimated to be around US$266 million from an investment of $53 million, which gives an internal rate of return of about 27% (Figure 2). It is expected that the benefits will continue to increase as the remaining planted area to sugarcane (i.e., 39%) is replaced with newer superior varieties developed by CENICAÑA.

Oilpalm

Research funds for CENIPALMA also come from levy funds equivalent to 0.5% of the total value of production. These funds are complemented with small allocations from other investors which represent about 10% of levy funds. Most of the research is executed in private plantations according to priorities established by a technical advisory committee with experts from CENIPALMA and the institutions. The Government of Colombia, which was responsible for collection of the levy, was difficult to implement, and the legal status of the fund opened a case to other problems and sources of funds. Recently, CENIPALMA has been specialized in a public law similar to the acquired. Based on this law, CENIPALMA was able to access negotiating funds, but the government has the custody of the oil palm levy funds being collected as well as to participate in the allocation of these funds. Currently the government has a limited representation in the management bodies of the fund.

Research contributed to changes in the oil palm production (Table 4). Most of these funds were allocated to industry development and integrated pest and disease management and capital and labor productivity. However, during the 1990's industry growth was explained by increase in the area of oil palm. In this period, the area increased 2.9% per year, while productivity increased from 13.0 to 17.4 t/ha (Table 4). In spite of the 30% per year research investment (CENIPALMA 2000), almost (over 80%) of the research had to be outsourced (CENIPALMA 2000).

Oil palm production expanded on large private commercial plantations. Since 1990, CENIPALMA has been promoting production in small farms through the creation of community-owned extraction palms and collective marketing. Small producers are expected to pay the oil palm levy.

Lessons Learned

The private sector, mostly farmers but also processors, invested in areas where research and technology transfer could quickly obtain a return on investment either by increasing yields or reducing production costs. The profitability for the privately-funded research was high because the most expensive investment was allocated by publicly-funded institutions.

Non-Government Organizations (NGO's) and the private sector employ about one-third of all research scientists in Colombia. However, these individuals were educated and trained by CORPOICA in the past. Most of them are working for CORPOICA (CORPOICA 1999). Although the private sector has been investing in research, the amount is still very low. Only 1.7% of all PROMATECA's budget is for research. The private sector has shown little interest in investing in the last 20 years, which justifies the analysis of mechanisms for a better distribution of benefits among producers.

Critical Issues To Face In The Future

Research & Development Challenges

Private investment in agricultural R&D activities will face several challenges in the near future. With globalization of agricultural markets, productivity criteria will have to be complemented with other parameters such as product acceptability and efficiency within the agricultural food chain. Also, emerging international trade restrictions derived from the sustainable use and preservation of natural resources will call for a research agenda that could meet simultaneously land intensification and environmental objectives. Finally, it is expected that agricultural R&D activities will help to alleviate poverty and reduce income inequalities, through the creation of new investment opportunities, which must have a bias towards the use of the most abundant production factor, labor. This last challenge will require a significant investment of private funds. New investments are needed specially in tropical fruits and forestry.

The main constraint faced by private investors is the continuing weakness of the overall agricultural research system within Colombia. Public funds play an important role in providing the basic and strategic research output to increase payoffs to private investments. Similarly, most scientific human resources were trained in public universities and in public research institutions. The private sector has been able to draw from this stock the most talented and promising researchers. However, due to current fiscal restrictions and the new government role as facilitator and coordinator, these sources are being depleted. Therefore, private investments in basic research and human development will be needed and appropriate incentives need to be put in place.

Development of social capital

The crisis of the agricultural sector has demonstrated how fragile is the social capital in the rural sector and how easy it was destroyed with the trade liberalization policy implemented by Colombia since the early 90's. Besides the low economic returns obtained from the agricultural sector, the greatest impact was produced by the destruction of social capital that generated trust and confidence among bankers, entrepreneurs, marketing agents, technical support people, and producer organizations. Five decisions lead to this situation:

Urban bias in government services: The Colombian government was conscious that an overvalued exchange [illegible]

[illegible] agreed to buy the national crops, and producers had more access to credit. However, with free-trade agreements starting in the early 90's, these alliances were eliminated by the industry since they were free to buy raw materials anywhere in the world without any agreements. This situation occurred with cotton, sorghum, corn, and rice. Therefore, given the insecurity of the internal market, the financial system reduced the amount of credit allocated. This situation forced producers to make individual agreements with input suppliers which then bought the crop from producers at prices

employment. In addition, the systematic reduction in real incomes of most producers implies they are not able to allocate resources to co-finance this modernization process.

Efficiency in the allocation of resources

The level of long-term international competitiveness is based on the capacity of the productive system to incorporate new technologies and to allocate reserve funds to withstand low price cycles and climatic adversity. In addition, the private sector needs to consider the externalities caused by the effects of their production systems and detect those areas where marginal investment in natural resource management will contribute to maintain long-term competitiveness.

Small producers are not able to make this change by themselves and require the support of other sectors of society to help them in the efficient administration of these resources through strategic alliances.

This will require research to identify the best-bet opportunities and to obtain the greatest benefit from available resources.

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Table 1. Summary information of levy paid by producers, mean farm size of producers, the decision-making process of establishing a research agenda, and their effectiveness compared to the public sector.

Attribute	**Coffee**	**Rice**	**Sugar**	**Oil palm**
Mean farm size of producers (ha)	2	10	98	580**
Levy on producers (% of output value)	*	0.50	0.55	0.5
Who makes decision on research priorities?[1]	BOT and MCRC	BOT	BOT	BOT and RC
Proportion of research agenda contracted out (%)	< 10	<10	< 10	<10
Effectiveness of research compared to public sector[2]	Higher	Higher	Higher	Higher

[1] BOT = Board of Trustees; MCRC = Municipal Coffee Regional Committees; RC = Research Committee of the federation of sugarcane producers in the Cauca Valley.

[2] Defined as the effectiveness of the process of problem identification and feedback mechanisms from experiments. Although by-product research is negotiated each year based on the export price for coffee. Estimated figures based on USDA.

* No impact fund. Annual budget for research is negotiated each year based on the export price for coffee.

** Average farm size of 750 members of FEDEPALMA.

Table 2. Area affected by rust and area planted to the rust-resistant, improved coffee variety 'Colombia'

Year	**Rust-infected area (ha)**	**Percentage of nation's crop**	**Area planted to improved variety 'Colombia' (ha)**
1982/83	5,383	0.5	207
1983/84	30,462	3.0	863
1984/85	331,703	32.9	2,756
1985/86	523,000	51.8	5,059
1986/87	688,000	68.2	11,383
1987/88	800,000	79.2	21,055
1988/89	869,517	80.1	54,282
1996/97	300,543	25.8	215,036

Source: FEDECAFE, cited by Farfán (1999).

Table 3. Changes in productivity of sugarcane due to research in the development of new varieties during the period 1977-97 in Colombia

Variable	**1977**	**1997**
% of planted area to varieties introduced and evaluated by CENICAÑA	0	61
% of planted area to varieties developed by CENICAÑA	0	22
Yield (mt sugar/ha/yr)	7	12
Harvest age (months)	18	12.6
Sugar yield (%)	11.0	11.8
Area (ha)	122,000	188,000

Source: CENICAÑA (1998)

Table 4. Returns to research in the Colombian Oil palm industry during the period 1990-1999

Indicator	
Investment in research (million US$ of 1999) - Oilpalm industry - Other investors	 10.8 1.7
Yield (mt/ha) - 1990 - 1999	 13 17
Oil extraction rate (%) - 1990 - 1999	 18 21
Planted Area (ha) - 1990 - 1999	 86,000 150,000
Economic Surplus due to Research - Agriculture - Industry - Total	 29.0 6.8 35.8
Generation of employment due to research (man-days in 1999) - Agriculture - Industry - Total	 7,779 3,182 10,961

Source: Estimated by authors from CENIPALMA (2000).
Source: Jaramillo and de Angel (1999).

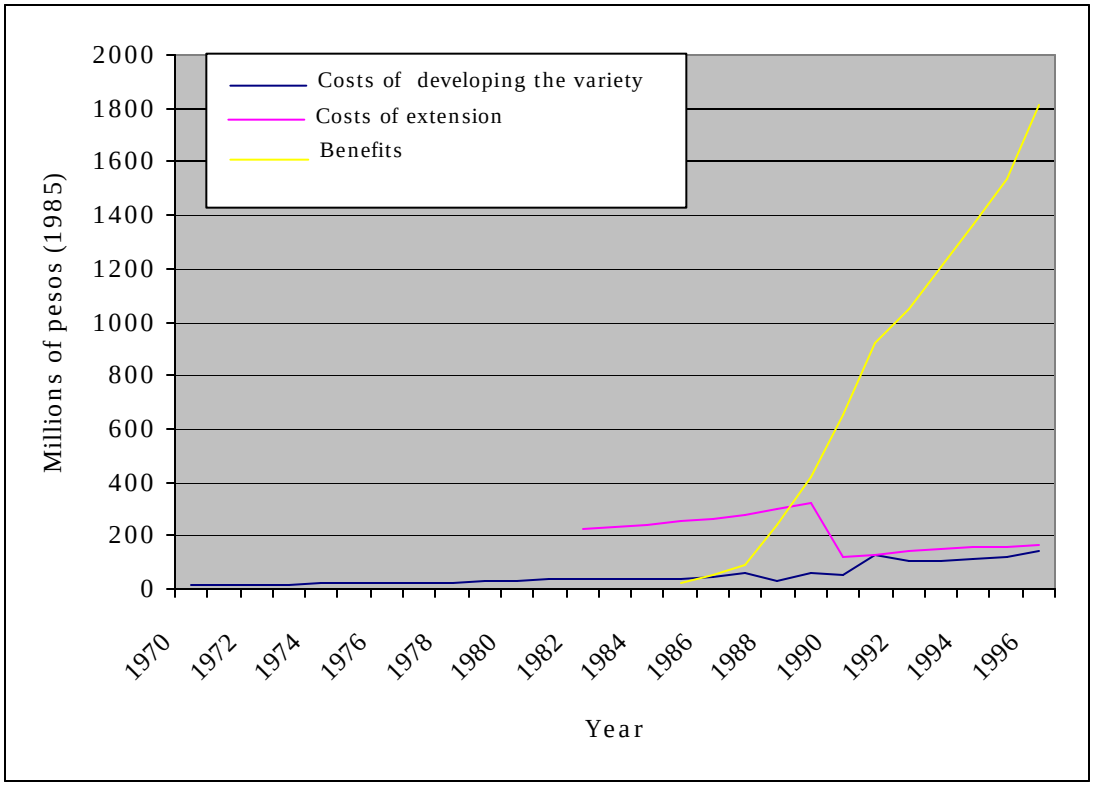

Figure 1. Costs and benefits of developing and transferring the coffee rust-resistant variety 'Colombia'

Source: Farfán (1999).

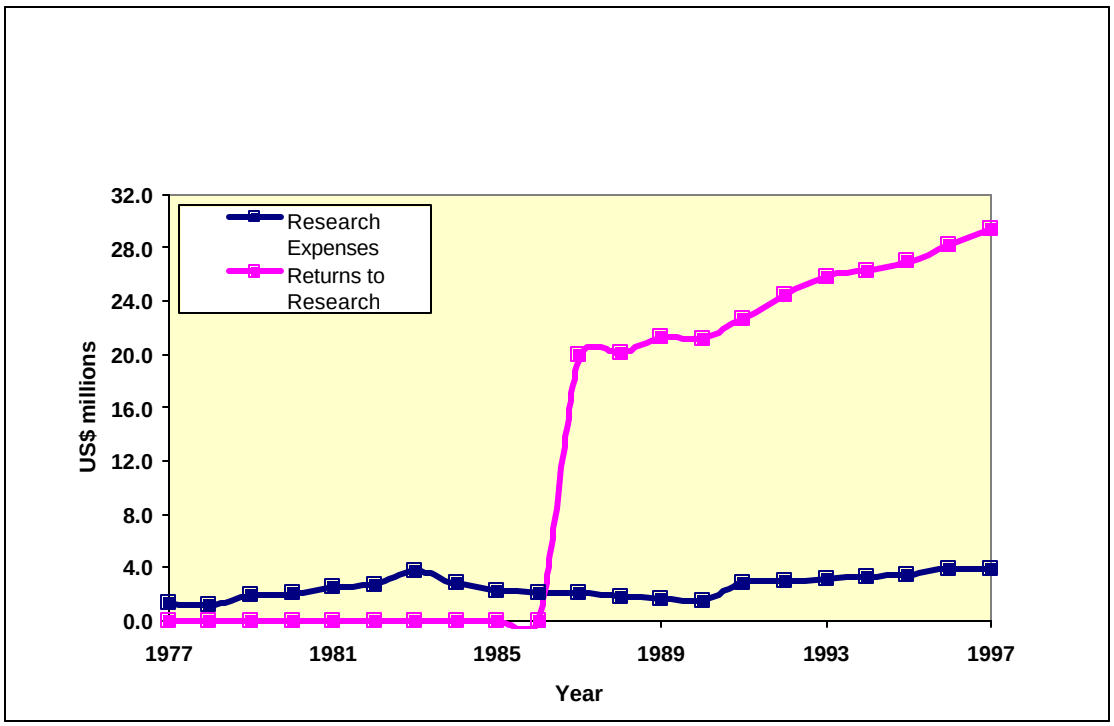

Figure 2. Annual budget of CENICAÑA and estimated returns to research from increased productivity (in constant US million dollars of 1995)

Source: CENICAÑA (1998).

[1] Dr. Nestor Gutierrez, CEO, National Rice Federation of Colombia (personal communication).