



# AGRICULTURAL RESEARCH PRIVATE FUNDING: THE COLOMBIAN EXPERIENCE<sup>1</sup>

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## INTRODUCTION

### Private sector definition and characterization

It is expected that by the end of the first XXI decade the private sector will increase its participation in the agricultural research finance structure, as new opportunities to capture the associated benefits will emerge with the application of modern scientific knowledge and technology being developed in the biotechnology laboratories. Under this assumption the term private sector tends to be associated solely with the multinational enterprises that dominate the agricultural input markets, such as machinery, agrochemical inputs, and improved seed.

However, in the Colombian case, the term private sector encompasses a broader group of financial sources. In this paper, private sector agricultural research resources will include all those funds that are not originated from the National Treasury, nor are included in the National Investment Plan. This definition will allow to ear-mark as private funds: (a) the producer union and farm cooperative contributions to solve specific technological constraints; (b) the investments done by the agricultural input suppliers in adaptive research; as well as, (c) the costs associated with the development of new products done by processing plants to satisfy the requirements of domestic and international markets.

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The major actors in the agricultural research sector of Colombia are: the individual crop producer associations, a large number of non- government organizations (NGO's), the agricultural machinery importers and distributors, the multinational agrochemical companies, the multinational seed companies, and recently the national and international agroindustrial processing companies. Currently, this dissection is not easy as quite strategic alliances are constantly being done within the so-called vertically integrated agricultural production chains.

Several efforts have been made to characterize the investments in agricultural research in Colombia (Beintema et al., (1999); ISNAR (1992); Samper (1989); World Bank (1991). As expected, there are differences among him or her in respect to the absolute and relative participation of each actor. However, all studies agreed that private investment has been a dynamic force to guide agricultural research in this country. Also, some of these studies have made efforts to identify absolute and relative distribution of the investments done in basic research, adaptive research, and adoption. None of these studies has approached the questions related with resource allocation priorities or efficiency on the application of these resources.

## **Objectives**

This paper has three major objectives. In the first instance it will relate the different stages of the agricultural research private funding process with the historical macroeconomic scenarios that have characterized the Colombian economy during the last fifty years. The working hypothesis is that agricultural research private funding has responded, as an economic variable, to the incentives and signals given by the national government and the market.

An analysis of the private agricultural research political economy is taken as a second objective. Different actors, including the government, have different interests to support and to promote agricultural research private funding. The control to allocate the financial resources available for agricultural research has been seen as a means to maintain political power and to create market opportunities. The adaptation and adoption of technical innovations in a reduced number of crops has induced production increases and market expansions, around which many commercial opportunities have arisen. The Colombian government has been proactive in the design and implementation of negotiating mechanisms.

Finally, an attempt is made to call attention upon some critical issues related with the allocation of private funds to agricultural research. Despite that private funding and efficiency are, in principle, highly correlated, it seems useful to review project portfolio compositions, short and long run tradeoffs, externalities related with natural resource management and the interaction between social and private benefits.

As these objectives are reached the message of this paper will be straightforward. Private agricultural research funding is an economic variable, which have to be strategically managed to induce the expected economic and social impacts. Otherwise, this variable could promote social inequalities, such as the economic power derived from production and market concentration.

## **The Proposed Model**

As stated in the first section, the paper uses a historical approach to relate private agricultural research funding with the overall macroeconomic situation of the country. The emphasis will be given in each period to answer the basic questions of: a) why private investors were interested? , b) what type of research was relevant?, c) which were the perceived short term outputs and long term impacts, and d) who were the winners and losers?

In the second section the paper looks towards the immediate future. It is discussed whether the current institutional framework facilitates the flow of private investment or not. In addition, this paper deals with the issue where private investors must be ready to trade short term private financial returns for long term social and environmental returns, in a new institutional context, based on strategic alliances.

In such terms the paper has to be taken as a discussion document, aimed to provoke a deeper analysis. It does not reflect the philosophy, or the policies of the Colombian government, nor of the authors' home base institutions.

## **1. CRONOLOGY OF DEVELOPMENT**

### **1.1 Import substitution period (1945- 1980)**

Colombia, like most Latin American countries, used the import substitution approach immediately after the end of the Second World War. The agricultural sector was seen as provider of cheap food and raw materials. Only in few cases agricultural production was used to generate export revenues. In such cases, agricultural production and exports were organized as plantations, isolated from the domestic markets.

Technology used in these plantation enclaves were imported from abroad, and it was based on the environmental and climate advantages of given regions for given crops, on the intense use of cheap labor and on the extensive use of natural resources, mainly land and water. Some agronomic practices and some mechanical operations were introduced and adapted. Also some organizational and administrative methods, to maximize cash returns were applied. A typical example was banana production, managed by multinational companies. Later on the early sixties flower production and exports were organized in the same way, adapting foreign technology but with domestic capital.

An exception was coffee production. Some immigrants imported coffee during the colonial period. It was grow and processed in small family plots. Coffee producers concluded that the only way to capture an emerging international market was the consolidation of large supplies in order to reduce transaction and transportation costs. An export quota, to be administered jointly by the national government and the producer association, was created. 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 national government translated all

responsibilities related with agricultural research, production promotions and export market development to the so-called “Coffee Producer Association”

In early years coffee agricultural research was concentrated on the development of agronomic practices oriented to improve grain quality, a variable considered as strategic in the consolidation of international markets. Later the danger of the arrival of a fungus, rust, induced the allocation of resources on genetic breeding, to develop rust resistant varieties. On both cases, researchers were successful and coffee research was taken as a model.

This was a perfect win-win arrangement. Producers had a non-stop growing market, exporters assured the needed quantity and qualities, the coffee region communities received rural development investments, and the national government had the capacity to manage the export revenues at its convenience, mainly through the use of selective foreign exchange rates.

In 1963, rice producers followed the coffee model. A rice quota, collected at the mill gate, was created. The main objective was to promote domestic production to satisfy an internal growing urban market. A large percentage of the rice quota revenues were use to promote the use of improved varieties, developed by the agricultural national research institution, and the application of a technical package, based on the intensive use of fertilizers and other agrochemical, to control emerging pests and diseases. Multinationals firms assembled the technical package. Import licenses and quotas protected domestic seed and agrochemical markets.

Again this was a success story. Rice production increased and the domestic market was satisfied with cheaper rice of high quality. Rice agronomic practices, irrigation and harvest were mechanized. A rice-input market able to attend the increasing demand for commercial inputs was established. A complex network of rice wholesalers and retailers was seen as a perfect competition model. It was claimed that the adoption of improve rice production technologies at the farm level was the dynamic force.

Everything worked well until domestic production exceeded domestic consumption. At that point the national government was forced to implement subsidized market interventions. Internal rice domestic prices were tied to increasing production costs. The domestic market had to be isolated from the international market in order to protect domestic production.

In a similar strategy, producers of other crops such as cotton, maize, sorghum, soybeans began to use improved seed, agrochemical package, mechanization and irrigation. Mainly international companies promoted these technological improvements. There was a domestic demand, on the hands on an infant processing industry, for these raw materials. However, production problems at the farm level, mainly related with land degradation and the increasing negative impact of pests and diseases, induced a cost production spiral. Government intervention was called to protect the interest of both primary producers and processors. Again national markets were isolated.

During this period a duality in the agricultural sector was created. All these technological and marketing developments, financed by private funds, were

concentrated on the so-called tradable products. Substantial differences were present at the end of the seventies among the so-called commercial agriculture and the peasant agriculture. The latter remained technological stagnated and concentrated on non-tradable crop production, mainly for subsistence consumption.

In summary, private agricultural research funding was induced in this period by the opportunity to satisfy a domestic market, by the government support to create and collect funds through special producer quotas, and the easiness to introduce, to adapt and to distribute technological innovations due to legal and regulatory flexibility.

## **1.2 The Fiscal and Monetary Adjustment Period (1980-1990)**

Colombia has been known as one of the most disciplined countries in terms of the management of its macroeconomic variables, especially in terms of fiscal deficits, exchange rates, and inflation rates. But the less developed countries debt crisis started to emerge in the early eighties and despite that Colombia's share in the total international debt was small it had to bargain and to implement a number of fiscal and monetary adjustments.

In the agricultural sector these adjustments have a direct effect on a number of policy instruments such as subsidized credit, market intervention, extension services, low trade tariffs for the import of agricultural machinery and agrochemical products and on public agricultural research. Domestic agricultural markets still were protected through a complex tariff and import quota system.

The experience from the coffee and rice producers induced other crop producer association to ask the government support to establish quotas. In 1983 the cereal quota was established, very similar to the rice quota. The cereal quota revenues were used partly to finance direct market interventions and partly to finance adaptive research. As the public research model began to deteriorate, the sugar cane industry and the African palm producers decided to invest directly on the creation of their own agricultural research institutions, at a national level.

In all cases, the research agenda was developed to confront the more pressing farm production constraints. These constraints were usually related with low yield and the incidence of the intensive use of agrochemical products, to control pests and diseases, on total production costs. In few cases, some research was done to improve the use of agricultural machinery and irrigation infrastructure, also looking for cost reductions. In general terms, agricultural research financed by producers was aimed to increase efficiency in order to maintain the profitability of the commercial agriculture, in the absence of government intervention.

The international agrochemical companies began to introduce new products that were more specific for given pests and diseases, and therefore they were most cost effective.

Constant technological adaptation and adoption allowed commercial agriculture producers to maintain their profitability levels despite the decreasing government intervention. Land and capital rentals were maintained. Input to output relative prices was reduced in some cases. Domestic market protection did not allowed consumers to

receive part of these benefits. Domestic prices remain high in relation with international prices.

Again, the peasant agriculture remained absent from these technological changes. However the reduce availability of some subsidized services such as credit, transportation and extension had negative effects on their profitability levels. These effects were internalized mainly trough lower returns to family labor and capital.

### **1.3 The Globalization of Agricultural Markets Period (1990-2000)**

In the early nineties most of the agricultural market protection was eliminated. A uniform, but progressive, import tariff replaced the former complex system of import tariffs and quotas. Industrial transformation and other production activities that added value were stimulated by the adoption of low tariffs and almost no restrictions to the imports of raw materials.

At the same time the government role, as provider of some services, changed. The government was seen as a facilitator and coordinator for these services. As a consequence, many public institutions were privatized, including the national agricultural research institution. At the same time, a scheme of competitive grants was adopted to finance agricultural technology transfer and extension. It was expected that private firms under contracts would provide these services.

The impact, of this new policy scheme, on the agricultural sector was dramatic, but not homogeneous. Imports of tradable commodities substituted local production. For example, it was estimated, by the end of the nineties, that the area planted with cereals (rice, corn, wheat, barley, sorghum, etc.) was only 50 % with respect to 1989. Also, production of other short-term crops such as cotton, soybeans, tobacco, beans, etc. was reduced substantially.

On the other hand, the area planted with permanent crops, especially African palm, banana, and some tropical fruits increased, in this decade, at high rates. Also, part of the former agricultural areas were transformed into pastures for cattle extensive production.

In general, the major effect of this induced structural transformation of the rural sector of Colombia, was a reduction in land and capital rentals and an increase in rural unemployment. Also it had a negative effect on the providers of agricultural inputs such as improved seeds, machinery and agrochemical inputs. Their number was reduced substantially and there was a capital flow to other non-agricultural activities.

Agricultural research also was negatively affected. Revenues originated from producer quotas diminished. Most of these revenues were used to support market interventions by the producer associations.

Agricultural research financed by the producer was requested to generate technologies oriented to reduce production costs. As genetic transformation of seeds apparently had reached a yield ceiling new research topics, related with the improve management

of other related inputs, were included in the agenda. Improvements on soil preparation, crop rotations, integrated pest and disease management, irrigation management, harvest losses, etc. were demanded. In many cases researchers were able to meet these demands, but the lack of an appropriate extension service system was a serious constraint to reach a substantial percentage of producers.

Food markets at the consumer level also were transformed. Local consumer had access to new transformed products especially in poultry, dairy, oil, and fruit base beverages. Local food processing industry had to compete with imports. This competition induced local investors to look for new transformed products and to look for new raw materials. The concept of vertical integration within the food chains began to be promoted by the government and adopted by farmers and industrial processors.

Concepts such as geographical localization and the quality of the raw materials began to be translated as demands to the agricultural researcher. The private sector, represented both by farmers and industry, was called by the government to provide matching funds, to complement the research grants allocated by the established competitive funds. The response was positive.

It could be affirmed that this was a partially win/loss situation. Consumers were confronted with a wider and better supply of products. Consumer prices tended to stabilize and to have a lesser impact on the annual inflation rate. Some commercial farmers were successful in their integration with processing industry. Agricultural researcher received clear demand signals from the potential user.

On the negative side, some commercial farmers, in specific geographical regions, were not able to adjust to the new model and left the sector. Peasant agriculture remained isolated, but in many cases it has to absorb the labor force that was displaced from the commercial agriculture. As a result rural unemployment increased and family labor retributions diminished.

## **2. FACING THE FUTURE**

### **2.1 THE CURRENT INSTITUTIONAL FRAMEWORK**

Private funded research in Colombia had significant impact in the short term mainly from testing and validating improved varieties and new production systems. This dynamic facilitated the private sector to capture significant benefits which, in the majority of cases, were shared with consumers resulting from a reduction in prices. The main factors from these arguments are:

#### **2.1.1 Agricultural research was profitable and a public good easily accessible.**

The majority of research carried out in Colombia was based on the paradigm of the green revolution, which demonstrated to be successful in increasing yields in the short term. It is now recognized that ex-post analysis on the returns to investment in

agricultural research were superior to other sectors of the economy [ex., soybeans 79 to 96% (Montes, 1979); rice 53% (Ardila, 1973)].

The development of agricultural technology was based mainly in the free exchange of genetic resources, as well as in the technology and information associated to the design and the implementation of these resources. Most of this research was funded and obtained from public research institutions that were not interested in obtaining a return. Thus, under these circumstances it was very attractive to allocate private funds because small marginal investments (i.e., <1% of production costs) produced significant benefits.

These arguments are supported by the following three case studies reviewing the private sector financing of agricultural research in Colombia for the sugar, oil palm, and coffee sectors. Each case study contains (1) a brief history of producer financing, (2) the institutional arrangements that have been used, and (3) an evaluation of how effective it has been in terms of cost effectiveness and productivity.

#### **2.1.1.1. 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 by the eleven sugarmills and 1400 individual sugar producers who form the Colombian Association of Sugar Producers (ASOCAÑA) by means of parafiscal funds. The annual budget allocated to CENICAÑA represents 0.55% of total sugar sales and has averaged about US\$ 2.54 million dollars per year during the 1977-97 year period, but this budget has been increasing during the last 5 years as a result of the expansion in planted area (Table 1 and Graph 1). In addition, this 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 (ie., sucrose) content, reduced harvest time (i.e., closer to 12 months), resistant to economically important diseases, and during the last 10 years, emphasis has been placed on the development of varieties which defoliates and are erect to facilitate the harvest mechanically (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 last 21 years, increasing productivity by 71%, reducing harvest time by 43%, and increasing sucrose content in cane by more than 7% (Table 1). All these factors have made the industry more competitive, which led to a 54% increase in planted area from 122,000 ha to 188,000 ha.

These changes in productivity as a result of research investment has produced important benefits to the industry which are estimated to be around US\$266 (million dollars from a \$53 million investment, which gives an internal rate of return of about

26.6% (Graph 1). It is expected that the benefits will continue to increase as the remaining planted area to sugarcane (ie., 39%) is replaced with new varieties developed by CENICAÑA which are superior to current ones.

### **2.1.1.2 Oilpalm**

The case study of the Colombian Oilpalm Research Center (CENIPALMA) is analyzed for the period 1990 to 1999 (CENIPALMA, 2000). The main results are summarized in Table 2 and the conclusions derived from this analysis are:

- (a) Research funds for CENIPALMA also comes from parafiscal funds, which are equivalent to 0.5% of the total value of production. These funds are complemented with marginal allocations from other investors which represent about 10% of parafiscal funds.
- (b) Most of the research agenda is executed in private plantations and the agenda is established based on a technical advisory committee with experts from the production and processing sides.
- (c) Research expenditures grew at a rate of 22% per year between 1990 and 1999 and about 89% of these resources came from oilpalm producers (Table 2).
- (d) Most of these funds were allocated to the development of integrated pest and disease management and soil improvement practices, which contributed to significant increases in productivity (ie., from 13 to 17.4 mt/ha; Table 2). It has been in these two areas where most (81.1%) returns to research have been obtained (CENIPALMA, 2000).
- (e) Research investment contributed to change the production pattern of the oilpalm industry. During the 80's, industry growth (ie., 12% per year) was explained by an increase in the use of factors (11.5% per year increase in labor use and 13.1% per year increase in the use of capital). During the 90's industry growth (ie., 9.3% per year) was explained by an increase in total productivity (ie., labor use only increased 2.9% per year and capital use increased 3% per year).
- (f) Increases in planted area and yield were accompanied by a greater efficiency in the use of labor. In 1980 6.12 ha of oilpalm generated one minimum salary and this relationship in 1999 was 7.12 : 1.
- (g) These technological changes increased marginal production by 1.53 million tons during the period 1990-99. If this change had not occurred, Colombia would now be importing 186,000 mt/year. During 1999 Colombia exported 109,000 mt.

### **2.1.1.3 Coffee**

Although no comprehensive evaluation of investment in research by the Colombian coffee-growing Federation (FEDECAFE) exists, several *ex post* analyses have been carried out. To describe the impact of research, two cases—rust and the coffee berry borer—are given of problems recently faced by coffee growers and representing a major threat to the industry. These alternatives also contrast in terms of the work carried out on experiment stations and on farm by extension agents. To solve the problem of coffee rust, a resistant variety, 'Colombia', was developed. But obtaining a variety that tolerated the coffee berry borer was impossible. Instead, its spread was faced by

implementing cultural controls, which, although lowered on-station research costs, represented higher extension costs.

Resisting coffee rust. The fungus *Hemileia vastatrix*, which causes coffee rust, appeared for the first time in the Americas in 1970 in Brazil. Because strong control measures were adopted, Colombia was the last country in the Americas where the disease appeared, in late 1983. In Colombia, coffee is grown in areas with cool climates that favor rust development. Rust readily attacks the varieties most commonly grown in coffee-producing regions.

To assess the impact of the disease in the field, plantations receiving chemical control were compared with plantations not treated. Production in the latter decreased between 14% under shade and 30% under full exposure (López et al. 1990). In controlled experiments, production decreased from 10.9% to 20.7% for local varieties receiving no rust control. No significant difference was observed between the local varieties with rust control and the improved variety 'Colombia' receiving no control. Table 3 shows how the disease evolved and how farmers responded by planting the improved variety 'Colombia'.

Six control methods, based on protection and systemic fungicides, are available. Determining the degree of adoption of the different control systems in the field was impossible. Graph 2 shows the results obtained with one of the cheapest control methods. The internal rate of return varied between 12% and 31%, depending on the control method used. The most expensive was "pneumatic pressure" with protective fungicide and the cheapest, "Motax" with systemic fungicide.

Integrated management of the coffee berry borer. The coffee berry borer, *Hypothenemus hampei* (Ferrari), is the major insect pest attacking coffee worldwide. It 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 380,721 coffee farms and 715,073 hectares (Herrón 1998). The borer, in addition to reducing coffee production by destroying the bean, also causes fruit fall, increases the proportion of grain broken during processing, and alters beverage flavor.

To control the pest while protecting the agroecological system, FEDECAFE accepted, as policy, to develop and use an integrated pest management system that included the collection of borer-infested beans (*Re-Re*), spraying coffee trees with the fungus *Beauveria bassiana*, and releasing the beetle *Cephalonomia stephanoderis* for disease control. Both the fungus and beetle attack the borer. Insecticide applications were to be used according to established infestation levels that are determined by periodic samplings.

Extension workers were trained in the technology to disseminate it. In 1994, the groundwork was laid for conducting an *ex post* analysis of the impact of these pest control and coffee production practices. Four hundred coffee farms were monitored to assess the impact of several variables such as farm size, farmer's level of education, planting density, variety type, age of coffee plantation, shading versus full exposure, topped and free-growing coffee cultivation, attendance to training events, and

technical assistance at the farm level. Although a formal study relating investment with achieved benefits has not been conducted, available evidence shows the complexity of the situation when technology adoption, rather than involving the release of a new variety, requires changes in crop management and farmer behavior (Table 4, Graph 3).

An analysis of the relationship between socioeconomic variables and adoption indexes indicated a direct correlation (with a level of significance greater than 0.1) for the following variables: formal education, area planted to coffee, and farm's level of specialization. Other variables, such as years as coffee grower, time with coffee berry borer, land tenure, farmer's age, and family size, had no relationship with technology adoption. There was a direct and significant relationship with contracted labor and with labor availability in the region. Availability of family labor had no relationship with adoption levels. There was a direct and significant relationship between the variables of transfer (e.g., groups of friends, attendance to courses, and permanent technical assistance) and credit.

### **2.1.2 The private sector 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 private sector funded-research was higher because the most expensive investment was allocated by public-funded institutions. This can be demonstrated by the following arguments:

2.1.2.1 Human resources. Non-Government Organizations (NGO's) and the private sector have about one-third of all research scientists in Colombia . These individuals were educated and trained by the Colombian Institute of Agriculture (ICA). Trained personnel is the single most important research cost and has represented between 56% and 70% of the total cost of private-funded research since 1986 (Beintema et al., 1999).

2.1.2.2 Investment areas. The private sector concentrated its research in annual crops in order to get returns to investment in the shortest period of time and where scientists had more experience. About 86.4% of scientists worked in annual crops, 7.5% in perennial crops, 3.4% in post-harvest losses and handling, 1.7% in livestock, and 1% in management of natural resources. Of total private-funded research costs, 63% was allocated to testing and validation of new crop varieties (Beintema et al., 1999).

### **2.1.3 Low interest in forming strategic alliances with public-funded research.**

When the Colombian Institute for Agricultural Research (CORPOICA) was created by the government it was expected that a significant amount of research funds would come from the private sector. However, during the last 5 years this amount has represented less than 4% of total operational costs of CORPOICA (Beintema et al., 1999). Thus, there is little incentive for the private sector to form a strategic alliance because it implies a higher cost with lower probability of capturing the benefits of

research because any research product coming out of CORPOICA is public even if funds come from the private sector.

#### **2.1.4 Low investment in technology transfer.**

The private sector has been reluctant to support research in technology transfer mechanisms because large producers have easy access to information. This type of research should be concentrated on small producers, which have high social benefits but low private returns to investment. Efforts by the National Program of Technology Transfer (PRONATTA) to stimulate the private sector to establish strategic alliances have shown little impact. This is proven by the fact that only 1.7% of all PRONATTA projects are currently being executed with the private sector (PRONATTA, 1998).

#### **2.1.5 Low investment in the management of natural resources.**

Most scientists recognize that the investment in research on natural resource management is inferior to the needs to recuperate the negative effects on soil degradation and biodiversity loss needed to maintain current agricultural productivity. As an example, the existing mechanisms to set irrigation costs are obsolete. Thus, the current tariffs are lower than the real cost of water, creating huge amounts of resource waste in the short term (CONDESAN, 1996).

#### **2.1.6 Low investment in the analysis of the distribution of benefits among producers.**

For many years it was accepted that the greatest benefit to research was related to lower consumer prices and little emphasis was given to the analysis of benefit distribution among producers. The private sector argued this was a responsibility of the public sector. However, studies

have shown that rural poverty has been significantly increasing during the last 20 years, which justifies the analysis of mechanisms for a better distribution of benefits among producers.

### **2.2 CHALLENGES OF THIS DECADE**

The analysis of the Colombian agricultural sector carried out by CIAT and CONDESAN is showing:

- (a) a systematic reduction in real incomes of producers which minimizes their capacity to respond to price cycles and climatic adversity;
- (b) a reduction in the utilization of technology and inputs which induces lower profits and generates lower returns to labor, thus increasing poverty levels;

- (c) a progressively lower potential of traditional systems to produce the needed surplus capital so that producers can evolve to crops that are more labor-intensive and high profitability;
- (d) the interest rates for commercial agricultural credits are higher than the actual returns on investments which are being obtained by the production systems (Graph 4);
- (e) the payback period of commercial credits are shorter than most initial harvest time of permanent crops, thus making financially impossible the investment in these agricultural alternatives (see Graph 5). This argument is based on the fact that, with high nominal interest rates due to inflation, the payback period is effectively achieved during the short term, thus changing the cash flows (in real terms) agreed at the beginning of the loans.
- (f) A literal destruction of public institutions and strategic alliances currently supporting the agricultural sector.

Under these circumstances, private research traditionally executed in Colombia is not sufficient to lead and generate agricultural growth. It will require a different process, with more economic and social compromise, than the one carried out up to date. The confidence in the capacity of technological change to satisfy the needs of the agricultural sector has been wearing out and little emphasis has been placed on institutional reforms required to allow small producers to hope for a better quality of life.

The crisis of the rural sector has been so drastic that the Colombian government recognizes it does not have the capacity to solve. Therefore, it is designing mechanisms to allow the private sector to respond to this challenge by improving the priority ranking process and the implementation of these priorities at the local level.

Besides the research traditionally funded, other areas exist which need to be considered in the next 10 years. In order of priority these new research challenges are:

### **2.2.1 Development of social capital.**

The crisis of the agricultural sector has been useful to demonstrate how fragile is the social capital existing 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. Three decisions created a large turmoil and destroyed the little social capital that existed:

- 2.2.1.1** Support for the urban sector in detriment of the rural sector. The Colombian government was conscious that an overvalued exchange rate would have a large negative impact on rural income. In effect, the Colombian peso was overvalued at a rate of 8.2% per year between 1990 and 1997 which caused

a reduction in real agricultural prices (Table 5) and the planted area to agricultural crops was reduced by more than 1 million hectares during the same period. The decision to maintain an overvalued exchange rate sent a clear message to the rural sector indicating that the priority was to support the large entrepreneurial conglomerates related to services and importation and not the generation of rural employment.

- 2.2.1.2** Short payback periods on agricultural loans. With an average annual inflation rate during the 90's of 20% and real interest rates of 15%, all medium and long-term agricultural loans were, in practice, paid back in three years under an environment of price reduction in real terms and climatic disasters. These conditions forced producers to pay moratoria interests on overdue loans, which were close to 1 billion dollars. Many producers lost their farms.
- 2.2.1.3** Low government support to the cooperative movement. During the 90's the financial system was re-capitalized with help from the Colombian government by more than 2 billion dollars but the agriculture cooperative system received no support whatsoever.
- 2.2.1.4** Decreasing land prices and collateral. The overvalued exchange rate caused a reduction in real prices of most agricultural commodities, which in turn caused a decline in land prices. With overdue loans, the financial system began to receive farms as payment in-kind for loans that were financially impossible to be paid back by producers. This situation induced the financial system to stop accepting farm land as collateral for future loans, thus leaving small and medium producers out of financing opportunities, which in turn deepened the crisis of agriculture even more.
- 2.2.1.5** Destruction of existing strategic alliances. Strategic alliances were formed between producer organizations and other segments of the agroindustrial chain during the late 80's. These alliances were destroyed during the 90's and were substituted by more fragile agreements, which have proven unstable. These transaction costs have been passed on to the weaker partners of these agreements, which are the producers.

Therefore, the current agricultural production systems are not in capacity to generate the necessary surplus capital to modernize agriculture or to move to crops that are more capital-intensive that could generate more 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.

Thus, financial resources must come from other sectors of the economy. However, unless the system does not re-establish the needed social capital it will be difficult to generate back the required trust and confidence to modernize agriculture. The situation is even more critical as now it is required 80% of total funds to modernize the agricultural sector from external sources and not 30% as in the past. Producers are literally broke and their capacity to co-finance farm improvements is very low. This fact makes the need to build social capital more relevant in order to get out of this crisis.

Graph 6 shows the profit received by producers and the processing plant (ie., the entrepreneur) taking as a case study an oil palm plantation for export. In the ex-ante analysis the profitability was 13% in US dollars. However, when adjustments were made considering the payback system of the loan in Colombian pesos and price cycles were considered, the producers absorbed most of the risk with its associated losses. Thus, under these circumstances it will be difficult to build social capital.

### **2.2.2 Increasing the capacity to generate employment.**

Due to the fact that real incomes in the rural sector have been drastically diminished, producers have switched to agricultural activities that require less labor, such as livestock, but creating a large social unrest due to lack of employment opportunities. Therefore, additional efforts are needed to identify agricultural activities that have the greatest potential to compete with high use of labor.

### **2.2.3 Administering the process of capitalizing the rural sector.**

The Colombian government does not have the capacity to lead an orderly process to capitalize the rural sector. Many changes have occurred during this decade in the production systems, in the mechanisms for integrating with industries, and in opportunities to market access. All these elements are difficult to be managed by the public sector which has lost flexibility and which is now acting in a normative mode.

## **2.3 CRITICAL ISSUES TO FACE DURING THIS DECADE**

The main issues that the private sector has to respond to itself are related to externalities, social and private benefits, management of natural resources, and benefit distribution among producers. These issues should be analyzed in an integral form considering the following four priority areas:

### **2.3.1 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. In addition, it is required:

- a. the allocation of resources in the rural sector in those areas where it is profitable to do it;

- b. the reduction in production costs and the increase in farm size, but only in those agricultural activities with economies of scale that allow a trickle-down effect to the poor;
- c. the generation of employment, but giving opportunities to the poor in order to achieve the greatest social benefits; and
- d. A good administrator that will assign the resources efficiently.

All these efforts will require research to identify the best-bet opportunities and to obtain the greatest benefit from available resources. With the support of IDRC and IDB, CONDESAN and CIAT have generated a series of mechanisms to rank investment opportunities. These mechanisms have:

- a. Utilized watershed analysis to identify priority areas where initial investments are required in order to obtain the greatest impact on externalities;
- b. Implemented methodologies to select the objective population through inclusion and exclusion criteria, which quickly allow the identification of target communities and within them the individual persons through studies of quality of life by local perceptions.
- c. Generated a process for economic and financial analysis of projects. This includes not only the profitability of the project, but also the distribution of benefits among the different partners of the strategic alliance. This process includes the accounting of benefits to producers not only from earned salaries but also as shareholders of the alliance.
- d. Established several project administration schemes that, even when it generates an adequate profitability rate, it also gives high emphasis to the social performance of the investment.

The early experience obtained in the implementation of these alternatives has been successful but it requires that these initiatives and type of analysis be implemented in other regions.

### **2.3.2 Support strategic alliances.**

This is a new field of analysis that should be quickly implemented to stimulate the private sector to come in. Some achievements have been obtained by changing policies to stimulate the private sector to initially help in the administration through the integration of alliances among the productive chain. Even though the Colombian government has made significant efforts (i.e., provides 80% of the required investment capital when entrepreneurs and small producers form alliances), the response by the private sector has been limited due to the adverse conditions the country is going through (i.e., insecurity) and the lack of an organizational structure that allows groups of organized producers to contact entrepreneurs, and vice-versa.

The support fund for the formation of strategic alliances constitutes a sustainable instrument for additional analysis that are needed to correct the weakness identified by CONDESAN and development banks in different regions of Latin America in the quest to generate progress for the poor rural population. These analyses will help to increase the potential to extrapolate these results to other mountain regions, where most of the identified weaknesses are concentrated.

### **2.3.3 Design, management, and administration of rural projects.**

This is a new field in which little information exists, especially in regards to the implementation of administrating projects based on performance. The Colombian government is creating more investment funds but it is concerned for the quality of the administration service that is required from using public resources in strategic alliances with small producers.

Another important research field is in the design of mechanisms so that the strategic alliances evolve from producing or buying agricultural products at fixed prices to the execution of more complex activities such as distributing benefits based on flexible long-term prices, management of natural resources, and social development.

### **2.3.4 Design and management of early feedback mechanisms.**

We are evolving into an environment where the macroeconomic conditions and policies are influencing the behavior of the rural sector more rapid. Thus, it is necessary to design early feedback mechanisms to inform government officials and entrepreneurs about the impact of these factors on the profitability at the micro level and on the distribution of benefits. This information will facilitate the development of social capital and to design better policies with the participation of producers.

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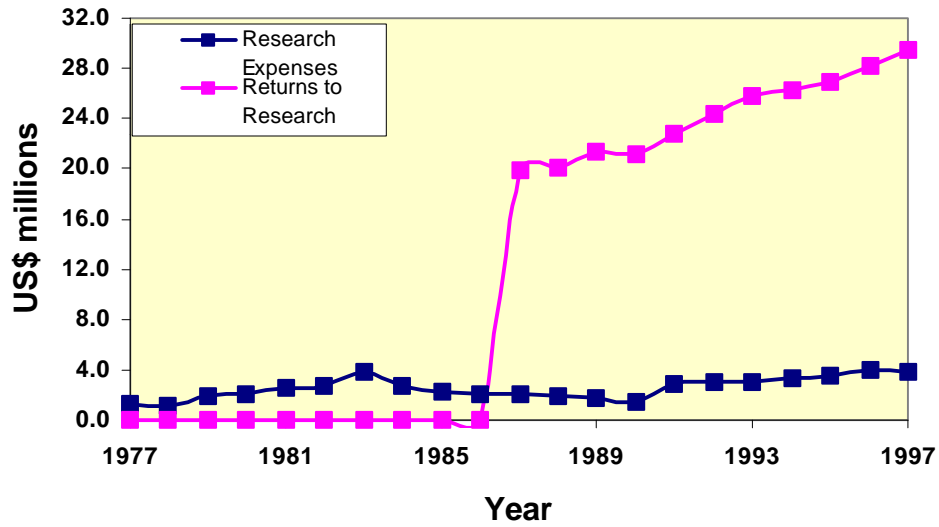
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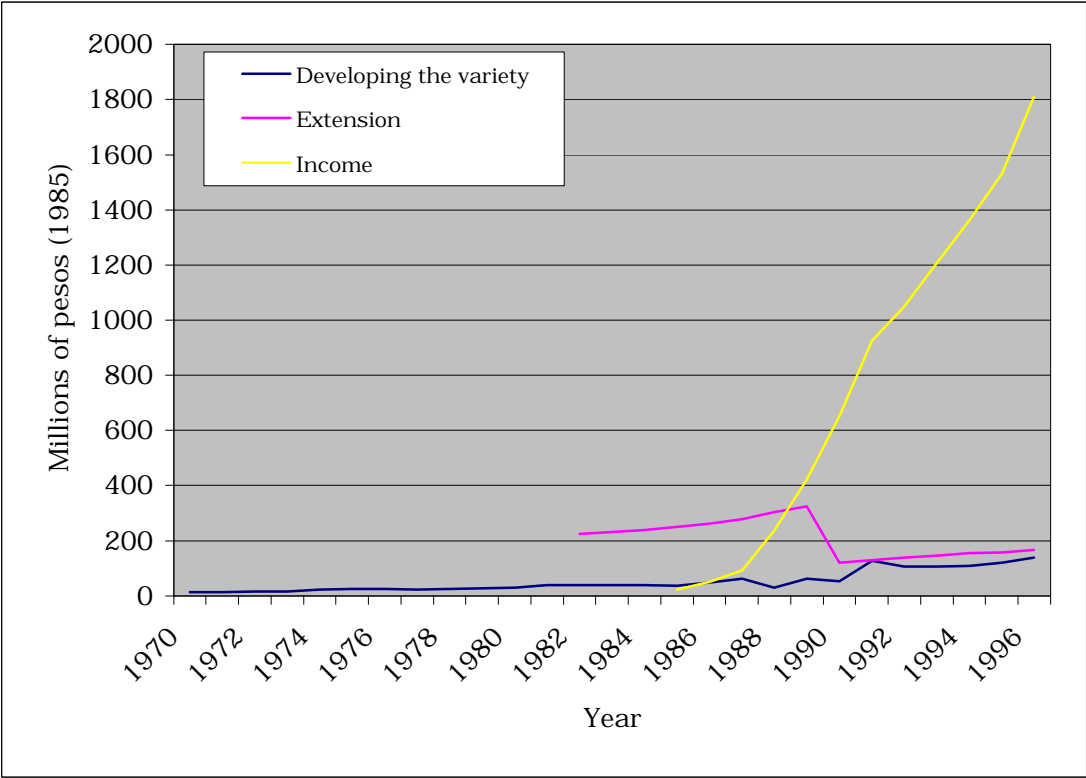
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**Graph 1. Annual budget of CENICAÑA and estimated returns to research from increased productivity (in constant US million dollars of 1995)**

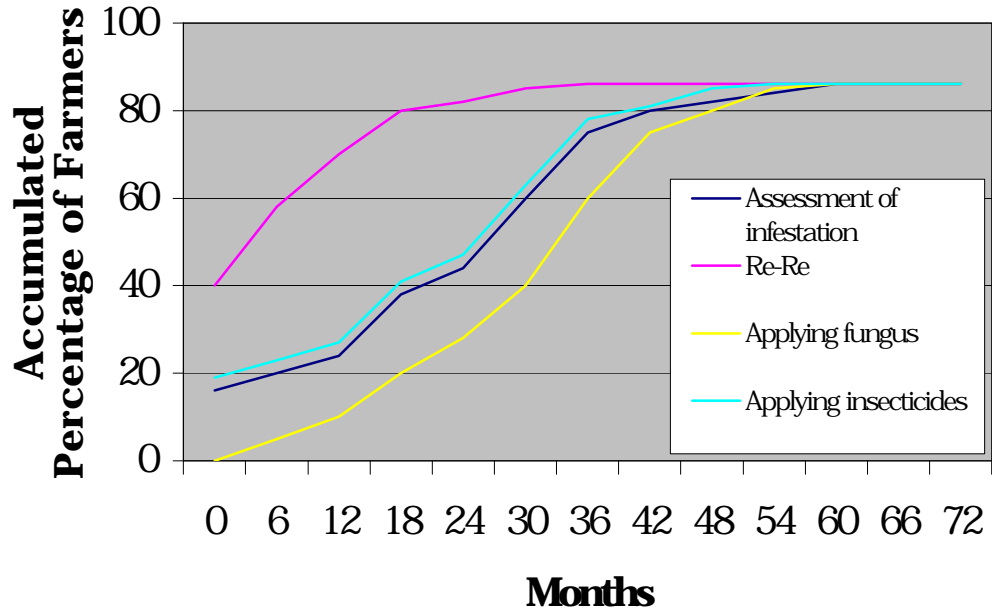


**Graph 2. Costs and benefits of developing and transferring the coffee rust-resistant variety 'Colombia'**

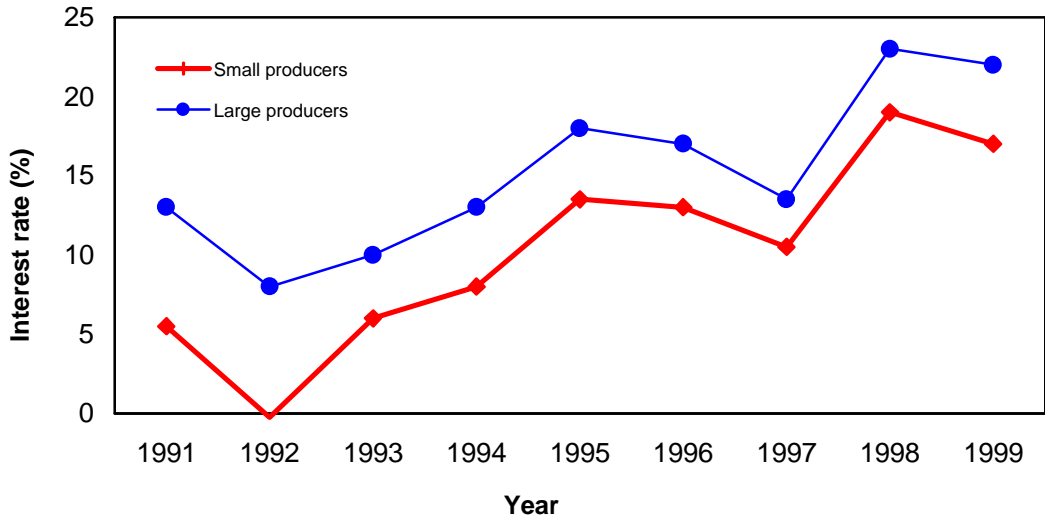


SOURCE: Farfán (1999).

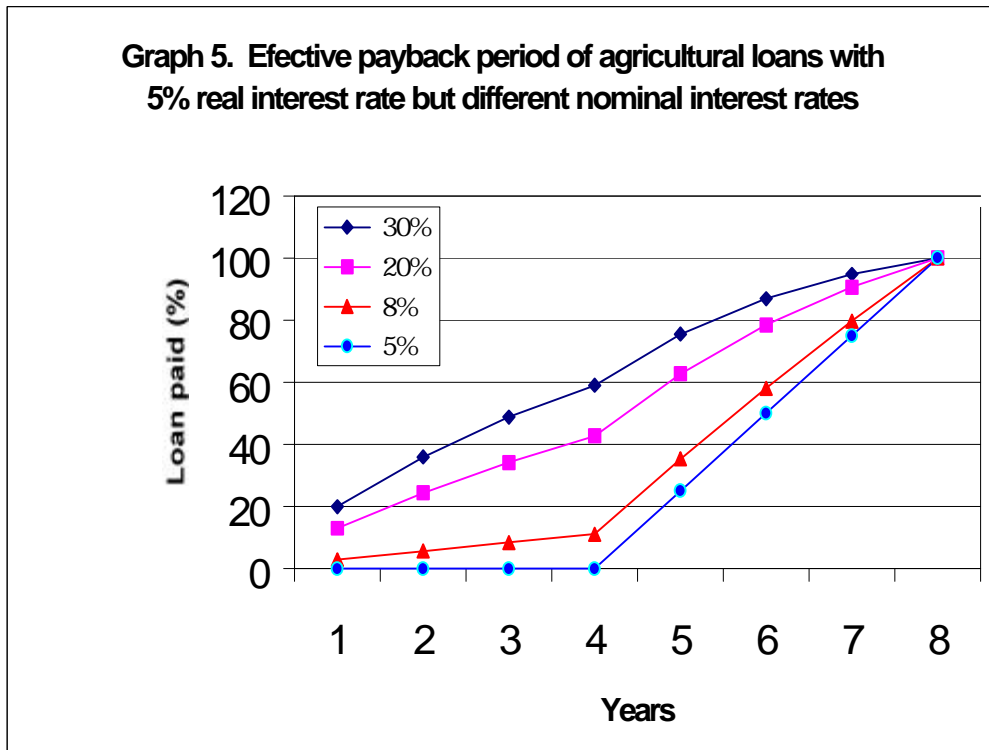
**Graph 3. Logistic curves of adoption**



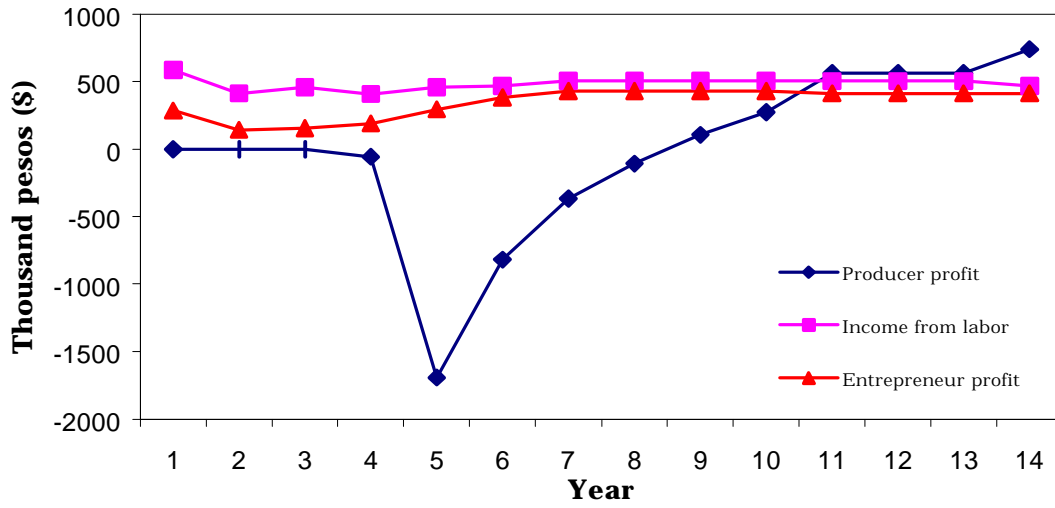
**Graph 4. Real interest rates in the agricultural sector of Colombia.**



**Graph 5. Effective payback period of agricultural loans with 5% real interest rate but different nominal interest rates**



**Graph 6. Net cashlows from current strategic alliances**



**Table 1. Changes in productivity of sugarcane due to research in the development of new varieties during the period 1977-97 in Colombia.**

<b>Variable</b>	<b>1977</b>	<b>1997</b>	<b>Change (%)</b>
% of planted area to varieties introduced and evaluated by CENICAÑA	0	61	+ 61
% of planted area to varieties developed by CENICAÑA	0	22	+ 22
Productivity (mt sugar/ha/yr)	7	12	+ 71.4
Harvest age (months)	18	12.6	- 42.9
Sugar yield (%)	11.0	11.8	+ 7.3
Area (ha)	122,000	188,000	+ 54.1

**Table 2. Returns to research in the Colombian Oilpalm industry during the period 1990-1999.**

<b>Indicator</b>	
Investment in Research (million US\$ of 1999)	
- Oilpalm industry	10.8
- Other investors	1.7
Productivity (mt/ha)	
- 1990	13
- 1999	17
Oil extraction rate (%)	
- 1990	18
- 1999	21
Planted Area (ha)	
- 1990	86,000
- 1999	150,000
Total Economic Surplus (million US\$ of 1999)	
- Agriculture	147.5
- Industry	34.2
- Total	181.7
Economic Surplus due to Research	
- Agriculture	29.0
- Industry	6.8
- Total	35.8
Generation of direct employment (man-days in 1999)	
- Agriculture	19,718
- Industry	5,343
- Total	25,061
Generation of employment due to Research (man-days in 1999)	
- Agriculture	7,779
- Industry	3,182
- Total	10,961

Source: Estimated by authors from CENIPALMA (2000).

**Table 3. 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	80.13	54,282
1996/97	300,543	25.75	215,036

SOURCE: FEDECAFE, Cited by Farfán (1999).

**Table 4. Adoption of components of an integrated pest management (IPM) system for the coffee berry borer.**

<b>IPM component</b>	<b>Percentage of farmers (%)</b>
Infestation	
Not evaluated	42.56
Well evaluated	11.41
Poorly evaluated	46.02
Collection of mature fruits	
Not performed	2.80
Carried out, using conventional methods	74.60
Carried out, using other methods	22.60
Application of <i>Beauveria bassiana</i> (fungus that attacks the pest)	
Did not apply	63.51
Applied correctly	12.61
Applied poorly	4.52
Did not apply because was not necessary	19.36
Records of flowering	
Not kept	70.68
Well kept	21.05
Poorly kept	8.27
Application of insecticides	
Did not apply	24.63
Applied correctly	27.62
Applied poorly	35.86
Did not apply because were not necessary	10.86

SOURCE: Table based on information from Duque and Chaves (2000).

**Table 5. Factors that affected the reduction of agricultural prices in Colombia (annual means in real terms for the period 1990-1997).**

Crop	Farmgate Price (%)	International Price (%)	Exchange Rate (%)	Tariff (%)	Lobby (%)
Corn	-11.29	-0.59	-8.16	-0.28	-2.26
Sorghum	-8.89	0.99	-8.16	0.32	0.58
Rice	-1.82	0.08	-8.16	0.98	7.24
Wheat	-12.4	0.83	-8.16	-1.26	-3.8
Sugar	-2.22	-2.88	-8.16	1.48	7.34
Cotton	-7.62	-1.83	-8.16	0.0	2.38
Coffee	-4.09	3.76	-8.16	0.85	-1.58

Source: Jaramillo (1998).