RETURNS ON INVESTMENTS OF THE AGRICULTURAL RESEARCH AGENCY OF THE STATE OF MINAS GERAIS - EPAMIG[1]

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ABSTRACT

This study evaluated the returns of research investments accomplished by EPAMIG (Agricultural Research Agency of the State of Minas Gerais) through the period of 1974 to 1997. The internal rate of return was used as the evaluation criterion. The benefits were estimated on the basis of the net gains obtained by producers who adopted the generated technologies. The costs were calculated considering the expenses with personnel, investments and the cost of maintaining the Agency's research structure. The internal rate of return (31.8%) shows that research investments done by EPAMIG have been generating returns rather compensatory for society.

Key words: evaluation, internal rate of return, technology.

1 Introduction

Agricultural research has performed an important role in the evolution of agriculture, both in Brazil and in the State of Minas Gerais, through the last decades. This has been proved, for example, by productivity gains obtained for several crops and livestock, the intense occupation of the area under "cerrado" vegetation and the recent

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expansion of agriculture in the Amazon and Semi-arid areas.

In Brazil, the importance of research investments for the modernization of the agricultural sector took long to be recognized. This may be explained by the way economic policies have been conducted along the years. Schuh (1971) attributed this fact to the definition of industrialization priorities in the Brazilian development model.

The so called "agricultural modernization policies", from which the concern about the scientific and technological development became preponderant, started to be delineated from the Strategic Development Program - PED (1968-1970).

At the beginning of the 1970s, Brazilian government increased investments in technology generation and diffusion through profound changes that culminated with the creation of the *Empresa Brasileira de Pesquisa Agropecuária* - EMBRAPA, by 1973. Following the new federal government guidelines, the state of Minas Gerais also promoted the reformulation of its activities on agricultural research with the creation of the *Empresa de Pesquisa Agropecuária de Minas Gerais* - EPAMIG, in 1974.

2 The Agricultural Research Agency of the State of Minas Gerais – EPAMIG

The Agricultural Research Agency of the State of Minas Gerais - EPAMIG was instituted as a public agency through Law nº 6.710, by May 8 1974. It represents the main institution that executes agricultural research in Minas Gerais, and its objective is to generate, to adapt, to develop and to diffuse knowledge and technologies in the field of agricultural production and technological transformation of its products, as well as in the socioeconomic area.

On August 6, 1974, through an agreement celebrated among the State's government, the Agricultural Secretary, the Bureau of Agriculture and EMBRAPA, EPAMIG received the attribution of administering and coordinating agricultural research in the State of Minas Gerais.

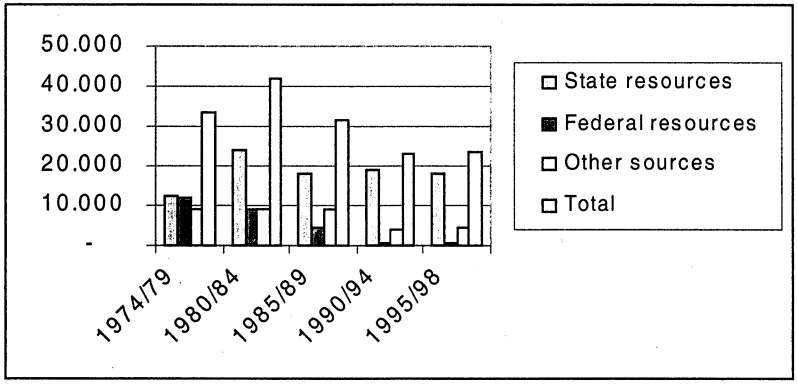
To conduct its activities and to develop programs, EPAMIG maintains its head office in the city of Belo Horizonte and a decentralized structure composed of five regional research centers, twenty experimental farms and two experimental fields located in strategic areas of the State. The Agency also maintains two research and teaching centers, being one for research and teaching at the dairy farms area, located in the city of Juiz de Fora, state of Minas Gerais, and the other for the agro-technical and cooperativism teaching in Pitangui, Minas Gerais.

The Agency research work is based in the following Research State Programs: Cotton, Rice, Bovine, Coffee, Agricultural Diversification (Forests, Rubber trees, Soils, Irrigation, Aquiculture, Socioeconomic Studies, among others), Beans, Milk and its derivatives, Horticulture, Small animals, Wheat and Special Programs. The last one is related to specific problems as technology generation for the small rural producers and government programs (EPAMIG, 1992).

Considering that the final product of EPAMIG is research, the quality of the human resources is vital. The Agency has a total of 991 employees from which 169 are researchers, which represents 17% of the total. In 1977, just one third of the researchers were at a master and/or PhD degree, and this percentage rose to 80% in 1998.

From the second half of the 1980s, the Science and Technology institutions suffered drastic budgeting reductions. In Minas Gerais, the research institutions were seriously affected. EPAMIG specifically, besides suffering the effects of the financial crisis, also suffered the effects of the state government's political guidelines, which relegated the research activities to a second plan in the state. This can be verified by the decrease in resource volumes received by the Company, according to the financing sources (Figure 1).

Figure1- Resources received by EPAMIG, annual average for period, according to the financing sources from 1974 to 1998. Values in thousands of Reais in December/97.



Source: Research data.

As a consequence of those financial difficulties, EPAMIG disabled and alienated some of its research units, discarding machines and equipment and, mainly, it went through a great loss of staff and had the number of employees reduced on almost 45% between 1986 and 1998. This loss is larger when considering that the total number of researchers was reduced from 272 to 169 in that period.

Brazilian agricultural research has traditionally been more concerned about supplying technologies than attending society's demands. However, with the changes that are happening in the current world, such as a lower interference of the State in the economy, the globalization of the markets, the greater organization of the different social groups, the consumers' greater awareness, demands to the market for larger quantity, more diversity and quality of the supplied products, processes and services.

In this context, EPAMIG has also been trying to position strategically a new research paradigm, that recognizes the commands and rules from its business environment.

Since 1996, EPAMIG began a strategic planning, according to which its technology generation process would go through a total restructuring. Today the customers - the producer, the agroindustrial person, the consumer - impose their need for research according to their importance in the production chain, which is a concept that determines the functions and the roles at the technology generation and diffusion process.

3 Problem, Importance and Objective

As public resources are scarce and the allocation in a certain activity occurs in detriment of other alternative uses, society begins to demand an efficient use of these resources. Therefore, the investment of public resources in agricultural research requires a periodic evaluation of the obtained returns.

In general, it is known that the technologies generated by EPAMIG and their diffusion had a great influence upon the expansion and rationalization of agriculture in the state, providing it with significant productivity gains. The research results also allowed producing in areas considered inadequate to agriculture.

In the case of EPAMIG, although its importance for the growth of Minas Gerais's agricultural sector has been recognized, there is no measure of the benefits obtained by society that originated from the investments accomplished by this Agency.

Therefore, the importance of this study for the Minas Gerais and for EPAMIG, relates to the fact that there are few works that have evaluated investments on research, and neither that have particularly evaluated the Agricultural Research Agency of Minas Gerais – EPAMIG. More specifically, evaluations of the returns obtained with technologies generated by this Agency are lacking.

The general objective of this study was to evaluate the returns from the investment applied on research in the Agricultural Agency of Minas Gerais over the period from 1974 to 1997, by estimating the internal

rate of return from the accomplished investments.

4 Methodology

4.1 Theoretical Reference

The methods that measure the returns of research in terms of its effect on the agricultural yield use the approach of the supply curve displacement to evaluate the returns from the research investments and has the concept of Alfred Marshall's economic surplus as a theoretical reference.

In this work, a variant of the economic surplus concept was used for the calculation of benefits. It is the focus of the economic surplus with the hypothesis of the perfectly inelastic supply curve and the perfectly elastic demand curve. Such approach is used when both, the supply and demand elasticity of the product under study are not available (in this case the aggregate product).

This hypothesis, used to calculate economic surplus was initially adopted by Tosterud et al. (1973) to analyze the benefits from the research on wheat in Canada, and by Kislev & Hoffmam (1978) to evaluate the research on wheat in Israel. This hypothesis was also used by Cruz et al.(1982), while evaluating EMBRAPA's investments and by Barbosa et al. (1988) to calculate the social and economic benefits of the same company. Cruz et al. (1991) in evaluated the economic impacts of the *Programa Cooperativo de Investigación Agricola for La Andean Subregión* (PROCIANDINO) based on the same hypothesis.

This hypothesis considers that displacement of the supply curve to the right, as a consequence of the adoption of research, results does not affect the aggregate ratio of agricultural prices. Therefore, in the absence of a price decrease resulting from technological progress, the research benefits go to producers. Consumers benefit by the greater availability of products, but they do not take advantage from the economic benefits in this simplified model of the surplus generated by research.

4.2 Analytical Reference

The procedure used for calculating investment's economic profit performance was the internal rate of return determination. The internal rate of return represents an interest rate that equals the present value of the benefits to the present value of costs. Therefore, it reflects the remuneration for the invested capital. It is an approach commonly used as a decision parameter. The approach says that the enterprise is conceivable if its rate of return is equal or superior to the remuneration of capital invested in other sectors of the economy.

The internal rate of return (r) is obtained through the following formula:

$$\sum_{t=0}^{n} \frac{(B_t - C_t)}{(1+r)^t} = 0 \qquad (1)$$

where:
B_t = the year economic benefits over t; C_t = economic costs over the year t; $(B_t - C_t)$ = net economic benefits over the year t; t = evaluation period; n = final year of the flow; r = internal rate of return.

5 Procedures

The identification of the main technologies generated was done in stages. Initially, a series of interviews was made with the coordinators of several research programs of EPAMIG in order to identify the developed technologies which, through their diffusion, possibly contributed to the elevation of the producers' net incomes through the increase of the physical productivity or through the reduction of costs, or still by expansion in new areas. The chosen Research Programs were those for cotton, rice, coffee, beans, fruit cropping, horticulture and soybean, from which the cultures have high economic and social importance for the state. Therefore, they constituted the main research problems for EPAMIG.

After this first step, researchers who developed such technologies

were interviewed, and the main effects of each technology were distinguished in a summarized form.

The adoption of the new techniques and cultivars generated by EPAMIG were estimated with the aid of the *Instituto Mineiro de Agropecuária* (Agriculture Institute of Minas Gerais) (IMA), that is responsible for seed production inspection in Minas Gerais, together with *the Associação de Produtores de Sementes de Minas Gerais* (Seed Producers Association of Minas Gerais (APSMG), and the *Empresa de Assistência Técnica e Extensão Rural de Minas Gerais* (Technical Support and Rural Extension Agency of Minas Gerais) (EMATER-MG).

The economic benefits resulting from research carried out by EPAMIG is shown as its average value that was obtained by farmers who adopted each of the generated technologies. More specifically, the benefits are estimated by comparing the results of the new technology with those of the technology previously used, the "traditional one", and both the productivity increases and the cost reductions. The gains due to area expansion are also taken into account.

As an institution that integrates the National System of Agricultural Research and coordinates the State System on Agricultural Research in Minas Gerais, EPAMIG develops its researches in partnership with several academic and research institutions at the federal and state extent. Therefore, many technologies available to farmers are the result of the inter-institutional efforts, what makes the precise definition of each organization's contribution difficult while taking the final product level as a reference.

In the present work, the approach used by Cruz et al. (1982), Ávila et al. (1985) and Lanzer et al. (1989) was adopted. This approach consisted on proportionally dividing the benefits for each one of the technological innovations, among the involved institutions. With the support of the researchers' team of the pertinent programs the percentage participation of EPAMIG in the generation of the referred technologies was distinguished. This was also possible by isolating the participation of the rural extension.

Besides the aspects related to the measuring process, another point deserving prominence refers to the discrepancy between investments on research and the effects on production. According to Evenson (1981), the average time between the investments on research and their effects on production is from six to seven and a half years in the case of the United States. For being researches with perennial and annual crops that have maturation in different periods, a discrepancy period of six years was used, which means that the benefits began to show in 1980. This still prevents the benefits previous to the creation of EPAMIG from not being captured. After 1980, the benefits were estimated in agreement with the adoption rate observed in each technology and/or generated product.

The prices used for estimating the benefits refer to those received by producers in the state of Minas Gerais, in annual average terms, corrected by the *IGP-DI* index based in December 1997. Similarly to the benefits, the costs were also deflated by the same index.

6 Results

In Table 1 the net benefits are presented at the producer level relatively to the participation of EPAMIG, as well as the technologies and/or products developed in the research programs of pineapple, cotton, rice, banana, potato, coffee, bean, tomato and soybean during the period from 1974 to 1997. Among all technologies presented in Table 1 some will be described as follows, with the objective of giving a better perspective of the obtained results as well as the resulting volume of benefits.

Plant breeding programs introduced five new cultivars of cotton, adapted to the state of Minas Gerais edapho-climatic conditions. More productive cultivars were determined based on its higher tolerance to pests and diseases and with characteristics of consentaneous fiber adapting the architecture of the plant to the mechanical harvesting.

The concern with *"bicudo"*, which is a pest, led EPAMIG to

develop some forms for coexistence with this hardly combated pest. For example, the introduction of the variety "EPAMIG-5" or "EPAMIG-PRECOCE 1" in 1993, avoiding the attack of this pest due to its precocious cycle.

The integrated management of cotton pests is a tecchnology to reduce production costs, although the possibility of higher physical returns is not excluded. The use of this technique allows the reduction of 34.3% of the conventional cost for fighting the pests.

EPAMIG has introduced 18 new cultivars of rice, of which nine are non-irrigated rice, seven for flood irrigated rice and two for wet low and flat land. The new cultivars presented greater tolerance to pests and diseases, and mainly a higher productivity than the ones traditionally cultivated.

The coffee crop was implanted in recently deforested areas from which the natural fertility of the soil allowed to obtain reasonable productivities over many years. From the 1970 decade, these areas practically disappeared, just remaining the low fertility soils under "cerrado" vegetation.

The research tried to equate the several problems of soil fertility under "cerrado" vegetation and that of low fertility, aiming to contribute for its rational use.

The modern coffee growing requires the use of fertilizers and correctives in appropriate quantity, to attend the economic approach and at the same time to maintain the crop. The knowledge about the limitations that affect the coffee growing is important to the soil fertility and coffee nutrition. The following was developed by EPAMIG: some techniques for soil correction; nutrient response curves in the several soil conditions, and, at the same time, the establishment of critical levels for these soils; response to the organic fertilizations; the use of conditioners for deeper soil layers by supplying calcium and eliminating the toxic effects of aluminum and propitiating a developed root systems; micronutrient studies for the formation and production phases.

Table 1. Net gain estimate at the producer level, for technology and, or, product adopted in the state of Minas Gerais from 1980 to 1997. In R$ 1,000.00 of December 1997

Technologies and/ or products	EPAMIG's articipation (%)	1980	1981	1982	1983
PINEAPPLE					
• Production system	40	1,402	1,444	1,061	935
COTTON					
• Cultivar introduction	40	5,137	4,366	3,265	1,629
• Integrated management of pests	40		54	95	136
RICE					
• Non-irrigated rice	40				
• Irrigated rice	40				
BANANA					
• Production systems of irrigated banana	40				
POTATO					
• Production systems	40	8,173	5,091	2,608	6,327
COFFEE					
• Introduction into soils under "cerrado" vegetation	40	36,250	85,038	40,067	45,214
BEANS					
• Cultivar introduction	40				
• Planting of autumn-winter beans	10				
TOMATO					
• Production systems	40	2,822	2,455	3,514	3,424
SOYBEAN					
• Introduction into soils under "cerrado" vegetation	20	32,042	25,627	36,754	75,384
Total	-	85,826	24,075	87,364	133,049

Table 1. cont

Technologies and/ or products	EPAMIG's articipation (%)	1984	1985	1986	1987	1988
PINEAPPLE						
• Production system	40	1,246	2,135	3,732	1,374	3,577
COTTON						
• Cultivar introduction	40	965	386	804	396	132
• Integrated management of pests	40	176	217	258	299	340
RICE						
• Non-irrigated rice	40				1,931	12,082
• Irrigated rice	40	3,464	2,997	4,364	3,002	2,792
BANANA						
• Production systems of irrigated banana	40					
POTATO						
• Production systems	40	2,476	3,387	10,942	8,114	6,878
COFFEE						
• Introduction into soils under "cerrado" vegetation	40	64,639	54,360	84,632	15,558	01,709
BEANS						
• Cultivar introduction	40					
• Planting of autumn-winter beans	10	2,431	2,084	3,450	3,792	4,982
TOMATO						
• Production systems	40	2,537	3,056	10,912	6,960	3,464
SOYBEAN						
• Introduction into soils under "cerrado" vegetation	20	78,258	98,542	79,553	74,303	92,326
Total	-	56,192	67,164	98,647	15,729	28,282

Table 1. cont

Technologies and/or products	EPAMIG participation (%)	1989	1990	1991	1992
PINEAPPLE					
• Production system	40	1,300	1,278	3,207	2,566
COTTON					
• Cultivar introduction	40	42	1,360	414	140
• Integrated management of pests	40	380	421	462	503
RICE					
• Non-irrigated rice	40	5,998	8,186	5,624	5,567
• Irrigated rice	40	1,699	1,869	874	991
BANANA					
• Production systems of irrigated banana	40		2,245	3,500	5,943
POTATO					
• Production systems	40	2,888	5,633	3,179	6,335
COFFEE					
• Introduction into soils under "cerrado" vegetation	40	71,432	70,954	61,355	37,488
BEANS					
• Cultivar introduction	40				
• Planting of autumn-winter beans	10	7,470	5,659	7,173	6,558
TOMATO					
• Production systems	40	2,774	5,227	2,869	2,311
SOYBEAN					
• Introduction into soils under "cerrado" vegetation	20	75,947	37,098	52,441	68,604
Total	-	169,930	139,930	141,098	137,006

Table 1. cont

Technologies and/or products	EPAMIG participation (%)	1993	1994	1995	1996	1997
PINEAPPLE						
• Production system	40	4,906	4,514	3,165	2,691	1,559
COTTON						
• Cultivar introduction	40	1,111	1,838	1,550	1,798	756
• Integrated management of pests	40	543	584	625	666	706
RICE						
• Non-irrigated rice	40	8,190	4,427	2,659	2,190	1,530
• Irrigated rice	40	1,118	131	176	85	122
BANANA						
• Production systems of irrigated banana	40	10,646	20,469	38,448	34,595	27,071
POTATO						
• Production systems	40	4,950	3,439	5,849	4,728	3,858
COFFEE						
• Introduction into soils under "cerrado" vegetation	40	122,998	184,825	80,466	92,361	84,275
BEANS						
• Cultivar introduction	40		796	833	955	448
• Planting of autumn-winter beans	10	15,907	16,069	5,162	6,713	6,980
TOMATO						
• Production systems	40	4,217	5,571	2,543	2,918	3,164
SOYBEAN						
• Introduction into soils under "cerrado" vegetation	20	122,204	78,616	49,053	50,035	60,014
Total	-	296,790	321,279	190,529	199,735	190,483

Source: Research data

Consequently, to new cropping practices, pests, such as *"ácaro-vermelho", "bicho-mineiro"*, and caterpillars, constituted one of the main problems. In this sense, EPAMIG developed research to establish efficient schemes for the chemical control of the disease, relatively to the selection of better products, dosages and number of applications. On the other hand, EPAMIG also tries to obtain the resistant varieties for a gradual substitution of the traditional varieties that are susceptible to the disease.

In the state of Minas Gerais, the traditional bean planting happens over two periods, as follows: the rainy season crop, in which the soil moisture and temperature conditions are favorable to the development of the crop, but harmful for harvest; and the drought season crop, when beans are planted on February- March, and are generally damaged by the lack of rain.

A third crop season, ("winter"), has been arousing the large and medium farmers' interest. In this time, planting may occur from April to July by using irrigation, since there is practically no rain. The research results showed that yields of 1,500 to 2,500 kg/ha are easily obtained in this cropping season.

Eight new bean *cultivars* which were more productive and more resistant to pests and diseases were introduced. In the period from 1980 to 1997, beans of the wet season presented an increase of only 6.6% in productivity. However, beans of the dry season had an increase of 54.5% in productivity over the same period. This productivity growth was provided not only by new cultivars, but also by the new planting techniques announced by the research.

The incidence of *fusariosis* is still the greatest problem in pineapple cropping in the state of Minas Gerais. In order to determine efficient and economic measures for the control of the disease, the EPAMIG developed several research lines. Considering that the dissemination of the *fusariose* in a crop or from a region to another mainly occurs through the contaminated seedlings, some techniques were developed aiming at the yield of disease-free seedlings as well as practices that will make possible

for the producer to harvest in seasons when the index of the disease infestation is minimized.

The State Research System (EPAMIG – and the universities UFLA,UFMG, and UFV) coordinated by EPAMIG, is present in the evolution of the productive process of the potato and tomato crops, from which the productivity growth in the last 20 years was annually 4.18% for the potato crop and 3.5% for the tomato crop mainly through the elaboration of production systems, which reflect the results of the researches.

The expansion of the banana cropping on northern Minas Gerais, and more precisely in the Gorutuba and Jaíba Projects, was extremely fast due not only to the favorable climate conditions but also to the irrigation techniques, identification of adequate cultivars to the region, nutrition and fertilization, pests and diseases combat.

The production system of the *Banana-prata-anã* crop developed for northern Minas Gerais and an integrant part of the Quality Banana Program aims at the standardization of the productive process of banana cropping in the region, by approaching the whole productive process since the seedling formation to the harvest and after-harvest, seeking to reach the quality demanded by national and international markets.

The pronounced development of soybean crop in "cerrado" areas due to the research resulted in the viability of this crop in the region, by adapting it to the soil and climatic conditions of " cerrado" areas. We may conclude that social benefits were much superior to costs resulting from the resource allocation.

The costs of research over the period from 1974 to 1997 are presented in Table 2. We can verify that the resources applied on the research by EPAMIG increased at a rate of 20.39% a year in the period from 1974 to 1986 and at negative rates of 7.08% a year from 1986 to 1997.

These data show that EPAMIG, as a public company, suffers the effects from the administrative discontinuance of the State Similarly to other institutions of this kind, it is susceptible to political influences,

many of the times not related to the interests of agricultural research.

Table 2. Resources applied by EPAMIG from 1974 to 1997 for expense rubric. In R$ 1,000.00 of December 1997

Year	Personnel	Investments	Other costs	Total
1974	1,776	368	2,886	5,031
1975	7,341	1,422	12,333	21,096
1976	17,615	2,286	12,818	32,719
1977	20,863	1,177	15,197	37,236
1978	25,724	1,003	14,676	41,402
1979	36,387	939	5,634	42,959
1980	27,197	859	11,857	39,913
1981	23,160	837	8,583	32,580
1982	30,975	723	12,839	44,537
1983	25,757	854	12,969	39,580
1984	24,204	3,472	15,066	42,742
1985	29,445	1,265	14,289	44,999
1986	29,011	1,616	15,993	46,620
1987	13,580	713	12,142	26,435
1988	7,492	67	5,414	12,974
1989	7,368	7,999	8,438	23,804
1990	6,332	13,322	3,946	23,601
1991	10,619	0	4,226	14,846
1992	8,790	234	5,334	14,359
1993	22,522	1,471	5,287	29,281
1994	22,114	817	8,524	31,455
1995	18,438	2,040	6,507	26,984
1996	14,524	1,058	8,996	24,578
1997	14,646	812	5,318	20,776

Source: Research data

Under the assumption that the benefits began in 1980, it is verified that the net benefits are negative until the year of 1979. From there on the net benefit of the research accomplished by EPAMIG is positive (Table 3).

Table 3. Benefits and costs of EPAMIG research over the period from 1974 to 1997. In R$ 1,000.00 of December 1997

Year	Cost	Gross benefit	Net benefit
1974	5,031		-5,031
1975	21,096		-21,096
1976	32,719		-32,719
1977	37,236		-37,236
1978	41,402		-41,402
1979	42,959		-42,959
1980	39,913	85,825	45,912
1981	32,580	124,074	91,495
1982	44,537	87,364	42,826
1983	39,580	133,048	93,468
1984	42,742	156,193	113,452
1985	44,999	267,164	222,165
1986	46,620	298,645	252,025
1987	26,435	215,728	189,294
1988	12,974	228,282	215,308
1989	23,804	169,930	146,126
1990	23,601	139,930	116,329
1991	14,846	141,098	126,253
1992	14,359	137,007	122,648
1993	29,281	296,790	267,509
1994	31,455	321,280	289,825
1995	26,984	190,527	163,543
1996	24,578	199,738	175,160
1997	25,776	190,483	164,707
Total	725,507	3,383,107	2,657,600

Source: Research data

From data of Table 3, the internal rate of return to the investments on research was estimated by EPAMIG, obtaining a TIR of 31.8%. This means that for each R$ 1.00 applied on research, the annual return is R$ 1.32.

The positive aspect of these results is still more evident when confronted with that of other studies that used a similar methodology. Cruz et al. (1982) evaluated the research of EMBRAPA and found an internal rate of return from 28.9% to 43%. Silva et al. (1986) estimated an internal rate of return (TIR) of 49.7% a year for ten years for the *Empresa de Pesquisa Agropecuária de Santa Catarina* (Agricultural Research Agency of Santa Catarina) – EMPASC, while Barbosa et al. (1988) also evaluating the EMBRAPA research, although over a period superior to the one considered by Cruz et al. (1982), estimated an internal rate of return of 40.5%. It is worth mentioning that international results as those obtained by Everson & Jha (1973) that estimated a rate of return of 40% for an aggregate evaluation in India, and by Everson (1967) who found a rate of 23% for the United States.

This rate is compared to the best results obtained by research institutions at both national and international levels, being sufficiently superior to those required in investment projects of international institutions such as the Inter-american Development Bank (IDB) and the World Bank (IBRD) which are between 6 and 10% and are also superior to the rates required by the national development banks such as the Banco de Desenvolvimento Econômico e Social (BNDES) and the Banco de Desenvolvimento de Minas Gerais (BDMG), which are between 9 and 12% (TJLP).

In reality, this value is close to the real interest rate practiced in the national financial market. It is worth to remind that these rates are among the highest in the world. This means that the returns of the research activities developed by EPAMIG are at least as high as the returns obtained in the national financial sector, except that the first ones have a social character.

7 Conclusion

The results of this study allow us to conclude that the government option in directing resources for agricultural research is providing high returns to the society.

It should be emphasized that the rate of return obtained in this work refers to the research programs with crops of pineapple, cotton, rice, banana, potato, coffee, beans, soybean and tomato. If on the one hand the benefits were estimated for these crops and on another for the costs, the total expenses of the company were counted, that is the expenses with all the EPAMIG research programs. This demonstrates that the benefits of the technologies adopted in these mentioned crops are above the cost of the knowledge generation in the institution as a whole.

In times of scarce resources, Science and Technology activities are commonly neglected in favor of others, being at the same time necessary to modernize and to guarantee competitiveness to agriculture in a world that is increasingly globalized. The results obtained are fundamental to orient resource allocation policies.

Finally, it may be concluded that the Agricultural Research Agency of the State of Minas Gerais - EPAMIG despite the crisis has been facing, is an efficient institution, once the analysis demonstrates that the benefits generated by the analyzed technologies overcome all costs of the Agency's research.

8 References

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