SETOR DE AGRICULTURA

D R A F T

COSTS AND RETURNS OF EDUCATION IN FIVE AGRICULTURAL AREAS OF EASTERN BRAZIL**

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It has been hypothesized that education plays a major role in agricultural development. However, studies of the economics of education in the agricultural sector have been based largely on aggregate data from developed countries {4, 6, 11, 20} . Studies in developing countries have focused on the non-agricultural sector and the agricultural sector, with the exception of {3, 8} , has been almost entirely neglected.

This study estimates the costs and returns to formal schooling and agricultural extension in five areas representing different levels of agricultural modernization. The first section discusses education's role in agricultural production. This is followed by description of the model used to measure the returns to education. The third section presents a description of areas studied. Fourth are the statistical results and estimated returns to schooling and extension. The fifth section contains the estimated costs of education and is followed by the benefit-cost ratios and internal rates of return. Implications of the results make up the final section.

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- EDUCATION'S ROLE IN AGRICULTURAL PRODUCTION.

One way of conceptualizing the role of educational activities (schooling or extension) in agricultural production is to consider education's impact on production of a firm. Welch {20} has attributed the value of education to a "worker effect" and an "allocative effect" which are directly related to the labor and managerial input components of the human factor. The worker effect arises because increased education may improve the quality of the labor component and can be defined as the ability to produce more, given the same resources other than labor[1]. Increased education may also improve the decision-making functions of the managerial component by increasing the farmer's ability to acquire, interpret and evaluate information, giving rise to the allocative effect[2].

The allocative effect has two aspects. The first refers to the allocation of resources, in the case of a multi-product firm, among competing products. In a market-oriented agricultural environment with changing product and/or factor prices there is typically continued need for adjustment in resource allocation, although production techniques and types of inputs may be constant. More nearly optimum allocations of resources among products by farmers with more education would be reflected by greater output, other factors constant[3].

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[1] This is essentially the "quality" of labor as considered by Griliches {7}.

[2] In part this includes the "innovative" effect discussed by Nelson and Phelps {15}.

[3] Increased education may also improve a farmer's ability to predict seasonal price variations. If prices received by an individual farmer, rather than average regional prices, were used to compute gross output, measures of the return to education would include the "price effect", if it exists.

Determination of the types and quantities of resources to be used in production is the second part of the allocative effect. Farmers with more education may adjust production plans according to changes in input prices and may be able to identify and utilize properly "new" inputs. In the short-run, the types and quantities of purchased inputs can be changed, while the types and quantities of firm-supplied resources can be changed in the longer-run.

With the transformation or modernization of agriculture, alternative production techniques and "new" inputs are developed. Farmers must continually evaluate alternative production techniques, resource and product combinations. It is hypothesized that if education aids farmers in allocative decisions, returns to education will be higher in areas with more modernized agriculture.

Assuming well-defined market values for farm outputs and inputs, other than operator labor-management, the value added by education and labor-management could be calculated as a residual. This value-added, as an appropriate function of education and operator labor-management, would yield a partial derivative that could serve as a measure of the marginal value-added by a unit of education. In essence this would be the marginal value product of education, aggregating all of the above effects of education for any given level of operator labor. Although conceptually simple, the complete value-added approach is difficult to implement because the market values of many inputs are not well defined in the real world, particularly in underdeveloped countries, and problems of operational definition and measurement arise with respect to all of the variables.

Alternatively education could be included as an explicit variable in a traditional production function. However, since education may affect the allocation of resources, the

partial derivative with respect to education could underestimate its marginal value product[4].

Assuming that the value of output, Y, is a function of factor services, X, and education, E, the relationship can be expressed as

$$Y = f(X, E). \tag{1}$$

If education does affect the choice of type and quantity of resources, then

$$X = g(E). \tag{2}$$

and it follows that

$$\frac{dY}{dE} = \frac{\partial Y}{\partial E} + \frac{\partial Y}{\partial X} \cdot \frac{dX}{dE} \tag{3}$$

with $\frac{dX}{dE}$ based on (2)

The first term on the right of the equality sign in equation (3) includes the direct effect of education on production and the second term is the gross indirect effect of education on production through the other inputs. If these other inputs are measured in value terms, then $\partial Y/\partial X$ is the marginal value product of X, which, at the optimum level of input use, equals the price of X. The net indirect effect of education can be represented as

$$\left(\frac{\partial Y}{\partial X} - P_X\right) \cdot \left(\frac{dX}{dE}\right) \tag{4}$$

and the net marginal product of education as

$$\frac{dY}{dE} = \frac{\partial Y}{\partial E} + \left(\frac{\partial Y}{\partial X} - P_X\right)\left(\frac{dX}{dE}\right) \tag{5}$$

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[4]For a multi-product firm, where the allocation of resources among products is not specified, ~~but~~ the partial derivative of education will include the worker effect and the effect of allocation of resources among products, but excludes the effect of determining the "right" types and quantities of resources to be used.{20}.

Estimates of $\partial Y/\partial E$ may be obtained by estimation of (1), while an estimate of dX/dE may be obtained by estimation of the auxiliary equation (2)[5]. Thus this procedure will yield an estimate of the marginal value product of education which includes all of the worker, allocative and price effects[6].

2 - STATISTICAL MODEL AND PROCEDURES

A modified version of the value-added function was estimated to obtain an empirical measure of education's impact on agricultural output in each of the areas studied. The specific form of the model was

$$\log VA = \log b_o + b_1 \, Sch + b_2 \, Ext + b_3 \log FC + u \qquad (6)$$

Value added, VA, was defined as the value of farm production minus the value of purchased non-labor inputs. Formal schooling, Sch, was measured as the years of schooling completed by the farm operator. Participation in extension activities, Ext, was measured by the number of direct contacts the farm operator had with the extensionist during the year studied. Farm supplied services of labor, land, livestock, equipment and other forms of fixed capital were aggregated into a single variable, FC[7].

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[5] A similar approach has been used by Haller {8 }.

[6] Although this discussion is in terms of the value of output, empirically the value of any input with a well-defined market value could be subtracted from output.

[7] Labor, a quasi-fixed factor in much of Brazil, was valued at the prevailing agricultural wage of the areas. Services of fixed capital (buildings, improvements, equipment and livestock) were measured as depreciation, interest and repairs. Individuals purchasing land as a hedge against inflation have distorted land prices, thus services of land were measured using average rental values in the areas.

Many farmers in the areas studied do not have any formal schooling and/or have not participated in extension activities, yet have non-zero production. Specification of schooling and extension in linear form allows zero as a "legitimate" observation. The estimated coefficients can be interpreted as the percent change in value-added from an additional year of schooling or contact with the extensionist, that is, the direct effect of education on production[8].

The indirect effect of education on the quantity of farm supplied resources was estimated by the auxiliary equation

$$\log FC = b'_o + b'_1 \text{ Sch} + b'_2 \text{ Ext} + u \qquad (7)$$

Aggregation of the farm supplied resources into a single variable excludes part of the effect of selecting the "right" types and quantities of resources. Part of this effect will be picked up by the value-added function, while the auxiliary equation will pick up primarily the effect of selecting the "right" quantity of farm supplied resources. Correlations among the various forms of farm supplied resources were extremely high, suggesting they should be aggregated into a single variable to avoid the estimational problems associated with high multicollinearity.

The estimated marginal product of schooling, is the annual return accruing to the individual in the form of value-added and does not include other possible returns to schooling. It is assumed this return would accrue to an individual for 35 years beginning at age 20. It is assumed that 50 percent of the benefits from farmer's participation in extension activities in year t accrue to him in year t,

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[8] Increasing marginal products associated with positive coefficients of schooling and extension do not appear unreasonable within the range of the data. An additional year of schooling represents a larger investment in a more mature student, while additional contacts are often necessary for the extensionist to gain a farmer's confidence and reinforce teachings.

30 percent in year t + 1, and 20 percent in year t + 2[9]. A discount rate of 10 percent, the assumed real rate of interest, was used to obtain the present value of these income streams.

Data used in estimating the functions were obtained from surveys of farmers {2, 5, 10, 13, 14} in five areas. Information obtained included years of school completed, number of contacts with extension agents, labor used, current value and expected life of fixed capital resources, purchased inputs, and gross farm output. These farmers also furnished information necessary to estimate the cost of their participation in extension activities, earnings foregone by their school age children, and direct costs of schooling. This study was limited to commercial farmers (normally more than 5 hectares).

3 - AREAS STUDIED.

The areas studied in eastern Brazil represent a wide range of agricultural conditions and levels of agricultural development. Although there is considerable variation in soils, natural vegetation, topography and agricultural enterprises among the areas, within each area agricultural conditions are relatively homogeneous. All areas have been served by the extension service for a number of years. The areas studied, in ascending order of agricultural modernization, can be characterized as follows[10].

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[9]The time distribution of the effects of extension was based on the judgement of the researchers and others familiar with the situation, but more research is necessary to verify this time distribution. To the extent that it differs from that assumed, the benefit-cost ratios and internal rates of returns will be different than estimated, possibly changing the economic and policy implications.

[10]The subjective ranking of the areas was based largely on modern input use and recent changes in the area. For a more detailed description of the ranking system and areas studied see Patrick {16}.

PARACATU - in the state of Minas Gerais, is an area of relatively large farms with extensive grazing of beef cattle on natural pasture as the principal activity. Crop production has increased since the establishment of Brasília, but very little machinery is used and very few farmers use fertilizers. Although many of the production practices are quite traditional, some changes are occurring.

CONCEIÇÃO DO CASTELO - in the state of Espírito Santo, is an area of coffee production and livestock is of minor importance. The farms are relatively small and often grow corn and dry beans in addition to coffee. Most of the farmers use traditional production techniques, although some are using fertilizers and controlling erosion. There is a tendency toward diversification of crops and the extension service is promoting production of washed coffee.

ALTO SÃO FRANCISCO - in Minas Gerais, is a transitional agriculture and part of the are has developed a reputation as a center of purebred cattle. Many farmers have established improved pastures, use mineral supplements and some use protein supplements during the dry season. Crops, mainly corn and dry beans, are often used to prepare the land for establishment of improved pastures.

VIÇOSA - in Minas Gerais, contains another transitional agriculture. Coffee, the traditional crop, has declined in relative and absolute importance and major adjustments have followed its decline. Many of the farms are small and have a diversified production. Dairy and horticultural crops are increasing in importance and many farmers use fertilizers and insecticides. Some farmers with dairy cattle are using supplemental pasture during the dry season and introducing Holstein blood.

RESENDE - in the state of Rio de Janeiro, has the most modernized agriculture of the areas studied and is specialized in milk production. The area is one of the more advanced dairy areas in Brazil. Most of the cattle carry a high proportion of Holstein blood and are intended for dairy, rather than dual purpose. Use of supplemental forage during the dry season, feeding of concentrates and mineral supplements is common.

4 - ESTIMATED RETURNS TO EDUCATIONAL ACTIVITIES

The estimated value-added and auxiliary functions for each of the areas studied are presented in Table 1. Educational activities were generally not statistically significant in the value-added functions, while farm supplied resources were highly significant in all of the areas. In Viçosa and Resende the estimated coefficients of schooling were significant or larger than their standard error, but they were negative in the 3 less modernized areas. The estimated coefficients of extension were positive in all areas, but significant only in C. de Castelo. These results indicate that educational activities had limited direct impact on value-added in the areas studied[11].

The indirect effect of schooling, measured in gross terms by the auxiliary equations, was highly significant in all of the areas except C. de Castelo indicating the level of farm supplied resources is affected by schooling. However, given the high cost of schooling in Brazil, it could argued that farmers whose fathers were well-to-do may have had the opportunity to obtain more schooling and

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[11] Information on recommended practices adopted by individual farmers was available in all areas except Conceição de Castelo. Farmers were divided into 3 categories by years of schooling completed: low (none); medium (1 to 3 years); and high (4 or more years). A chi square test indicated significant differences in the number of practices adopted did exist among schooling levels in Alto São Francisco and Viçosa. A similar test for extension activities indicated significant differences existed in Paracatu, Alto São Francisco and Viçosa. Farmers were classified by the number of extension contacts as low (none), medium (1 to 5 contacts) and high (more than 5 contacts).

Table 1

Parameter Estimates and Standard Errors for the Value-Added Function and Auxiliary Regression in the Areas Studied[1]

Variable	Area Paracatu n=86	C. de Castelo n=54	A. São Francisco n=82	Viçosa n=337	Resende n=62
VALUE-ADDED FUNCTION					
Constant	.94622	.43970	1.0038	-.20122	.71437
X_1 Schooling	-.01676 (.01191)	-.00919 (.01232)	-.01255 (.01932)	.02324** (.00811)	.00993 (.00895)
X_2 Extension	.00056 (.00275)	.00901** (.00339)	.00432 (.00442)	.00268 (.00261)	.00099 (.00794)
X_3 Farm Resources log	.72595** (.06885)	.93122** (.06285)	.67265** (.08982)	1.0116** (.04748)	.73426** (.10539)
R_2	.58577	.82461	.44205	.62376	.55092
AUXILIARY REGRESSION[2]					
Constant	3.5924	3.1498	3.4272	3.2825	3.9289
X_1 Schooling	.05100** (.01814)	.00552 (.02744)	.07360** (.02264)	.03998** (.00908)	.03717** (.0094)
X_2 Extension	-.00585 (.00434)	.00434 (.00752)	.00019 (.00554)	.00729 (.00298)	.00869 (.00974)
R_2	.10148	.00920	.10771	.09000	.20308

[1] Two asterisks indicate the coefficient is significant at the 1 per cent level.

[2] Dependent variable is X_3, farm supplied resources in log form.

also received or had greater facility in obtaining resources. The indirect effect of participation in extension activities was significant only in Viçosa[12].

Prices of farm supplied resource services exceeded their estimated marginal products, at the sample means, in all of the areas except C. de Castelo. Overutilization of resources in these areas, combined with positive coefficients in the auxiliary equations, indicate net indirect effects were negative except for extension in Paracatu. In part, the negative net indirect effects of education may be the result of improper specification and measurement of farm supplied resource services. Alternatively, given the highly inflationary environment and negative real rates of interest on bank loans in Brazil during the 1960's, farmers may have been attempting to maximize their real asset position or growth rather than net income or value-added[13]. The net indirect effects were generally small and affected the signs of the annual returns to education only in Resende.

Table 2 presents the annual return to an individual who had completed various years of schooling (or extension contacts) compared to an individual with the same resources and no schooling (or extension contacts). Returns to schooling, computed from coefficients which were nonsignificant in the value-added functions, were negative for all levels in the three less modernized areas. Although the net indirect effect of schooling in C. de Castelo was positive (about CR$4), it was not large enough to overcome the negative direct effect. In Viçosa,

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[12] A model in linear form indicated no significant interaction between schooling and extension in the areas studied.

[13] For a more extensive discussion of this Brazilian situation see Alves {1}.

Table 2

Estimated Annual Returns, in CR$[1], to Various Years of Schooling Completed and Contacts with Extension in the Areas Studied, 1967/1968[2]

	A R E A				
	Paracatu	C. de Castelo[3]	A. São Francisco	Viçosa	Resende
Years of Schooling		S C H O O L I N G			
1	- 217.7	- 48.1	- 182.9	89.4	- 75.7
2	- 396.1	- 99.9	- 300.9	192.6	27.3
3	- 571.9	-151.2	- 424.6	300.1	130.2
4	- 745.9	-200.4	- 555.6	413.0	233.9
5	- 918.5	-249.0	- 685.6	531.9	336.2
6	-1090.8	-298.2	- 847.0	656.9	438.9
Extension Contacts		E X T E N S I O N			
1	17.3	54.1	26.9	11.2	- 59.5
3	25.2	158.5	70.9	35.7	- 35.6
5	34.2	267.3	119.7	61.6	- 11.9
7	44.6	380.7	169.5	87.7	11.8
9	53.2	498.9	220.2	114.2	35.5
11	62.3	622.2	272.1	141.2	59.0
13	71.2	750.7	324.9	168.3	82.4
15	80.5	884.0	378.8	195.8	105.7

[1] During the 1967/1968 agricultural year the exchange rate increased from CR$2.70 to CR$3.20 per US$1.00.

[2] The marginal product of the n th year (or contact) may be computed by subtracting annual return of year n-1 from year n.

[3] Results for C. de Castelo refer to 1966/1967 agricultural year.

the schooling variables were significant in both equations and although the net indirect effect was negative, the returns to schooling were positive. The negative net indirect effect in Resende reduced annual returns by CR$204 for the first year, but the direct effect was large enough so positive returns existed for additional years of schooling. Although not conclusive, the statistical significance of the coefficients and estimated returns indicate the value of schooling tended to increase with the level of agricultural modernization as hypothesized.

Returns to participation in extension activities, generally computed from nonsignificant coefficients, were positive at all levels in the four less modernized areas. In Resende the negative net indirect effect reduced returns by CR$75 to CR$110 and was sufficient to overcome the positive direct effect until the level of 7 contacts. Net indirect effects did not exceed CR$12 in other areas. The generally small and nonsignificant net indirect effects of extension were not unexpected since many of the extension services activities were oriented toward improving production practices.

There is some tendency for returns to extension to be lower in the more modernized areas. In Resende, the most modernized area studied, there are a number of input suppliers which may serve to replace the extension service as a source of information with respect to new inputs and practices[14]. However, the extension service may be working with the "poorer" farmers in the more modernized areas and statistical results may be measuring the quality of farmer assisted rather than returns to the extension activities per se.

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[14] Resende was the only area with data available where farmers assisted by the extension service had not adopted a significantly higher number of recommended production. practices.

5 - ESTIMATED COSTS OF EDUCATIONAL ACTIVITIES

Formal Schooling

In Brazil primary school attendance for 4 years beginning at age 7 is required by law, but compliance is far from universal. Many rural children do not begin school at age 7 and/or fail to make normal progress. Most of the primary schools are publicly supported and only about 3 percent of the students attend schools where they must pay tuition. The secondary school system consists of two cycles, the ginásio of 4 years and the colégio of 3 years. These schools are normally located in urban areas and about 60 percent of the students attend private schools where they must pay tuition.[15]

Table 3 summaries the components of the cost of schooling an average male student in rural areas by grade attended in 1968. Annual earnings forgone were adjusted to reflect expected labor force participation by male students if not studying and assumed they could work 300 days per year. The individual's direct cost includes books, supplies, uniforms, tuition of those in private schools and transportation, room and board of students attending schools away from home. Costs of personnel and supplies were derived from secondary sources and adjusted to reflect costs per student in 1968. Estimated costs of the physical plant and equipment include depreciation, repairs, maintenance and interest on average investment. At the ginásio and colégio levels only 40 percent of the estimated costs per public school student were included to reflect the percentage of students attending private schools and paying tuition[16].

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[15] See [9] for a further discussion of schooling in Brazil.

[16] For a further discussion of these costs and adjustments see [16].

Components of Per Student Costs of Schooling and Percentage of Total Cost Borne by the Individual, 1968.

Grade Attended[1]	Annual Earnings Forgone[2] CR$	Individualists Direct Costs[3] CR$	Cost of Personnel and Supplies[4] CR$	Costs of Building and Equipment[4] CR$	Total Cost CR$.	Percent of Total Cost Borne by Individual %
P_1	25,56	83.69	42.40	13.80	165.45	66.1
P_2	47.04	90.83	42.40	13.80	194.07	71.0
P_3	61.43	92.64	42.40	13.80	210.27	73.0
P_4	78.47	125.79	42.40	13.80	260.46	78.4
G_1	75.73	329.02	56.50	16.56	487.81	85.0
G_2	107.01	405.19	56.50	16.56	585.26	87.5
G_3	149.11	425.74	56.50	16.56	647.91	88.7
G_4	193.51	546.28	56.50	16.56	812.85	91.0
C_1	211.90	685.16	56.50	19.32	972.88	92.2
C_2	299.57	685.16	56.50	19.32	1 060.55	92.9
C_3	299.57	685.16	56.50	19.32	1 060.55	92.9

[1] P, G, and C indicate primary, ginásio and colégio school cycles. Subscript refers to year within each cycle.

[2] Earnings forgone are adjusted for labor force participation, assume students could work 300 days per year if not studying and begin school at age 8. No discrimination was made between students 17 years age and older.

[3] Includes tuition of students attending private schools. Number of observations did not permit estimation of years of the colégio cycle separately.

[4] Available data did not permit discrimination of costs by year of cycle attended or between ginásio and colégio for personnel and supplies. Only 40 percent of estimated per student costs in public schools are included for the ginásio and colégio cycles to reflect the percentage of students attending private schools.

All costs increased with grade attended, the largest increases occurring between cycles. Approximately 75 percent of the average primary school cost of CR$200 per year was borne by the individual and represented about one-third of rural per capita incomes[17]. At the ginásio and colégio levels, total costs were about CR$600 and CR$100 per year respectively, as much or more than the per capita incomes in the areas studied, and about 90 percent of the cost were borne by the individual[18]. The high costs of schooling borne by the individual, relative to incomes, may be a major reason why only 51 percent of the rural Brazilian children between the ages of 7 and 14 attended school in 1964.

Agricultural Extension

The federal extension service, Associação Brasileira de Crédito e Assistência Rural (ABCAR), serve areas where about 52 percent of the rural population is located. About 60 percent of its efforts have been devoted to production-oriented assistance and the rest to community development, home economics and other programs[19]. The estimated public cost of production-oriented activities was CR$120 per farm in 1968.

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[17] The per capita gross national product in Brazil was CR$1108 or approximately US$320 in 1968. Incomes in rural areas are about one-half the national average {18}.

[18] In the United States, costs of primary and secondary schools were about 10 and 40 percent of per capita incomes in 1956. Based on Schultz {19}.

[19] Mosher {14} discusses the history and development of ACAR, the ABCAR agency in Minas Gerais. Later developments and a review of studies of ACAR is provided by Ribeiro and Wharton {17}, while the present ABCAR system is described by Schuh{18}.

Of the farmers surveyed, 38 percent participated in extension activities and had an average of 9.65 contacts with the extension agent. Farmers estimated their costs, in terms of time and out-of-pocket expenses, of participation in extension activities as CR$31.07 per year or CR$3.22 per contact. Total cost of production-oriented extension activities was CR$151.07 farm or CR$15.65 per contact in 1968. In contrast to schooling, 79 percent of the costs of extension were publicly supported.

6 - INVESTMENTS IN EDUCATIONAL ACTIVITIES

Investments in schooling in Paracatu, C. de Castelo and Alto São Francisco yielded negative annual returns at all levels. In Viçosa annual returns were positive and the private benefit-cost ratios were 2.71, 2.73, 2.75, 2.66, 2.21 and 1.96 for the first through sixth years of schooling. The respective social benefit-cost ratios were 1.79, 1.87, 1.93, 1.93, 1.69 and 1.55. The internal rate of return was about 16 percent for the individual for the first four years of schooling and declined to 14.6 percent for the sixth year . The social internal rate of return was about 2 percent lower than the private rate at all levels. In Resende, annual returns to schooling were negative in first year.Private benefit-cost ratios for the second to sixth years of school were 0.39, 1.19, 1.51, 1.40 and 1.31 with internal rates of return of 5.3, 11.0, 12.5, 12.1 and 11.7 percent respectively. The corresponding social internal rates of return were 3.7, 9.0, 10.5, 10.4 and 10.2 percent.

Individual and social benefit-cost ratios and internal rates of return for various numbers of extension contacts are presented in Table 4. In general the private benefit-cost ratios and internal rates of return were very high. The private internal rates of return exceeded 500 percent in C. de Castelo, 350 percent in A. São Francisco and 100 percent in Viçosa. Returns for up to 7 contacts were negative, but were relatively high for 9 or more contacts in Resende. Although returns to individuals' investments in extension activities were generally high, the social benefit-cost ratios exceeded unity only in C. de Castelo and A. São Francisco. In the other areas, returns to extension activities did not offset society's cost of providing them.

TABLE 4

Individual and Social Benefit-Cost Ratios and Internal Rates of Return to Various Numbers of Extension Contacts in Areas Studied, 1967/68[1]

Number Of Contacts	A R E A									
	Paracatu		Conceição de Castelo		A.São Francisco		Viçosa		Resende	
	I[3]	S[4]	I	S	I	S	I	S	I	S
1	4.58 196	0.94 6	14.33 500	2.95 131	7.12 350	1.47 40	2.61 110	0.61 *	*[5] *	* *
3	2.25 87	0.46 *	13.99 500	2.88 127	6.26 350	1.29 29	3.15 143	0.65 *	* *	* *
5	1.81 62	0.37 *	14.16 500	2.91 129	6.34 350	1.30 30	3.26 149	0.67 *	* *	* *
7	1.68 54	0.35 *	14.40 500	2.96 131	6.41 350	1.32 31	3.32 153	0.68 *	0.45 *	0.09 *
9	1.57 47	0.32 *	14.68 500	3.02 135	6.48 350	1.33 32	3.36 155	0.69 *	1.04 13	0.21 *
11	1.50 42	0.31 *	14.98 500	3.08 139	6.55 350	1.35 33	3.40 157	0.70 *	1.42 37	0.29 *
13	1.46 39	0.30 *	15.29 500	3.15 143	6.62 350	1.36 34	3.43 159	0.71 *	1.68 54	0.35 *
15	1.42 37	0.29 *	15.61 500	3.21 147	6.69 350	1.37 35	3.46 161	0.71 *	1.87 64	0.38 *

[1] Internal rates of return are given in the second line

[2] Ratios and rates for C. de Castelo are underestimated since returns were estimated from 1966-1967 data.

[3] I = Individual

[4] S= Social

5 A * indicates a negative benefit-cost ratio or internal rate of return.

7 - IMPLICATIONS

Although statistical results do not support strong conclusions with respect to education and are based on a limited geographical area, some implications can be drawn. Clearly if educational activities by themselves increased farmers' incomes, ordinarily the statistical significance of the educational variables in the equations estimated would have been much higher than discovered[20].

If returns in agriculture to schooling are zero or negative, as in 3 of the 5 areas studied, there is serious question whether investment in schooling is the best use of scarce resources. However, only the economic returns accruing to the individual in the form of increased value-added were considered in this analysis. External benefits, both economic and non-economic, as well as other returns accruing to the individual were ignored. Schooling may have its greatest impact, at the present stage of development, on increasing mobility of rural youth and facilitating the rural-urban transfer[21]. Those who have benefitted most

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[20] These results are consistent with the hypothesis that many variables affect agricultural development. Any of these variables can serve as a bottleneck to development, but the removal of a bottleneck without a balanced approach is unlikely to speed development greatly.

[21] The Brazilian school system has a classical orientation, thus material may be of limited usefulness in agriculture or taught in a context such that its relationship to problems faced by farm operators is unclear.

from schooling may seek other employment or migrate from the area, leaving those who benefitted least from their schooling. There also may be high complementarity, particularly for society, between investments in schooling and other investments not considered in this study.

As noted previously, returns to schooling and to increase with the level of modernization of the areas considered. In the areas of more traditional agriculture the number of alternative techniques available may be limited, giving farmers little opportunity to use the increased decision-making and managerial capacity developed by schooling. In Viçosa, a transitional area undergoing major adjustments, returns to investments in schooling were higher than they were in the more modernized area of Resende where agriculture is highly specialized.

The public sector could reduce the costs of schooling borne by the individual by providing more public schools, particularly at the secondary level. However, a large portion of the population apparently has incomes so low that they are not sending their children to existing public primary schools and would probably be unable to send their children to secondary school even if more public schools were provided. If schooling is considered a means of improving individual and social welfare, public support of schooling may need to take the form of direct subsidies or payments to low income facilities in addition to public schools to be effective[22].

Greater public support of extension, relative to schooling, may indicate that society feels a higher proportion of the returns from extension activities accrue to society. Farmers assisted by extension may

[22] A free hot lunch program has substantially increased school attendance in some areas. Direct costs of schooling could also be reduced by not requiring school uniforms or providing them for low-income students.

become early adopters of a new techniques and as such, the recipients of the benefits of early adoption. However, if the market is functioning properly, other farmers will adopt this new technology and society will benefit through having either greater output at the same cost or the same output at lower cost. This spillover effect, which accrues to society, may be sufficiently large as to justify strong public support of extension although the returns considered in this study did not cover social costs in 3 of the 5 areas.

Extension activities can be used in part as a substitute for schooling. It is clearly impractical to give formal schooling to most of the present farmers, but they can be exposed to new techniques and information through extension activities. Formal schooling in rural areas is a long-term investment which may have high returns in the non-agricultural sector and may pay off very well for the next generation of farmers if agriculture is modernized. The shorter-term investment in extension may well serve as a step toward modernization. The problem is one of balancing the allocation of resources currently available between modernization through extension and formally educating farmers of the future sufficiently to be able to go a step further in their turn.

REFERENCES

(1) - ALVES, Eliseu Roberto de Andrade - "An Economic Evaluation of the Impact of an Extension Program, Minas Gerais, Brasil", Unpublished M.S. thesis, Purdue University, 1968.

(2) - CASTRO, José Ramalho P. de - "A Cooperativa Agrária dos Cafeicultores de Venda Nova: A Comercialização e o Emprego de Novas Tecnologias, Conceição do Castelo, Espírito Santo, 1966/1967", M.S. thesis, Universidade Federal de Viçosa, 1969.

(3) - CHAUDRI, Dharam Pal - "Farmers Education and Productivity: Some Empirical Results from Indian Agriculture", Human Capital Paper 69:4, University of Chicago, 1969.

(4) - GISSER, Micha - "On Benefit-Cost Analysis of Investment in Schooling in Rural Areas" - American Journal of Agricultural Economics, Vol. 50, Nº 3, (August 1968), pp. 621-629.

(5) - GONZALES, Thomas Backer Ecos - "Diagnóstico do Uso dos Fatores de Produção de Leite e Sugestões para sua Maior Eficiência, Resende, R.J., 1967/1968", M.S. thesis, Universidade Federal de Viçosa, 1969.

(6) - GRILICHES, Zvi - "Research Expenditures, Education and the Aggregate Agricultural Production Function", American Economic Review, Vol. LIV, Nº 6, (December 1964),pp.961-974.

(7) - _____ "Notes on the Role of Education in Production Functions and Growth Accounting", Report 6839, Center for Mathematical Studies in Business and Economics, University of Chicago, 1968.

(8) - HALLER, Thomas - Ph.D. - thesis at Purdue

(9) - HAVIGHURST, Robert J. and J. Roberto Moreira - Society and Education in Brazil, Pittsburgh, University of Pittsburgh Press, 1965.

(10) - IRIAS, Luiz J. M. - "Avaliação do Módulo Rural Médio para a Região de Viçosa, 1967/1968", M.S. thesis, Universidade Federal de Viçosa, 1970.

(11) - KISLEV, Yoav - "Estimating a Production Function From U. S. Census of Agriculture Data", Unpublished Ph.D. thesis, University of Chicago, 1965.

(12) - LESSA, Carlos A. - "Estudo da Estrutura do Capital Agrícola no Cerrado Mineiro para sua Dinamização através do Crédito Agrícola", M.S. thesis, Universidade Federal de Viçosa, 1969.

(13) - MAFFIA, Dalva Lúcia - "Impactos das Modificações do Tamanho da Propriedade sobre a Produção Agrícola, Município de Viçosa, 1969.

(14) - MOSHER, Arthur T. - Technical Co-operation in Latin American Agriculture, Chicago, University of Chicago Press, 1957.

(15) - NELSON, R.R. and E.S. Phelps - " Investment in Humans, Technological Diffusion and Economic Growth ", American Economic Review, Vol. LVI, Nº 2, (May 1966), pp.69-75.

(16) - PATRICK, George F. - "Agriculture and Economic Development in Eastern Brazil", Unpublished Ph.D. thesis, Purdue University, 1970.

(17) - RIBEIRO, José P. and Clifton R. Wharton Jr. - " The ACAR Program in Minas Gerais, Brazil" - Clifton R. Wharton Jr.,ed. Subsistence Agriculture and Economic Development, Chicago, Aldine Publishing Company, 1969.

(18) - SCHUH, G. Edward, The Agricultural Development of Brazil, New York, Praeger Press, 1970.

(19) - SCHULTZ, Theodore W. - " The Economic Value of Education, New York, Columbia University Press, 1963.

(20) - WELCH, F. - "Education in Production", Journal of Political Economy , Vol. 78, Nº 1 (January/February 1970),pp.35-59.