

509

AGENCY FOR INTERNATIONAL DEVELOPMENT WASHINGTON, D. C. 20523 BIBLIOGRAPHIC INPUT SHEET	FOR AID USE ONLY
---	-------------------------

1. SUBJECT CLASSIFICATION	A. PRIMARY ECONOMICS B. SECONDARY AGRICULTURAL CREDIT
----------------------------------	--

2. TITLE AND SUBTITLE
RURAL CREDIT AND INCOME DISTRIBUTION IN COLOMBIA

3. AUTHOR(S)
WAYNE R. THIRSK

4. DOCUMENT DATE SUMMER 1974	5. NUMBER OF PAGES 28 PAGES	6. ARC NUMBER ARC CD-332.7-T447
--	---------------------------------------	--

7. REFERENCE ORGANIZATION NAME AND ADDRESS
RICE UNIVERSITY
PROGRAM OF DEVELOPMENT STUDIES
HOUSTON, TEXAS 77001

8. SUPPLEMENTARY NOTES (*Sponsoring Organization, Publishers, Availability*)

9. ABSTRACT
 This paper focuses on some of the reasons to expect that many small farmers may be more productive users of credit than most larger farmers at any point in time. An obvious factor is that credit markets may systematically discriminate against small farmers by rationing credit according to solvency criteria instead of expected profitability. Small farms may also have surplus labor which is complementary to the inputs purchased on credit. An offsetting factor is that larger farmers may be better educated and therefore better able to use credit productively. Based on a sample of small farm data for Colombia, this paper describes an attempt to use Cobb-Douglas production functions to measure the marginal productivity of intermediate inputs on farms of different size. Using Chow-type significance tests, it was found that in a majority of the crop-regions examined small farms enjoyed superior productivity in the use of intermediate inputs. An unexplored issue is the link between more credit and choice of input purchases as it was simply assumed here that small farmers bought more intermediate inputs.

10. CONTROL NUMBER FN-AAA-699	11. PRICE OF DOCUMENT
12. DESCRIPTORS SMALL FARMS, LARGE FARMS, SOLVENCY, SURPLUS LABOR, INPUTS, EDUCATION, COBB-DOUGLAS PRODUCTION FUNCTION	13. PROJECT NUMBER 931-19-995-534
	14. CONTRACT NUMBER AID/csd - 3302
	15. TYPE OF DOCUMENT DISCUSSION PAPER

PROGRAM OF DEVELOPMENT STUDIES

WILLIAM MARSH RICE UNIVERSITY
Houston, Texas
77001

Paper No. 51

Rural Credit and Income Distribution
in Colombia

by

Wayne R. Thirsk

Summer, 1974

The author is Visiting Assistant Professor of Economics at Rice University. The research reported in this paper was done under Agency for International Development contract no. AID/csd-3302 on "Distribution of Gains, Wealth and Income from Development." Program Discussion Papers are preliminary materials circulated to stimulate discussion and critical comment. References in publications to Discussion Papers should be cleared with the author to protect the tentative character of these papers.

Rural Credit and Income Distribution in Colombia*

1. Introduction

Recently the World Bank, aid donors, and others have shown greater interest in improving the income prospects of small farmers in LDC's. This interest springs in part from the fact that small farmers are at the bottom of the income ladder in many poor countries (though landless rural workers may be even worse off). Proposals to raise small farmer incomes have run the gamut from wide sweeping land reform to urban migration. Credit reallocation towards small and away from large farms has also been consistently advocated and has received renewed impetus due to the perceived failure of other alternative measures. Effective land reform has been found difficult to achieve short of full scale political revolution while the enthusiasm for nonagricultural solutions has been tempered by the slow growth of high income employment opportunities in urban sectors.

This paper is an empirical attempt to measure the productivity of credit or, more accurately, credit-induced inputs on farms of different size in Colombia. It seeks answers to the question of whether or not small producers of a given crop may obtain a higher return at the margin from using credit than would larger producers. This efficiency issue has important implications for income distribution. If small farmers can make the most productive use of credit, the channeling of more credit to them

*The author wishes to acknowledge the generous and capable research assistance provided by James R. Ray in the preparation of this paper. Sam Daines and Kathy Gleason at AID in Washington, D.C. were unstintingly cooperative in making the data available and helping to interpret the data tapes. I owe them a debt of gratitude.

will raise total output and lessen income inequality at the same time. If there is no output cost attached to credit redistribution it is much more likely that it will receive the support of national policy-makers and international institutions than if the converse were true. If total output were reduced, the policy of granting more credit to small farmers would have to be compared with other types of policy that purchase greater income equality at the cost of lower levels of output.

The link between credit and income distribution has both obvious and subtle connections. The distribution of credit among potential users cannot be logically divorced from a discussion of interest rate policies. Income distribution is affected by considerations of both who gets the credit and how much is paid for it. Assessing the ramifications for income distribution of changes in interest rate levels is beyond the scope of this study which is concerned with the quantity rather than the price aspect of credit. Suffice it to say that there is probably a consensus within the economics profession for the view that low (nominal and real) interest rate policies benefit wealthy borrowers and harm poor savers. We ignore this important issue and concentrate instead on the allocation of credit among different farm sizes.

So long as small farmers are not initially in equilibrium with the rate of return to a marginal amount of credit equal to its cost the allocation of more credit to small farmers represents a transfer of income-earning resources to them. If this credit otherwise would have gone to large farmers they might have used it to employ new capital-intensive technologies which would reduce the demand for labor services, including those of small farmers, and to expand their output levels which would reduce the price small farmers receive for their output. However, the reduction in

product prices would benefit consumers, especially poor ones as they tend to spend a larger fraction of their income on food products than consumers with higher incomes. Nonetheless, total output will increase if small farmers receive more credit and use it more productively than larger ones and, to an extent which depends on the price elasticity of demand and the supply elasticity of large farms, small farmers and consumers both will be better off than otherwise.¹

A less obvious influence on income distribution is the link between new and old sources of credit and between the receipt of credit and savings behavior. Not all of the newly channeled credit to small farmers will appear as a net increase in resources because some of it may substitute for either previous lines of credit or for personal savings otherwise made. As annual interest rates charged by lenders in the informal rural credit market often run as high as 50 or even 100 percent the switching of business away from this source may improve income distribution directly if rural moneylenders are in the upper income brackets. Credit may also substitute for personal savings if small farmers have high rates of time preference that exceed the rate of return from extra investment. While such savings behavior would be welfare-maximizing for the small farmer it also forestalls the day when capital income will become a significant fraction of small farmers' total income. On the other hand, if new technology is indivisible and requires both credit and personal savings for its purchase and if it also offers a return in excess of the rate of time preference, extra credit may elicit more saving from smaller farmers and thus augment their future incomes.¹ The distribution of credit between small and large

¹Of course if only some small farmers receive extra credit they will gain at the expense of those who are excluded and face lower output prices.

²This position has been cogently advanced by R. McKinnon, Money and Capital in Economic Development (Washington, D.C.: The Brookings Institution, 1973).

farms may also affect the distribution of income between small farmers and landless workers. A policy of redirecting credit to smaller farms may make landless workers worse off if small farms hire less labor per dollar of credit than do larger farms. Offsetting any tendency in this direction is the increased demand for landless workers that results if more inputs to small farmers leads them to supply less labor to the labor market. This point is explored in more detail later on.

Is there any reason to expect that small farms have a higher marginal productivity of credit than large farms? Several considerations suggest an affirmative answer to this question. In Colombia, as in a number of LDC's, the institutional lenders are required by law or regulation to charge borrowers relatively low real rates of interest. These low real rates typically generate an excess demand for loans and force lenders to ration their lending capacity. One of the main criteria used to determine eligibility for loans is credit worthiness or the amount of collateral a prospective borrower can muster. This loan strategy protects the lender from any risk of default but results in an institutional bias in favor of large landowners who command large amounts of net worth. Where lending is based primarily on the solvency of the borrower it is not surprising if many high yielding investment projects on small farms are unrealized due to a lack of finance.

Institutional credit from all sources reaches about 25 percent of Colombia's farmers. In Colombia the semi-official Agricultural Bank, the Caja Agraria, has traditionally relied on commercial banking standards in extending loans to the agricultural sector. This organization is responsible for about one-half the outstanding loans to agriculture and has been criticized by some observers for catering mainly

to the loan demands of large farmers. Private banks and the semi-official livestock bank (Banco Ganadero) together account for about 40-45 per cent of agricultural credit and likewise slant their lending activities almost exclusively in the direction of large farmers.¹ The only major source of institutional finance for smaller farmers is the supervised credit program of the land reform institute INCORA which in recent years has accounted for about 5 per cent of total agricultural loans outstanding and has benefitted about 35,000 families over the period 1964-1972. By way of contrast there are currently about 850,000 small farmers (those working less than 5 hectares) who produce approximately 20 per cent of all crop output and 15 per cent of all livestock production. Alternatively, if small farms are defined as those encompassing fewer than 10 hectares these percentages should be adjusted to about 33 per cent and 22 per cent respectively. One effect of a small farm credit shortage is that it encourages sharecropping arrangements (compania) in many areas due to an inability of non-owners to obtain credit for working capital. Thus the terms of tenure agreements may be sensitive to the distribution of credit by farm size.

A unique feature of the Colombian financial system is a regime of obligatory investments imposed on financial institutions that is designed to control the sectoral allocation of credit. For example, private banks are required by law to allocate 15 per cent of their total deposits for agricultural sector loans (including subscription to bonds issued by the

¹Recently the Caja Agraria, by Law 35 of 1971, has been permitted to extend credit on the basis of production and income from the activity financed and there is some evidence that it has been attempting to shift more of its loan portfolio towards smaller farmers. See R.L. Tinnermeir, "Small Farmer Credit Activities of the Colombian Agricultural Bank," Small Farmer Credit in Colombia, A.I.D. Spring Review, Vol. 5, February 1973, No. SR105.

Caja Agraria) and 5 per cent of their demand deposits to bonds of the Caja Agraria. Moreover, 6 per cent of the portfolio of private banks must be invested in the paper of the Fondo Financiero Agrario, a special agricultural rediscount fund. These credit controls, and others like them, are needed to force funds to flow toward agricultural activities bearing regulated rates of loan interest lower than those charged for the finance of non-agricultural activities. Aggregate financial statistics attest to the apparent success of this government directed channeling of credit. The share of agriculture in total loans outstanding has been slightly greater than its output share in Gross Domestic Product (a loan share of 35 per cent compared to a GDP share of 30 per cent for the past 10 years). Since no important sector has been obviously starved for funds it makes sense to examine the effects of a redistribution of total agricultural credit and to be less concerned initially about whether the return to credit is higher in some nonagricultural uses than on small farms.

In addition to rationing there is another consideration which can explain the prior expectation of superior credit productivity on smaller farms. This is the wide difference in factor proportions among farms of different size in the production of a given crop. Generally speaking smaller farms are significantly more labor-intensive than large farms in the sense of employing greater amounts of labor per hectare for each field operation.¹ These differences in factor proportions appear to be associated with a relatively lower cost of capital and higher cost of labor on larger farms. If credit is used for the purchase of intermediate inputs, their

¹For a more detailed discussion of this matter see R. Albert Berry, "Land Distribution, Income Distribution and the Productive Efficiency of Colombian Agriculture," Food Research Institute Studies in Agricultural Economics, Trade and Development, XII, 3 (1973).

productivity may be highest on the smaller farms due to the presence of greater amounts of complementary labor. On large farms, in contrast, some intermediate inputs (herbicides, for example) may be used to substitute for labor that has low opportunity cost in alternative employments. While privately profitable, the use of these inputs on large farms may yield low social returns since little extra output results from the reduction in labor employment. However, if land and credit are complements the argument would be turned around since a smaller land base would result in lower returns to credit. This possibility is implausible in the case of intermediate inputs, virtually all of which are substitutes for land, but carries more weight in the case of lumpy, indivisible inputs such as many kinds of farm machinery.

There is one other aspect of the initial conditions in agriculture that could conceivably produce the result that larger farms are the most productive users of credit. Operators of larger farms probably have higher levels of education and receive more visits and attention from extension personnel than smaller operators. If these elements of human capital are complementary with the use of credit then the marginal productivity of credit may be higher on large farms if this effect outweighs the other factors that have been previously introduced. Another way of viewing this matter is to recognize that, owing to their access to information and education, large farmers may have vastly superior management capabilities compared to small farmers.

The second section of this paper discusses the model and the data base used to shed some empirical light on the issue of credit allocation. A following section presents the empirical results and discusses some of their

implications. In a final section these findings are compared with the results of earlier research and some limitations of the methodology and scope of this study are mentioned.

2. The Model

The data base consisted of cross-section observations on inputs and output produced on farms of various size broken down on a crop and region basis. Because it has been used with success elsewhere and its properties are well known, a Cobb-Douglas production function was fitted to this data for each region-crop combination and for various farm sizes. The basic problem of the exercise is one of determining what role credit plays in a production function context. An obvious solution would be to treat credit as a productive input and enter it separately into a regression equation but this procedure is objectionable for a number of reasons. First and foremost, it makes little sense to ask, as a regression equation does, what the marginal productivity of credit is holding other inputs (including those financed by credit) constant. The answer to the preceding question is zero since the purpose of credit is to facilitate the purchase of other inputs. A conceptually satisfactory model would have to have at least two equations, one indicating how credit influences farmers' choice of inputs and another, the production function, explaining how input levels affect the amount of output. Unfortunately, the data are too coarse to enable one to determine the particular way in which more credit relaxes the resource constraint faced by farmers. While the data distinguish the purpose for which a loan was made it is still impossible to identify that purpose with the effect of credit. The problem here is caused by the fungibility of

credit since the financed activity may have gone forward in any event and the effect of credit is to make possible the purchase of an input other than the one which for the loan was obtained.¹ Even if credit could be justified as a separate independent variable it smacks strongly of double counting to enter both credit and the input financed by credit and causes the interpretation of the results to be more hazardous than otherwise. Another difficulty is that current credit lines may be used to finance inputs either previously used or for use in future periods.

In view of these difficulties it was decided to exclude credit from the production function and to introduce into the regression equation only the durable inputs (farm machinery) and annual production factors (intermediate inputs) for which credit was obtained from the lender. This is a shortcut procedure which ignores the important question of how credit pays for inputs and influences their use. The regression variables were defined in the following way:

- Y_1 = Total quantity of single crop output produced in a given semester.
- Y_2 = Value of total production of a single crop in a given semester
- X_1 = Number of hectares used in the production of either Y_1 or Y_2
- X_2 = Total purchases of intermediate inputs: the sum of expenditures on seeds, fertilizer, pesticides, and irrigation for crop production in a given semester.
- X_{31} = Total value of machinery and equipment on the farm
- X_{32} = Total value of machinery and equipment on the farm plus the value of rentals for machinery or animal power.

¹For an interesting application of the fungibility concept to international lenders see A.C. Harberger, "Issues Concerning Capital Assistance to Less Developed Countries," Economic Development and Cultural Change, XX, 4 (July, 1972).

X_4 = Total value of family and hired labor used in the production of
of a crop in a given semester. $X_4 = X_{41} + X_{42}$ where

X_{41} = Purchases of hired labor used in crop production

X_{42} = Value of family labor employed in crop production

The choice of these variables was dictated by the available data.

Ideally, the services of physical inputs should be used to explain variations in the level of physical output. Some compromise with this ideal is obviously necessary in using the set of variables just defined. If input prices are constant across all the observations it does not matter if inputs are expressed in either physical or value terms. It is assumed here that each farm in a given region pays the same amount for his hired labor and intermediate inputs and places the same value on his use of family labor. Land in any region is apt to be more heterogeneous than other inputs.

One method of taking into account the variability in the quality of land services is to use information on land prices to convert physical hectares into units of effective hectares of homogeneous quality. An effort was made in this direction but, for unknown reasons, met with a singular lack of success. Since the reported value of land was one factor in the granting of a loan it is possible that this institutional requirement destroyed the accuracy of the price data. In any event it is of necessity assumed that the quality of land services does not vary significantly within a region. The variable for farm machinery is a stock concept or, in the case of X_{32} , a mixture of stock and service flow concepts so it is necessary to assume for this variable that the flow of machinery services is strictly proportional to the value of the stock and, as well, that the production of each crop requires a positive amount of these services.

An aggregation of intermediate inputs was resorted to because it was discovered that when each input was entered separately multicollinearity proved fatal to the results. That is, nearly doubling the number of explanatory variables destroyed the significance of some previously significant variables and frequently resulted in a bewildering array of implausible negative coefficients. However, the cost of circumventing this problem through aggregation is the stringent requirement of assuming that the composition of the aggregate is irrelevant in explaining variations in farm productivity. If two farms spend the same amount on intermediate inputs it is assumed that there would be no effect on output if one spent all on irrigation and the other all on pesticides. This, like the others, is a reasonably strong assumption. Two alternative output variables were used to test for the sensitivity of the results to interfarm variation in prices received for final output. Few farmers are guaranteed prices for their output so they must make their production plans on the basis of expected prices which may diverge widely from prices actually received. Farmers with erroneous expectations and imperfect information may produce either too much or too little from the point of view of private production efficiency.

Moreover, even if farmers could forecast future prices perfectly, they may be unable to adjust their input levels with sufficient speed to permit them to achieve maximum profits from employing these inputs. This is, in a basic sense, the nature of the hypothesis under investigation. Within each farm size group it is assumed that the adjustment capacity of individual farms is sufficiently slow to permit the identification of a portion of the production surface. Otherwise, if all farmers in a region faced the

same input and output prices only a point on the production surface would be observable. Between farms of different size which might pay identical prices for purchased inputs it is hypothesized that differential access to credit causes the marginal productivity of these inputs to be larger on the smallest farms. This is a key assumption since, if there were no imperfections in credit allocation and no cross-sectional differences in input prices by farm size, there would be no variation in interfarm productivity to explain. Given these two major sources of productivity differences it was a maintained hypothesis of this exercise that input prices do not vary significantly by farm size. There is no evidence to refute this assumption and it seems reasonable enough in the Colombian context. To the extent it is satisfied, farm size related differences in marginal productivity can be ascribed more easily to the relative ease or difficulty in obtaining credit. Of course, it is still not possible to rule out differences in information and attitudes toward risk as alternative explanations since these variables would be included in any theory of the demand for credit by farms of different size. For pragmatic reasons the demand side of the credit market has been suppressed in this exercise in order to focus on what are felt to be important restrictions on the supply side.

The data originates from a sample of 2,900 individual farm loan records developed by INCORA under its supervised credit program. The main characteristics of this body of data have been presented elsewhere and will be only summarized here.¹ All loans were either for the purchase of durable inputs (including livestock) or to finance variable costs. In the

¹See D. Dalrymple, "The Use of INCORA Supervised Credit in Colombia in 1959," Small Farmer Credit in Colombia, op. cit., pp.1-13.

aggregate the loans were divided evenly between these two purposes, financing all of the cost of durable inputs and about one-half the value of the variable inputs purchased. Variable cost loans were allocated among purchases of labor, fertilizer, seeds, pesticides, irrigation and machinery rental. A major advantage of the data is the disaggregated basis on which it is available. Because they refer to different kinds of crop production in a specific region (an INCORA project within some department) the data are extremely useful in pinpointing specific situations in which a re-allocation of credit would be desirable on output, or efficiency, grounds. A more aggregated specification which indicated farm size productivity differences would be much less useful for policy purposes since it would leave unanswered the question of whether the differences held in all regions and for all crops. Another positive feature of the data results from the fact that the supervision of the credit received probably removes a large portion of the farm size variation in credit use attributable to risk and information factors.

The major limitation of the data is that they capture only a restricted range of farm sizes and exclude the largest farms in a region which rely on non-INCORA sources of credit. Another potentially damaging defect of the data could occur if INCORA were to apply more liberal loan criteria to the smaller farms it services than other lenders might use. That is, the operations of INCORA may be a poor reflection of how the other components of the credit system allocate their funds to farms of different size. Nothing is known about this potential source of disturbance.

In stochastic form the equation

$$\ln Y_i = \sum_1^4 B_i \ln X_i + u$$

was estimated for various crop-region-farm size combinations. The random variate u is assumed to be log-additive, to have a zero mean, and to be distributed independently of the levels of the inputs X_1 . It may be considered as a measure of the impact of unexpected weather fluctuations so that the levels of X_1 are chosen on the basis of expected weather conditions. However, some simultaneity is evident even under this assumption since many inputs such as harvest labor are selected after the weather has played its production role.

The null hypothesis is to be tested is that the marginal productivity of intermediate inputs is independent of farm size. Using previous notation this can be expressed as

$$H : (\partial Y / \partial X_2)_s = (\partial Y / \partial X_2)_l$$

where the subscripts "s" and "l" refer to small and large farms respectively.

Since the marginal product of any factor X_1 is equal under the Cobb-Douglas assumption to $B_1 (\bar{Y}/\bar{X}_1)$, where B_1 is the regression coefficient (or output elasticity) of X_1 , and (\bar{Y}/\bar{X}_1) is the average product of X_1 evaluated at the geometric mean of each variable, the null hypothesis can be alternatively written as

$$H: B_{2s} (\bar{Y}/\bar{X}_2)_s = B_{2l} (\bar{Y}/\bar{X}_2)_l$$

A method of testing this hypothesis is to impose the restriction implied by the hypothesis on a pooled version of the regression equation (pooling across farm sizes for a given crop region) and use the F-test to compare the constrained and unconstrained versions of the pooled regression. This is an adaptation of the Chow test for equality of regression coefficients across different equations. The constraint is imposed by entering the variable $\left[\ln X_{2s} (\bar{Y}/\bar{X}_2)_l (\bar{X}_2/\bar{Y})_s + \ln X_{2l} \right]$ in the pooled regression. With

just two farm sizes, if SS_{12} denotes the residual sum of squares of the constrained pooled regression, SS_1 and SS_2 refer to the residual sum of squares of the individual regressions for each farm size, T is the total number of observations and K the number of estimated parameters in the pooled regression, then F statistic is calculated as the ratio $SS_{12} - (SS_1 + SS_2) / (SS_1 + SS_2)$ with one and $(T-K)$ degrees of freedom.¹ If the estimated F value is less than the critical F value for the same degrees of freedom then the null hypothesis of equal marginal productivities is accepted. Otherwise, the null hypothesis is rejected at some level of confidence.

3. Results

Table 1 presents the regression results. In total, nine regions (departments) and five different crops were considered to give reasonably reliable results, especially in terms of achieving statistically significant coefficients for intermediate inputs. Observations with zero values for intermediate inputs were excluded from the regression equation. Farm size intervals were determined by the requirement that no size group should contain fewer than ten observations. In some crop-regions three size ranges could be distinguished but in the majority of cases only two size groups, often uncomfortably small in absolute size, could be obtained. Thus with twelve crop-region combinations a total of twenty-eight crop-region-farm size regressions were, to some extent, successfully run.

¹If SST refers to the total sum of squares then the residual sum of squares bears a simple relationship to the R^2 statistic. $R^2 = 1 - SS_{12} / SST_{12}$, so $SS_{12} = (1 - R^2) SST_{12}$ and, similarly, $SS_1 = (1 - R_1^2) SST_1$ and $SS_2 = (1 - R_2^2) SST_2$.

TABLE 1: Crop-Region Farm Regressions

Region-Crop	Farm Size (Ha.)	Dependent* Variable	Intercept	X ₁	X ₄₁	X ₄ or X ₄₂	X ₃₁ or X ₃₂	X ₂	R ²	No.
Antioquia - Beans	S. (0-9.99)	Y ₁	0.52181 (0.88800)	0.17480 (1.59898)		0.36416 (3.78065)*	0.00050190 (0.17294)	0.60570 (6.15310)*	0.9880	(1)
	"	Y ₁	1.4227 (1.56840)	0.26348 (1.99100)	0.20441 (3.18825)*	0.0082128 (1.73048)	-0.0025022 (-0.78540)	0.54420 (3.61947)*	0.9858	(2)
	"	Y ₂	2.8928 (4.07785)	0.31982 (2.42327)*		0.28646 (3.40882)*	-0.0056938 (-1.62508)	0.54489 (4.58510)*	0.9849	(3)
	"	Y ₂	4.0572 (3.65166)*	0.43935 (2.71046)*	0.20975 (2.67092)*	0.0098093 (1.68744)	-0.0094251 (-2.41533)	0.46353 (2.51700)*	0.9815	(4)
	L. (10-up)	Y ₁	1.7291 (1.32447)	0.44923 (1.90100)*		-0.029273 (-0.23010)	-0.0030660 (-0.73753)	0.69838 (2.59230)*	0.9616	(5)
	"	Y ₁	2.0570 (1.22028)	0.46339 (1.77176)	-0.0029142 (-0.02057)	0.0030771 (0.44707)	-0.0020023 (-0.45609)	0.63153 (1.85735)	0.9591	(6)
- Corn	S. (0-4.99)	Y ₁	4.3520 (1.76182)	0.26384 (0.64528)		0.37136 (1.28648)	0.0030896 (0.02151)	.090071 (1.11439)	0.9660	(7)
	"	Y ₂	1.1211 (0.21210)	-0.44317 (-0.50652)		0.74889 (1.21239)	0.075161 (0.24451)	0.24998 (1.44538)	0.8894	(8)
	M. (5-9.99)	Y ₁	6.4376 (11.76010)*	0.76813 (6.19621)*		0.010549 (0.12619)	-0.0046515 (-0.91613)	0.091526 (1.91286)*	0.9300	(9)
	"	Y ₂	5.0599 (5.89758)*	0.39323 (2.02391)*		0.26393 (2.01439)*	-0.012706 (-1.59675)	0.11126 (1.48358)	0.8339	(10)
	S.M. (0-9.99)	Y ₁	5.9345 (13.23922)*	0.68583 (6.12491)*		0.10847 (1.62920)	-0.0014507 (-0.30942)	0.077347 (1.90167)*	0.9357	(11)
	"	Y ₂	4.4139 (6.45916)*	0.28080 (1.64498)		0.35484 (3.49609)*	-0.0097178 (-1.35964)	0.13698 (2.20909)*	0.8706	(12)

NOTES: a/ Numbers beneath each regression coefficient indicate the t-value of the estimated coefficient. Asterisk denotes significance at the 95 per cent confidence level.

b/ R² is the R² statistic adjusted for degrees of freedom.

TABLE 1--Continued.

Region-Crop	Farm Size (Ha.)	Dependent variable	Intercept	Land	Labor Total or Family		Machinery	Intermediate inputs	R ²	No.
					Hired	Family				
tropical Corn	L. (10-up)	Y ₁	5.1076 (2.88188)*	0.54303 (1.25783)	0.14841 (0.79203)		-0.011292 (-0.94049)	0.20730 (1.07043)	0.8835	(13)
	"	Y ₂	3.8446 (2.92620)	0.16383 (0.51190)	0.35384 (2.54729)*		-0.00040859 (-0.04591)	0.24059 (1.67585)	0.9222	(14)
Potatoes	S. (0-4.99)	Y ₂	1.9626 (3.43681)*	0.24405 (1.74316)*	0.14675 (2.16854)*		0.0077758 (1.14949)	0.76805 (6.41961)*	0.9256	(15)
	"	Y ₂	1.6870 (1.77228)*	0.19747 (1.27133)	-0.0031838 (-0.52227)	-0.0014531 (-0.31838)	0.0050627 (0.70066)	0.93059 (7.82929)*	0.9162	(16)
	M. (5-9.99)	Y ₁	2.3627 (3.69257)*	0.23855 (1.70402)*	0.37801 (4.09489)*		-0.0027521 (-0.26870)	0.51321 (4.32794)*	0.9222	(17)
	"	Y ₂	2.6881 (4.17865)*	0.23418 (1.80469)*	0.26183 (3.05990)*		-0.26183 (-0.58795)	-0.0055820 (5.37350)*	0.9278	(18)
	"	Y ₂	4.8397 (5.21959)*	0.42222 (2.97848)*	0.24596 (3.28086)*	0.018425 (3.61224)*	-0.0045029 (-0.50943)	0.34540 (2.51128)*	0.9371	(19)
	L. (10-15.99)	Y ₁	3.4925 (3.51705)*	0.32594 (1.70891)*	0.059732 (4.71894)*		0.0019870 (0.20083)	0.67140 (5.51621)*	0.8665	(20)
	"	Y ₁	4.9242 (4.64062)*	0.55595 (2.82981)*	0.048600 (3.94035)*	0.013269 (2.78938)*	-0.0013679 (-0.14770)	0.51960 (4.10774)*	0.8853	(21)
	"	Y ₂	3.4811 (4.14215)*	0.33152 (2.05378)*	0.042123 (3.93211)*		0.00048434 (0.05784)	0.68070 (6.60817)*	0.8954	(22)
"	Y ₂	4.5038 (4.86016)*	0.49605 (2.89118)*	0.034029 (3.15920)*	0.0094397 (2.27228)*	-0.0019341 (-0.23913)	0.57230 (5.18065)*	0.9043	(23)	

TABLE 1--Continued.

Region-Crop	Farm Size (Ha.)	Dependent* variable	Intercept	Labor			Mach- inery	Inter- mediate inputs	\bar{R}^2	No.
				Land	Total Hired or Family	Family				
Bolivar - Corn	S.(0-14.99)	Y ₁	4.1945 (3.23666)*	-0.31160 (-0.45385)	0.020498 (1.09980)	0.032445 (2.59725)*	0.045393 (0.54317)	0.64791 (2.36673)*	0.9012	(24)
	"	Y ₂	5.2705 (3.89989)	0.0037106 (0.00814)	0.030105 (1.54887)	0.028430 (2.8236)*	0.091159 (1.04579)	0.38395 (1.34490)	0.8832	(25)
	L.(15-up)	Y ₁	2.7363 (4.85083)*	-0.0091205 (-0.55592)	0.54461 (5.34491)*		0.012226 (0.92974)	0.19608 (2.30323)*	0.8320	(26)
	"	Y ₁	6.3354 (8.87989)*	-0.000126 (-0.00556)	0.030899 (2.43123)*	-0.0022822 (-0.16722)	0.018599 (0.94519)	0.25738 (2.15579)*	0.6698	(27)
Boyaca - Potatoes	S.(0-4.99)	Y ₁	3.1823 (3.61924)*	0.36009 (2.42241)*	0.22653 (1.88600)*		-0.0033185 (-0.45339)	0.54947 (4.89613)*	0.8164	(28)
	"	Y ₁	4.8755 (6.90235)*	0.50490 (4.05488)*	0.055276 (5.06190)*	-0.007603 (0.18534)	0.0012078 (5.68662)*	0.50905	0.8577	(29)
	"	Y ₂	2.6584 (3.06928)*	0.42082 (2.87391)*	0.38350 (3.10424)*		-0.016742 (-2.32207)	0.47946 (4.33705)*	0.8404	(30)
	"	Y ₂	4.7553 (6.03866)*	0.63592 (4.53725)*	0.044468 (3.55632)*	0.0062038 (0.63640)	0.039556 (0.64115)	0.47370 (4.38207)*	0.8349	(31)
	M.(5-9.99)	Y ₁	-1.5651 (-0.77226)	0.050381 (0.46316)	0.38154 (7.66388)*		0.65148 (3.21306)*	0.44231 (1.88644)*	0.3994	(32)
	"	Y ₁	-0.26505 (-0.11873)	0.068568 (0.57447)	0.16757 (4.04250)*	0.085042 (2.48013)*	0.51835 (2.34789)*	0.55013 (2.14280)*	0.2831	(33)
"	Y ₂	-1.6437 (-0.83135)	0.056110 (0.52876)	0.39304 (8.09275)*		0.61109 (3.08942)*	0.46722 (2.04265)*	0.4240	(34)	

TABLE 1--Continued.

Region-Crop	Farm Size (Ha.)	Dependent* variable	Intercept	Land	Labor Total		Machinery	Inter-mediate inputs	R ²	No.
					Hired	or Family				
MCC - Corn & Rice	M. (5-9.99)	Y ₂	-0.29166 (-0.13223)	0.074943 (0.63551)	0.17021 (4.15608)*	0.087039 (2.56922)*	0.47107 (2.15964)*	0.58100 (2.29053)*	0.2947	(35)
	L. (10-14.99)	Y ₁	3.2179 (3.16912)*	0.28285 (2.02933)*	0.36848 (2.88769)*		-0.00067065 (-0.07832)	0.42509 (4.72680)*	0.8932	(36)
	"	Y ₁	3.9814 (4.94891)*	0.30421 (2.40875)*	0.28238 (2.99130)*	0.025703 (2.19026)*	0.0028825 (0.35803)	0.40624 (4.58333)*	0.9007	(37)
	"	Y ₂	3.2063 (2.38015)*	0.28635 (1.54849)	0.39507 (2.33370)*		-0.0070098 (-0.61706)	0.39710 (3.32827)*	0.8194	(38)
	"	Y ₂	4.0604 (3.67891)*	0.31706 (1.82990)*	0.30009 (2.31717)*	0.022693 (1.40953)	-0.0033195 (-0.30053)	0.37792 (3.10710)*	0.8203	(39)
	"	Y ₁	5.0059 (10.78891)*	0.94373 (16.42694)*	0.21369 (3.63429)*		0.0027490 (1.51649)	0.082789 (2.83436)*	0.9380	(40)
	"	Y ₁	5.2967 (10.74284)*	0.93345 (13.08197)*	0.0025166 (1.25155)	0.18619 (2.67481)*	0.0035144 (1.69222)	0.079475 (2.47794)*	0.9262	(41)
	"	Y ₂	3.4799 (1.57967)	0.85602 (2.94728)*	0.29560 (1.05887)		-0.0048769 (-0.56664)	0.25378 (1.82996)*	0.3633	(42)
	"	Y ₂	3.9501 (2.86078)*	0.016414 (0.81868)	0.57272 (3.17510)*		0.0021764 (0.19083)	0.067162 (0.51919)	0.3564	(43)
	MIDREMARCA - Corn	S. (0-4.99)	Y ₁	4.3970 (6.95376)*	0.018895 (0.42324)	0.052110 (1.95085)8	0.018813 (1.87760)*	0.0096406 (0.48853)	0.54694 (4.19915)*	0.4136
"		Y ₂	5.2198 (9.88539)*	0.066783 (1.47430)	0.040359 (1.39224)		0.0069399 (0.41618)	0.46335 (4.58019)*	0.4447	(45)

TABLE 1--Continued.

Region-Crop	Farm Size (Ha.)	Dependent* variable	Intercept	Land	Labor Total		Machin- ery	Inter- mediate inputs	\bar{R}^2	No.
					Hired	Family				
	S. (0-4.99)	γ_2	5.1444 (9.54461)*	0.11448 (3.00837)*	-0.0067214 (-0.29521)	0.013958 (1.63429)	0.010015 (0.59541)	0.53127 (4.78524)*	0.4424	(46)
	M. (5-9.99)	γ_1	0.68859 (0.50545)	-0.15381 (-0.53787)	0.67274 (3.24680)*		0.14395 (4.94288)*	0.28495 (1.82354)*	0.6247	(47)
	"	γ_1	4.3881 (4.68816)*	0.55968 (2.90169)*	0.017339 (0.73653)	0.0031522 (0.33022)	0.16513 (4.69388)*	0.35318 (1.96889)*		
	"	γ_2	5.2893 (4.18655)*	0.58225 (2.19934)*	0.038889 (0.20273)		0.038052 (1.41132)	0.36057 (2.49242)*	0.5132	(49)
	"	γ_2	5.8014 (7.36382)*	0.68344 (4.20983)*	-0.012143 (-0.61286)	0.0081913 (1.01952)	0.049224 (1.66242)	0.30494 (2.01972)*	0.5196	(50)
	L. (10-14.99)	γ_1	1.7899 (0.83233)	0.10427 (0.26651)	0.47119 (1.62937)		-0.020873 (-1.33814)	0.48248 (2.50773)*	0.6022	(51)
	"	γ_1	5.3880 (5.08323)*	0.49100 (1.89216)*	0.026997 (1.76071)*	0.016580 (1.98936)	-0.022073 (-1.50807)	0.40323 (1.86208)*	0.6369	(52)
	"	γ_2	1.6357 (0.72366)	0.045112 (0.11057)	0.53176 (1.75954)*		-0.019635 (-1.19762)	0.48457 (2.39631)*	0.5808	(53)
	"	γ_2	5.7810 (5.38813)*	0.48286 (1.83829)*	0.031744 (2.04526)*	0.020491 (2.42893)	-0.021679 (-1.46323)	0.38160 (1.74095)*	0.6451	(54)
Narino - Corn	S. (0-9.99)	γ_1	2.4275 (3.86185)*	0.25027 (1.43838)	0.63594 (6.35189)*		0.0081967 (1.71342)*	0.13116 (3.54048)*	0.9218	(55)
	"	γ_1	3.2910 (5.41378)*	0.37658 (1.95433)*	0.50763 (5.16947)*	0.0060407 (1.16406)	0.0096159 (1.85216)*	0.13750 (3.25201)*	0.9073	(56)

TABLE 1--Continued.

Crop	Farm Size (Ha.)	Dependent* variable.	Intercept	Land	Labor Total		Machinery	Inter-mediate inputs	R ²	No.
					Hired	or Family				
Tender - Rice	L. (10-up)	Y ₁	3.3407 (2.85062)*	0.71030 (3.47496)*	0.44441 (2.89713)*		-0.041818 (-1.05781)	0.18824 (2.48426)*	0.9466	(57)
	"	Y ₁	6.0096 (9.94356)*	0.99688 (6.05241)*	0.030865 (2.26635)*	0.013767	0.014802 (0.30118)	0.16468 (1.46740)	0.9336	(58)
	"	Y ₂	3.8124 (2.78600)*	0.69736 (2.92185)*	0.48055 (2.6830)*		-0.020256 (-0.43881)	0.071919 (0.81288)	0.9369	(59)
	"	Y ₂	6.4839 (10.56395)*	0.85315 (5.10111)*	0.035100 (2.53816)*	0.032710 (2.97012)*	-0.017363 (-0.34794)	0.19822 (1.73938)	0.9407	(60)
	S. (0-49.99)	Y ₁	3.7171 (4.32181)*	0.19019 (1.79574)*	0.31397 (3.45513)*		0.13741 (2.12889)*	0.19442 (2.63810)*	0.7183	(61)
	L. (80-up)	Y ₁	4.5079 (7.67583)*	0.57408 (4.73420)*	0.36021 (3.38632)*		0.015894 (0.38065)	0.052054 (0.69689)	0.9138	(62)
	"	Y ₁	4.8044 (7.20717)*	0.62198 (4.77031)*	0.27155 (2.62330)*	0.0010142 (0.19157)	0.023813 (0.51629)	0.096969 (1.18827)	0.9032	(63)
	Maize - Corn	S. (0-19.99)	Y ₂	3.2434 (2.84393)*	0.35154 (1.68215)*	0.52842 (3.08103)*		-0.016282 (-1.22070)	0.18380 (3.19065)*	0.7713
"		Y ₂	6.5367 (16.11033)*	0.91036 (7.14503)*	-0.015295 (-0.86974)	0.0031825 (0.67832)	-0.012372 (0.83738)	0.22509 (3.34705)*	0.7248	(65)
L. (20-up)		Y ₂	3.4115 (2.86993)*	0.23199 (0.76138)	0.45169 (1.99288)*		0.0063886 (0.44256)	0.26170 (2.77222)*	0.7691	(66)
"		Y ₂	4.0750 (2.93459)*	0.38172 (1.15506)	0.36105 (1.51926)	0.0094683 (1.32132)	0.014550 (0.15188)	0.24600 (2.06119)*	0.7517	(67)
S. (5-9.99)		Y ₁	2.3081 (1.14955)	-0.28215 (-0.50370)	0.095194 (3.85507)*		0.13225 (1.23035)	0.74665 (2.05782)*	0.8276	(68)

TABLE 1--Continued.

-Crop	Farm Size (Ha.)	Dependent* variable	Intercept	Land	Labor Total		Machin- ery	Inter- mediate inputs	\bar{R}^2	No.
					Hired	or Family				
	S. (5-9.99)	Y_2	3.2576 (1.59445)	-0.12035 (-0.21114)	0.10574 (4.20819)*		0.12694 (1.16051)	0.62641 (1.69661)	0.8301	(69)
	"	Y_2	3.4018 (1.54780)	-0.00851 (-0.01066)	0.10879 (3.82464)	-0.0021601 (-0.14338)	0.13309 (1.14862)	0.57541 (1.28195)	0.8171	(70)
	L. (10-up)	Y_1	5.9253 (3.37501)*	0.56008 (1.71836)	0.067658 (0.26925)		-0.0046622 (-0.65807)	0.29370 (2.26214)*	0.9049	(71)
	"	Y_1	4.2029 (3.79180)*	0.24542 (0.67030)	0.32656 (1.37813)	-0.0047885 (-0.64908)	-0.084407 (-1.27919)	0.27151 (1.96124)*	0.9278	(72)
	"	Y_2	5.75 (6.13)	.472 (2.06)	.12 (6.45)		-.0056 (-.50)	.311 (1.78)	.867	(73)
ns	S. (0-4.99)	Y_1	5.3831 (5.22221)*	0.75490 (3.58480)*	0.070577 (0.54184)		0.0045863 (0.36129)	0.23061 (1.99727)*	0.7250	(74)
	"	Y_1	5.5083 (5.32990)*	0.73018 (3.27494)*	0.017384 (0.14626)	0.0055236 (1.13249)	0.0028161 (0.22086)	0.28185 (2.35360)*	0.7256	(75)
	"	Y_2	6.7355 (6.41792)*	0.77597 (3.61930)*	0.020496 (0.15455)		0.0014097 (0.10908)	0.23057 (1.96134)*	0.7041	(76)
	"	Y_2	6.8122 (6.27903)*	0.73485 (3.27874)*	-0.032322 (-0.26341)	0.0054009 (1.303006)	0.000633 (0.01027)	0.28908 (2.40245)*	0.7140	(77)
	L. (5->.99)	Y_1	5.4196 (3.05920)*	0.67057 (2.02759)*	0.15610 (0.96487)		0.097243 (1.38066)	0.027443 (0.11308)	0.4145	(78)
	"	Y_1	4.1251 (2.01098)*	0.52844 (1.56907)	0.19390 (1.16428)	0.0049079 (0.60243)	0.22154 (2.04158)*	0.037892 (0.16237)	0.4411	(79)
	"	Y_2	5.5079 (3.13858)*	0.74483 (2.27350)*	0.21911 (1.36717)		0.047075 (0.67473)	0.11044 (0.45739)	0.5313	(80)
	"	Y_2	5.9915 (3.22639)*	0.77331 (2.30656)*	0.17052 (0.99592)	0.0077175 (0.91801)	0.042907 (0.58922)	0.11540 (0.47073)	0.5139	(81)

It is readily seen from Table 1 that a given set of regression variables was able to provide a better explanation of the dependent variable y_1 in some cases but not in others. The weakest explanatory variable was farm machinery which is not too surprising in view of the unsatisfactory measurement of this input. In only a few instances was machinery significant. Total labor and land, on the other hand, were usually, but not always, significant. The attempt to separate labor into hired and family provided components was on the whole unsuccessful. Where it was tried the typical result was that only one of the labor variables-- most frequently, hired labor -- emerged as a significant variable. This result could reflect the fact that farmers are more careful or calculating in their use of hired labor than in their allocation of family labor or, more likely, the problem of error in measuring the distribution of family time between crop and non-crop production. In Table 2 is shown the estimates of the marginal physical and marginal value product of labor (total labor in most instances) and intermediate inputs on farms of different size for various crop-region combinations. The numbers in parentheses beneath each estimate are estimated values of the variance of each estimate.¹ Two points about Table 2 are worth noting. First, marginal productivity comparisons were made holding the regression specification constant across farm sizes. Thus the estimates of marginal product

¹The variance of each marginal product (MP) is estimated according to the formula

$$\text{VAR}(\text{MP}) = (\bar{y}_1 / \bar{x}_1)^2 \cdot \text{VAR}(B_1) + \frac{(1-R) B_1^2}{\eta}$$

where $(1-R^2)$ is the variance unexplained by the regression, B_1 is the regression coefficient, η is the number of observations, and other notation is defined as before. The formula is due to H.O. Carter, and H.O. Hartley, "A Variance Formula for Marginal Productivity Estimates Using the Cobb-Douglas Function," Econometrica (April, 1958), pp. 306-313.

TABLE 2: Marginal Productivity of Intermediate Inputs and Labor by Farm Size

Region-Crop	Regression no.	Farm Size (Ha.)	Marginal Products		F Value	
			Intermediate inputs	Labor	Estimated	Critical
Antioquia - Beans	(1)	0-9.9	.37 (.0036)	.25 (.0045)	4.09	4.18
	(3)	"	\$2.63 (.33)	--	--	--
	(5)	10-up	.43 (.03)	-.04 (-.03)	--	--
Antioquia - Corn	(7)	0-4.99	1.18 (1.11)	1.12 (.87)	--	--
	(8)	"	\$1.36 (1.64)	\$1.26 (1.44)	--	--
	(9)	5-9.99	.91 (.23)	.03 (.07)	(7)&(9) .59	4.32
	(10)	"	\$1.25 (.73)	\$.95 (.23)		
	(13)	10-up	1.22 (1.45)	.35 (.20)	(9)&(13) .90	4.23
	(14)	"	\$1.30 (1.32)	\$.96 (.15)		
	(11)	0-9.99	.83 (.192)	.34 (.05)	(7),(9)&(13) .53	4.13
	(12)	"	\$1.65 (.57)	\$1.27 (.14)		
Antioquia - Potatoes	(15)	0-4.99	\$2.33 (.14)	\$1.44 (.44)	(15)&(18) 8.39	3.97
	(18)	5-9.99	\$1.97 (.14)	\$2.56 (.707)		
	(22)	10-14.99	\$2.36 (.14)	\$1.25 (.11)	(18)&(22) .31	3.98
Bolivar - Corn	(24)	1-14.99	5.47 (5.46)	2.74 (1.15)		
	(25)	"	\$3.11 (5.38)	\$2.31 (1.14)	6.74	4.23
	(27)	15-up	2.11 (.876)	-.03 (40.1)		

TABLE 2--Continued.

Crop	Regression no.	Farm Size (Ha.)	Marginal Products		F Value	
			Intermediate inputs	Labor	Estimated	Critical
Boyaca - Potatoes	(28)	0-4.99	1.77 (.14)	2.31 (.15)		
	(30)	"	\$1.37 (.10)	\$3.34 (1.18)		
	(32)	5-9.99	1.05 (.32)	6.18 (.85)	(28)&(22) 7.19	3.9
	(34)	"	\$1.02 (.25)	\$5.85 (.69)	(30)&(34) 6.89	3.9
	(36)	10-14.99	1.31 (.08)	3.39 (1.41)	(36)&(28) 6.47	3.9
	(38)	"	1.12 (.12)	\$3.32 (.21)		
Cundinamarca - Corn	(44)	0-4.99	6.04 (1.23)	.58 (.09)		
	(45)	"	\$7.43 (3.06)	\$.29 (.04)		
	(47)	5-9.99	3.27 (3.28)	1.10 (.12)	(47)&(44) 8.1	3.02
	(49)	"	\$6.27 (6.61)	\$.10 (.22)	(49)&(45) 2.07	3.9
	(51)	10-14.99	6.05 (6.29)	.76 (.23)		
	(53)	"	\$7.88 (11.63)	\$1.12 (.43)		
	(46)	0-4.99	\$8.52 (3.72)	\$.11 (.13)	(54)&(46) 8.02	3.97
	(50)	5-9.99	\$5.30 (7.09)	\$.14 (.05)		
	(54)	10-14.99	\$6.21 (13.11)	\$.55 (.07)		
	Nariño - Corn	(55)	0-9.99	4.53 (1.66)	1.14 (.03)	
(57)		10-up	1.55 (.40)	1.10 (.15)	4.63	3.99
(59)		"	\$.69 (.73)	\$1.39 (.27)		

TABLE 2--Continued.

Region-Crop	Regression no.	Farm Size (Ha.)	Marginal Products		F Value	
			Intermediate Inputs	Labor	Estimated	Critical
Santander - Rice	(61)	0-49.99	1.93 (.51)	.78 (.06)	7.14	4.00
	(62)	80-up	.66 (.88)	1.04 (.10)		
Tolima - Corn	(64)	0-19.99	\$1.80 (.37)	\$1.56 (.30)	4.54	3.99
	(66)	20-up	\$3.83 (2.02)	\$1.30 (.43)		
Valle - Corn	(68)	5-9.99	4.41 (1.47)	1.84 (.26)	2.28	4.38
	(70)	"	5.18 (.95)	2.88 (.53)		
	(71)	10-up	3.00 (1.80)	.24 (.81)		
	(73)	"	\$3.20 (3.28)	\$1.45 (.06)		
Valle - Soybeans	(74)	0-4.99	.76 (.15)	.15 (.07)	3.83	3.99
	(76)	"	\$2.03 (1.09)	\$.11 (.54)		
	(78)	5-9.99	.11 (.36)	.45 (.12)		
	(80)	"	\$.70 (2.32)	\$1.15 (.73)		
Choco - Corn & Rice	(40)	0-4.99	1.55 (.30)	.76 (.05)	1.94	4.11
	(42)	"	\$4.28 (5.88)	\$.95 (.82)		
	(43)	50-up	\$1.19 (5.26)	\$1.86 (.42)		

NOTES: a/ Estimates of marginal productivity rely on the results of Table 1.

b/ The variance of the marginal productivity estimate appears in brackets beneath each estimate.

c/ Critical values for the F statistic are determined at the 95 percent confidence level.

d/ For corn production in Bolivar the marginal product of family labor appears; for corn production in Cundinamarca the last three estimates of labor's marginal productivity refer to hired labor.

e/ The numbers above the estimated F values refer to the particular regressions that were pooled.

were derived from farm size regressions containing the identical set of regression variables. As a related matter, it proved difficult to acquire comparable regressions since a regression form that worked well for one farm size often performed badly for another size group. This accounts for the limited number of comparisons in Table 2 given the large number of regressions reported in Table 1. Secondly, only the marginal value product estimates indicate whether any size group was close to an equilibrium position in its use of labor and intermediate inputs. Since the latter are measured in value terms the marginal value products indicate the peso return from spending another peso on the input. To make the same comparison using the estimate of marginal physical product it is necessary to multiply that estimate by the price of a unit of output. Taking into account the fact that small farmers are risk averters and the cost of credit to purchase inputs, an equilibrium (profit-maximizing) marginal value product would likely be in the range of \$1.1 to \$1.5. In Table 2 the estimates of the marginal value productivity of intermediate inputs range from \$.70 to \$8.52 but a large number of the estimates appear to satisfy the conditions for an equilibrium.

F-test comparisons of farm size differences in the marginal productivity of intermediate inputs are presented in the last column of Table 2. At a 95 percent confidence level it can be established that smaller farms are more productive users of intermediate inputs in the case of potatoes in Antioquia (comparing only small and medium sized farms), corn in Bolivar and Nariño, potatoes in Boyaca, rice in Santander and, on one comparison, corn in Cundinamarca. For corn and soybeans in Valle, rice and corn in Choco, and corn in Antioquia, small farms have higher estimates of the marginal product of intermediate inputs but these are not significantly

larger than those measured for larger farms. Estimates of the marginal product of labor display a great deal of diversity and show no consistent pattern of being higher or lower on one size group than on another.

To the extent that the allocation of credit is closely linked to the distribution of intermediate inputs it can be inferred from the results in Table 2 that in six out of twelve cases (crop-regions) the marginal productivity of credit is significantly higher on smaller farms. In another four cases the estimated marginal productivity is higher on smaller farms but the difference is not large enough to be statistically significant at the 95 percent confidence level. This test of the superior productivity of credit (or more accurately, intermediate inputs) on small farms is a fairly stringent one. In the first place, even if the estimated marginal productivity were highest on larger farms this result could occur simply because large farms tend to use credit to apply new and productive technology first. That same new technology (e.g., new seed varieties) might be even more productive on smaller farms if instead all farms of different size had access to it. Secondly, because the data refer to a size range of INCORA serviced farms that is much narrower than the range of farm sizes in the whole country the differences in marginal productivity that exist may be obscured by relying only on the INCORA data. The amount of credit per hectare is probably distributed much more unequally for the entire country than in the INCORA sample. Table 3 shows the ratio of the Caja Agraria loans extended in 1971 to the value of output on farms of different size. If commercial bank credit flowing only to larger farms were included, this ratio would increase significantly with farm size and, unless large farms were engaged in relatively more credit-intensive production activities, there is a presumption of higher marginal (as well

as average) credit productivity on smaller sized farms which currently receive a disproportionately small share of credit.

4. Other Findings and Conclusions

Using the same data base, only one other study is known to have attempted to measure the productivity of credit on small farms in Colombia. Relying on the manipulation of a linear programming model, Whitaker,¹ Riordan, and Walker discovered that an extra peso of credit for the small corn farms in their sample would raise profits by .7 to 1.2 pesos. The effect of more credit was to encourage a shift to more modern technology (greater use of fertilizer, pesticides, and machinery-animal rentals) requiring greater use of labor. Depending on the exact assumptions involved, production rose by 35-54 percent and profits by 13-29 percent. However, without knowing what kind of shadow prices for working capital their methodology would generate in other sectors these findings only weakly support the desirability of reallocating more credit to small farms.

More satisfying corroborative evidence is available from research on the southern agricultural area of Brazil. In that region Rao found that purchased inputs had a higher marginal return on small than on large farms.² This finding was confirmed by Singh and Ahn.³ With a recursive

¹M. Whitaker, J. Riordan and T. Walker, Supervised Credit: Its Impact on Profits, Production, Factor Use, Technical Change and Efficiency of Resource Allocation in Corn Production in Colombian Agriculture, Analytical Working Document No. 8, Sector Analysis Division, Bureau for Latin America, Agency for International Development, March 1973.

²B.P. Rao, "The Economics of Agricultural Credit-use in Southern Brazil," unpublished Ph.D. Dissertation, Ohio State University, 1970.

³I.J. Singh and C.Y. Ahn, "Employment and Capital-Labor Substitution in South Brazilian Agriculture," Occasional Paper No. 72, Department of Agricultural Economics and Rural Sociology, Ohio State University, March 1972.

TABLE 3: "Caja Agraria Credit/Value of Output" by Farm Size

Size (Hectares)	Value of 1960 Output in millions of 1971 pesos (1)	Number of loans (2)	Farms (3)	Number of loans farm (4)	Value of loans (5)	Value of Loans Value of Output (6) = (5)/(1)	
< 2	2,114	} 3119	115,000	606,423	.190	376.3	12.06
2 - 3	1,005						
3 - 4	996	} 1695	} 70,000	} 150,182	.466	302.1	17.82
4 - 5	699						
5 - 10	3,004		75,000	169,145	.443	406.26	13.56
10 - 20	3,224		46,000	114,231	.403	383.35	11.89
20 - 30	1,575		} 25,000	} 70,549	.354	314.06	11.44
30 - 40	1,170						
40 - 50	866		5,000	16,240	.308	105.3	12.16
50 - 100	2,815		9,318	39,990	.233	277.60	9.86
100 - 200	2,635		6,351	22,317	.285	279.81	10.62
200 - 500	3,143		4,500	13,693	.329	374.26	11.91
500 - 1,000	1,898		1,300	4,142	.314	383.41	20.20
1000 - 2,500	1,536		} 401	} 2,761	.145	} 269.79	} 18.57
≥ 2,500	1,453						

SOURCE: Output figures are from R. Albert Berry, "Land Distribution...", *op. cit.* The credit figures are from Berry, The Development of the Agricultural Sector in Colombia, Appendix Table A-79.

(dynamic) linear programming model they determined that the shadow price of capital (credit) was several times larger on small farms than on large ones. The financial system had allocated a much larger fraction of credit resources to large farms where capital productivity was lowest.

There is little reason to doubt that employment on small farms would respond positively to larger injections of credit. For example, Yudelman, Butler and Banerji conclude from extensive studies that the adoption of land augmenting innovations (essentially new high yielding seed varieties requiring complementary inputs of water and fertilizer) appears to have resulted in a 30-40 percent increase in labor use per hectare.¹ How increases in labor demand of this magnitude would be divided between owners of small farms and landless labor is a problem that has received scant attention. If all of the increase in labor demand were absorbed through greater employment of small farmers, landless workers would gain indirectly insofar as fewer services of small farmers would be offered in the labor market. In Colombia only one study has been able to shed a little light on the matter. From a linear programming model of a representative farm in Cundinamarca Doster and Suttor find that the availability of more credit results in large increases in the employment of family, but not hired, labor.² The greatest use of hired labor tended to occur where no credit was available at all. If these results are at all representative they suggest that a portion of the income gain received by small farmers from a policy

¹M. Yudelman, G. Butler, and R. Banerji, Technological Change in Agriculture and Employment in Developing Countries, Development Center Studies, O.E.C.D., Employment Series: no. 4, Paris 1971.

²J. Doster and R.E. Suttor, Linear Programming Analyses of the Impact of Credit on Small Farm Production, Inputs and Profit, Analytical Working Document No. 9, Sector Analysis Division, Bureau for Latin America, Agency for International Development, April 1973.

of reallocating credit away from larger farmers may be achieved at the expense of landless workers who, in Colombia, are at the very bottom of the income ladder.¹

Another comparison of some interest is the relative cost of creating additional employment on small farms versus the same cost in other sectors. Schwinden and Feaster calculate that it requires just over 13,000 pesos of current credit (expressed in terms of 1964 values) to generate a man-year of employment (both on and off the small farm).² Presumably this figure should be compared with the annual cost of renting a unit of capital in other sectors which would employ one person full time. Taking a weighted average of the ratio of constant peso (1958) net investment to employment changes for 14 manufacturing industries over the period 1957-1966 the Colombian Planning Department recently estimated a capital cost per worker of 57,200 pesos.³ If the rental rate for capital in Colombia is .15 for the sake of argument (including a charge for depreciation) the annual cost of employing an extra person in the non-agricultural would be about 8,580 pesos. Using the implicit price deflator for gross fixed investment in Colombia 13,000 1964 pesos is equivalent to about 7,679 pesos in 1958. The two figures are surprisingly close indicating that it may not cost more at the margin to create a higher paying non-agricultural job than to employ another person in the small farm sector. However, it is probably much

¹For a discussion of how land reform may have a similarly mixed distributional impact see R. Albert Berry, "Land Reform and Agricultural Income Distribution," Pakistan Development Review, XI, 1 (Spring, 1971), 30-44.

²J. Schwinden and C. Feaster, op. cit., p. 58.

³See Revista de Planación y Desarrollo, XI, 2 (June 1970), 296.

cheaper to create employment in the latter sector than it is in large scale, mechanized agriculture.¹

There are several aspects of credit allocation that have implications for income distribution and which have been neglected in this study. An overall evaluation of credit distribution should consider these omitted considerations. Instead of comparing the productivity of different sized farms it would be interesting to compare the productivity of credit for different crops and different regions. If credit is allocated to where it earns the highest return this could require that small farmers in some areas transfer control over resources to small farmers in other regions growing different crops. The labor intensity of different crops would be important in determining the distributive outcome of such a transfer. It would also be desirable, if possible, to disaggregate by type of intermediate input and measure the separate contribution of each type to various kinds of crop output on farms of different size. For example, fertilizer could be competitive with the use of labor if it is strongly complementary with a land-using, labor-saving crop. It might also be worthwhile to broaden the scope of the investigation and focus on the marginal productivity of land on different sized farms. No lending institution in Colombia lends money directly for the acquisition of agricultural land. Such a gap in the long-term credit market may be an important deficiency if the marginal product of land on many small farms is sufficiently high to enable small farmers to pay for more land and still have something left over. Perhaps a land constraint is the basic reason

¹For some evidence on the extremely high capital intensity of large mechanized farms see Wayne R. Thirsk, "A Harberger General Equilibrium Model of Equity and Efficiency: Farm Mechanization in Colombia," forthcoming in Sage Professional Papers in Political Economy.

intermediate inputs are more productive on small farms since they substitute for land purchases otherwise made.

On the methodological front more work is needed to provide a theoretical framework of how credit affects the demand for different types of inputs. Only with such a framework can the serious problem of the fungibility of funds be adequately handled. The absence of such a framework constitutes the main weakness of this study. Despite this shortcoming, the results of this study hint at the conclusion that current credit resources are misallocated in a number of specific instances and corrective policies would allocate more resources and income to poorer farmers. Improvements in the allocative efficiency of rural credit markets also promise to deliver less inequality in the distribution of income.

PROGRAM OF DEVELOPMENT STUDIES

Discussion Papers

34. "Ease of Factor Substitution in Agriculture" (1972), 24 pp., W.R. Thirsk.
35. "The Contribution of Traditional and Small Scale Culture Goods in International Trade and in Employment" (1972), 26 pp., Y.M. Ho and Donald L. Huddle.
36. "The Distribution of Income and Tax Incidence in Panama, 1969" (1972), 39 pp., Charles E. McLure, Jr.
37. "General Equilibrium Incidence Analysis: The Harberger Model after Ten Years" (1972), 34 pp., Charles E. McLure, Jr.
38. "On the General Equilibrium Analysis of Tax Incidence" (1973), 34 pp., J. Gregory Ballentine and Ibrahim Eris.
39. "The Impact of Demand on Labor Absorption and the Distribution of Earnings: The Case of Brazil" (1973), 47 pp., Samuel A. Morley and Jeffrey G. Williamson.
40. "A Note on Z Goods, Marketed Surplus and the Labor Intensity of Small Farm Agriculture" (1973), 22 pp., Wayne R. Thirsk.
41. "The Incidence of Colombian Taxes, 1970" (1973), 66 pp., C.E. McLure, Jr.
42. "What to Do about Foreign Direct Investment: A Host Country Perspective" (1973), 28 pp., Samuel A. Morley.
43. "Income Distribution Consequences of Agricultural Price Supports in Colombia" (1973), 32 pp., Wayne R. Thirsk.
44. "Factor Intensity of Consumption Patterns, Income Distribution and Employment Growth in Pakistan" (1973), 34 pp., Ronald Soligo.
45. "Industrialization in Malaysia: A Penang Micro-Study" (1973), 42 pp., Fred R. von der Mehden.
46. "Short-run Effects of Income Distribution on Some Macro-economic Variables: The Case of Turkey" (1973), 33 pp., Tuncay M. Sunman.
47. "The Inequity of Taxing Iniquity: A Plea for Reduced Sumptuary Taxes in Developing Countries" (1973), 51 pp., C.E. McLure, Jr., & W.R. Thirsk.
48. "A Numerical Exposition of the Harberger Model of Tax and Expenditure Incidence" (1973), 51 pp., C.E. McLure, Jr. & W.R. Thirsk.
49. "Public Goods and Income Distribution: An Explanatory Comment" (1974), 17 pp., C.E. McLure, Jr.
50. "Education and Modernization in Zaire: A Case Study" (1974), 29 pp., Gaston V. Rimlinger
51. "Rural Credit and Income Distribution in Colombia" (1974), 26 pp., Wayne R. Thirsk.

NOTE: Discussion Papers are available upon request to individual scholars and researchers and libraries of educational institutions.