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Economic Development: Diagnosis of the High Andean Valleys of Venezuela (Tuñame and Burbusay)

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ECONOMIC DEVELOPMENT: DIAGNOSIS OF THE

HIGH ANDEAN VALLEYS OF VENEZUELA

(TUÑAME AND BURBUSAY)

by

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Eloy Davila

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ABSTRACT

Economic Development: A Diagnosis of the

High Andean Valleys of Venezuela

(Tuñame and Burbusay)

by

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The primary objective of this study was to set development policies applicable for the high Andean valleys of Tuñame and Burbusay (Venezuela); and secondly to develop a quick and inexpensive way to assess development prospects of high Andean valleys similar to the ones studied here.

The methodology employed was to classify various agricultural regions with specific development phases using the Thorbecke's classification and policy scheme. Production functions were estimated, fitted and analyzed to determine the parameters pertinent to such a classification for the two valleys where data was available.

The analyses and classifications permitted a limited enumeration of policies for the valleys that could logically be expected to bring economic development. However, the study fell short of devising a quick and inexpensive method to assess developmental prospects of similar areas, which would not require some additional data collection and further refinement of the evaluation methodology.

(99 pages)

CHAPTER I

INTRODUCTION OF THE PROBLEM AND JUSTIFICATION FOR RESEARCH

The Andean region of Venezuela, located in the southwest area of the country, is characterized by extremes in elevation and rugged terrain which, when combined with technically poor cultivation methods, have contributed to generally limited agricultural development. The areas are entirely rural and populated by low income farm families.

Some "High Andean Valleys", however, are suspected to have higher productivity potential. They are characterized by gentle terrain, by altitudes ranging from approximately 4,200 to 11,000 feet, and by more productive soils, or by soils whose productivity can be significantly increased with proper cultural and managerial practices. These areas are also characterized by an uneven rainfall distribution which requires the introduction of irrigated agriculture to capture and enhance current crop production possibilities.

The "Corporación de Los Andes" (CORPOANDES), an autonomous public corporation, financed by the Venezuelan Government for the special purpose of aiding the economic development of the entire Andean region, has under study the so-called "High Andean Valleys Program", and is supporting a a project under which three of these valleys will be used as pilot areas to determine the means by which the socio-economic conditions of the farmers can be improved via more productive and better technical exploitation of the land.

Thus far, information for two valleys has already been collected; they are "Tuñame" and "Burbusay". This data was collected during the months of July through October, 1970. Three people, including the writer, were in charge of interviews utilizing questionnaires specifically prepared for this project by the staff of Centro Interamericano de Desarrollo Integral de Aguas y Tierras (CIDIAT) and the Centro de Investigacienes Para el Desarrollo Integral de Aguas y Tierras of the University of Los Andes (CIDIAT-ULA). CIDIAT-ULA is responsible to CORPOANDES for the formulation of the project geared to development of these pilot areas.

CORPOANDES selected the first two areas on the assumption that they are representative of the Andes high valleys and that the experiences gained from implementation of the policies based on this study will be extended (with required modifications for individual areas) to the rest of the Andes.

Production and income characteristics of the study areas:

Tuñame

Preliminary research done by CORPOANDES in 1966 found higher income per capita than the average for the Andean region. The average income per farm for 1970 was 58,685 Bolivars.[1] The farmers are mainly potato growers and 90.7 percent of the land was used exclusively for potato growing in 1965.[2] By 1970, 100 percent of the farmers grew potatoes. The 1965 report shows 18,000 kilograms/hectare of potatoes for the

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[1]In 1970, the exchange rate was approximately Bs. 4.50 for one U.S. dollar.

[2]An unpublished study by CIDIAT-ULA, done in 1966

valley average. This is around 5,000 kilograms/hectare more than the national average.[3]

The 1970 survey indicated a further increase in average production to 24,148 kgs per ha per year for the sample families interviewed. However, the averages are misleading. If we exclude the top seven producers from the sample (34 observations), this becomes clear. The mean output per potato farm, using all 34 observations,[4] fell about 14 percent, from 24,148 kgs. to 20,752 kgs. When the top seven are taken out then the net income mean falls to 7,179 Bs. The total income for the 34 observations is 2,112,667 Bs., when the top seven are taken out this income falls to 193,855 Bs. The income range for the 34 observations spans from a high of 503,106 Bs. to a low of -7,389 Bs. The range of land holdings under operation extends from 80 ha to .02 ha. It is found that when the farms are broken down according to size, over two-thirds of the sample have insufficient land area to adopt alternative production possibilities other than traditional subsistance farming (see Table 1).

Average input expenditures used in the production process of the Tuñame farms provide an approximation of the present situation (see Table 2).

From the information of these 34 observations of the Tuñame Valley and the 33 observations of the Burbusay Valley, production funtions will be derived. Common to the two areas is the fact that the units of production are family operated. More about this will be said in the section dealing with procedure.

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[3]One hectare is equivalent to 2.47 acres, and a kilogram equals 2.2 pounds.

[4]Originally 44 observations were recorded. However, ten of them were not completed or had more than one crop for which break-down and allocation of crop expenses was not possible. Hence, they were left out of the study.

Table 1. Tuñame: Break-down of sample farms by size, 1970

Hectares	Number of farms	Percentage	Cumulative %
40-80	2	5	5
10-39	5	11	16
9- 5	7	16	32
1- 4	17	39	71
0- .99	13	29	100
Total	44	100	--

Source: CIDIAT-ULA. Field research. July-October 1970.

Table 2. Tuñame: Mean value of resources used on crops and its returns

Item	Amount
Average value of production per farm*	75,134
Average value of production per farm included in the production function	96,107
Average input per farm/per ha included in the production function:	
Fuel and repairs	450.35
Fertilizer	1,024.11
Insecticides, pesticides, and herbicides	242.09
Hired labor	457.91
Family labor	10,024.24
Capital (does not include land and irrigation equipment)	11,781.05
Irrigation equipment	4,948.24
Seed	2,163.27
Average net income per farm included in the production function	58,685
Average net income per farm/per ha included in the production function	6,643
Average size per farm	8.84 ha
Average size of land under irrigation per farm	6.37 ha
Percentage of total land under irrigation	4.5 %

*Average values expressed in Bolivars

Source: CIDIAT-ULA. Field research. July-October 1970.

Burbasay

The Burbusay area was suspected of being a medium income area with high potential. However, no prior study had been made in this area as was done for Tuñame by CIDIAT-ULA. Like Tuñame, it is predominantly a one-crop area. Different physical characteristics are noted such as longer daylight, lower altitude, and poorer soil.

The average income per farm is 16,222 Bs. which, as expected, is lower than that of Tuñame. The survey revealed lower returns than in Tuñame, for instance, the range of income extends from 60,744 Bs. to to -1,100 Bs. The mean income per farm is 9,517 Bs. If we consider just the observations below this mean, the new mean is 3,595 Bs.; this represents a fall of 53 percent vs. 87 percent for Tuñame. The average farm size is smaller than in Tuñame (4.74 ha vs 8.84 ha). Also, there is a smaller variation in land holdings among farms than was found in Tuñame (see Table 3).

Table 3. Burbusay: Break-down of sample farms by size, 1970

Hectares	Number of farms	Percentage	Cumulative %
10-13	4	12	12
5- 9	10	30	42
1- 4	19	58	100
Total	33	100	--

Source: CIDAT-ULA. Field research. July-October 1970.

Average input expenditures used in the production process in the sample farms of this area also provide an approximation of the present situation regarding the kinds of inputs used and the average net returns generated.

Crop production in this area is somewhat more diversified as far as land utilization is concerned. About 45 percent of the land was used for three or more crops (see Table 4).

Table 4. Burbusay: Mean value of resources used on crops and its returns

Item	Amounts	
Average value of production per farm*	16,222	
Average input per farm per ha:		
Capital	182.00	
Fuel and repairs	117.87	
Miscellaneous	115.18	
Seed	944.21	
Fertilizer	734.18	
Irrigation equipment	4,510.64	
Herbicides, pesticides, insecticides	286.42	
Hired labor	278.84	
Family labor	2,725.76	
Average size per farm	4.74	
Average net income per farm	9,371	Bs
Average net income per ha	1,982	Bs
Percent of total land under irrigation	51.0	%

*Average values expressed in Bolivars.
Source: CIDIAT-ULA. Field research. July-October 1970.

Information in study areas

The mean values of investment in irrigation equipment in Tuñame is 437 Bs/ha higher than it is in Burbusay, and the area under irrigation is 51 percent in Burbusay as compared to 45 percent in Tuñame. However, the volume of available water per ha appears to be less in Burbusay. This is confirmed by the fact that 100 percent of the people interviewed in Burbusay expressed the opinion that there was not enough water

Table 5. Burbusay: Percentage of land devoted to one or more crops

Number of crops	Percentage
1	18.2
2	36.4
3	33.3
4	9.1
6	3.0
Total	100.0

Source: CIDIAT-ULA. Field research. July-October 1970.

available. Their irrigation expenditure, they argued, was very high due to the distance from the source of irrigation water.

Another common characteristic of the areas under study is the bad condition of access roads. This observation was made consistently during the interviews. However, the roads in Burbusay appeared to be in an even worse state of repair. All the people interviewed in Burbusay said their roads were in poor condition all year around while those in Tuñame said their roads were in fair condition during the dry season and bad during the rainy season.

The role of the public sector at the national level in both areas can safely be considered at best neutral. During the 1966-1970 period, institutional forces to promote development in either area were nil, consisting mainly of initial data gathering efforts carried out for the most part by CORPOANDES.

Relative levels of development

It was generally accepted that Tuñame had experienced a great deal of development during the past five years while no such impression existed in relation to Burbusay. This fact prompted investigation of the particular conditions that promoted the development of one area in a relatively short time compared to the accepted notion that the Burbusay area could be still considered traditional and lacking developmental possibilities.

Actually the development of Tuñame is confined to a small percentage of the farms in the area. This reality somewhat qualifies the accepted generalization that the area is comparatively better than Burbusay. Nevertheless, one area is more advanced than the other.

The particular aim of this work is to study the different conditions and opportunities which made it possible that two underdeveloped areas with fairly similar physical characteristics, located not too far apart, and subject to the same institutional help, or lack of it, could have achieved different degrees of development in a relatively short period of time.

CHAPTER II

OBJECTIVES OF THE STUDY

Objectives

1. The primary objective of this work is to find bases for setting development policies and strategies which, if and when applied, will make possible higher productivity and lead to higher income levels for farmers in the high Andean valleys of Venezuela.

2. The strategies ought to be general and broad enough to be applicable to many of the neighboring valleys in order to achieve positive results in the form of higher productivity and income levels.

3. Attempts will be made to find less costly ways, in terms of time and money, to assess exact developmental prospects for a large number of similar valleys which could warrant the utilization of policy measures as contemplated by Thorbecke.[1]

The proposed approach consists of testing the application of some criteria utilized by E. Thorbecke on production and income data from the study areas. A review of literature dealing with production functions has been undertaken, the purpose being to be able to fit some production functions for both areas taking into account the principal production possibilities facing farmers, and the results of these various input

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[1]Erick Thorbecke, in "Agrarian Reforms as a Conditioning Influence in Economic Growth" addressed himself to the contributions that can be made within an "agrarian reform" to agricultural development. He developed a classification scheme of agriculture development stages. In each of these stages he suggests policies which can speed the development process. [To these policies is the above reference made (35)].

combinations. A discussion of the most commonly employed production functions[2] follows since it is necessary to select the formulation that might best serve the intended purpose given the kind and amount of available information. To complete this chapter, a review is made of the main concept and issues related to agricultural development and its process together with a condensed discussion of Thorbecke's model. This aids development of the conceptual framework necessary to interpret results of statistical analysis of the production functions.

The empirical work consists of an analysis of (ten variable) production function models for the areas of Tuñame and Burbusay, together with a corresponding discussion of the results of each model in terms of its variables, their marginal value products, the degree of contribution of each input category by means of the partial determination and correlation coefficients, the mean value expenditures, and the value of the total product for each case.

Inter area productivity comparisons are next taken into consideration using the production model that provides the best input-output relationship at prevailing factor-product prices.

Finally, based on the preceeding approach, and in the context of Thorbecke's model, the possible applicability of the conclusions is sought. Policy recommendations aimed at the stage of agricultural development of each area are discussed in terms of the results found in the previous analysis. Possible application of these policies might be sought as information from similar areas is made available and processed.

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[2]Production functions are computed using the Multivariate Data Collection Revised and Stepwise Multiple Regression Revised programs at the University Computer Center.

CHAPTER III

ANALYTICAL FRAMEWORK

This chapter reviews selected studies concerned with empirical estimation of production functions and to the concept and measurement of economic development in the agricultural sector. Particular attention was given to the Cobb-Douglas production function.

An exhaustive review of the vast amount of literature available in these two areas would be edifying, but much beyond the scope and resources available for this study. Therefore, attention is concentrated on those studies which have the closest relation to the problem at hand.

Production Functions-
Review of Literature

Heady (11) describes the principles of production, the applicability and uses of marginal analysis. In a detailed manner the whole theory of the production function is presented. All of the concepts that follow are drawn from this particular work; they can be considered as the theoretical framework of this work, as far as production functions are concerned.

The production function, he describes, as a physical relationship between inputs and outputs given the technique used in the production process. It provides one of two kinds of information needed for choosing among economic alternatives or specifications of the use of resources and pattern of output for efficeint allocation of scarce resources (the other half needed is price data).

The physical relationship can be expressed in the following mathematical terms:

$$Y = f\ (X_0, X_1, X_2, X_3, \ldots, X_n)$$

The total product derived from the combination of inputs is expressed by Y, while X_0, X_1, X_2, ..., X_n are the resources used in the production process. This function includes all inputs, from X_0 to X_n, that are used in any one given production process. Consider the following function:[1]

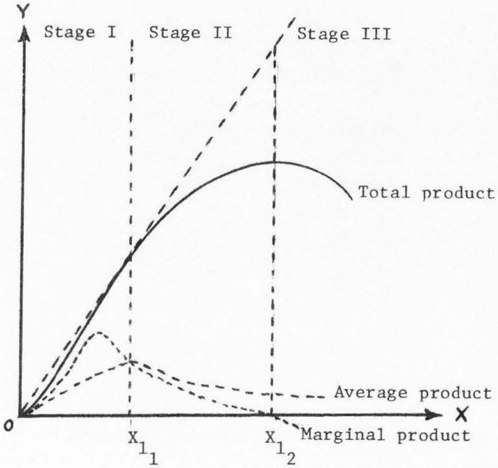

Figure 1. Production function.

[1]Since only two dimensional graph is drawn here, it illustrates a hypothetical production function for Y which requires only one input: X_1. The subscripts 1_1 and 1_2 indicate the same input X_1, but at different rates of input application per unit time.

The production function exhibits ranges of increasing, constant, and decreasing marginal products as the units of input X are increased. If profits from a technical unit are to be maximized, it will pay to produce only within the second stage, the stage of "rational" production. To use X_1 at a level less than X_{1_1} will not achieve the possible maximum, or at a level more than X_{1_2} will reduce product. In Stage I the Marginal Product (MP) curve is increasing and reaches a maximum, and it remains above the Average Product (AP) curve throughout the entire stage; this means that each additional unit of input output is adding to the Total Product (TP) first at increasing rates, then beginning at the point of inflection of the TP curve, at a decreasing rate.

In stage III the MP becomes negative, which means that additional units of X_1 will actually reduce the TP. Stage II then defines the limits of a range, where the optimum rate of input usage and output are found.

After establishing this basic concept Heady goes on to discuss the relationships which exist first among different types of outputs in one technical unit (farm). He tests them as being (a) competitive - they compete for the use of resources, (b) complementary - they complement each other. Further, he gives examples of how different types of enterprise activities should be combined given the resources available.

For inputs he lists the same relationships existing as above together with the concept of input substitution - how one type of input can be substituted for another and at what levels it would be profitable to do so given the existing price relationships among substitutive inputs.

He defines and describes the utilization of such curves as iso-product, or isoresource, and their use in analyzing production surfaces.

Heady also discusses planning under conditions of imperfect knowledge i.e., risk and uncertainty and the aggregate aspect of production.

As it can be appreciated Heady's work encompasses all aspects of the theory of production functions some of which have no direct application as far as the purpose of this work, hence no further details are given.

Heady and Dillon (12) review the theory of production and empirical estimation functions, however, not in the same detail as Heady (11). This work begins where the former leaves off. The treatment given to the theory is through very explicit examples. First, the economic applications of the production function are reviewed. Then, forms of production functions are cited such as quadratic, power, linear, and their different variations. Review here is limited to characteristics of the C-D function.

Of the Cobb-Douglas functions, the following generalized function is of primary relevance here:

$$Y = a\, x^b$$

Where: Y = output

x = input

b = transformation ratio when x changes

a = constant (interpreted by some authors as the level of technology)

The marginal product of x (MP_x) is estimated as:

$$\frac{dy}{dx} = bax^{b-1}$$

The elasticity of production (E_p) indicates the change of output related to the change in input

$$E_p = \frac{dy}{dx} \cdot \frac{x}{ax^b} = b$$

Thus, this elasticity of production (E_p) can be estimated directly as the b values of the equation. From the above computation it is easy to see that the Cobb-Douglas function in fact assumes a constant elasticity of production. Further, if $b = 1$ there is constant returns to scale; if $b > 1$ there is increasing returns to scale; and if $b < 1$ there is an indication of decreasing returns to scale (b's refer here to the b coefficient of Cobb-Douglas type power functions). b is allowed to have but one value. Thus any given function cannot have increasing and decreasing marginal products; so it cannot be used to describe the full range of a hyperbole which includes the stage of the production function.

A logarithmic transformation can be done of this function:

$$\log Y = \log a + b \log x.$$

Its properties do not change. Heady and Dillon state that:

> It has been widely used because of its convenience in interpreting elasticities of production, because estimation of parameters include fewer degrees of freedom than other algebraic forms, and because of its simplicity of computation. (Heady and Dillon, 11, p. 25)

They also state, in reference to the Marginal Value Product (MVP)

> ... [it] may be used to indicate whether disequilibrium in resources used is great or small. One criterion is the magnitude of the MVP of a unit of a particular input as compared to the unit price of the resource. (Heady and Dillon, 11, p. 67)

In Chapter 4 the authors discuss the statistical tools and problems which must be mastered in fitting a production function, plus other problems related to the estimation of production functions. The least squares principle is one of the methods mentioned, and described as the minimization of squared deviations between the observed values of Y and the corresponding estimated values of $\hat{Y}$.

Correlation coefficients are defined as the degree of association between variables. The authors lay down the rule that: if the correlation coefficient between a pair of independent variables is, roughly speaking, greater than .8, the problem of multicolinearity may arise. By multicolinearity is meant the situation where explanatory variables do not conform to the assumption of independence, that is, there is a high degree of interrelationship among supposedly independent variables.

The coefficient of multiple determination (R^2) indicates the percentage of the variation in n observed values of Y which is explained by the fitted regression equation.

The usefulness of F and t-test are also briefly mentioned in this particular chapter, along with explanations of how to use them.

In the chapter dealing with Economic Specification, the authors deal with the choice of variables. The view is put forth that the researcher is the sole judge of the variables to be included. Those variables which the researcher considered to be important, based on production theory and apriori knowledge of the production relationship should be included regardless of what statistical tests may say. They also express their conviction that the researcher to a certain extent will have to use trial and error methods on deciding among choice of variables.

In the choice of algebraic forms, Heady and Dillon suggest that knowledge of the researcher concerning the physical processes involved should serve as a guide for the selection of variables. They state that there is no statistical test that can tell us which functions best describe the process. But they do mention rules for determining statistical adequacy, although not necessarily the basic logical adequacy. They are: size of the coefficient of multiple determination (R^2) which is desirable to have it as close to unity as possible. When using an F test of the regression mean square and a comparison of the lack of fit and error mean squares, however, they state that for nonexperimental data only the first are feasible. Again they repeat that a variable should be dropped only if there is no strong logical grounds for including the variable according to the judgement of the researcher.

The function chosen as best will depend on the weight the researcher attaches to the various criteria i.e., logical and statistical. At this stage, the selection of a function is more of an art than a science.[1]

The rest of the book is a collection of empirically estimated production functions. Among them is a Cobb-Douglas function fitted to 160 acre farms at random. The results presented and interpreted provide a useful pattern for this study.

Heady, Johnson, and Hardin (13) edited, in book form, the proceedings of a conference which was focused on the measurement of resource productivity. Their presentation includes:

a. The relationship of scale analysis of productive ananysis (Heady, Chapter 8).

b. Classification and accounting problems in fitting production functions (Johnson, Chapter 9).

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[1]All of these tools and problems or statistics are found in Karl Fox Intermediate Economic Statistics (9) in much greater detail and refinement.

c. Problems in encounter estimation of MVP on multiple enterprise farms (Beringer, Chapter 11).

d. Significance tests in production function research and their application (Tinter, Chapter 14). An example is given presenting a Cobb-Douglas type function which is extremely useful in this work.

e. Summary of the relevant criticism found in the literature of the use of Cobb-Douglas function is presented (McAlexander, Chapter 17; Haver, Chapter 18).

This book to a great extent, repeats all of the concepts discussed in the works mentioned above, hence reinforcing the thoughts and conclusions of the former authors.

Plaxico (30, p. 664) addresses aggregation problems in production function estimation (1) to show how aggregation of products into a dependent variable and aggregation of inputs into different independent variables may affect the value and reliability of estimated parameters; (2) to indicate the conditions associated with an optimum aggregation (he mentions the rules that follow below); (3) to question the usefulness of C-D estimates as guides for intrafarm policy. He concludes that even though C-D estimates are questionable to guide intrafarm policy, they are most useful as guides for setting general interfarm policies. (Some authors, however, question how a function that is not reliable enough or good enough to set intrafarm policies, can conceivably be any better in setting guides for inter farm policies).

Another problem of production functions estimation is that of "input aggregation." The accepted rules for aggregation are expressed as follows (30, p. 668).

1. The inputs within an individual category should be as nearly as possible perfect substitutes or perfect complements.
2. Relative to each other, the categories of inputs should be neither perfect substitutes nor perfect complements.

This problem is of the highest relevance to the study. The misfit can be serious if these rules are not observed. Statistics can arise which lead to errors in interpretation of results. All authors concur that aggregation should be avoided if possible but when aggragated, which is nearly always done, great care must be exercised. Aggregation of inputs is as troublesome as that of output. The justification of the grouping procedure is that products within groups of farms are treated as if they were joint products produced in fixed proportion.

Plaxico, in dealing with the problems of factor-product aggregation in the productivity values found on a Cobb-Douglas concludes that "marginal value productivity estimates derived from the Cobb-Douglas type function can be seriously biased by non optimum aggregation of outputs" (30, p. 669).

The Cobb-Douglas type function, since its original application, has been the cause of great concern as to its theoretical soundness and the claims made for it. This discussion is found in articles by Walters, Reeder, Douglas and Bronfenbrenner (39, 33, 7) with whom the controversy started. These articles were useful since they show major depth of insight into the use and application of the functions. Tinter (37) and Tinter and Boorowlee (36), in separate articles, discuss the derivation of the production function. Phelps-Brown (31) discusses problems of correlation and divergence of the function with the real world. Particular mention should be made of the Cobb-Douglas function on data for a 160-acre farm, and the article "Production Functions from a Random Sample of Farms" (16).[2]

Production function research on data from the agricultural community of Turen, Edo. Portuguesa, Venezuela has been carried out by Sergio Verdugo (38). Cobb-Douglas type functions were used by Verdugo although the variables were defined differently. His methodology is no different from the one used in this study. He relied on E. O. Heady's experiences; they are also the main guide of the present work

Agricultural Economic Development

In regard to economics of development or underdeveloped economies, the literature available is quite extensive. The subject of development and underdevelopment continues to occupy the best minds of economics. However, no single model has been proven most efficient or general enough to encompass all existing situations of underdevelopment. All that can be said is that some models have withstood tests and analytical critics better than others. Even the definition of underdevelopment and statistics which measure economic growth are not wholly accepted by all scholars.

Benjamin Higgins (21) in his book, Economic Development; Principles, Problems and Policies, does an excellent survey of different theories of economic development. He presents some very interesting case studies as a means for illustrating the problems of underdevelopment. Particular emphasis is given to planned or directed development where there appears to be one of the rare consensus among leading development economists.

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[2]This listing presented here is not intended as a literary review but to point out where criticism of the Cobb-Douglas can be found and to point to two articles which, although repeat the same principles expressed by Heady in his books, are most useful because of its condensed nature.

W. F. Owen (29) develops fundamental ideas on the subject dividing the whole field into two basic camps, "The Basic Communist or Marx-Lennist Model," and "Major Non-Communistic or Marshallian-Mills Model." The first he characterizes as follows:

1. Direct intervention of the state where the primary objective has been the exploitation of anticipated economies of scale and technology, labor supervision, and central planning.

2. First claims on a substantial part of farmer's output, and

3. Persuasive utilizaiton of acquired agriculture surplus.

The second or alternative model he characterizes by:

1. Family operated units (farms), and

2. Oriented to production for the purpose of acquisition (private).

He further argues for the failure of the first model because of the attempt to cash in the economies of scale by converting the farm into an industrial factory:

> To seek to impose the factory upon agriculture is, therefore, to defy some rather convincing facts of life. Economies of scale as it exists in the industrial sector doesn't really exist in agriculture. First and foremost, the division or specialization of labor cannot be carried out to the degree of the factory. Operations cannot be carried out simultaneously, and secondly, there exists spatial limitations. (Owen, 29, p. 61)

Owens also argues that production in the agrarian sector is "market oriented" and geared to the automatic realization of productive potentials. The last he states as the basic difference between the two systems, and because they are not recognized in the Marxist-Lennist model it failed.

J. W. Mellor (27) gives a full picture of the problems and requirements of agricultural development. His book is divided into three sections concerning the role of agriculture in overall economic development. In the first section he argues most convincingly that agriculture is the source and pivot of overall natural development. It can make a major contribution to the overall development effort because it can be developed in large part with relatively low opportunity cost resources. His second section deals with the economic nature of traditional agriculture. Mellor elaborates in the three general inputs: land, labor, and capital. He concludes that, in general, labor is abundant whereas capital sources are limited and land in most countries is limited or becoming so. The third section deals with modernization of agriculture where he develops its own three phases or steps of agricultural development and ways to push agriculture along this path. His three phases of agricultural development are:

1. Traditional Agriculture characterized by technological stagnation where production is increased "largely through slowly increased application of traditional forms of land, labor, and capital."
2. Technological Dynamic Agriculture Low Capital Technology. Its characteristics are: (a) agriculture still represents a large portion of the total economy; (b) demand for agricultural products is rising rapidly; (c) capital for industrial development is particularly scarce and returns are rising; (d) limitations of the pace of economic transformation and pressure of population growth preclude enlargement of the average acreage per farm; and, (e) use of labor-saving agricultural machinery is largely precluded by unfavorable labor-capital cost relationships.
3. Technologically Dynamic Agriculture High Capital Technology. He states the key characteristics of this phase as "the substitution of capital in the form of large scale machinery

for labor." Development of institutions creating a stream of "labor saving" mechanical innovations and facilities in and around the whole production process. At this stage he claims the agricultural sector has diminished significantly in relative importance.

Each of the three sections of the book deals with these phases of agriculture.

A. Lewis (2, p. 400-449) based on the classical assumptions of unlimited labor supply, develops a model in which using the classical assumptions he uses this labor surplus to create an agricultural surplus. He assumes that marginal productivity of labor is zero and thus the agricultural sector can and does transfer labor to the industrial sector; where the real wage remains constant for unskilled labor. Hence with growing agricultural surplus and constant real wage the industrial investment can rapidly proceed. The rate that the capitalist of the industrial sector has to pay is determined outside the sector.

The model says, in effect, that if unlimited supplies of labor are available at a constant real wage, and if any part of profits is re-invested in productive capacity, profits will grow continuously relative to the national income; and capital formation will also grow relative to the national income.

Ranis and Fei (21, p. 309) set their purpose "to present a theory of development relevant to the typical labor surplus type of under-developed economy and to extract some policy conclusions from them." Their basic model, as summarized by Higgins (21, p. 309) has the following fundamental features:

1. The supply of land is sharply limited;

2. A constant institutional wage exists in the industrial sector and at this wage, the supply of labor is perfectly elastic which is slightly above the real wage in agriculture;
3. Labor is redundant in the agricultural sector;
4. Any number of workers can be absorbed in the industrial sector, with lack of additions to the capital stock and without innovations;
5. Innovations in the industrial sector as such, thus lead to the transfer of workers to this sector. Innovations raise the marginal physical productivity of labor and its employment, which will increase until MPP is again once reduced to the critical minimum wage;
6. The transfer of labor to the industrial sector is limited to the agricultural surplus; and,
7. Capital stock accumulation also raises employment.

So the thrust of the argument hinges here, as it does with Lewis, on the notion that there exists a pool of unutilized or underutilized resource, i.e., labor. This resource, the authors contend, can be utilized productively without any great requirements or additional burden in the already scarce capital resource. This can be done by putting labor to work in projects which are capital saving. The crucial point Lewis argues is the use of indigenous technology to raise productivity. A classical example is, in the agricultural sector, digging ditches, construction of wells, etc., which add to the capital stock and increase the productivity of labor. At the same time a number of workers can be transferred to the industrial sector without reducing total output of agriculture. As an example of the success in the application of these models, they cite the case of Japan whereas India is one of failure.

Both labor surplus concepts mentioned above have enjoyed popularity. However, it also has its critics who contend that labor redundancy does not, in fact, exist in the underdeveloped countries: (1) that it did not exist in India as other authors maintain; (2) that any number of workers cannot be released from the agricultural sector; and furthermore, (3) that it is difficult to find in developing countries industries which are labor intensive; in fact, they argue that the opposite is true. Hence their contention is that the industries available has historically been (as Higgins also asserts in the case of Japan) capital intensive.

E. Thorbecke (35, p. 1) in trying "to relate agrarian reforms to the process of economic development" follows the main assumption of Lewis (2, p. 400-449) and Ranis and Fei (21, p. 309) approach: Labor redundancy in the agricultural sector plus the idea of an institutional wage floor. He also bases his ideas on Jan Tinbergen with whom he concurs in the belief that:

> At present it is widely believed that in an early stage of development great reliance needs to be placed on the use of exogenous forces under the control of the government, such as public investment and agrarian reforms, to generate growth. It is only after a certain equilibrium position of the ecosystems has been achieved that growth becomes self-sustained and cumulative and the reliance on exogenous impetuses through central planning, for instance, can be reduced. (Thorbecke, 35, p. 2)

Tinbergen's approach is presented in terms of an objective welfare function or preference function and the division of variables which indicate to the policymaker which one he should manipulate; plus the specifications of "a system of structural relationship" which can be identified by the policymaker for policy formulation.

Furthermore, he accepts Tinbergen's classification of variables which have effects upon important economic indices or targets of an economic system. Thorbecke (35, p.3) summarizes them in the following form:

Exogenous, or independent which are the data, are considered the influence, and the endogenous, or dependent variables which are the economic phenomenon per se. These later variables are in turn of two types: (1) those over which the policy maker cannot exert any influence at this level of control and (2) those under the control of the latter (policy means). These can be further subdivided: (a) instrumental variables which are of quantitative character and are used to adapt the economy to small and frequent changes in some of the other data, (b) structural changes which are means for altering the underlying structures of the economy such as quantitative restrictions, built in stabilizers, antitrust legislation, and allocation of public investment as between projects in a developing economy; and, (c) reforms which are changes in the foundation of the economy in terms of the ownership of the means of production and income relationships between individuals in society.

The next two classes of variables consisting of exogenous variables in the theory of economic policy are: (1) target variables, which incorporate the immediate goals of policy makers; and (2) irrelevant variables which are the additional changes in which the policymaker is not interested at the time of decision-making.

The third major element of Tinbergen's approach consists of the specification of a system of structural relationships reflecting the technical (i.e., production function), behavioral and institutional relationship in the economy. The set of causal relations constitutes the model.

Another characteristic of Tinbergen's model, outlined by Thorbecke, concerns "the flexibility of its methodology which permits ... application at regional or national levels first and second to the study of any individual sector, and finally to any time period."

Next Thorbecke summarized Lewis' postulate (2, p. 400-449) and Ranis and Fei elaboration, thus setting the stage for the presentation of a model of his own which uses these authors' ideas.

In his model he classified states of agricultural development into three major phases, with distinctive characteristics for each one, and particular policy recommendations aimed at influencing these variables over which the policymaker has control. He cites those major objectives which are chosen to be met along with economic development.

Furthermore, Thorbecke acknowledges that any classification scheme is arbitrary to a degree and that his is no exception. However, it is easy to see that he favors some kind of classification where the whole model package can be presented in a way that policy makers can distinguish the trade offs among different alternatives and choose those which are appropriate for whatever area is under consideration. His classification is summarized in Table 6.

A common feature among all these writers is then that agriculture is of vital importance in the development process. Even some others such as Jorgenson (25), who disagrees very strongly with the existance of labor reduncancy in the agricultural sector, agrees that this sector can and does contribute a great deal to overall development. Even in cases such as Venezuela, where the oil sector has taken the role of a pilot sector around which the country develops and grows; all authors previously discussed, agree that agriculture must develop along with the other sectors in order to achieve a "proper equilibrium."

Table 6. Agrarian policy means and the process of economic development

Economic development phase	Characteristic features	Major objectives	Principal agrarian policy means appropriate to period and conducive to
Phase I: Stagnation	MPP labor = 0 (Labor redundancy) Supply of labor in agriculture infinitely elastic at institutional wage rate Supply of labor in industrial sector infinitely elastic at institutional wage rate Economic dualism Preconditions to takeoff not met Existence of agricultural surplus	Distributive justice Equality of opportunity Economic development	Land redistribution (C2) Changes in land tenancy (C1) Taxation (A1) Social-overhead capital (B4) Subsidies (A2) Extension (B8) Reforms most important policy means
Phase II: Takeoff	0 < MPP labor < institutional wage rate Supply of labor in agriculture infinitely elastic at institutional wage rate Supply of labor in industrial sector upward sloping	Economic development Productive efficiency Equality Justice	Research (B2) Public investment in social-overhead capital and farm implements (B4, B3) Education (B7) Extension (B8) Credit and marketing facilities (B6) Taxation (A1) Structural changes most important policy means
Phase III: Commercialized agriculture	MPP labor > institutional wage rate Agricultural and industrial sectors fully integrated	Productive efficiency Economic growth	A number of instrument variables

Source: Erick Thorbecke (35, p. 27).

An interesting and most convincing example appears in Ragaei El Mallakh's book (32), "Economic Development and Regional Cooperation: Kuwait." The author discusses how, in spite of the many characteristics of development in Kuwait--highest per capita income in the world ($3,215), a high saving rate equivalent to 44 percent of its GNP, a considerable rate of growth in the order of 8 percent annually, and a favorable balance of payments account--Kuwait can still be considered as underdeveloped, i.e., a one-product economy, limited and unskilled labor supply, high dependence on external markets for capital and consumption goods. It is also interesting to point out that Kuwait does not have a viable agricultural sector. It has no more than 100 acres of land under cultivation, and these are under experimental agencies. Mallakh's contention is that it is imperative to "create" a feasible agricultural sector as a means to sustain and enhance the development possibilities of its economy.

If this is not the case, the agrarian sector will drain the economy of needed resources and will be an obstacle to the development process. Furthermore, some economists argue for balanced growth (2). Ragni Nurske argues for a "frontal attack ... a wave of capital investment in a number of different industries." This he called a "balance growth." Higgins summarizes the core of his argument as saying that: "the only way out of the dilemma (underdevelopment) is 'more or less a synchromized application of capital to a wide range of different industries.' There is an escape from deadlock; here the result is an over-all enlargement of the market ... Most industries catering for mass consumption are complementary in the sense that they provide a market for, and thus support, each other ... the case for 'balanced growth' rests on the need for a 'balanced diet.'"

Thorbecke's contribution and refinement on labor surplus theory is that even though he stresses the importance of labor redundancy, the nonexistance of this phenomenon is not under his classification, non-operative. It can still be applied by relying on his policy recommendations and following them. The other characteristics given besides the productivity of labor in relation to the institutional wage can be used, i.e., economic dualism, existance of agricultural surplus, etc. Certainly his policy recommendations in regard to the use of labor in creation of social over-head capital would have to be altered, but the other such extensions for instance would still apply.

CHAPTER IV

RESULTS OF AGRICULTURAL PRODUCTION FUNCTIONS OF THE AREAS STUDIED

This section presents the material dealing with the estimation of Cobb-Douglas type production functions and the results of the fitted production functions.

The purpose of fitting these production functions is the provision of analytical tools which will allow (a) the use of the Thorbecke classification via the MPP of family labor, and (b) an economic picture of the two valleys under study.

Source of Data

The data used in this study were collected during the summer months of 1970. Interviews were conducted with farmers of both areas, using a questionnaire prepared by the staff of CIDIAT for that purpose. The nature of the data is cross-sectional. Answers to questions were given in most cases by recollection of the manager-owners since very few kept any sort of records. Thus, some erroneous replys were probably received. The potential for such errors was minimized due to the timing of the data collection. In Tuñame, the survey was taken in the middle of the potato growing season while experiences were still fresh in the memories of the farmers. Also, the fact that most farmers in this area have been growing potatoes for a number of years, using very much the same kinds and amounts of inputs, helped them in their recollection.

In Burbusay the time of data collection coincided with the harvesting of some major products. This probably helped the data collection because at least the output figures were fresh in their minds. Prices quoted were those prevailing in the market at the time.

Statistical Analysis

The model building, multiple regression equations, and analyses of variance were computed using the Multivariate Data Collection, Revised and Stepwise Multiple Regression Revised programs of the Computer Center of Utah State University. Also generated by these programs were the logarithmic transformations, correlation matrix and regression, and various statistics, including mean squares, coefficient of variation, and F tests.

Theoretical Framework

The different stages of the production function discussed in the previous chapter would indicate that farm managers follow the rationale there summarized. Hence, it would be expected that most farmers, since they are in the business to realize the maximum profit, or so we assume, will operate in stage II, the stage of profit optimization. Hence, the assumption, if true, will reduce the variation among the observations, and most observations will be in stage II of production. That is, we would be receiving points along a section of the production curve, which is limited by the boundaries of stage II. These points would have a small variation; thus the function obtained is not a true function, only a section of it. This makes it difficult to establish a casual relationship between input and output. The observation range on input usage may increase the size of the standard error and thus reduce the reliability of the estimated marginal value products.

These problems may be compounded by any concealed in the collected information. It is possible that a meaningful value, that of water, might have been left out.

The volume of water used in the production process was not available. This input is suspected of being a limiting factor in Burbusay, and of having primary importance in Tuñame. In order to overcome this lack, a proxy variable was used, i.e., investments in irrigation equipment, with the hope that this variable would provide some reflection of the contribution of the water used.

The Production Function

The Cobb-Douglas function transformed into its logarithmic form was chosen for this study. The C-D function offers all of the practical advantages mentioned in the previous Chapter. It is a very well known form of production function, and has been used extensively by agricultural economists. Its most important advantages are:

1. The C-D function is a very efficient user of degrees of freedom.
2. It has properties which allow for easy interpretation.
3. It is not cumbersome in its computations.

Plaxico describes the function in the following way:

> The Cobb-Douglas function postulates complementarity among inputs and allows diminishing marginal productivity to each input factor as well as increasing or decreasing returns to scale. The function is not capable of reflecting successive areas of increasing, decreasing, and negative returns, as elasticities of production over the entire range of inputs. Cobb-Douglas functions are easy to interpret because the coefficients of the ordinary least squares equation are the elasticities of production of the respective input variables. (Plaxico, 30, p. 665)

Johnson says the following:

> In general the mathematical function used in these studies (cross-sectional data to yield value productivity functions) has been the Cobb-Douglas. Such studies have yielded rather conclusive estimates for purposes of general policy recommendations of the marginal value productivities of categories of inputs. (Johnson, 23, p. 211)

Tinter (37, p. 27) states the following: "If the errors of data are small and normally distributed. A logarithmic transformation of our variables will preserve the normality to a substantial degree ... "

The logarithmic transformation also added simplicity to the calculation, the coefficient of determination (R^2) improved, as did the statistical significance of the variables.

Variables

Classification of variables used in a production function can cause serious problems. The manner in which inputs are aggregated may influence parameter estimation. This problem is particularly serious in the use of the Cobb-Douglas function because it postulates complementarity among inputs.

The rules for aggregation are: That perfect complements and perfect substitutes must be aggregated, otherwise they will bias the estimates (30). Plaxico (30) describes this particular problem as well as others related to aggregation of variables and he concludes that in spite of:

> ... these precautions, estimates may be subject to sizeable bias due to: (1) certain inputs are not included; (2) managers likely seek to maximize returns over a longer period of time than that period under consideration; (3) farmers use a mixture of old and new techniques; (4) managers plan on the basis of expected prices and technical relationships but the analysis is based on realized prices. (Plaxico, 30, p. 668)

However, as Plaxico states, the reasonability of aggregation can be tested on the basis of correlation analysis. (If the value of the correlation coefficient is above .80, Heady suggests that there is a correlation problem).

Two different sets of variables were examined for each area. A non-aggregated set (Set I) which includes ten variables, and an aggregated set (Set II) which includes four input categories. Definition of each variable for both areas and both sets follows:

Tuñame area. Set I.

Output Category (Y) — Output represents the volume of double cropped production within the agricultural year expressed in kg/ha.

Input Category (X_1, ..., X_n)

Land — Land is held constant at one hectare due to the fact that the available soils study made by Ford and Agricultural Organization technicians classified the soils of each area to be homogeneous in quality. Also, no information was available in regard to land prices which might have indicated land quality differentials, and/or land improvements. Hence the only alternative was to include the number of hectares cultivated of the potato crop. But since it was the intention of this work to compare the two valleys, it was considered that the two production functions should be kept as uniform as possible.[1]

[1]In Burbusay the number of hectareas allocated to each crop could not be determined since two crops, figs and onions, grow together.

In Production function run by Heady, among others, where land was kept to one acre; the results obtained were satisfactory.

X_1 Fuel and Repairs

Expenditures valued in Bs. (all expenditures for all correspond to the two growing seasons within an agricultural year).

X_2 Fertilizers — Expenditures valued in Bs.

X_3 Transportation — Expenditures valued in Bs.

X_4 Herbidices, pesticides, and fungicides

Expenditures valued in Bs.

X_5 Hired Labor — Represents the average wage of Bs. 9 per working day.

X_6 Family Labor — This variable is treated according to the following correlation.

Table 7. Correlation for valuation of family labor according to sex and age

Member of the household	Estimated labor coefficient	Annual returns (Bs.)
Head of household	1.00	3,600
Woman over 18 yrs of age	0.50	1,800
Man between 16 and 18 yrs of age	0.50	1,800
Child between 14 and 16 yrs of age	0.25	900

The average estimated working days per annum range between 250 and 300 days. In this case the upper limit is used due to the labor intensive nature of potato production in the area. Moreover, an estimated wage of Bs. 12 daily was inputed due to the assumed improved labor skills of the owner-operator in the area.

X_7 Capital investment

Capital investment (adjusted for depreciation charges), excluding irrigation equipment.

X_8 Irrigation equipment

Investment in irrigation equipment (adjusted for depreciation charges). Irrigated agriculture in this area represents a feasible production alternative in what would otherwise be a moisture deficient area due to uneven rainfall distribution. Hence, investment in irrigation is used as a proxy variable for amounts of water used.

X_9 Seed — Expenditures valued in Bs.

Tuñame area. Set II.

Output Category (Y) — Output represents the volume of potato production in the agricultural year expressed in kg/ha.

Input Category (X_1, ..., X_n)

Land — Land is also held constant at one hectare due to homogeneous quality of soils, and lack of information about land prices.

X_1 Crop Expenses — Refers to all around variable expenditures valued in Bs.

X_2 Machinery Expenses

Refers to variable expenditures valued in Bs. including depreciation changes.

X_3 Hired Labor — Represents the average wate of Bs. 9 per working day.

X_4 Family Labor — Defined as in Set I taking into consideration the family labor distribution, the estimated annual working days, and the imputed remuneration to their own labor input.

Burbusay area. Set I.

Output Category (Y) — All farms had at least two marketable crops. Therefore, the volume of each crop times the average price received is added up, and expressed as the value of output in Bs.

Input Category (X_1 ..., X_n)

Land — Land is held constant at one hectare for the same reasons indicated above. Total production costs correspond to volume of production of one hectare regardless of individual crops on account of limited cost information for each particular crop.

X_1 Capital Depreciation Charges

This variable expressed in Bs. is used as proxy for capital investment excluding irrigation equipment.

X_2 Fuel and Repairs Expenditures valued in Bs.

X_3 Miscellaneous Expenses

This variable is included in the model because many samples do not specify expenditures of key inputs while the miscellaneous category represents rather high outlays.

X_4 Seed — Expenditures valued in Bs.

X_5 Fertilizer — Expenditures valued in Bs.

X_6 Irrigation Equipment

Investment in irrigation equipment (adjusted for depreciation charges). The explanation for including this variable is the same as before (see variable X_8 Tuñame area. Set I).

X_7 Herbicides, pesticides, and fungicides

Expenditures valued in Bs.

X_8 Hired Labor — Represents the average wage of Bs. 8 per working day in this area.

X_9 Family Labor — Defined as in Sets I and II of the Tuñame area.

Burbusay. Set II.

Output Category (Y) — Value of crops marketed expressed in Bs.

Input Category (X_1, ..., X_n)

Land — Land is held constant at one hectare for the same reasons indicated above.

X_1 Crop Expenses — Refers to variable expenditures valued in Bs.

X_2 Machinery Expenses — Refers to variable expenditures valued in Bs. including depreciation charges.

X_3 Hired Labor — Represents the average wage of Bs. 8 per working day in this area.

X_4 Family Labor — Defined as Sets I and II of the Tuñame area, and Set I of the Burbusay area.

All of the above variables had a constant added equivalent to a unity in order to eliminate the problem posed by the inexistence of a given input in some cases. This method has been widely used by Heady and others.

The Model

The production function model utilized in this study is of the Cobb-Douglas type. Several combinations of variables are tested and the results are presented in Table 7. The remainder of this chapter discusses the statistical significance of each variable, the coefficient of determination values, and the order in which the program deleted some of the variables included in each model. The following chapter contains the economic inferences that can be made in relation to the individual and aggregated elasticity values obtained, together with the corresponding economic implications of the Marginal Value Product of each variable, and the changes that take place in the MVP's in the several variable combinations. The final step in Chapter V consists of an analysis of the two models that best explain the most adequate resource combination, given the existing constraints in each area, and in a comparative way the inter area productivity levels. Hence the relative degree of development of each area can be further analysed following Thorbecke's model in order to test objectively the initial hypothesis of this work. This analysis, in turn, will be used in Chapter VI to determine the policies that might be instrumental for better utilization of the available resources, and therefore the needed agricultural investment and organization development in these and similar areas of the Venezuelan Andean region.

In all the derived production functions the inputs are measured in bolivars and refer to the flow of services or expenses for the year. They are, with one exception, not capital values. Calculations of profitability can be made directly. If the marginal return is greater than 1 Bs., the particular bolivar of input or expense more than paid for itself.

The one exception is Tuñame variable Set I (see page 35). Here a capital variable is defined as such. The cost of capital is considered to be 6 percent, since the Agricultural Bank (Banco Agricola y Pecuario) makes the loans available to the farmers of the area at 6 percent interest rate per year.[2] Hence, any MVP of capital above 1.06 pays for itself. The concept expressed here is thus basic for the interpretation of the results.

As already explained for each area, two sets of variables were initially used. A third combination was also tried. In it family labor is valued at the cost of a food basket. The analysis of the results of

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[2]This information was conveyed during the interviews. Furthermore, the interest rates that the bank is allowed to charge are established by law.

this model are found in Appendix . Tables 8-15 contain the results of the original combinations for each area.

A number of results are presented due to the fact that all of the sample observations are not included in some tests. As a result there are ten results divided across the areas and models discussed earlier. In the table titles the variable sets are identifed as I and II.

The b values in Table 8 are simply the regression coefficients of individual variables. b(0) is the shift in the Y axis as the exponential function was transformed to a logarithmic function. The level of statistical significance is found by means of an F test. The means are of the observations for particular variables. The Marginal Value Productivity (MVP) is given by differentiating the Cobb-Douglas equation with respect to each input

$$\frac{dy}{dxi} = \frac{(bi)}{(X_1)}Y.$$

The values for Xi and Y in each are those of the input at the mean.

The Marginal Physical Product[3] of family labor is estimated simply by dividing the estimated marginal value product by its price.

$$MVP = MPP_{x_i} P_{x_i} \therefore MPP_{x_i} = \frac{MVP_{x_i}}{P_{x_i}}$$

The coefficient of multiple determination (R^2) is shown in the tables and again next to the variables as they are deleted. Hence this new

[3]For the other production function the derivation of MVP's and MPP is used in the same manner. The F test is used. This same form of presentation is used in all production functions.

value of R^2 shows what explanation of the variation is given by the remaining variables in ten models.[4]

The mean values are simply the mean values of the particular variable and for shich the b values were found.

Tuñames Four Production Functions

Table 8. Tuñame. Model I[a] (includes all 34 observations)

Variables	b values[b]	Statistical level of significance	Means	MVP	MPP
X_1 crop expenses	0.1124	.25	3,186.4	.8518	
X_2 machinery expenses	0.1576	.05	1,255.8	.3030	
X_3 hired labor	0.0739	.25	5.7.0	3.4517	
X_4 family labor	0.0377	.25	10,024.2	.1417	.0157
	b_0 7.4679	Model at .05			
		R^2 = .28			
Total product (Y)			24,148.4		
Sum of elasticities .3816					

[a]Variable set II
[b]Elasticity of production for the variable X_n.

The stepwise method of linear regression deletes the variables in their order of significance and contribution to R^2. For the particular function shown in Table 8 they were deleted in the following order: (1) family labor (127); (2) hired labor (.24); (3) crop expenses (.16).

[4]The new R^2 value resulting from deleting the particular variable is shown in parenthesis.

Tuñame Model II

The original model or function contained the 10 variables defined as Tuñame variable set I. However, Model II includes a total of six variables only. The reasons for the change is that the use of the stepwise regression allows for the choice. The model with six variables appears the best.

Even though R^2 is lower than when the 10 variables are included, it is only by a small percentage (2 percent). The level of statistical significance of the model as a whole, and the variables improved individually when compared with the original.

Table 9. Tuname's Model II[a]

Variables	b values	Statistical level of significance	Means	MVP	MPP
X_1 fuel and repairs	.0657	.25	450.4 Bs	3.725	
X_2 fertilizer	.1489	.10	1,024.1 Bs	3.713	
X_9 seed	1.1097	.05	2,163.2 Bs	3.712	
X_6 family labor	-.0201	.75	10,024.2 Bs	-.0048	-.0005
X_8 irrigation equipment	.0753	.10	4,948.2 Bs	3.885	
	b_0 -.05771	Model at α = .005			
Total product			24,148.4 Kg		
		R^2 = .45			
Sum of elasticities 1.245					

[a]Variable set I.

The variables were deleted in the following order: (1) transportation (.47); (2) hired labor (.47); (3) insecticides and pesticides (.46); (4) capital (.45). These variables contributed very little to the variation of the function.

The variables retained in the model are deleted in the following order: (1) family labor (.45); (2) fuel and repairs (.40); (3) fertilizer (.34); (4) irrigation equipment (.17).

Table 10. Tuname's Model III[a]. (27 observations below the mean net farm income of the sample)

Variables	b values	Statistical level of significance	Means
X_1 Fuel and repairs	.0112	none	3,916
X_2 Fertilizer	.0600	.025	922.2
X_3 Transportation	-.0416	.50	-338.5
X_4 Insecticides and pesticides	-.0405	.75	-216.2
X_5 Hired labor	.0466	.50	335.8
X_7 Capital	-.1659	.50	-12,337
X_8 Irrigation equipment	.0239	.75	5,297.1
X_9 Seed	.0243	.75	2,124.8
X_6 Family labor	.0449	.75	11,843.8
	b_0 7.405	Model at = .05	
		R^2 = .58	
Sum of elastices	-.0371		
Total product Y			20,752

[a]Variable set I.

Tuñame's Model III

The stepwise multiple regression made no significant statistical improvement on this model.

The order in which these variables were deleted and the respective change in R^2 follows: (1) seed (.58); (2) fuel and repairs (.58); (3) insecticides and pesticides (.58); (4) irrigation equipment (.57); (5) family labor (.56); (6) hired labor (.56); (7) transportation (.55); (8) capital (.53).

An interpretation of this model would be an educated guess at best because of the lack of statistical significance of the variables. This could be a result of an attempt to determine a production function when there is more than one. However, when variables are aggregated the results are better (see Model I); a problem then could arise as a result of disaggregation of variables, or possible problems with measurement.

Tuñame's Model IV

An additional Tuname production function with five variables included was estimated. Y is defined in this instance as market value received by the farmers. (Product which was not sold was priced at the market price). The four independent variables are crop expenses, machinery expenses, hired labor expenses, and family labor, defined as in variable Set II. The results are shown in Table 11.

Table 11. Tuñame's Model IV

Variables	b values	Statistical level of significance	Means	MVP	MPP
X_1 Crop expenses	.1843	.025	3,186.4	.4851	
X_2 Machinery expenses	.1537	.025	1,255.8	1.027	
X_3 Hired labor	.0365	.75	517.0	.5921	
X_4 Family labor	-.781	.25	10,024.2	-.0653	-.0072
	b_0 6.831	Model at α = .005			
		R^2 = .41			
Sum of B values .2964					
Total value product			8,387.3		

The input variables deletion order and the corresponding changes in R^2 are as follows: (1) hired labor (.40); (2) family labor (.34); (3) crop expenses (.23).

Burbusay Four Production Function Combinations

Burbusay Model I

The step-wise multiple regression deletes the variables in the following order (the change in R^2 is shown in parentheses): (1) machinery expenses (.55); (2) hired labor (.55); (3) crop expenses (.30).

The 10 variable model including all of the 33 observations is statistically nonsignificant. However, when the observations were divided into two groups using the mean net income of 9,517 per farm as the breaking point, two production functions were obtained which are statistically significant.

Table 12. Burbusay Model I (Five variable Model Set for 33 observations)

Variables	b values	Statistical level of significance	Means	MVP	MPP
X_1 Crop expenses	.4047	.005	2,561	1.065	
X_2 Machinery expenses	.0167	None	418	.269	
X_3 Hired labor	-.0141	None	276	-.344	
X_4 Family labor	.3397	.005	2,710	.8449	.0983
b_0	2.4047	Model at α = .001			
		R^2 = .55			
Total value product (Y)			6,741		
Sum of elasticities					
	.7470				

Burbusay Model II

For observations the mean net income a total of 12 observations are included. The production functions chosen include a total of eight variables. As in Tuñame's Model II, ten variables are first considered, but through the process of stepwise multiple regression a more plausible eight variable model is generated. Statistical results of the eight variable model are shown in Table 13.

The two variables not shown in this function are as follows, in the order in which they were dropped: (1) insecticides and pesticides (.98): (2) depreciation expenses (.98).

The variables retained in Model II are deleted in the following order: (1) family labor (.87); (2) miscellaneous expenses (.78); (3) irrigation equipment (.71); (4) fertilizer (.63); (5) hired labor (.51); (6) seeds (.25).

Table 13. Burbusay Model II[a] (12 observations included)

Variables	Value of b(i)	Statistical level of significance	Means	MVP	MPP
X_8 Hired labor	.1552	.025	323	4.72	
X_2 Fuel and repairs	-.0948	.05	211	-4.41	
X_3 Miscellaneous expenses	-.0115	.10	290	-.398	
X_4 Seed	.1432	.05	1,008	1.40	
X_5 Fertilizer	.3263	.10	577	5.55	
X_6 Irrigation equipment	.0799	.05	6,753	.116	
X_9 Family labor	.1101	.10	3,245	.340	.378
	b_0 4.960	Model at $\alpha = .025$			
		$R^2 = .95$			
Total value product (Y)			9,819		
Sum of elasticities					
	.7084				

[a]Variable set.

Burbusay Model III

For observations below the mean net income (21 observations) the model retained a total of six variables. Ten variables were originally included and the least significant are deleted through the stepwise procedure. The original model included the following variables and the change in R^2 is shown in parentheses: (1) miscellaneous expenses (.83); (2) depreciation (.83); (3) fuel and repairs (.82); (4) irrigation equipment (.82). The coefficients of these variables all have negative values.

The variables retained in the production function above are deleted from the model in the following order: (1) fertilizer (.80); (2) family labor (.75); (3) herbicides and pesticides (.41); (4) hired labor (.67).

Table 14. Burbusay Model III[a] (21 observations included)

Variables	b values	Statistical level of significance	Means	MVP	MPP
X_8 Hired labor	-.1949	.025	253	-.384	
X_7 Herbicides and pesticides	.4058	.05	238	8.43	
X_9 Family labor	.1395	.25	2,429	.286	.0318
X_4 Seed	.5353	.01	908	2.94	
X_5 Fertilizer	-.1045	.25	824	-.6316	
Sum of b values	.78.2	Model at α = .001			
	b_0 3.289	R^2 = .82			
Total value product (Y)			4,981		

[a]Variable set I.

Burbusay Model IV

In this next production function total product (Y) is replaced, as in Tuñame, by market value received. Any part of the product not sold is valued at its market price. Results are shown in Table 15.

The order of variable deletion and the change in R^2 are as follows: (1) hired labor (.54); (2) machinery expenses (.53); (3) crop expenses (.46).

Table 15. Burbusay Model IV[a] (33 observations included.)

Variables	b values	Statistical level of significance	Means	MVP	MPP
X_1 Crop expenses	.3469	.10	2,561	1.007	
X_2 Machinery expenses	.1024	.50	1,418	.537	
X_3 Hired labor	-.0098	none	276	-.264	
X_4 Family labor	.6191	.001	2,710	1.698	.188
b_0	1.059	Model at α = .001			
		R^2 = .54			
Total value product (Y)			7,434		

[a]Variable set II.

CHAPTER V

ECONOMIC ANALYSES OF RESULTS

The purpose of this section is to offer an economic interpretation of the fitted Cobb-Douglas type functions. Analyses of each model are presented which give economic meaning to the statistical results obtained. Comparisons between areas are made and based on these analyses the valleys are brought into the Thorbecke classification.

Tuñame

Tuñame Model I

The sum of the elasticities of this model (.3816) indicates that the farmers of the area are operating under the condition known as diminishing returns.

A comparison of individual marginal products indicates that at the mean the farmers are obtaining less than one bolivar in return per bolivar spent, with the exception of hired labor when the return is shown to be 3.45 Bs. per one bolivar spent. One possible explanation is that hired labor is usually brought at peaks of labor utilization of the growing season such as harvesting. Wages paid are in some cases not on a fixed amount per day or hour, but per unit or amount of potatoes dug. Hence, it is conceivable that such an arrangement can induce labor to be more productive. In contrast, family labor has the lowest marginal value product at .1417. This is expected and is consistent with the assumptions of labor surplus summarized in the literature review. What is unexpected is a low return in machinery expenses. This may be attributed to uneaven rainfall within the areas which caused sizable amounts of expenditures (the mean is 1.255 Bs.) in the operation of irrigation equipment which are deemed to be of higher productivity than that shown.[1]

Also unexpected is crop expenses ranking second in MVP, since some of these expenditures were for herbicides which can easily be substituted for labor (family labor). However, it appears that use of herbicides is more profitable than use of family labor. (Remember, results are in terms of the stated means.) However, the expenditures on fertilizer (which is included in crop expenses) can partially account for this because, as will be seen in Model II, such expenditures have a high MVP.

The sequence of variable deletion seems unusual. Family labor is the first, it contributes only 1 percent to R^2. Possibly this result is attributable to errors in accounting for family labor. It must also be noted that this variable is significant at $\alpha = .25$ (as are crop expenses and hired labor). This suspicion of errors in measurement will become even more justifiable as we examine the other models. The second variable to be deleted was hired labor, which contributed only 3 percent to R^2. Finally crop expenses showed 8 percent contribution toward the explanation of variation. Remaining in the model is machinery expenses with 16 percent contribution toward explanation of variation, hence the most significant variable. The feeling existing among CIDIAT engineers could be interpreted as partial evidence of the importance of water availability to the process of production and coupled with its rather low productivity (MVP). It is possible that a more efficient system

[1]More about this hypothesis will be presented in the analysis of Model II.

should be found--probably an irrigation project in the area? It must also be noted that even though the model as a whole is statistically significant at $\alpha = .05$ as determined by an F test, machinery expenses are the only variable significant at high level ($\alpha = .05$). Furthermore, R^2, the coefficient of determination explains only 28 percent which means that 72 percent of the variation in value of output remains unexplained. Hence, caution must be exercised in interpreting and making recommendations based upon the results.

Tuñame Model II

As stated, this particular production function originally included 10 variables. However, this one (with 4 variables excluded) is shown because it gave the best statistical reliability. However, explanation of capital is somewhat disturbing. It would normally be assumed that capital contributes to total product. Capital data used in the regression housing facilities for the family were included, which in the case of the smaller farmers, accounts for a sizable portion of the capital investment. Hence, this could probably be a reason for its apparent unimportance. Hired labor, which was excluded, is also disturbing since it is inconsistent with the result obtained in the previous model.

In general, the model still seems better for R^2 increases to .47 and the level of significance is $\alpha = .005$. Also the MVP increases greatly with exception of family labor. The sum of the elasticities is now 1.245 which indicates increasing returns; hence increase of the inputs will increase total product more than proportionately. This result suggests that a mere increase of these inputs will increase the productivity.

Irrigation equipment is next to the last variable to be deleted even though its elasticity of production is .0753, and its MVP at the mean level (4,948 Bs.) is the highest at 3.885 Bs. It is statistically significant at $\alpha = .10$ and contributes .17 percent of the explained variation. The irrigation equipment result, when coupled with fuel (MVP of 3,725, significant at $\alpha = .25$), is consistent with results obtained for this variable in Model I.

The elasticities of fertilizer (.148) and seed (1.1097) indicate that further use of these inputs, especially seed, is warranted. (They have the highest elasticities of production.) Their MVP's are 3.713 and 3.712, respectively.

Family labor has a negative elasticity of production at -.0201. Its level of significance is $\alpha = .75$. This, as stated before, suggests the question of whether appropriate measurements were made. Obviously it is not impossible that the use of less labor may increase the size of the product. Such a situation would be consistent with current theories of economic growth. This result is consistent with that obtained in the previous model. Family labor contributes 5 percent to the explanation of variation in value of output.

Of particular interest are the MVP's of the inputs, with the exception of labor (family). They are 3,725, 3,713, 3,712, and 3,885. This could be interpreted as a sign of good average management. The levels of return per bolivar invested in the inputs listed are almost identical mean values. This indicates that expenditures among the different inputs are distributed in a way which brings in near equal returns, thus providing some indication of an efficient allocation of resources. However, it must be remembered that all inputs when examined statistically were assumed to be used at their geometric mean levels. Hence, if the standard deviations were small this speculation of good management will hold. But the standard deviation for the most part is large, so the sign of efficiency would only be true for those observations which are closer to the mean.

Tuñame Model III

This model explores the possibility that two distinctly different production technologies exist between larger and smaller farm units. The seven largest producers account for two-thirds of the total output, and have the largest holdings of land; when these seven are excluded from the sample, however, the average production per hectare only declined to 20,752 kgs. from 24,184 kgs., or 12.5 percent which is not really large considering the difference in sizes of land holdings between these two groups.

The model using all 34 observations is significant (at $\alpha = .05$), and R^2 increases to 58 percent. However, only one variable is significant at an acceptable level and all others were not, hence it is disregarded.[2]

Tuñame Model IV

As it is mentioned in the previous section, the only difference between this model of production and Model I is the dependent variable Y, which in this case is expressed in terms of bolivars representing the quantity produced times price received in the market. The independent variables or inputs remained the same.

Compared with Model I the elasticity of production values increased for crop expenses, remained about the same for machinery expenses, decreased for hired labor, and decreased for family labor. The MVP

[2]Another model of production, this time with the three lowest income observations dropped, was tried with equally unsatisfactory statistical results.

decreased for crop expenses, increased for machinery expenses, sharply decreased for hired labor, and family labor is now negative (as in Model II).

The R^2 value increased from 28 to 41 percent; and regression coefficients for machinery expenses increased their levels of significance. The order in which family and hired labor were deleted was reversed from the result obtained in Model I.

Burbusay

Burbusay Model I

The sum of elasticities of this particular model at .7470 indicates that farmers operate under decreasing returns.

The R^2 value is .55 and the model is significant at $\alpha = .001$. Two variables are statistically significant--crop expenses and family labor. The other two are not significant. Hired labor shows a negative MVP, however, as noted it is not statistically significant. Crop expense shows a MVP of 1.065 and is the only result to be above one. There is a wide range among the MVP's which would appear to indicate that efficiency gains are possible with a rearrangement of resources at the mean levels of input.[3]

The MVP at .8449 of family labor is low, but not as low as it might be expected in relation to comparable values obtained in the previous model fitted for Tuñame data. The order of deletion indicates that family labor makes the largest contribution in explaining the variation of total product (30 percent). This result was expected because production is labor oriented.

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[3]This statement must be weighed regarding what was previously said about the means and the standard deviation.

Machinery expenses and hired labor make a negligible contribution and again are not statistically significant.

Burbusay Model II

As it is mentioned, a 10 variable model that included all the observations was tried with very poor statistical results. Hence, the observations were broken into two categories according to mean net incomes assuring that perhaps there exist different types of production functions. The results appear to reinforce this supposition.

This model gives the best statistical results of the entire study. R^2 value is at .95 in the model; hence, it would appear that all important variables are included in the model. Of the 10 original variables, two were not taken into the model because together they account for only 3 percent of the variation and were not statistically significant. Depreciation expense, one of these variables, was intended as a proxy for capital and it seemed a poor one.

The level of significance of the model as a whole is at $\alpha = .025$. The elasticity of production stands at .7084, indicating decreasing returns. This result is similar to that of the previous model.

Fuel and repairs, and miscellaneous expenses have negative elasticities which indicate that lower levels than those used at the mean would increase the total product. This seems logical in the case of miscellaneous expenses, particularly since these expenses could have been overestimated or include items not related to production. (It was noted in the previous section that in some cases they seemed rather high. The mean for the 33 observations is 155 Bs.; for those included here it is 290 Bs. However, this larger mean could be a result of larger farm sizes.) The fuel and repair result may partially be related to the fact that vehicles are used for other purposes than work on the farm. (Most of the vehicles were jeeps used for work and family purposes.)

Hired labor elasticity at .1552 and MVP of 4.72 changes remarkably from results obtained in previous analyses. Additionally it is interesting to note that the MVP for labor is the highest for any of the models.

Fertilizer has the highest elasticity of production and MVP. This seems quite rational, since it is stated in the first section, the quality of soil found by the FAO study is rather poor.

Seed has the second largest elasticity of production (.1432), and a MVP of 1.40 and explains 26 percent of the variation.

Irrigation equipment has rather low elasticity of production at .0799 and low MVP at .116. This latter result may be explained in part by the irrigation methods used in the area, as well as the very small amount of water actually used. One hundred percent of the farmers interviewed indicated that there was insufficient water available, and what water they had was available at what they thought was a very high cost. This is reflected in the fact that of an average farm of 4.7 hectares, only 4.2 hectares is under cultivation and onl6 2.54 hectares is irrigated with quantities of water which the farmers consistently claimed was insufficient. Hence, a more efficient irrigation system that would make water available in sufficient quantities at a lower cost could very well change the MVP. It is interesting to note that the correlation between this variable and total product (as defined) is .73, which would indicate a very close association between the two variables.[4]

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[4]Farmers of this area consistently manifested that the area of production could be significantly increased with more water available.

It appears that further scrutiny of the resources used in irrigation may be warranted. Assuming that the proxy variable included in this model is reliable (α = .01), it could indicate that investment of capital at mean levels or larger for irrigation equipment in the present form is inefficient, or possibly in stage I. But this does not mean that they are not necessary. A capital investment in irrigation equipment that operates more efficeintly by bringing the water into the field at a lower cost would then be satisfactory. If this were the case, the MVP of such an investment would be higher, especially if the water volume is in sufficient quantities as to irrigate larger areas, with larger amounts of water at a lower cost.

The elasticity of production of family labor is higher than in any other model at .340, but it still does not pay for itself. The large variations among marginal value productivities of some of the variables would indicate that there is room for improving the efficiency of production by rearranging the different levels of inputs used at the mean.

The results obtained for individual inputs must be interpreted with caution due to the nature of the cross-sectional data.

Burbusay Model III

This model included a total of 21 observations which were below the mean net income. The model as a whole is significant at α = .001, and includes six variables. The other variables originally included are not presented here because they were not statistically significant. It is interesting to note that all four of these variables had negative elasticities. They were miscellaneous expenses, depreciation, fuel and repairs, and irrigation equipment.

In the present model the value of R^2 equals .82 and all variables are significant at levels of α = .25 or better.

The most unexpected result is with respect to the variable fertilizer, which has a negative coefficient of elasticity of -.6316. It has a correlation coefficient of .097 with total product (Y). In the previous model the same correlation coefficient was -.06, both are rather low. Problems of intercorrelation are suggested here by the differing signs between regression and correlation coefficient. A high degree of inter correlation between level of fertilizer used with the available amount of water would possibly provide an explanation for these results. However, the correlation of fertilizer with irrigation equipment (the proxy variable for water) is only -.12. Possibly the negative elasticity of production and the negative correlation exists because of the low levels of investment in irrigation equipment, if indeed investment in irrigation equipment means higher volumes of water for irrigation. It must be noted that the mean for irrigation equipment drops from an average of 6,573 bolivares for the 12 top producers to a 3,229 bolivares for the bottom producers, a drop of 49 percent. Fertilizer goes from an average 577 bolivares to an average 823. It actually increases for the 27 lower income farms.

Hired labor also has a negative elasticity of production at -.1949, and a MVP of -3.84. One possible explanation is simply poor management. Another could be that the measurement of labor is not satisfactory. We are lumping in this case all labor together, when in fact the productivity might not be the same. The labor used in harvesting, weeding, irrigation, seeding, etc., is not homogeneous. Hence, the results given could be entirely misleading.

Herbicides and pesticides have an elasticity of .4058 and the highest MVP of 8.43 bolivares at the mean value of 238 bolivares.

Family labor has an elasticity of .139 and a MVP of .286. Seed, which explains the greatest variation within the model (.67), remains as the last variable to be deleted and has a MVP of 2.94 bolivares at the mean.

Burbusay Model IV

This model is the counterpart of Tuñame's Model IV. (Y), the total value product is defined as quantity times the market price commanded (Q.P.). R^2 is equal to .54 and the model as a whole is significant at $\alpha = .001$. In contrast to Model I for this area, machinery expenditures have a higher elasticity of production but the level of statistical significance is low ($\alpha = .50$). Hired labor production elasticity remains negative but again is not statistically significant.

Family labor has elasticity of .619--almost double; and for the first time shows a MVP greater than 1 at 1.698. This is unusual because it would appear that family labor would make some sort of extra contribution that had not been made before; possibly a quality factor is reflected here. Crop expenses have an elasticity of .3469 with a MVP of 1.007 Bs. which is consistant with that of 1.065 in Model I.

In summary of the models it can be seen that differences exist within the regions. However, much of this variation may be attributed to different aggregations of the variables. This was expected based on the results obtained in earlier studies as discussed in Chapters II and III. Also the stepwise deletion method could be questioned since once a variable is dropped it cannot re-enter the model. The others are rearranged so that the model looks statistically better when one variable is dropped. R^2 becomes smaller since some explanation of occurrence is lost.

These problems may seem to explain why Models I and IV of Tuñame gave poorer statistical results than Model III.

It looks like two production functions are presented. This is drawn from the fact that Model III, which included all of the observations, have only one of its variables significant, even though the model as a whole was significant. When the same production function was run, but without the observations above the mean income level, the statistical indicators improved, i.e., a greater number of variables are significant.

The problem of aggregation of variables is present too. This can be seen in the different results obtained from Models I and II where the variable was defined differently. (Two sets of variables were defined at the outset.)

In regard to Burbusay, examination of the data suggests two production functions existed. As in Tuñame, this could have very important policy implications. The aggregation of variables rests reliability to the models if we look only at R^2.

A certain degree of consistancy was observed in results in the use of family labor which is of importance to this work. With one exception, their MVP's were less than one and MPP's were in a few cases negative or very near zero. It is disturbing, however, that in most instances their levels of statistical significance were so low. There were inconsistancies in the sum of the elasticities, but again that may be attributable to the reasons noted above.

Burbusay seems to enjoy some advantage over Tuñame in the use of family labor. This impression is given by the MVP of Model IV, in which the MVP of family labor is larger than its purchase price or cost. But, it is disturbing to see that other inputs such as herbicides, pesticides, and insecticides, in models using variables defined in Set I, or crop and machinery expenses as defined in variable Set II, are more productive than labor. Possibly differences in the technology account for this result. The implication is that in a less developed agrarian sector, where there is underutilization of the human resource, a type of technology is used which contributes to existance of this sort of situation. Obviously this is an important, if not the most important question addressed and which is derived directly from the empirical work conducted here.

Because of the importance of the MPP's of family labor in this work, and doubts which existed regarding the salary paid to this type of labor, two more models were tried in which family labor was priced at level of subsistance. This subsistance wage consisted of the value of a basket of goods consumed during the year by the working members of the family. The results for the two models are shown in Appendix I. It can be seen that they show no significant improvement in the statistics relating to the MPP of family labor.

Interregional Productivity Comparisons

This section is designed to show interregional comparisons of resource productivities between Model IV of Tuñame and Model IV of Burbusay.

Production elasticity comparisons
and labor/capital ratios for both
valleys

The comparison employed a method used by Heady and Dillon. First, we ask if the differences in the productivity coefficients found are significant. In this regard, Heady reasons that since a productivity figure of any level involves sampling errors, we must evaluate the differences in terms of the errors attached to each elasticity coefficient. Thus the equivalent value of the production elasticity in Tuñame necessary to equal the marginal products in Burbusay is found and then compared, as a constant, against the actual elasticity in a null hypothesis test.

Comparison of differences in marginal value productivities of resources in Tuñame and Burbusay; elasticity coefficient necessary to give marginal resource value productivity in Tuñame to that in Burbusay.

	b values	t value	
Crop expenses	.167	.00004	Accept
Machinery expenses	.251	.0010	Accept
Hired labor	.022	.00006	Accept
Family labor	-.024	.00001	Accept

Given t value shown above, the null hypothesis is accepted. Thus, we are saying that considering the mean quantities of resources used, there is no significant difference in the productivities of the two areas.

The models used for these comparisons were Burbasay's Model IV and Tuñame's Model IV because they are uniform in regard to the similarity in the aggregation of the variables. Lack of uniformity rules out similar tests between the other models.

The results here obtained invalidate the assumption originally made that Tuñame was more productive, because this test suggests the elasticities of production of the two valleys derived from the value product function are not significantly different from each other.

However, this comparison is done based on two models, Burbusay and Tuñame IV. But there were other models for which we did not compare the elasticities of production, because of the different definition of variables.

If we compare the MVP of Tuñame's Model II with Burbusay's equivalent at their mean values it appears that Tuñames efficiency level is higher than Burbusay. So if the t test is done, based on the results obtained from the Model IV of both valleys elasticities, it could be that they are not significantly different. The MVP figures are still an open question as to the relative efficiency of production between the two valleys. Furthermore, if the MVP figures are taken as representative of those of the farms in the valley, it would have to be said that Tuñame is more efficient in the use of its inputs.

Another characteristic which is common to both valleys is the land distribution. There exists a few farms which hold relatively larger amounts of land next to a majority of farms with smaller holdings of land, some are nothing more than home gardens (see Tables 1 and 3). Furthermore they are, without exception, family operated farms in both valleys.

Ratios L/C

In order to see whether differences in important characteristics other than those already cited by Thorbecke are present between these two valleys, labor/land and labor/capital ratios were calculated and a t test is utilized to learn if their respective means come from a different population. The t test said that they came from different populations.

$$H: M_1 = M_2$$

$$t = \frac{36.23 - .713}{\sqrt{x_1 - x_2}}$$

$$t = \frac{36.23 - .713}{S^2/n_1 + S^2/n_2}$$

$$t = \frac{36.23 - .713}{(231.84/33) + (2.09/34)}$$

$$t = 35.54/7.06 = 5.034 > 3.466$$

$\therefore$ reject

Tuñame's mean L/C = .713, range .017 → 9.13

Burbusay's mean L/C = 36.23, range .014 → 874.0

Dividing the L/C according to income levels for the two areas, we have

Tuñame { High mean .160, range .036 → 1.54; Low mean .8907, range .017 → 9.13 }

Burbusay { High mean 1.361, range .016 → 8.16; Low mean 50.80, range .014 → 878.0 }

Hence, we conclude they come from two different populations.

If we look at the L/C for the two areas as they are divided according to income levels, it is observed that low mean income of Tuñame and the high mean of Burbusay are very similar. This similarity appears to be most obvious when examined in terms of the ranges of the L/C. It can be inferred then, that in spite of the fact that they come from different populations the top income farms of Burbusay, and the bottom income farms of Tuñame have similar L/C. Furthermore, in both valleys the low income farms have a much wider range on L/C and the upper limit of these ranges is higher than for the high income farms. This would indicate that farms which have more capital per labor invested enjoys higher incomes, which brings back the question of labor productivity, and points toward a policy of higher investments of some sort in order to raise the productivity of labor. Also, if the L/C can be used as an indicator of income derived by farms and/or productivity, it would appear that Burbusay's top income receivers are equal to Tuñame's lower income receivers.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Classification under Thorbecke's System

In Table 6 Thorbecke's classification scheme was reproduced in a summary form. The list of characteristic features of phase I (stagnation) is as follows:

a. The $MPP_L = 0$ (Labor redundancy)

b. Supply of labor in agriculture infinitely elastic at the institutional wage rate

c. Supply of labor in industrial sector infinitely elastic at institutional wage rate

d. Economic dualism

e. Preconditions to take off not met

f. Existance of an agricultural surplus

It is difficult to obtain all of this information on a regional basis; however some inferences can be made. On a national basis, it can be proved that all of these conditions are met with a probable exception of assumption e.

On the regional basis, which is the problem at hand, it can be affirmed that the first condition is fulfilled. This primary condition is the most important from the classification point of view because proving this condition ($MPP_L = 0$) the rest of the conditions can be inferred.[1]

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[1]One purpose of fitting production function, it can be remembered was to find out MPP of labor.

In Tables 11 and 15 it is observed that the MPP of family labor for Tuñame is negative and for Burbusay it is not significantly different from zero.[2] Hence, strong evidence exists for labor redundancy. However, caution must be exercised in regard to the estimated MPP of labor. For example, consider the MPP (family labor) derived from Model I of Burbusay and Tuñame. The significance level of the elasticity coefficient of production is $\alpha = .25$ for Tuñame. For Burbusay, $\alpha = .005$ is highly significant. The MPP_L were chosen from these two models because the models are uniform. And in the case of Tuñame, $\alpha = .25$ for the coefficient of production is the highest available. This is also true for Burbusay.

By the same token, if labor redundancy exists, one could infer that the elasticity of labor supply is infinite or at least very large and positive at the institutional wage rate.[3]

Some difficulty was encountered in defining the institutional wage. In Thorbecke's formulation institutional wage rate is equal to agricultural output divided by the labor component; and it is assumed to remain constant. Existing evidence suggests that this is not so. The agricultural output has increased considerably and labor employed by the agricultural sector has diminished constantly. This is also true for the State of Trujillo where these two valleys are located.

There is no industrial sector in either of these two valleys, hence there is limited local demand for labor in an industrial sector. This characteristic appears to be true in the industrial as well as in the

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[2]We compare Models IV because of their similarity in the definition of variables.

[3]During the interviews farmers were asked if they had sufficient amounts of labor. The answer invariably was yes.

agricultural sector. During the past four years the national unemployment rate has been approximately 12 percent. Such a high rate of unemployment would support the inference that characteristic b and e are present, at least that there exists a significant surplus of labor in either the agricultural sector or the industrial sector,[4] whatever the institutional rate may be.

Economic dualism at the national level has been assumed from the start and Appendix II includes some further evidence and comments on it. As for assumption e: on account of large oil and iron resources, Venezuela is not faced with the problem of capital scarcity in the public sector. For more than two decades oil exports have generated between 60 and 70 percent of fiscal reserves and over 90 percent of the hard currency needed for capital goods imports. In most recent years it contributes approximately one-fifth of the GNP.

Therefore, in Rostow's terminology, the pre-conditions for the take-off are present in the Venezuelan economy. The key problem, however, appears to be the lack of integration between the agricultural sector--at least for the largest proportion of farmers--and the rest of the economic sector.

Characteristic (f) the existance of an agricultural surplus is defined as the difference of agricultural output, and agricultural consumption. Defined as such, it is difficult to prove. However, it is known that agricultural output valued at constant prices has tripled during the

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[4]This seems to be more certain since the unemployment rate is suspected of being much higher than 12 percent in the Andean states of which Trujillo is one.

1950-1970 period; the agricultural crop index has increased from 100 in 1950 to an estimated value of 150 in 1969. At the same time, the livestock index has increased from 100 to 286 during the above indicated period. The agricultural labor force has shown a decline of about 90,000 people during the same period (1950 to 1970). Therefore, it is certainly possible to accept the existence of agricultural surplus during most of the past twenty years. This, of course, is at the national level. It cannot be said positively that this is also typical of the two valleys, but if the valleys have not kept up with the nation, at least Tuñame seems to have shared some of this progress.

The report of CORPOANDES in 1965 pointed to a "higher standard of living" as compared to other valleys of similar endowment conditions. Since the regional economies depend entirely on agriculture, this "higher living" could not be possible without an agricultural surplus.

After examining all of these characteristics (a-f) noted in the Thorbecke classification, it can be positively concluded that the valleys remain in the stage (I) of stagnation. It remains to ask only where in stage I the valleys are because there appears to be some range. The answer, a speculative one at best, is considered to be near the end of this stage because with the introduction of such inputs as certified seed.

The objectives pursued in the work stated in Chapter 2 were in general (a) to find a basis for setting development policies applicable to the two areas that were studied such that when applied they bring about higher levels of productivity and income; (b) that these policies be general and broad enough to be applicable with similar results to other similar Andean Valleys; and (c) attempt to find more efficient means both in terms of time and costs to assess developmental prospects of valleys similar to the ones studied. In view of these objectives, a summary of the results and their analyses is presented in this section for the purpose of assessing the success of this study in meeting the objectives. Some conclusions are extracted from the analysis, which in those cases where it is possible, will take the form of policy recommendations.

It was found that the valleys could be classified within stage I in Thorbecke's classification scheme. Characteristics of the valleys which prompted this classification are noted as follows below.

The existance of labor redundancy was established along with four other characteristics, there noted, based on the Model IV of Tuñame and Burbusay.

Statistical analyses of production elasticities and of L/C indicated that the two valleys studied were not significantly different. In testing for differences in the production elasticities of these two models, a t test revealed no significant differences in the production elasticities of the two valleys. However, Model II for Tuñame would indicate a more efficient use of the production inputs. This observation was qualified because of the large size of the standard deviations.

Consideration was given to the fact that more than one production function may have existed cross sectionally in each valley. This possibility was not tested completely in Tuñame but only in terms of variable Set I since there were not enough observations to run a second one in the higher income group. Statistical and data problems were encountered. The kinds of significance of all variables was not always acceptable, the R^2 variable was also low in some cases. Problems of intercorrelation among variables were evident as it was indicated by change of signs of correlation coefficient of fertilizer.

In spite of these limitations the achievement of the first objective is clear. The valleys were classified regarding the developmental stage of their agricultural economies.

The accomplishment of the first objective immediately sets the basis for pursuing the second objective, and that is the policy recommendations.

Thorbecke, in the table which was reproduced in Chapter 3, recommends policies which are conducive to the attainment of economic development although none of these are contrary to objectives stated for this work; in many instances they tend to be too inexplicit to be useful at the regional or valley level. For these reasons an analysis was made in particular reference to these two valleys. What follows will stay within the limits of this analysis.

The first thing that the analysis of the results brings out is the problem of labor redundancy. This can be viewed as the subutilization of the human resource and consequently a level of productivity which is very low. This was demonstrated in the analyses and results by the magnitude of the MPP of family and hired labor. However, family labor provided the most notable example.

Results for labor were essentially the same for both valleys in Model IV. By looking at the MVP of family labor of Model II and III of Burbusay and Model II of Tuñame we see that family labor does not pay for itself at mean rates of use.[5]

These models also show that inputs other than labor are more productive which in a stagnated underdeveloped economy would presumably

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[5]Looking at Model IV of Burbusay, it can be seen that family labor pays itself (MVP = 1.69 Bs.)

be scarce. Hence it could be concluded that the particular technology used does not make an efficient use of one abundant resource, i.e., labor.

The data also points to problems of land ownership and tenure. For example, the larger families operated smaller farms. In the case of Tuñame, the problem of landholding seems to be acute. In the sample taken, 37 percent of the farms operate with .99 hectares or less, and 75 percent with four hectares or less.

The problem of landholding can be, if not largely responsible for the problem of labor redundancy, at least aggravating to the problem. Family farms were restricted to employ their own labor on very small amounts of land, obviously this could result in labor redundancy because of the law of diminishing marginal returns, hence the result is not surprising. Obviously a change of land tenancy structure could tend to alleviate the problem, particularly in the case of Tuñame. Such a policy which makes more land available to the small land holders could permit a more efficient utilization of labor.

In this study a minimum size of farm per family or per agricultural worker was not obtained. Whatever amount of land is needed to employ the family labor in a productive way should be provided. This would then bring higher income to the majority of families.

Also the determination of a minimum size farm could dictate consolidation in which case employment alternatives should be considered.

Land is not the only resource which might be subject for redistribution. The estimated L/C ratios showed that those farms which have higher capital investments also received the highest incomes. Although this characteristic at first sight would seem to indicate that some positive correlation can be inferred between higher investments and

and income, it is not satisfactorily supported by the analyses. Such is the situation of the capital variable for Tuñame and the irrigation equipment variables. Hence, even though investment can, in all probability, increase the efficiency of production, from this study it cannot be said what amount of what kind of capital investment is necessary. It can be said that those which called for the use of labor will help in eliminating the problem of labor redundancy.

The analyses suggest some obvious possibilities for the use of extension services. There are probably at least two production functions in Burbusay, and in all probability this is the same situation in Tuñame. Neither of these can be said to be as efficient as it is possible in the use of resources. The services provided by extension specialists can help in attaining a higher level of efficiency.

The use of such services can help in many ways. It can help the unskilled family labor to be more productive by instructing and demonstrating the usage of such things as fertilizer, certified seed, irrigation methods, cultural methods, etc. Most of these cultural practices and usage of new products are supported by the MVP. For instance, Tuñame's Model II and Burbusay's II and III, but especially Tuñame shows seed MVP among the highest. In Burbusay, low income farms were using too much fertilizer apparently. An extension service can be most helpful in these cases.

One problem faced by CORPOANDES is trying to decide whether or not to invest in irrigation projects for these valleys. However, not much can be said here, and what little is said is speculative. The reason for this is due partially to lack of appropriate data. An extension service can help as a data collection center not only for data of general interest to the community, but the managers can be taught the advantages of keeping records and how to collect them. It can serve as a source of information for much needed data for further and more detailed research. It can teach and experiment on crop rotation, and introduction of new cash crops.

The list of services does not end here, although it is impossible at this stage to determine its value in terms of bolivares, its needs and advantages are obvious. Some argument can be made from the study in support of investments in social overhead capital.

Educational opportunities prepare labor to render more productive services to the agricultural sector as well as making the worker capable of taking opportunities in the industrial sector or other sectors of the economy. A skilled laborer could be withdrawn at no detriment to a regions agricultural output because it has excess labor, which under existing circumstances does not contribute significantly to production.

Investment in public works such as schools, roads and irrigation projects would take advantage of readily available low-cost labor and would give a little time for other longer run programs concerned with developing human capital to be implemented and take effect.

Vertical integration of agricultural production and industry would provide additional sources of employment for the available labor. Conceivably this could provide jobs in close proximity to pools of labor that exist in these two areas, and which are strongly suspected to exist in other similar valleys. However, it is recognized that several of the possibilities mentioned are long range policy considerations which call for major studies to establish their feasibilities and cannot rest on the results of a single study.

The success in implementation of these policies seems certain since they are specifically addressed to the problems created by labor redundancy, a condition which was uniformly suggested in this analysis. Unfortunately, little can be said in this study about intrafarm production decisions, with the same degree of confidence as what has been said here about interfarm policy. This is due to the fact that time series data is lacking. Time series data would permit research that can answer specific questions of intrafarm policy whose knowledge is necessary and questions which have been suggested but left unanswered here.

This study did not provide an entirely satisfactory answer to such specific questions as the water development question. Whether to build an irrigation system is advisable and how much to invest could not be answered with the data at hand. In this respect, the study falls short of expectations primarily because of the lack of suitable data.

The policies here recommended are on the one hand broad enough to be implemented in other similar valleys where labor redundancy is suspected to exist and in this respect it meets the second objective.

Further Research

In meeting the third objective of this work, the data does not permit the complete development of a method for assessing developmental prospects of similar areas in a less expensive and less time consuming manner. However, it does serve to confirm Lewis' hypothesis of labor redundancy in stagnated economies and does set some qualitative limits and direction on policy for such areas.

More research in other valleys with similar conditions or better data should provide clues or establish common characteristics which would help to further refine such a method.

Of course, care should be exercised in refining measurements of labor, possibly by dividing for the different types of work performed. Refinements in measuring water and capital investments are also indicated.

Marketing aspects of agricultural products of which not enough is known in Venezuela should be a follow-up study to determine the impact on the market of increasing production.

Studies in the marketing aspects of agriculture will point out the necessities of the country and help in the location of producing areas, and whatever problems may be encountered. Besides it will point out the regional advantages and disadvantages that may be present in the cases of the Andean region.

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APPENDICES

Appendix A

Table 16. Summary of production function results—Tunsme

Independent Variables	b values	Level of statistical significance	MVP	b values	Level of statistical significance	MVP	b values	Level of statistical significance	b values	Level of statistical significance	MVP
Set II											
Crop expenses	.1129	.25	.8518						.1843	.025	.4851
Machinery expenses	.1576	.05	.3030						.1537	.025	1.027
Hired labor	.0739	.25	3.4517						.0365	.75	.5921
Family labor	.0377	.25	.1417						-.0781	.25	.0653
Set I											
Fuel and repairs				.0657	.25	3.725	.0112	None			
Fertilizer				.1487	.10	3.713	.0600	.025			
Transportation							-.0416	.50			
Insecticides, pesticides, herbicides							-.0405	.75			
Labor hired							.0466	.50			
Capital							-.1659	.50			
Irrigation equipment				.0753	.10	3.885	.0239	.75			
Seed				1.1097	.05	3,712	.0243	.75			
Family labor				-.0201	.75	-.0048	.0449	.75			
Miscellaneous expenses											
Depreciation expenses											
Dependent Variables											
Y = total product kgs.	b(o) 7.4679			b(o) -.0577							
Y = total value product (Bs)									b(o) 6.831		
R^2 =		.28			.47			.58		.41	
Level of significance for the model		α = .05			α = .05			α = .05			
Sum of elasticities $\sum_{A=1}^{n} b_1$	.3816			1.245			-.0371		.2964		
		MODEL I			MODEL II			MODEL III		MODEL IV	
Observations	All 34 observations included			All 34 observations included			27 obversations below mean income level included		All 34 observations included Y = kgs x market value		

Table 16. (Continued) Summary of production function results--Burbussy

Independent Variables	b values	Level of statistical significance	MVP	b values	Level of statistical significance	MVP	b values	Level of statistical significance	MVP	b values	Level of statistical significance	MVP
Set II												
Crop expenses	.4047	.005	1.065							.3496	.10	1.007
Machinery expenses	.0167	None	.269							.1024	.50	.537
Hired labor	-.0141	None	-.344							-.0098	None	-.264
Family labor	.3397	.005	.8449							.6191	.001	1.698
Set I												
Fuel and repairs				-.0948	.05	-4.41						
Fertilizer				.3263	.10		-.1045	.25	-.6316			
Transportation												
Insecticides, pesticides, herbicides							.4058	.05	8.43			
Labor hired				.1552	.025	4.72	-.1949	.025	3.84			
Capital												
Irrigation equipment				.0799	.05	.116						
Seed				.1432	.05	1.40	.5353	.01	2.94			
Family labor				.1101	.10	.340	.1395	.25	.186			
Miscellaneous expenses				-.0113	.10	-.398						
Depreciation												
Dependent Variables												
Y = total product kgs.												
Y = total value product	b(o) 2.4047			b(o) 4.960			b(o) 3.289					
R^2		.55			.95			.82			.54	
Level of significance for the model		α = .001			α = .025			α = .001			α = .001	
Sum of elasticities $\sum_{A=1}^{n} b_1$	.7470			.7084			.7812			1.059		
		MODEL I			MODEL II			MODEL III			Model IV	
Observations	All 33 observations included			12 observations above mean income level			21 observations below mean income level			All observations included		
	Y value as product x mean market value						Y = product (kgs) x market price					

Appendix B

In view of the results of the MPP of family labor, a different form of valuation of labor was tried. This time family labor was valued at what could be called "subsistence wage." A basket of food expenditures was elaborated using 1969 prices when available. All other variables remained as before.

The reason for trying this new price for labor was that it was felt by members of the committee that the figure of 3,600 bolivares per year per man was much too high, since, in fact, the real cost is what they consumed in food. The results follow below:

Table 17. Tuñame

Variables	b values	Statistical level of significance	Means
Crop expenses	.1260	$\alpha = .25$	3,186.4
Machinery expenses	.1419	$\alpha = .05$	1,255.8
Hired labor	.0633	$\alpha = .50$	517.0
Family labor	-.0169	α = none	6,214.2
		$R^2 = .27$	
	b_0 7.8787		
Sum of elasticities	.3143		

The order in which the variables are deleted is as follows, with the change in R^2 shown in parentheses: 1) family labor (.27); 2) hired labor (.24); 3) crop expenses (.16).

If we compare this production to its counterpart (Tuñame's Model I) we will note that no significant overall change took place. The variables were deleted in exactly the same way. R^2 went from .28 to .27 and as the variables were deleted the change in it was exactly the same.

The family labor elasticity of production went from .0377 in the previous functions to -.0169. It went from positive to negative. More significant is that this variable is not significant at any level--its f value being .0021--compared to α = .25 in Tuñame's Model I. Hence, it can be concluded that no improvement took place with the changes in labor cost.

Table 18. Burbusay

Variables	b values	Statistical level of significance	Means
Crop expenses	.5191	α = .01	2,561.3
Machinery expenses	.1038	α = .50	417.9
Hired labor	-.0193	α = none	275.8
Family labor	-.1110	α = .50	2,410.72
	b_0 3.382	R^2 = .34	
Sum of elasticities	.7146		

The order in which the variables were deleted and the respective change is R^2 is as follows: 1) hired labor (.34); 2) family labor (.32) 3) crop expenses (.28).

In this case, comparing it to its counterpart, R^2 went from .55 to .34. The order in which the variables were deleted changed. Hired labor was deleted first as against second in the previous model. It retained its negative, elasticity of production slightly increased from -.0141 to -.0193.

Family labor is deleted second and its elasticity of production changes from .3397 to .1110. However, the level of statistical significance went from a very reliable α = .005 to an unacceptable level of .50.

Crop expense is deleted third vs. same order as in the past model.

Machinery expense stays in until the last, but with significance levels in the former model of none vs. α = .50 in this one.

Hence, the major changes occurred in the order of variables deletion. The statistics do not suggest any improvement has resulted from the change in measurement of the variables.

Appendix C

In both areas the physical characteristics are similar. Resource endowments are also similar with small variations in water availability, topography, soils, etc. Farms and farm tenancy are also typical of the entire Andean region; there are many family-owned and family-operated small farms which coexist with a few relatively large farms. The level of agricultural technology appears to be highly variable. On one hand, some inputs are very advanced such as the improved variety of potatoes imported from Canada. At the same time, the type of irrigation practiced in both areas is wasteful of a scarce resource (water). Due to its inefficient application it may increase total production costs because it may necessitate the use of larger amounts of fertilizer. Moreover, endogenous institutional factors in the form of technical assistance, agricultural credit, marketing alternatives, etc., are virtually non-existent in both areas. Relative geographical and cultural isolation are likewise rather similar. The educational levels are fairly low. Therefore, the prevalent social and living conditions in both areas are at the sub-sistance level with few exceptions.

This situation is but a portrait of the entire agricultural sector of the country where there exists a very marked economic dualism. Although Venezuela's labor force engaged in agricultural activities is decreasing in relative numbers from 44.1 percent in 1950 to 28.5 percent in 1970, the decrease in absolute numbers is less pronounced from 905 thousand to 815 thousand during the same period. Agriculture still represents the most important sector in terms of the labor force employed.

In spite of these trends, the contribution of the agricultural sector to the GNP has been approximately seven percent during any one year for the past 20 years, and within the sector it is estimated that the more progressive farmers representing about 10 percent of the total number contributed over four-fifths of the agricultural product in 1950, decreasing to about three-fourths in 1970. It follows, therefore, that the annual average value of the per capita product for 75 percent of agricultural producers is roughly $230, while the more progressive sector's annual average value of the per capita product is approximately $6,000.

This situation is not exclusive of the agricultural sector, it is also present in the entire economy of the country. A productivity index of various sectors shows a sharp contrast among them as can be seen in the following table.

Table 19. Venezuela. Productivity index for selected sectors, 1970

Economic sector	Productivity index Agriculture = 1.00
Agriculture	1.00
Manufacturing	2.88
Oil industry	83.84
Power	7.11
Other sectors	2.99

Source: National Commission for the Development of Water Resources - Macro Economic Analysis of Venezuela. Paper No. 17. (Table 38, p. 48. Caracas, November 1970)

It can be argued, however, that it is in the agricultural sector where the problem of economic dualism is more prevalent, and at the same time more acute. This fact can be seen by the observations made in the two areas of study. The range of farm size, other resource availabilities and the average returns is so great, that the possible economic inferences to be derived from both areas have to accomodate to the more common situation, i.e., the small farmers. Agricultural policy implications, and consequently policy recommendations are primarily concerned with this same group of farmers wherever they are found.

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