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AN ANALYSIS OF THE VARIABLES THAT AFFECT THE ECONOMIC BEHAVIOR OF FARM-HOUSEHOLDS IN THE SOUTHERN VALLEYS AREA OF BOLIVIA

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AN ANALYSIS OF ECONOMIC VARIABLES FOR THE SOUTHERN VALLEYS OF BOLIVIA

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Prepared for:

USAID/Bolivia
Contract AID/SOD/PDC-C-0219
Work Order No. 16

H. Van de Wetering

Final

November 1981

EXPERIENCE, INCORPORATED
MINNEAPOLIS MINNESOTA 55402

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TABLE OF CONTENTS

	page
PREFACE	I
SECTION I. INTRODUCTION	1
The objectives of this report	1
Major findings	2
Methodology used	5
Map of the area of the study	6
SECTION II. RESOURCES	21
Resource Endowments of the farm-household	21
Farm size and land utilization	21
The farm-household labor force	23
SECTION III. THE PRODUCTION UNIT	33
The farm household as a production unit: a graphical analysis	33
Variables that influence crop yields: a graphical analysis	50
The farm-household as a production unit: an algebraic analysis	67
Relative efficiency of land utilization	67
The demand for land and labor	75
SECTION IV. EMPLOYMENT AND LABOR USE	86
Variables that influence the employment of farm-household labor off-farm in agriculture	86
Variables that influence the employment of hired labor	98
Mutual exchange of labor and communal labor practices	103
SECTION V. INCOME VARIABLES	109
Alternative income definitions	109
Variables that influence net household income	115
Variables that influence net household income per capita	135
Net farm income per capita and per hectare	136
Gross farm income per crop per hectare	138
SECTION VI. CONSUMPTION AND MARKETING OF PRODUCTS	150
The farm-household as a consumption unit	150
Variables that affect the quantity net farm output used for human consumption	152

Variables that affect the marketed surplus 158
Variables the affect the composition of crops 174
Perceived needs as indicated by farm-households 186

RECOMMENDATIONS FOR FUTURE ANALYSIS 201

REFERENCES CITED 204

LIST OF FIGURES 205

LIST OF TABLES 206

PREFACE

Description of the farm policy study and documentation

The Bolivian Farm Policy Study Project was an outgrowth of an AID/W initiative, dating back to December, 1974, to develop an Agricultural Sector Analysis. The project purpose was two-fold: (a) to obtain reliable information on the socio-economic characteristics of rural farm and nonfarm households; and (b) to utilize this information to better formulate strategies and policies which will contribute to the achievement of the project goal - which was to increase the per-capita income and improve the standard of living of Bolivia's rural people - and improve GOB and USAID/B programs in the rural sector.

The project initially comprised the following data gathering and analysis activities:

a) National Socio-Economic Farm Survey, the principal purpose of which was to provide benchmark information on the socio-economic characteristics of agricultural establishments in Bolivia and to utilize this information both to define appropriate target populations for development assistance and to make more informed judgements as to the relative advantage of different policy instruments in effectively reaching different target populations.

b) Analysis of Southern Valley-Survey Data, the purpose of which was to analyze in greater depth and more completely the data gathered in April and May of 1977 in the Departments of Chuquisaca, Potosi and Tarija to facilitate the more precise identification and characterization of the target population of the Agricultural Sector II Project.

c) Credit Analysis, whose purpose was two-fold: (1) to evaluate the impact of credit provided under Agricultural Sector I and II Projects on the incomes and production of recipients and to attempt to identify the conditions and characteristics of small agricultural establishment operators, and help explain the success or failure of credit: and (2) to analyze the Bolivian rural financial markets as a whole in order to be enabled to make recommendations to improve their capacity to serve the small agricultural establishment operator and to develop their longrun viability.

d) National Crop and Livestock Technology Survey, whose purpsoe was to provide benchmark information as to the basic level of technology employed by the small agricultural establishment operator and its affect on the costs incurred and returns realized for individual crop and livestock enterprises. Data and information resulting from this survey was to serve to identify directions for future small-establishment-oriented agricultural research and assist in the identification of opportunities currently being realized by relatively few agriculturalists which are expandable to a broader population.

e) Traditional Practices Study, the purpose of which was to provide information supplied by the small agricultural establishment operators as to the many subtleties of their decision-making activities and the dynamics of technology adjustment and development over time.

f) Rural Household Study, the purpose of which was to collect and analyze data related to the characteristics and performance of rural households. This included data on: levels of consumption, variety of diet, patterns of expenditures, income from nonagricultural sources, the role of women and children in household and agricultural

activities, health and health-related expenditures, mortality, quantity and type of savings, migration patterns, education and school attendance, inventory of household equipment and furnishings, ritual feasting and "godfather" expenditures, etc.

g) Data Integration, the purpose of which was to integrate the data and information generated by the several surveys and studies of the project, complement them with other available information and compile a comprehensive Sector Assessment of the rural sector of Bolivia which would: (1) describe the constraints to achieving a more rapid and broader development of the small agricultural establishment subsector and an improvement in the per-capita income and standard of living of the rural people of Bolivia, (2) detail the socio-economic characteristics of the rural target populations, and (3) recommend strategies and policies to overcome the identified constraints.

The surveys and studies included in the Farm Policy Study project were to build upon the Southern Valleys Survey which was accomplished at the Mission's request in order to identify more specifically the target population for the Agricultural Sector II Project. The Southern Valleys Survey which consisted of 750 agricultural households in the departments of Chuquisaca, Potosi and Tarija was conducted in April and May of 1977. The coding, editing and tabulation of the data was completed immediately thereafter, and initial analysis was performed in July and August of that year.[1/] The following is a list of the type of data enumerated by survey questionnaire section:

[1/] *An Assessment of the Southern Valleys Region of Bolivia*, Analytical Document No. 1A, by James Riordan, Ministry of Rural Affairs and Agriculture of Bolivia, La Paz, July, 1977.

Section I: Demographic data on the producer and members of his household; literacy; formal education, special agricultural training; languages spoken in the home; migration, and technical assistance.

Section II: Access to roads and markets; means of transport; land tenure; and land use and characteristics.

Section III: Area, production, consumption, sales and value of sales by cropping pattern for each crop on the establishment.

Section IV: Technology employed for each crop on the establishment; expenditures for purchased crop inputs; availability of irrigation water; use of paid and traded labor; transportation expenses related to input acquisition and product marketing; and storage of crop production.

Section V: Animal inventory at time of interview; cash sales; production and value of cash sales for animal products; expenditures for animal purchases; production expenditures; replacement, useful life, and feeding of oxen.

Section VI: Production and value of cash sales for products elaborated on the establishment; elaboration input expenditures.

Section VII: Off-farm and nonfarm income of household members; miscellaneous expenditures.

Section VIII: Credit use and characteristics; machinery and equipment inventory; existence of and membership in cooperatives and/or other local organizations; and miscellaneous questions.

The National Socio-economic Farm Survey (*Encuesta Sectorial Agropecuaria*) was enumerated in June and July of 1978. The questionnaire content was similar to that of the Southern Valleys Survey: both questionnaires had the same eight sections and a total of 72 questions. The Socio-economic Farm Survey included greater detail in some areas such as distribution of crop production, demographic data related to household members, and credit use and characteristics, among others. In addition, more detailed data was coded and transcribed to the data files than was accomplished for the Southern Valleys Survey (1142 data cells compared to 412). The Socio-economic Farm Survey geographically included all areas of the nation with the exception of the Departments of Beni and Pando and the four provinces east of the Rio Grande River in the Department of Santa Cruz. The sample, larger than that of the Southern Valleys Survey, contained 1609 segments.

The Credit Survey was enumerated in three rounds: 116 agricultural households were interviewed in 1978, 225 in 1979 and 280 in 1980. The questionnaire used was the same as that of the Socio-economic Farm Survey. The sample for the Credit Survey was selected from a list of "small" agriculture producers in the Departments of Chuquisaca, Potosi and Cochabamba who had received credit from the Agricultural Bank of Bolivia (*Banco Agricola de Bolivia*) and a control group of similar producers in those areas who had not received credit from that institution.

The National Crop and Livestock Technology Survey was enumerated in 1979 using a questionnaire designed to collect much more detailed data regarding the level of technology employed by agricultural establishments in crop and livestock production activities as well as data related to area, quantity produced, and distribution of production. The sample drawn was a sub-sample of the Socio-economic Farm Survey. Due to a series of problems

encountered prior to the data processing phase of this survey, which included, among other problems, sample design and questionnaire design, a decision was made to discontinue project support of the survey. The collected data was retained by the Bolivian Ministry of Rural Affairs and Agriculture for manual editing, coding and tabulation of selected items.

The Traditional Practices Study consisted of a data gathering activity in the Departments of La Paz, Cochabamba and Santa Cruz. Thirteen communities (five on the Altiplano, three in the Valleys and five in the Tropics) were selected with six to twelve participants each who maintained diaries of their socio-economic activities over a twelve-to-fifteen month period. Community and regional supervisors provided periodic assistance in ensuring completeness and accuracy of diary entries. The type of knowledge acquired included: 1) cropping and livestock raising practices employed; 2) family member participation in agricultural activities; 3) health and nutritional data; 4) enterprise accounts; and 5) social and religious activities; to name a few. The final product of this study is viewed as being an "encyclopedia" of rural agriculture in Bolivia.

The Rural Household Study, the purpose of which was described above, was eliminated from the project due to the difficulty of coordinating the survey and of identifying a Bolivian institution willing and able to assume primary responsibility for its implementation.

The purpose of the current document and others in this series is to present a complete rendition of all survey procedures and results. The series is divided into three categories of documents for each survey; methodological, statistical and analytical. The methodological documents are intended to provide the user of survey information with details on the survey planning, sample design, implementation, data editing, and tabulations

in order that the strengths and weaknesses of the final products can be appreciated more fully. It is anticipated that these methodological documents will prove useful to others who desire to conduct similar surveys. The statistical documents are intended primarily as vehicles for the dissemination of tabulated survey data. The content and organization of the data files are documented for the analyst who wants to work directly with them or who simply wants to more fully understand the variables employed in the tabulation of published statistics. The analytical documents will explore the statistical data in some depth, describe the research results and make policy recommendations. All these documents will be published in both Spanish and English language.

A statement of the overall project goals, individual survey objectives and content, statistical properties of the samples and survey implementation will be included in each of the statistical and methodological documents. This will be done due to the expected broad range of users, many of whom will be unfamiliar with the project in general and the surveys in particular.

Documents published as a result of these projects will follow the general number scheme as outlined in Table 1. Should two or more documents of a given type be published for an individual survey, an alphabetic character will be added to the document number. For example, if two statistical documents are published for the Southern Valleys Survey, they would be numbered SD#1A and SD#1B.

Table 1. Project document numbering system

Survey	Documents		
	Methodological	Statistical	Analytical
Southern Valleys Survey	MD # 1	SD # 1	AD # 1
Socio-economic Farm Survey	MD # 2	SD # 2	AD # 2
Credit Survey	MD # 3	SD # 3	AD # 3
Traditional Practices Study	MD # 4	SD # 4	AD # 4

The final product of this project will be a comprehensive assessment of the rural sector of Bolivia. This will result from the data integration phase in which information generated by the series of surveys and studies under this project will be combined with pertinent secondary source information.

SECTION I. INTRODUCTION

The objectives of this report

The objective of this report is to explain the observed variability in the socio-economic profiles obtained for 699 farm households in the southern valleys area of Bolivia, with emphasis on the following aspects:

1) variables that influence net household income;
2) variables that influence net farm income;
3) variables that influence off-farm income
4) variables that influence off-farm employment in agricultural activities;
5) variables that influence the employment of hired labor;
6) variables that influence crop productivity;
7) variables that influence cropping patterns;
8) variables that influence human consumption of farm-household-produced commodities;
9) variables that influence the marketed surplus of the farm household.

In addition to the above, the report discusses the following aspects:

1) farm size and land use;
2) the household labor force and its use;
3) the mutual exchange of labor (ayni-minka) and communal labor practices;
4) alternative definitions of net income;
5) perceived needs by the farm household.

Major findings

The thrust of this report is technical in nature. It is, therefore, expedient to list the major findings first, lest they go unnoticed when reading this report.

1) The Southern Valleys Survey provides a comprehensive and representative socio-economic profile of the farm households living in that area.

2) In 1977, the average annual net household income per capita for the 699 farm households included in the survey equalled 1840 pesos or 92 U.S. dollars.

3) There are substantial variations in this figure between the Chuquisaca, Tarija and Potosi departmental areas.

4) There are substantial variations in net household income per capita between farm households within a given area.

5) Off-farm income for the region as a whole accounts for 44 percent of net household income.

6) Farm households with members employed off-farm in nonagricultural activities have substantially higher incomes than farm households relying on farm income exclusively.

7) Farm households with members employed off-farm in agricultural activities have substantially higher incomes than farm households relying on farm income exclusively.

8) The creation of additional off-farm employment would proportionately result in the greatest increase in material welfare of the farm households in the southern valleys area.

9) There is substantial mobility of labor between farms, within the region and between Bolivia and contiguous countries.

10) The average daily wage rate in agriculture equalled 31 pesos or 1.55 U.S. dollars.

11) The mutual exchange of labor (ayni-minka) and communal labor practices are very common in the area, but they are insignificant as a proportion of the total amount of labor used in crop and livestock production.

12) Time to market exerts a very significant influence on off-farm employment and, hence, on net household income.

13) Time to market exerts a significant influence on net farm income.

14) Prices received for basic food crops are not systematically related to time to market.

15) Irrigated cropland is a common practice throughout the region. In the Chuquisaca area, net farm income on irrigated farms is almost double that of nonirrigated farms. The corresponding differences for the Tarija and Potosi areas are quite small.

16) Farm households receiving technical assistance/training have significantly higher net farm incomes than farms not receiving technical assistance/training.

17) Only 1.7 percent of the farm households in the region receive technical training/assistance.

18) 97.3 percent of the respondents in the region indicate a desire for increased technical training/assistance.

19) Farms receiving bank credit have significantly higher net farm incomes than farms not receiving bank credit.

20) Only 3 percent of the farm households in the region receive bank credit.

21) Of the perceived needs by the farm household credit is mentioned most often.

22) A cash flow analysis of the farm household's cash income and cash expenditures on agricultural inputs shows that the latter equals approximately 75 percent of the former. This percentage is not materially different between farms of different size or different levels of net household cash income.

23) Off-farm employment may create the additional cash required to purchase off-farm produced modern inputs such as improved seed, fertilizer, etc.

24) The use of industrially produced modern inputs such as improved seed, chemical fertilizer, herbicides, pesticides, etc., is not unknown in the region. Yet, the hectareage of crops using these modern inputs is quite small.

25) Yields per hectare on farms using these modern inputs are not systematically higher than yields per hectare on farms not using these modern inputs. This may indicate that the available modern inputs are not well-adapted to the pedological and ecological conditions of the region.

26) Yields per hectare are significantly higher for farms less than 1 hectare size than for farms larger than 1 hectare in size.

27) Beyond the 1 hectare size, there is no systematic relationship between size of farm and crop yields per hectare for 19 annual crops.

28) The size of the farm has no systematic influence on the composition of crops grown.

29) Virtually all farm households have off-farm sales of crops.

30) The proportion of production sold increases more than proportionately with farm size.

31) Nevertheless, for any given crop (except specialty crops), the majority of farms growing that crop do not have off-farm sales.

32) The human consumption of commodities produced by the farm household is closely related to the level of net household income. For the region, the corresponding income elasticity equals 0.40.

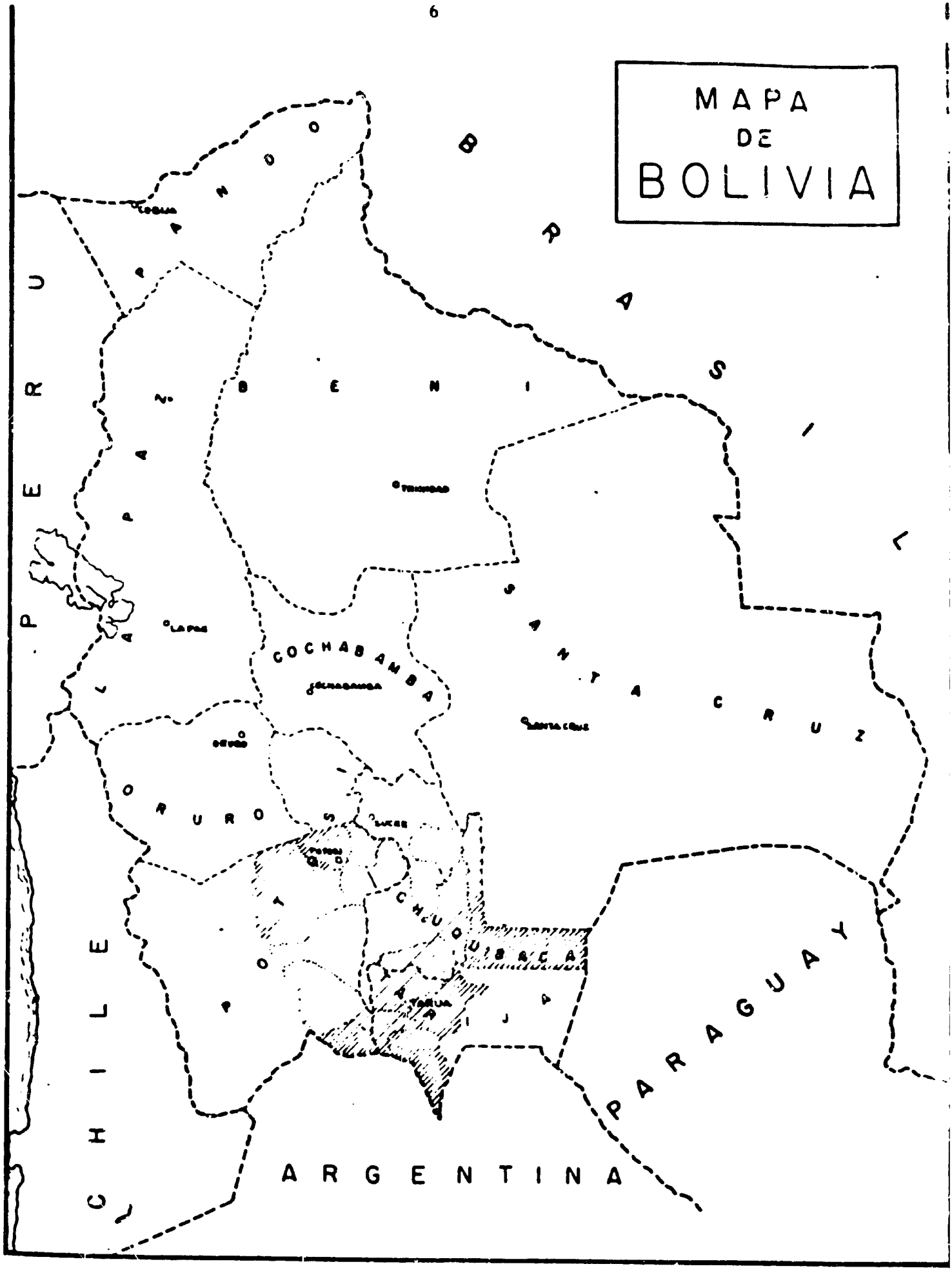
Methodology used

The 1977 socio-economic survey covered 699 farm households living in the valley areas of the southern departments of Tarija, Potosi and Chuquisaca.[1/] The questionnaire in processed form contains 422 coded responses to an equal number of variables of interest.[2/] The totality of this information constitutes a comprehensive and representative socio-economic profile of farm households in the survey area. The questionnaire contains 8 sections:

1) the producer and his household;
2) the farm;
3) production, consumption and sales of crops;
4) technology and crop production expenditures;
5) livestock production;
6) processed products;
7) other incomes and expenditures;
8) credit and miscellaneous.

1/ The tabulations in this report exclude all 51 observations in the Chaco Primary Sampling Unit for being atypical.

2/ The input record consists of 415 cells. Eighteen cells serve for farm-household identification purposes. The output record adds 25 additional cells to the input record. The output record can be expanded beyond 25 cells if necessary.



AREA OF THE STUDY

The variables of interest in these sections are interrelated. What a farmer produces is related to the needs of his household. The amount of household labor employed on the farm depends on the amount and the quality of the farm's resources and the opportunity earnings of labor off the farm in the agricultural and nonagricultural sector. The kind of crops grown and how crops are grown depends on the farm household's resource endowments, distance to market, tenancy, credit availability, factor prices and commodity prices. This implies that many of the variables which make up the socioeconomics of the farm household are simultaneously determined. Such variables we will call dependent variables, e.g., net farm output, the quantity of labor employed by the farm, the quantity consumed by the household of products produced by the household, the marketed surplus, net household income, etc. The remaining group of variables we will call independent variables. Such variables are given to the household, e.g., the off-farm agricultural wage rate, prices paid and prices received. The size of the farm, the size of the household, the relative efficiency of labor and land are also given in the short run.

The question arises as to whether a potentially very large number of relationships between dependent and independent variables can be captured by means of a compact behavioral model of the farm household. The advantage of this procedure is that it generates numerous internally consistent hypotheses. Such hypotheses can be used to interpret the survey data when transformed in terms of appropriate cross-tabulations. If the survey data confirm such hypotheses, then they can be used for predictive purposes. Programs designed to alleviate rural poverty must necessarily rest on the predicted impact of the policy instruments (irrigation, mechanization, improved seed and fertilizers, access to roads, tenancy reform, access to

roads and markets, credit technical training and assistance, etc.) to be used by the public sector. In order to predict the impact of these measures, one must know the actual situation of the farm-household and how it will respond to incentives which are generated outside the farm household.

Prediction, therefore, must go beyond description. It must show how the farm household behaves as a compact socio-economic system while giving due recognition to farm-household specific factors such as family size, farm size, climate, soils, supplemental irrigation, distance to market, credit availability, tenancy, past and current access to technical assistance and training. Because farms are different with respect to these environmental factors, no two farms will have identical socio-economic profiles. This, however, does not preclude the existence of a characteristic common to all farm households, i.e., economically rational behavior. Given this, farm households will on the average allocate their own and purchased resources so as to achieve maximum material family welfare. If the material welfare of these farm households is to increase, then selected environmental constraints, such as the amount and the quality of productive resources, tenancy, off-farm income opportunities, credit, market access, technical assistance and education, must be relaxed. If such constraints are not relaxed, then the typical farm household will remain in stationary equilibrium. Farmers will have no inducement for change, and to an outside observer it will appear as if all production consumption and resource allocation decisions are determined by tradition rather than incentives. The view that farm households do not respond to material incentives is no longer fashionable.[1/] Analysis of the socio-economic survey of the southern valleys offers a unique opportunity to demonstrate that farm households

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1/ Theodore W. Schultz, *Transforming Traditional Agriculture*, Yale University Press, New Haven, 1964.

are economically rational and to draw the practical conclusions there from when designing public sector programs.

The farm households included in the survey can be classified in a number of ways. In this report, we emphasize the dual nature of the farm household, i.e., as a production unit and as a consumption unit. In what follows, we pay particular attention to two aspects.

1) From what source does the farm draw its labor?

2) From what source does the household draw its consumption of food and fiber?

Nakajima[1/] asserts that these two characteristics lead to a four-fold classification of farms. A family farm draws its labor predominantly from members of the farm household. A nonfamily farm will predominantly rely on hired labor. A commercial farm sells the major share of its production. A subsistence farm consumes most of its production. Above definitions are illustrated in Figure 1. The 1977 survey includes observations of all four types of farms.[2/] Because of this, a behavioral model of the farm household must be adaptable to all four types of farms.[3/] Above classification is validated with reference to Tables 2 and 3.

1/ Chihiro Nakajima, "Subsistence and commercial farms: some theoretical models of subjective equilibrium," Chapter 6, in Clifton Wharton ed. *Subsistence Agriculture and Economic Development*, Aldine, Chicago, 1971.

2/ The exclusion of the 51 farm households in the Chaco area is a regional exclusion, resulting in a narrower geographical description of the southern valleys area. Allan Le Baron and Harry Wing suggested in 1979 the additional exclusion of a number of nonfamily farms in the southern valleys area properly speaking. The tabulations used in this report do not reflect that recommendation.

3/ It must allow, in addition, for the existence of part-time farmers, i.e., farm households whose head of household is primarily employed in nonagricultural activities.

Figure 1. A classification of farm households in the 1977 Southern Valley Survey

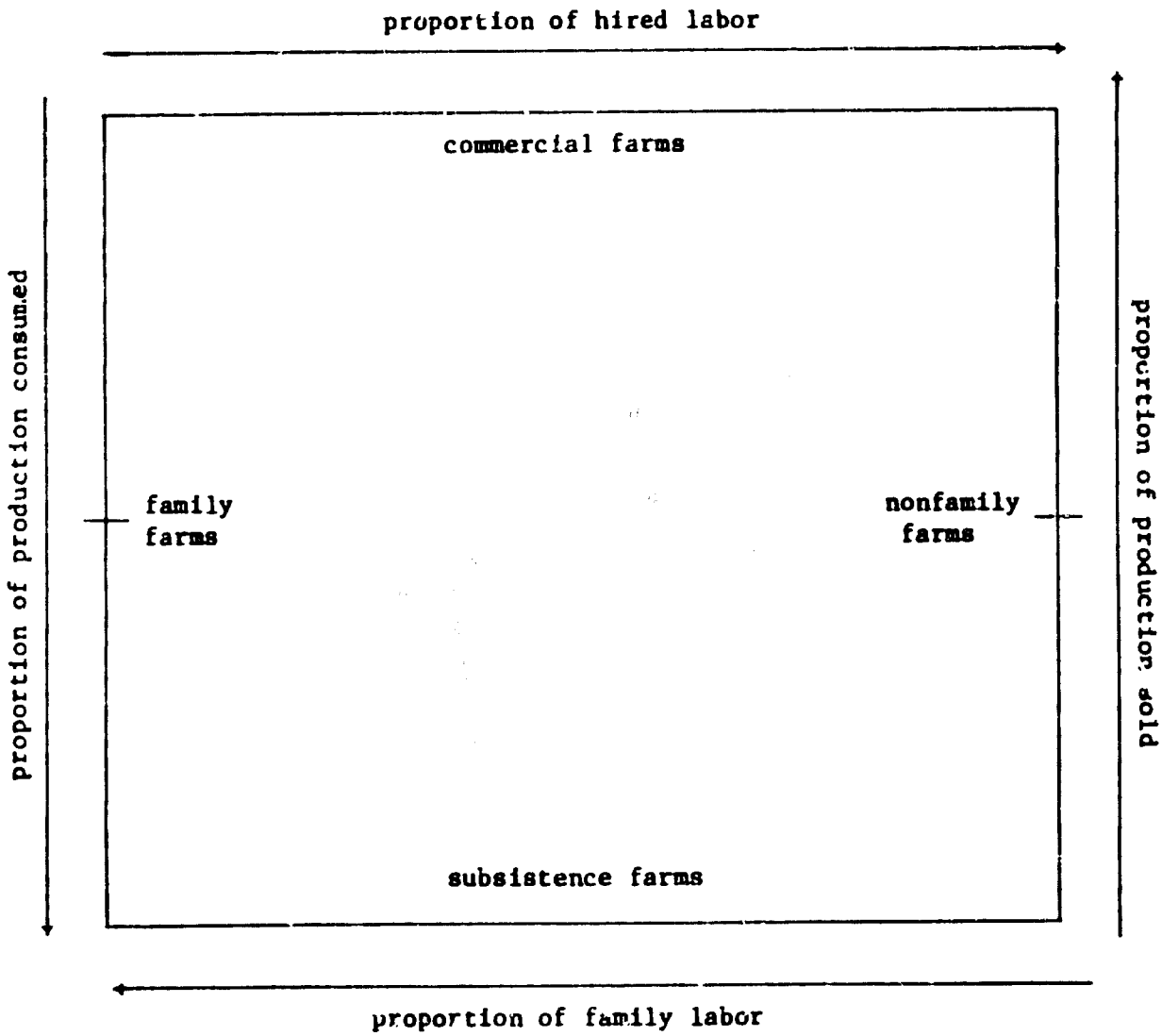

Table 2 features the volume of production and the disposition of production for farms reporting production of 19 crops for the southern valleys region.[1/] This table leads to several interesting findings. First, the quantity used for payment in kind is negligible for each of the 19 crops included. Second, the quantity consumed by farm households producing a given crop exceeds the quantity sold of that crop, with the exception for specialty crops such as carrots, peppers, quinua and grapes. Third, that the majority of farms producing a given crop do not sell any quantity of that crop, the exception being again the above-mentioned specialty crops. For example, 480 farms reported production of corn, but only 105 farms reported sales of corn. Similarly, 454 farms reported production of potatoes, but only 125 farms reported sales of potatoes. Fourth, that a majority of the farm households grow at least two crops, i.e., corn and potatoes. Wheat and barley are grown by one out of four households. Peas, peanuts, oca and peppers are grown by no more than one of ten households. Other crops, particularly fruits, are grown by proportionately few households.

The average volume sold per farm is quite small. For example, 105 farms sold a total of 63 tons of corn; 125 farms sold a total of 76.5 tons of potatoes. The total quantity sold of the 19 crops included in Table 2

[1/] The tables appearing in this report are derived from tabulations provided by the U.S. Bureau of the Census. These primary tabulations are indicated by the capital letter T. This capital letter is followed by a number within the range of 4 through 51. This number identifies the selected list of variables of interest. A variable of interest is then cross-tabulated given a standard table layout containing the "explanatory" variables against which the selected variable of interest is being cross-tabulated. There are 13 standard tables. All but standard tables 10-13 are available on a regional, departmental or zonal basis. For details, see David Malkovsky, Data Processing System Documentation, Bolivia Agricultural Sector Loan II Survey, U.S. AID/Bolivia, 1977, pages 122-209. Primary tables T50, T51 and standard tables 10, 11, 12, 13 were written especially for this report by Loyd Brown, U.S. Bureau of the Census - U.S. AID/Bolivia.

Table 2. Production and disposition of production for farms reporting production of 19 crops for the southern valleys region, 1977

Crops	Production for farms reporting production (1000 kilos)	Quantity used for payment in kind (1000 kilos)	Quantity consumed by farm-household (1000 kilos)	Quantity sold (1000 kilos)	Other uses of production (1000 kilos)
Corn (grain)	425.4	2.2	254.0	63.2	105.1
	(480)	(10)	(463)	(105)	(267)
Potatoes	299.0	1.1	154.0	76.6	66.7
	(454)	(7)	(444)	(125)	(183)
Wheat	58.4	.6	31.2	16.0	10.8
	(201)	(3)	(192)	(38)	(108)
Barley (grain)	69.5	.3	40.7	14.4	14.2
	(171)	(1)	(148)	(36)	(99)
Beans (green)	17.5	-	10.0	6.5	1.1
	(86)	(0)	(79)	(16)	(26)
Corn (on the cob)	32.1	(2)	23.3	6.2	2.5
	(76)	(1)	(72)	(16)	(35)
Peas (green)	10.6	(2)	4.0	5.3	1.2
	(66)	(1)	(49)	(24)	(17)
Peanuts	11.3	.4	4.5	5.7	.7
	(63)	(1)	(61)	(28)	(23)
Oca	11.4	-	7.1	3.0	1.2
	(50)	(0)	(49)	(7)	(16)
Peppers	10.0	.1	.5	9.3	.1
	(46)	(1)	(23)	(40)	(5)

Table 2. *Continued*

Crops	Production for farms reporting production (1000 kilos)	Quantity used for payment in kind (1000 kilos)	Quantity consumed by farm-household (1000 kilos)	Quantity sold (1000 kilos)	Other uses of production (1000 kilos)
Papaliza	7.4	-	4.9	1.6	.9
	(46)	(0)	(43)	(6)	(22)
Beans (dry)	1.0	-	.6	.4	.1
	(7)	(0)	(6)	(3)	(3)
Barley (green)	11.2	-	1.2	.2	9.1
	(24)	(0)	(3)	(2)	(19)
Quinua	4.3	-	1.4	2.8	0.1
	(6)	(0)	(6)	(3)	(1)
Carrots	18.5	.1	1.2	16.8	.5
	(10)	(1)	(7)	(10)	(4)
Grapes	120.3	-	3.4	83.4	33.6
	(16)	(0)	(8)	(15)	(2)
Peaches	19.4	-	1.0	18.5	-
	(7)	(0)	(2)	(4)	(0)
Oranges	145.0	-	-	130.0	15.0
	(9)	(0)	(0)	(2)	(1)
Alfalfa	3.0	-	-	.7	2.3
	(6)	(0)	(0)	(2)	(6)

Source: Table T51, stubs 6, 8, 15, 16, 18, 19, 21, 22, 31, 32, standard Table 10.

Note: Number in parentheses indicates number of farms reporting production, payment in kind, human consumption, sales or other uses.

(2) Less than half the unit reported.

equals 459.6 tons or 658 kilos per farm when calculated with respect to the 699 farms included in the survey. Given that each farm had an equal probability of 146.25 of being selected,[1/] we can estimate the marketed surplus for the southern valleys area at 67 thousand tons. Nevertheless, very few of the 699 farms included in this report are pure subsistence farms, because virtually all farms report cash sales (see Table 52).

Table 3 shows that the use of hired labor and off-farm employment are common practices in the southern valleys area. Of the 699 farms included in this report, 188 farms or 27 percent used hired labor. Of the 699 farm households, 343 farm households or 49 percent had members employed off the farm. There are substantial departmental variations in these figures. One out of two farms in the Chuquisaca area hires labor. The corresponding figure for the Potosi area is only one out of seven. In the Potosi area, eight out of ten farm households have members employed off farm. In the Tarija area and Chuquisaca area, approximately one out of every two households has members employed off-farm. Above figures indicate substantial labor mobility between farms, between departments and even between Bolivia and contiguous countries.

The observed variability in the proportion of output sold and labor mobility are but two aspects that reflect the economic behavior of the farm household. For analytical purposes, we need a comprehensive yet compact model if we are to explain above phenomena. Such a model is given by the ten equations in twenty key variables of interest below.

[1/] William Owens, sample design for the socio-economic study of the south of Bolivia, Bureau of the Census, Washington, 1977.

Table 3. Frequency of farms employing hired labor and frequency of farm households with off-farm employment.

	Region	Chuquisaca	Tarija	Potosi
Frequency of households with members employed off-farm in agriculture in Bolivia[1/]	155	45	54	56
Frequency of households with members employed off-farm in agriculture outside Bolivia[1/]	20	0	1	19
Frequency of households with members employed off-farm in nonagricultural activities[1/]	168	38	66	64
Frequency of farms employing hired labor[2/]	188	70	67	51
Total farm households	699	144	212	343

Source: [1/] Table T38, standard table 7, [2/] Table T31, standard table 7.

1) $Q_B = Q_B[\hat{X}_1, \hat{X}_2]$

2) $\hat{X}_1 = R_1 \cdot X_1$

3) $\hat{X}_2 = R_2 \cdot X_2$

4) $\partial Q_B/\partial X_{11} = W/P_B$

5) $\partial Q_B/\partial X_{12} = W/P_B$

6) $X_1 = X_{11} + X_{12}$

7) $X_1^* = X_{11} + X_{12}^* + X_{13}^*$

8) $Q_B = Q_{B\cdot 1} + Q_{B\cdot 2}$

9) $NHI = P_B \cdot Q_B + X_{12}^* \cdot T + X_{13}^* \cdot S - X_{12} \cdot W - D$

10) $U = U[Q_D, Q_{B\cdot 1}]$

The discussion of this model will proceed in four separable stages:

1) a brief discussion of the nature of each of the nine relationships and the identification of the variables appearing in these relationships;
2) a detailed discussion of the decisions which the farm household must make as a production unit and as a household in finding gainful employment for the family labor force on the farm or off the farm;
3) a detailed discussion of the decisions which the farm household has to make as a consumption unit;
4) detailed discussion of those variables which will cause the farm household to change its current decisions as to the use of owned and purchased resources.

The variables, listed in order of appearance, are

Q_B: an index of net farm output. Net farm output equals off-farm sales plus household consumption. Q_B is a dependent variable.

$\hat{X}_1$: an index of the quantity of efficiency labor used by the farm household. $\hat{X}_1$ is expressed in efficiency units, e.g., adult equivalent days worked. $\hat{X}_1$ is a dependent variable.

$\hat{X}_2$: an index of the quantity of efficiency land used by the farm household. $\hat{X}_2$ is expressed in efficiency units, e.g., cropland equivalent hectares. $\hat{X}_2$ is an independent variable.

X_1: an index of the quantity of labor used. X_1 is expressed in natural units, e.g., days worked. X_1 is a dependent variable.

X_2: an index of the quantity of land used. X_2 is measured in natural units, e.g., hectares. X_2 is an independent variable.

R_1: a conversion factor which translates natural units of labor X_1 into efficiency units of labor $\hat{X}_1$. R_1 is an independent variable.

R_2: a conversion factor which translates natural units of land X_2 into efficiency units of land $\hat{X}_2$. R_2 is an independent variable.

W: the off-farm agricultural daily wage rate. W is an independent variable.

P_B: an index of prices received by the farm household. P_B is an independent variable.

$\partial Q_B/\partial X_{11}$: the marginal physical product of household labor X_{11}. Q_B and X_{11} are dependent variables.

$\partial Q_B/\partial X_{12}$: the marginal physical product of hired labor X_{12}. Q_B and X_{12} are dependent variables.

X_{11}: the quantity of household labor employed by the farm household. X_{11} is a dependent variable.

X_{12}: the quantity of hired labor employed by the farm household. X_{12} is a dependent variable.

X_1^*: the total quantity of labor supplied by the farm household. X_1^* is an independent variable.

X_{12}^*: the quantity of off-farm household labor in agriculture. X_{12}^* is a dependent variable.

X_{13}^*: the quantity of off-farm household labor in nonagricultural activities. X_{13}^* is an independent variable.

$Q_{B \cdot 1}$: the quantity consumed by the household of net farm output produced by the farm household. $Q_{B \cdot 1}$ is a dependent variable.

$Q_{B \cdot 2}$: the quantity of net farm output sold. $Q_{B \cdot 2}$ is a dependent variable.

NHI: net household income. NHI is a dependent variable.

S: the (implied) daily wage rate in nonagricultural activities. S is an independent variable.

D: cash outlay on purchased inputs, except labor, by the farm-household. D is an independent variable.

U: an index of material welfare of the farm household.

Q_0: an index of the quantity of commodities consumed by the farm household which are not produced by the farm household. Q_0 is a dependent variable.

<u>Equation 1</u> $Q_B = Q_B(\hat{X}_1, \hat{X}_2)$ is a production function which relates net farm output Q_B to the use of efficiency labor $\hat{X}_1$ and efficiency land $\hat{X}_2$. <u>Equation 2</u> $\hat{X}_1 = R_1 \cdot X_1$ is a relationship which converts labor in natural units

X_1 into labor in efficiency units $\hat{X}_1$ by means of a conversion or relative efficiency index R_1. Equation 3 $\hat{X}_2 = R_2X_2$ is a relationship which converts land in natural units X_2 into land in efficiency units $\hat{X}_2$ by means of a conversion or relative efficiency index R_2. Equation 4 $\partial Q_B/\partial X_{12} = W/P_B$ states that the value of the marginal physical product of family labor X_{11} cannot be less than the off-farm agricultural wage rate W. Equation 5 $\partial Q_B/\partial X_{12} = W/P_B$ states that the value of the marginal physical product of hired labor X_{12} cannot be less than the off-farm agricultural wage rate W.[1/] Equation 6 is an accounting identity which states that the total quantity of labor X_1 used by the farm is furnished by the farm household X_{11} or else hired from outside the farm X_{12}. Equation 7 is an accounting identity which states that the total quantity of labor X_1^* supplied by the household is employed on the farm X_{11}, off the farm in agriculture X_{12}^* or off the farm in nonagricultural activities X_{13}^*.[2/] Equation 8 is an accounting identity which states that net farm output Q_B is distributed between household consumption $Q_{B\cdot 1}$ and off-farm sales $Q_{B\cdot 2}$. Equation 9 is an accounting identity which states that net household income equals the value of net farm output $P_B \cdot Q_B$ plus off-farm earnings in agriculture $X_{12}^* \cdot W$ plus off-farm earnings outside agriculture $X_{13}^* \cdot S$ minus wages paid to hired labor $X_{12} \cdot W$ minus cash outlays on purchased inputs D. Equation 10 is a conventional utility function or index of the material welfare of the farm household. This index is based on two

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[1/] The daily wage in nonagricultural activities S is substantially larger than W, but non-agricultural employment activities are limited. Consequently, W becomes the relevant guide for opportunity earnings off the farm.

[2/] The identity does not contain the additional terms and symbols which might represent the quantity of mutually exchanged labor (ayni or minka) and the quantity of labor supplied without compensation for community-based activities. Both categories, while very common, constitute only a small fraction of the total quantity of labor supplied by the household.

arguments — the consumption $Q_{B \cdot 1}$ of on-farm produced commodities and the consumption Q_0 of off-farm-produced commodities.

The model contains ten dependent variables (Q_B, $\hat{X}$, X_1, X_{11}, X_{12}, X^*_{12}, $Q_{B \cdot 1}$, $Q_{B \cdot 2}$, NHI, Q_0). Assuming that farm households behave rationally, as producers and as consumers we will be able to find the farm household's decisions with respect to each of these variables given the values for the ten remaining independent variables ($\dot{X}_2$, X_2, R_1, R_2, W, P_B, X^*_1, X^*_{13}, S and D). Because the employment variable X^*_1 does not directly enter into the index of material welfare, we are able to solve the model in two steps. In the first step we analyze the farm-household's decisions as a production unit. Given its decisions in this respect we can then analyze its decisions as a consumption unit. Having solved for all of the dependent variables, we can then extend the analysis by means of simple subtraction, addition, multiplication or division to groups of dependent and independent variables, e.g. net farm income $P_B Q_B$, the value of home consumption $P_B Q_{B \cdot 1}$, the average value productivity of farm household labor employed on the farm $P_B Q_{B \cdot 1} \div X_{11}$, average yields per hectare Q_B/X_2 or similar performance ratios of interest.

SECTION II. RESOURCES

Resource endowments of the farm household - land and labor

The size of the farm, i.e., the amount of land, and the size of the household, i.e., the family labor force constitute the fundamental resource endowments of the farm household. The magnitude of these endowments determine to large extent net household income and net farm income. At the same time, variations in the endowments ratio, i.e., the man-land ratio, have important consequences as to what kind of crops a family grows, how it produces such crops, and conditions the extent to which members of the household may find off-farm employment economically attractive.

Farm size and land utilization

The average size of the 699 farms covered by the survey equals 3.99 hectares. Of this average, 1.90 hectares are in annual crops, with .35 hectares in fallow, .18 hectares in preparation for planting, .06 hectares in permanent crops in production, and .02 hectares in permanent crops in pre-production stage. The remaining 1.48 hectares is divided in 1.05 hectares of natural pastures and .35 hectares of noncultivable hectareage.

There are substantial variations in average farm size between departments. The average farm size of 6.33 hectares for Chuquisaca is more than twice the average farm size of 2.53 hectares for Potosi. There are also substantial differences between departments as to land utilization. The departments with the smallest average farm size (Tarija, Potosi) proportionally use a much larger proportion of cultivable area in annual crops. On the other hand, a proportionately large proportion of land in Chuquisaca is in natural pastures. Land utilization is not dictated exclusively by ecological and pedological conditions, but also by economic and institutional

Table 4. Farm size and utilization of farm land by region and departments

	Region	Chuquisaca	Tarija	Potosi
Average farm size (hectares)	3.99	6.34	4.75	2.54
Average hectareage in annual crops	1.90	1.50	3.05	1.37
Average hectareage in permanent crops in production	.06	.22	.03	.01
Average hectareage in permanent crops in pre-production stage	.02	.03	.04	(2)
Average hectareage in natural pasture	1.06	3.59	.92	.08
Average hectareage in cultivated pasture	.01	0	0	.01
Average hectareage in fallow	.35	.31	.43	.31
Average hectareage in preparation for planting	.18	.19	.11	.27
Average noncultivable hectareage	.42	.51	.18	.53
Number of farms in above averages	699	144	212	343

Source: Table T15, stubs 1 through 18, standard Table 7.

(2) - Less than half the unit reported.

considerations. More intensive land utilization through changing the crop mix allows a small farm to compensate to a considerable extent for a relative labor surplus.

Table 5 shows the association between farm size and land utilization. Of 699 farms, 204 farms are less than 1 hectare in size, whereas 57 farms are larger than 10 hectares. The average farm size for the 204 smallest farms equals .40 hectares, whereas the average farm size for the largest 57 farms equals 22.54 hectares. The survey covered exclusively small farms. Above statistics suggest that farm size proportionately varies much more than any other variable of interest given to the farm household such as family size, prices paid or received. The proportion of land in natural pasture or noncultivable hectareage increases approximately exponentially with farm size.

The farm household labor force

The total population of the 699 farm households included in the survey equals 3705 persons, yielding a mean household size of 5.3 persons. Of this total, 2094 persons are between 13 to 60 years old and economically active, or 3.0 persons per farm household. Only sixty-six percent of the economically active population are engaged principally in agriculture, or 2.0 persons per farm household. This percentage is surprisingly low considering that the survey includes exclusively farm households, and not households living in rural aglomerations such as villages, small cities, etc. The economic activity rate of males is almost double that of females. Eighty-five percent of economically active males are employed in agriculture. The corresponding percentage for females is only forty-six percent. One of four households had members who emigrated for temporary work, or an average of .4

Table 5. Farm size and utilization of farm land by size of farm

	Size of farm					
	< 1 ha.	1-1.99 has.	2-4.99 has.	5-9.99 has.	> 9.99 has.	Total
Average farm size (hectares)	.40	1.37	2.96	6.48	22.55	3.99
Average hectareage in annual crop	.34	.97	1.93	3.83	6.34	1.90
Average hectareage in permanent crops	.01	.05	.07	.06	.18	.06
Average hectareage in permanent crops in preproduction stage	(2)	.03	.02	.03	.03	.02
Average hectareage in natural pasture	(2)	.03	.23	1.17	10.04	1.06
Average hectareage in cultivated pasture	0	(2)	0	.03	.01	.01
Average hectareage in fallow	.02	.19	.34	.87	1.03	.35
Average hectareage in preparation for planting	.02	.07	.21	.26	.82	.18
Average noncultivable hectareage	.01	.05	.15	.23	4.07	.42
Number of farms in above averages	204	146	190	102	57	699

Source: Table T15, stubs 1 through 18, standard Table 7.

(2) Less than half the unit reported.

Table 6. Frequency of males and females 13-60 engaged principally in agriculture, average number of household members emigrating for temporary or permanent work and mean family size by region and departments

	Region	Chuquisaca	Tarija	Potosi
Frequency of males 13-60 engaged principally in agriculture[1]	895 [147]	163 [40]	303 [46]	429 [61]
Frequency of females 13-60 engaged principally in agriculture[1]	485 [567]	85 [129]	129 [201]	271 [237]
Frequency of farm households with members emigrating[2] for temporary work	195	9	78	108
Average number of household members emigrating for temporary work[2]	.4 (695)	.1 (144)	.6 (208)	.4 (343)
Frequency of farm-households with members emigrating for permanent work[2]	75	18	23	34
Average number of household members emigrating for permanent work[2,3]	.2 (695)	.3 (143)	.2 (209)	.2 (343)
Mean household size[4]	5.3 (699)	5.3 (144)	6.0 (212)	4.9 (343)

Source: [1]Table T5, stubs 5, 6, 7, 8, standard Table 7; [2]Table 9, stubs 1, 2, 3, 4, 5, 6, standard Table 7; [3]Not included in calculating household size; [4]Table 4, stubs 5, 6, standard Table 7.

Note: Numbers in parentheses indicate number of observations used in average.

Note: Numbers in square brackets indicate numbers of males or females <u>not</u> engaged principally in agriculture.

members per farm household. Only one of ten households had members who emigrated for permanent work, or an average of .2 members per farm household.

There are significant differences in household size between departments. The mean household size varies from 6.0 for Tarija to 4.9 for Potosi. Such differences are not explained by household members emigrating for permanent work, becuase such members are excluded by definition in calculating household size. Economic activity rates and the sector of employment do not vary as much between departments, nor does the frequency of farm households with members emigrating for permanent work. There are, however, substantial regional differences in the frequency of farm households with members emigrating for temporary work. For the department of Chuquisaca, only one household out of sixteen has members emigrating for the temporary work, while for Tarija and Potosi, one out of every three households has members emigrating for temporary work.

Table 7 examines several characteristics of the farm household labor force in relation to net household income. Families with higher incomes have more persons economically active per household. For example, families with less than 801 pesos annual net household income have 433 economically active members out of a total of 918 family members. Families with more than 10,000 pesos annual income have 426 economically active members out of a total of 459 family members.

The relative frequency of farm households with members emigrating for temporary or permanent work also increases with the level of net household income. For example, for households with less than 801 pesos annual income, only one out of nine households has members emigrating for temporary work. Virtually all households with more than 10,000 pesos annual income have

Table 7. Frequency of males and females 13-60 engaged principally in agriculture, average number of household members emigrating for temporary or permanent work and mean family size by levels of net household income

	<801 $b	801-2100 $b	2101-4700 $b	4701-10,000 $b	>10,000 $b	Total
Frequency of males 13-60 engaged principally in agriculture[1]	183 [30]	172 [15]	188 [15]	173 [192]	164 [66]	895 [147]
Frequency of females 13-60 engaged principally in agriculture[1]	118 [102]	103 [86]	114 [112]	78 [124]	68 [128]	458 [567]
Frequency of farm-households with members emigrating for temporary work[2]	24	24	35	57	53	195
Average number of household members emigrating for temporary work[2]	.3 (146)	.2 (137)	.3 (154)	.7 (122)	.7 (125)	.4 (695)
Frequency of farm households with members emigrating for permanent work	11	9	17	18	19	75
Average number of household members emigrating for permanent work[2,3]	.1 (146)	.1 (138)	.2 (154)	.3 (121)	.4 (125)	.2 (695)
Mean household size[4]	4.5 (204)	4.9 (146)	5.6 (190)	6.2 (102)	6.3 (75)	5.3 (699)

Source: [1]Table T5, stubs 5, 6, 7, 8, standard Table 7; [2]Table T9, stubs 1, 2, 3, 4, 5, 6, standard Table 7; [3]Not included in calculating household size; [4]Table T4, stubs 5, 6, standard Table 7.

Note: Numbers in parentheses indicate number of observations used in average.

Note: Numbers in square brackets indicate number of males or females <u>not</u> engaged principally in agriculture.

members emigrating for temporary work. The average number of household members emigrating for temporary or permanent work increases with the level of net household income.

Families with higher levels of net household income are on the average larger than families with lower levels of net household income. Income, however, increases proportionately much faster than family size. Above findings suggest that the size of the family and its structure have an important, but not dominant, influence on the determination of the level of net household income.

Table 8 allows us to examine how a change in the size of the farm influences the frequency of farm households with members emigrating for temporary or permanent work. One would expect a negative association between farm size and those frequencies. The data in Table 8 do not support that hypothesis. Nor does farm size affect the average number of household members who emigrate for temporary or permanent work. On the other hand, an increase in the size of the farm is associated with a smaller proportion of males engaged principally in agriculture. The data show no firm evidence that size of farm affects either male or female overall activity rates.

Table 9 features literacy and formal education according to levels of net household income. Of the 699 farm households included in the survey, 486 households or 69 percent have literate heads of households, spouses or eldest sons. Illiteracy, as expected, is related to the absence of formal education. Of the 699 households, 219 households or 31 percent did not have heads of households, spouses or eldest sons having completed formal education. Of the 699 households, 265 households or 38 percent had heads of households, spouses or eldest sons who had completed 1-3 grades. Only

Table 8. Frequency of males and females 13-60 principally in agriculture, average number of household members emigrating for temporary or permanent work and mean family size by size of farm

	Size of farm					
	<1 ha.	1-1.99 has.	2-4.99 has.	5-9.99 has.	>9.99 has.	Total
Frequency of males 18-60 engaged principally in agriculture[1]	220 [34]	179 [21]	246 [43]	155 [23]	95 [26]	895 [147]
Frequency of females 18-60 engaged principally in agriculture[1]	140 [149]	97 [114]	118 [155]	84 [90]	46 [59]	485 [567]
Frequency of farm-households with members emigrating for temporary work[2]	72	30	50	30	13	195
Average number of household members emigrating for temporary work[2]	.5 (204)	.3 (146)	.4 (187)	.5 (101)	.5 (57)	.4 (695)
Frequency of farm-households with members emigrating for permanent work[2]	16	18	25	5	11	75
Average number of household members emigrating for permanent work[2,3]	.2 (203)	.3 (146)	.3 (187)	.1 (102)	.4 (57)	.2 (695)
Mean household size[4]	4.5 (204)	4.9 (146)	5.6 (190)	6.2 (102)	6.3 (57)	5.3 (699)

Source: [1]Table T5, stubs 5, 6, 7, 8, standard Table 7; [2]Table T9, stubs 1, 2, 3, 4, 5, 6, standard Table 7; [3]Not included in calculating household size; [4]Table T4, stubs 5, 6, standard Table 7.

Note: Numbers in parentheses indicate number of observations used in average.

Note: Numbers in square brackets indicate number of males or females <u>not</u> engaged principally in agriculture.

Table 9. Literacy and formal education according to levels of net household income

	Net household income per farm ($b)					
	<801	801-2100	2101-4700	4701-10,000	>10,000	Total[a]
Frequency of literate heads of households, spouses, or eldest sons	83	79	95	100	120	486
Frequency of heads of households, spouses, or eldest sons having completed no formal education	65	65	57	23	7	219
Frequency of heads of households, spouses, or eldest sons having completed 1-3 grades	48	39	54	58	58	265
Frequency of heads of households, spouses, or eldest sons having completed 4-12 grades	11	6	14	16	23	70
Frequency of heads of households, spouses, or eldest sons having completed some higher education	1	1	1	4	9	17
Frequency of heads of households	146	139	154	122	127	699

Source: Table T4, standard Table 7; Table T6, standard Table 7.

[a]Includes invalid responses.

70 out of 699 households had principal members who had completed 4-12 grades. Of the 699 households, 17 households had principal members having completed some higher education.

The frequency of illiteracy is inversely related to the level of net household income per farm. Conversely, the frequency of primary, secondary and higher education is directly related to the level of net household income per farm. These facts are not sufficient by themselves to establish a causal relationship between formal education and net household income per farm.

Table 10 shows that only 1.7 percent of farm households are receiving technical assistance, whereas 97.3 percent indicate that they would like to receive technical assistance. There exists, therefore, a huge excess demand for agricultural extension and education services in the southern valleys area. Of 692 households, 21 households or 3 percent indicated as having participated in agricultural demonstrations. Of 692 households, 27 households or 4 percent indicated as having some formal agricultural education. An acceleration of the transformation of the agricultural sector in the southern valleys area requires that above figures are increased at least tenfold.

There are substantial departmental variations in the percentage of farm households receiving technical assistance. In the Chuquisaca area, 4.2 percent of farm households indicated receiving technical assistance. But the corresponding figures for the Tarija and Potosi area are only 1.9 percent and .6 percent respectively. The agricultural extension and education programs are, therefore, biased towards the Chuquisaca area, which already has much higher average levels of net farm income per farm than the Tarija and Potosi areas.

Table 10. Frequency of heads of households spouses or eldest sons having formal agricultural education, acquaintance with agricultural assistance activities and desiring assistance

	Region	Chuquisaca	Tarija	Potosi
Frequency of heads of households, spouses or eldest sons having some formal agricultural education	27	11	7	9
Frequency of heads of households, spouses or eldest sons having participated in agricultural demonstrations	21	7	8	6
Percentage of farm households receiving technical assistance	1.7	4.2	1.9	.6
Number of farm households used in calculating %	695	144	209	342
Percentage of farm households desiring technical assistance	97.3	97.9	97.6	96.8
Number of farm households used in calculating %	692	144	207	341

Source: Table T7, stubs 1 through 6, standard Table 7.

SECTION III.
THE PRODUCTION UNIT

The farm household as a production unit: a graphical analysis

Most formal models of the farm household include the amount of family labor as a direct determinant of the material welfare of the farm household.[1/] [2/] [3/] [4/] In these models, the total number of days worked by the farm household, on the farm or off-farm, therefore, constitutes one of the arguments of the utility function under the *a priori* reasonable assumption that the consumption of commodities contributes to material welfare, but that work or physical effort, beyond a certain range, detracts from material welfare. In this view, the economically rational farm household must balance the gains in family welfare from additional work, translated into additional net household income, against the losses in family welfare associated with additional work.

The subjective equilibrium of the farm household then determines the total number of days worked. Utilizing the method of comparative statistics, the plausible sign of the change in employment can be determined given an assumed change in selected exogenous variables such as the off-farm wage rate, the size of the farm, the size and composition of the

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1/ Nakajima *op. cit.*

2/ A. K. Sen, "Peasants and dualism with and without surplus labor," *Journal of Political Economy*, Volume 74, 1966, pages 425-449.

3/ Joseph E. Stiglitz, "Rural-Urban migration, surplus labour, and the relationship between urban and rural wages," *Eascern African Economic Review,* Volume 1, 1969, pages 1-35.

4/ R. A. Berry and R. Soligo, "Rural-urban migration, agricultural output and the supply price of labour in a labour surplus economy," *Oxford Economic Papers*, Volume 20, 1968, pages 230-269.

family, prices received and paid, etc. In these models the employment decision is made simultaneously with the consumption decision. It follows that these decisions also are related to the list of exogenous variables listed above. It is not possible, however, to establish a direct causal relationship between net household income and consumption, or the amount of labor supplied by the household, because net household income is an endogenous variable rather than one determined outside the model. At best, one can hope to determine an associative relationship between net household income and consumption and household employment.

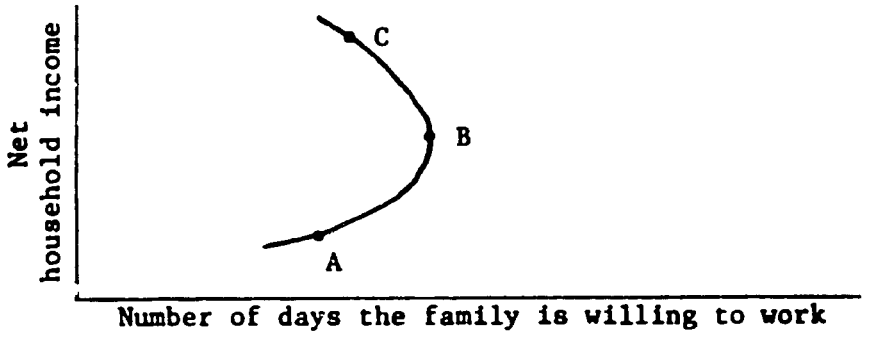
If primary interest is related to the employment decision, the distinction between the consumption of home produced and purchased commodities is dropped, i.e., all farms are assumed to be commercial farms. Even with this undesirable simplification, the resulting models cannot be cast into plausible specific functional representations. In order to resolve this problem, one must choose between two alternatives.

1) Assume that the total number of days worked by the household is an exogenous variable.

2) Assume an *a priori* associative relationship between the number of days worked by the household and net household income.

The second alternative is represented in Figure 2.

Figure 2. The farm household labor supply curve



The curve drawn in Figure 2 reflects the usual assumption that at a sufficiently low level of net household income, the marginal valuation of labor relative to that of income is such that an increase in income will call forth an increase in the number of days the family is willing to work. For a sufficiently high level of net household income, the family labor supply curve will become backward bending. Along this curve, the "income-work-leisure" combination represented by point C is preferred to that of point B, and the "income-work-leisure" combination of point B is prefered to that of point A.

The Southern Valleys Survey contains adequate data to measure net household income. It also contains adequate data on the size and composition of the family. It, however, does not contain the minimal data set required to measure the number of days the family worked, and, hence, presumably was willing and able to work. The data are, therefore, not sufficient to statistically determine the farm household labor supply curve. Because of this, we must have recourse to the first alternative, i.e., assume that the number of days the family is willing to work X_1^* as exogenously determined.

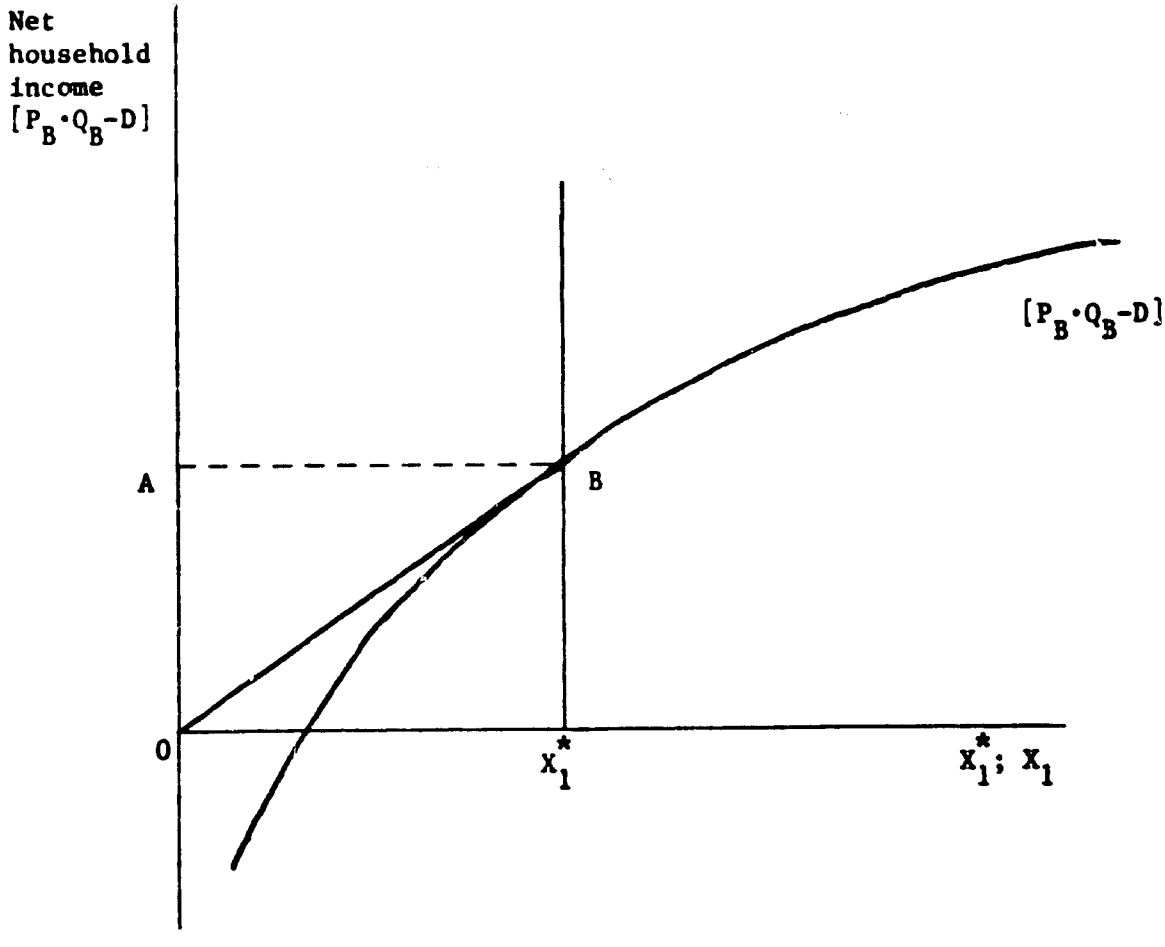
The farm household as a production unit can draw the labor used in production X_1 from the household itself X_{11}, or it can use hired labor X_{12} or both. In 1977, approximately one out of three farm households in the southern valleys employed on the average 58 days of hired labor (see Table 33). One out of three households used reciprocal labor services for an average of 16 days (see Table 35). The farm household as a consumption unit can find employment on the farm X_{11} or off the farm X_{12}^*. In 1977, one out of four household had members employed off-farm in agriculture for a weighted average of 79 days (see Table 26). Also, one out of four

households had members employed off-farm in nonagricultural activities (see Table 29). Above findings indicate substantial mobility of family labor between farms and between the agricultural and nonagricultural sector. Nevertheless, the pure family farm, such that all of the labor X_1 used by the farm also equals the family supply of labor X_1^*, is not atypical.

For such a farm, net household income equals $[P_B Q_B - D]$. Net farm output Q_B is determined by the amount and quality of the resources owned by the farm family. If we assume that the amount of land, or size of farm, is given, then, net household income is increasing function of family labor. But due to the decreasing marginal productivity of labor, net farm output will increase at a decreasing rate. In Figure 3, we take the quantity of family labor supplied as given. In effect, we assume the supply curve of family labor to be perfectly inelastic with respect to net household income. Such a vertical labor supply curve is a special, but not unrealistic, version of the labor supply curve drawn in Figure 2. Because $X_1^* = X_1$, and because the size of the farm X_2 is assumed constant, net household income equals OA. An increase in the size of the farm or the quality of land would cause an upward shift in the $[P_B Q_B - D]$ curve and for given X_1^* would increase net household income. Similarly, a rightward shift in the family labor supply curve, due, e.g. to an increase in the number of family members of working age, will cause an increase in net household income.

The tangent of BOX_1^* measures net household income per day worked. If the size of the farm X_2 expands proportionately with the quantity of labor supplied by the family, then net household income per day worked may stay the same. For this to be possible, the production function

Figure 3. The determination of net household income when the labor used by the farm X_1 also equals the family supply of labor X_1^*



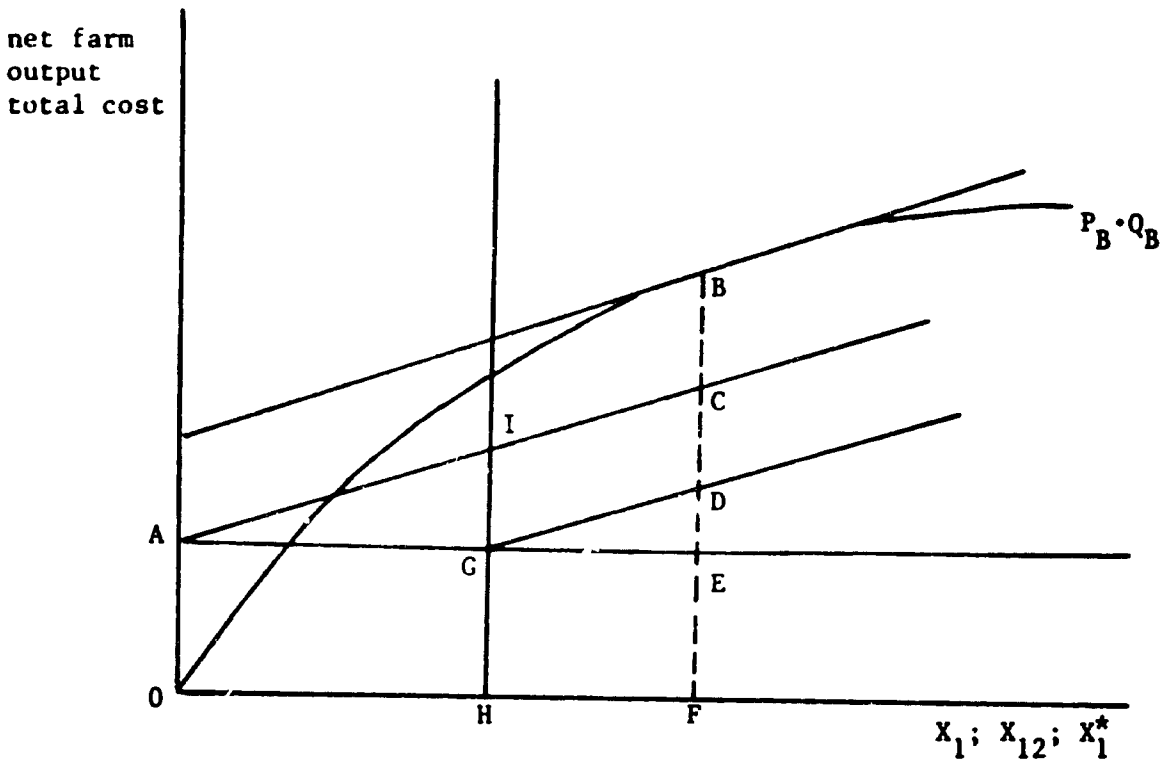
$Q_B = Q_B[\hat{X}_1, \hat{X}_2]$ must exhibit constant returns to scale, and cash outlays D on purchased durable and nondurable inputs must increase proportionately with the size of the farm. An increase in the quantity supplied of X_1^* without a corresponding increase in the size of farm will decrease average net household income per day worked. If the number of days worked is proportional to the size of the family, then an increase in the man-land ratio will lead to a decrease in net household income per capita. While this statement is correct, it should be recognized that the number of days worked does not necessarily increase proportionately with the size of the household. The typical household goes through a life cycle such that it initially increases in size with a subsequent decrease in size. During this cycle, the demographic composition of the household changes and thereby influences the number of days the family is willing and able to work.

Net household income as calculated in Figure 3 is not necessarily the maximum level of net household income attainable by the farm household. The vertical family labor supply curve implies that more income is preferred to less income for the same amount of work. If the farm household is economically rational, it will look for such income augmenting alternatives. Two possibilities are of particular interest to this connection:

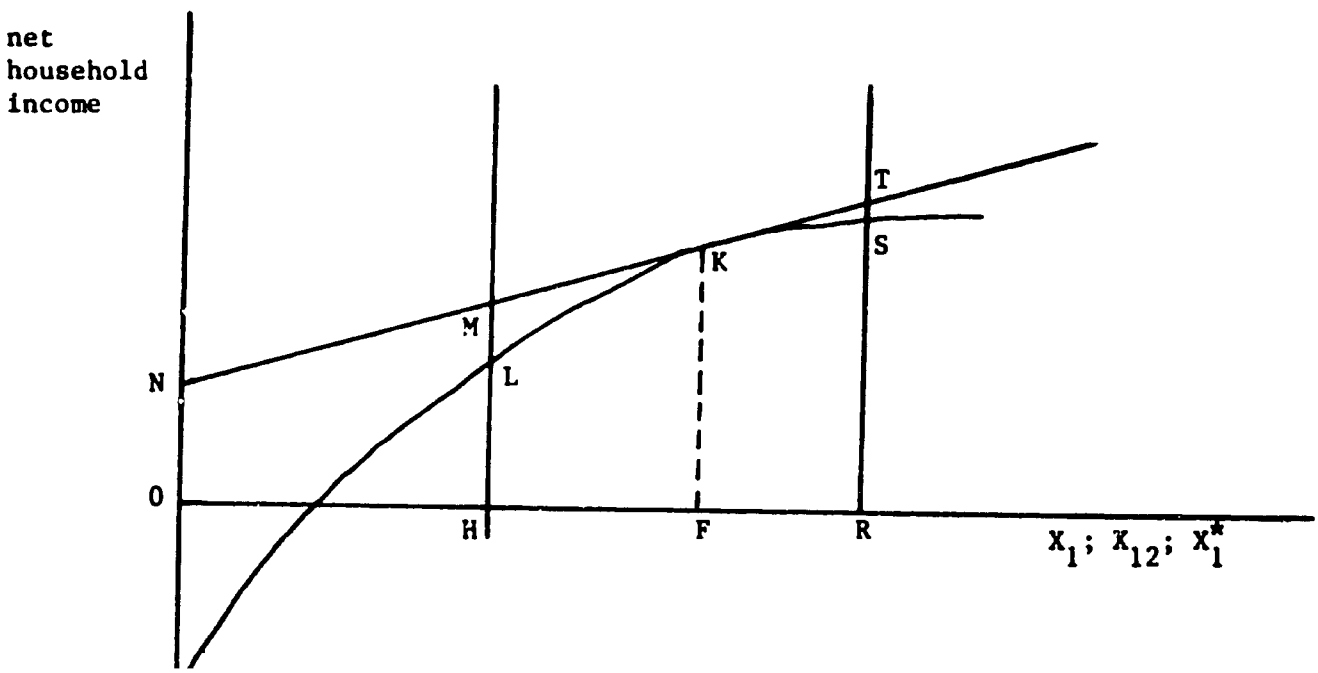
1) the possibility of hiring labor X_{12} in addition to the amount of family labor X_1^* employed on the farm;
2) the possibility of decreasing the amount of family labor X_{11} employed on the farm and hiring out the freed amount of family labor $(X_{12}^* + X_{13}^*)$ elsewhere in agriculture X_{12}^* or in nonagricultural work X_{13}^*.

Figure 4. The determination of net household income when the labor used by the farm X_1 equals the family supply of labor X_1^* plus a certain amount of hired labor X_{12}

4(a)



4(b)



In Figure 4(a), the value of net farm output is represented by the P_BQ_B curve. Let OA represent cash outlays on purchased durable and nondurable inputs, except labor. We assume for convenience that such outlays do not vary with the amount of labor X_1 used in producing farm output Q_B. Assume that the quantity of family labor supplied is zero or negligible as will be the case for large nonfamily farms. Such farms rely exclusively on hired labor. Assume that the wage rate W for hired labor X_{12} is given. If the farm uses exclusively hired labor, then its total cost curve is given by OAC. Economic rationality dictates that in order to maximize profits, this farm will hire a quantity of labor OF such that the value of the marginal product of labor equals the wage rate.

But, nonfamily farms are not at all typical of the southern valleys area. The major share of the labor used by the farm is furnished by the farm household itself. Assume that in Figure 4(a) OH represents the quantity of labor furnished by the farm household. If this farm household desires to maximize net household income, it must consider the broken line OAGD as its relevant total cost curve. Net household income BD is maximized if the farm household employs a quantity HF of hired labor in addition to the quantity OH of labor supplied by the farm itself.

Consider now the diagram in Figure 4(b). LK corresponds to the net income curve drawn in Figure 3. If the farm household does not consider the possibility of hired labor, net household income equals LH. If all labor were to be hired, net household income would equal ON, which equals BC in Figure 4(a). Suppose that the farm household substitutes for hired labor. For each unit of hired labor replaced by family labor, net household income will increase by W, i.e., the daily wage rate. The income consequences of this replacement process are indicated by the straight line

NK. But there is a limit to this replacement process. The maximum amount of family labor supplied equals OH. At that point, the farm will employ HF units of hired labor. Its net household income equals HM, which is larger than LH as expected. It will be observed that HF units of hired labor increase net household incomes by ML. HF as a proportion of OH is quite large, whereas ML as a proportion of LH is quite small. Consequently, a proportionately large expansion in labor employed leads to a proportionately small expansion in net household income. Given an increase in the size of the household, the family labor supply curve LH will move to the right. The amount of hired labor HF will decrease as will its contribution to net household income.

As long as the wage rate W for hired labor stays the same, the total amount of labor employed OF stays the same. This is true whether the farm relies exclusively on hired labor or exclusively on family labor. This is an important result. It demonstrates that the wage for hired labor W dictates the total quantity of labor employed by the farm household irrespective of the size of the household. The size of the household only influences the sources from which such labor is drawn, i.e., from the household itself or from outside.

If the size of the household is large relative to the size of the farm, often all of the labor employed by the farm will be furnished by the household. For such farm households, net household income potentially may increase if some of the available family labor be hired out, i.e., employed off the farm. Assume that in Figure 4(b) OR represents the quantity of family labor supplied. If all of this labor is employed on the farm, net household income equals RS. If, however, FR of available family labor is hired out at a daily wage W, net household income increases from RS to RT.

The effective income opportunity curve available to this farm household is therefore not LKS but NKT.

We previously established NMK as the effective income opportunity curve if the farm household considered the possibility of hiring labor. It will be seen that KT is the extension of NMK. Figure 4(b) demonstrates that farm households typically should either hire labor or else employ part of available family labor off the farm. The pure family farm such that $X_1^* = X_1$ occurs in Figure 4(b) at only one point, i.e., if $X_1^* = X_1 = OF$. With an unequal distribution of land and labor such that the median labor/land ratio is less than the average labor/land ratio, the family labor supply curve of more than half of the farm households in the southern valleys will be found to the right of KF. Consequently, the number of farm households hiring out labor should be larger than the number of farm households hiring labor. This is in agreement with the previously cited figures.

It also follows that labor mobility insures that the value of the marginal product of labor among farm households will be approximately the same, i.e., equal to the going daily wage. We find (Table 33) that the 187 farm households hiring labor paid an average daily wage equal to 28 pesos. We find (Table 26) that 147 farm households reported employment of household members on a day-to-day basis off-farm in agriculture in Bolivia. The average compensation per day of such work equalled 31 pesos. This equality of the wage rate paid to hired labor and the wage rate received by household labor employed off the farm in agriculture underlies the farm household net income opportunity curve NMKT in Figure 4(b).

Members of the household may also be employed off the farm in nonagricultural activities. The head of household, e.g., may be a part-time farmer, i.e., employed as a carpenter, truck driver, miner, etc. The survey

does not contain sufficient information which will allow us to compute the implied average daily wage for such activities. But in those instances where members are so employed, the share of net household income derived from nonagricultural activities is much larger than that derived from farming. The implied daily wage for nonagricultural activity is therefore almost certainly larger than the agricultural wage rate.

This leads to a modification of the income opportunity NMKT in Figure 4(b). In Figure 5 we assume that MH represents the family labor supply curve. If all family labor is employed on the farm, and no labor is hired, net household income equals LH. If all family labor is employed on the farm and HF of labor is hired, then net household income equals HM. If UH of family labor is employed off the farm in nonagricultural activites, at a daily wage approximately triple the agricultural wage rate, then net household income equals HZ. The income opportunity curve open to such a household is given by the broken line NVZ. The family labor supply curve MH is now decomposed into an agricultural and nonagricultural part. The curve UV represents household labor supplied for agricultural activities. It follows that UF now represents the quantity of hired labor. The increase UH in hired labor substitutes for an equal number of days members of the household spend in nonagricultural activities. Recalling the two equations representing the sources and uses of labor, we have

$$X_1 = X_{11} + X_{12}$$

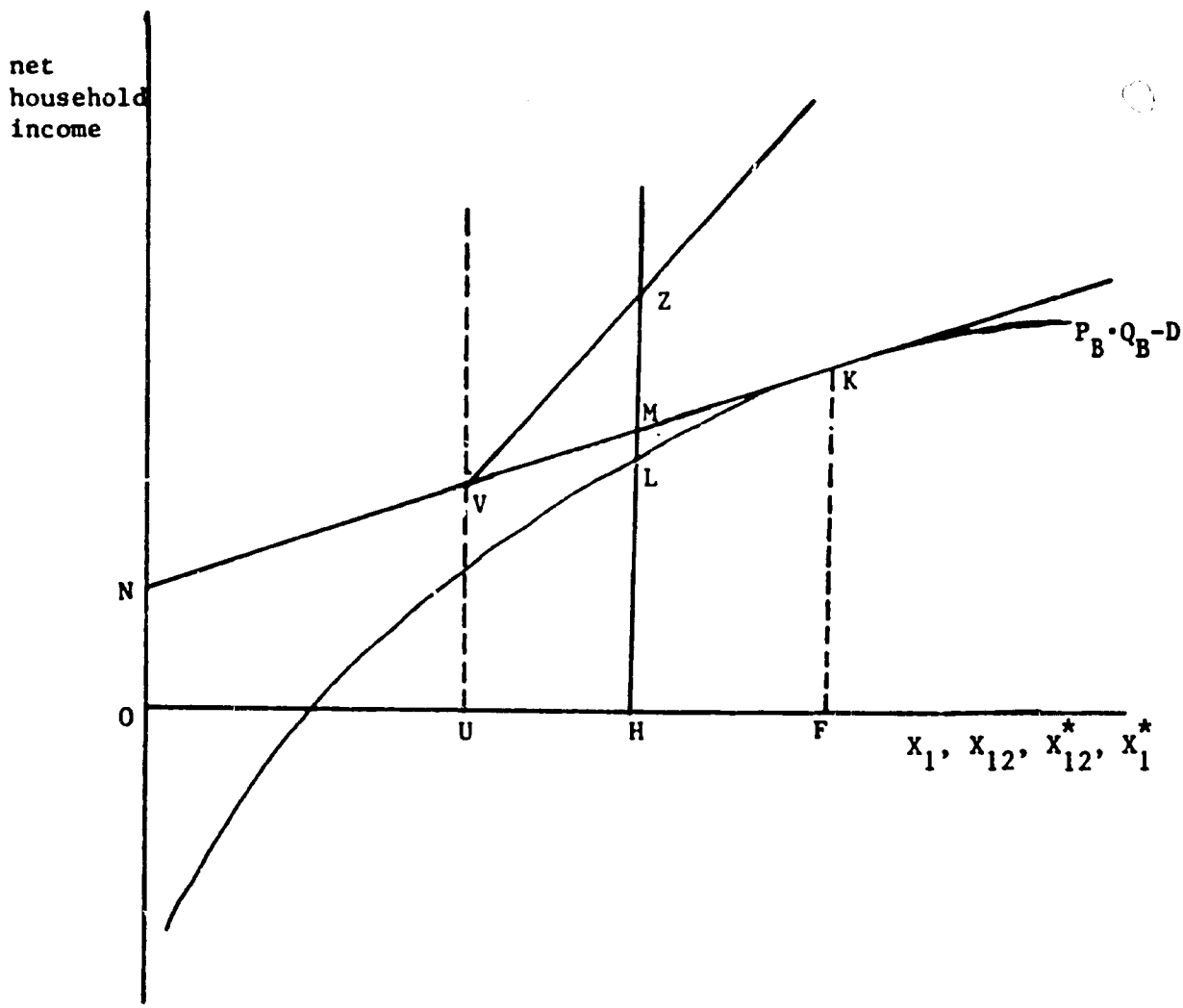
$$X_1^* = X_{11} + X_{12}^* + X_{13}^*.$$

Applying these equations to Figure 5, we have

$$OF = OU + UF$$

$$OH = OU + UH \qquad (X_{12}^* = 0).$$

Figure 5. The net household income opportunity curve when members of the household work off the farm in nonagricultural accivities



The household labor supply curve MH in Figure 5 has been drawn such that if all household labor is employed on the farm, its value marginal product at point L is larger than the going agricultural wage W. We can also start with the alternative possibility such that value marginal product of household labor is less than the going wage. In that case, the household labor supply curve must be positioned to the right of KF in Figure 5. It is easily shown that this does not affect the amount of labor OF used by the farm. Consequently, not all of household labor will be used on the farm. Off-farm employment may be in agricultural or nonagricultural activities. In the case of employment in nonagricultural activities, hired labor may again be substituted for household labor. This explains the apparent paradox that small farms with large households may nevertheless employ hired labor.

The foregoing analysis suggests that farms be classified as to the sources of net household income. In Table 11 we distinguish four types of farms as determined by off-farm income and size.

I. farms with off-farm agricultural income but no off-farm nonagricultural income;

II. farms with off-farm nonagricultural income but no off-farm agricultural income;

III. farms with both off-farm agricultural income and nonagricultural income;

IV. farms with neither off-farm agricultural or off-farm nonagricultural income.

Of the 619 valid responses, 325 farms or 52 percent are of type IV, i.e., farms with no off-farm income. The remainder of the 619 farms have off-farm agricultural income, off-farm nonagricultural income or both. The

Table 11. Average net household income according to size of farm and type of farm as determined by off-farm income

	Size of farm					
	<1 ha.	1-1.99 has.	2-4.99 has.	5-5.99 has.	>9.99 has.	Total
All farms	6,188 (184)	5,239 (133)	7,437 (156)	7,469 (94)	6,868 (52)	6,550 (619)
Farms with off-farm agricultural income but no off-farm nonagricultural income	6,251 (54)	4,776 (33)	5,953 (25)	8,474 (19)	6,254 (6)	6,150 (137)
Farms with off-farm nonagricultural income but no off-farm agricultural income	12,645 (33)	10,361 (30)	16,008 (39)	9,720 (18)	12,689 (10)	12,725 (130)
Farms with both off-farm agricultural income and nonagricultural income	13,424 (13)	1,590 (2)	9,601 (5)	5,306 (7)	--- (0)	9,735 (27)
Farms with neither off-farm agricultural or off-farm nonagricultural income	2,490 (84)	3,312 (68)	3,896 (87)	6,579 (50)	5,353 (36)	3,984 (325)

Source: Table T50.

Note: Numbers in parentheses indicate number of observations used in average.

number of type II farms, i.e., farms with off-farm nonagricultural income but no off-farm agricultural income is surprisingly large. Of the 619 farms, 130 farms or 21 percent are of this type. Twenty-two percent (137 of 619) of the farms is of type I, i.e., farms with off-farm agricultural income but no off-farm nonagricultural income. Only 27 farms or 4 percent are of type III, i.e., farms with both off-farm agricultural and nonagricultural income.

A striking feature of Table 11 is that the 130 farms with off-farm nonagricultural income but no off-farm agricultural income have an average net household income equal to 12,725 pesos. On the other hand, the 325 farms with no off-farm income have an average net household income equal to 3984 pesos. Type I farms, i.e., the 137 farms with off-farm agricultural income, only have an average net household income equal to 6149 pesos. Type III farms, i.e., the 27 farms with both agricultural and nonagricultural income, have an average net household income equal to 9735 pesos. The foregoing results indicate that off-farm income is the major determinant of net household income. Many farm households are, therefore, poor because of the lack of off-farm earning opportunities. An effective program in increasing the material welfare of the rural poor in the southern valleys area, therefore, would be the creation of off-farm jobs, possibly involving permanent migration of the labor force to other rural areas of Bolivia.

There is no strong relationship between the size of farm and the level of net household income of farms of types I, II, and III. This is not unexpected, because the existence of off-farm earning opportunities. Such opportunities do not exist, or are not made use of, by type IV farms, i.e., farms with no off-farm income. In this instance, as expected, net

Table 12. Composition of net household income according to source of income by type of farm

	Income measure			
	Net household income	Net farm income	Off-farm agricultural income	Off-farm nonagricultural income
All farms	4,034,584 (619)	1,828,625 (634)	613,972 (187)	1,556,311 (168)
Farms with off-farm agricultural income and no off-farm nonagricultural income	842,530 (137)	317,704 (137)	525,057 (157)	0 (0)
Farms with off-farm nonagricultural income but not off-farm agricultural income	1,654,278 (130)	275,467 (130)	0 (0)	1,379,551 (140)
Farms with both agricultural and nonagricultural income	262,836 (27)	13,481 (27)	71,515 (27)	176,160 (27)
Farms with neither off-farm agricultural or nonagricultural income	1,294,940 (325)	1,193,547 (326)	0 (0)	0 (0)
Invalid responses	0 (0)	28,726 (14)	17,400 (3)	600 (1)

Source: Table T50.

Note: Numbers in parentheses indicate number of observations used in sum.

household income increases with farm size, although not proportionately.

In Table 12, we repeat the classification of farms according to the source of off-farm income. We then look at the composition of four income measures:

1) net household income;
2) net farm income;
3) off-farm agricultural income;
4) off-farm nonagricultural income.

The total amount of net household income for 619 farms equals 4 million pesos. Of this total, 1.3 million pesos or 32 percent originated on the 325 farms of type IV, i.e., on farms with no off-farm income. Type II farms, i.e., farms with off-farm nonagricultural income but no off-farm agricultural income accounted for 1.7 million pesos or 41 percent. Type I farms, i.e., farms with off-farm agricultural income but no off-farm nonagricultural income accounted for .8 million pesos or 21 percent.

For the 325 farms of type IV, net farm income is the only source contributing to net household income. For farms of type I, II and III, off-farm income contributes also to net household income. For the 130 farms of type II, off-farm nonagricultural income equals 1.4 million pesos as compared with .3 million pesos of net farm income. Consequently, on type II farms, off-farm nonagricultural income accounts for 83 percent of net household income. For the 137 farms of type I, off-farm agricultural income equals .5 million pesos as compared with .3 million pesos of net farm income. Consequently, off-farm agricultural income on type I farms accounts for 62 percent of net household income on those farms. For the 27 farms of type III, off-farm income equals .2 million pesos as compared to a

negligible amount of net farm income. Consequently, on type III farms, off-farm income accounts for 95 percent of net household income.

Column 2 of Table 12 can be used to calculate net farm income per farm for each type of farm. One would expect the following sequence of inequalities:

$$NFI_{IV} > NFI_{I} > NFI_{II} > NFI_{III}.$$

This sequence is confirmed by the data in Table 12. Net farm income per farm of type IV farms, i.e. farms with no off-farm income, equals 3661 pesos. Net farm income per farm of type I farms, i.e., farms with off-farm agricultural income equals 2319 pesos. Net farm income per farm of type II farms, i.e., farms with off-farm nonagricultural income equals 2118 pesos. Finally, farms with both agricultural and nonagricultural income have a net farm income per farm equal to 499 pesos. The above results demonstrate that increased off-farm employment for a given farm household decreases net farm income but increases net household income. This, too, is as expected.

Variables that influence crop yields: a graphical analysis

The characterization of the farm household as a production unit in the previous section aggregates all crops and livestock into an index of net farm output. Alternatively, we may consider the model as representative of a farm household growing a single crop. Assume that the production function underlying such a crop is linear homogeneous in labor and land.

$$Q_B = Q_B[X_1, X_2]$$

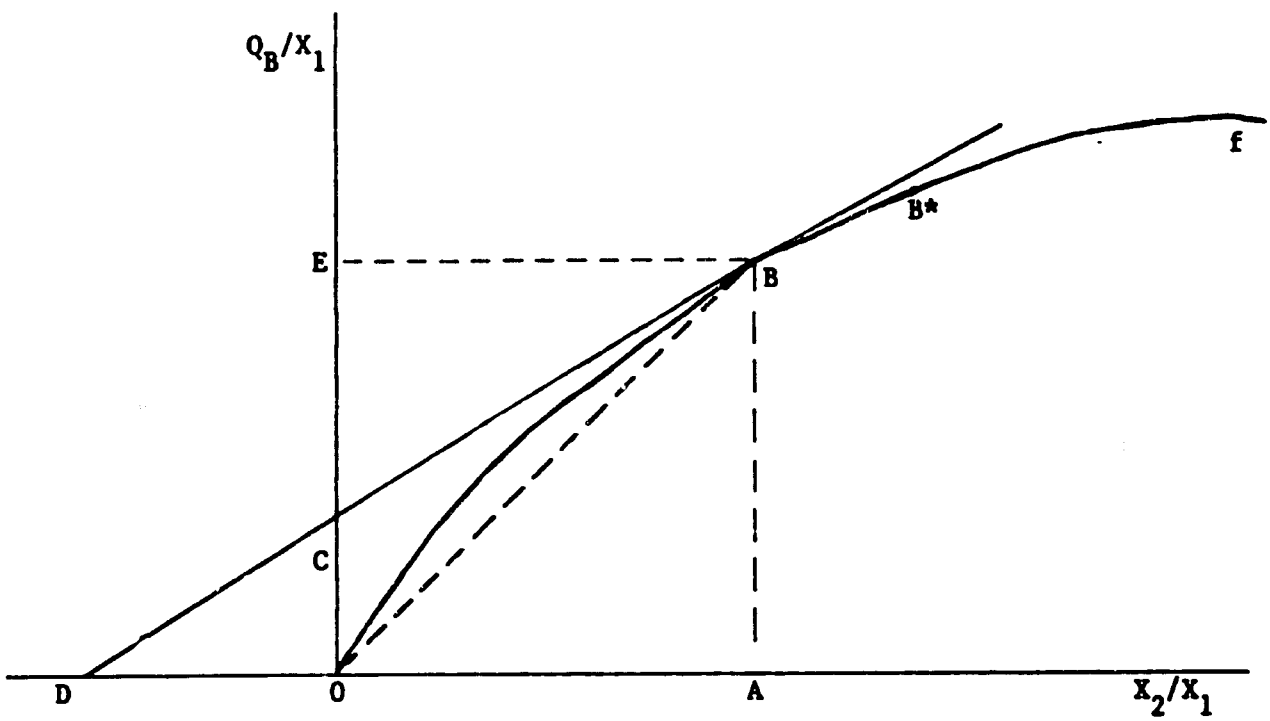
where X_1 is the quantity of labor and X_2 the quantity of land used in

producing gross output Q_B.[1/] If the production function for crop B is homogeneous of degree one, we can rewrite that function in productivity form

$$Q_B/X_1 = f(X_2/X_1).$$

The above expression states that average labor productivity (Q_B/X_1) depends on the land-labor ratio (X_2/X_1). It can be shown that the function f increases at a decreasing rate as in Figure 6. Line BD is drawn tangent to the labor productivity function at point B. It can be shown[2] that OC equals the marginal physical product of labor $\partial Q_B/\partial X_1$.

Figure 6. The labor productivity function



[1/] In the previous section, we used a net output concept. In this section, we use a gross output concept, because yields per hectare are usually expressed in this fashion. The survey data, however, can be used to calculate net output per hectare. Net output equals gross output minus intermediate use for seed and feed minus losses.

[2/] H. Van de Wetering, "Lecture notes in capital and growth theory," Iowa State University, 1980.

Economic rationality dictates that in equilibrium the value of the marginal product of labor must equal the agricultural wage rate P_1, i.e.,

$$\partial Q_B/\partial X_1 = P_1/P_B.$$

Assume that at OC, above, equality is fulfilled. This implies that the farm household chooses point B on the labor productivity function. The corresponding technique of production is indicated by the land-labor ratio OA. The tangent of angle BOA measures the corresponding gross yield per hectare. Average labor productivity is indicated by OE. It can be shown that the distance DO measures the wage-rental ratio (P_1/P_2) where P_1 is the agricultural wage rate and P_2 the imputed shadow rental of one hectare of land. The point elasticity of the labor productivity function at point B measures the imputed share k_2 of land in the value of gross output P_BQ_B. As long as the factor price-product price ratio OC stays constant, there will be no inducement to change existing crop technologies.

Assume now that the wage rate P_1 increases while the product price P_B stays constant. OC will then become larger, and the corresponding point of tangency will then be found to the right of B. An increase in the wage rate causes a shift towards a less labor-intense technology. Average labor productivity increases, but the yield per hectare decreases. An increase in the price received P_B will lower OC and have effects opposite to that of a wage increase. Inflation, such that wages and prices received increase at equal rates, does not affect agricultural productivity.

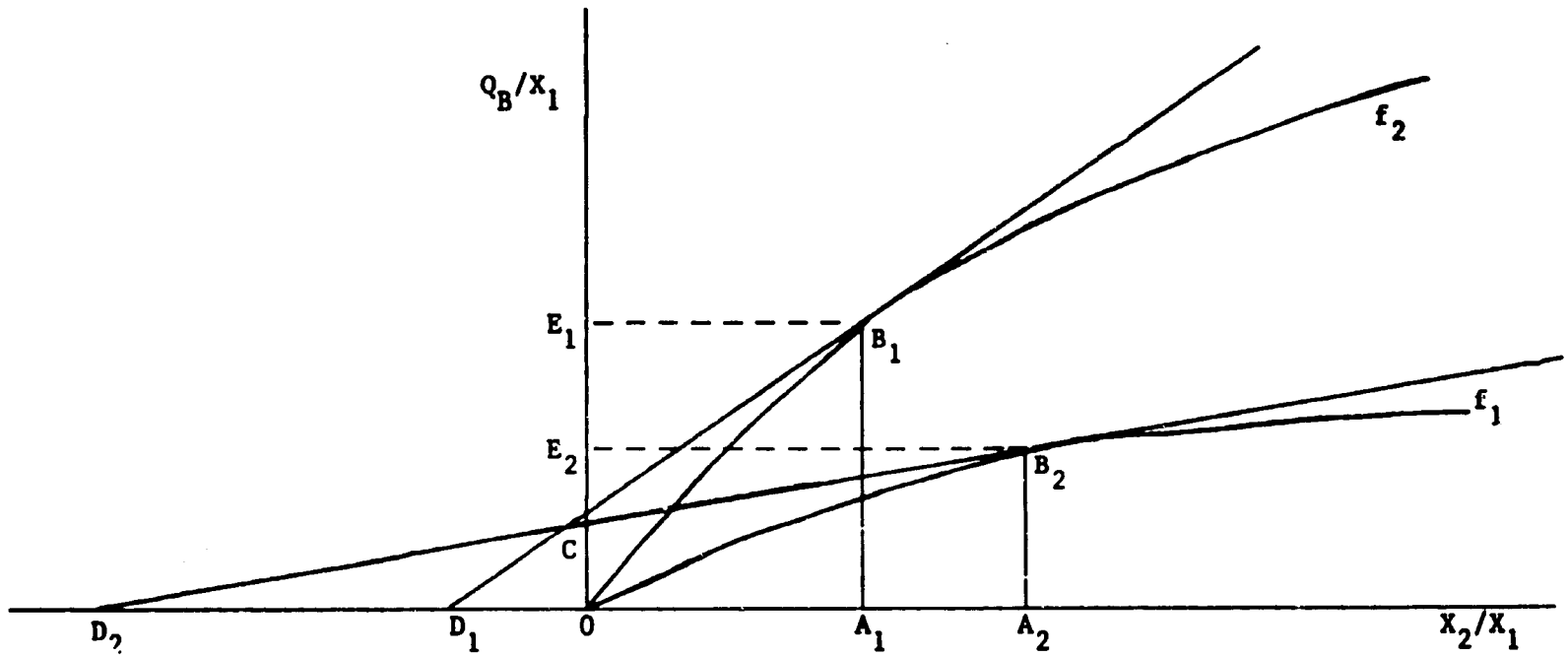
Figure 6 also illustrates why crop sharing is considered as a socially inefficient form of tenancy. With crop sharing, it is as if the farmer receives only a fraction of the price of the product, i.e., the ratio (P_1/P_2) increases. It follows that the technology adopted by the share

renter will fall to the right of B_1. There will be a corresponding shift to a less labor-intensive technique of production. The average yield per hectare will decline, but average labor productivity increases as compared to tenancy involving a fixed annual cash rent.

The land farmed by a farm household often varies in quality. Assume, for example, two classes of land. The crop production functions will be different between these two classes of land. In Figure 7, we assume that land class 1 for a given land-labor dose always yields a higher output per worker than land class 2. Because the wage rate P_1 and the price received P_A are not affected by the quality of the land on which the crop is grown, it follows that the value of the marginal productivity of labor must be equal to OC on both classes of land. This condition dictates the corresponding points B_1 and B_2 on the average labor productivity functions f_1 and f_2 for land of class 1 and 2, respectively. It follows that prime land (class 1) will have a <u>lower</u> land-labor ratio ($OA_1 < OA_2$) than marginal land (class 2). Average labor productivity will be higher on prime land ($OE_1 > OE_2$). Yields per hectare will also be higher on prime land ($tg\ B_1OA_1 > tg\ B_2OA_2$). The share k_2 imputed to land will be higher on prime land than on marginal land. In effect, truly marginal land is that land class for which $k_2 = 0$, i.e., the Ricardian extensive margin such that the shadow rental equals zero. For such land, the wage rental ratio OD_2 becomes infinite. For such land, all of (gross) income must be imputed to labor.[1/] If farm households have lands of varying quality, then it may be economically rational not to farm the poorer parcels of land.

[1/] This gives rise to the Ricardian notion that at the margin labor compensation equals the cost of production.

Figure 7. Crop technology when land is not of uniform quality



The original qualities of land can be modified (or maintained) through human intervention. Irrigation, fertilization, improved seeds, technical training and assistance all result in an increase in total factor productivity. In Figure 7, such actions shift the labor productivity functions upward from f_1 to f_2. Consequently, yields per hectare and per worker will increase. There will be a shift towards more labor-intensive crop technologies. But the share of labor k_1 in the value of farm output will fall. The shadow rental rate P_2 of land will increase, etc.

Land is not only heterogeneous among parcels for a given farm household, it is likely to be much more heterogeneous when we compare the productivity of the land farmed by different farm households. Assume that larger farms also work lower quality lands. Assume that small and large face identical factor and product prices. Given this, the small farm will choose point B_2 on productivity function f_2. It follows that the smaller farm will use a more labor-intensive technique of production, it will obtain a larger yield per hectare, and its average labor productivity may also be larger.

There is yet another reason as to why small farms may have higher yields per hectare than large farms. In the preceding analysis, we have assumed that farm households can always find off-farm employment in agriculture at the given wage rate P_1. Should such an opportunity not exist, then P_1 is effectively perceived to be equal to zero. Under these circumstances, all of available household labor X_1^* will be employed on the farm, i.e., $X_1 = X_1^*$. If we also assume that such a farm household cannot rent additional land, then both the quantity of labor employed X_1 and the size of the farm must be taken as given. Consequently, the ratio of these variables X_2/X_1 the land-man ratio is also given.

In Figure 6, X_2/X_1 now becomes the independent variable which for a given production function will determine average labor productivity, the yield per hectare and the marginal physical productivity of labor. It will also determine the shadow wage rate of labor which equals the value of the marginal product of labor. If the marginal product of labor equals zero, then the shadow wage rate also equals zero. All of gross output is then imputed to the remaining productive factor, i.e., land.

If small farms are characterized by a low land-man ratio and large farms by a high land-man ratio, but in all other aspects identical, then it follows from Figure 6 that large farms must have lower yields per hectare but a higher labor productivity than small farms.

Table 13 features crop yields per hectare for farms reporting production of 19 crops according to size of farms. Crop yields on farms less than one hectare in size are virtually without exception substantially higher than for farms larger than one hectare. The difference in crop yields per hectare of farms between one and two hectares as compared with farms larger than two hectares are not as pronounced, and in several instances lower than for larger farms. Except for very small farms, crop yields therefore do not seem to be influenced by the size of farm.

Average crop yields are quite low, with the exception of specialty crops such as carrots, peppers, quinua, grapes and fruits. The average yield of corn is 655 kilos per hectare; that of potatoes, 1422 kilos per hectare; that of wheat, 240 kilos per hectare; that of barley (grain), 686 kilos per hectare. Of the 350 farms smaller than 2 hectares, 231 farms or 66 percent produce corn (grain). Of the 159 farms larger than 5 hectares, 126 farms or 79 percent produce corn (grain). The size of farm does not have a strong effect on the specialization in this crop.

Table 13. Average production (kilos) per hectare for farms reporting production of 19 crops according to size of farm

	Size of farm					
	<1 Ha.	1-1.99 Has.	2-4.99 Has.	5-5.99 Has.	>9.99 Has.	Total
Corn (grain)	1325	892	791	431	521	655
	(141)	(90)	(123)	(84)	(42)	(480)
Potatoes	1824	1285	1213	1127	1865	1422
	(119)	(98)	(134)	(62)	(41)	(454)
Wheat	63[illegible]	558	365	214	190	240
	(16)	(29)	(65)	(51)	(40)	(201)
Barley (grain)	1212	838	619	635	604	686
	(35)	(40)	(59)	(19)	(18)	(171)
Beans (green)	1001	432	557	657	675	636
	(16)	(17)	(27)	(12)	(14)	(86)
Corn (on the cob)	1336	883	399	755	822	819
	(34)	(7)	(14)	(8)	(13)	(76)
Peas (green)	264	605	385	215	225	270
	(4)	(5)	(20)	(19)	(18)	(66)
Peanuts	1100	607	480	614	309	518
	(1)	(11)	(29)	(16)	(6)	(63)
Oca	1661	1019	744	646	1901	1[illegible]1
	(5)	(12)	(23)	(6)	(4)	(50)
Peppers	--	517	536	802	442	589
	(0)	(6)	(29)	(8)	(3)	(46)
Papaliza	836	980	974	965	736	963
	(2)	(16)	(23)	(4)	(1)	(46)
Beans (dry)	--	552	231	184	509	399
	(0)	(1)	(2)	(1)	(3)	(7)

Table 13. *Continued*

	Size of farm					
	<1 ha.	1-1.99 has.	2-4.99 has.	5-5.99 has.	>9.99 has.	Total
Barley (green)	1950	1227	946	0	1157	1029
	(5)	(8)	(8)	(1)	(2)	(24)
Quinua	276	--	184	70	961	782
	(1)	(0)	(1)	(1)	(3)	(6)
Carrots	3680	736	1801	3785	3735	3216
	(1)	(1)	(3)	(3)	(2)	(10)
Grapes	2904	3321	6163	4759	5367	4864
	(5)	(4)	(3)	(3)	(1)	(16)
Peaches[1/]	52970	6571	--	148	--	21050
	(3)	(2)	(0)	(2)	(0)	(7)
Oranges[1/]	--	--	9615	0	60000	27885
	(0)	(0)	(6)	(2)	(1)	(9)
Alfalfa	--	1150	1700	502	1792	806
	(0)	(1)	(1)	(2)	(2)	(6)
Total farms in size interval	204	146	190	102	57	699

Source: Table T51, stubs 8, 10, standard Table 10.

Note: Number in parentheses indicates a number of farms reporting production of crop i = 1...19.

1/ Unit of measure is fruits.

Of the 350 farms smaller than 2 hectares, 217 farms or 62 percent produce potatoes. Of the 159 farms larger than 5 hectares, 103 farms or 65 percent produce potatoes. The size of farm does not have a strong effect on the specialization in this crop.

Of the 350 farms smaller than 2 hectares, 45 farms or 13 percent produce wheat. Of the 159 farms larger than 5 hectares, 91 farms or 57 percent produce wheat. Larger size farms therefore comparatively specialize in wheat production.

Of the 350 farms smaller than 2 hectares, 75 farms or 21 percent produce barley (grain). Of the 159 farms larger than 5 hectares, 37 farms or 23 percent produce barley. The size of farm has no strong effect on the specialization in this crop.

Of the 350 farms smaller than 2 hectares, 33 farms or 9 percent produce green broad beans. Of the 159 farms larger than 5 hectares, 26 farms or 16 percent grow green broad beans. Larger-sized farms therefore have a comparative specialization in green broad beans.

Of 350 farms smaller than 2 hectares, 17 farms or 5 percent grow quinua, carrots, grapes, peaches or oranges. Of 159 farms larger than 5 hectares, 18 farms or 11 percent grow these crops. Larger-sized farms therefore show a comparative specialization in these minor crops.

The questionnaire does not contain data on the labor requirements for each crop. The expectation is that smaller-sized farms, given a fixed labor force, should specialize in relatively labor intensive crops. If, however, labor is mobile between different sizes of farms, then this specialization effect does not take place. Such seems to be the case for the southern valleys area. The major specialization effect between small and large farms therefore is probably related to cropping and livestock

activities. If larger farms specialize in the latter, then a larger proportion of these farms should be in natural pastures. This is the case, as can be seen in Table 5.

Table 14 features average production per hectare for farms reporting production of 19 crops according to the type of seed used. Very few farms use improved seed. Of the 482 farms reporting production of corn, only 4 farms or less than 1 percent used improved seeds. Of the 454 farms reporting production of corn, only 5 percent used improved seed. Of the 200 farms reporting production of wheat, only 2 percent used improved seed. For the remaining sixteen crops, with the exception of grapes, the use of improved seed is negligible.

The expectation is that the use of improved seed should increase average production per hectare. This hypothesis is not universally confirmed. For example, the 21 farms using improved potato seed obtained a yield of 1115 kilos per hectare. The 424 farms using local seed obtained an average yield of 1432 kilos per hectare. In several instances, the use of improved seed for a crop seems to decrease the average production per hectare. On the other hand, the use of improved seed for corn, barley, peppers and grapes increases the yields per hectare. Nevertheless, the number of observations is too small to attach significance to this finding.

Table 15 features average production per hectare for farms reporting production of 19 crops by type of fertilizer and irrigation. The use of organic fertilizer is a very common practice in the production of all of the 19 crops. For example, of the 467 farms producing corn (grain), 340 farms or 73 percent use organic fertilizer. Out of 443 farms producing potatoes, 405 farms or 91 percent use organic fertilizer. Of the 192 farms producing wheat, 120 farms or 63 percent use organic fertilizer.

Table 14. Average production (kilos) per hectare for farms reporting production of 19 crops according to the type of seed used

	Type of seed		
	Native seed	Hybrid or improved seed	Seed of Unknown Source
Corn (grain)	651	2065	778
	(473)	(4)	(3)
Potatoes	1432	1115	1856
	(424)	(21)	(9)
Wheat	239	235	199
	(196)	(3)	(1)
Barley (grain)	689	1104	--
	(170)	(1)	(0)
Beans (green)	644	184	447
	(79)	(1)	(6)
Corn (on the cob)	823	858	1000
	(70)	(1)	(3)
Peas (green)	274	230	157
	(59)	(2)	(5)
Peanuts	529	231	--
	(62)	(1)	(0)
Oca	1041	--	--
	(50)	(0)	(0)
Peppers	565	2208	--
	(45)	(1)	(0)
Papaliza	966	--	767
	(45)	(0)	(1)
Beans (dry)	400	--	--
	(7)	(0)	(0)
Barley (green)	1029	--	--
	(24)	(0)	(0)

Table 14. *Continued*

	Type of seed		
	Native seed	Hybrid or improved seed	Seed of unknown source
Quinua	782	--	--
	(6)	(0)	(0)
Carrots	3232	--	2760
	(9)	(0)	(1)
Grapes	5467	8495	1379
	(9)	(2)	(5)
Peaches[1/]	52286	--	11500
	(4)	(0)	(2)
Oranges[1/]	60000	--	9091
	(1)	(0)	(6)
Alfalfa	806	--	--
	(6)	(0)	(0)

Source: Table T51, stubs 8, 10, standard Table 10.

Note: Number in parentheses indicates number of farms using indicated type of seed for crop i = 1...19.

1/ Unit of measure is fruits.

Table 15. Average production (kilos) per hectare for farms reporting production of 19 crops by type of fertilizer and irrigation

	Organic fertilizer Chemical fertilizer Irrigation	Yes No Yes	Yes No No	No Yes Yes	No Yes No	Yes Yes Yes	Yes Yes No	No No Yes	No No No
Corn (grain)	(467)	650	354	301	262	460	850	989	1058
		(166)	(162)	(1)	(5)	(7)	(5)	(14)	(107)
Potatoes	(443)	1158	1255	1327	1662	1428	3001	1316	1486
		(116)	(232)	(4)	(4)	(31)	(26)	(6)	(24)
Wheat	(192)	294	241	126	--	--	710	308	252
		(15)	(103)	(2)	(0)	(0)	(2)	(6)	(64)
Barley (grain)	(167)	683	812	--	--	--	--	519	602
		(20)	(70)	(0)	(0)	(0)	(0)	(4)	(73)
Beans (green)	(84)	632	450	--	--	621	--	1042	573
		(33)	(21)	(1)	(0)	(3)	(0)	(6)	(20)
Corn (on the cob)	(72)	1017	422	--	--	4600	2300	438	1508
		(50)	(14)	(0)	(0)	(1)	(1)	(2)	(4)
Peas (green)	(62)	155	201	384	--	321	767	310	369
		(9)	(30)	(4)	(0)	(7)	(1)	(5)	(6)
Peanuts	(62)	374	320	--	4600	511	--	313	657
		(8)	(11)	(0)	(1)	(2)	(0)	(6)	(34)
Oca	(48)	15[illegible]4	1108	--	--	--	5520	789	760
		([illegible])	(25)	(0)	(0)	(0)	(1)	(2)	(14)
Peppers	(41)	300	419	--	--	--	--	583	695
		(2)	(6)	(0)	(0)	(0)	(0)	(4)	(29)
Papaliza	(45)	--	1100	--	--	--	--	920	649
		(0)	(36)	(0)	(0)	(0)	(0)	(1)	(8)
Beans (dry)	(7)	184	509	0	--	552	--	--	692
		(1)	(3)	(1)	(0)	(1)	(0)	(0)	(1)
Barley (green)	(24)	1826	1160	--	--	--	--	0	608
		(2)	(15)	(0)	(0)	(0)	(0)	(1)	(6)

Table 15. *Continued*

	Organic fertilizer Chemical fertilizer Irrigation	Yes No Yes	Yes No No	No Yes Yes	No Yes No	Yes Yes Yes	Yes Yes No	No No Yes	No No No
Quinua	(5)	920	731	--	--	--	--	184	--
		(1)	(3)	(0)	(0)	(0)	(0)	(1)	(0)
Carrots	(9)	482	2760	--	--	5152	--	3580	--
		(3)	(1)	(0)	(0)	(2)	(0)	(3)	(0)
Grapes	(11)	5021	1472	--	--	5096	9200	5832	--
		(6)	(1)	(0)	(0)	(3)	(1)	(0)	(0)
Peaches[1/]	(4)	511	--	--	--	--	--	74476	--
		(2)	(0)	(0)	(0)	(0)	(0)	(2)	(0)
Oranges[1/]	(4)	60000	--	--	--	--	--	22222	0
		(1)	(0)	(0)	(0)	(0)	(0)	(2)	(1)
Alfalfa	(6)	455	--	--	--	--	--	1220	--
	(6)	(2)	(0)	(0)	(0)	(0)	(0)	(4)	(0)

Source: Table T50, stubs 8, 10, standard Table 11.

Note: Numbers in parentheses indicate number of farms using indicated combination of cropping practices for crop i = 1...19.

[1/] Unit of measure is fruits.

The use of chemical fertilizer is not very common with the exception of potatoes. Of 443 farms producing potatoes, 65 farms or 15 percent use chemical fertilizer. The percentages on other crops are much less. In several instances, a crop is produced with no producer reporting the use of chemical fertilizer.

The use of irrigation is quite common for most crops. Of the 467 farms producing corn (grain), 188 farms or 40 percent use irrigation. Of the 443 farms producing potatoes, 157 farms or 35 percent use irrigation. Of the 192 farms producing wheat, 23 farms or 12 percent use irrigation. Only papaliza, a minor crop, has a lower irrigation frequency. On the other hand, 9 out of 11 grape producers use irrigation.

A basic premise is that for a sufficiently large sample, farms that use organic and/or chemical fertilizer and irrigation should have, for a majority of the 19 crops included, higher crop yields per hectare than farms not relying on either of these three cropping practices. The premise is not confirmed.

When comparing the first and second column in Table 15, we observe that farms using irrigation do not usually have higher crop yields per hectare, contrary to our expectations in this respect. The greatest surprise occurs when we compare the crop yields obtained with organic fertilizer (columns 1 and 2) or chemical fertilizer (columns 3 and 4) with the crop yields obtained by farms using neither organic nor chemical fertilizer (column 8). This comparison reveals that for the majority of the 19 crops included in Table 15, average production per hectare is highest on farms not using chemical or organic fertilizer.

Table 16 reports average production per hectare for farms reporting production of 19 crops by source of power. The striking feature of Table

Table 16. Average production (kilos) per hectare for farms reporting production of 19 crops by source of power

Crops	Source of power			
	Mechanical and animal	Only mechanical	Only animal	No mechanical No animal
Corn (grain)	1438	276	599	1507
	(1)	(1)	(391)	(67)
Potatoes	2300	-	1410	1400
	(1)	(0)	(362)	(70)
Wheat	-	-	230	1229
	(0)	(0)	(183)	(7)
Barley (grain)	-	-	644	1323
	(0)	(0)	(147)	(18)
Beans (green)	-	276	576	1117
	(0)	(1)	(70)	(14)
Corn (on the cob)	-	-	682	1309
	(0)	(0)	(36)	(34)
Peas (green)	-	-	313	165
	(0)	(0)	(58)	(3)
Peanuts	-	-	488	595
	(0)	(0)	(52)	(5)
Oca	-	-	1095	809
	(0)	(0)	(39)	(9)
Peppers	-	-	649	523
	(0)	(0)	(28)	(9)
Papaliza	-	-	984	780
	(0)	(0)	(39)	(6)
Beans (dry)	-	-	400	0
	(0)	(0)	(7)	(0)
Barley (green)	-	-	1030	1022
	(0)	(0)	(22)	(2)
Quinua	-	-	782	828
	(0)	(0)	(3)	(2)
Carrots	-	-	3228	2944
	(0)	(0)	(8)	(2)
Grapes	-	9200	-	4741
	(0)	(1)	(0)	(13)
Peaches[1/]	-	-	-	52287
	(0)	(0)	(0)	(4)
Oranges[1/]	-	-	-	57778
	(0)	(0)	(0)	(2)
Alfalfa	-	-	-	804
	(0)	(0)	(0)	(5)

Source: Table T50, stubs 8, 10, standard Table 12.

Note: Numbers in parentheses indicate number of farms using indicated cropping practice for crops i = 1...19.

[1/] Unit of measure is fruits.

16 is that the vast majority of farms rely exclusively on animal traction in the production of each of the 19 crops. Human energy as a source of power comes in as a distant second. Only 2 farms rely on animal and mechanical traction. Only 1 farm out of the 699 farms covered by the survey relies exclusively on mechanical traction.

For some important crops such as corn and grains, average crop yields per hectare on farms relying exclusively on human energy as a source of power are higher than on farms relying exclusively on animal power. For most other crops, however, there is no systematic difference in crop yields per hectare between these two sources of power.

Table 17 reports production per hectare for farms reporting production of 19 crops by use of herbicides, pesticides and fungicides. The use of these is not unknown in the southern valleys area. Of the 402 farms producing potatoes, 49 farms or 12 percent use such chemicals. Of the 461 farms growing corn, 13 farms or 3 percent use these chemicals. The latter percentage is typical for most crops except for quinua, carrots, grapes, peaches and oranges. Farms using herbicides, pesticides and fungicides tend to have higher yields than farms not using these chemicals. A notable exception is corn, perhaps because the chemicals are used not in a preventive sense but to minimize damage already sustained.

The farm household as a production unit: an algebraic analysis

Relative efficiency of land utilization Farming consists of the transformation of inputs into outputs. A concise description of this transformation process is represented by the production function

1) $Q_B = Q_B(\hat{X}_1, \hat{X}_2)$.

Table 17. Average production (kilos) per hectare for farms reporting production of 19 crops by use of other chemical products[a]

	Other chemical products are used	Other chemical products are not used
Corn (grain)	412	658
	(13)	(461)
Potatoes	1894	1262
	(49)	(402)
Wheat	468	221
	(5)	(194)
Barley (grain)	739	696
	(2)	(167)
Beans (green)	1417	559
	(3)	(82)
Corn (on the cob)	335	897
	(3)	(72)
Peas (green)	400	242
	(9)	(56)
Peanuts	500	521
	(3)	(60)
Oca	-	1041
	(0)	(50)
Peppers	782	571
	(3)	(43)
Papaliza	-	963
	(0)	(46)
Beans (dry)	386	408
	(1)	(6)
Barley (green)	-	1029
	(0)	(24)
Quinua	1012	169
	(2)	(4)
Carrots	3445	2392
	(5)	(5)
Grapes	5139	354
	(12)	(2)
Peaches[1/]	69000	13252
	(1)	(5)
Oranges[1/]	60000	4878
	(1)	(5)
Alfalfa	-	806
	(0)	(6)

Source: Table T50, stubs 8, 10, standard Table 13.

Note: Numbers in parentheses indicate number of farms using indicated cropping practice for crops i = 1...19.

[a]Herbicides, pesticides, fungicides, etc.

[1/]Unit of measure is fruits.

The above production function has two arguments, efficiency labor X_1 and efficiency land X_2, i.e., both labor and land are measured in efficiency units. The usual procedure is to measure inputs in terms of natural units, e.g., hours of labor and acres of land. No input, however, is homogeneous. Between farms, land will differ in quality, although they be of equal size. Between families, the quality of labor (male-female-child) will be different, although families may be of equal size. Furthermore, land and labor are not the only factors of production. Mechanization will increase the efficiency of a given amount of labor and possibly also increase the efficiency of land. Fertilizer, pesticides, improved seed and adequate water will increase the efficiency of land and possibly also the efficiency of labor. It follows that output can increase not only through an increase in the amount of resources, but also through an increase in the quality or efficiency of resources. The data of the Southern Valleys Area Survey are all expressed in natural units. The operational question is how to measure natural units in terms of efficiency units. The procedure followed here is to postulate, but not actually calculate, conversion factors between efficiency units and natural units.

2) $\hat{X}_1 = R_1 \cdot X_1$

3) $\hat{X}_2 = R_2 \cdot X_2$

In the southern valleys area, smaller farms use their available land resources much more intensively than large farms, because smaller farms dedicate a proportionately larger share of the area operated by the farm household to annual crops rather than natural pastures.

Table 18 examines selected features of resource efficiency in relation to the size of farm. One out of every two farms covered by the survey is smaller than two hectares. Yet, the 57 largest farms covered by

Table 18. Average farm size, average hectarage in annual crops, average value of crop production, average value of variable crop input cash costs, average value of miscellaneous crop cash costs by size of farm

	Size of farm					
	<1 ha.	1-1.99 has.	2-4.99 has.	5-5.99 has.	>6 has.	Total
Average farm size in hectares[1]	.40 (204)	1.37 (146)	2.96 (190)	6.48 (102)	22.55 (57)	3.99 (699)
Average hectarage in annual crops[1]	.34 (204)	.97 (146)	1.93 (190)	3.83 (102)	6.34 (57)	1.90 (699)
Average value of crop production[2]	1775 (204)	3044 (146)	5423 (189)	7185 (101)	15860 (57)	4966 (697)
Average value of variable crop input cash costs[3,4]	174.2 (204)	420.4 (146)	612.5 (186)	884.2 (102)	1749.5 (56)	574.9 (694)
Frequency of farm households with variable crop input cash costs[3]	143	87	112	63	39	444
Average value of miscellaneous crop cash costs[3,4]	24.5 (204)	44.7 (146)	27.7 (189)	119.1 (102)	395.6 (57)	73.7 (698)
Frequency of farm households with miscellaneous crop cash costs[3]	72	30	38	32	28	200
Average number of males and females 13-60 engaged principally in agriculture per household minus average number of household members emigrating for temporary work[6]	1.26 (204)	1.59 (146)	1.55 (190)	1.87 (102)	1.97 (57)	1.58 (699)
Average net household cash income per farm-household[5]	4989.0 (192)	3957.9 (136)	5931.5 (160)	5728.5 (94)	3304.6 (52)	4977.2 (634)

Source: [1]Table T15, stubs 1, 2, 3, 4, standard Table 7; [2]Table T23, stubs 1, 4, standard Table 7; [3]Table T49, stubs 4 through 9, standard Table 7; [4]excludes hired labor; [5]Table T28, stubs 1, 2; Table T9, stubs 1, 2, 3, 4, 5, 6, standard Table 7.

Note: Numbers in parentheses indicate number of observations used in average.

the survey average 22.5 hectares in size. Proportionately, therefore, farm size varies tremendously even though the survey covers exclusively "small farms." The average number of males and females between ages 13-60 engaged principally in agriculture per household minus the average number of household members emigrating for temporary work varies proportionately much less in relation to the size of farm. Consequently, the man-land ratio[1/] varies from 2.90 for farms smaller than 1 hectare to .08 for farms larger than 10 hectares. This very wide range in the basic factor endowment ratio has the immediate consequence[2/] that for identical cropping practices between relatively small and large farms, the former will specialize in those crops which are relatively intensive in the use of labor, whereas large farms will specialize in those crops which are relatively intensive in the use of land. We, therefore, would expect smaller farms to dedicate a proportionately larger share of arable land to annual crops and larger farms to dedicate a proportionately larger share of arable land to natural pastures.

Because the man-land ratio varies so much, we would expect also a substantial variation in the ratio of hectarage in annual crops to average farm size between different farm size groups. In Table 18, this ratio varies from .85 for farms smaller than 1 hectare to .28 for farms larger than 10 hectares. It follows that on the average, small farms will utilize many more labor days per hectare (of farm size) than large farms. The same principle should hold as to the composition of annual crops,

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[1/] Here defined as the ratio between the adjusted agriculturally active household labor force and the size of farm.

[2/] T. M. Rybczynski, "Factor endowments and relative commodity prices," *Economica*, N.S. Vol. 22, 1955, pages 336-341. For a simple proof of above theorem, see H. Van de Wetering, "A class of policy models based on the two product-two factor general equilibrium model of the competitive industry," Iowa State University, Ames, Iowa, 1979, p. 11-13.

where smaller farms will specialize in the relatively more labor-intensive crops. The average value of crop production per hectare for smaller farms should therefore be higher than for larger farms.

In Table 18, farms with .96 hectares in annual crops achieve an average value of crop production equal to 3,044 pesos. The largest farm size group with 6.34 hectares in annual crops achieves an average value of crop production equal to 15,860 pesos. A 6.6-fold increase in area, in annual crops leads to a 5.2-fold increase in the value of crop production. The expansion is less than proportionate, as would have been the case if small and large farms use identical cropping practices and if the composition of crops would have been the same.

Seven out of ten farms use variable cash costs (fertilizer, improved seed, etc., but not expenditure on hired labor) producing crops. This relative frequency does not vary systematically between farm size groups. On the other hand, the average value of variable crop input cash costs per hectare is larger for smaller farms than larger farms. Farms less than 1 hectare in size spend 512 pesos on variable crop input cash costs per hectare. The corresponding figure for farms larger than 10 hectares in size equals 276 pesos.

Land resources can also be used more effectively when land is flat and tractorable, through irrigation, multiple cropping and leaving a lesser proportion of land in fallow. Tables 19 and 20 examine these factors for the southern valleys area. Table 19 presents the average farm size, average hectarage in annual crops and average irrigated hectarage in annual crops by size of farm. Of 699 farms, 317 indicated irrigation of annual crops. Such farms irrigated an average of 1.37 hectares in annual crops. The proportion of farms who irrigate varies inversely with farm

Table 19. Average farm size, average hectarage in annual crops and average irrigated and nonirrigated hectarage in annual crops by size of farm

	Size of farm					
	< 1 ha.	1-1.99 has.	2-4.99 has.	5-9.99 has.	> 9.99 has.	Total
Average farm size (hectares)	.40 (204)	1.37 (146)	2.96 (190)	6.48 (102)	22.55 (57)	3.99 (699)
Average hectarage in annual crops	.34 (204)	.97 (146)	1.93 (190)	3.83 (102)	6.34 (57)	1.90 (699)
Average irrigated hectarage in annual crops	.32 (148)	.91 (67)	1.96 (64)	3.89 (23)	7.45 (15)	1.37 (317)
Average nonirrigated hectarage in annual crops	.40 (56)	1.02 (79)	1.94 (123)	3.82 (79)	5.95 (42)	2.36 (379)
Total number of farms	204	146	190	102	57	699

Source: Table T15, stubs 1, 2, 3, 4, standard table 7, standard table 2.

Note: Number in parentheses indicates number of observations used in average.

Table 20. Fallow land, multiple cropping each type of terrain by size of farm

	Size of farm					
	<1 ha.	1-1.99 has.	2-4.99 has.	5-9.99 has.	>9.99 has.	Total
Frequency of farms						
1. With fallow land in rotation	5	6	12	7	6	36
2. With fallow land for lack of time	6	18	14	8	5	51
3. With fallow land for lack of labor	3	5	9	3	0	20
4. With fallow land for lack of inputs	4	6	18	8	6	42
5. With fallow land for other reasons	11	9	4	7	2	33
6. With fallow land not responding	0	0	1	0	1	2
7. With multiple cropping	34	18	31	12	15	110
8. With flat, tractorable land	79	53	84	59	28	303
9. With flat, nontractorable land	50	30	32	18	14	144
10. With rolling land	8	9	13	5	6	41
11. With steep land	64	50	60	19	9	202
Frequency of farms in size group	204	146	190	102	57	699

Source: Table T1 , stubs 1-11, standard Table 7.

Note: Items 2, 3, 4, 5 allow for multiple responses.

size. The average hectareage in annual crops between farms who irrigate and who do not irrigate tends to be different for each size group. Such differences do not appear to be related to farm size.

Table 4 showed that for the 699 farms included in the survey, the average area in fallow equals .35 hectares per farm or 9 percent of the average size of farm. Often, land in fallow is part of a rotation. Table 20 indicates, however, that a majority of the reasons given as to why land is in fallow are related to the lack of inputs, time, or labor. Table 20 also shows that multiple cropping is not uncommon in the southern valleys areas. Of 699 farms, 110 farms or 16 percent use this practice. Of 350 farms smaller than 2 hectares, 52 farms or 15 percent use this practice. It follows that the use of multiple cropping must be slightly above average on farms larger than 2 hectares.

Table 20 also contains information about the nature of the terrain on which farms are located. Of the 350 farms smaller than two hectares, 114 farms or 33 percent are located on steep land. Of the 159 farms larger than 5 hectares, 38 farms or 18 percent are located on steep land. Of the 350 farms smaller than two hectares, 232 farms or 66 percent are located on flat land. Of the 159 farms larger than 5 hectares, 119 farms or 75 percent are located on flat land. Consequently, smaller farms tend to operate land which is less suitable to animal or mechanical traction. This difference between smaller and larger is much less than might have been expected. The nature of the terrain is not a major determinant of the difference in net farm income between farms.

The demand for land and labor

In what follows, we will assume that the production function of the farm household does not exhibit scale economies. If both land and labor

are increased by an equal proportion, then output is assumed to increase by that same proportion. The mathematical equivalent is to assume that the production function is homogeneous of degree one in efficiency labor and efficiency land. This allows us to rewrite the production function in productivity form

1B) $Q_B/\hat{X}_1 = f[\hat{X}_2/\hat{X}_1]$

The above equation states that output per unit of efficiency labor depends exclusively on the efficiency land-efficiency labor ratio. We will show subsequently that this implies that the size of farm does not influence the technology used by the farm or its average cost of production. The average cost curve for such a farm is horizontal. Because of this, its marginal cost curve coincides with its average cost curve. Farms with identical efficiency land-efficiency labor ratios will have identical costs of production if the underlying production function is the same. Should this not be so, then costs of production will differ between farms. Because of substantial independent variations in the size of household (X_1) and the size of the farm (X_2) and in the quality of the resources between farms, we should expect a great deal of additional variation in the costs of production between farms. But we do not attribute such differences in costs of production to the size of farm.

Economic rationality dictates that farm households minimize the cost of production of a given output and, furthermore, choose that output which maximizes material welfare. In order to minimize costs for a given output, we must have the following first order conditions:

4) $P_B \cdot \partial Q_B/\partial \hat{X}_1 = \hat{P}_1$

5) $P_B \cdot \partial Q_B/\partial X_2 = \hat{P}_2$

where P_B is the price of commodity B, $\hat{P}_1$ the efficiency price (or efficiency wage) of labor and $\hat{P}_2$ the efficiency rental of land. These common-sense conditions underlie the following compact system of factor demand equations.[1/]

Table 21. Factor demand equations and the cost function in efficiency inputs and prices

	$\hat{p}_1$	$\hat{p}_2$	q
$\hat{x}_1$	$-k_2\sigma$	$k_2\sigma$	1
$\hat{x}_2$	$k_1\sigma$	$-k_1\sigma$	1
p_B	k_1	k_2	0

In this table, the lower case symbols $\hat{x}_1$, $\hat{x}_2$, $\hat{p}_1$, $\hat{p}_2$, q and p_B indicate percentage rates of change, e.g., $q = \Delta Q/Q$. The coefficient σ represents the elasticity of factor substitution between efficiency labor and efficiency land. The value of σ lies between zero and infinity. It will tend towards the latter value if land is a perfect substitute for labor. If land and labor cannot substitute for each other, then $\sigma = 0$. The data in the survey do not permit us to estimate σ statistically.[2/] Ibanez[3/] obtained the following partial Allen elasticities of substitution after estimating the value added tranolog production function for the agricultural crop sector in the Central and Sacaba valleys in Cochabamba, Bolivia.

$\sigma_{\text{land, water}} = -.60$

[1/] For the derivation, see Van de Wetering, *op. cit.*

[2/] Statistical estimation of σ is possible for the 1978 sector survey.

[3/] Carlos Ibanez Meier, "An agricultural model for the Central and Sacaba valleys in Cochabamba, Bolivia," Unpublished M.Sc. thesis, Utah State University, Logan, Utah, 1980.

$\sigma_{water,\ labor} = +.46$

$\sigma_{land,\ labor} = +.53$

These results indicate that water and land are complimentary factors of production but that labor is a substitute for both land and water. Aggregation of land and water into one category results in an elasticity of substitution between land and labor below unity.

The coefficient $k_1 = P_1X_1/P_BQ_B$ is the share of labor in the market value of net farm output P_BQ_B. Its complement $k_2 = P_2X_2/P_BQ_B$ is the share of land in the market value of net farm output. The sum of these two coefficients equals unity given our assumption that the production function is homogeneous of degree one in efficiency labor and efficiency capital.[1/] The share of income k_2 attributed to land varies with the land-man ratio (X_2/X_1) such that[2/]

$$\frac{\Delta k_2}{k_2} = -\frac{1-\sigma}{\sigma} \cdot k_1 \cdot \frac{\Delta(X_2/X_1)}{(X_2/X_1)}$$

An increase in the land-labor ratio (X_2/X_1) will decrease k_2 whenever $\sigma <$ 1. The land-labor ratio for the farm households in the southern valleys increases with farm size X_2. Consequently, k_2 decreases with the size of farm. Table 22 reflects that the survey observed 31 farm households who rented cropland with payment in kind. The median crop share accruing to the landowner equalled 50 percent.[3/] No farm larger than 5 hectares rented land. For these farms, we may assume that [illegible] somewhat less

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[1/] H. Van de Wetering, "Lecture notes in capital and growth theory," Iowa State University, Ames, 1980.

[2/] Ibanez, *op. cit.* p. 134, obtained the following value for ratio $k_1/k_2 = 1.42$. Assuming that $k_1 + k_2 = 1$, it follows that $k_1 = .59$ and $k_2 = .41$.

[3/] Tabulations, Table 7-14.

Table 22. Frequency of cash rental and share cropping by size of farm

	Size of farm					
	<1 ha.	1-1.99 has.	2-4.99 has.	5-9.99 has.	>9.99 has.	Total
Frequency of farms renting with payments in cash	7	6	10	6	3	32
Frequency of farmers renting with payment in kind	1	10	20	0	0	31
Frequency of payments in kind						
up to 20% of crop	1	0	5	0	0	6
21 to 35% of crop	0	0	1	0	0	1
36 to 45% of crop	0	0	1	0	0	1
46 to 55% of crop	0	9	13	0	0	22
56 to 65% of crop	0	0	0	0	0	0
66 to 80% of crop	0	0	0	0	0	0
More than 80% of crop	0	1	0	0	0	1
Frequency of farm-households by farm size interval	204	146	190	102	57	699

Source: Table T14, stubs 1-9, standard Table 7.

than .50.[1/] For farms larger than 5 hectares, the share imputed to land k_2 is likely to be smaller than .50. We therefore postulate the following inequality to hold for each of the five farm size cohorts of the southern valleys survey

$$0 \leq k_2 \leq \sigma \leq 1.$$

In Table 21, we consider factor prices and output as independent variables, whereas the quantities demanded of the factors and the cost of production are considered as dependent variables. But in the previous section, we took the size of the farm as given, i.e., x_2 is not a dependent variable, but an independent variable.[2/] On the other hand, the most profitable level of production q was considered to be a dependent variable and not an independent variable as in Table 21. Executing the desired transposition of variables and resolving the three simultaneous equations in the desired set of dependent variables yields Table 23. In the previous

Table 23. Three key variables that determine the demand for labor and the optimal level of production of the farm household

	$\hat{p}_1$	$\hat{x}_2$	p_B
$\hat{x}_1$	$-\sigma/k_2$	1	σ/k_2
q	$-k_1\sigma/k_2$	1	$k_1\sigma/k_2$
$\hat{p}_2$	$-k_1/k_2$	0	$1/k_2$

[1/] The crop share refers to gross farm output, k_2 is calculated for net farm output.

[2/] If farm households rent land, then the size of farm is not really an independent variable, although we may still assume so for purposes of analysis. Of the 699 covered by the survey, 63 farm households rented land (Table 7-14). The average area rented is not available.

section, we used variables in natural units. In Table 23, four variables appear in efficiency units. The transition from efficiency units to natural units proceeds as follows. By definition

$$\hat{X}_1 = R_1 \cdot X_1$$

$$\hat{X}_2 = R_2 \cdot X_2.$$

Indicating percentage rates of change by lower case letters, we have

$$\hat{x}_1 = r_1 + x_1$$

$$\hat{x}_2 = r_2 + x_2.$$

Also, by definition

$$\hat{P}_1 \cdot X_1 = P_1 \cdot X_1$$

$$\hat{P}_2 \cdot X_2 = P_2 \cdot X_2.$$

Taking percentage rates of change and using the results above, it is easily shown that

$$\hat{p}_1 = p_1 - r_1$$

$$\hat{p}_2 = p_2 - r_2.$$

Substituting natural concepts for efficiency concepts in Table 23, we obtain the first three rows in Table 24. Taking combinations of variables, we obtain the last eight rows in that table. Table 24 is a comprehensive characterization of the predicted economic behavior of the farm household as a production unit. It contains 55 testable hypotheses. The sign (+ or -) of these hypotheses is known in most instances. If we assume the following inequality to hold $0 \leq k_2 \leq \sigma \leq 1$, then all of the signs are known. The top row in Table 24 lists five exogenous variables.

p_1: the % change in the off-farm agricultural wage rate w

p_B: the % change in the price received by farmers

x_2: the % change in the size of the farm, expressed in natural units

Table 24. A comprehensive characterization of the farm household as a production unit

	p_1	x_2	p_B	r_1	r_2
x_1	$-\sigma/k_2$	1	σ/k_2	$\frac{\sigma - k_2}{k_2}$	1
q	$-k_1\sigma/k_2$	1	$k_1\sigma/k_2$	$k_1\sigma/k_2$	1
p_2	$-k_1/k_2$	0	$1/k_2$	k_1/k_2	1
$(q - x_1)$	σ	0	$-\sigma$	$(1-\sigma)$	0
$(q - x_2)$	$-k_1\sigma/k_2$	0	$k_1\sigma/k_2$	$k_1\sigma/k_2$	1
$(x_2 - x_1)$	σ/k_2	0	$-\sigma/k_2$	$\frac{k_2 - \sigma}{k_2}$	-1
$(p_B + q)$	$-k_1\sigma/k_2$	1	$\frac{k_1\sigma + k_2}{k_2}$	$k_1\sigma/k_2$	1
$(p_1 + x_1)$	$\frac{k_2 - \sigma}{k_2}$	1	σ/k_2	$\frac{\sigma - k_2}{k_2}$	1
$(p_2 + x_2)$	$-k_1/k_2$	1	$1/k_2$	k_1/k_2	1
$(p_B + q - x_1)$	σ	0	$(\sigma - 1)$	$(1 - \sigma)$	0
$(p_B + q - x_2)$	$-k_1\sigma/k_2$	0	$\frac{k_1\sigma + k_2}{k_2}$	$k_1\sigma/k_2$	1

r_1: the % change in the relative efficiency of labor on farm A compared to farm B

r_2: the % change in relative efficiency of land on farm A as compared to farm B.

We distinguish eleven endogenous variables.

x_1: the % change in the demand for labor by the farm household

q: the % change in net farm output

P_2: the % change in the imputed rental rate of 1 hectare of land

$(q-x_1)$: the % change in net farm output per hour (or per worker or per capita)

$(q-x_2)$: the % change in net farm output per hectare

(x_2-x_1): the % change in the land-labor ratio or the labor intensity of the production technology used by the farm household

(p_B+q): the % change in the value of net farm output

(p_1+x_1): the % change of the share of gross farm income imputed to labor

(p_2+x_2): the % change in the share of gross farm income imputed to land

(p_B+q-x_1): the % change in the value of net farm output per hour (or per worker or per capita)

(p_B+q-x_2): the % change in the value of net farm output per hectare.

Table 24 is the reduced form of the behavior of the farm household as a production unit. Each row in that table gives the expected values of the coefficients of an ordinary least squares multiple regression. Such regressions could be run for the region as a whole, or for each of the departmental areas. Additional exogenous variables such as time to market could also be included as explanatory variables. In order to run the regressions,

one would need to construct an index of prices received (p_B) for each farm, as well as the indices of relative labor efficiency (r_1) and land efficiency (r_2). The data of the survey would enable one to construct these data for each farm and, hence, execute the causal econometric analysis suggested by Table 24.

Available tabulations for this report did not anticipate multiple regression analysis of the data. The procedure followed in its place is to obtain a cross tabulation for each intersection, i.e., each individual coefficient, in Table 24. Such a procedure stratifies a selected exogenous variable, e.g., farm size into farm size groups, and then calculates the average of the dependent variable, e.g., number of man-days of hired labor for each farm size group. If the selected exogenous variable exhibits substantial variation and/or has a disproportionately large influence on the endogenous variable selected, then the inferred relationship of the cross tabulation between the selected endogenous and exogenous variable will be approximately a causal one. If, however, the selected exogenous variable shows little variability and/or does not exhibit a proportionately large influence on the selected endogenous variable, then the causal inference of the cross tabulation will be spurious, even though accidentally an apparently close relationship between the selected pair of variables may be apparent.

If the elasticity of factor substitution $.6 < \sigma < 1$, then a study of the coefficients of Table 24 reveals that none of the five exogenous variables can be selected *a priori* as having proportionately the largest effect on any of the eleven endogenous variables. The implicit assumption in the survey cross tabulations is, however, that size of farm is the major explanatory variable. Given the foregoing, this will be true only if the remaining exogenous variables exhibit little or no variability.

We do not believe that is so. Consequently, comprehensive cross tabulations which stratify these variables (the agricultural wage rate, prices received by farmers, the relative efficiency of labor, the relative efficiency of land) would have been desirable. They were not available for this report, but should be considered in the analysis of the 1978 sector survey.

SECTION IV.
EMPLOYMENT AND LABOR USE

Variables that influence the employment of farm household labor off-farm in agricultural activities (X^*_{12})

Table 25 summarizes alternative configurations of the sources and uses of labor. It reflects the following five assumptions:

1) Some household labor will always be employed on the farm, i.e., $X_{11} > 0$.
2) If members of the farm household are employed off the farm in agriculture, then the farm household will not use hired labor, i.e., if $X^*_{12} > 0$, then $X_{12} = 0$.
3) If the farm household uses hired labor, then members of the farm household will not be employed off the farm in agriculture, i.e., if $X_{12} > 0$, then $X^*_{12} = 0$.
4) Members of the farm household employed off the farm may or may not find employment in nonagricultural activities, i.e., $X^*_{13} \geq 0$.
5) All of the labor used by the farm household may be furnished exclusively by members of the farm household; in that case $X_{11} > 0$, but $X^*_{12} = X^*_{13} = X_{12} = 0$.

When considering the sources and uses of labor, we made use of two accounting identities:

$$X_1 = X_{11} + X_{12}$$

$$X^*_1 = X_{11} + X^*_{12} + X^*_{13}.$$

The two identities contain six employment-related variables. The two identities have therefore in principle multiple solutions. In the above two equations, we consider the supply of household labor X^*_1 as exogenous.

In the previous section, we showed that the amount of labor employed X_1 by the farm household is determined by the off-farm agricultural wage ($p_1 = w$), prices received (p_3), the size of the farm (x_2), and the relative efficiency of labor (r_1) and land (r_2). None of these five variables appears in the above two equations. We may, therefore, consider X_1 as an exogenous variable to the remaining variables appearing in those equations. From Table 25, we have that if the household employs members off the farm in agriculture ($X^*_{12} > 0$), then the farm household will not use hired labor ($X_{12} = 0$). On the other hand, if the farm household uses hired labor ($X_{12} > 0$), then members of the farm household will not be employed off-farm in agriculture ($X^*_{12} = 0$). Consequently, in the above pair of equations, either ($X^*_{12} > 0$, $X_{12} = 0$) or ($X^*_{12} = 0$, $X_{12} > 0$).[1/] We know from Table 29 that

Table 25. Alternative configurations of the sources and uses of farm household labor

	Alternative Configurations				
	(a)	(b)	(c)	(d)	(e)
Farm household labor					
employed on the farm (X_{11})	+	+	+	+	+
employed off-the-farm					
in agricutlure (X^*_{12})	+	+	0	0	0
outside agriculture (X^*_{13})	0	+	0	+	0
Hired labor					
employed on the farm X_{12}	0	0	+	+	0

[1/] A third possibility $X^*_{12} = X_{12} = 0$ is irrelevant whenever we want to investigate cases where $X^*_{12} \neq 0$; $X_{12} \neq 0$.

off-farm employment in nonagricultural activities X^*_{13} is relatively well paid. Assume now that such employment activities are limited because of sex, age, location or other considerations. If the farm household maximizes net household income for a given supply of household labor, then in allocating its labor resources, it will first of all fill this employment opportunity. X^*_{13}, therefore, may also be taken as exogenously determined. Solving the two equations for X^*_{12} or X_{12}, respectively, we obtain

A) $X^*_{12} = -(X_1 - X^*_1 + X^*_{13})$; $(X_{12} = 0)$

B) $X_{12} = X_1 - X^*_1 + X^*_{13}$; $(X^*_{12} = 0)$.

In the above equations, X_1, X^*_1, X^*_{13} are known variables. It will be observed that equations A and B are identical except for signs, i.e., they register an opposite reaction with respect to variations in X_1, X^*_1 or X^*_{13}. Rewriting equation A in percentage rates of change,[1/] we obtain

$$x^*_{12} = \frac{-X_1}{X^*_{12}} \cdot x_1 + \frac{X^*_1}{X^*_{12}} \cdot x^*_1 - \frac{X^*_{13}}{X^*_{12}} \cdot x^*_{13} .$$

From Table 24, we obtain

$$x_1 = (-\sigma/k_2) \cdot p_1 + 1 \cdot x_2 + (\sigma/k_2) + \left(\frac{\sigma-k_2}{k_2}\right) r_1 + 1 \cdot r_2 .$$

Substituting for x_1 in the first equation yields the following conclusions:

1) An increase in the off-farm wage rate ($p_1 = w$) will decrease the amount of labor used by the farm household X_1 the thereby <u>increase</u> the amount of household labor X^*_{12} employed off-farm in agricultural activities.

2) An increase in the size of farm (x_2) will increase the amount of

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[1/] Lower case letters are used throughout this report to indicate percentage rates of change, e.g., $x^*_{12} = \Delta X^*_{12}/X^*_{12}$.

labor employed by the farm X_1 and thereby <u>decrease</u> the amount of household labor X_{12}^* employed off-farm in agricultural activities.

3) An increase in prices received by farmers (P_B) will increase the amount of labor used by the farm household X_1 and thereby <u>decrease</u> the amount of household labor X_{12}^* employed off-farm in agricultural activities.

4) An increase in the relative efficiency of labor (r_1) will increase the amount of labor used by the farm household X_1 and thereby <u>decrease</u> the amount of household labor X_{12}^* employed off-farm in agricultural activities.

5) An increase in the relative efficiency of land (r_2) will increase the amount of labor used by the farm household X_1 and thereby <u>decrease</u> the amount of household labor X_{12}^* employed off-farm in agricultural activities.

6) An increase in the quantity of labor X_1^* supplied by the household will <u>increase</u> the amount of household labor X_{12}^* employed off-farm in agricultural activities.

7) An increase in the quantity of household labor employed off the farm in nonagricultural activities X_{13}^* will <u>decrease</u> the amount of labor X_{12}^* employed off-farm in agricultural activities.

Table 26 shows that 155 households of the 699 households covered by the survey had members employed off-farm in agriculture in Bolivia. To this, we may add 20 households who had members employed off-farm in agriculture outside of Bolivia. One out of four households, therefore, had members employed off-farm in agriculture. There are departmental differences in the relative frequency of off-farm employment in agriculture.

Table 26. The amount and renumeration of off-farm agricultural employment by region and departments

	Region	Chuquisaca	Tarija	Potosi
Frequency of households with members employed off-farm in agriculture in Bolivia[1/]	155	45	54	56
Average number of man-days worked off-farm in agriculture in Bolivia by households with members employed off-farm	72.8 (149)	72.6 (42)	68.8 (54)	76.7 (53)
Average value of man-days worked off-farm in agriculture in Bolivia by households with members employed off-farm	31.1 (149)	20.5 (42)	37.1 (54)	33.4 (53)
Frequency of households with members employed off-farm in agriculture outside Bolivia	20	0	1	19
Average number of man-days worked off-farm in agriculture outside Bolivia by households with members employed off-farm	126.9 (19)	- (0)	120.0 (1)	127.2 (18)
Average value of man-days worked off-farm in agriculture outside Bolivia by households with members employed off-farm	4263.2 (19)	- (0)	4000.0 (1)	4277.8 (18)
Average earnings from other agricultural work off-farm on a nondaily basis	287.1 (694)	7.7 (143)	235.9 (209)	435.2 (342)

Source: Table T38, stubs 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, standard Table 7.

1/ Equals number of farms having attribute.

Note: Numbers in parentheses equal the number of observations used in average.

Thirty-one percent of the farm households in Chuquisaca had members employed off-farm in agriculture. The corresponding figures for Tarija and Potosi are 25 and 21 percent, respectively.

The average number of man-days worked off-farm in agriculture in Bolivia by households with members employed off-farm equalled 72.8 man-days. There is relatively little variation in this average among departmental areas. On the other hand, the average number of man-days worked off-farm in agriculture outside Bolivia is much larger at 126.9 man-days.

The average value of a man-day worked off-farm in Bolivia equalled 31.1 pesos. The corresponding figure for off-farm employment in agriculture outside Bolivia is almost the same at 33.6 pesos. It is interesting to note that the 187 farms hiring labor (see Table 2) paid an average daily wage of 27.7 pesos, which is below the daily wage of 31.1 pesos indicated by the recipients. This discrepancy holds for all three departmental areas. As before, Chuquisaca reports the lowest daily wage rate with Tarija and Potosi indicating significantly higher wage rates. The wage rate is, therefore, far from uniform throughout the area.

Virtually, all households indicate earnings from other agricultural work off-farm on a nondaily basis. Such earnings amount to 287 pesos per family or 4.3 percent of net household income (see Table 39). There are substantial departmental differences in this item. For example, for the Potosi area, average earnings from other agricultural work off-farm on a nondaily basis equals 435 pesos or 8.6 percent of net household income. The corresponding figure for the Chuquisaca area is close to zero.

The 155 households with members employed off-farm in agriculture in Bolivia provided 10,847 man-days of hired labor. From Table 31, we observe that the 187 farms employing hired labor indicated a total use of

10,883 man-days of hired labor. The coincidence of these figures attests to the reliability of the data generated by the southern valleys area survey.

Table 27 shows that the relative frequency of households with members employed off-farm in agriculture in Bolivia shows no relationship with the size of farm, except for farms larger than 10 hectares. The average number of man-days worked off-farm in agriculture in Bolivia for such households is not related to farm size, but varies closely around the regional average of 72.8 man-days. The wate rate received by household members working off-farm in agriculture in Bolivia is not influenced by size of farm and varies closely around the regional average daily wage of 31.1 pesos.

Average earnings from other agricultural work off-farm on a nondaily basis tends to be higher for smaller sized farms. For farms smaller than 1 hectare, such income accounts for 9 percent of net household income. For farms larger than 5 hectares, such income accounts for 2.6 percent of net household income.

Table 28 shows that 152 households had members employed off-farm in agriculture. Of these households, 15 or 9.9 percent received technical training/assistance, bank credit or both. Of the 699 farms included in the survey, 59 farms or 8.4 percent received technical training/assistance, bank credit or both. Consequently, training and credit availability are not skewed against farm households with members employed off-farm in agriculture.

The average number of man-days worked off-farm in agriculture does not vary between these groups, i.e., it is equal to the regional average of 78.9 man-days. On the other hand, definitive title and proximity to market influence the number of man-days worked off-farm in agriculture. For farm

Table 27. The amount and renumeration of off-farm agricultural employment by size of farm

	Size of farm					
	<1 ha.	1-1.99 has.	2-4.99 has.	5-9.99 has.	>9.99 has.	Total
Frequency of households with members employed off-farm in Bolivia[1/]	44	38	39	27	7	155
Average number of man-days worked off-farm in agriculture in Bolivia by households with members employed off-farm	81.5 (40)	70.2 (36)	56.1 (39)	85.7 (27)	74.4 (7)	72.8 (149)
Average value of man-days worked off-farm in agriculture in Bolivia by households with members employed off-farm	33.1 (40)	27.0 (36)	30.1 (39)	35.0 (27)	30.7 (7)	31.1 (149)
Frequency of households with members employed off-farm outside Bolivia[1/]	16	1	1	1	1	20
Average number of man-days worked off-farm in agriculture outside Bolivia by households with members employed off-farm	133.6 (16)	40.0 (1)	180.0 (1)	120.0 (1)	60.0 (1)	126.9 (19)
Average value of man-days worked off-farm in agriculture outside Bolivia by households with members employed off-farm	4312.5 (16)	2000.0 (1)	0 (0)	4000.0 (1)	6000.0 (1)	4263.2 (19)
Average earnings from other agricultural work off-farm on a nondaily basis	558.6 (203)	131.0 (145)	190.9 (189)	302.0 (101)	0 (57)	287.1 (694)

Source: Table T38, stubs 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, standard Table 7.

[1/] Equals number of farms having attribute.

Note: Numbers in parentheses equal the number of observations used in average.

Table 28. Average number of man-days worked off-farm in agriculture in Bolivia and outside Bolivia by households with members employed off-farm according to technical training/assistance, credit source, tenancy and time to market

	No training/ assistance, No bank credit	Training/ assistance, No bank credit	No training/ assistance, Bank credit	Training/ assistance, Bank credit	Non-response	Total
Definitive title <3 hours to market	56.9 (26)	60.0 (1)	120.0 (1)	15.0 (2)	300 (1)	64.0 (31)
No definitive title <3 hours to market	93.9 (47)	85.0 (2)	181.5 (2)	- (0)	45.0 (2)	95.0 (53)
Definitive title >3 hours to market	46.4 (24)	52.5 (2)	- (0)	- (0)	100.0 (1)	48.8 (27)
No definitive title >3 hours to market	75.4 (31)	75.0 (4)	- (0)	- (0)	- (0)	75.4 (35)
No response	21.5 (4)	10.0 (1)	- (0)	- (0)	1.0 (1)	16.2 (6)
Total	78.7 (132)	64.5 (10)	161.0 (3)	15.0 (2)	88.5 (5)	78.9 (152)

Source: Table T38, stubs 2, 4, 6, 8, standard Table 8.

Note: Numbers in parentheses are numbers of observations used in average.

households with members employed off-farm, with definitive title and more than 3 hours to market, the average number of days worked off-farm in agriculture 48.8 man-days. For similar farms, but with less than 3 hours to market, the corresponding average increases to 64.0 man-days. For households with members employed off-farm in agriculture, with no definitive title and with more than three hours to market, the average number of man-days worked off-farm in agriculture equals 74.5 days. For similar households with less than three hours to market, the corresponding average equals 95.0 man-days.

Table 29 shows that one in four households had members employed off-farm in nonagricultural activities. There is some departmental area variation in this figure. For the Potosi area, only one out of five households had members employed off-farm in nonagricultural activities. The corresponding relative frequencies for Tarija and Chuquisaca are 32 and 27 percent, respectively.

For the 168 households with members employed off-farm in nonagricultural activities, average annual earnings from such activities equalled 9264 pesos. There is surprisingly little variation in this figure between departmental areas.

Table 30 shows that the relative frequency of households with members employed off-farm in nonagricultural activities declines with time to market. For farms with less than three hours to market, one of two households has members employed off-farm in nonagricultural activities. For farms with more than three hours to market, only one out of seven households has members so employed.

Average earnings per household with members employed off-farm in nonagricultural activities decrease very rapidly with time to market. For

Table 29. Frequency and average earnings of off-farm employment in nonagricultural activities by region and departments

	Region	Chuquisaca	Tarija	Potosi
Percent of households with members employed off-farm in nonagricultural activities[1/]	24.3	27.0	31.6	18.8
Average earnings from nonagricultural activities off-farm	9264	9174	9592	8979
Number of farms used in average	168	38	66	64

Source: Table T38, stubs 11, 12, 13, standard Table 7.

[1/] Equals number of farms having the attribute divided by total number of farms in region or department.

Table 30. Frequency and average earnings of off-farm employment in nonagricultural activities by time to market

	Time to market				
	<1 hour	1-3 hours	3-6 hours	>6 hours	Total
Frequency of households with members employed off-farm in nonagricultural activities[1/]	44	65	40	17	168
Average earnings from nonagricultural activities	15301	9624	3850	5706	9264
Total number of farms	116	170	200	183	691[2/]

Source: Table T38, stubs 11, 12, 13, standard Table 3.

1/ Number of farms having the attribute.

2/ Includes invalid responses to "time to market."

the 109 households with less than three hours to market, average earnings off-farm in nonagricultural activities equalled 11,916 pesos. For the 57 households with more than three hours to market, the corresponding average equalled 4103 pesos.

Variables that influence the employment of hired labor

Equation B can be rewritten in percentage rates of change.

$$x_{12} = \frac{X_1}{X_{12}} \cdot x_1 - \frac{X_1^*}{X_{12}} \cdot x_1^* + \frac{X_{13}^*}{X_{12}} \cdot x_{13}^*$$

As before

$$x_1 = (-\sigma/k_2)p_1 + 1 \cdot x_2 + (\sigma/k_2)p_B + \left(\frac{\sigma-k_2}{k_2}\right) r_1 + 1 \cdot r_2.$$

The variables in these equations determine the rate of change in the employment of hired labor X_{12}.

1) An increase in the off-farm wage rate ($p_1 = w$) will decrease the amount of labor used by the farm household X_1 and thereby decrease the amount of hired labor X_{12} used by the farm household.
2) An increase in the size of farm (x_2) will increase the amount of labor used by the farm household (X_1) and thereby increase the amount of hired labor X_{12} used by the farm household.
3) An increase in prices received by farmers (p_B) will increase the amount of labor used by farm households and thereby increase the amount of hired labor X_{12} used by the farm household.
4) An increase in the relative efficiency of labor (r_1) will increase the amount of labor used by the farm household X_1 and thereby increase the amount of hired labor X_{12} used by the farm household.

5) An increase in the relative efficiency of land (r_2) will <u>increase</u> the amount of hired labor X_{12} used by the farm household.

6) An increase in the quantity of labor X_1^* supplied by the farm household will <u>decrease</u> the amount of hired labor used by the farm household.

7) An increase in the quantity of household labor employed off-farm in nonagricultural activities X_{13}^* will <u>increase</u> the amount of hired labor X_{12} used by the farm household.

Table 31 shows that 188 farms of the 699 farms covered by the survey used hired labor for an average of 58.2 man-days per farm hiring labor. This yields a total of 10,941 hired man-days for the region or 6.2 hired man-days per hectare in crops (including fallow). The southern valley survey did not obtain data on total labor requirements per hectare in crops. Ibanez[1/] found that for the Central and Sacaba Valleys total labor requirements per hectare in crops (including fallow) equalled 88.4 man-days. If we take this figure as a guide for the southern valleys area, we find that hired labor accounts for seven percent of total labor requirements in crop production. If we add to this total the labor requirements in livestock production, then the proportional importance of hired labor as a component of the total use of labor is less than seven percent.

It would have been useful to calculate the proportional contribution of hired labor to the total use of labor by farms hiring labor. The required tabulations, however, are not available which would allow us to execute this calculation.

[1/] Carlos Ibanez-Meier, "An agricultural model for the Central and Sacaba valleys in Cochabamba, Bolivia," Unpublished M.Sc. thesis, Utah State University, Logan, Utah, 1980, Table 3, p. 103; table 4, p. 104.

Table 31. Average number of man-days of hired labor employed by farms employing hired labor and the average value of a man-day of hired labor by region and departments

	Region	Chuquisaca	Tarija	Potosi
Frequency of farms employing hired labor[1/]	188	70	67	51
Average number of man-days of hired labor employed by farms employing hired labor	58.2 (187)	108.3 (70)	27.8 (66)	28.8 (51)
Average value of a man-day of hired labor	27.7	25.0	29.6	28.9
Total farm-households	699	144	212	343

[1/] Equals number of farms employing hired labor.

Note: Numbers in parentheses equal the number of observations used in average.

Source: Table T31, stubs 1, 2, 3, 10, standard Table 7.

There are substantial differences in the relative frequency of farms employing hired labor between departmental areas. In Chuquisaca, one of every two farms employs hired labor; in Tarija, one of every three farms does so; while in Potosi, only one out of seven farms employs hired labor.

The average value of a man-day of hired labor equals 27.7 pesos. There is a slight difference in this statistic between regions, with Tarija and Potosi having higher wage rates than Chuquisaca.

Table 32 shows that even very small farms, i.e., farms less than 1 hectare, employ hired labor. One out of eight farms < 1 hectare in size employed hired labor. The relative frequency with which farms hire labor increases with size. For example, one of every two farms > 10 hectares employs hired labor. The average number of man-days of hired labor also increases with size. Nevertheless, the 55 farms < 2.0 hectares in size

who employed hired labor accounted for 14 percent of the total of hired man-days in the region.

The average value of a man-day of labor equals 27.7 pesos for the region. The wage rate paid by the smaller farms equals 27.2 pesos. The wage rate paid by farms > 5 hectares equals 29.2 pesos. The wage rate, therefore, does not increase very much with farm size.

Table 32. Average number of man-days of hired labor employed by farms employing hired labor and the average value of a man-day of hired labor by size of farm

	Farm size group					
	<1 ha.	1-1.99 has.	2-4.99 has.	5-9.99 has.	>9.99 has.	Total
Frequency of farms employing hired labor[1/]	26	29	62	40	31	188
Average number of man-days of hired labor employed by farms employing hired labor	17.3 (26)	36.3 (29)	78.6 (61)	54.6 (40)	77.4 (31)	58.2 (187)
Average value of a man-day of hired labor	27.2 (26)	27.1 (29)	26.5 (61)	29.1 (40)	29.2 (31)	27.7 (187)
Total farms	204	146	190	102	57	699

[1/] Equals number of farms employing hired labor in farm size group.

Source: Table T31, stubs 1, 2, 3, 10, standard Table 7.

Note: Number in parentheses equals number of observations used in average.

Table 33 shows that the relative frequency of farms employing hired labor decreases with time to market. Forty percent of farms less than one hour to market hires labor. For farms more than three hours to market, the corresponding figure equals twenty percent. The average number of man-days of hired labor for farms employing hired labor decreases with time to market. Farms employing hired labor and less than 1 hour to market hire an average of 113 man-days of labor. For farms more than three hours to market, the corresponding figure equals 46 man-days.

The average value of a man-day of labor does not change very much with distance to market. The average daily wage paid by farms less than 1 hour to market equalled 29.2 pesos. The corresponding figure for farms more than 3 hours to market equalled 27.1 pesos, which is slightly below the regional average of 27.7 pesos.

Table 34 shows that farms employing hired labor but not receiving technical training/assistance or bank credit hired an average of 27.6 man-days. Farms employing hired labor and receiving technical/training or credit or both hired an average of 198.1 man-days. Farms employing hired labor, with definitive title and less than three hours to market hired an average of 83.9 man-days. Farms employing hired labor, with no definitive title and more than 3 hours to market hired an average of 41.6 man-days of labor. Of the 187 farms employing hired labor, 33 farms or 18 percent received technical training/assistance, bank credit or both. This is more than double the average for all of the farms included in the survey, because of the 699 farms covered by the survey only 59 farms or 8 percent received technical training/assistance, bank credit or both. (See Table 67).

Table 33. Average number of man-days of hired labor employed by farms employing hired labor and the average value of a man-day of hired labor by time to market

	Time to market				
	<1 hour	1-3 hours	3-6 hours	>6 hours	Total[2/]
Frequency of farms employing hired labor[1/]	47	59	32	45	188
Average number of man-days of hired labor employed by farms employing hired labor	112.7 (47)	32.9 (58)	26.6 (32)	59.4 (45)	58.2 (187)
Average value of a man-day of hired labor	29.2 (47)	27.6 (58)	28.4 (32)	26.3 (45)	27.7 (187)
Total number of farms	117	181	201	184	697

Source: Table T31, stubs 1, 2, 3, standard Table 3.

1/ Equals number of farms employing hired labor.

2/ Includes invalid responses to "time to market."

Note: Numbers in parentheses indicate the number of observations used in average.

Table 34. Average number of man-days of hired labor employed by farms employing hired labor according to technical training/assistance, credit source, tenancy and time to market

	No training/ assistance, No bank credit	Training assistance, No bank credit	No training/ assistance, Bank credit	Training/ assistance Bank credit	Non-response	Total
Definitive title <3 hours to market	26.4 (48)	355.1 (8)	318.8 (4)	21.3 (3)	2.5 (2)	83.9 (65)
Definitive title >3 hours to market	18.9 (38)	159.0 (5)	151.5 (2)	287.0 (1)	107.0 (2)	48.3 (48)
No definitive title <3 hours to market	39.6 (32)	101.5 (4)	19.7 (3)	- (0)	21.0 (1)	43.8 (40)
No definitive title >3 hours to market	26.9 (27)	972.0 (1)	10 (1)	0 (0)	0 (0)	41.6 (29)
Nonresponse	32.3 (4)	26.0 (1)	- (0)	- (0)	- (0)	31.0 (5)
Total	27.6 (149)	238.9 (19)	164.7 (10)	87.8 (4)	48.0 (5)	58.2 (187)

Source: Table T31, stubs 1, 2, 3, standard Table 8.

Note: Numbers in parentheses are number of observations used in average.

Mutual exchange of labor and communal labor practices

The mutual exchange of labor and communal labor practices are well known features of agriculture in the Andes. It is also believed that the use of these practices is more common among Quecha speaking households than Spanish speaking households. Riordan [Table 14, page 30] indicates that virtually all of the households in the Tarija area are Spanish speaking. In the Chuquisaca area, only 21 percent of the respondents speak Quecha. In the Potosi area, 86 percent of the respondents speak Quecha. Table 35 shows that many farms avail themselves of reciprocal labor exchange as typified by ayni or minka labor. Almost one-third of the 699 farms covered by the survey used ayni or minka labor. The average number of man-days exchanged, however, is quite small, i.e., 15.6 man-days per farm employing ayni-minka labor. The total number of man-days required to produce the 1754 hectares of crops (including fallow) of the 699 farms included in the survey equals 155,000 man-days. Ayni-minka labor provides only 3682 days of this, i.e., 2.4 percent.

The relative frequency of farms employing ayni-minka labor varies substantially between departmental areas. One out of two farms in the Potosi area employs ayni-minka labor. The corresponding figures for Tarija and Chuquisaca are 13 and 19 percent respectively. The average number of man-days of ayni-minka labor employed by farms employing ayni-minka labor varies from 17.4 man-days for Potosi to 10.6 and 8.5 man-days, respectively, for Tarija and Chuquisaca.

All 699 farms (except three invalid responses) covered by the survey participate in communal work activities. The average number of man-days of communal work by farm households equals 5.7. For Potosi, this figure equals 6.7 man-days. The corresponding figures for Chuquisaca and Tarija are 3.7 and 5.4 man-days, respectively.

Table 35. Average number of man-days of Ayni (Minka) labor and communal work by farm households by region and departments

	Region	Chuquisaca	Tarija	Potosi
Frequency of farms[1/] employing Ayni (minka) labor	236	27	27	182
Average number of man-days of Ayni (Minka) labor employed by farms employing Ayni (Minka) labor	15.6	8.5	10.6	17.4
Frequency of farms[1/] participating in communal work	696	143	212	341
Average number of man-days of communal work by farm-households	5.7	3.7	5.4	6.7
Total farm-households	699	144	212	343

Source: Table T31 stubs 4, 5, 6, 7, 8, standard Table 7.

[1/] Equals number of farms having the attribute.

Table 36 shows that the relative frequency of farms employing ayni or minka labor increases with time to market. Only 14 percent of the farms with less than 1 hour to market employ ayni-minka labor. The corresponding figure for farms with more than three hours to market equals 46 percent. On the other hand, the average number of man-days of ayni-minka labor stays the same with distance to market. The corresponding average for farms less than 3 hours to market, and for farms with more than 3 hours to market equals in both instances the regional average of 15.4 man-days.

The average number of man-days of communal work by farm households increases by time to market. But in all instances, the average number of communal man-days is too small to affect the overall use of available family labor.

Table 36. Average number of man-days of Ayni (Minka) labor and communal work by farm-households according to time to market

	Time to market				
	<1 hour	1-3 hours	3-6 hours	>6 hours	Total[2/]
Frequency of farms[1/] employing Ayni (minka) labor	16	36	98	80	236
Average number of man-days of Ayni (Minka) labor employed by farms employing Ayni (Minka) labor	22.4 (16)	12.4 (36)	14.0 (98)	17.2 (80)	15.6 (236)
Frequency of farms[1/] participating in communal work	116	181	201	184	696
Average number of man-days of communal work by farm-households	3.6 (116)	6.0 (181)	6.6 (201)	5.9 (184)	5.7 (696)
Total number of farms	116	181	201	184	696

Source: Table T31, stubs 4, 5, 6, 7, 8, standard Table 3.

1/ Equals number of farms having the attribute.

2/ Includes invalid responses to "time to market."

Note: Numbers in parentheses equal the number of observations used in average.

SECTION V.

INCOME VARIABLES

Alternative income definitions

There is no unique definition of income for the farm household. The tabulations of the southern valleys survey use four net income definitions:

1) net farm cash income;
2) net farm income;
3) net household cash income;
4) net household income.

Table 37 presents a complete list of revenue items, and the cell number of each item in the questionnaire. Column 2 indicates whether the survey observed the physical volume of production of each item. Such data are available only for independent and associated crops. Consequently, gross income measures cannot be calculated. The loss of this possibility is not important whenever income measures serve as a proxy for measuring the material welfare of the farm household. The third column indicates whether the survey observed the physical volume of home consumption. Such data are available only for independent and associated crops. The fourth column indicates whether the survey observed the physical volume of production sold. Such data are available for independent crops, associated crops, fruits, and livestock production [live or carcass, by-products, processed by-products]. Information is also available on the number of days worked off the farm in agricultural activities inside or outside Bolivia. No information is available on the number of days worked off the farm in nonagricultural activities. No information is available on the amount of land, machinery or livestock rented out. Nor is information available on the quantity of nonagricultural products sold.

Table 37. Revenue items that enter into alternative income definitions

	Cell number in questionnaire 1/	Production	Human consumption	Quantity sold	Price received	Gross value of production	Imputed value of human consumption	Value of off-farm sales		Riordan '77 LeBaron '78			
		(2) Q_P	(3) Q_C	(4) Q_S	(5) P_S	(6) (2x5)	(7) (3x5)	(8) (4x5)	(9) (7x8)	Net farm cash income	Net household cash income	Net farm income	Net household income
Revenue items	(1)									(10)	(11)	(12)	(13)
Major independent crops	p.14,15	a	a	a	a	a	a	a	a	8	8	9	9
Other independent crops	154	na	nc	na	na	na	na	a	na	8	8	8	8
Associated crops	p.16,17	a	a	a	a	a	a	a	a	8	8	9	9
Vegetables	222	na	nc	na	na	na	na	a	na	8	8	8	8
Fruit outside orchards	225	na	nc	a	a	na	na	a	na	8	8	8	8
Livestock [live or carcass]	341	na	nc	a	a	na	na	a	na	8	8	8	8
Livestock by-products	343	na	nc	a	a	na	na	a	na	8	8	8	8
Processed livestock by-products	359	na	nc	a	a	na	na	a	na	8	8	8	8
Agric. work off-farm in Bolivia	365,366	--	--	a	a	--	--	a	--		8		8
Agric work off-farm outside Bolivia	367,368	--	--	a	a	--	--	a	--		8		8
Other agric. work off-farm	369	--	--	na	na	--	--	a	--		8		8
Nonagric. work off-farm	370	--	--	na	na	--	--	a	--		8		8
Land, livestock and mach. rentals	371	--	--	na	na	--	--	a	--	8	8	8	8
Sale of nonagric. products	372	--	--	na	na	--	--	a	--		8		8
Other income	373	--	--	na	na	--	--	a	--		8		8

1/ Encuesta Socioeconomica, (Chuguisaca, Potosi, Tarija), Area Sur de Bolivia, Proyecto Sectorial II.

- \- does not apply
- a available
- na not available
- nc not considered, nor available

The fifth column indicates whether the survey observed prices received by farm hosueholds. Prices received are available for independent and associated crops, fruits, livestock products [live or carcass, by-products or processed by-products] and the daily wage rate (including food) for agricultural work off the farm inside or outside Bolivia. The imputed daily wage for work off the farm outside agriculture is not available. Rental rates charged for land, livestock and machinery are not available. Because of missing data, the gross value of production can be calculated only for independent and associated crops. Because of missing data, the imputed value of human consumption can be calculated only for independent and associated crops. Because all farm households indicate livestock production, and because more than three-fourths of this is destined for home consumption, it follows that the survey tabulations underestimate the sum total of the value of human consumption. On the other hand, the survey tabulations permit a complete accounting of the itemized values of off-farm sales. Consequently, net cash income calculations will be more accurate than net income calculations. Column 10 lists the revenue items that compose net farm cash income. That list is complete. Column 11 lists the revenue items that compose net household cash income. That list, too, contains no missing items. Column 12 lists the revenue items that make up net farm income. The information underlying the construction of that column is incomplete in the sense that the required entries should have been taken from column 9, which equals the sum of the entries in columns 7 and 8. Survey tabulations omit some required items in column 7. Consequently, actual net farm income is larger than that indicated by the survey tabulations. The last column in Table 37 lists the revenue items that compose net household income. Ideally, the entries in this column

should have been based on the information in columns 7 and 8. Since the information in column 7 is incomplete, it follows *a fortiori* that actual net household income is larger than tabulated net household income.

Table 38 is a complete list of the expenditure items that are used in deriving each of the four net income definitions. The first column in this table lists the cell number of the expenditure item in the questionnaire. The detail of this list is impressive. A complete accounting record would answer for each item the following questions:

1) the physical volume of on-farm production;
2) the volume of on-farm use;
3) the volume purchased;
4) the imputed price for on-farm use;
5) prices paid for purchased items.

Given above information, it is then possible to calculate the value of on-farm-produced inputs, the value of on-farm use of farm-produced inputs and the value of purchased inputs. The southern valleys survey observed only the value of purchased inputs. Given the considerable use of home-produced inputs (seeds, manure, animal traction, transportation, etc.), it follows that available tabulations underestimate production expenditures. This, however, does not matter when calculating the four net income measures. The absence of information on the quantities of inputs used makes it difficult to establish the physical relationships between production and inputs. The immediate consequence is that a relationship such as a production function is impossible to estimate. Riordan and LeBaron based their production expense definitions on the value of purchased inputs only. Not all of such items should be included in net income calculations. Table 6 indicates that in the calculation of net farm cash income, we

Table 38. Expenditure items used in alternative net income definitions

Expenditure items	Cell number in questionnaire[1/]	On-farm production	On-farm use	Quantity purchased	Imputed price for on-farm use	Price paid	Value of on-farm use of farm prod. inputs	Value of purchased inputs		Riordan '77				Le Baron '78[2/]			
		(2) Q_P	(3) Q_{HC}	(4) Q_B	(5) P_S	(6) P_P	(7) 3x5	(8) 4x6	(9) 7+8	Net farm cash income	Net household cash income	Net farm income	Net household income	Net farm cash income	Net household cash income	Net farm income	Net household income
	(1)									(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Land rent	79	-	-	-	-	na	-	a	-	8	8	8	8	8	8	8	8
Seed	307	nc	nc	na	nc	na	na	a	na	8	8	8	8	8	8	8	8
Fertilizer (organic & inorganic)	308	nc	nc	na	na	na	na	a	na	8	8	8	8	8	8	8	8
Other chemicals	309	nc	nc	na	na	na	na	a	na	8	8	8	8	8	8	8	8
Machinery rentals	310	-	-	na	-	na	-	a	-	8	8	8	8	8	8	8	8
Livestock rentals	311	-	-	na	-	na	-	a	-	8	8	8	8	8	8	8	8
Waterrights	312	-	-	na	-	na	-	a	-	8	8	8	8	8	8	8	8
Hired labor	315,316	-	-	a	-	a	-	a	-	8	8	8	8	8	8	8	8
Commercial labor (ayna-minki)	315,318	-	-	a	-	a	-	a	-			8	8			8	8
Transportation of harvest	322	nc	nc	na	nc	na	na	a	na	8	8	8	8	8	8	8	8
Transportation, packaging of inputs	323	nc	nc	na	nc	na	na	a	na	8	8	8	8	8	8	8	8
Purchase of live animals	345	-	-	a	-	a	-	a	-	8	8	8	8	8	8	8	8
Feed, salt, hay, medicine, hired labor	346	nc	nc	na	nc	na	nc	a	nc	8	8	8	8	8	8	8	8
Direct costs [except labor] of processed agr. & livestock products	360	-	-	na	-	na	-	a	-	8	8	8	8	8	8	8	8
Purchase of tools and machinery	374	nc	nc	na	nc	na	nc	a	nc	8	8	8	8				
Construct. & Maint. of capital structures	375	nc	nc	na	nc	na	nc	a	nc	8	8	8	8				
Other direct nonallocable costs	376	-	-	na	-	na	-	a	-	8	8	8	8	8	8	8	8
Interest payments	384	-	-	a	-	a	-	a	-	8	8	8	8	8	8	8	8
Communal labor capital structures	319	-	-	a	-	a	-	a	-								
Depreciation																	

1/ Encuesta Socioeconomica (Chuguisaca, Potosi, Tarija), Area Sur de Bolivia, Proyecto Sectorial II.

2/ Le Baron also considered an alternative cost adjustment which would include cell 345, but exclude cells 374 & 375.

- = does not apply; a = available; na = not available; nc = not considered, nor available.

should not include the imputed expenditure for ayni-minka labor, whereas this item should be included when calculating net farm income or net household income.[1/] The imputed value of communal labor used in the construction and cleaning of irrigation canals and similar capital structures could be given similar treatment. Le Baron argued that the purchase of live animals, tools and machinery constitutes an acquisition of durable assets whose cost cannot be fully charged in any one year. This argument is correct. Nevertheless, Loyd Brown[2/] showed that for a sample of farms, the sample average of the sum of items 345, 374, and 375 can be taken as a first estimate of depreciation of livestock and other capital items. In this report, we follow Riordan and Brown's procedure. A fundamental problem is that the survey questionnaire does not cover changes on capital account which, among other things, would allow for a correct calculation of a depreciation allowance. In particular, a complete beginning and ending inventory of cattle, pigs, poultry, etc., would have been helpful in estimating the increase (or decrease) in net worth of these items. The 1977 agricultural crop year was characterized by drought, which may have resulted in a depletion of the livestock inventory. This would tend to create a temporary increase in farm cash income and other income measures. We previously observed that the value of human consumption of farm-produced items was underestimated. These excluded items off-set each other, but it must be acknowledged that the net effect on net farm income and net household income is unknown. The net change on capital account, i.e.,

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1/ In calculating net cash income, only the cash portion of the wages paid to hired labor should be included. The only wage rate recorded by the survey includes cash payments plus payments in kind.

2/ Loyd Brown, "Depreciation versus fixed asset acquisition cost in net income calculation at the aggregate level," Ministry of Agriculture and Campesino Affairs, La Paz, 1979.

the change in net worth, is also unknown.[1/] A change in net worth affects current and future welfare of the farm household. Future surveys might try to capture this, because the role of savings out of farm household income is of importance in projecting the future income potential of farm households in the southern valley areas.

Variables that influence net household income

There are several income measures which are useful in analyzing the behavior of the farm household. The southern valleys survey uses four definitions:

1) net farm cash income (NFCI);
2) net household cash income (NHCI);
3) net farm income (NFI);
4) net household income (NHI).

In terms of the variables defined on page 16, we obtain the following four accounting identities:

1) $NFCI = P_B \cdot Q_{B \cdot 2} - X_{12} \cdot W - D$

2) $NHCI = P_B \cdot Q_{B \cdot 2} + X^*_{12} \cdot W + X^*_{13} \cdot S - X_{12} \cdot W - D$

3) $NFI = P_B[Q_{B \cdot 1} + Q_{B \cdot 2}] - X_{12} \cdot W - D$

4) $NHI = P_B[Q_{B \cdot 1} + Q_{B \cdot 2}] + X^*_{12} \cdot W + X^*_{13} \cdot S - X_{12}W - D$

Net farm cash income (NFCI) equals off-farm sales ($P_B \cdot Q_{B \cdot 2}$) minus cash payments for hired labor ($X_{12} \cdot W$) and cash outlays on purchased inputs D. Net household cash income (NHCI) is calculated by adding off-farm earnings in agriculture ($X^*_{12} \cdot W$) and outside agriculture ($X^*_{13} \cdot S$) to net farm cash income. Net farm income (NFI) is calculated by adding the imputed values

[1/] Investment (real or financial) in land figures large in farm household decision making.

of human consumption ($P_B \cdot Q_{B\ 1}$) to net farm cash income. Net household income (NHI) is calculated by adding both off-farm income and the value of human consumption to net farm cash income. It follows that net household income is the most comprehensive measure of income. It is also that measure of income which should be used in measuring the material welfare of farm households and which underlies household consumption of commodities produced by the farm household. There are five sets of variables that determine net household income:

1) the set of variables that determines the value of net farm output P_BQ_B, i.e., $P_1 = W$, X_2, P_B, R_1 and R_2;
2) the set of variables that determines off-farm earnings in agriculture $X^*_{12} \cdot W$, i.e., P_1, X_2, P_B, R_1, R_2, X^*_1, X^*_{13};
3) the set of variables that determines off-farm earnings outside agriculture $X^*_{13} \cdot S$, i.e., X^*_{13} and S [both taken as exogenous variables];
4) the set of variables that determines the employment of hired labor $X_{12} \cdot W$, i.e., P_1, X_2, P_B, R_1, R_2, X^*_1 and X^*_{13};
5) the set of variables that determines cash outlays on purchased inputs D, taken as an exogenous variable.

A complete list of variables that determines net household income contains nine items.

1) P_1 the agricultural wage rate
2) X_2 the size of the farm
3) P_B prices received by farmers
4) R_1 the relative efficiency of labor
5) R_2 the relative efficiency of land
6) X^*_1 the size of the household

7) X^*_{13} off-farm employment opportunities outside agriculture

8) S the implied wage rate of employment off-farm outside agriculture

9) D the cash outlay on purchased inputs other than labor.

It follows that size of farm (X_2) is not the only variable influencing net household income and that its effect may not be apparent because of simultaneous off-setting changes in the remaining eight variables. Assume that if household labor is employed off the farm in agriculture ($X^*_{12} > 0$), then the farm household will not employ hired labor ($X_{12} = 0$). This simplifies our definition of net household income

$$NHI = P_B Q_B + X^*_{12} \cdot W + X^*_{13} \cdot S - D.$$

Transforming this definition into percentage rates of change, we have

$$n.h.i. = \frac{P_B Q_B}{NHI} (p_B + q_B) + \frac{X^*_{12} \cdot W}{NHI} (x^*_{12} + p_1) + \frac{X_{13} \cdot S}{NHI} (x^*_{13} + s) .$$

In the above equation, the level of farm output is determined by the following variables:

$$q_B = {}^{-k_1\sigma}/k_2 \cdot p_1 + 1.x_2 + {}^{k_1\sigma}/k_2\, p_B + {}^{k_1\sigma}/k_2\, r_1 + 1.r_2 \quad .$$

Similarly, the quantity of off-farm labor is determined by the following variables

$$x^*_{12} = -X_1/X^*_{12} \cdot x_1 + X^*_1/X^*_{12} \cdot x^*_1 - X^*_{13}/X^*_{12} \cdot x^*_{13}.$$

In the above equation, the quantity of labor employed by the farm household is given by the following relationship:

$$x_1 = -\sigma/k_2\, p_1 + 1.x_2 + \sigma/k_2\, p_B + \frac{(\sigma - k_2)}{k_2} \cdot r_1 + 1.r_2 \ .$$

Substitution for x_1, x^*_{12} and q_B in out net household income definition yields the following results:

1) <u>The wage rate effect</u>: $nhi = \frac{X_{12}^{*} \cdot W}{NHI} \cdot P_1$

An increase of one percent in the agricultural wage P_1 will increase net household income by a fraction of one percent. This fraction equals the current share of off-farm income earned in agriculture in NHI.

2) <u>The farm size effect</u>: $nhi = \frac{k_2 \cdot P_B Q_B}{NHI} \cdot x_2$

An increase of one percent in the size of the farm will increase net household income by a fraction of one percent. This fraction is determined by the imputed share of land k_2 in net farm output, and the share of net farm output in NHI.

3) <u>The price received effect</u>: $nhi = \frac{P_B Q_B}{NHI} \cdot p_B$

A one percent increase in the prices received by farmers will increase net household income by a fraction of one percent. The fraction equals the share of net farm output in net household income.

4) The relative efficiency of labor: $nhi = \frac{k_1 \cdot P_B Q_B}{NHI} \cdot r_1$

A one percent increase in the relative efficiency of labor will increase net household income by a fraction of one percent. The fraction equals the share of labor k_1 in net farm output, multiplied by the share of net farm output in NHI.

5) The relative efficiency of land effect: $nhi = \frac{k_2 P_B Q_B}{NHI} \cdot r_2$

A one percent increase in the relative efficiency of land increases net household income by a fraction of one percent. This fraction

is determined by the imputed share k_2 of land in net farm output and the share of net farm output in NHI.

6) <u>The size of household effect</u>: $nhi = \frac{W \cdot X_1^*}{NHI} \cdot x_1^*$

A one percent increase in the size of household will increase net household income by less than one percent. The fraction is determined by the opportunity cost $W \cdot X_1^*$ of the total quantity of labor X_1^* supplied by the family. In Figure 4(b), page 39, the slope of the net income opportunity line NT equals the agricultural wage rate W. The slope of the line through the origin OT equals (NHI/X_1^*) or average income per unit of labor supplied. It follows that $W < (NHI/X_1^*)$, i.e., $WX_1^* < NHI$.

7) <u>The nonagricultural employment effect</u>: $nhi = \frac{(S-W)X_{13}^*}{NHI} \cdot x_{13}^*$

A one percent increase in nonagricultural employment increases net household income by less than one percent. The fraction equals the share of <u>net</u> nonagricultural income of NHI. The net concept (S-W) implies that farm households do not experience involuntary employment. If a household member accepts additional nonagricultural employment, then the opportunity cost of such employment equals the current agricultural wage rate W.

8) The nonagricultural wage effect: $nhi = \frac{X_{13}^* \cdot S}{NHI} \cdot s$

An increase of one percent in the nonagricultural wage rate will increase net household income by less than one percent. The fraction equals the share of nonagricultural income in NHI.

The foregoing effects were established for a farm household that did not employ hired labor ($X_{12} = 0$), while some members worked at least part time off the farm in agriculture ($X^*_{12} > 0$). The opposite case of a farm household that hires labor ($X_{12} > 0$) but whose members do not work off the farm in agriculture ($X^*_{12} = 0$) is also of interest. The definition of net household income for such a farm household is

$$NHI = P_B Q_B + X^*_{13} S - X_{12} \cdot W - D$$

and where

$$X_{12} = X_1 - X^*_1 + X^*_{13}.$$

Output Q_B is determined as before by equation q_B. The total quantity of labor X_1 employed by the farm household is determined as before by equation x_1. Substitution for X_1, X_{12} and Q_B in the relevant definition of net household income shows that the wage rate effect now equals

$$nhi = \frac{X_{12} \cdot W}{NHI} \cdot p_1 .$$

An increase of one percent in the agricultural wage rate <u>decreases</u> net household income by less than one percent. The fraction will equal the current share of expenditure on hired labor in NHI.

The farm size effect, the price received effect, the relative efficiency of labor effect, the relative efficiency of land effect, the size of household effect, the nonagricultural employment effect and the nonagricultural effect are the same as before. The signs of these effects are, therefore, the same when ($X^*_{12} > 0$, $X_{12} = 0$) and when ($X_{12} > 0$, $X^*_{12} = 0$). This is an important finding, because it shows that when analyzing the variables that influence net household income, it will not be necessary to divide the 699 observations into two mutually exclusive groups, except when analyzing the influence of the agricultural wage on NHI.

Equality of signs, however, does not imply equality of the proportional response coefficients. If a farm household hires labor ($X_{12} > 0$), then the value of net farm output P_BQ_B is not necessarily smaller than net household income. In Figure 4(b) with FH of hired labor, the value of net farm output P_BQ_B equals KF, which is larger than net household income MH. It follows that $k_1P_BQ_B \gtrless$ NHI and $k_2P_BQ_B \gtrless$ NHI. Consequently, with ($X_{12} > 0$, $X^*_{12} = 0$), a one percent increase in farm size may or may not increase net household income <u>by more than one percent</u>. This result also applies to the price received effect, the relative efficiency of labor effect and the relative efficiency of land effect, i.e., any response coefficient involving both P_BQ_B and NHI.

Table 39 features the composition of net household income per farm-household and per capita. One is struck by the low level of material welfare of farm-households in the southern valleys area. Average annual net household income equals 1233 pesos, or 62 U.S. dollars. Yet in this statistic, there are substantial departmental variations. Average net household income per capita in the Potosi area equals 1042 pesos or 50 U.S. dollars, whereas the corresponding figures for Chuquisaca and Tarija equal 1800 pesos and 1150 pesos, respectively.

The second outstanding feature of Table 39 is the composition of net household income. Net farm income contributes only 44 percent to net household income. Nonagricultural income accounts for 40 percent, with off-farm agricultural income accounting for the remainder.[1/]

There are substantial departmental variations in these figures. Nonagricultural income contributes half of net household income in the Tarija

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[1/] All income measures are calculated for valid responses only. The number of valid responses varies between income measures. This results in an undesirable adding problem, which cannot be avoided with the available tabulations.

Table 39. Average net household income per farm and per capita, average off-farm agricultural income per farm and per capita, average nonagricultural income per farm and per capita, average net farm income per farm and per capita by region and departments

	Region	Chuquisaca	Tarija	Potosi
Average net household income per farm-household[1/]	6547.2 (619)	9597.1 (126)	7042.8 (177)	5053.5 (316)
Average net household income per capita[1/]	1233.3 (3286)	1799.5 (672)	1153.2 (1081)	1041.7 (1533)
Average off-farm agricultural income per farm-household[1/]	888.5 (691)	366.6 (142)	1031.0 (211)	1018.9 (338)
Average off-farm agricultural income per capita[1/]	167.5 (3666)	69.7 (747)	170.9 (1273)	209.2 (1646)
Average nonagricultural income per farm-household[1/]	2625.7 (690)	2687.1 (141)	3597.4 (208)	2007.5 (341)
Average nonagricultural income per capita[1/]	496.5 (3649)	511.3 (741)	595.8 (1256)	414.4 (1652)
Average net farm income per farm-household[2/]	2881.3 (634)	6107.7 (130)	2136.5 (181)	2000.2 (323)
Average net farm income per capita[2/]	543.8 (3359)	1147.4 (692)	350.3 (1104)	413.3 (1563)

Source: [1/]Table T28, stubs 1 through 16, standard Table 7, [2/]Table T26, stubs 9 through 12, standard Table 7.

Note: Numbers in parentheses indicate number of observations used in average.

area. The corresponding figures for Chuquisaca and Potosi are 28 percent and 40 percent, respectively. The contribution of off-farm agricultural income to net household income in the Chuquisaca area is almost negligible, but in Potosi, it con ributes 20 percent of net household income. Net farm income contributes 64 percent to net household income in the Chuquisaca area. The corresponding figures for Tarija and Potosi are 30 percent and 40 percent, respectively. The departmental variability in the composition of net-household income shows that income earning opportunities are quite different between departmental areas, even though the southern valleys area was thought to be homogeneous in this respect.

Table 40 confirms the hypothesis that larger farms should have a higher average net farm income. The effect of farm size on net farm income is, however, surprisingly small. Farms smaller than 2 hectares average .80 hectares in size, with a corresponding net farm income per farm-household equal to 1912 pesos.[1/] Farms larger than 5 hectares average 12.23 hectares in size, with a corresponding net farm income per farm-household equal to 4631 pesos. Consequently, a fifteen-fold increase in size results in only a 241 percent increase in net farm income per farm-household. Much of the variability in net farm income between farm-households, therefore, cannot be explained by size of farms as such.

In Table 40, average off-farm agricultural income per household equals 1030 pesos for farms less than 2 hectares in size, and 973 pesos for farms more than 5 hectares in size. Size as such does not significantly influence off-farm agricultural income. Table 40 also shows that nonagricultural income decreases with farm size. For farms smaller than

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[1/] The number of observations in both averages includes valid responses. The number of responses varies between these averages, but is not expected to put into doubt the validity of the comparison.

Table 40. Average net household income per farm and per capita, average off-farm agricultural income per farm and per capita, average nonagricultural income per farm and per capita, net farm income per farm and per capita by size of farm

	Size of farm					
	<1 ha.	1-1.99 has.	2-4.99 has.	5-5.99 has.	>9.99 has.	Total
Average net household income per farm-household[1/]	6187.7 (184)	5236.0 (133)	7436.0 (156)	7452.8 (94)	6867.5 (52)	6547.2 (619)
Average net household income per capita[1/]	1363.5 (835)	1051.9 (662)	1391.2 (865)	1195.8 (586)	1056.5 (338)	1233.3 (3286)
Average off-farm agricultural income per farm-household[1/]	1368.3 (200)	562.7 (145)	555.9 (187)	1267.6 (102)	446.8 (57)	888.5 (691)
Average off-farm agricultural income per capita[1/]	303.1 (903)	113.5 (719)	99.2 (1048)	203.0 (637)	70.9 (359)	167.5 (3666)
Average nonagricultural income per farm-household[1/]	2881.6 (203)	2435.6 (143)	3193.2 (186)	1783.0 (101)	1832.2 (57)	2625.7 (690)
Average nonagricultural income per capita[1/]	640.0 (914)	491.2 (709)	573.3 (1036)	285.4 (631)	290.9 (359)	496.5 (3649)
Average net farm income per farm-household[2/]	1672.6 (188)	2103.7 (136)	3347.6 (163)	4662.4 (95)	4569.4 (52)	2881.3 (634)
Average net farm income per capita[2/]	369.9 (850)	424.5 (674)	602.9 (905)	748.2 (592)	703.8 (338)	543.8 (3359)

Source: [1/] Table T28, stubs 1 through 16, standard Table 7; [2/] Table T26, stubs 9 through 19, standard Table 7.

Note: Numbers in parentheses indicate number of observations used in average.

5 hectares, nonagricultural income per farm-household equals 2871 pesos. The corresponding figure for farms larger than 5 hectares equals 1801 pesos.

Table 41 shows that time to market exerts a substantial influence on all three components of net household income. Average net household income per farm-household with less than three hours to market equals 9941 pesos. The corresponding figure for farm-households with more than three hours to market equals 4023 pesos. Average net farm income per farm-household with less than three hours to market equals 3801 pesos or 38 percent of net household income. The corresponding figure per farm-household for farms with more than three hours to market equals 2231 pesos or 55 percent of net household income. The relative share of net farm income in net household income increases, therefore, with time to market. Average nonagricultural income per farm-household with less than 3 hours to market equals 5082 pesos or 51 percent of net household income. The corresponding figure for farm-households with more than 3 hours to market equals 810 pesos or 20 percent of net household income. The relative share of nonagricultural income, therefore, decreases with time to market. It follows that the opposite trend must prevail for off-farm agricultural income. Consequently, temporary farm labor must move from areas distant from market to areas closer to market.

Variables that influence net farm income

By definition, net farm income (NFI) equals net household income (NHI) minus off-farm income $[X^*_{12}W + X^*_{13}S]$

$$NFI = P_B Q_B - X_{12} \cdot W - D$$

A comparison of this definition with the definition of NHI on page 117

Table 41. Average net household income per farm and per capita, average off-farm agricultural income per farm and per capita, average nonagricultural income per farm and per capita, net farm income per farm and per capita by time to market

	Time to market				
	<1 hr.	1-3 hr.	3-6 hr.	>6 hr.	Total[3]
Average net household income per farm household[1]	12361.5 (111)	8311.8 (153)	3904.7 (185)	4157.9 (161)	6547.2 (619)
Average net household income per capita[1]	2394.6 (573)	1556.6 (817)	757.2 (954)	744.6 (899)	1233.3 (3286)
Average off-farm agricultural income per farm household[1]	519.1 (116)	1137.7 (181)	593.1 (200)	1251.9 (180)	888.5 (691)
Average off-farm agricultural income per capita[1]	101.0 (596)	212.7 (968)	114.8 (1033)	224.2 (1005)	167.5 (3666)
Average nonagricultural income per farm-household[1]	6804.6 (116)	5959.3 (178)	854.1 (200)	762.4 (183)	2625.7 (690)
Average nonagricultural income per capita[1]	1331.1 (593)	739.5 (953)	165.8 (1030)	137.7 (1013)	496.5 (3649)
Average net farm income per farm household[2]	4788.5 (113)	3094.2 (158)	2398.7 (187)	2042.2 (167)	2881.3 (634)
Average net farm income per capita[2]	929.7 (582)	560.6 (842)	463.9 (967)	368.7 (925)	543.8 (3359)

Source: [1] Table T28, stubs 1 through 16, standard Table 3, [2] Table T26, stubs 9 through 12, standard Table 3.

[3] Includes invalid responses to "time to market."

Note: Number in parentheses indicates number of observations used in average.

reveals that the analysis of the variables that influence net farm income is formally identical with the case ($X_{12}^* = 0$, $X_{12} > 0$). There is, therefore, no need for a separate analysis, and we may write forthwith

1) <u>The wage rate effect</u>: $nfi = \frac{-X_{12} \cdot W}{NFI} \cdot P_1$

A one percent increase in the agricultural wage rate will decrease net farm income by less than one percent. The (negative) fraction equals the expenditure on hired labor divided by the level of net farm income.

2) <u>The farm size effect</u>: $nfi = \frac{k_2 P_B Q_B}{NFI} \cdot x_2$

A one percent increase in the size of farm may or may not increase net farm income by one percent. The result is determined by the share of land in net farm output ($k_2 < .6$) and the ratio of the value of net farm output $P_B Q_B$ to net farm income ($P_B Q_B/NFI > 1$). If farm households do not use hired labor ($X_{12} = 0$) and spend little on purchased inputs ($D = 0$), then the fraction $k_2 P_B Q_B/NFI$ is less than unity. Then a one percent increase in farm size will increase net farm income by less than one percent. Such is probably the case for the southern valleys.

3) <u>The price received effect</u>: $nfi = \frac{P_B Q_B}{NFI} \cdot P_B$

A one percent increase in the prices received by farmers will increase net farm income by more than one percent, because $P_B Q_B/NFI > 1$.

4) <u>The relative efficiency of labor</u>: $nfi = \frac{k_1 P_B Q_B}{NFI} \cdot r_1$

An increase of one percent in the relative efficiency of labor may or may not increase net farm income by more than one percent. The

result is determined by the share of labor in the value of net farm output ($k_1 < 1$) and the ratio of the value of net farm output P_BQ_B to net farm income ($P_BQ_B/NFI > 1$).

5) <u>The relative efficiency of land effect</u>: $nfi = \frac{k_2P_BQ_B}{NFI} \cdot r_2$

An increase of one percent in the relative efficiency of land may or may not increase net farm income by more than one percent. The result is determined by the share of land in the value of net farm output ($k_2 < 1$) and the ratio P_BQ_B/NFI which is larger than one.

6) <u>The size of household effect</u>: $nfi = \frac{W \cdot X_1^*}{NFI} \cdot x_1^*$

An increase in the size of household will increase net farm income by less than one percent. In Figure 4b, W equals the slope of the income opportunity line NT. Average net farm income per unit of family labor (NFI/X_1^*) is given by the slope of OM (when $X_{12}^* = 0$; $X_{12} > 0$) or the slope of OT (when $X_{12} = 0$; $X_{12}^* > 0$). In either instance, $W < (NFI/X_1^*)$, i.e., in both instances, $WX_1^* < NFI$.

Table 42 presents several partial productivity measures on a regional and departmental area basis. Average net farm income per farm equals 2881 pesos or 144 U.S. dollars. There are substantial departmental variations in this figure. Average net farm income per farm for the Chuquisaca area equals 6108 pesos. The corresponding figures in the Tarija and Potosi areas are only one-third of this, i.e., 2036 pesos. Net farm cash income equals 47 percent of net farm income. There are substantial departmental variations in this percentage. For example, for the Potosi area, net farm cash income equals 28 percent of net farm income. Average net cash farm income per capita is a measure of the per capita value added contributed

Table 42. Average net farm income and average net farm cash income per farm, per capita, per hectare and per cultivated hectare by region and departments

	Region	Chuquisaca	Tarija	Potosi
1. Average net cash farm income				
1.1 per farm	1358.6 (649)	3593.4 (136)	1134.5 (186)	556.7 (327)
1.2 per capita	256.5 (3437)	685.4 (713)	186.6 (1131)	114.3 (1593)
1.3 per hectare	341.1 (2585)	552.9 (884)	232.9 (906)	228.9 (795)
1.4 per cultivated hectare	698.1 (1263)	2127.1 (230)	351.9 (600)	419.7 (434)
2. Average net farm income				
2.1 per farm	2881.3 (634)	6107.7 (130)	2136.5 (181)	2000.2 (323)
2.2 per capita	543.8 (3359)	1147.4 (692)	350.3 (1104)	413.3 (1563)
2.3 per hectare	712.4 (2564)	900.0 (882)	434.1 (890)	816.4 (791)
2.4 per cultivated hectare	1465.0 (1247)	3481.2 (228)	657.3 (588)	1500.5 (431)

Source: Table T26, stubs 1 through 16, standard Table 7.

Note: Numbers in parentheses indicate number of observations used in average.

by the agricultural sector to Gross Natonal Product. For the region as a whole, it equals only 257 pesos per capita. This figure is indicative of the low net productivity of the human resources in agriculture in the southern valleys area. This low productivity is caused at least to some extent by the low productivity per hectare. For example, for Tarija, net farm income per hectare equals only 434 pesos.

Average net farm income per farm increases with the size of the farm (Table 43). For farms smaller than 2 hectares, average net farm income equals 1853 pesos per farm. For farms larger than 5 hectares, the corresponding figure equals 4630 pesos. Nevertheless, the increase in net farm income per farm does not increase proportionately with size. This is because average net farm income per hectare decreases with the size of the farm. For farms smaller than 2 hectares, net farm income per hectare equals 2284 pesos. The corresponding figures for farms larger than 5 hectares equals 374 pesos. The decline in productivity per hectare is less pronounced if one considers net farm income per cultivated hectare. For farms less than 2 hectares in size, net farm income per cultivated hectare equals 2892 pesos. The corresponding figure for farms larger than 5 hectares equals 954 pesos.

Net farm cash income as a percentage of net farm income increases with farm size. The principal item that accounts for the difference between these income measures is the consumption of commodities by the farm-household produced by the farm-household. Consequently, the value of the latter type of consumption decreases with farm size.

For farms smaller than 2 hectares, net farm cash income equals 710 pesos per farm or 38 percent of net farm income. For farms larger than 5 hectares, net farm cash income equals 2240 pesos per farm or 48 percent of

Table 43. Average net farm income and average net farm cash income per farm, per capita, per hectare, and per cultivated hectare by size of farm

	Size of farm					
	<1 ha.	1-1.99 has.	2-4.99 has.	5-5.99 has.	>9.99 has.	Total
1. Average net farm cash income						
1.1 per farm	603.9 (196)	858.6 (139)	1884.4 (167)	2916.1 (95)	1006.4 (52)	1358.6 (649)
1.2 per capita	132.7 (885)	172.2 (693)	338.7 (929)	468.0 (592)	154.8 (338)	256.5 (3437)
1.3 per hectare	1512.4 (78)	622.6 (192)	636.4 (494)	451.0 (614)	43.0 (1206)	341.1 (2585)
1.4 per cultivated hectare	1713.4 (69)	824.1 (145)	937.5 (356)	738.9 (375)	154.6 (339)	698.1 (1263)
2. Average net farm income						
2 per farm	1672.6 (188)	2103.7 (136)	3347.6 (163)	4662.4 (95)	4569.4 (52)	2881.3 (634)
2.2 per capita	369.9 (850)	424.5 (674)	602.9 (905)	748.2 (592)	703.0 (338)	543.8 (3359)
2.3 per hectare	4176.5 (75)	1524.3 (188)	1134.6 (481)	721.0 (614)	197.0 (1206)	712.4 (2564)
2.4 per cultivated hectare	4745.7 (66)	2024.5 (141)	1674.4 (326)	1181.4 (375)	701.9 (339)	1465.0 (1247)

Source: Table T26, stubs 1 through 16, standard Table 7.

Note: Numbers in parentheses indicate number of farms, persons, hectares or cultivated hectares used in average.

net farm income. It may be observed that the ratio between net farm cash income and net farm income increases less than proportionately with an increase in farm size.

The value productivity of agricultural resources declines with increasing time to market (Table 44). For farms with less than 3 hours to market, average net farm income per farm equals 3801 pesos. The corresponding figure for farms with more than three hours to market equals 2608 pesos. The proportional decline in net farm cash income per farm with increasing time to market is much more pronounced. For farms with less than three hours to market, net cash farm income per farm equals 2390 pesos or 63 percent of net farm income. For farms with more than three hours to market, net cash income per farm equals 611 pesos, or 23 percent of net farm income per farm.

A farm household's contribution to the Gross National Product originating in the agricultural sector declines sharply with time to market. For example, the per capita annual agricultural value added contribution for farm-households with more than 6 hours to market in the southern valleys area equals only 31.5 pesos, or 1.5 U.S. dollars.

Table 45 shows that tenancy does not significantly affect net farm income per cultivated hectare. Net farm income per cultivated hectare of farms with definitive title equals 1488 pesos. The corresponding average for farms without definitive title equals 1460 pesos per hectare. Farms receiving training/assistance, bank credit, or both, have a net farm income per cultivated hectare equal to 2429 pesos. The corresponding figure for farm households <u>not</u> receiving training/assistance or bank credit is approximately half this amount or 1306 pesos. Net farm income per cultivated hectare of farms receiving bank credit equalled 2286 pesos. The

Table 44. Average net farm income and average net farm cash income per farm, per capita, per hectare, and per cultivated hectare according to time to market

	Time to market				
	<1 hr.	1-3 hrs.	3-6 hrs.	>6 hrs.	Total[1/]
1. Average net cash farm income					
1.1 per farm	3510.5 (115)	1588.8 (161)	1015.6 (188)	176.2 (175)	1358.6 (649)
1.2 per capita	684.3 (590)	300.6 (851)	197.0 (969)	31.5 (978)	256.5 (3437)
1.3 per hectare	886.2 (456)	321.0 (797)	351.4 (543)	39.9 (773)	341.1 (2585)
1.4 per cultivated hectare	1446.7 (279)	705.4 (363)	568.9 (336)	113.7 (271)	698.1 (1263)
2. Average net farm income					
1.2 per farm	4788.5 (113)	3094.2 (158)	2398.7 (187)	2042.2 (167)	2881.3 (634)
2.2 per capita	929.7 (582)	500.6 (842)	463.9 (967)	368.7 (925)	543.8 (3359)
2.3 per hectare	1201.1 (450)	615.9 (794)	825.8 (543)	447.8 (762)	712.4 (2564)
2.4 per cultivated hectare	1971.2 (275)	1355.6 (361)	1337.0 (335)	1298.4 (263)	1465.0 (1247)

Source: Table T26, stubs 1 through 16, standard Table 3.

[1/] Includes invalid responses to "time to market."

Note: Numbers in parentheses indicate number of farms, persons, hectares or cultivated hectares used in average.

Table 45. Average net farm income per cultivated hectare according to training/assistance, credit source, tenancy and time to market

	No training/ assistance. No bank credit	Training/ assistance, No bank credit	No training/ assistance, Bank credit	Training/ assistance, Bank credit	Non-response	Total
Definitive title <3 hours to market	910.8 (279)	4828.4 (52)	5831.1 (17)	733.7 (6)	-621.4 (10)	1656.0 (364)
No definitive title <3 hours to market	1755.0 (233)	-2368.3 (10)	1845.7 (22)	-442.9 (3)	361.9 (4)	1575.6 (271)
Definitive title >3 hours to market	1359.1 (343)	1273.4 (42)	-978.7 (10)	1793.3 (8)	2683.4 (12)	1341.4 (414)
No definitive title >3 hours to market	1299.4 (161)	1078.0 (14)	- (0)	- (0)	1413.7 (6)	1285.7 (181)
Nonresponse	431.9 (13)	1926.7 (1)	- (0)	- (0)	426.3 (3)	499.4 (16)
Total	1306.6 (1028)	2507.3 (118)	2692.0 (49)	1046.6 (16)	1056.2 (34)	1465.0 (1247)

Source: Table T26, stubs 15, 16, standard Table 8.

Note: Numbers in parentheses indicate number of cultivated hectares used in average.

corresponding figure for farms not receiving credit equalled 1430 pesos. Table 45, therefore, suggests that time to market, bank credit and technical training/assistance can substantially affect net farm income per cultivated hectare.

Variables that influence net household income per capita

When comparing two farm households with equal net household incomes, we may infer that these two households have achieved an equal level of material welfare provided the size of the household is also the same. If this latter condition does not hold, then the family with a higher per capita income can be said to have achieved a higher level of material welfare.

The quantity of labor supplied by the family X_1^* has no exact relationship to the size of the family. Yet, as a first approximation, we will assume that a one percent increase in the size of the family will also expand the quantity of labor supplied by the family by one percent. Consequently, we may analyze the variables that determine the (NHI/X_1^*) ratio. We previously established that NHI is determined by the agricultural wage rate (P_1), the size of the farm (X_2), prices received (P_B), the relative efficiency of labor (R_1), the relative efficiency of land (R_2), the size of the family (X_1^*), off-farm employment opportunities in the nonagricultural sector (X_{13}^*), and the rate of renumeration in the nonagricultural sector (S). We will assume that a change in the size of the family (X_1^*) does not influence above variables. Yet, one might expect larger families to work larger farms (X_1^* influences X_2^*) The *a priori* relationships between X_1^* and P_1 or X_1^* and R_1, etc. are much more difficult to formulate; in fact, they can go in either direction. Cross tabulations of above

variables should reveal as to whether they are indeed systematically interrelated. In what follows, we assume that they are not. Consequently, to take an example, P_1 will influence NHI, but not X_1^*. It follows immediately that in order to study the influence of P_1 on (NHI/X_1^*), i.e., net household income per capita, we have to study only its impact on the numerator of that ratio. But these effects have already been analyzed. For example, an increase in the size of the farm (X_2) will increase net household income. If the total quantity of labor supplied by the farm household X_1^* stays constant, then net household income per capita (NHI/X_1^*) must increase.

Nevertheless, there remains one case that must be analyzed separately, i.e., where the denominator in (NHI/X_1^*) changes. What then is the effect of an expansion in family size on net household income per capita? The appropriate expression (in percentage rates of change) is immediately derived from page 119

$$(nhi - x_1^*) = \left[\frac{W \cdot X_1^*}{NHI} - 1\right] \cdot x_1^*$$

At that time, we determined that the first term in square brackets was smaller than one. Given this, an expansion in family size must lead to a lower level of net household income per capita, because the sum of the two terms within square brackets will be negative.

Net farm income per capita and per hectare

Net farm income (NFI) equals net household income (NHI) minus off-farm income $(X_{12}^* \cdot W + X_{13}^* \cdot S)$. NFI will, therefore, equal NHI whenever the farm household has no off-farm income. In this case, NFI substitutes for NHI as a measure of material welfare of the farm household. In general,

however, net farm income is an incomplete measure of the material welfare of the farm household, and we, therefore, do not emphasize its use in this report.

Net farm income can also be taken as a comprehensive measure of the productivity of all the resources used by the farm household. If two farms use exactly the same package of resources, then the farm with the highest net farm income makes better use of its resources. However, no two farms are ever alike in their resource structure. The usual fact that small farms have higher yields and that large farms have higher average labor productivities in itself carries no normative implications. The only implied norm in this report is that of economic rationality. Both large and small farms may be lacking in this respect. There certainly is no evidence that only small farms or only large farms are lacking in this respect. We, therefore, do not assign any normative significant to differences in single factor productivity ratios. Yet, their use is so widespread that we feel compelled to discuss two of them, i.e., the influence of family size on per capita net farm income and the influence of farm size on net farm income per hectare. In both instances, we assume that a change in family size (X_1^*) does not imply a change in farm size X_2 and vice versa. Family size and farm size are, therefore, taken to be independent of each other.

The farm size effect follows immediately from a related result on page 127. In percentage terms, we have

$$(nfi) - x_2) = \left[\frac{k_2 P_B Q_B}{NFI} - 1\right] \cdot x_2 \quad .$$

The first term within square brackets may be larger than unity. It will

be smaller than one if $k_1 P_B Q_B > X_{12} \cdot W + D$. In the southern valleys, the outlay on purchased inputs (D) and hired labor ($X_{12}W$) is probably less than the share of labor k_1 in the value of net farm output. Consequently, a one percent increase in the size of farm will tend to decrease net farm income per hectare. Observe, however, that net farm income per capita will increase if the size X_2 of the farm increases with the size X_1 of the household remaining constant.

The household size effect was discussed on page 128. We may use this result and obtain in per capita terms

$$(nfi - x_1^*) = \left[\frac{W \cdot X_1^*}{NFI} - 1\right] \cdot x_1^* \quad .$$

The first term in square brackets is less than one. Consequently, a one percent increase in family size will decrease net farm income per capita. But, if the size of the farm X_2 is constant, then net farm income per hectare will increase.

Gross farm income per crop per hectare

It was indicated previously that available survey data do not permit the calculation of gross income measures except for annual crops. Gross income measures have no immediate implications for the welfare of the farm-household. They are readily observable, however, and are often the basic data in compiling a Yearbook of Agricultural Statistics. As such, they serve as an approximate standard to evaluate the productivity of all agricultural resources between traditional and modern agriculture, between farms and between regions.

Table 46 features the average value per hectare for farms reporting production of 19 crops by size of farm. The striking feature of Table 46

Table 46. Average value[a] per hectare for farms reporting production of 19 crops by size of farm

	Size of farm					
	1 ha.	1-1.99 has.	2-4.99 has.	5-5.99 has.	9.99 has.	Total
Corn (grain)	445.9 (141)	185.5 (90)	125.9 (123)	79.4 (84)	94.4 (42)	129.6 (480)
Potatoes	432.5 (119)	256.1 (98)	264.3 (134)	251.3 (62)	426.7 (41)	315.6 (454)
Wheat	208.5 (16)	155.2 (29)	111.3 (65)	67.1 (51)	67.2 (40)	77.9 (201)
Barley (grain)	237.4 (35)	162.7 (40)	130.4 (59)	120.3 (19)	149.6 (18)	143.9 (171)
Beans (green)	233.0 (16)	120.0 (17)	141.5 (27)	157.8 (12)	151.6 (14)	151.4 (86)
Corn (on the cob)	401.8 (34)	334.7 (7)	92.9 (14)	251.2 (8)	225.9 (13)	247.9 (76)
Peas (green)	59.9 (4)	157.7 (5)	106.8 (20)	56.3 (19)	45.8 (18)	66.3 (66)
Peanuts	454.0 (1)	370.5 (11)	287.0 (29)	371.2 (16)	171.3 (6)	310.0 (63)
Oca	152.9 (5)	127.1 (12)	103.9 (23)	98.6 (6)	323.1 (4)	153.7 (50)
Peppers	- (0)	586.0 (6)	485.6 (29)	795.3 (8)	569.7 (3)	573.5 (46)
Papaliza	136.1 (2)	189.2 (16)	219.1 (23)	232.4 (4)	192.1 (1)	208.5 (46)
Beans (dry)	- (0)	120.0 (1)	80.3 (2)	36.0 (1)	74.6 (3)	76.9 (7)

Table 46. *Continued*

	Size of farm					
	<1 ha.	1-1.99 has.	2-4.-9 has.	5-5.99 has.	>9.99 has.	Total
Barley (green)	466.0 (5)	294.4 (8)	224.7 (8)	0 (1)	276.4 (2)	295.8 (24)
Quinua	96.0 (1)	- (0)	64.7 (1)	35.0 (1)	370.9 (3)	301.4 (6)
Carrots	400.0 (1)	159.0 (1)	390.0 (3)	329.3 (3)	804.8 (2)	541.9 (10)
Grapes	2131.3 (5)	2311.7 (4)	4821.9 (3)	3630.0 (3)	4316.4 (1)	3747.2 (16)
Peaches	1015.0 (3)	114.3 (2)	- (0)	76.4 (2)	- (0)	424.6 (7)
Oranges	- (0)	- (0)	365.4 (6)	- (2)	2400.0 (1)	1250.0 (9)
Alfalfa	- (0)	74.8 (1)	147.0 (1)	32.7 (2)	123.1 (2)	53.9 (6)

Source: Table T51, stubs 6, 12, standard Table 10.

Note: Numbers in parentheses indicate number of farms reporting production.

[a]Values in tens of pesos.

is the variability of the average value per hectare between crops and between farm size groups. For example, the weighted average value of grape production per hectare equals 37,472 pesos. In contrast, the weighted average value of alfalfa production per hectare is only 539 pesos. Among the seven principal crops, potatoes rank first with 3156 pesos, or 158 U.S. dollars per hectare, fresh corn ranks second with 2479 pesos per hectare, green broad beans rank third with 1514 pesos per hectare, barley (grain) ranks fourth with 1439 pesos per hectare, corn (grain) ranks fifth with 1296 pesos per hectare, wheat ranks sixth with 779 pesos per hectare, green peas rank seventh with 663 pesos per hectare. Unfortunately, no information is available on costs of production and quantities of inputs, which would allow us to study the relative profitability of different crops.

We previously found that the weighted average value of crop production per hectare decreases if the size of farm increases (see Table 19, lines 2 and 3). This relationship does not hold without exception for individual crops. For 13 crops out of 19, the average value of crop production per hectare for farms less than 1 hectare is above the weighted average taken over all farm sizes, i.e., the last column in Table 46. It is true, in particular, for five out of seven principal crops, the exception being green peas. When comparing all farms, differences in value productivity of farms between one and two hectares is less obvious.

Table 47 features the average value per hectare for farms reporting production of 19 crops by type of seed used. The presumption is that improved seed should lead to higher average values of production per hectare. Table 47 does not confirm this hypothesis, particularly for principal crops. This calls into question the nature of improved seed, the possible lack of complementary inputs, and the lack of local adaptation. It is also possible

Table 47. Average value per hectare[1/] for farms reporting production of 19 crops by type of seed used

	Type of seed used		
	Native seed	Hybrid or improved seed	Seed of unknown source
Corn (grain)	128.6 (473)	417.5 (4)	206.9 (3)
Potatoes	316.6 (424)	269.0 (21)	420.1 (9)
Wheat	76.7 (196)	95.4 (3)	78.6 (1)
Barley (grain)	144.5 (170)	265.0 (1)	49.9 (1)
Beans (green)	153.4 (79)	41.6 (1)	97.9 (6)
Corn (on the cob)	243.3 (70)	800.8 (1)	246.4 (3)
Peas (green)	67.3 (59)	53.0 (2)	46.3 (5)
Peanuts	316.1 (62)	139.2 (1)	- (0)
Oca	153.7 (50)	- (0)	- (0)
Peppers	556.4 (45)	1728.0 (1)	- (0)
Papaliza	208.6 (45)	- (0)	200.1 (1)
Beans (dry)	76.9 (7)	- (0)	- (0)

Table 47. *Continued*

	Type of seed used		
	Native seed	Hybrid or improved seed	Seed of unknown source
Barley (green)	295.8 (24)	- (0)	- (0)
Quinua	301.4 (6)	- (0)	- (0)
Carrots	537.7 (9)	- (0)	659.9 (1)
Grapes	4157.6 (9)	7333.6 (2)	1097.3 (5)
Peaches	995.6 (4)	- (0)	287.5 (2)
Oranges	2400.0 (1)	- (0)	345.9 (6)
Alfalfa	53.9 (6)	- (0)	- (0)

Source: Table T51, stubs 6, 12 standard Table 10.

Note: Numbers in parentheses indicate number of farms reporting indicated cropping practice for crops i = 1...19.

1/ In tens of pesos.

that the number of farms that use improved seed is so small that no significant comparison can be made.

Table 48 features the value of production per hectare for farms reporting production of 19 crops according to type of fertilizer and irrigation. Comparing the first and second column of that table, we observe that irrigation increases the average value of crop production per hectare for six of the seven principal crops (i.e., corn (grain), potatoes, wheat, barley (grain), green broad beans, fresh corn). The only exception is green peas, and then only marginally so.

When we compare columns 3 and 4, irrigation is again the dichotomous variable. But the number of farms using chemical fertilizer is possibly too small to make meaningful comparisons. This also holds for columns 5, 6 and 7. The number of observations is sufficient, however, to compare columns 2 and 8. The dichotomous variable between these columns is the use (or nonuse) of organic fertilizer (manure). Surprisingly, the use of organic fertilizer results in higher average values of crop production per hectare for only 6 out of 13 crops. It is impossible with the information at hand to identify the unknown factor which upsets this comparison.

Table 49 compares the average value of production per hectare of farms reporting production of 19 crops according to source of power. The only relevant comparison is between "animal power only" and "human power only," i.e., columns three and four in Table 49. For the 14 comparisons that can be made, "animal power only" yields an above average value of production for six crops. More importantly, "human power only" yields above average values of production per hectare for 5 out of 7 of the principal crops. The above results in total indicate that human and animal energy are close technical substitutes for each other. It is the economic

Table 48. Average value of production per hectare[1/] for farms reporting production of 19 crops according to type of fertilizer and irrigation

Organic fertilizer Chem. fertilizer Irrigation	Yes No Yes	Yes No No	No Yes Yes	No Yes No	Yes Yes Yes	Yes Yes No	No No Yes	No No No
Corn (grain)	203.7 (166)	77.3 (162)	82.6 (1)	57.1 (5)	119.3 (7)	142.8 (5)	134.2 (14)	149.3 (107)
Potatoes	333.0 (116)	252.8 (232)	294.9 (4)	362.2 (4)	323.5 (31)	661.7 (26)	307.4 (6)	218.1 (24)
Wheat	93.3 (15)	79.8 (103)	38.2 (2)	- (0)	- (0)	288.0 (2)	90.9 (6)	75.6 (64)
Barley (grain)	167.3 (20)	155.6 (70)	- (0)	- (0)	- (0)	- (0)	120.4 (4)	133.6 (73)
Beans (green)	143.0 (33)	109.3 (21)	- (0)	- (0)	146.0 (3)	600.0 (1)	189.5 (6)	182.0 (21)
Corn (on the cob)	355.3 (50)	120.3 (14)	- (0)	- (0)	1000.0 (1)	750.0 (1)	145.4 (2)	335.0 (4)
Peas (green)	41.2 (9)	45.7 (30)	89.3 (4)	- (0)	77.9 (7)	166.7 (1)	128.8 (5)	77.8 (6)
Peanuts	269.6 (8)	170.9 (11)	- (0)	383.3 (1)	335.6 (2)	- (0)	153.9 (6)	379.4 (34)
Oca	266.8 (6)	165.5 (25)	- (0)	- (0)	- (0)	480.2 (1)	128.5 (2)	100.2 (14)
Peppers	260.0 (2)	522.9 (6)	- (0)	- (0)	- (0)	- (0)	452.6 (4)	669.5 (29)
Papaliza	- (0)	255.0 (36)	- (0)	- (0)	- (0)	- (0)	180.3 (1)	102.8 (8)
Beans (dry)	36.0 (1)	74.6 (3)	0 (1)	- (0)	120.0 (1)	- (0)	- (0)	240.8 (1)

Table 48. *Continued*

Organic fertilizer Chem. fertilizer Irrigation	Yes No Yes	Yes No No	No Yes Yes	No Yes No	Yes Yes Yes	Yes Yes No	No No Yes	No No No
Barley (green)	436.5 (2)	277.0 (15)	- (0)	- (0)	- (0)	- (0)	0 (1)	145.3 (6)
Quinua	320.0 (1)	332.7 (3)	- (0)	- (0)	- (0)	- (0)	64.0 (1)	- (0)
Carrots	45.7 (3)	659.9 (1)	- (0)	- (0)	448.2 (2)	- (0)	754.8 (3)	- (0)
Grapes	3740.9 (6)	764.0 (1)	- (0)	- (0)	4093.1 (3)	8000.3 (1)	3923.5 (3)	- (0)
Peaches	263.2 (2)	- (0)	- (0)	- (0)	- (0)	- (0)	1309.4 (2)	- (1)
Oranges	2400.0 (1)	- (0)	- (0)	- (0)	- (0)	- (0)	444.4 (2)	0 (1)
Alfalfa	32.2 (2)	- (0)	- (0)	- (0)	- (0)	- (0)	79.6 (4)	- (0)

Source: Table T51, stubs 6, 12, standard Table 11.

Note: Numbers in parentheses indicate number of farms reporting indicated cropping practice for crop i = 1...19.

1/ In tens of pesos.

Table 49. Average value of production per hectare[1] of farms reporting production of 19 crops according to source of power

	Source of power			
	Mechanical and animal	Only mechanical	Only animal	No mechanical, no animal
Corn (grain)	455.7	60.0	119.9	289.5
	(1)	(1)	(391)	(67)
Potatoes	500.0	-	316.4	302.8
	(1)	(0)	(362)	(70)
Wheat	-	-	77.6	210.7
	(0)	(0)	(183)	(7)
Barley (grain)	-	-	140.7	202.9
	(0)	(0)	(147)	(18)
Beans (green)	-	62.1	145.8	214.4
	(0)	(1)	(70)	(14)
Corn (on the cob)	-	-	206.2	402.3
	(0)	(0)	(36)	(34)
Peas (green)	-	-	77.4	32.6
	(0)	(0)	(58)	(3)
Peanuts	-	-	287.6	292.3
	(0)	(0)	(52)	(5)
Oca	0	0	167.2	93.5
	(0)	(0)	(39)	(9)
Peppers	-	-	656.6	447.6
	(0)	(0)	(28)	(9)
Papaliza	-	-	223.4	117.2
	(0)	(0)	(39)	(6)
Beans (dry)	-	-	76.9	-
	(0)	(0)	(7)	(0)
Barley (green)	-	-	245.9	244.3
	(0)	(0)	(22)	(2)
Quinua	-	-	362.0	288.0
	(0)	(0)	(3)	(2)
Carrots	-	-	538.9	607.9
	(0)	(0)	(8)	(2)
Grapes	-	8000.3	-	3613.4
	-	(1)	(0)	(13)
Peaches	-	-	-	995.6
	(0)	(0)	(0)	(4)
Oranges	-	-	-	2222.2
	(0)	(0)	(0)	(2)
Alfalfa	-	-	-	53.7
	(0)	(0)	(0)	(5)

Source: Table T51, stubs 6, 12, standard Table 12.

Note: Numbers in parentheses indicate number of farms reporting indicated cropping practice for crop i = 1...19.

1/ In tens of pesos.

circumstances of the farm-household which dictate the source of power. It is also interesting to observe that for the southern valley areas, mechanization at the present time is not economically attractive given its virtual absence as a source of power.

Table 50 lists the average value of production per hectare for farms reporting production of 19 crops according to the use of herbicides, fungicides and pesticides. The premise is that the use of these chemicals increases the average value of crop production per hectare. This premise is confirmed. For 12 of 15 crops for which such a comparison can be made, the use of herbicides, fungicides or pesticides increases the value of crop production per hectare. The production increase is important for principal crops as well as minor crops. Among the latter, fungicides and pesticides are almost a prerequisite to obtain satisfactory crop production levels per hectare.

Table 50. Average value of production per hectare[1/] for farms reporting production of 19 crops according to use of other chemical products[2/]

	— Other chemical products —	
	Used	Not used
Corn (grain)	97.5	129.2
	(13)	(461)
Potatoes	455.2	268.1
	(49)	(402)
Wheat	190.5	69.1
	(5)	(194)
Barley (grain)	173.0	145.9
	(2)	(167)
Beans (green)	284.3	138.3
	(3)	(82)
Corn (on the cob)	92.7	273.1
	(3)	(72)
Peas (green)	113.0	57.0
	(9)	(56)
Peanuts	365.2	303.6
	(3)	(60)
Oca	-	153.7
	(0)	(50)
Peppers	866.8	545.3
	(3)	(43)
Papaliza	-	208.5
	(0)	(46)
Beans (dry)	48.0	95.6
	(1)	(6)
Barley (green)	-	245.8
	(0)	(24)
Quinua	390.0	65.2
	(2)	(4)
Carrots	565.4	457.4
	(5)	(5)
Grapes	3966.2	115.4
	(12)	(2)
Peaches	1124.7	394.6
	(1)	(5)
Oranges	2400.0	97.6
	(1)	(5)
Alfalfa	-	53.9
	(0)	(6)

Source: Table T51, stubs 6, 12, standard Table 13.

Note: Numbers in parentheses indicate number of farms reporting indicated cropping practice for crop i = 1...19.

[1/] In tens of pesos.

[2/] Herbicides, fungicides, pesticides, etc.

SECTION VI.

CONSUMPTION AND MARKETING OF PRODUCTS

The farm household as a consumption unit

In the foregoing sections, we have analyzed the behavior of the farm household as a production unit. We must now analyze the farm household as a consumption unit. The decisions taken as a production unit determine the level of net household income. The farm household must then make a decision as to how to spend this income.

Assume the existence of an index of material welfare

$$U = U[Q_0, Q_{B \cdot 1}].$$

The above equation represents a conventional utility function. It has two arguments, Q_0 and $Q_{B \cdot 1}$. Q_0 represents the consumption of the quantity of purchased commodities by the farm household. $Q_{B \cdot 1}$ represents the consumption of commodities produced by the farm household. $Q_{B \cdot 1}$ will consist primarily of food products in primary or processed form, but it may also contain home-made textile products and leather products. Q_0 consists primarily of non-food products, but it may also contain food products which the farm household does not produce itself. The essential distinction between Q_0 and $Q_{B \cdot 1}$ is, therefore, the source of acquisition, i.e., off-farm or on-farm. The quantity consumed $Q_{B \cdot 1}$ must be less than the net quantity produced Q_B by the farm household. The ratio $Q_{B \cdot 1}/Q_B$ in Figure 1 determines whether a farm should be classified as a commercial or as a subsistence farm. The majority of farms covered by the southern valleys survey are subsistence farms, but very few are pure subsistence farms, which requires that $Q_{B \cdot 1} = Q_B$.

The farm household's utility function underlies its demand for commodities produced on the farm and purchased off the farm. Net household income,[1/] the imputed price of home-produced goods and the explicit price of purchased commodities for household consumption determine the quantities Q_0 and $Q_{B \cdot 1}$ demanded by the farm household. If Q_0 and $Q_{B \cdot 1}$ are normal commodity bundles, i.e., substitutes in consumption, then the income effects are positive, the direct price effects negative and the cross price effects non-negative. In what follows, we assume the cross price effects to be equal to zero. Because of the homogeneity condition, the direct price elasticities then equal the negative value of the corresponding income elasticities. Furthermore, because of the Cournot aggregation condition, each of the direct price elasticities must equal -1.[2/] With the above assumption, the demand for home-produced and non-home-produced goods is represented by a compact linear expenditure system.

$$P_B \cdot Q_{B \cdot 1} = a \cdot NHI$$

$$P_0 \cdot Q_0 = (1 - a) \cdot NHI$$

$P_B \cdot Q_{B \cdot 1}$ represents the implicit expenditure on home-produced goods. The parameter (a) represents the constant fraction of net household income spent on home-produced goods. The above equations represent an operationally expedient interpretation of the utility function $U[Q_0, Q_{B \cdot 1}]$. The data of the southern valleys can be used to test the first of these hypotheses with the caveat that the survey did not collect home consumption

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[1/] Net household income equals net cash household income plus the imputed value $P_B \cdot Q_{B \cdot 1}$ of household consumption of on-farm produced commodities.

[2/] Eugene Silberberg, *The Structure of Economics: A Mathematical Analysis*, McGraw-Hill, 1978, pages 250-251.

of primary and processed livestock products. The latter constitute a significant proportion of home consumption.[1/]

Variables that affect the quantity of net farm output used for human consumption by the farm household $Q_{B \cdot 1}$

In the previous section, we assumed that the consumption behavior of the farm household could be represented by a linear expenditure system. Because of this, the imputed outlay on commodities produced by the farm households is a constant fraction of net household income

$$P_B \cdot Q_{B \cdot 1} = a[M + P_B \cdot Q_{B \cdot 1}] .$$

In the above equation, P_B is an index of prices received by farmers. $Q_{B \cdot 1}$ is the volume of human consumption of commodities produced by the farm household, and M equals net household cash income (NHCI). The latter plus the imputed outlay $P_B \cdot Q_{B \cdot 1}$ on commodities produced by the farm household equals by definition[2/] net household income (NHI). In the above equation, a is a constant such that $0 \leq a \leq 1$.

Translating the above equation in percentage rates of change, we have

$$P_B + q_{B \cdot 1} = nhi.$$

Transposition of the rate of change in prices received yields

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[1/] The implicit unit value of these products is high relative to crops and virtually all of primary and processed livestock production is for home consumption [Riordan, *op. cit.*, tables 40, 41, pp. 68, 69]. Price and quantity data for these items are lacking, however. An econometric hypothesis allowing for nonzero cross price effects is, therefore, impossible given the lack of the required information. The survey does not include information on quantities and prices of consumption goods purchased off the farm. The expenditure on such commodities by definition equals net household cash income.

[2/] For the definitions of NFCI, NHCI, NFI and NHI, see page 115.

$$q_{B\cdot 1} = nhi - p_B \cdot$$

In order to study the variables that influence the consumption of commodities produced by the farm household, we must study the variables that influence net household income. For that purpose, we may use the results of the previous section. The relevant variables are

1) the agricultural wage rate P_1
2) the size of the farm (X_2)
3) the prices received by farmers (P_B)
4) the relative efficiency of labor (R_1)
5) the relative efficiency of land (R_2)
6) the size of the family (X_1^*)
7) nonagricultural employment (X_{13}^*)
8) the implied wage rate in nonagricultural employment (S)
9) the cash outlay on purchased inputs other than labor (D).

The effects of above variables on $Q_{B\cdot 1}$ are obtained by using the results obtained for the variables that influence net household income discussed in pages 54 and 55.

1) <u>The wage rate effect</u>: $q_{B\cdot 1} = \frac{X_{12}^* \cdot W}{NHI} \cdot p_1$ <u>or</u> $q_{B\cdot 1} = -\frac{X_{12} \cdot W}{NHI} \cdot p_1$

   Here, we must distinguish two cases. If the farm household has off-farm income in agriculture, then $X_{12}^* > 0$ and $X_{12} = 0$. Given this, a one percent increase in the agricultural wage P_1 will <u>increase</u> human consumption $Q_{B\cdot 1}$ by less than one percent. The fraction equals the current share of off-farm income in agriculture in NHI. If the farm household hires labor, then $X_{12} > 0$ and $X_{12}^* = 0$. Given this, a one percent increase in the agricultural wage will <u>decrease</u> human consumption $Q_{B\cdot 1}$ by less than one percent.

2) <u>The farm size effect</u>: $q_{B \cdot 1} = \frac{k_2 P_B Q_B}{NHI} \cdot x_2$

Here, we must distinguish two possibilities. If the farm household has off-farm income in agriculture, then ($X^*_{12} > 0$; $X_{12} = 0$). In Figure 5, net household income HZ is larger than the value of net farm output KF. Consequently, a one percent increase in the size of the farm will increase consumption $Q_{B \cdot 1}$ by less than one percent. If, however, the farm uses hired labor, then $k_2 P_B Q_B \gtrless NHI$, and $Q_{B \cdot 1}$ may increase by more than one percent.

3) <u>The price received effect</u>: $q_{B \cdot 1} = \left[\frac{P_B Q_B}{NHI} - 1 \right] \cdot P_B$

Here, we must distinguish two possibilities. Given off-farm income in agriculture, we have as before $P_B Q_B < NHI$. A one percent increase in the prices received by farmers for products which are partially consumed by the farm household will <u>decrease</u> the amount $Q_{B \cdot 1}$ consumed by the farm household. If, however, the farm household uses hired labor, then $P_B Q_B \gtrless NHI$ and an increase in P_B <u>may then increase</u> $Q_{B \cdot 1}$.

4) <u>The relative efficiency of labor</u>: $q_{B \cdot 1} = \frac{k_1 P_B Q_B}{NHI} \cdot r_1$

Here, we must distinguish two possibilities. If the farm household has off-farm income in agriculture, then $P_B Q_B < NHI$. A one percent increase in the relative efficiency of labor will increase human consumption $Q_{B \cdot 1}$ by less than one percent. If, however, the farm uses hired labor, we may have $k_1 P_B Q_B \gtrless NHI$, and $Q_{B \cdot 1}$ will then increase by more than one percent.

5) <u>The relative efficiency of land</u>: $q_{B \cdot j} = \frac{k_2 P_B Q_B}{NHI} \cdot r_2$

Here, we must distinguish two cases. For a farm household with off-farm income in agriculture $P_B Q_B < NHI$. A one percent increase in the relative efficiency of land will increase $Q_{B \cdot 1}$ by less than one percent. If the farm household uses hired labor, then $k_2 P_B Q_B \gtrless NHI$, and $Q_{B \cdot 1}$ may increase by more than one percent.

6) <u>The size of household effect</u>: $q_{B \cdot 1} = \frac{W \cdot X_1^*}{NHI} \cdot x_1^*$

We previously established the inequality $W \cdot X_1^* < NHI$. Hence, a one percent increase in the size of the family will expand the quantity of human consumption $Q_{B \cdot 1}$ by less than one percent.

7) <u>The nonagricultural employment effect</u>: $q_{B \cdot 1} = \frac{(S-W)X_{13}^*}{NHI} \cdot x_{13}^*$

We previously established the inequality $(S-W)X_{13}^* < NHI$. Hence, a one percent increase in nonagricultural employment will increase the quality of human consumption $Q_{B \cdot 1}$ by less than one percent.

8) <u>The nonagricultural wage effect</u>: $q_{B \cdot 1} = \frac{X_{13}^* \cdot S}{NHI} \cdot s$

We previously established the inequality $X_{13}^* S < NHI$. Consequently, a one percent increase in the nonagricultural wage S will increase the quantity for human consumption $Q_{B \cdot 1}$ by less than one percent.

In order to avoid repetition, we discuss the cross-tabulations illustrating each of the separate effects until the section on marketed surplus. In the following pages, we illustrate the key relationship

$$P_B \cdot q_{B \cdot 1} = a \cdot NHI.$$

That is, we study the relationship between the value of net farm output used for human consumption and net household income.

Table 51 shows that the average value of crops consumed per farm-household equals 1810 pesos or 28 percent of net household income. There is substantial departmental variation in these figures. The average value of crop consumption per farm household in the Chuquisaca area equals 2489 pesos, but this constitutes only 26 percent of net household income for that area. The former figure equals 1779 pesos for the Potosi area, but it constitutes 35 percent of net household income for that area. The average value of crop consumption in the Tarija area is 1399 pesos, i.e., much below the regional average of 1810 pesos. Nevertheless, it constitutes 20 percent of net household income for the Tarija area.

The average value of crop consumption per farm-household increases with net household income. For net household income levels less than 4700 pesos, the average value of crop consumption equals 1385 pesos out of corresponding net household income equal to 1164 pesos.[1/] For net household income levels above 4700 pesos, the average value of crop consumption equals 2547 pesos out of an average value of net household income equal to 15715 pesos. The implied net income elasticity for home-produced food, therefore, equals .34.[2/] With a linear expenditure system, the income

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[1/] In the short run, consumption can be larger than net household income provided the farm-household can borrow or else liquidate part of its assets. The 1977 agricultural crop year was characterized by drought which may account for the 130 households with negative net household income.

[2/] Income elasticity $E = \frac{\Delta c}{\Delta y} \cdot \frac{\bar{y}}{\bar{c}}$.

$\Delta c = (2547 - 1385) = 1162$; $\Delta y = (15715 - 1164) = 14551$.

$\bar{y} = .5(1164 + 15715) = 8450$; $\bar{c} = .5(1385 + 2547) = 1966$.

Table 51. Average value of crops consumed by farm-households by regions and level of net household income per farm-household

	Net household income per farm-household ($b.)					
	<801	801-2100	2101-4700	4701-10,000	>10,000	Total
Region						
Average value of crop consumption per farm-household[1]	1046	1269	1813	2400	2688	1810
	(145)	(139)	(153)	(122)	(127)	(697)
Average net household income per farm-household[2]	-1231.4	1386.0	3250.7	6798.9	24710.2	6547.2
	(130)	(124)	(136)	(115)	(114)	(619)
Chuquisaca						
Average value of crop consumption per farm-household[1]	1617	1303	1803	3640	3764	2489
	(21)	(22)	(40)	(24)	(32)	(143)
Average net household income per farm-household[2]	-914.7	1492.5	3207.1	7364.2	32917.1	9597.1
	(93)	(19)	(34)	(23)	(30)	(126)
Tarija						
Average value of crop consumption per farm-household[1]	779	951	1660	1730	1751	1399
	(43)	(31)	(47)	(38)	(46)	(211)
Average net household income per farm-household[2]	-1646.2	1283.2	3444.1	6731.7	22469.9	7042.8
	(40)	(24)	(39)	(33)	(41)	(177)
Potosi						
Average value of crop consumption per farm-household[1]	1041	1376	1922	2328	2865	1779
	(81)	(86)	(66)	(60)	(49)	(343)
Average net household income per farm-household[2]	-131.0	1391.3	3092.6	6616.1	21120.7	5035.5
	(70)	(81)	(63)	(59)	(43)	(316)

Source: [1]Table T23, stubs 3, 4, standard Table 7, [2]Table T28, stubs 5, 6, standard Table 7.

Note: Numbers in parentheses indicate number of observations used in average.

elasticity should equal 1.00. The demand for home-produced food by farm-households cannot be represented by a linear expenditure system. The income elasticity for home-produced food is low considering the low per capita level of net household income for the southern valleys area. Utilizing the data in Table 51 in a similar corresponding manner for Tarija and Potosi, we find arc income elasticities equal to .20 and .29, respectively. The income elasticity for home-produced food, therefore, shows some variation between departmental areas.

Variables that affect the marketed surplus $Q_{B \cdot 2}$

The farm household may contribute in three ways to economic development, i.e., as a source of savings, as a source of gainful employment and as a source for food and fiber for the nonagricultural population. Let the marketed surplus of food and fiber be represented by $Q_{B \cdot 2}$, i.e., that portion of net farm output which is sold by the farm household. By definition

$$Q_B = Q_{B \cdot 1} + Q_{B \cdot 2} \ .$$

In previous sections, we analyzed the variables that influenced net farm output Q_B and the share of production $Q_{B \cdot 1}$ consumed by the farm household. The effect of these variables on the marketed surplus $Q_{B \cdot 2}$ is obtained by subtraction, because

$$Q_{B \cdot 2} = Q_B - Q_{B \cdot 1} \ .$$

The relevant variables were previously identified as the agricultural wage rate P_1, the size of farm X_2, the prices received by farmers P_B, the relative efficiency of labor R_1, the relative efficiency of land R_2, the size of the household X_1^*, the quantity of nonagricultural employment X_{13}^* and the nonagricultural wage S.

Translating the above equation in percentage terms, we have

$$q_{B\cdot 2} = \frac{Q_B}{Q_{B\cdot 2}} \cdot q_B - \frac{Q_{B\cdot 1}}{Q_{B\cdot 2}} \cdot q_{B\cdot 1} \ .$$

The effects of P_1, X_2, P_B, R_1, R_2, X_1^*, X_{13}^* and S on Q_B and $Q_{B\cdot 1}$ are found on page 82 and pages 153 through 155. By subtraction, we obtain the following effects.

1) <u>The agricultural wage rate effect</u>:

We must distinguish two cases. If the farm household has off-farm income in agriculture, then $X_{12}^* > 0$ and $X_{12} = 0$. The analytical expression then equals

$$q_{B\cdot 2} = - \left[\frac{Q_B}{Q_{B\cdot 2}} \cdot \frac{k_1 \sigma}{k_2} + \frac{Q_{B\cdot 1}}{Q_{B\cdot 2}} \cdot \frac{X_{12}^* \cdot W}{NHI} \right] \cdot p_1 \ .$$

In the above expression, the production effect (the first term) and the consumption effect (the second term) are both negative. An increase in the agricultural wage will therefore decrease the marketed surplus $Q_{B\cdot 2}$. The first term in square brackets will tend to be larger than one. A one percent increase in the agricultural wage rate then decreases the marketed surplus by more than one percent.

If the farm household has no off-farm income in agriculture, then $X_{12} > 0$ and $X_{12}^* = 0$. The wage effect then equals

$$q_{B\cdot 2} = \left[- \frac{Q_B}{Q_{B\cdot 2}} \cdot \frac{k_1 \sigma}{k_2} + \frac{X_{12} \cdot W}{NHI} \right] \cdot p_1 \ .$$

The first term in square brackets is negative and possibly smaller than -1. The second term is positive and smaller than 1. Consequently, a one percent increase in the agricultural wage will

decrease the marketed surplus, but the response will be comparatively less than for a farm household not using hired labor.

2) The farm size effect:

Taking the production effect from Table 3 and the consumption effect from page 155, we obtain

$$q_{B\cdot 2} = \left[\frac{Q_B}{Q_{B\cdot 2}} \cdot 1 - \frac{Q_{B\cdot 1}}{Q_{B\cdot 2}} \cdot \frac{k_2 P_B Q_B}{NHI}\right] \cdot x_2 .$$

This expression can be simplified as

$$q_{B\cdot 2} = \frac{Q_B}{Q_{B\cdot 2}} \left[1 - k_2 \cdot a\right] \cdot x_2 .$$

The imputed share of land is $0 < k_2 < 1$ and the proportion of net household consumption spent on home produced commodities is $0 < a < 1$. Net farm output Q_B is larger than the marketed surplus, i.e $Q_B > Q_{B\cdot 2}$. Therefore, an increase in the size of farm may or may not increase the marketed surplus by more than one percent. For very large farms, i.e., nonfamily farms, the ratio $Q_B/Q_{B\cdot 2}$ will equal unity. For such farms, a one percent increase in size will increase the marketed surplus by less than one percent.

3) The price received effect:

Taking the production effect from Table 3 and the consumption effect from page 155, we have

$$q_{B\cdot 2} = \left\{\frac{Q_B}{Q_{B\cdot 2}} \cdot \frac{k_1 \sigma}{k_2} - \frac{Q_{B\cdot 1}}{Q_{B\cdot 2}} \left[\frac{P_B Q_B}{NHI} - 1\right]\right\} P_B .$$

The above expression can be simplified to

$$q_{b\cdot 2} = \left\{ \frac{Q_B}{Q_{B\cdot 2}} \left[\frac{k_1\sigma}{k_2} - a \right] + \frac{Q_{B\cdot 1}}{Q_{B\cdot 2}} \right\} \cdot p_B \ .$$

The expression within accolades will be positive whenever the production response elasticity $k_1\sigma/k_2$ is larger than the expenditure share a of home-produced commodities in net household income. By definition, $0 < a < 1$. Under our assumptions, $k_1\sigma/k_2$ is slightly larger than unity. Consequently, the sum of the terms within accolades is also positive. An increase in prices received will increase the marketed surplus. For very large farms, i.e., nonfamily farms, the ratio $Q_B/Q_{B\cdot 2} = 1$ and $Q_{B\cdot 1}/Q_{B\cdot 2} = 0$. For such farms, the price response elasticity equals $k_1\sigma/k_2$. It should be observed that the expression within accolades is not necessarily positive. Assume, for example, that land cannot be substituted for labor; in that case, $\sigma = 0$, and the first term in equation $q_{B\cdot 2}$ vanishes. What happens to the marketed surplus is then determined by the consumption effect. From the analysis of page 155, we know that this effect may be positive or negative.

4) <u>The relative efficiency of labor effects</u>:

Taking the production effect from Table 3 and the consumption effect from page 155, we have

$$q_{B\cdot 2} = \left[\frac{Q_B}{Q_{B\cdot 2}} \cdot \frac{k_1\sigma}{k_2} - \frac{Q_{B\cdot 1}}{Q_{B\cdot 2}} \ \frac{k_1 P_B Q_B}{NHI} \right] \cdot r_1 \ .$$

This expression can be simplified as

$$q_{B\cdot 2} = \frac{Q_B}{Q_{B\cdot 2}} \left[\frac{k_1(\sigma - a)}{k_2} \right] \cdot r_1 .$$

The sign of the expression within brackets will be positive if the elasticity of factor substitution between land and labor (σ) is larger than the proportion (a) of net household income spent on home-produced commodities. Under our assumptions, $\sigma > a$. An increase in the relative efficiency of labor will increase the marketed surplus. It will be observed, however, that if $\sigma < a$, an increase in the relative efficiency of labor will decrease the marketed surplus.

5) <u>The relative efficiency of land effect</u>:

Taking the production effect from Table 3 and the consumption effect from page 155, we have

$$q_{B\cdot 2} = \left(\frac{Q_B}{Q_{B\cdot 2}} \cdot 1 - \frac{Q_{B\cdot 1}}{Q_{B\cdot 2}} \cdot \frac{k_2 P_B Q_B}{NHI} \right) r_2 .$$

This expression is identical to the farm size effect. It can be rewritten as

$$q_{B\cdot 2} = \frac{Q_B}{Q_{B\cdot 2}} \left[1 - k_2 a \right] \cdot r_2 .$$

The expression within brackets is positive, because $0 < k_2 < 1$, and $0 < a < 1$. An increase in the relative efficiency of land will increase the marketed surplus.

6) <u>The size of household effect</u>:

An increase in the size of household will not affect the quantity of labor employed by the farm household provided the off-farm wage in agriculture is positive. An increase in the size of household, therefore, does not increase the output of the farm household.[1/]

[1/] It will increase output elsewhere, of course, but that is a different story.

The only effect to be considered is, therefore, the consumption effect on page 155.

$$q_{B\cdot 2} = -\frac{Q_{B\cdot 1}}{Q_{B\cdot 2}} \cdot \frac{WX_1^*}{NHI} \cdot x_1^*.$$

An increase in the size of the household decreases the marketed surplus.

7) <u>The nonagricultural employment effect</u>

An increase in nonagricultural employment X_{13}^* does not affect the total quantity of labor employed by the farm household. Consequently, the increase in X_{13}^* must be compensated by an equal increase in hired labor X_{12} or an equal decrease in off-farm labor in agriculture X_{12}^*. The production effect is, therefore, zero, and only the consumption effect needs to be considered

$$q_B = -\frac{Q_{B\cdot 1}}{Q_{B\cdot 2}} \cdot \frac{(S-W)X_{13}^*}{NHI} \cdot x_{13}^* .$$

An increase in nonagricultural employment will decrease the marketed surplus.

8) <u>The nonagricultural wage effect</u>

An increase in the nonagricultural wage does not affect net farm output. Therefore, only the consumption effect on page 155 needs to be considered.

$$q_{B\cdot 2} = -\frac{Q_{B\cdot 1}}{Q_{B\cdot 2}} \cdot \frac{X_{13}^* S}{NHI} \cdot s.$$

An increase in the nonagricultural wage rate decreases the marketed surplus.

Table 52. Average value of crop production and crop sales per farm by regions by size of farm

	Size of farm					
	<1 ha.	1-1.99 has.	2-4.99 has.	5-5.99 has.	>9.99 has.	Total
Region						
Average value of crop production per farm	1775 (204)	3044 (140)	5423 (189)	7185 (101)	15860 (57)	4966 (697)
Average value of crop sales per farm	284 (204)	1266 (146)	2274 (189)	4241 (101)	5378 (57)	2019 (697)
Chuquisaca						
Average value of crop production per farm	2428 (48)	6477 (35)	16418 (31)	21012 (13)	31019 (16)	11340 (143)
Average value of crop sales per farm	996 (48)	4448 (35)	9311 (31)	16405 (13)	7906 (16)	5818 (143)
Tarija						
Average value of crop production per farm	452 (8)	1910 (27)	3356 (88)	4681 (67)	5033 (21)	3648 (211)
Average value of crop sales per farm	8 (8)	521 (27)	1177 (88)	2425 (67)	2137 (21)	1540 (211)
Potosi						
Average value of crop production per farm	1634 (148)	1979 (84)	3152 (70)	6616 (21)	15100 (20)	3119 (343)
Average value of crop sales per farm	68 (148)	179 (84)	537 (70)	2506 (21)	6758 (20)	730 (343)

Source: Table T23, stubs 1, 2, 4, standard Table 7.

Note: Numbers in parentheses indicate number of observations used to average.

Table 52 features the average value of crop production per farm and the proportion sold of crop production in relation to size of farm. The average value of crop production per farm equals 4966 pesos, of which 41 percent is sold in the form of a marketed surplus. There are substantial departmental variations in these figures. The average value of crop production per farm in the Chuquisaca area equals 11340 pesos of which 51 percent is sold. On the other hand, the average value of crop production per farm in the Potosi area is only 3119, of which only 23 percent is sold.

The proportion of crop production sold increases with the size of the farm. Farms less than 2 hectares sell 30 percent of the value of crop production. Farms greater than 5 hectares sell 45 percent of the value of crop production. The above figures indicate that, on the basis of the criteria developed in Figure 1, the majority of farms in the southern valleys area can be classified as subsistence farms. This holds true particularly for the Potosi and Tarija areas and to a lesser extent for the Chuquisaca area. Paradoxically, in this area middle-sized small farms market a larger proportion of the value of crop production than either very small or large farms.

Irrigation is quite common in the southern valleys area. Of the 699 farms covered by the survey, 317 farms irrigate their land (see Table 53). From Table 19, we know that the average size of irrigated farms is not very different from non-irrigated farms. Table 53 demonstrates that irrigation has a substantial effect on the average value of crop production. For the region as a whole, the average value of crop production per irrigated farm equals 6878 pesos of which 48 percent is sold. The corresponding value of crop production per farm on nonirrigated farms is only 3371 pesos, of which 29 percent is sold. From this comparison, one is obliged

Table 53. Average value of crop production and crop sales per farm by regions and by irrigation use

	Irrigated	Non-irrigated	Non-response	Total
Region				
Average value of crop production per farm	6878 (317)	3371 (377)	3305 (3)	4966 (697)
Average value of crop sales per farm	3279 (317)	972 (377)	593 (3)	2019 (697)
Chuquisaca				
Average value of crop production per farm	17309 (73)	5169 (69)	1448 (1)	11340 (143)
Average value of crop sales per farm	10300 (73)	1160 (69)	0 (1)	5818 (143)
Tarija				
Average value of crop production per farm	5238 (64)	2938 (145)	4233 (2)	3648 (211)
Average value of crop sales per farm	2326 (64)	1202 (145)	890 (2)	1540 (211)
Potosi				
Average value of crop production per farm	3230 (180)	2995 (163)	- (0)	3119 (343)
Average value of crop sales per farm	770 (180)	686 (163)	- (0)	730 (343)

Source: Table T23, stubs 1, 2, 4, standard Table 2.

Note: Numbers in parentheses indicate number of observations used in average.

to conclude that small irrigation works, as well as the improvement and extension of existing irrigating works, must be quite profitable from both the private and social point of view. This, however, is not true in all regions. In the Potosi area, the average value of crop production of irrigated farms is only marginally larger than on nonirrigated farms. On the other hand, in the Chuquisaca area, the average value of crop production per irrigated farm is more than triple the average of nonirrigated farms. Irrigation, therefore, is not a panacea for all departments.

Time to market affects the average value of crop production per farm and the percentage of crop production sold (see Table 54). Farms with less than 3 hours to market have an average value of crop production per farm equal to 6349 pesos of which 53 percent is sold. Farms with more than 3 hours to market have an average value of crop production per farm equal to 3986 pesos, of which 25 percent is sold. The value of crop sales for the 697 farms covered in the survey equals 1.41 million pesos; of this, 72 percent is produced by the 298 farm-households with less than 3 hours to market.

The data for the Chuquisaca exhibit two interesting features. First, that the 25 farms with greater than 1 hour time to market were higher in both average value of production per farm, and the average value of crop sales per farm. Secondly, that 43 farms in this area with more than six hours to market nevertheless have comparatively high values for both crop production and sales.

Average value of crop sales per farm equals 2019 pesos, or 100 US dollars. This sales value is too small to allow the acquisition of specialized mechanical transportation equipment. Furthermore, the small

Table 54. Average value of crop production and crop sales per farm by regions and by time to market

	Time to market				
	<1 hr.	1-3 hrs.	3-6 hrs.	>6 hrs.	Total[a]
Region					
Average value of crop production per farm	9594 (117)	4251 (181)	2895 (201)	5177 (184)	4966 (697)
Average value of crop sales per farm	5888 (117)	1758 (181)	685 (201)	1362 (184)	2019 (697)
Chuquisaca					
Average value of crop production per farm	27038 (25)	4821 (62)	2466 (11)	14371 (43)	11340 (143)
Average value of crop sales per farm	20178 (25)	2045 (62)	1141 (11)	4374 (43)	5818 (143)
Tarija					
Average value of crop production per farm	5419 (31)	3680 (72)	2880 (70)	3485 (32)	3648 (211)
Average value of crop sales per farm	2719 (31)	1952 (72)	795 (70)	1015 (32)	1540 (211)
Potosi					
Average value of crop production per farm	4566 (61)	4373 (47)	2943 (120)	2046 (109)	3119 (343)
Average value of crop sales per farm	1642 (61)	1081 (47)	580 (120)	275 (109)	730 (343)

Source: Table T23, stubs 1, 2, 4, standard Table 3.

Note: Numbers in parentheses indicate number of observations used in average.

[a]Includes nonresponse.

values of sales must put a seller of this type in a disadvantageous position with respect to monopsonistic buyers.

Table 55 shows that farms receiving technical training/assistance have higher average values of crop production per farm, as well as higher average values of crop sales per farm. Training/assistance programs, thereby, increase both on-farm consumption of agricultural crops, as well as increasing the marketable surplus. The efficacy of training/assistance programs has been questioned by several studies. Possibly, these conclusions can be attributed to faulty evaluation techniques. The 638 farms receiving neither training nor assistance produced an average value of crop production per farm equal to 4,046 pesos, of which 1285 pesos worth was sold. The 40 farms receiving technical training or assistance or both produced an average value of crop production per farm equal to 20,734 pesos, of which 14,407 pesos worth was sold. Consequently, the 6 percent of the farms receiving technical assistance/training produced 41 percent of the marketed surplus.

It might be hypothesized that the technical training/assistance might be more effective in naturally productive areas such as Chuquisaca than in comparatively disadvantaged areas such as Potosi. For Chuquisaca, we have seen that farms with neither training nor assistance have an average value of crop production equal to 8392 pesos. The corresponding figure for farms with training, assistance or both, equals 32,095 pesos. The ratio between these two figures equals 3.8. For the Potosi area, we have seen that the average value of crop production per farm for farms receiving no technical assistance or training equals 2788 pesos. The corresponding figure for farms receiving technical assistance, training or both equals 17,628 pesos.

Table 55. Average value of crop production and average value of crop sales per farm by region and technical training and/or assistance

	No training, no assistance	Training no assistance	No training, assistance	Training, assistance	Non-response	Total
Region						
Average value of crop production per farm	4046 (638)	21372 (29)	24968 (5)	14119 (6)	2643 (19)	4966 (697)
Average value of crop sales per farm	1285 (638)	13828 (29)	24327 (5)	8936 (6)	589 (19)	2019 (697)
Chuquisaca						
Average value of crop production per farm	8392 (121)	41821 (12)	21421 (2)	8253 (4)	7141 (4)	11340 (143)
Average value of crop sales per farm	3388 (121)	29826 (12)	20740 (2)	3242 (4)	2392 (4)	5818 (143)
Tarija						
Average value of crop production per farm	3448 (189)	2568 (11)	40283 (2)	1795 (1)	942 (8)	3648 (211)
Average value of crop sales per farm	1254 (189)	569 (11)	40077 (2)	650 (1)	115 (8)	1540 (211)
Potosi						
Average value of crop production per farm	2788 (328)	14947 (6)	1435 (1)	49907 (1)	2016 (7)	3119 (343)
Average value of crop sales per farm	527 (328)	6138 (6)	0 (1)	39997 (1)	100 (7)	730 (343)

Source: Table T23, stubs 1, 2, 4, standard Table 4.

Note: Numbers in parentheses indicate number of observations used in average.

The ratio of these two last figures equals 6.4. One, therefore, may conclude tentatively that the proportionate increase in production possible through technical training/assistance does not by itself discriminate against naturally disadvantaged areas. Secondly, that perhaps in several instances, the absolute increases in production possible through technical training/assistance programs may well be the same in naturally productive and unproductive areas.

Table 56 shows that farms receiving credit have higher average values of crop production per farm. The average value of crop production per farm for 650 farms not receiving credit equals 4163 pesos. The corresponding figure for 47 farms receiving credit equals 16,064 pesos. The average value of crop sales per farm for 650 farms not receiving credit equals 1699 pesos, or 41 percent of average value of crop production. The average value of crop sales per farm for 47 farms receiving credit equals 6455 pesos, or 40 percent of average value of crop production. Credit availability apparently does not increase the proportion of crop production sold, although it increases the value of production sold.

There are substantial departmental variations in the above figures. In the Potosi and Tarija areas, credit use has no apparent effect on the average value of crop production per farm. It is only in the Chuquisaca area that this effect is apparent, and particularly so for the 12 sampled farms in that area receiving "high credit." These 12 farms, or 1.7 percent of the total number of farms, account for 17 percent of the marketed surplus in the southern valleys area.

Table 57 shows that farm-households with definitive title to their land have a substantially higher average value of crop production per farm and a substantially higher average value of crop sales per farm than farm

Table 56. Average value of crop production and average value of crop sales per farm by regions according to credit levels

	No credit	Low credit	High credit	Non-response	Total
Region					
Average value of crop production per farm	4163 (650)	5160 (33)	41767 (14)	- (0)	4966 (697)
Average value of crop sales per farm	1699 (650)	1803 (33)	17419 (14)	- (0)	2019 (697)
Chuquisaca					
Average value of crop production per farm	7932 (125)	9778 (6)	47624 (12)	- (0)	11340 (143)
Average value of crop sales per farm	4512 (125)	5345 (6)	19657 (12)	- (0)	5818 (143)
Tarija					
Average value of crop production per farm	3534 (191)	4787 (19)	3756 (1)	- (0)	3648 (211)
Average value of crop sales per farm	1564 (191)	1291 (19)	1780 (1)	- (0)	1540 (211)
Potosi					
Average value of crop production per farm	3112 (334)	2582 (8)	9495 (1)	- (0)	3119 (343)
Average value of crop sales per farm	723 (334)	363 (8)	6199 (1)	- (0)	730 (343)

Source: Table T23, stubs 1, 2, 4, standard Table 5.

Note: Numbers in parentheses indicate number of observations used in average.

Table 57. Average value of crop production and average value of crop sales per farm by region according to tenancy

	Definitive title	Non-definitive ownership	Other forms of tenancy	Nonresponse	Total
Region					
Average value of crop production per farm	6244 (386)	3497 (277)	2497 (32)	1267 (2)	4966 (697)
Average value of crop sales per farm	2737 (386)	1235 (277)	259 (32)	325 (2)	2019 (697)
Chuquisaca					
Average value of crop production per farm	16299 (75)	6874 (52)	2611 (16)	- (0)	11340 (143)
Average value of crop sales per farm	8860 (75)	3197 (52)	72 (16)	- (0)	5818 (143)
Tarija					
Average value of crop production per farm	4411 (100)	3069 (100)	2134 (9)	1267 (2)	3648 (211)
Average value of crop sales per farm	1909 (100)	1184 (100)	784 (9)	325 (2)	1540 (211)
Potosi					
Average value of crop production per farm	3538 (211)	2433 (125)	2704 (7)	- (0)	3119 (343)
Average value of crop sales per farm	915 (211)	459 (125)	11 (7)	- (0)	730 (343)

Source: Table T23, stubs 1, 2, 4, standard Table 6.

Note: Numbers in parentheses indicate number of observations used in average.

households with no definitive title. The average value of crop production per farm for the 386 farms with definitive title equals 6244 pesos, of which 44 percent is sold. The average value of crop production per farm for the 309 farms with nondefinitive ownership or other forms of tenancy equals 3416 pesos of which 33 percent is sold. This implies that farm households with definitive title (55 percent of the total) account for 75 percent of the marketed surplus.

In all three departmental areas, farms with definitive title produce more and sell more than farms with nondefinitive ownership or other forms of tenancy. The difference is particularly pronounced for the Chuquisaca area, where crop production per farm for the 75 farms with definitive title is more than triple the corresponding figure for the 68 farms with nondefinitive ownership or other forms of tenancy. The difference in crop production per farm of farms with definitive title and no definitive ownership is much less in the Potosi and Tarija areas.

Variables that affect the composition of crops

In this section, we examine the composition of crops as related to farm size, to the type of seed used, to the type of fertilizer used and irrigation, to source of power, to the use of fungicides, pesticides and herbicides, and to time to market. We make a distinction between principal crops and minor crops on the basis of the area produced of each of these two classes of crops.

Table 58 features the hectareage for farms reporting production of 19 crops according to size of farm. The 697 farms included in the survey produced 1427 hectares or 2.04 hectares per farm of the 19 crops listed in Table 58. The 350 farms smaller than 2 hectares produced 229

Table 58. Hectareage for farms reporting production of 19 crops according to size of farm

	Size of farm					
	<1 ha.	1-1.99 has.	2-4.99 has.	5-5.99 has.	>9.99 has.	Total
Corn (grain)	40.1 (141)	69.8 (90)	180.6 (123)	220.0 (84)	138.9 (42)	649.5 (480)
Potatoes	17.6 (119)	31.9 (98)	64.2 (134)	43.3 (62)	53.3 (41)	210.2 (454)
Wheat	1.7 (16)	7.9 (29)	38.0 (65)	78.2 (51)	117.2 (40)	242.9 (201)
Barley (grain)	5.8 (35)	15.3 (40)	36.1 (59)	20.3 (19)	23.9 (18)	101.4 (171)
Beans (green)	1.6 (16)	2.8 (17)	7.2 (27)	3.7 (12)	12.2 (14)	27.6 (86)
Corn (on the cob)	7.7 (34)	5.6 (7)	9.5 (14)	6.2 (8)	10.3 (13)	39.2 (76)
Peas (green)	.4 (4)	1.8 (5)	7.6 (20)	13.9 (19)	15.8 (18)	39.5 (66)
Peanuts	(2) (1)	2.0 (11)	9.4 (29)	7.8 (16)	2.8 (6)	22.0 (63)
Oca	.4 (5)	1.8 (12)	4.7 (23)	1.9 (6)	2.3 (4)	10.9 (50)
Peppers	- (0)	1.5 (6)	10.2 (29)	4.0 (8)	1.4 (3)	17.1 (46)
Papaliza	.2 (2)	2.2 (16)	4.4 (23)	.6 (4)	.3 (1)	7.7 (46)
Beans (dry)	- (0)	.3 (1)	.8 (2)	.3 (1)	1.3 (3)	2.6 (7)

Table 58. *Continued*

	Size of farm					
	<1 ha.	1-1.99 has.	2-4.99 has.	5-5.99 has.	>9.99 has.	Total
Barley (green)	.4 (5)	2.4 (8)	3.6 (8)	1.0 (1)	3.5 (2)	10.9 (24)
Quinua	.5 (1)	- (0)	.3 (1)	.5 (1)	4.3 (3)	5.5 (6)
Carrots	(2) (1)	.3 (1)	1.2 (3)	1.8 (3)	2.5 (2)	5.8 (10)
Grapes	1.4 (5)	4.4 (4)	5.7 (3)	7.3 (3)	6.0 (1)	24.7 (16)
Peaches	.3 (3)	.3 (2)	- (0)	.3 (2)	- (0)	.9 (7)
Oranges	- (0)	- (0)	2.6 (6)	.6 (2)	2.0 (1)	5.2 (9)
Alfalfa	- (0)	.2 (1)	(2) (1)	2.8 (2)	.8 (2)	3.7 (6)
Total hectareage	78.2 (204)	150.5 (146)	386.1 (189)	414.5 (101)	398.3 (57)	1427.3 (697)

Source: Table T51, stubs 5, 8, standard table 10.

Note: Numbers in parentheses indicate number of farms reporting production.

(2) Less than half the unit reported.

hectares or 16 percent of this total hectareage. The remainder was produced on the 347 farms larger than 2 hectares. The last column of Table 58 lists the hectareage of crops in approximately descending order. On the basis of this, we may classify corn (grain), potatoes, wheat, barley (grain), green broad beans, fresh corn, and green peas as the seven principal crops of the southern valleys area. The remaining twelve crops we will call minor crops.

Farms smaller than 2 hectares grow 210 hectares of principal crops and 19 hectares of minor crops. Farms larger than 2 hectares grow 1103 hectares of principal crops and 96 hectares of minor crops. It follows that for both size groups 92 percent of the total hectareage grown is in principal crops. It also follows that of this level of aggregation, the size of the farm does not influence the composition of crops grown.

There is, of course, substantial variation in this percentage for individual crops. The 480 farms producing corn (grain) produced 650 hectares of corn. Of this total, 110 hectares or 17 percent was grown by 231 farms smaller than 2 hectares. The 454 farms growing potatoes produced 210 hectares. Of this total, 50 hectares or 24 percent were grown by the 217 farms smaller than 2 hectares. The 201 farms growing wheat produced 243 hectares. Of this total, 10 hectares, or 4 percent, was grown by the 45 farms smaller than 2 hectares. The 171 farms growing barley (grain) produced 101 hectares. Of this total, 21 hectares, or 21 percent, was produced by the 75 farms smaller than 2 hectares. The 86 farms growing green broad beans produced 28 hectares. Of this total, 4.4 hectares, or 16 percent, was produced by the 33 farms smaller than 2 hectares. The 76 farms growing fresh corn produced 39 hectares. Of this total, 13

hectares, or 34 percent, was grown by the 34 farms smaller than 2 hectares. The 66 farms growing green peas produced 39.5 hectares. Of this total, 2.2 hectares, or 6 percent, was grown by the 9 farms smaller than 2 hectares.

Table 59 features the hectareage for farms reporting hectareage[1/] of 19 crops according to type of seed used. The total reported hectareage equals 1437 hectares. Of this total, only 24 hectares, or 1.7 percent, was planted with improved seed. From Table 14, we see that improved seed does not seem to improve average production per hectare. Given these two findings, one would conclude that, in general, the public sector has not been able to provide farmers in the southern valleys area with required locally adopted improved seed. Even potatoes do not escape this general statement. Of the reported hectareage equal to 197 hectares, only 10 hectares, or 5 percent, was planted with improved seed.

Table 60 features the hectareage for farms reporting hectareage of 19 crops according to type of fertilizer and irrigation. The total reported hectareage equals 1381 hectares. Of this total, 330 hectares, or 24 percent, was grown without the use of organic or chemical fertilizer or irrigation. The use of organic or chemical fertilizers is quite common in the southern valleys area. Of the total reported hectareage equal to 1381 hectares, 1006 hectares, or 73 percent, was grown using organic fertilizer, chemical fertilizer, or both. Exclusive reliance on chemical fertilizer is rare. Of the total reported hectareage equal to 1381

[1/] Reported hectareage exceeds produced hectareage by hectareage with total loss of production. Total hectareage lost was quite small even though 1977 crop year was a year with below normal rainfall. The impact of the drought, therefore, may have been restricted to below normal yields. Supplemental irrigation may also have mitigated the impact of the drought.

Table 59. Hectareage for farms reporting hectareage of crops according to type of seed used

	Type of seed used		
	Native seed	Hybrid or improved seed	Seed of unknown source
Corn (grain)	646.3	1.3	4.7
	(474)	(4)	(9)
Potatoes	197.1	10.2	3.8
	(424)	(21)	(14)
Wheat	232.6	9.0	2.0
	(196)	(3)	(2)
Barley (grain)	100.2	.3	2.0
	(170)	(1)	(2)
Beans (green)	26.8	.3	1.2
	(79)	(1)	(10)
Corn (on the cob)	37.6	.5	1.6
	(70)	(1)	(6)
Peas (green)	37.5	.5	1.7
	(59)	(2)	(6)
Peanuts	23.2	.8	-
	(63)	(1)	(0)
Oca	10.9	-	-
	(50)	(0)	(0)
Peppers	16.8	.3	-
	(45)	(1)	(0)
Papaliza	7.6	-	.1
	(45)	(0)	(1)
Beans (dry)	2.6	-	-
	(7)	(0)	(0)
Barley (green)	10.9	-	-
	(24)	(0)	(0)
Quinua	5.5	-	-
	(6)	(0)	(0)
Carrots	5.6	-	.2
	(9)	(0)	(1)
Grapes	19.5	1.1	4.5
	(10)	(2)	(5)
Peaches	.3	-	.5
	(4)	(0)	(5)
Oranges	2.0	-	3.8
	(1)	(0)	(9)
Alfalfa	3.7	-	(2)
	(6)	(0)	(1)
Total hectareage	1386.7	24.3	26.1

Source: Table T51, stubs 1, 2, standard Table 10.

Note: Numbers in parentheses indicate number of farms reporting indicated cropping practice for crop i = 1...19.

(2) Less than half the unit reported.

Table 60. Hectareage for farms reporting hectareage of 19 crops according to type of fertilizer and irrigation

	Organic fertilizer Chem. fertilizer Irrigation	Yes No Yes	Yes No No	No Yes Yes	No Yes No	Yes Yes Yes	Yes Yes No	No No Yes	No No No
Corn (grain)	636.0	136.8	273.3	2.8	3.0	9.5	6.9	14.7	189.0
		(167)	(163)	(1)	(5)	(7)	(5)	(14)	(107)
Potatoes	204.9	46.1	93.8	2.0	5.3	30.3	16.8	2.6	8.0
		(116)	(232)	(4)	(4)	(31)	(26)	(6)	(24)
Wheat	230.2	8.6	156.3	-	8.8	-	1.8	5.8	48.9
		(15)	(103)	(0)	(2)	(0)	(2)	(6)	(64)
Barley (grain)	97.7	10.2	39.3	-	-	-	-	3.5	44.7
		(20)	(70)	(0)	(0)	(0)	(0)	(4)	(73)
Beans (green)	27.6	8.6	8.3	-	-	2.3	.5	3.8	4.1
		(36)	(21)	(0)	(0)	(3)	(1)	(6)	(21)
Corn (on the cob)	35.7	19.7	12.1	-	-	(2)	.5	.6	2.8
		(50)	(14)	(0)	(0)	(1)	(1)	(2)	(4)
Peas (green)	38.0	6.1	14.6	4.3	-	9.0	.3	1.6	2.1
		(9)	(30)	(4)	(0)	(7)	(1)	(5)	(6)
Peanuts	23.8	5.6	3.2	-	(2)	2.3	-	1.7	11.0
		(9)	(11)	(0)	(1)	(2)	(0)	(6)	(34)
Oca	10.1	1.5	4.7	-	-	-	(2)	.7	3.2
		(6)	(25)	(0)	(0)	(0)	(1)	(2)	(14)
Peppers	15.2	.5	2.8	-	-	-	-	1.5	10.4
		(2)	(6)	(0)	(0)	(0)	(0)	(4)	(29)
Papaliza	7.5	-	5.3	-	-	-	-	.2	2.0
		(0)	(36)	(0)	(0)	(0)	(0)	(1)	(8)
Beans (dry)	2.7	.3	1.3	.5	-	.3	-	-	.3
		(1)	(3)	(1)	(0)	(1)	(0)	(0)	(1)
Barley (green)	10.9	2.0	4.9	-	-	-	-	1.0	3.0
		(2)	(15)	(0)	(0)	(0)	(0)	(1)	(6)
Quinua	5.3	3.0	2.0	-	-	-	-	.3	-
		(1)	(3)	(0)	(0)	(0)	(0)	(1)	(0)

Table 60. *Continued*

	Organic fertilizer Chem. fertilizer Irrigation	Yes No Yes	Yes No No	No Yes Yes	No Yes No	Yes Yes Yes	Yes Yes No	No No Yes	No No No
Carrots	5.3	1.0 (3)	.2 (1)	- (0)	- (0)	1.3 (2)	- (0)	2.8 (3)	- (0)
Grapes	23.1	10.4 (7)	.5 (1)	- (0)	- (0)	9.0 (3)	1.0 (1)	2.2 (3)	- (0)
Peaches	.2	(2) (2)	- (0)	- (0)	- (0)	- (0)	- (0)	.2 (2)	- (0)
Oranges	3.1	2.0 (1)	- (0)	- (0)	- (0)	- (0)	- (0)	1.0 (3)	.1 (1)
Alfalfa	3.7	2.0 (3)	- (0)	- (0)	- (0)	- (0)	- (0)	1.7 (4)	- (0)
Total hectareage	1381.1	264.4	622.6	9.6	17.1	64.0	27.9	45.9	329.6

Source: Table T51, stubs 5, 8, standard Table 11.

Note: Number in parentheses indicates number of farms reporting indicated cropping practice for crop i = 1...19.

(2) Less than half the unit reported.

hectares, only 27 hectares, or 2 percent, was grown relying exclusively on chemical fertilizer. The most common practice is to rely exclusively on organic fertilizer (manure). Of the total reported hectarage equal to 1381 hectares, 887 hectares or 64 percent was grown relying exclusively on organic fertilizer.

Irrigation is a common practice in the southern valleys area. Of the total reported hectareage equal to 1381 hectares, 384 hectares, or 28 percent, was grown with irrigation water. On the other hand, the simultaneous use of both types of fertilizer and irrigation was restricted to only 64 hectares, or 5 percent of the total reported hectareage.

The reported hectareage in the seven principal crops (corn (grain), potatoes, wheat, barley (grain), green broad beans, fresh, corn, green peas) equals 1270 hectares. Of this total, 300 hectares, or 24 percent, was grown without the use of organic fertilizer, chemical fertilizer or irrigation. Minor crops are no different in this respect from principal crops. Of the total reported hectareage for principal crops equal to 1270 hectares, 938 hectares, or 74 percent was grown using organic fertilizer, chemical fertilizer, or both. Again, minor crops are no different in this respect from principal crops. Of the total reported hectareage for principal crops equal to 1270 hectares, 834 hectares, or 66 percent, were grown relying exclusively on organic fertilizer (manure). Again, minor crops are no different from principal crops in this respect. Of the total of 1270 hectares in principal crops, 327 hectares, or 26 percent, was grown using irrigation. The corresponding percentage is much higher for minor crops, i.e., 67 percent.

From the foregoing follows that fertilization practices do not differ between principal and minor crops, but that this does not hold for

irrigation practices. There are, of course, substantial variations in cropping practices between single crops, potatoes and wheat being an example. Such variation is dictated by the economics of crop production. The 1978 sector survey contains the additional information required to analyze this variation.

Table 61 features the hectareage for farms reporting hectareage of 19 crops according to source of power. A striking result of Table 61 is that only 2 hectares are grown relying exclusively on mechanical power and that only 4 hectares are grown relying on a combination of mechanical and animal power. Of the total reported hectareage equal to 1375 hectares, 1238 hectares, or 90 percent, was grown relying exclusively on animal power. Of the total of 1375 hectares, 131 hectares, or 9.5 percent was grown using exclusively human energy. One would expect that human energy should be proportionately larger for minor crops than for principal crops. Of the 121 hectares in minor crops, 52 hectares, or 43 percent, are grown relying exclusively on human energy. This implies that of the 1254 hectares in principal crops, only 78 hectares, or 6 percent, was grown relying exclusively on human energy.

There are variations in the source of power used between individual crops. Not unexpectedly, the production of fruits, for example, relies almost exclusively on human energy.

Table 62 features the hectareage for farms reporting hectareage of 19 crops according to the use of herbicides, fungicides, or pesticides. Of the total reported hectareage equal to 1417 hectares, 139 hectares, or 10 percent, are grown using these chemical products. Of the total of 1300 hectares in principal crops, 101 hectares, or 8 percent, are grown using these chemicals. The corresponding percentage for minor crops equals

Table 61. Hectareage for farms reporting hectareage of 19 crops according to source of power

	Source of power			
	Mechanical and animal	Only mechanical	Only animal	No mechanical, no animal
Corn (grain)	1.0	.5	588.1	34.3
	(1)	(1)	(393)	(69)
Potatoes	3.0	-	182.5	16.3
	(1)	(0)	(363)	(71)
Wheat	-	-	228.8	3.1
	(0)	(0)	(183)	(7)
Barley (grain)	-	-	90.8	6.6
	(0)	(0)	(147)	(18)
Beans (green)	-	.5	23.1	4.0
	(0)	(1)	(72)	(15)
Corn (on the cob)	-	-	24.1	11.3
	(0)	(0)	(36)	(34)
Peas (green)	-	-	32.8	1.1
	(0)	(0)	(58)	(3)
Peanuts	-	-	20.7	1.6
	(0)	(0)	(53)	(5)
Oca	-	-	9.0	1.6
	(0)	(0)	(39)	(9)
Peppers	-	-	11.2	2.6
	(0)	(0)	(28)	(9)
Papaliza	-	-	6.5	1.2
	(0)	(0)	(39)	(6)
Beans (dry)	-	-	2.6	10.9
	(0)	(0)	(7)	(24)
Barley (green)	-	-	10.4	.5
	(0)	(0)	(22)	(2)
Quinua	-	-	1.8	3.5
	(0)	(0)	(3)	(2)
Carrots	-	-	5.5	.3
	(0)	(0)	(8)	(2)
Grapes	-	1.0	-	23.5
	(0)	(1)	(0)	(14)
Peaches	-	-	-	.3
	(0)	(0)	(0)	(4)
Oranges	-	-	-	2.8
	(0)	(0)	(0)	(3)
Alfalfa	-	-	-	3.7
	(0)	(0)	(0)	(5)
Total hectareage	4.0	2.0	1237.9	131.2

Source: Table T51, stubs 5, 8, standard Table 12.

Note: Numbers in parentheses indicate number of farms reporting indicated cropping practice for crop i = 1...19.

Table 62. Hectareage for farms reporting hectareage of 19 crops according to use of other chemical products[a]

	—Other chemical products—	
	Used	Not used
Corn (grain)	19.7	620.6
	(13)	(466)
Potatoes	53.0	157.6
	(49)	(406)
Wheat	13.9	227.8
	(5)	(195)
Barley (grain)	.6	99.6
	(2)	(169)
Beans (green)	2.5	25.3
	(3)	(86)
Corn (on the cob)	5.5	34.1
	(3)	(74)
Peas (green)	5.9	33.4
	(9)	(56)
Peanuts	2.3	21.7
	(3)	(61)
Oca	-	10.9
	(0)	(50)
Peppers	1.5	15.6
	(3)	(43)
Papaliza	-	7.7
	(0)	(46)
Beans (dry)	1.0	1.6
	(1)	(6)
Barley (green)	-	10.9
	(0)	(24)
Quinua	4.0	1.5
	(2)	(4)
Carrots	4.5	1.3
	(5)	(5)
Grapes	22.8	.3
	(13)	(2)
Peaches	.2	.6
	(1)	(8)
Oranges	2.0	3.4
	(1)	(9)
Alfalfa	-	3.7
	(0)	(6)
Total hectareage	139.4	1277.6

Source: Table T51, stubs 1, 2, standard Table 13.

Note: Numbers in parentheses indicate number of farms reporting indicated cropping practice for crop i = 1...19.

[a]Herbicides, fungicides, pesticides, etc.

49 percent. In this respect, there is a significant difference between principal and minor crops. Much of the difference. however, is explained by the almost universal use of fungicides in growing one minor crop, i.e., grapes.

Perceived needs as indicated by farm-households

The survey questionnaire tried to ascertain respondents' opinions as to what factors would be needed to increase production. The specific question was[1/]

"In general, what do you need to produce more?"

The question, therefore does not directly refer to all of the factors that may affect net household income. Each farm household was permitted to list up to three responses to the above question. The responses are listed in Table 63. The very low frequencies of better or more secure prices, more accessible markets and diversification can be understood with reference to the question asked. It probably is not representative of the extent to which these variables limit farm-household income. Logically, enough irrigation, more land, availability of inputs at reasonable prices are mentioned more often than other factors. The most striking result is that the need for credit is mentioned by two out of three households.

Riordan (Table 75, p. 128; Table 76, p. 129) showed that the relative frequency with which the need for credit is cited decreases somewhat with increases in the level of net houehold income and that this relative frequency increases with time to market. The frequency with which the need for credit is cited is paradoxical in the sense that one usually thinks of

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[1/] Encuesta Socio-Economica, Proyecto Sectorial II, p. 38.

Table 63. Percentages of farm households expressing different needs concerning future increases in production by region and department[a]

Need	Region	Chuquisaca	Tarija	Potosi
No need or desire to produce more	3.0	2.8	2.4	3.5
Credit	66.1	65.3	42.5	81.0
Land improvements (irrigation, etc.)	49.9	28.5	58.0	53.9
More land	47.2	45.8	44.3	49.6
Information or technical assistance	45.5	49.3	28.8	54.2
Availability of inputs at reasonable prices	20.7	18.1	32.5	14.6
Better or more secure prices	11.3	6.9	17.5	9.3
More accessible markets	7.6	9.7	5.7	7.9
Labor	6.6	13.2	5.2	4.7
Diversification of production	0.4	-	0.5	0.6
Other needs	6.6	2.1	11.8	5.2

Source: Calculated from data in Table 47, stubs 1-11, standard table 1.

[a]Numbers sum to more than 100 percent because up to three valid responses are permitted per questionnaire.

a subsistence economy as having no need for external capital assistance.

Table 64 presents a list of production related cash outlays per farm according to levels of net household income. The total of production related cash outlays for the 699 farms covered in the survey equalled 2.0 million pesos or 2834 pesos per farm. A striking result of Table 64 is that farms less than one hectare in size have the highest per farm cash outlay on production expenditures for each item except hired labor.

For farm-households with more than 800 pesos net household income, average total production related cash outlays per farm equal 2456 pesos or 123 U.S. dollars. Expenditures on hired labor equal 724 pesos and form the single largest cash outlay. Variable plus miscellaneous cash outlays equal 587 pesos and constitute the second largest cash outlay. Livestock purchases plus livestock inputs equal 412 pesos and constitute the third largest cash outlay. Gross investment in machinery, tools, improvements and maintenance equals 272 pesos and constitutes the fourth largest cash outlay. Processed products cash inputs equal 261 pesos and constitute the fifth largest cash outlay. Cash rents equal to 15 pesos constitute the smallest cash outlay.

Table 65 relates the total of production-related cash outlays to each of the 4 standard income measures used throughout this report. For farm households with more than 800 pesos net household income, a one percent increase in one of these four income measures is associated with more than a one percent increase in production related cash outlays, i.e., cash outlays increase as a proportion of gross income.

Table 65 also illustrates why many of the farm-households in the southern valleys area may have a liquidity problem, and, therefore, rate the availability of credit as the primary constraint for increased production.

Table 64. Production related cash outlays per farm according to levels of net household income

	Total	Net household income $b. <801	801-2100	2101-4700	4701-10,000	>10,000	Total last 4 columns
Cash rents							
Average value	58.8	226.0	20.4	9.3	9.5	19.2	14.5
Number of farms	699	146	139	154	122	127	542
Farms with cash rents	31	2	7	5	10	6	28
Variable crop input cash costs							
Average value	574.9	674.6	159.4	313.8	292.2	1489.8	545.0
Number of farms	694	146	137	153	122	126	538
Farms with variable cash costs	444	93	74	92	79	99	344
Miscellaneous crop cash costs							
Average value	73.7	131.4	4.8	39.6	21.2	178.5	41.9
Number of farms	698	146	139	153	122	127	541
Farms with misc. crop cash costs	200	36	28	46	45	44	163
Livestock purchases							
Average value	448.8	958.8	284.5	210.1	155.1	610.8	310.8
Number of farms	698	146	138	154	122	127	541
Farms with purchases	131	41	17	23	21	23	84
Livestock cash inputs							
Average value	111.0	150.1	51.1	101.9	99.7	155.9	101.0
Number of farms	698	146	139	153	122	127	541
Farms with cash inputs	468	99	95	98	73	73	369
Processed products cash inputs							
Average value	541.7	1619.4	32.4	25.7	420.4	645.7	261.3
Number of farms	697	146	139	153	122	126	540
Farms with cash inputs	353	70	52	74	73	73	282

Table 64. *Continued*

	Total	Net household income $b. <801	801-2100	2101-4700	4701-10,000	>10,000	Total last 4 columns
Machinery, implement and tool purchases							
Average value	141.7	136.2	51.4	94.2	99.1	343.0	142.6
Number of farms	699	146	139	154	122	127	542
Farms with purchases	225	51	37	48	38	47	170
Construction, improvement, maintenance and repair costs							
Average value	134.7	164.2	3.6	26.8	138.4	383.4	120.5
Number of farms	697	145	139	154	121	127	541
Farms with costs	59	15	1	8	12	23	44
Miscellaneous farm level costs							
Average value	317.8	827.2	49.4	65.2	308.8	363.1	185.8
Number of farms	699	146	139	154	122	127	542
Farms with cash costs	668	140	136	145	117	119	517
Hired labor							
Average expenditures	431.3	309.7	94.0	127.5	271.9	1587.4	493.5
Number of farms	699	146	139	154	122	127	542
Farms with hired labor	188	38	27	33	33	53	146
Total of production related cash outlays	2820.0	5196.7	746.7	1011.0	1815.2	5760.0	2237.0

Source: Table T49, stubs 1-27, standard Table 7; Table T31, stubs 1, 2, 3, 9, 10, standard Table 7.

Table 65. Total of production related cash outlays per farm, mean net farm cash income per farm, mean net household cash income per farm, mean net farm income per farm, mean net household income per farm by levels of net household income

	Total	Net household income $b.				
		<801	801-2100	2101-4700	4701-10,000	>10,000
Total of production related cash outlays per farm	2820.0	5196.5	746.7	1011.0	1815.2	5,760.0
Mean income per farm						
Mean net farm cash income	1358.6	-2290.9	-26.2	553.4	1289.8	7,791.7
Mean net household cash income	4977.2	-2020.5	297.5	1638.8	4631.8	22,007.4
Mean net farm income	2881.3	-1482.4	1056.4	2187.4	3493.2	10,193.1
Mean net household income	6547.2	-1231.4	1386.0	3250.7	6798.9	24,710.2

Source: Table T26, Stubs 1, 5, standard Table 7; Table T28, Stubs 1, 5, standard Table 7.

The 350 farm-households with no off-farm income must finance the purchase of production-related inputs out of the previous year's cash income. A comparison of the first and second lines in Table 65 illustrates the virtual impossibility of this. If we consider, furthermore, that farm-households will inevitably spend a substantial proportion of cash income on non-production related items or consumer goods then the liquidity gap is even more evident. Even farm-households with off-farm income, which results in a dollar for dollar increase in net household cash income, are not exempt from a cash flow deficiency. Consequently, the pattern of needs expressed by farm-households with different levels of net household income tend to be quite similar (see Table 66).

We previously commented that off-farm job opportunities were the single most important variable that determines increased levels of net household income. The above analysis suggests that it is also the most important variable in increasing production by giving farm-households sufficient funds to purchase the nonfarm-produced physical inputs required for increased production.

Farm-households almost universally indicate the need for increased technical assistance/training and credit. The actual situation in this respect for the 699 households included in the survey is summarized in Table 67.

Table 67 indicates the hectareage in annual crops by training/assistance, credit source, tenancy and time to market. Of the 1330 hectares in annual crops, 1122 hectares were grown by farm-households who received neither training/assistance or bank credit. Consequently, 15 percent of the hectareage in annual crops grown by 699 farm-households received either training/assistance or credit. Only 19 hectares, or 1.4 percent of the

Table 66. Percentages of farm households expressing different needs concerning future increases in production by net household income groups[a]

	All farm households	Net Household Income Groups $b.				
		Group I <801	Group II 801-2100	Group III 2101-4700	Group IV 4701-10,000	Group V >10,000
No need or desire to produce more	3.0	4.1	2.9	3.2	1.6	3.1
Credit	66.1	72.6	76.3	61.7	55.7	63.0
Land improvements (irrigation, etc)	49.9	52.1	44.6	50.0	53.3	48.8
More land	47.2	49.3	48.9	56.5	39.3	37.8
Information or technical assistance	45.5	43.2	54.7	53.5	47.5	40.9
Availability of inputs at reasonable prices	20.7	13.7	17.3	20.8	27.9	26.0
Better or more secure prices	11.3	6.8	7.2	7.8	18.9	17.3
More accessible markets	7.6	6.8	7.2	5.8	11.5	6.3
Labor	6.6	4.1	5.8	7.1	9.0	7.9
Diversification of production	0.4	-	0.7	-	-	1.6
Other needs	6.6	5.5	5.8	6.5	8.2	7.1

[a]Numbers sum to more than 100 percent because up to three valid responses are permitted per questionnaire.

Table 67. Hectareage in annual crops by training/assistance, credit source, tenancy and time to market

	No training/ assistance No bank credit	Training/ assistance No bank credit	No training/ assistance Bank credit	Training/ assistance Bank credit	Non-responsive	Total
Definitive title <3 hours to market	317 (121)	40 (13)	17 (7)	9 (3)	10 (3)	394 (147)
No definitive title <3 hours to market	246 (135)	7 (6)	25 (8)	2 (1)	3 (4)	285 (152)
Definitive title >3 hours to market	366 (217)	40 (7)	2 (2)	8 (1)	14 (5)	430 (232)
No definitive title >3 hours to market	176 (138)	12 (8)	6 (1)	- (0)	6 (5)	201 (152)
Invalid responses	15 (13)	1 (2)	- (0)	- (0)	3 (1)	19 (16)
Total	1122 (622)	102 (36)	50 (18)	19 (5)	36 (18)	1330 (699)

Source: Table %15, stubs 3, 4, standard Table 8.

Note: Numbers in parentheses indicate number of farms having attribute (ij).

hectareage in annual crops received both training/assistance and bank credit. Farm-households with definitive title accounted for 824 hectares or 62 percent of hectares in annual crops, the remainder grown by farm-households with no definitive title to their land. Of the 1330 hectares in annual crops, 679 hectares, or 51 percent, were grown within 3 hours to market, the remainder being grown by farm households with more than 3 hours to market.

Farm-households do not perceive higher prices received as a primary need for increased production. The southern valleys area collected data on prices received, but these were not perceived as variables of interest or as "explanatory" variables to be included in standard tables. However, the prices of six major crops can be calculated using a combination of available tabulations.

One would expect that the prices received by farmers should decrease with time to market. Table 68 does not confirm this hypothesis unambiguously[1/] for any of the six major crops grown in the southern valleys area. For example, the price received for potatoes increases with time to market. A second interesting feature is that the relative price ratios fluctuate in the narrow range of 1.00 to 1.50. For example, the price of barley (grain) and corn (grain) both equal two pesos, which is also equal to the average price of potatoes. On the other hand, the average price received for wheat equals 3.2 pesos or 1.5 times the price of barley (grain) and corn (grain). Available tabulations do not permit the

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[1/] A partial explanation of this may be that the product prices are determined in the market place (or set by government); farmers often sell to intermediaries (truckers) at the farm who discount transport costs and profit margins from the "market" price when determining the price paid to the farmer.

Table 68. Prices received[a] by farmers for barley, corn, potatoes and wheat according to time to market

	Time to market				
	<1 hr.	1-3 hrs.	3-6 hrs.	>6 hrs.	Total
Barley (grain)	2.6	1.9	2.1	1.6	2.0
Barley (green)	2.5	2.1	2.2	2.3	2.2
Corn (grain)	2.4	1.8	1.9	1.7	2.0
Corn (on the cob)	2.6	3.4	3.5	1.9	2.9
Potatoes	2.0	2.0	2.4	2.4	2.1
Wheat	3.2	3.3	3.1	1.2	3.2

Source: Table T21, stubs 1, 2, standard Table 3; Table T24, stubs 1, 10, standard Table 3.

[a]Pesos per kilo.

calculation of the prices received for other crops. Future tabulations might take such prices as variables of interest to be analyzed by standard cross tabulations. It would also be desirable to construct an index of prices received for each farm, and cross tabulate intervals of this index for a large number of variables of interest.

Table 69 reports the hectareage in crops and average value of crop production per hectare for 19 crops according to time to market. The first premise is that an increase in the time to market will be associated with a decrease in the average value of crop production. The second premise is that an increase in the time to market affects the composition of crops between principal crops and minor crops. The data in Table 69 do not confirm the first hypothesis. The bottom row in Table 69 shows that the weighted average value of crop production initially decreases with increasing time to market, but that this tendency is reversed for farms with more than six hours to market. The average value of crop production for farms with less than 3 hours to market equals 2395 pesos. The corresponding figure for farms with more than three hours to market equals 2195 pesos, i.e., a decline of 8 percent as compared to farms with less than three hours to market. Individual crops such as corn (grain), potatoes, barley (grain), fresh corn, and fruits show exceptions to this pattern.

The total hectareage produced of the 19 crops listed in Table 69 equals 1467 hectares. Of this total, 782 hectares, or 53 percent, are produced by farms with less than three hours to market. The total hectareage of the seven basic crops (corn (grain), potatoes, wheat, barley (grain), green broad beans, fresh corn, green peas) equals 1326 hectares. Of this total, 711 hectares, or 54 percent, are produced by farms with less than three hours to market. It follows that time to market does not influence the composition of hectareage between principal crops and minor crops.

Table 69. Hectareage in crops and average value of crop production per hectare for 19 crops according to time to market

	1 hour		1-3 hours		3-6 hours		6 hours		Total[a]	
	has.	100 $b/ ha.	has.	100 $b/ ha.	has.	100 $b/ ha.	has.	100 $b/ ha.	has.	100 $b/ ha.
Corn (grain)	120.0	10.0	201.6	9.5	162.0	9.7	175.2	18.8	637.0	12.9
Potatoes	46.2	35.6	75.0	27.8	48.8	33.4	39.6	30.2	232.0	26.9
Wheat	49.4	7.8	92.4	7.1	77.0	6.3	21.6	5.8	242.4	7.8
Barley (grain)	19.8	15.1	29.4	13.4	42.6	14.0	11.1	15.2	103.8	14.1
Beans (green)	9.6	16.7	7.5	13.8	4.2	15.6	5.2	18.4	27.9	24.6
Corn (on the cob)	16.2	16.7	9.0	18.1	12.0	35.6	3.5	28.3	40.5	24.0
Peas (green)	20.3	8.6	15.0	4.4	3.9	4.6	2.1	1.3	42.0	6.2
Peanuts	6.3	28.6	7.5	42.7	2.8	19.6	6.6	18.7	25.6	26.6
Oca	1.0	42.2	3.3	17.3	5.2	11.4	1.1	10.8	10.6	16.1
Peppers	.6	62.0	5.2	69.3	6.5	50.3	4.5	48.4	18.8	52.0
Papaliza	0	0	1.2	13.0	7.0	19.5	.6	18.0	9.4	17.3
Beans (dry)	.6	6.5	1.2	9.1	.7	.7	1.6	3.6	3.6	5.9
Barley (green)	2.4	40.9	2.4	12.9	1.2	20.2	5.5	20.8	12.0	22.3
Quinua	.5	9.6	.8	42.3	3.9	25.1	1.0	60.0	6.3	26.4
Carrots	4.8	60.7	.8	6.5	.2	66.0	.1	20.0	6.0	51.9
Grapes	19.6	312.4	1.6	877.5	.6	160.8	9.6	314.0	29.9	355.8
Peaches	2.1	21.4	.6	37.5	0	0	1.2	127.7	5.2	43.4
Oranges	0	0	.4	187.5	1.5	13.3	4.0	130.0	6.5	87.1
Alfalfa	6.6	7.5	.8	7.5	.3	22.3	0	0	7.7	8.1
Total	326.0	33.8	455.7	16.9	380.4	14.8	294.1	31.2	1467.2	23.5
Total excluding grapes, peaches and oranges	304.3	15.9	453.1	13.7	378.3	14.6	279.3	19.8	1425.6	16.1

Source: Table T19, stubs 1, 2, standard Table 3; Table T20, stubs 1, 2, standard Table 3; Table T21, stubs 1, 2, standard Table 3; Table T22, stubs 1, 2, standard Table 3.

[a]Includes hectareage of invalid responses.

Table 70 features the distance from the farm to closest road and distance from farm to market according to size of farm. Of 699 farms, 257 farms or 37 percent are situated less than .5 km from the closest road. On the other hand, 300 farms, or 43 percent, are located at more than 3 km from the closest road. Accessibility to commercial transportation, therefore, is a problem to a majority of farms.

The marketed surplus cannot be disposed of locally. Of 699 farms, only 29 farms, or 4 percent, indicate a distance of 1 km or less to market. Of 699 farms, 610 farms, or 87 percent, indicate a distance of more than 5 kilometers to market. It would have been interesting to cross tabulate distance from road and distance from market with time to market. It was previously shown that time to market is a major determinant of net household income and net farm income. It is, therefore, a matter of interest how time to market is influenced respectively by distance from road and distance from market. If the former is the predominant element, then improved access to roads should increase net household income. If distance from market influences net household income, then the creation of local marketing cooperatives might reduce transportation costs and monopsonistic buying practices.

The data in Table 70 show no systematic relation between the size of farm and distance from road or distance from market. This would indicate that the size distribution of landed property is independent of distance to road and distance to market.

Table 70. Distance from farm to closest road and from farm to market according to size of farm

	Size of farm					
	<1 ha.	1-1.99 has.	2-4.99 has.	5-9.99 has.	>9.99 has.	Total
Frequency according to distance from road	204	146	190	102	57	699
Less than .5 km	95	45	60	35	22	257
.5 to less than 1 km.	7	15	23	11	6	62
1 to less than 3 km.	9	20	28	15	8	80
3 to less than 5 km.	14	13	23	18	3	71
5 to less than 10 km.	33	28	39	12	8	120
10 km. or more	46	25	17	11	10	109
Frequency according to distance from market	199	144	186	101	57	687
Less than .5 km	10	3	6	6	0	25
.5 to less than 1 km.	1	2	1	0	0	4
1 to less than 3 km.	3	6	4	2	4	19
3 to less than 5 km.	5	8	10	3	3	29
5 to less than 10 km.	19	24	31	15	12	101
10 km. or more	161	101	134	75	38	509

Source: Table 110, stubs 1 through 10, standard Table 7.

RECOMMENDATIONS FOR FUTURE ANALYSIS

The causal analysis of the southern valleys survey presupposes the existence of two groups of variables: dependent variables and independent variables. These two groups of variables enter into a number of interdependent relationships which represent the analyst's view as to how the farm household behaves. Often, as in this report, it is possible to obtain a reduced form such that each dependent variable is expressed exclusively in terms of independent variables which causes changes in the dependent variables. The crucial variables among the dependent variables are the four net income measures and the employment variables, because they directly reflect the material welfare of the household or are important components of it. In this report, we identified the following nine independent variables:

1) the size of the household;
2) the size of the farm (area operated);
3) prices received by farmers;
4) the agricultural wage rate;
5) off-farm employment in nonagricultural activities;
6) the implicit daily wage of nonagricultural work;
7) the cash outlay of off-farm produced inputs;
8) the relative efficiency of land;
9) the relative efficiency of labor.

In principle, each of the 422 variables of interest should have been cross tabulated against each (or combinations thereof) of the above independent "explanatory" variables. Before such a cross tabulation can take place, the relevant independent variable must be calculated for each farm. Given this, farms can be divided into appropriate groups. For the size of

the household, the size of the farm (area operated), the agricultural wage rate and the cash outlay on off-farm produced inputs, this poses no problem, since they are already aggregated and/or expressed in natural units. Special programs would have to be written to calculate the index of prices received by each farm, and the indices of relative efficiency with which land and labor are used. The questionnaire does not contain information about the amount and unit renumeration of nonagricultural work.[1/] The foregoing suggests that the southern valleys survey data or the 1978 sector survey data be cross tabulated not only with respect to farm size, but also with respect to the other identified explanatory variables.

The data processing documentation of the 1977 survey provides for the calculation of the variances and the coefficients of variation for selected variables of interest. It is important to have this information for each coefficient or intersection in the standard tables produced by the Bureau of Census tabulation system. Without this information, no rigorous statistical inference is possible.

Throughout this report, we have stressed the usefulness of the production function as a standard tool of analysis when analyzing the farm as a whole or when analyzing individual crops. The 1978 survey questionnaire shares that view and will make it possible to estimate crop production functions for all major crops. A crop production function is not only an economical way of describing a mass of data, its primary usefulness is for prediction, i.e., for causal analysis. The 1977 survey data are not adequate to derive crop production functions. They can be used to derive

[1/] This can be easily remedied in future surveys by including the specific questions. It would also be useful to ascertain the minimum wage rate w* at which a person currently employed full time by the farm household would be willing to accept off-farm agricultural work. For farm households with no off-farm agricultural work, w* presumably exceeds the going agricultural wage rate of 32 pesos.

farm production functions. It is suggested that the latter type of production functions be constructed for both the 1977 and 1978 surveys. They are possibly a preferable alternative to the current system of cross tabulations, whose primary purpose is descriptive and not causal.

The model of the farm household which underlies this report does not distinguish between crops and livestock. A majority of the farm households in the 1977 survey produce both crops and livestock. Differences in the man-land ratio among farms reflect themselves primarily in the proportion of the total area operated dedicated to crop land, the remainder being in natural pastures. But it is the latter that provide the feed for livestock production. It is recommended, therefore, that the livestock sector be analyzed separately or jointly with the crop sector of the farm household.

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LIST OF FIGURES

Figure 1. A classification of farm households in the 1977 southern valleys survey

Figure 2. The farm-household labor supply curve

Figure 3. The determination of net household income when the labor used by the farm X_1 also equals the family supply of labor X_1^*

Figure 4. The determination of net household income when the labor used by the farm X_1 equals the family supply of labor X_1^* plus a certain amount of hired labor X_{12}

Figure 5. The net household income opportunity curve when members of the household work off-farm in nonagricultural activities

Figure 6. The labor productivity function

Figure 7. Crop technology when land is not of uniform quality

LIST OF TABLES

Table 1. Project document numbering system

Table 2. Production and disposition of production for farms reporting production of 19 crops for the southern valleys region, 1977

Table 3. Frequency of off-farm employment for the region and departmental areas

Table 4. Farm size and utilization of farm land by region and departments

Table 5. Farm size and utilization of farm land by size of farm

Table 6. Frequency of males and females 13-60 engaged principally in agriculture, average number of household members emigrating for temporary or permanent work and mean family size by region and departments

Table 7. Frequency of males and females 13-60 engaged principally in agriculture, average number of household members emigrating for temporary or permanent work and mean family size by levels of net household income

Table 8. Frequency of males and females 13-60 engaged principally in agriculture, average number of household members emigrating for temporary or permanent work and mean family size by size of farm

Table 9. Literacy and formal education according to levels of net household income

Table 10. Frequency of heads of households, spouses or eldest sons having formal agricultural education, acquaintance with agricultural assistance activities and desiring assistance

Table 11. Average net household income according to size of farm and type of farm as determined by off-farm income

Table 12. Composition of net household income according to source of income by type of farm

Table 13. Average production per hectare for farms reporting production of 19 crops according to size of farm

Table 14. Average production per hectare for farms reporting production of 19 crops according to the type of seed used

Table 15. Average production per hectare for farms reporting production of 19 crops by type of fertilizer and irrigation

Table 16. Average production per hectare for farms reporting production of 19 crops by source of power

Table 17. Average production per hectare for farms reporting production of 19 crops by use of other chemical products

Table 18. Average farm size, average hectareage in annual crops, average value of crop production, average value of variable crop input cash costs, average value of miscellaneous crop cash costs by size of farm

Table 19. Average farm size, average hectareage in annual crops and average irrigated hectareage in annual crops by size of farm

Table 20. Fallow land, multiple cropping by type of terrain by size of farm

Table 21. Factor demand equations and the cost function in efficiency inputs and prices

Table 22. Frequency of cash rental and share cropping by size of farm

Table 23. Three key variables that determine the demand for labor and the optimal level of production of the farm household

Table 24. A comprehensive characterization of the farm household as a production unit

Table 25. Alternative configurations of the sources and uses of farm household labor

Table 26. The amount and renumeration of off-farm agricultural employment by region and departments

Table 27. The amount and renumeration of off-farm agricultural employment by size of farm

Table 28. Average number of man-days worked off-farm in agriculture in Bolivia and outside Bolivia by households with members employed off-farm according to technical training/assistance, credit source, tenancy and time to market

Table 29. Frequency and average earnings of off-farm employment in non-agricultural activities by region and departments

Table 30. Frequency and average earnings of off-farm employment in non-agricultural activities by time to market

Table 31. Average number of man-days of hired labor employed by farms employing hired labor and the average value of a man-day of hired labor by region and departments

Table 32. Average number of man-days of hired labor employed by farms employing hired labor and the average value of a man-day of hired labor by size of farm

Table 33. Average number of man-days of hired labor employed by farms employing hired labor and the average value of a man-day of hired labor by time to market

Table 34. Average number of man-days of hired labor employed by farms employing hired labor according to technical training/assistance, credit source, tenancy and time to market

Table 35. Average number of man-days of Ayni (Minka) labor and communal work by farm households by region and departments

Table 36. Average of man-days of Ayni (Minka) labor and communal work by farm households according to time to market

Table 37. Revenue items that enter into alternative income definitions

Table 38. Expenditure items used in alternative net income definitions

Table 39. Average net household income per farm and per capita, average off-farm agricultural income per farm and per capita, average nonagricultural income per farm and per capita, average net farm income per farm and per capita by region and departments

Table 40. Average net household income per farm and per capita, average off-farm agricultural income per farm and per capita, average nonagricultural income per farm and per capita, average net farm income per farm and per capita by size of farm

Table 41. Average net household income per farm and per capita, average off-farm agricultural income per farm and per capita, average nonagricultural income per farm and per capita, average net farm income per farm and per capita by time to market

Table 42. Average net farm income and average net farm cash income per farm, per capita, per hectare and per cultivated hectare by region and departments

Table 43. Average net farm income and average net farm cash income per farm, per capita, per hectare, and per cultivated hectare by size of farm

Table 44. Average net farm income and average net farm cash income per farm, per capita, per hectare, and per cultivated hectare according to time to market

Table 45. Average net farm income per cultivated hectare according to training/assistance, credit source, tenancy and time to market

Table 46. Average value per hectare for farms reporting production of 19 crops by size of farm

Table 47. Average value per hectare for farms reporting production of 19 crops by type of seed used

Table 48. Average value of production per hectare for farms reporting production of 19 crops according to type of fertilizer and irrigation

Table 49. Average value of production per hectare of farms reporting production of 19 crops according to source of power

Table 50. Average value of production per hectare for farms reporting production of 19 crops according to use of other chemical products

Table 51. Average value of crops consumed by farm-households by regions and level of net household income per farm-household

Table 52. Average value of crop production and crop sales per farm by regions by size of farm

Table 53. Average value of crop production and crop sales per farm by regions and by irrigation use

Table 54. Average value of crop production and crop sales per farm by regions and by time to market

Table 55. Average value of crop production and average value of crop sales per farm by region and technical training and/or assistance

ıble 56. Average value of crop production and average value of crop sales per farm by regions according to credit levels

Table 57. Average value of crop production and average value of crop sales per farm by region according to tenancy

Table 58. Hectareage for farms reporting production of 19 crops according to size of farm

Table 59. Hectareage for farms reporting hectareage of 19 crops according to type of seed used

Table 60. Hectareage for farms reporting hectareage of 19 crops according to type of fertilizer and irrigation

Table 61. Hectareage for farms reporting hectareage of 19 crops according to source of power

Table 62. Hectareage for farms reporting hectareage of 19 crops according to use of other chemical products

Table 63. Percentages of farm households expressing different needs concerning future increases in production by region and department

Table 64. Production related cash outlays per farm according to levels of net household income

Table 65. Total of production related cash outlays per farm, mean net farm cash income per farm, mean net household cash income per farm, mean net farm income per farm, mean net household income per farm by levels of net household income

Table 66. Percentages of farm households expressing different needs concerning future increases in production by net household income groups

Table 67. Hectareage in annual crops by training/assistance, credit source, tenancy and time to market

Table 68. Prices received by farmers for barley, corn, potatoes and wheat according to time to market

Table 69. Hectareage in crops and average value of crop production per hectare for 19 crops according to time to market

Table 70. Distance from farm to closest road and from farm to market according to size of farm