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Economic questions such as farm sizes and profits are considered. Farm size is defined as the number of persons on the cooperative farm, actual size of the farm, and the degree of mechanization. The farm size providing the highest income per person in the cooperative is about fourteen hectares per person. If a loss of ten percent income is acceptable, the farm size can be reduced to seven hectares per person. It is more advantageous to raise crops thar sheep, because sheep raising yields lower profits and requires a higher use of labor. Partial mechanization is better for smaller farms, while full mechanization is more profitable in larger farms. This pattern evolves because the smaller farms have a higher land-to-land ratio. Recommendations suggest the renting of land, upgrading of managerial and mechanical skills, standardized record-keeping, and availability of an agricultural economists.

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Preliminary report

Optimal allocation of agricultural resources in the Development Area of Patacamaya, Bolivia. A linear programming approach

by

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CHAPTER I. INTRODUCTION

Nature of the Problem and its Setting

In 1953, when the Land Reform was launched, the Bolivian Government proceeded to transform agriculture from traditional to modern forms and methods.

Although initially a change in land tenure arrangements, the Land Reform was intended to have far-reaching effects upon productive aspects of agriculture. Since inception of the reform, increased agricultural production, both to improve farmers' standard of living and to reduce the deficit in the balance of payments, has been one of the main concerns of the National Government in establishing policies for development of agriculture. A recent study (Clark 1968) has shown that any decrease in production after 1953, especially in the supply reaching the cities, was not a direct result of the changes in land tenure effected by the Land Reform. Some reductions in agricultural supply were inevitable consequences of a popular Revolution (of which Land Reform was only one component) whose major aim was to destroy the minority-based power structure and to create a more broadly based government (Clark 1970, pp. 52-53).

Within Government, both before and after the reform, there has existed the conviction that a necessary ingredient of agricultural development is a strong program of research and extension. This conviction stemmed from the realization of very low levels of education and technology within the agricultural sector. Policies were not always enacted in accordance with

that conviction mainly because of budgetary constraints. However, in recent years, renewed emphasis has been placed upon research and extension work revolving around the Experimental Stations.

In the high plateau region, known as the Altiplano, the Ministry of Agriculture maintains three experimental stations: Belén, by Lake Titikaka; Patacamaya, at the southern edge of the Department of La Paz; and Chinoli, in the Department of Potosí. The Experimental Station of Patacamaya, founded in 1958, has received a larger share of support and is viewed by the National Government as a pilot project in testing the role an experimental station can play in the development of the surrounding area.

Although founded as an Experimental Station primarily for the improvement of sheep, Patacamaya has also been quite successful in crop improvements. Research in potato, quinua and forages has already yielded considerable increases in production. Recent informal experiences with gladiola and some vegetables seem to open new possibilities. And, of course, there is continuous work being done in improving sheep through cross-breeding with imported animals and through better feeding and management.

Formal extension activities by the Station began in 1963. In 1966, the Development Area of Patacamaya was established and the cooperative firm was chosen as the framework within which extension work would proceed. Apparently, the activities and results of the Experimental Station are largely responsible for the new drive for progress which is quite noticeable throughout most of the Development Area.

Given the experience accumulated so far and the planning being done for the near future in the area, it seemed that economic analysis could make a valuable contribution to the developmental activities. Economic analysis should help answer questions that have been forming for several years in the minds of the personnel working in the Area of Patacamaya. These questions concern productivity potential, optimal farm size, scarcity of resources, employment opportunities, selection of activities and degree of mechanization to be promoted. This research endeavors to provide answers to these questions.

Conclusions of this study should shed light on the possibilities of agriculture in the Development Area of Patacamaya. To the extent that the entire Altiplano has common characteristics, the conclusions can also suggest some general directions for the development of the entire region.

Objectives of this Research

The broad purpose of contributions from economic analysis to the developmental efforts in the Development Area of Patacamaya is specified for this study in terms of the following four objectives:

(1) To determine optimal land/person ratios, optimal degree of mechanization and paths for mechanization in the Area.

(2) To determine the quantities of land, labor, capital and water required under the optimal conditions established in objective one.

(3) To determine the composition of crop and livestock activities and the level of output under the optimal conditions.

(4) To estimate changes in per capita income, employment and productivity of the Area to be realized under the optimal conditions as compared with present conditions.

Terms included in these objectives, such as optimal, income per capita, factor productivity and mechanization require definitions which will be provided in Chapter III, in conjunction with model development.

Attainment of the first objective enables us (i) to identify the amount of land a cooperative should have from an economic viewpoint according to the number of its members, (ii) to determine the degree of mechanization adapted to each cooperative size and the path for progressive mechanization, (iii) to estimate the opportunity cost, in terms of income foregone, of deviating from the optimal conditions and (iv) to show the trade-offs to be incurred if alternative criteria of optimality are chosen.

The second objective allows us to detect seasonal and overall scarcities of resources in the area. The third objective is relevant in (i) choosing those activities on which agricultural research and extension should concentrate and (ii) predicting the production that could be expected. Results of the fourth objective can be used as a preliminary evaluation of the developmental efforts in the area.

A fifth objective had been included in initial plans for this research, but had to be dropped for lack of funds for computer time. This objective was to determine changes in the farm plans and in the levels of production as responses to variations in the prices of outputs and inputs. Knowledge

of such responses (price elasticities of supply) would offer guidelines for policies intended to influence agricultural production by manipulating prices of outputs or inputs. More will be said on the subject in Chapter IX, when making suggestions for further research.

The paths for progressive mechanization, mentioned under objective one above, may prove important, because they will allow the timing of progressive mechanization [illegible] i) the acquisition of managerial and mechanical skills by the cooperatives and (ii) employment needs in the Area. This should matter a great deal when attempting to bring farm machinery into a primitive agriculture, as it is the case in the Development Area of Patacamaya.

Methods Used in Pursuing the Objectives

As Chapter III will explain in detail, the linear programming method with the maximization option is used in this study, including variable-resource and parametric modalities. With the variable-resource modality, various degrees of mechanization are considered, while the parametric modality is used to examine changing land/person ratios.

The model is processed with the IBM Mathematical Programming System (MPSX) at the Computation Center at Iowa State University.

An explanation is in order about the units of weight and measurement used in this study, which for obvious reasons of relevance are those prevalent in Bolivia. Although Bolivia is under the metric decimal system, a few other measures are also used.

Farm land is measured in hectares (ha), one hectare being ten thousand square meters, approximately 2.47 acres. Distances are measured in meters (m) or kilometers (km = 1000 m). Agricultural output is usually measured in hundredweights (cwt), that is, 100 pounds or 45.36 kilograms; the metric ton, equal to 1000 kilograms is also used sometimes. Inputs such as seed, fertilizer and chemicals are quoted in kilograms (kg) or pounds (lb) when they are solid. Liters (lit) are the common measure when dealing with liquids, one liter being equal to 0.26 gallons. Water is also measured in cubic meters (m^3 = 264.17 gallons). Temperatures are given in degrees centrigrade, and rain is measured in milimeters (mm). The monetary unit is always the peso boliviano, equal to US$ 0.0833 (12 pesos = 1 dollar).

More complete Tables on weights and measures are included in Appendix A. The conversion factors listed there are used throughout this study.

Organization of the Study

Following this introductory chapter, Chapter II describes the situation and problems within the area of study. The model and the procedures to satisfy the objectives are explained in Chapter III. Chapters IV to VI inclusive, contain resource availabilities, constraints, activities with coefficients, prices, and costs and revenues. Chapters VII and VIII present the application of the model, and the results with their interpretation. The two final chapters include the conclusions and recommendations and the summary, respectively.

After two months in preparing the analytical framework, ten months were spent in collecting the information needed--from September, 1969, through June, 1970, four months in La Paz and six months within the Area of Patacamaya. Processing the data, computation and analysis, and writing were performed at Iowa State University. Primarily because of budget constraints, this research has taken two and one half years to complete, one year on full-time and the rest on half-time basis. This fact, however, does not lessen the timeliness of the results, because change in the Bolivian Altiplano is a slow process.

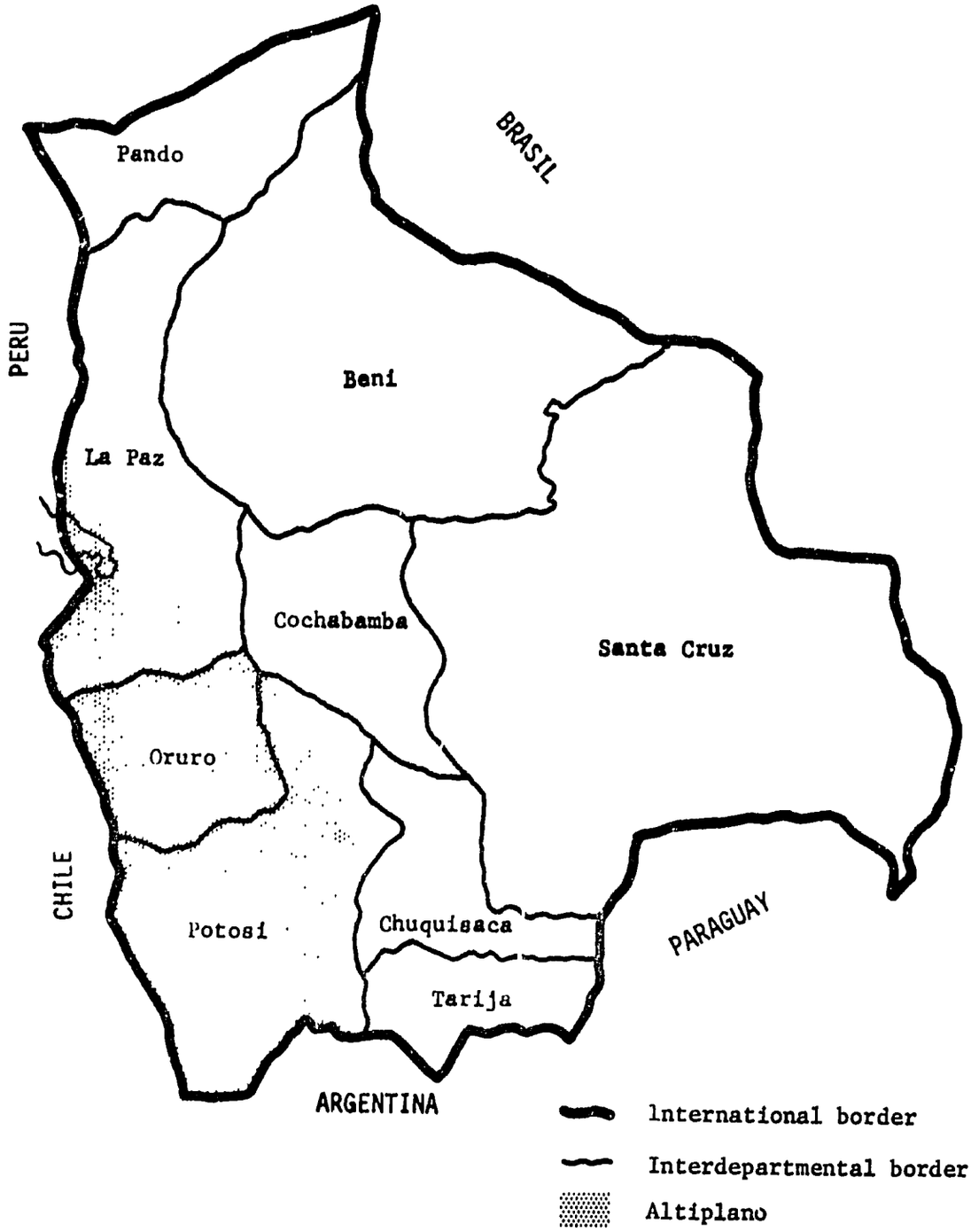
CHAPTER II. AREA OF STUDY

The Development Area of Patacamaya

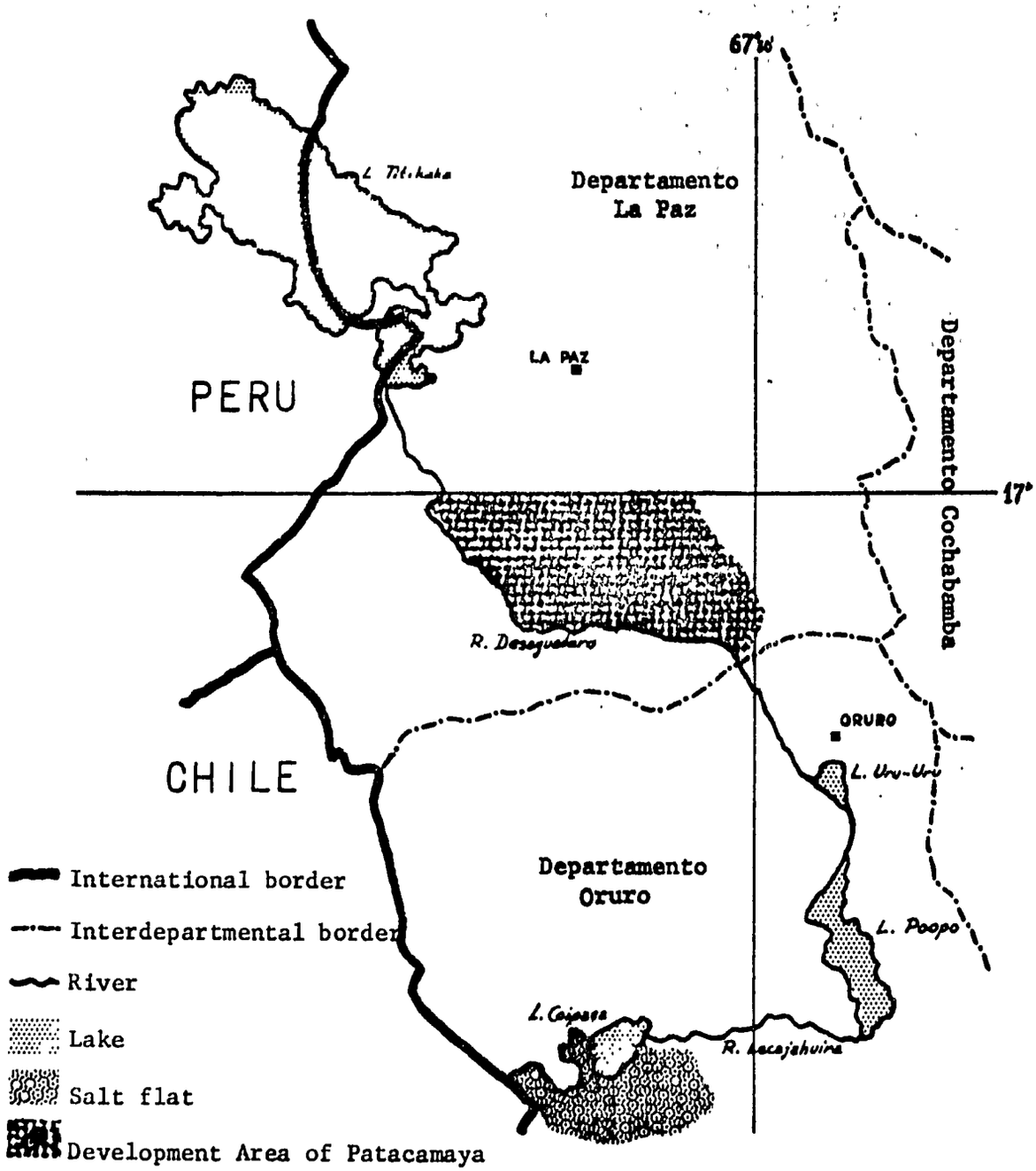
The Development Area of Patacamaya (termed DAP hereinafter) is located in the northern part of the Altiplano, the high plateau in the western edge of Bolivia. The Altiplano lies at an average altitude of 3800 m above sea level and partly comprises the Departments of La Paz, Oruro and Potosí. Map 2-1 shows the location of the Altiplano within Bolivia and Map 2-2 shows the DAP within the Altiplano.

Although there are no accurate data on the Area, the Bolivian Altiplano covers about 142,750 km^2, of which 22,570 km^2 are taken by lakes and salt flats, another 29,340 km^2 are above 4500 ms of altitude, and the remaining 90,840 km^2 will accept some kind of crop or livestock activity (Cardozo 1967a, p. 2). Out of these 90,840 km^2, some 66,000 km^2 are thought to be tillable with machinery. The area presently under cultivation is around 150,000 ha, representing 1.66% of the tillable area (Gandarillas 1969, p. 12; Cardozo 1967b, p. 2). It is estimated that the Altiplano has a population of some 1.6 million persons, of whom one million are rural (Bolivia 1967c, p. 4).

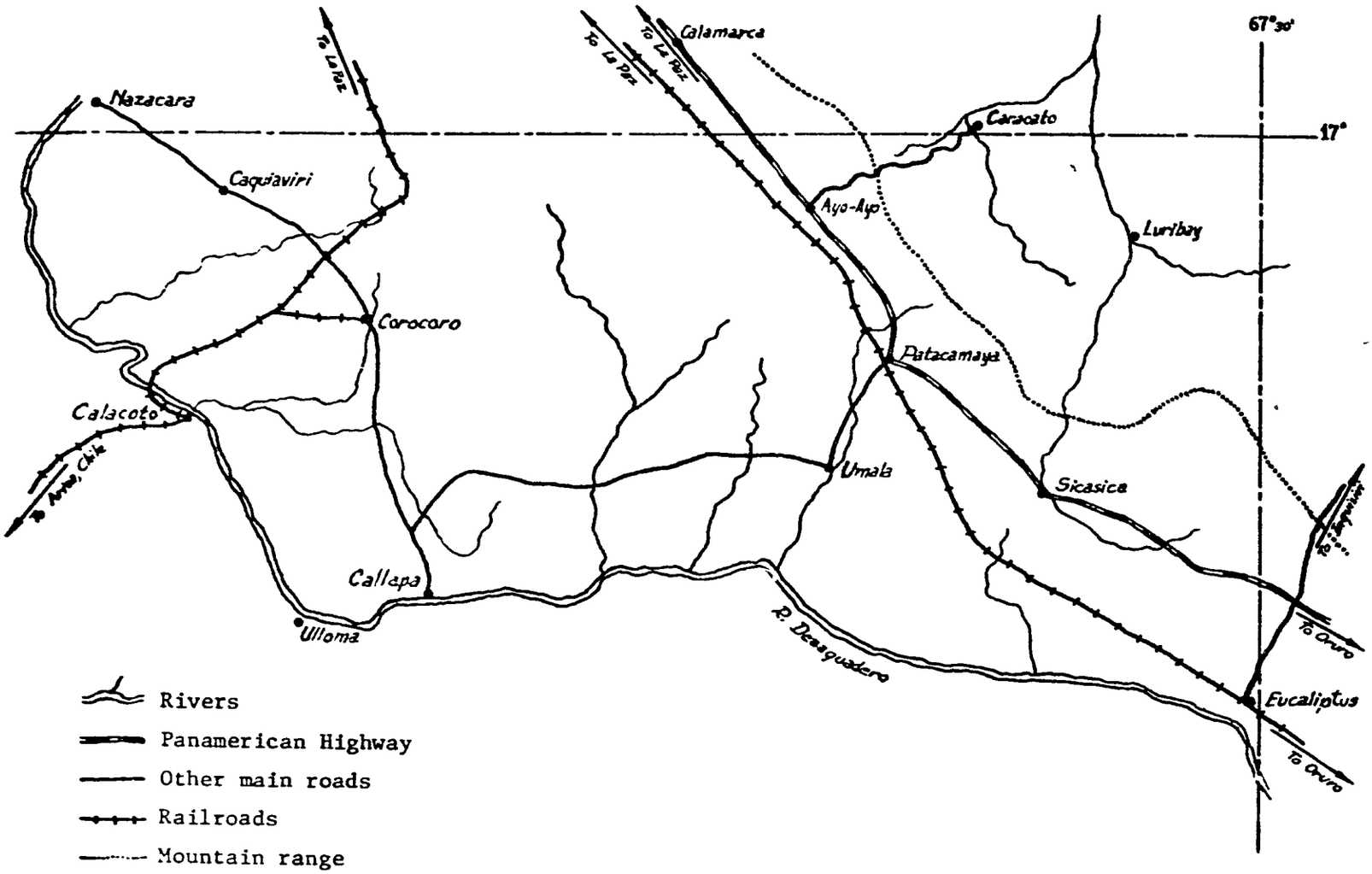
In 1966, the DAP was defined as having the boundaries shown in Map 2-3. To the North, the 17th parallel which runs approximately along the northern borders of the provinces Aroma and Pacajes. To the West and South, the Desaguadero River on its way down from Lake Titikaka to Lake Poopo. To the East, the road Eucaliptus-Inquisivi and the mountain range



Map 2-1. Bolivia. Departments and location of the Altiplano



Map 2-2. Location of the Development Area of Patacamaya, Bolivia



Map 2-3. The Development **Area of Patacamaya, Bolivia**

between the provinces of Aroma and Loayza. Thus, the DAP comprised originally that part of the province of Pacajes which lies East of the Desaguadero River (about one-fifth of the province) and the whole province of Aroma except for the small triangle East of the road Eucaliptus-Inquisivi. Geographically, that region consists of two plains divided by the gorge of Vizcachani and crossed by the small seasonal rivers Kheta and Aroma and by a series of medium-sized hills (Cardozo, Gandarillas and Chacón 1966, pp. 7-8). During the last three years, the extension activities of the Experimental Station have extended beyond the mountain range into the Loayza Province. Therefore, in this study the DAP will be enlarged to include the northeastern triangle bounded by the 17th parallel to the North and by the 67° 30' meridian to the East.

The area of the DAP has never been accurately known. When drawing Map 2-3 for this research, the carthographic division of the National Commission for Agrarian Reform gave 5870 km^2 as the size of the original DAP. The area of the extended DAP considered in this study would then be 7010 km^2, that is, 701,000 ha.

Few soil studies have been made in the Altiplano: The 217,621 ha covered by these studies represent only 4.29% of the area covered in the whole country as of 1968, while the Altiplano contains 13% of the nation's land. This is due to the fact that most of the resources of the Soils Division in the Ministry of Agriculture have been devoted to the colonization projects in the Low Lands (Sainz 1968, pp. 2-12). Soil quality in the Altiplano worsens, in terms of inherent productivity, from North to

South. The soils in the DAP exhibit the general characteristics of what Cardozo has called the Eastern Altiplano (Cardozo 1967a, pp. 7-10). These soils are mainly of colluvial origin, formed with deposits from the surrounding mountain slopes. In general, they are sand-loam and clay-loam, with good drainage but with little depth. Most soils are very poor in organic matter and nitrogen, and many of them are badly eroded. Presently, most of the DAP cannot be considered better than class V in the Land Capability Classification of the USDA Soil Conservation Service. However, should irrigation be readily available and good management enforced, the soil quality could be improved to classes II, III and IV (Cardozo 1967a, pp. 7-10; Gandarillas and Gebhardt 1962, p. 7).

Surface water availability for irrigation is limited to the Desaguadero River and a few seasonal streams. Any hope for substantial irrigation is in underground water. It has always been known that the water table is not far from the surface, but little is known about location of large water supplies in the DAP and their rate of recharge. Studies made so far have been incomplete (Misión Francesa para el Desarrollo del Altiplano 1967). However, a study on underground waters in the whole Altiplano is underway and should yield useful information (Bolivia 1967c). So far experience with wells at the Experimental Station of Patacamaya and a few other places has been encouraging (Cardozo, Gandarillas and Chacón 1966; Estación Experimental de Patacamaya 1969).

Main lines of communication and transportation for the DAP are the Panamerican Highway, the railroad connecting Patacamaya with La Paz and

Oruro, and the railroad which crosses the western corner of the Area and goes from La Paz to Arica, Chile (see Map 2-3). In the last decade there has been a transportation boom on the improved Panamerican Highway, which was recently paved in its entirety between La Paz and Oruro. The town of Patacamaya is 105 km from La Paz and Oruro by road, while the railroad distance is 122 km to both cities. The Experimental Station of Patacamaya is 5 km West of the town on a dirt road. Freight transportation to La Paz and Oruro can take 8 or 10 times longer by train than by truck. Such delay is not important when transporting minerals (for which Bolivian railroads were designed), but it can be very damaging when the cargo is perishable agricultural products including meat.

Weather conditions are typically adverse to crop production in the whole Altiplano and worse the farther South you move (away from the tempering influence of Lake Titikaka). In Tables 2-1a to 2-4, meteorological stations are listed in descending geographical order from North to South. As you move down in Table 2-1a, rainfall tends to be lower; however, the concentration of rainfall in December to March is much more of a problem than the total annual rainfall, because it means that approximately from June to September there is a severe drought all over the Altiplano. A pattern of decreasing temperatures and of increasing frosts and hailstorms is less uniform when moving down in Tables 2-2a to 2-4, since these variables are more affected by altitude and sheltered location. Monthly weather data are given in Appendix B for the stations presently functioning in the DAP.

Table 2-1a. Annual rainfall in the northern and central Altiplano, 1959-1968[a]

Meteorological[b] stations	Altitude in m	Annual rainfall in mm[c] 1959-60	1960-61	1961-62	1962-63	1963-64
Copacabana	3820	819.9	960.0	836.3	690.1	600.0
Desaguadero	3803	-[f]	-[f]	-[f]	-[f]	-[f]
El Alto	4100	688.1	621.0	560.4	677.7	577.6
Viacha	3831	-[f]	-[f]	-[f]	-[f]	-[f]
Calamarca*	3954	561.3	574.8	422.1	470.6	531.7
Comanche*	4055	-[f]	-[f]	-[f]	-[f]	-[f]
Ayo-Ayo*	3856	341.5	286.0	333.5	277.0	261.4
Patacamaya*	3788	500.1	480.4	459.8	392.2	392.6
Sicasica*	3820	234.0	225.5	182.5	186.5	129.0
Charaña	4057	257.5	336.8	351.0	319.4	127.2
Chuquiña	3823	456.5	441.3	438.5	401.	309.
Oruro	3708	287.3	283.5	348.6	374.8	307.1
Challapata	3820	-[f]	-[f]	-[f]	491.	414.2

[a]Sources: Computed from Bolivia 1969e and 1970.

[b]Listed in descending geographical order from North to South. The starred names belong to stations within the DAP; no information was available from the station at Estación General Pando.

[c]The agricultural year runs from July to June. For the few months in which information was missing, a figure was used which is the average for the same month from the four immediate years for which data are available. Since the sources for this Table follow the regular calendar year (January to December), the data were rearranged to fit the agricultural year, and the averages were recomputed.

[d]Average rainfall for the years listed in the Table.

[e]Average of the percent of rainfall fallen during December, January, February and March in the years listed in the Table.

[f]Data missing for the entire year.

Annual rainfall in mm[c]				Yearly[d]	Yearly	Yearly	% Dec.[e]
1964-65	1965-66	1966-67	1967-68	average	minimum	maximum	to Mar.
521.5	760.0	603.9	741.7	725.9	521.5	960.	66.83
-[f]	-[f]	441.9	915.8	678.8	441.9	915.8	74.74
728.1	525.7	449.3	563.2	599.0	525.7	728.1	70.29
434.8	443.7	393.8	542.	453.6	393.8	542.0	69.14
557.3	510.3	385.3	618.3	514.6	422.1	618.3	68.27
-[f]	-[f]	-[f]	450.3				63.42
263.7	250.5	258.0	472.3	304.9	250.5	472.3	74.29
361.5	261.1	246.8	446.3	413.8	246-8	500.1	72.58
125.0	109.0	123.5	143.0	162.0	109.0	234.0	74.43
93.2	-[f]	-[f]	-[f]	247.5	93.2	351.0	81.73
290.5	236.5	225.	405.5	356.0	225.0	456.5	75.30
352.	239.3	158.7	271.4	291.4	158.7	374.8	70.76
263.	299.5	329.	451.5	374.7	263.	491.0	77.71

Table 2-1b. Average rainfall, by months, in the northern and central Altiplano (in mm)[a,b]

Meteorological[c] stations	Years	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
Copacabana	1959-68	2.1	9.9	39.4	36.8	69.0	99.2	135.5	134.8	114.4	58.6	31.2	5.2
Desaguadero	1966-68	20.0	4.3	22.6	32.1	50.3	93.4	96.0	159.4	105.1	29.6	28.5	8.5
El Alto	1959-68	3.0	12.1	43.0	32.3	46.6	104.5	115.0	129.8	73.5	26.7	16.4	2.1
Viacha	1964-68	0.9	7.0	20.8	17.6	52.3	85.3	77.5	85.7	63.8	29.1	17.9	1.3
Calamarca*	1958-68	6.2	9.6	32.5	29.7	45.4	87.6	72.0	93.5	73.8	37.4	13.5	1.5
Comanche*	1967-68	8.4	6.3	32.6	29.0	50.9	49.5	48.6	167.2	41.2	24.6	11.6	7.1
Ayo-Ayo*	1958-68	0.9	6.0	19.3	19.3	33.2	56.0	69.2	59.3	47.2	14.3	6.5	2.7
Patacamaya*	1958-68	0.9	10.3	32.5	15.3	77.9	71.1	88.1	69.7	56.9	13.1	9.4	0.7
Sicasica*	1954-68	0.9	4.8	4.7	5.7	12.2	25.2	40.4	27.7	25.8	5.3	2.3	0.3
Charaña	1957-65	0.9	3.2	6.4	3.5	13.3	47.9	68.5	59.0	40.3	7.2	2.1	2.4
Chuquiña	1959-68	0.4	10.9	31.1	11.3	17.7	63.2	73.9	79.5	66.0	12.6	7.2	2.0
Oruro	1959-68	0.7	10.1	15.9	11.2	23.4	55.1	58.6	63.8	35.5	10.8	5.5	1.4
Challapata	1962-68	1.6	1.8	27.1	7.9	27.9	79.2	62.1	76.1	69.4	10.9	5.2	2.9

[a]Sources: Computed from Bolivia 1969e and 1970.

[b]The figure for each month is the average of the rainfall in that month during the years indicated in the Table.

[c]Listed in geographical descending order from North to South. The starred names belong to stations within the DAP; no information was available from the station at Estación General Pando.

Table 2-2a. Average temperature, by months, in the northern and central Altiplano (in degrees centigrade)[a,b]

Meteorological[c] stations	Years	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
Copacabana	1959-68	7.9	8.9	9.4	10.4	11.1	10.8	11.0	10.4	10.3	10.2	9.2	8.3
Desaguadero	1966-68	5.3	7.1	8.8	9.8	10.1	10.4	11.5	11.6	11.8	10.1	8.1	6.9
El Alto	1959-68	7.0	7.9	8.0	9.9	10.2	8.2	8.4	8.7	8.2	8.1	7.7	7.2
Viacha	1964-68	3.0	4.9	7.4	9.4	9.9	9.2	9.9	9.8	8.7	8.3	5.7	3.2
Calamarca*	1958-68	4.9	6.3	8.3	9.9	10.6	11.7	10.7	9.9	9.4	8.7	6.4	4.9
Comanche*	1967-68	4.2	5.7	7.8	9.2	9.6	8.8	9.6	9.0	9.0	8.2	6.8	4.8
Ayo-Ayo*	1958-68	4.7	5.0	7.5	9.2	10.4	11.5	11.7	11.8	10.2	9.0	6.5	4.6
Patacamaya*	1958-68	5.1	7.7	10.3	12.9	14.3	14.5	14.5	14.0	12.9	11.0	7.5	5.0
Sicasica*	1954-68	6.1	7.8	9.5	11.4	12.4	12.1	11.8	11.2	11.4	10.3	8.5	6.2
Charaña	1959-65	4.7	5.8	7.8	9.8	10.9	11.2	10.9	10.4	9.8	8.9	7.0	4.6
Chuquiña	1959-68	7.7	10.5	12.1	13.0	13.0	12.8	12.4	12.5	12.2	11.4	9.0	6.3
Oruro	1959-68	5.2	7.6	10.4	12.8	13.8	13.1	13.5	12.6	12.4	11.1	8.1	5.4
Challapata	1962-68	5.8	7.4	9.8	11.7	12.5	12.7	13.3	13.2	12.5	11.1	8.6	6.0

[a]Sources: Computed from Bolivia 1969e and 1970.

[b]The figure for each month is the average on the monthly averages in the years indicated in the Table.

[c]Listed in descending geographical order from North to South. The starred names belong to stations within the DAP; no information was available from the station at Estación General Pando.

Table 2-2b. Average highest temperatures, by month, in the northern and central Altiplano (in degrees centigrade)[a,b]

Meteorological[c] stations	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
Copacabana	13.1	14.0	14.3	15.1	15.9	15.5	15.6	14.8	14.8	15.0	14.1	13.5
Desaguadero	15.6	16.9	17.6	17.8	17.3	17.5	18.4	17.9	18.2	17.8	16.3	17.3
El Alto	13.0	14.3	13.8	16.1	16.1	13.9	13.4	13.6	12.9	14.0	13.5	13.2
Viacha	14.4	15.9	16.2	17.1	17.1	16.0	17.1	15.9	15.2	16.2	15.3	14.5
Calamarca*	9.8	11.6	13.6	15.6	16.5	17.4	16.5	14.7	14.0	13.6	10.8	9.6
Comanche*	16.2	17.4	18.2	19.5	19.1	17.2	17.1	14.5	16.1	18.7	18.4	17.4
Ayo-Ayo*	14.9	15.4	16.6	19.6	18.6	20.9	20.6	20.7	18.8	18.4	16.2	15.5
Patacamaya*	14.8	16.8	19.3	22.9	24.1	23.1	23.2	22.0	20.9	19.4	16.4	14.6
Sicasica*	11.7	13.9	15.6	16.7	18.2	17.5	16.4	15.9	16.4	15.5	14.2	11.9
Charaña	15.5	15.7	16.7	18.7	19.4	19.8	19.0	18.1	18.0	18.4	16.9	14.9
Chuquiña	19.4	20.5	21.1	22.5	22.6	21.7	20.5	20.6	20.4	21.6	19.9	19.0
Oruro	14.2	15.4	17.0	19.1	19.8	18.7	19.1	18.1	17.7	17.5	15.6	14.1
Challapata	14.4	15.8	18.0	20.0	20.4	19.8	20.3	19.6	19.0	18.7	16.7	14.4

[a]Sources: Computed from Bolivia 1969e and 1970.

[b]The figure for each month is the average of the highest daily temperatures during the month in the years indicated in Table 2-2a.

[c]Listed in descending geographical order from North to South. The starred names belong to stations within the DAP; no information was available from the station at Estación General Pando.

Table 2-2c. Average lowest temperature, by months, in the northern and central Altiplano (in degrees centigrade)[a,b]

Meteorological[c] stations	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
Copacabana	2.7	3.7	4.7	5.8	6.3	6.1	6.5	6.1	5.7	5.4	4.3	3.1
Desaguadero	- 4.9	- 2.6	0.1	-0.5	1.4	3.6	4.5	5.3	5.4	2.4	-0.1	- 3.6
El Alto	- 1.7	- 1.4	0.3	1.6	2.1	2.6	2.6	2.8	2.3	1.5	-0.2	- 1.3
Viacha	- 8.0	- 5.0	-1.4	0.6	2.4	2.8	3.4	4.2	2.9	-0.3	-3.5	- 8.0
Calamarca*	1.1	2.9	4.5	4.9	5.2	5.0	5.2	4.8	3.7	1.9	0.3	- 0.1
Comanche*	- 7.8	- 6.0	-4.0	-0.7	-0.1	1.2	2.1	3.4	1.9	-2.3	-4.6	- 7.6
Ayo-Ayo*	- 3.1	- 2.4	-0.7	-1.1	1.4	2.3	3.0	2.8	1.8	1.7	-3.1	- 6.3
Patacamaya*	- 4.5	- 2.4	1.3	3.2	4.5	5.8	5.9	6.1	4.9	2.6	-1.3	- 4.6
Sicasica*	0.6	2.1	3.9	5.7	6.0	6.8	6.9	6.6	6.3	4.7	2.7	0.7
Charaña	-13.0	-11.9	-8.5	-6.1	-3.6	-1.5	-1.5	-0.7	-2.1	-6.0	-9.4	-13.3
Chuquiña	- 4.7	8.6	3.2	3.5	3.5	4.0	4.3	4.4	4.0	1.4	-1.9	- 6.3
Oruro	-11.5	- 8.6	-3.0	-0.9	0.7	3.1	3.6	3.9	2.3	-1.2	-6.0	-11.0
Challapata	- 2.7	- 1.2	1.6	3.0	4.7	5.9	6.2	6.8	6.1	3.6	0.5	- 2.4

[a]Sources: Computed from Bolivia 1969e and 1970.

[b]The figure for each month is the average of the lowest daily temperatures during the month in in years indicated in Table 2-2a.

[c]Listed in descending geographical order from North to South. The starred names belong to stations within the DAP; no information was available from the station at Estación General Pando.

Table 2-3. Hailstorms per year in the northern and central Altiplano, 1959-1968[a]

Meteorological[b] stations	1959-60	1960-61	1961-62	1962-63	1963-64	1964-65	1965-66	1966-67	1967-68	Average
Copacabana	7	10	10	–[c]	1	5	2	0	2	4.6
El Alto	13	16	21	18	13	12	14	2	16	13.9
Calamarca*	2	12	5	3	8	6	2	5	11	6.0
Comanche*	–[c]	–[c]	–[c]	–[c]	–[c]	–[c]	–[c]	–[c]	40	
Ayo-Ayo*	4	8	4	3	3	3	4	3	5	4.1
Patacamaya*	8	15	29	14	9	17	8	11	9	13.3
Sicasica*	3	10	10	4	7	2	6	7	17	7.3
Charaña	4	12	8	8	17	5	–[c]	–[c]	24	11.1
Chuquiña	10	9	8	6	15	9	7	9	7	8.9
Oruro	5	4	10	7	2	8	9	3	6	6.0
Challapata	–[c]	–[c]	–[c]	21	17	6	15	22	20	16.8

[a]Source: Computed from Bolivia 1969e and 1970.

[b]Listed in descending geographical order from North to South. The starred names belong to stations within the DAP; no information was available from the station at Estación General Pando.

[c]Data missing for the entire year.

Table 2-4. Frosts per year in the northern and central Altiplano, 1959-1968[a]

Meteorological[b] stations	1959-60	1960-61	1961-62	1962-63	1963-64	1964-65	1965-66	1966-67	1967-68	Average	% of year
Copacabana	1	2	5	3	0	0	0	0	2	1.4	0.4
El Alto	113	101	129	128	120	-[c]	-[c]	-[c]	-[c]	118.2	32.38
Calamarca*	80	116	109	95	133	120	109	147	128	115.4	31.61
Comanche*	-[c]	-[c]	-[c]	-[c]	-[c]	-[c]	-[c]	-[c]	205		56.01
Ayo-Ayo*	256	125	143	138	146	161	173	195	148	165.0	45.21
Patacamaya*	119	106	135	133	118	121	135	126	131	124.9	34.21
Sicasica*	85	70	104	90	102	113	103	27	56	83.3	22.81
Charaña	-[c]	279	287	295	291	294	-[c]	-[c]	-[c]	289.2	79.23
Chuquiña	173	-[c]	105	67	117	89	127	104	122	113.0	30.96
Oruro	232	229	225	175	184	219	218	180	188	205.6	56.33
Challapata	-[c]	-[c]	-[c]	96	89	126	128	95	105	106.5	29.18

[a]Source: Computed from Bolivia 1969e and 1970.

[b]Listed in descending geographical order from North to South. The starred names belong to stations within the DAP; no information was available from the station at Estación General Pando.

[c]Data missing for the entire year.

Main agricultural activities in the DAP, as in the rest of the Altiplano, are potato, quinua, barley, broad beans, some alfalfa and a few other native crops (oca, cañahua, etc.). Sheep, mostly degenerate criollo type, are the predominant livestock activity. Llamas are not raised commercially and very little research has been done about them. Among the above crops, bitter potato and quinua are well resistant to frost, while quinua is also very resistant to drought. Irish potato is highly vulnerable to frost.

That part of production, some 50% or 60%, which is not consumed on the farm is marketed mostly in La Paz, either directly or through middlemen. It is not known what percent of the product goes to Oruro and from there to the mining centers, but these areas can undoubtedly become a substantial market for the DAP.

As throughout the Altiplano, the level of living (housing, health, education, etc.) in the DAP is low, although not as low as in the Southern Altiplano whose inhabitants are among the poorest in the nation (Cardozo 1968b, p. 6). Recent information exists for two Communities in the DAP (Tables 8-21 and 8-22): Income per capita in 1968, including agricultural and non-agricultural income plus on-the-farm consumption, was 763 pesos (64 dollars) in Antipampa and 1034 pesos (86 dollars) in Culli Culli Bajo. These figures represent between 35% and 48% of the income per capita for the entire country, which was 2172 pesos (181 dollars) in the same year 1968 (USAID-Bolivia 1970, p. 17).

Data on living conditions are very scarce. The only available information comes from a 1967 survey taken as a preliminary for establishing

public medical assistance in the DAP (Bolivia 1967a). Neither the medical assistance nor the complete results from the survey ever became a reality, but a few data were given which offer a glimpse at health and housing conditions. About two thirds of the deaths are children (age not specified), although no mortality indices were obtained. Only 35% of the persons are reached by medical personnel. Eight percent of the families live in one-room houses and 34% live in two-room houses. Ninety percent of the homes have a roof made of mud and straw, and 96% have dirt floors. None of the families have electricity in the house, and 96% of the homes have no sewage disposal of any kind.

Developmental Efforts in the Area

Government action in Patacamaya began with the establishment of the Experimental Station on November 24, 1958. Research started immediately on sheep and forages. Shortly afterwards potato and quinua were added to the program. Small experiments on vegetables, gladiola and forestry are also underway, and in the late 1960's a few genetic and feeding studies were made on llamas. Most of the results of research in Patacamaya have been regularly published in the annual reports of the Experimental Station and in a few other publications.

Some extension activities by the Experimental Station existed from the beginning, mainly through informal contacts with the neighboring Communities and with the Asociaciones Ganaderas, small Associations of Sheep Growers. These contacts were institutionalized in 1963 with the foundation

of AREGA, Asociación Regional de Ganaderos de la Provincia Aroma, which grouped 12 Associations with a total of 180 members. By 1966, the Associations numbered 36, and some of them had started to organize cooperatively. The time had arrived to launch a well coordinated development program under the leadership of the Experimental Station. Thus the Development Area of Patacamaya was established, with the boundaries described earlier (page 8, Map 2-3).

The development program in the DAP includes both research at the Experimental Station and extension through the Area. The approach to extension activities was clearly outlined in Research Bulletin 4-66 of the Experimental Station (Cardozo, Gandarillas and Chacón 1966). The package of activities consisted of improved seeds, fertilizer, irrigation and some machinery, all within the framwork of cooperative organization. Technical assistance would be provided by the Experimental Station. Capital for purchasing machinery as well as operating capital were to be lent by the Agricultural Bank (Banco Agrícola de Bolivia). Water for irrigation would be pumped from wells drilled in the various cooperatives according to the experience at the Experimental Station. A technical board would be created under the name CODAPA (Consejo de Desarrollo del Area de Patacamaya), whose functions would be to advise on developmental policies and to provide contact with the Ministry of Agriculture; membership of the board would consist of personnel from the Ministry and from the Experimental Station, selected from the various research and extension fields in crops and livestock.

The cooperative form of organization as the developmental entity was chosen because of the following reasons:

(i) There are in the social structure of the Communities in the DAP elements of collective organization and land tenure which have survived centuries of colonialism and domination. Group farming seems to incorporate well those collective elements.

(ii) The Agricultural Bank has a firm policy of extending credit only to "groups" of farmers, either cooperatives or other permanent associations. The Bank believes that group loans will be used more wisely and will have a higher probability of repayment than loans to small independent farmers.

(iii) Extension personnel at the Experimental Station is limited to three persons: an agriculturalist with his assistant and a home economics extensionist. Until mid-1970, the only means of transportation was a 1960 pickup-truck, too often immobilized by lack of parts and gas shortages. Presently, a later model pickup-truck is available. Obviously, under these conditions it is easier to reach a certain number of cooperatives than hundreds of individual small farmers.

(iv) Management for mechanized agriculture is a very scarce resource in the DAP. Whatever management capabilities now exist or may be developed in the future will be used more efficiently at the head of large cooperative farms than in small isolated farming units.

(v) In buying inputs and marketing the output, cooperative farms can realize economies of scale which are not available to small ungrouped

farmers. Specifically, wholesale discounts offered by dealers of fertilizer and chemicals in La Paz start at volumes which are far above those required by any small farmer.

The Communities to which extension activities in the DAP are directed are ancient Aymara-speaking Indian Communities, held together by family and historical bonds. These communities are quite autonomous social entities with very little mingling among them. However, there is enough outmigration to urban centers and subtropical regions to keep the size of the Communities practically constant; this same outmigration keeps the average size of the family at 5 persons (Delucca 1969b, p. 348; Curso Nacional de Planificación de Proyectos a Nivel de Finca 1968, p. 9). For centuries, the Communities have held a claim to their lands and in many cases possessed legally valid old titles. But in the last four hundred years, lands were taken over by landowners who, in quite a few cases, reduced whole Communities to a situation of feudal serfdom. The Agrarian Reform ended that situation in 1953 and restored the usurped lands to the Communities. However, the granting of land titles in the whole Altiplano has been a very slow process, only speeded up in the last two years through the Agrarian Reform Mobile Teams and the computerization of the paper work involved. The Mobile Teams are now granting collective titles to the land, leaving to the Communities' own decision-making mechanism the task of allocating the land among their members.

Traditionally, allocation of the land among members and uses has been part of a religious ceremony held on the Monday following Carnival Week,

when the land was allocated partly to communal pastures and partly to individual farming on a yearly rotational basis, while the rest (as much as 50%) was left fallow. In the last decade, a few elementary technical considerations are quietly and slowly replacing superstition and custom as criteria for allocating land among uses.

The organization of the cooperative firm in the DAP will be described in Chapter III. It was apparent from the beginning that obstacles to the cooperatives would come from several fronts. First opposition came from vested interest in the status quo, i.e., middlemen, political leaders and money-lenders (at interest rates as high as 10% per month). For example, money-lenders offered one Community two tractors free in exchange for refusing to start a cooperative. Another obstacle was the experience of past failures, including attempts of production cooperatives in Pujravi and Chiarumani in 1954 and of various consumers' cooperatives in 1957. Such experiences were added to an ingrained fear of being abused once more by government officials or by "outsiders". Finally, the whole array of magic beliefs associated with agriculture (see DeLucca 1969b and 1969c) would certainly hinder to some extent any technological innovation.

In order to overcome these obstacles, it was decided that cooperative activities would function during the first years as supplementary activities; that is, in addition to those being already performed by each family. It was hoped that a demonstration effect would take place. Confronted with good results, the Communities would feel encouraged to assume the higher risk involved in organizing cooperatively with borrowed capital and

mechanized operations. Thus, the cooperatives in the DAP have started operating on 100 ha of land and with a reduced membership made up voluntarily of the most enterprising families in the Community. The 100 ha are either donated or leased from the communal lands; the families joining the cooperative make a membership payment of 100 pesos or 2 ewes.

Presently, there are 21 cooperatives functioning in the DAP. Table 2-5 presents some of their characteristics and Map 2-4 shows their approximate location. Hints of a trend toward an increased involvement in the cooperatives can be seen in Table 2-5: Five cooperatives have put together their sheep in one flock, in three Communities all families belong to the cooperative, all the cooperatives eligible have joined the Central de Cooperativas.

Data on number of families in the Community and in the cooperative and data on land owned by the Community are given in Table 2-6. For the whole DAP, the number of families in a Community ranges from 15 to 400, and the area available to a Community varies from 500 to 32,000 ha. These upper and lower limits are estimations by the extension personnel, since no data have been released as yet by the Agrarian Reform Mobile Teams operating in the area. In 1970, twelve of the cooperatives in Table 2-5 were using machinery, including tractor, plow, harrow, motor-and-pump, sprayer, sorter and wagon, purchased with loans from the Agricultural Bank. Most of the cooperatives also borrow operating capital for fertilizer, seeds and chemicals from the Bank. As of 1970, wells have been dug in three cooperatives and pumps installed.

Table 2-5. Some characteristics of the cooperatives within the DAP, 1970[a]

Cooperatives[b]	Year of foundation	Status[c] before Land Reform	Map[d]	Cooperative sheep flock[e]	All[f] families in cooperative	Membership in Central[g]	Only[h] sheep activity
Patarani	1967	C	*		*	*	
Collpa-Huancarani	1967	CH		*	*	*	
San Martín de Iquiaca	1968	C				*	
Chiarumani	1967	C				*	
Pomani	1967	C	*			*	
San José de Llangas	1967	C	*	*		*	
Santiago de Collana	1967	C	**			*	
Llojlla	1970	C					
Laguna Blanca	1970	C				*	*
Huayllaroco	1970	C					
Sorasora	1970	H					*
Pujravi	1968	C	*	*		*	
Huaraco	1968	C				*	
Chica Belén	1970	C					
Huanucollo	1967	C	*			*	
Santari-Murmuntani	1967	H	**	*		*	

Tauca Punaya	1967	H				*	
Achaya	1967	H	**	*	*	*	
Quelcata	1965[i]	H				*	
Culli Culli Bajo	1970	H				*	*
Culli Culli Alto	1954[i]	H					*

[a]Source: Records at the Central de Cooperativas in Patacamaya.

[b]Besides the 21 cooperatives listed, there are 2 pre-cooperatives: Vizcachani and Sullcavi.

[c]"C" means that the Community was an independent Community even before the Land Reform. "H" means that the Community was included in an Hacienda (large private landholding) before the Land Reform. Collpa-Huancarani was in part an independent Community and in part an Hacienda.

[d]The three two-starred cooperatives have maps of both the cooperative land (100 ha) and the whole Community. The one-starred cooperatives have a map of the cooperative land alone.

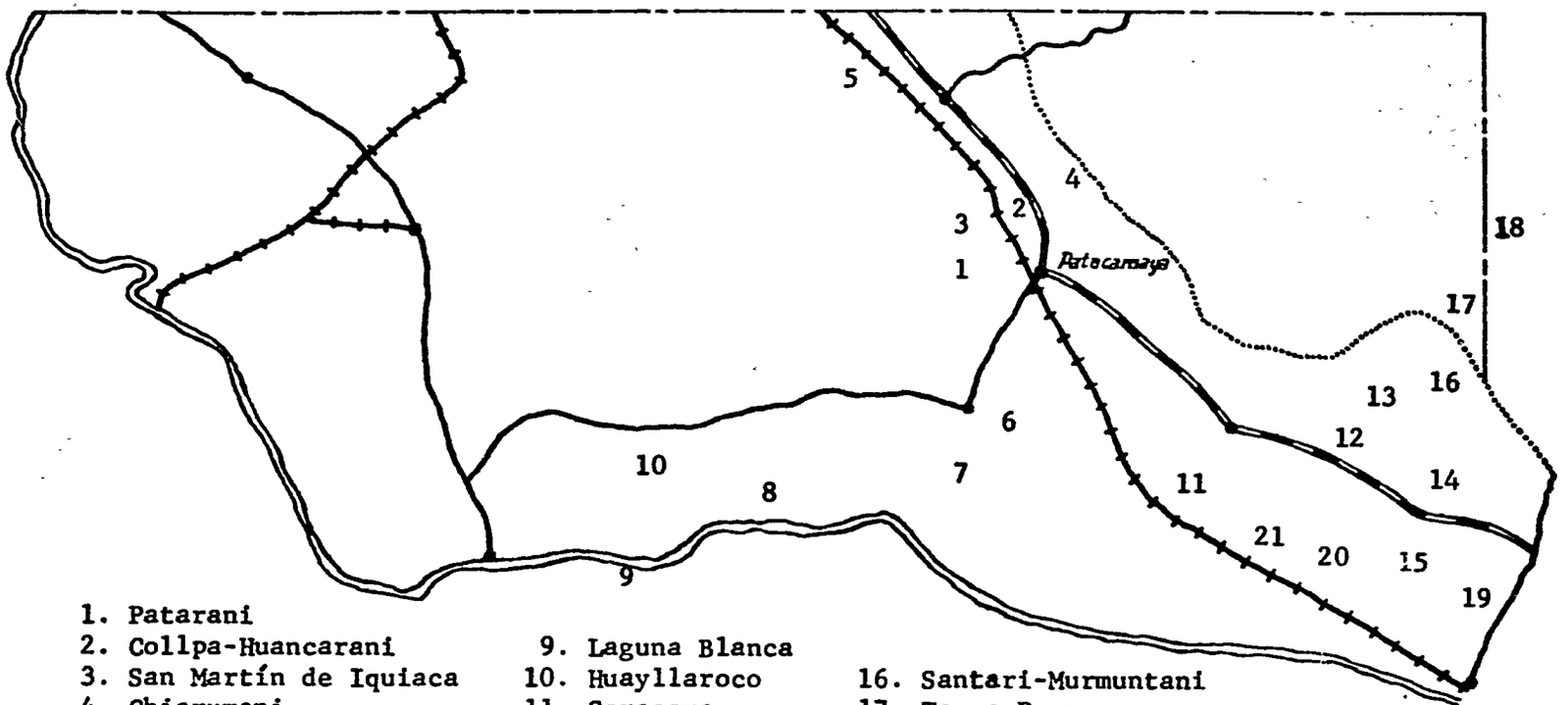
[e]These cooperatives have put in one common flock the sheep given by the members as membership payment when they first join the cooperative (payment is 100 pesos or 2 ewes). This cooperative flock numbers 70 heads in Collpa-Huancarani, 60 in San José, 40 in Pujravi, 60 in Santari-Murmuntani, 120 in Achaya.

[f]The fact that all families belong to the cooperative does not mean that all the activities are cooperative. It only means that all the families take part in some way in whatever cooperative activities are undertaken; these activities are still extra-activities, that is, in addition to those practiced by the individual families.

[g]The cooperatives may join the Central de Cooperativas only when there is a certain assurance of their solvency and continuity.

[h]These cooperatives do not have any cooperative agricultural activity, but only sheep raising. All of them are of recent foundation and will start agricultural activities in the near future.

[i]Although legally founded in that year (before the DAP was established) this cooperative did not function until the beginning of 1970.



1. Patarani
2. Collpa-Huancarani
3. San Martín de Iquiaca
4. Chiarumani
5. Pomani
6. San José de Llangas
7. Santiago de Collana
8. Llojlla
9. Laguna Blanca
10. Huayllaroco
11. Sorasora
12. Pujravi
13. Huaraco
14. Chica Belén
15. Huanucollo
16. Santari-Murmuntani
17. Tauca Punaya
18. Achaya
19. Quelcata
20. Culli Culli Bajo
21. Culli Culli Alto

Map 2-4. Cooperatives in the Development Area of Patacamaya, 1970

Table 2-6. Number of families, area, land/person ratio, and families in the cooperative, in the communities with a cooperative, 1970[a]

Communities	Families in the Community	Area of the[b] Community in ha	Number[c] of persons	Land/person ratio in ha	Families in the[d] cooperative	
					Number	Percent
Patarani	70.	800.	350.	2.286	70.	100.
Collpa-Huancarani	50.	5000.	250.	20.	50.	100.
San Martin de Iquiaca	62.	12000.	310.	38.71	38.	61.
Chiarumani	130.	8000.	650.	12.308	49.	33.
Pomani	140.	11000.	700.	15.714	30.	21.
San José de Llangas	120.	18000.	600.	30.	28.	23.
Santiago de Collana	200.	12000.	1000.	12.	57.	28.
Llojlla	27.	1500.	135.	11.111	22.	81.
Laguna Blanca	80.	20000.	400.	50.	42.	52.
Huayllaroco	40.	2500.	200.	12.5	26.	65.
Sorasora	40.	3000.	200.	15.	12.	30.
Pujravi	400.	32000.	2000.	16.	35.	9.
Huaraco	80.	8000.	400.	20.	40.	50.
Chica Belen	220.	15000.	1100.	13.636	62.	28.

Huanucollo	90.	-[e]	450.	-[e]	44.	49.
Santari-Murmuntani	80.	1500.	400.	3.75	61.	76.
Tauca Punaya	80.	6000.	400.	15.	43.	54.
Achaya	80.	2000.	400.	25.	80.	100.
Quelcata	300.	9200.	1500.	6.133	93.	31.
Culli Culli Bajo	49.	2685.	245.	11.	40.	82.
Culli Culli Alto	67.	9000.	335.	26.866	36.	54.
Total	2405.	179185.	12025.	15.48[f]	958.	40.
Average	114.52	8959.25[f]	572.6		43.71	

[a]Source: Derived from records at the Central de Cooperativas.

[b]These figures are only estimates by the extension personnel in the Area, but they are the best information at the present time. More accurate data from the Agrarian Reform Mobile Teams have not been made available yet by the Comisión Nacional de Reforma Agraria.

[c]The average family has 5 members.

[d]Families in the cooperative as a percent of all families in the Community.

[e]Not available.

[f]Excluding Huanucollo.

The cooperatives at Pujravi and Santiago de Collana have a Consumers' Service, and three other similar services are being planned for groups of cooperatives. Patarani and Pujravi have also started a Housing Service in order to improve living conditions in the Community. Both the Consumers' and the Housing Services have resulted from the cooperatives' own initiative, with no intervention by extension personnel other than technical assistance when solicited.

Soon after the first cooperatives began functioning, it became clear that a central agency was needed which would perform educational and marketing services for the cooperatives. In June 1969, the Central Local de Cooperativas Aroma was officially open in the town of Patacamaya, although it had been operating informally for more than a year. Presently the Central has four areas of activity: (i) Services, which include technical assistance, supervision and consultation, purchasing and distribution of inputs, orientation for new cooperatives, machinery repair, marketing of outputs; (ii) mill for quinua, which produces quinua flour, janckaquipa (instant soup) and bran on a commercial basis, and pasankalla (breakfast cereal) on an experimental basis; (iii) short courses with the cooperation of the Experimental Station; (iv) slaughterhouse for sheep and marketing of quality approved mutton. Much of the management of the Central is still under control of extension personnel, but it is being progressively transfered to the cooperatives themselves.

Because of the year-around necessity of technical assistance, communication of the cooperatives with the Central and with the Experimental Station is very important. Table 2-7 shows that these distances range

Table 2-7. Distances from the cooperatives to the Experimental Station and to the Central de Cooperativas (in km)[a]

Cooperativas	Approximate distance from the Experimental Station	Distance[b] from the Central de Cooperativas
Patarani	10	15
Collpa-Huancarani	8	10
San Martín de Iquiaca	10	15
Chiarumani	13	8
Pomani	30	35
San José de Llangas	22	27
Santiago de Collana	40[c]	45
Llojlla	45	50
Laguna Blanca	50	55
Huayllaroco	40	45
Sorasora	25	20
Pujravi	35	30
Huaraco	40	35
Chica Belén	45	40
Huanucollo	53	48
Santari-Murmuntani	50	45
Tauca Punaya	55	50
Achaya	70	65
Quelcata	70	65
Culli Culli Bajo	35	30
Culli Culli Alto	35	30

[a]Source: Derived from records at the Central de Cooperativas.

[b]Distances estimated by the extension personnel at the Experimental Station. Most of these roads can be considered all-weather roads, although driving is not easy in the rainy season. The only paved road in the Area is the Panamerican Highway that goes through Patacamaya.

[c]All-weather road via Umala. On a dry-season road, via San José, the distance is only 30 km.

from 8 to 70 km, but the figures in that Table are misleading unless one remembers that on many dirt roads the average speed will not be above 30 km per hour. Table 2-8 presents the road work which is deemed essential to a satisfactory communication and transportation for the cooperatives presently established.

Some extension work is also performed by the Experimental Station with the Asociaciones Ganaderas which number 65 at the present time. But it is an unstructured activity with which we are not concerned here.

Throughout this study, the expression "cooperative size" will refer to the number of persons in the cooperative (at 5 persons per family), and the expression "farm size" will refer to the number of hectares of land available to the cooperative. For example, cooperative size 125 will mean a cooperative with 125 persons (25 families), and farm size 500 will mean that the cooperative has 500 ha on which it can operate. Sometimes farm size will be quoted in hectares per person.

In Table 2-9, the 21 Communities are grouped into classes on the basis of number of persons, the class width being chosen so as to approach the normal distribution. This table will be used as the starting point for the procedures of analysis in Chapter III.

The Communities in Table 2-6 were not taken randomly from among all the Communities in the DAP, but they simply are those Communities which have chosen to organize cooperatively, and also they are practically the only Communities for which data are available. A random sample will only

Table 2-8. Projected road work for the cooperatives[a,b]

From	To	Approximate km	Type of work projected
Santiago	Romero Pampa	20	rebuilding
Romero Pampa	Patarani	7	new road
Patarani	Pomani	15	rebuilding
Tauca	Achaya	4	straightening
Exp. Station	Romero Pampa	10	rebuilding
Romero Pampa	Circa	6	rebuilding
Circa	Santiago	15	new road
Carachuyo	San José	18	new road

[a]Source: Derived from records at the Central de Cooperativas.

[b]Road work which, as of June 1970, was considered necessary to allow for a more expedite communication and transportation between the cooperatives and the Central and among the cooperatives themselves. No paving is involved but merely grading and packing.

Table 2-9. Distribution, by number of persons, of Communities with a cooperative[a,b]

Size[c]	Number of communities	Percent
50-200	3	14.29
201-350	5	23.81
351-500	6	18.57
501-750	3	14.29
751-1250	2	9.52
1251-2050	2	9.52
Total	21	100.00

[a]Source: Computed from Table 2-6.

[b]Communities in the DAP which presently have a cooperative.

[c]In number of persons in the community. Age distribution is presented in Tables 4-3 and 4-4.

be possible after the data from the Agrarian Reform Mobile Teams are released. The problems posed by the non-randomness of Table 2-6 if one wants to expand the results of this study to the entire DAP, will be discussed at the end of Chapter VIII.

CHAPTER III. DEVELOPMENT OF THE MODEL AND DATA NEEDS

Basic Considerations

In pursuing the four objectives of this research, certain considerations become crucial, some of them because they are inherent within the nature of the DAP and current developmental efforts, others because they reduce to manageable proportions the problem under study. These considerations involve (1) form of firm organization, (2) land tenure arrangements, (3) period of analysis, (4) levels of mechanization, (5) level of technology, (6) concept of optimality and (7) on-the-farm consumption. A more detailed explanation is now given.

(1) As reported in Chapter II, cooperative organization of production and marketing is one of the pivots of the developmental endeavors in the DAP, and it is therefore taken as an institutional constraint for this research. The main features of this cooperative organization, as it is beginning to function, can be summarized as follows: (a) collective production and marketing are practiced by each firm on the land collectively owned by the Community and on individual parcels pooled by the members, while the small home-plot, if any, is farmed individually, (b) the families in the Community are encouraged but not forced to join the cooperative organization, although it is expected that all the families will eventually join, as already is happening in a few Communities, (c) annual planning decisions on allocation of resources and marketing are taken by the elected board and submitted for approval to the General Assembly,

made up of all members, (d) day-to-day managerial decisions on timing of operations, labor schedules, etc. are made by the member of the board who is in charge of each particular activity, such as livestock, crops, marketing, etc., (e) during the year, members are paid an hourly wage for the labor they contribute to the collective enterprise, (f) at the end of the year, members share in whatever profits the enterprise realizes, (g) special attention is given to applying modern inputs, introducing machinery and drilling of wells for irrigation, all technological innovations being based on the research at the Experimental Station, and (h) extension personnel from the Station, paid by the Ministry of Agriculture, provide technical assistance and monitor the performance of each farm, by means of periodic visits and of the monthly meetings at the Central de Cooperativas with officers from all the cooperatives. The elected officers are not paid a salary at the present time, but, as managerial tasks become more sophisticated, a system of compensation will have to be devised.

The cooperative organization just summarized differs from the cooperative in Northern Europe and North America, mainly in the fact that the latter is typically a marketing and sometimes processing organization, while the cooperative being promoted in the DAP encompasses collective production as well, for reasons given in Chapter II in the section on "Developmental Efforts in the Area". Undoubtedly, the cooperative in the DAP has strong similarities with farm organizations such as the kibbutz in Israel, the proportional-profit farms tested in Puerto Rico, the state

and collective farms in Eastern Europe, etc. Comparing these types of organization would take us beyond the scope of this research, but one peculiarity of the cooperative in the DAP is worth emphasizing: It builds upon collective elements ingrained in the social structure of the Community, and no specific goals or farm plans are dictated by the national or local governments; thus, cooperative organization in the DAP seems to grow, so to speak, from below, from the deep roots of the Community, instead of being planned from above and more or less explicitly imposed.

(2) Certain land tenure arrangements are firmly established as a result of ancient customs and of the recent Land Reform. The Communities are being or will soon be granted collective titles on the lands which, in most cases, they have held for centuries. Renting of land is illegal since the Land Reform, and the few cases in which some land is rented occur between families within the same Community. Thus it appears quite legitimate to assume here that only the whole area owned by the Community is available for cooperative operation. The small home-plots, when existing, are considered non-competing with the cooperative farming.

(3) A one-year period analysis is used in this research. Therefore, no capital accumulation through the years is considered. For those agricultural activities whose physical horizon covers more than one year, like a five-year plantation of alfalfa, the approach is taken of considering one hectare as being in each one of the years involved; for example, in the case of alfalfa, the activity unit will be 5 hectares with one hectare being in the first year, another hectare in the second year, and so on.

(4) Two levels of mechanization are considered in this study, but bullock power is excluded. One reason for this exclusion lies in the high requirement of bullock-time relative to tractor-time in land preparation and planting operations (both operations together require about 60 hours, two bullocks, as compared with 8 to 9 hours of tractor time per hectare). Large numbers of bullocks would be needed, if enough land should be cultivated to rise from a subsistence to a commercial type of agriculture. Besides the huge fixed investment in bullocks, it seems that their "maintenance" cost (feed, drugs, management) would be at least as high as the variable costs of the machinery that can replace them (no cost studies exist, but extensionists at the Experimental Station estimate that feeding a bullock would cost about 1000 pesos a year). Another reason for excluding bullocks is that in bullock-powered operations the human labor requirement is also much higher than when a tractor is used (about 20 times higher in land preparation and 2 to 5 times higher in planting); this could cause labor to become scarce in a bullock-powered agriculture during the land preparation and planting seasons. It is on the basis of these facts that the cooperatives in the DAP turned to mechanization right from the start of their development efforts.

The two levels of mechanization considered in this study are called partial level and full level. Partial mechanization is the level being promoted at the present time in the DAP--it was described in Chapter II as consisting of tractor, plow, harrow, motor-and-pump, sprayer, sorter, wagon and sprinkler (for irrigating quinua). Full mechanization adds the

following: Potato planter, grain drill, cultivator, potato digger, forage harvester, hay rake and hay baler. Presently, partial mechanization is limited to one each of the machines listed above. However, in this study we will consider several degrees of mechanization for both partial and full mechanization; that is, we will allow more than one of each machine if it be profitable. The only piece of machinery which, in any case, will be limited to one is the motor-and-pump: Since so little is known about underground waters in the area, especially the rate of recharge, there is no assurance that more than one well per cooperative is feasible.

(5) The level of technology considered is the one being presently promoted by the extension services based at the Experimental Station. Admittedly, this level has reached only a few cooperatives so far, but in the coming years it should spread to most of the area. It is here, more than anywhere else, that this research is a look into the future rather than a description of the present or an evaluation of the past.

(6) Economic optimality is defined in terms of the highest income per capita, that is, wages paid during the year plus profit shared at the end of the year. Optimal farm size, optimal farm plan or optimal level of mechanization will be those providing the highest income per person in the cooperative. Other criteria of efficiency will also be examined such as productivity, value of output sold and average cost. Productivity of land, labor and capital is defined as the value of output sold divided by the hectares, hours of labor and operating capital used, respectively.

(7) No allowance is made for on-the-farm consumption of part of the output produced. Certainly, such consumption is a fact at the present

time and it will probably exist to some degree in the future; but it is immaterial when trying to determine economic optimality as defined below, since output consumed on the farm has a market value and is, therefore, as much a part of income as if it had been actually sold.

These seven considerations, together with the objectives defined in Chapter I, determine the model to be applied and the procedures by which answers will be obtained to the objectives of this research. Thus, the rest of this chapter deals with the model and procedures of analysis, as well as with data needs.

A Linear Programming Model

Attaining the objectives listed in Chapter I within the framework defined by the seven considerations specified above, becomes a problem that can be satisfactorily handled with the linear programming method; because the problem under study is actually one of optimal allocation of given resources (those in the DAP) among several competing alternatives or processes (agricultural production activities), in order to maximize a certain variable (income per person), subject to certain institutional constraints (cooperative organization, collective land tenure, levels of mechanization).

During the past 10 to 15 years, linear programming has become a widely known technique for agricultural planning at both the micro and macro levels, and to give here a detailed explanation would be redundant. Extended treatments of the method can be seen in Dorfman, Samuelson and

Solow (1958), Heady and Candler (1958), Hadley (1962), Dantzig (1963), Simmonard (1966) and many others.

The maximization form of linear programming is expressed by the following equations:

$$\text{Maximize} \quad C = \sum_{i=1}^{n} c_i x_i \qquad [1]$$

$$\text{subject to} \quad \sum_{i=1}^{n} a_{ji} x_i \leq b_j \qquad [2]$$

$$x_i \geq 0$$

where C = value of the program or solution

x_i = process i (i = 1,...n)

c_i = net contribution to C from process i

b_j = quantity available of resource j (j = 1,...m)

a_i = amount of resource j required for one unit of process i

Equation [1] is the objective function, while equations [2] express the contraints imposed by the given resources as well as the fact that a non-negative amount of each process must enter the maximal solution.

When using linear programming in the context of farm planning, a foremost advantage of the method is the ease with which it can handle the most diverse types of farm organization and management requirements. Such flexibility is achieved by carefully defining the objective function and adequately manipulating the constraints. The objective function always embodies the goal of the farm (optimization of a certain variable), be it an individual or a c lective farm, an autonomous decision-making firm or a firm whose goals are handed down by a central authority. Manipulation

of the constraints makes it possible to incorporate any self- or otherwise-imposed norms, such as lower or upper levels in resource use, in volume of total or specific outputs, etc. The adaptability of linear programming, together with other methods, to the entire spectrum of existing types of farm organization under various economic systems was made apparent by the East-West Seminar on Economic Models and Quantitative Methods for Decisions and Planning in Agriculture, held in the Summer of 1970 in Hungary (Heady 1971a).

When linear programming is applied to farm planning with the goal of maximizing the return to one or more factors of production, the symbols in equations [1] and [2] take on the following interpretations:

C = return to be maximized; in this study, this return is the income to the members of the cooperative, that is, the wage paid during the year plus the residual profit realized at the end of the year.

x_i = agricultural or livestock activities; in farm problems, the activities are often broken down into several subactivities, each one representing a different stage of production and connected among them by means of so-called transfer rows.

c_i = net returns above cash costs from each activity, when activities are broken down into subactivities, some c_i values may be negative (that is, a net cost) or zero.

b_j = given quantities of resources available for the farm operation; these are the resources that are fixed in the period under

consideration (for example, labor, owned land, housing for livestock, etc.).

a_{ij} = input-output coefficients, i.e. the amount of each resource used for one unit of each activity (for example, hours of tractor time needed for plowing).

The particular form of the objective function to be maximized is discussed in the fourth section of this chapter. The x_i activities and the a_{ji} coefficients are contained in Chapter V, the c_i values are computed in Chapter VI, and b_j values are derived in Chapter IV. Chapter VII describes the mechanical process of building the linear programming matrix which constitutes the model.

The last section of this chapter explains how two modalities of linear programming, variable-resource and parametric, will be applied. The solutions obtained should contain the information needed to satisfy the objectives of this research as formulated in Chapter I.

Data Needed and Their Collection

The data needed in this research are those required by the linear programming model. These data needs include:

(i) Resource availabilities and constraints. These are the quantities of land, labor, capital, water and machinery at the farm manager's disposal for allocation among the various possible activities. Land can be owned or rented, labor can be the owners' labor or hired, capital can be owned or borrowed, water can be extracted on the farm or bought outside, machinery can be owned or hired as custom services. Other relevant

constraints, if any, must also be known, such as minimum or maximum limits for certain activities, etc. Data on resources are given in the next chapter.

(ii) Activities or processes and their coefficients. Crop and livestock activities that are technically feasible for the farm must be known. If various levels of fertilization, irrigation, etc. give rise to different yields, those levels must be listed as separate activities, leaving it to the linear programming method to choose among them. The coefficients required are the input-output coefficients included in equation [2]; if the time dimension is involved, the time period to which each coefficient refers must be clearly indicated according to the crop and livestock calendars. All such information is presented in Chapter V.

(iii) Prices, costs and revenues. These are the prices of the inputs, the costs of the various farm operations, the prices of the outputs and the corresponding revenues. These data are shown in Chapter VI.

Data contained in Chapters IV to VI were obtained from the following sources:

1. Research reports or descriptive papers on file at the Library of the Ministry of Agriculture and other governmental offices or made available by the authors themselves. Some of these papers are unpublished.

2. Field-notebooks at the Experimental Station of Patacamaya, and direct collection by the author at the Station and at some cooperatives in the DAP.

3. Records that the Central de Cooperativas in Patacamaya keeps for each cooperative on farm plans, purchase of inputs, production, sales of

outputs, machinery, financial status and general characteristics.

4. Interviews with the research and extension personnel at the Experimental Station and with experts in various fields at the Ministry of Agriculture in La Paz.

The order in which these four sources are listed is the order in which they were used: First, existing data, published and unpublished, were collected; next, these data were augmented with direct observation in the Area; finally, all the data were checked and corrected with persons involved in each specialty.

Thus, this research incorporates the most reliable information that is available at the present time. There is no doubt that some of the data will be improved in the future. We welcome such improvements and can adjust the results accordingly with the aid of the model.

The Objective Function

In a linear programming model for farm planning, the objective function expresses the goal of the enterprise, that is, the variable which the farm managers intend to optimize. Therefore, the objective function must respond to the particular structure of the farm being planning.

Some objective functions exist which have been derived for various kinds of cooperative enterprises.

Objective functions of the type derived by Helmberger and Hoos (1962) and others are not applicable to the cooperative farm in the DAP. They deal with processing and marketing cooperatives only, while in the DAP the cooperative also includes collective production.

The DAP cooperative farm differs as well from those analyzed by Domar (1966), Heady (1971b), Ferenc in his second model, the "family-farm type cooperative" (Ferenc 1971, p. 168) and Vanek in his labor-managed firm (Vanek 1970, p. 20). They assume that cooperative members do not pay themselves a wage, while the members of the DAP cooperative do pay themselves a wage during the year in addition to sharing any residual profit at the end of the year. This kind of double income, wage and shared-profit, was certainly considered by Ward in his pioneering paper on market syndicalism (Ward 1948), and was a feature of the proportional-profit farm in Puerto Rico (Stahl 1966, p. 26); but no formal objective functions that could be used in linear programming were derived in the two cases.

However, the main difference between our cooperative farm and the farms considered by the authors mentioned above lies in the approach to the number of cooperative members or laborers. Those authors treat the number of members (labor suppliers and profit sharers) as a decision variable: The farm will employ (give cooperative membership to) that number of laborers which will maximize the average income per laborer. It is a logical approach, since those authors do not face any institutional constraint of a certain number of laborers that the farm must employ (give cooperative membership to).

On the contrary, the DAP cooperative farm has an institutionally fixed number of families, which are all the families belonging to the community. Therefore, the number of persons in each cooperative (cooperative size)

is a parameter given by the population in the community. It may well happen that not all members will find full-time employment in the cooperative farm, but all of them will share in the residual profit realized at the end of the year, in addition to wages received for any labor contributed to the cooperative. The basis on which the profits will be shared among the members, the question whether some profits will be used in community projects (instead of being distributed) and other administrative decisions do not bear upon the objective function to be chosen; because the relevant goal for the cooperative will still be the maximization of the average income per person, that is, the maximization of wages-plus-profit divided by the number of members in the cooperative, no matter how the resulting profit is distributed or whether all or just part of it is actually distributed.

Exceptions to the income-maximization goal would be those instances, mentioned by Ferenc (1971, p. 143), in which other goals are imposed by the Government, such as maximum aggregate output, highest employment, minimum land for a given output, maximum output for a given resource level, product quotas, etc. The Bolivian economy seems to be shifting rapidly toward a more socialist structure, consisting essentially on state ownership and administration of those industries that are considered crucial for economic development, such as mining, oil, sugar, etc. However, the possibility of the Government dictating specific goals for the agricultural cooperatives seems rather remote, because the Bolivian farmer would view such Government interference as a clear threat to the autonomy he acquired with the Agrarian Reform.

We now discuss the objective function to be used in this study, that is, the specific form of equation [1].

The objective function for a conventional owner-operated profit-maximizing farm is

$$\text{Max } \Pi = \sum_{i=1}^{n} p_i Y_i - \sum_{j=1}^{m} p_j X_j - F \qquad [3]$$

where Π = profit

p_i = prices of final outputs ($i = 1,\ldots n$)

Y_i = final outputs

p_j = prices of variable inputs ($j = 1,\ldots m$)

X_j = variable inputs; X_1 = labor in hours

F = annual fixed costs (machinery, buildings, etc.)

Now, this objective function maximizes profit or return to management (owner), while the objective function of the cooperative farm maximizes income per member.

The specific objective function for the cooperative depends on the concept of income. As stated above, income in the DAP cooperative farm is the addition of wages and profits. The objective function that maximizes such income per person will be

$$\text{Max } \phi = \left[W + \sum_{i=1}^{n} p_i Y_i - \sum_{j=1}^{m} p_j X_j - F \right] M^{-1} \qquad [4]$$

where ϕ = average income per cooperative member

W = wage bill ($=p_1X_1$)

M = number of cooperative members

However, in the DAP cooperatives M is a given parameter for each cooperative. This means that if aggregate income is maximized, income per family and income per person are maximized as well. Therefore, M can be omitted from equation [4], which then becomes

$$\text{Max } \psi = W + \sum_{i=1}^{n} p_i Y_i - \sum_{j=1}^{m} p_j X_j - F \qquad [5]$$

where ψ = aggregate income for the whole cooperative

with the only difference that [4] will be income per person while [5] will be aggregate income. Various optimal solutions for one cooperative (for example, at different degrees of mechanization) can be compared in terms of equations [4] or [5] indifferently; but intercooperative comparisons are meaningful only in terms of equation [4], which maximizes income per person, because M varies for each cooperative size.

The two components of income in equation [5] can be made more explicit by introducing parentheses:

$$\text{Max } \psi = W + \left(\sum_{i=1}^{n} p_i Y_i - \sum_{j=1}^{m} p_j X_j - F \right) \qquad [6]$$

The expression within parentheses is Π in equation [3]. This means that the DAP cooperative farm maximizes the same way an owner-operator does and then divides the residual profit among its members.

When used in linear programming, objective function [6] is no more than objective function [3] with a zero-value for the member-labor-using activity. Such zero-value automatically causes the addition of the wage

bill W to the residual profit Π, as required by equation [6]; it simply obviates the necessity of adding the wage bill to the profit in order to obtain the aggregate income as defined in this study.

The fact that in the DAP cooperatives all the operating capital, including the capital to pay wages, is borrowed imposes a modification on equation [5], which becomes

$$\text{Max } \psi = W + \sum_{i=1}^{n} p_i Y_i - (1+r) \sum_{j=1}^{m} p_j X_j - F \qquad [7]$$

where r = rate of interest at which operating capital is borrowed

Equation [7] is the final version of our objective function.

Given that $W = p_1X_1$, it is legitimate to ask whether our objective function does not imply a zero-wage, since equation [5] could be rewritten as

$$\text{Max } \psi = \sum_{i=1}^{n} p_i Y_i - \sum_{j=2}^{m} p_j X_j - F \qquad [8]$$

Equation [8] does imply a zero-wage and obviously would yield identical solutions as equation [5]. In equation [5] what is subtracted on one hand (p_1X_1) is added on the other ($W = p_1X_1$), while equation [8] simply omits the process of subtracting and adding the same quantity.

Equation [7], however, cannot be considered any more as a zero-wage objective function. The total labor cost is $(1+r)\ p_1X_1$, while the wage bill is only $W = p_1X_1$; that is, each hour of labor has a net cost to the cooperative of r times the hourly wage rate.

We said that, if capital were not borrowed to pay wages, it would not matter whether equation [8] or equation [5] was used. This is true only because M is a parameter and was, therefore, dropped from the objective function. When M is a decision variable, a zero-wage objective function must never be used; Ferenc has shown that this approach may lead to a misallocation of resources and, therefore, to a suboptimal solution (1971, p. 177). He strongly emphasizes that labor be given a price (opportunity cost), profit be maximized and income be shared among the members; it is what he calls the "pure enterprise model" for a cooperative. Functionally, wages become return to the labor input while residual profit can be viewed as return to "collective management" (Ferenc 1971, pp. 161, 178, 180).

In summary, equation [7] will be used as the objective function in our linear programming model. The resulting value of the program will be aggregate income (wage bill plus residual profit). Income per person will then be computed, and it will serve as a basis for comparisons of optimality between solutions for one cooperative and between solutions for different cooperatives.

Procedures to Satisfy the Objectives

In proceeding to satisfy the objectives of this study, the first step will be to develop two linear programming matrices, one for partial and one for full mechanization. The levels of mechanization will be reflected in different input-output coefficients in the two matrices.

As explained earlier, two resources are considered in fixed supply, labor and water. Available labor is only the labor supplied by the members of the cooperative, since there is no possibility of hiring outside labor. Water is fixed at the maximum obtainable from one well with one motor-and-pump. The way land and machinery are allowed to vary is explained below.

The six cooperative sizes (number of persons) to be studied are given by the column headings in Table 3-1. They are the class-midpoints from Table 2-9, and they adequately cover the actual range of Community sizes in the DAP which is between 75 and 2000 persons. The cooperative size enters the matrix through the supply of labor available, one of the b_j values in equation [2], which is obviously a function of the number of persons in the cooperative. Variable-resource programming is the practical way of handling such unequal changes in b_j values.

For each cooperative size a set of solutions will be obtained corresponding to various farm sizes which are assumed to be available to the cooperative. Each of these farm sizes defines a certain ha/person ratio, so that the set of solutions actually will examine a range of ha/person ratios for each cooperative size (remember again that cooperative size is number of persons, while farm size is number of hectares). Equal steps in ha/person ratios will enter the linear programming model as equal changes in one b_j value, which are handled by means of parametric programming.

The farm sizes to be studied parametrically within each cooperative size are listed in the body of Table 3-1. These farm sizes were computed

Table 3-1. Combinations of cooperative size and farm size to be studied with parametric programming[a,b]

Ha per person	Cooperative size[c] 125	275	425	625	1000	1650
2.		550.	850.	1250.	2000.	3300.
2.5		687.5	1062.5	1562.5	2500.	4125.
3.		825.	1275.	1875.	3000.	4950.
3.5		962.5	1487.5	2187.5	3500.	5775.
4.	500.	1100.	1700.	2500.	4000.	6600.
4.5	562.5	1237.5	1912.5	2812.5	4500.	7425.
5	625.	1375.	2125.	3125.	5000.	8250.
5.5	687.5	1512.5	2337.5	3437.5	5500.	9075.
6.	750.	1650.	2550.	3750.	6000.	9900.
6.5	812.5	1787.5	2762.5	4062.5	6500.	10725.
7.	875.	1925.	2975.	4375.	7000.	11550.
7.5	937.5	2062.5	3187.5	4687.5	7500.	12375.
8	1000.	2200.	3400.	5000.	8000.	13200.
8.5	1062.5	2337.5	3612.5	5312.5	8500.	14025.
9.	1125.	2475.	3825.	5625.	9000.	14850.
9.5	1187.5	2612.5	4037.5	5937.5	9500.	15675.
10.	1250.	2750.	4250.	6250.	10000.	16500.
10.5	1312.5	2887.5	4462.5	6562.5	10500.	17325.
11.	1375.	3025.	4675.	6875.	11000.	18150.
11.5	1437.5	3162.5	4887.5	7187.5	11500.	18975.
12.	1500.	3300.	5100.	7500.	12000.	19800.
12.5	1562.5	3437.5	5312.5	7812.5	12500.	20625.

[a]Source: Computed from Table 3-1 and criteria in the text in page 60.

[b]Figures in the body of the Table are the number of ha made available to the cooperative.

[c]Number of persons in the Community.

Table 3-1. (Continued)

Ha per person	Cooperative size[c] 125	275	425	625	1000	1650
13.	1625.	3575.	5525.	8125.	13000.	21450.
13.5	1687.5	3712.5	5737.5	8437.5	13500.	22275.
14.	1750.	3850.	5950.	8750.	14000.	23100.
14.5	1812.5	3987.5	6162.5	9062.5	14500.	23925.
15.	1875.	4125.	6375.	9375.	15000.	24750.
15.5	1937.5	4262.5	6587.5	9687.5	15500.	25575.
16.	2000.	4400.	6800.	10000.	16000.	26400.
16.5	2062.5	4537.5	7012.5	10312.5	16500.	27225.
17.	2125.	4675.	7225.	10625.	17000.	28050.
17.5	2187.5	4812.5	7437.5	10937.5	17500.	28875.
18.	2250.	4950.	7650.	11250.	18000.	29700.
18.5	2312.5	5087.5	7862.5	11562.5	18500.	30350.
19.	2375.	5225.	8075.	11875.	19000.	31350.
19.5	2437.5	5362.5	8287.5	12187.5	19500.	33000.
20.	2500.	5500.	8500.	12500.	20000.	
20.5	2562.5	5637.5	8712.5	12812.5	20500.	
21.	2625.	5775.	8925.	13125.	21000.	
21.5	2687.5	5912.5	9137.5	13437.5	21500.	
22.	2750.	6050.	9350.	13750.	22000.	
22.5	2812.5	6187.5	9562.5	14062.5	22500.	
23.	2875.	6325.	9775.	14375.	23000.	
23.5	2937.5	6462.5	9987.5	14687.5	23500.	
24.	3000.	6600.	10200.	15000.	24000.	
24.5	3062.5	6737.5	10412.5	15312.5	24500.	
25.	3125.	6875.	10625.	15625.	25000.	

on the basis of the following criteria: (i) lower and upper limits of 2 and 25 ha/person respectively, considering that the higher ha/person ratios in Table 2-6 are thought to be rather exceptions, (ii) farm size ranging from 500 to 32000 ha as it is the case in the DAP, (iii) steps of 0.5 in the ha/person ratios to be studied. The parametric routine will be applied starting at the lowest ha/person ratio, and the farm size will be allowed to increase until land becomes a non-limiting resource.

The first (most simple) degree of mechanization, under both partial and full levels, will consist of one piece of each machine entering that level.

The following criteria will be used in proceeding from one degree of mechanization to another and from one cooperative size to the next one:

(i) If machinery is limiting for a certain cooperative size, the same cooperative size will be analyzed with a higher degree of mechanization. That is, another piece of the limiting machine or machines will be introduced, unless the shadow-price was so low that clearly not even the fixed cost of the added machine could be covered (thus actually lowering the value of the program when introducing the new machines). For example, in Table 3-1, if with the first degree of mechanization tractor time is highly limiting (high enough shadow-price) for a cooperative of 125 persons, then this same cooperative size will be also analyzed with a higher degree of mechanization, that is, with an additional second tractor. If tractor was limiting only at, say, 5 ha/person and up, then the analysis with the second tractor will be performed only at 5 ha/person and up. The

same procedure will be followed with other machines. It is clear that the various degrees of mechanization cannot be specified apriori, but will be successively determined by the programming results themselves.

(ii) If labor is limiting at all farm sizes for a given cooperative size, it is meaningful to analyze the next larger cooperative with the same degree of mechanization. For example, in Table 3-1, if with the first degree of mechanization labor is limiting at all farm sizes for cooperative size 125, then cooperative size 275 will be analyzed also with the same degree of mechanization. The reason is that the cooperative size 275 adds a resource (labor) which was limiting at the size 125, thus offering the possibility for a higher value of the program. Of course, this is only true when the shadow-price of labor was higher than the wage to be paid.

(iii) If labor is limiting only above a certain farm size, then it is meaningless to analyze the next larger cooperative with the same degree of mechanization at farm sizes below that one. For example, in Table 3-1, if with the first degree of mechanization labor is limiting for cooperative size 125 at only 11 ha/person and up (i.e. at 1375 ha and up), then cooperative size 275 with the same degree of mechanization will be analyzed only at 5 ha/person and up (i.e. at 1375 ha and up). The reason is that, at farm sizes below 1375 ha cooperative size 275 would only add a resource (labor) which is non-limiting, with no possibility, therefore, to increase the value of the program. The extra 150 persons would only contribute an unusable resource, while they would still share in the profit; that is,

at the same farm size the income per person would decrease as the cooperative size increases, since more persons would share in the same total income. Therefore, the meaningful thing to do in that case is to start analyzing cooperative size 275 only at the next degree of mechanization (according to criterion (i) above).

(iv) If labor is not limiting at any farm size, then it is meaningless to analyze the next larger cooperative size with the same degree of mechanization at any farm size. For example, in Table 3-1, if with the first degree of mechanization labor is non-limiting for cooperative size 125 at any farm size, then no other cooperative size will be analyzed with that degree of mechanization. Analysis of cooperative size 275 will begin with the next degree of mechanization (according to criterion (i) above).

No other criterion is needed for the case in which water becomes a limiting resource; because, on the one hand, the supply of water is considered as given in a fixed amount by the one existing well and, on the other hand, the other resources can still be used in crop activities without irrigation.

Obviously, before the analysis is actually carried out, there is no way to know how many solutions will have to be obtained for each cooperative size or for each degree of mechanization. Each solution may or may not call for other solutions.

It is true that by using integer programming on all farm machinery an absolutely optimal solution for each cooperative size would be directly obtained; that is, the optimal degree of mechanization would be simultaneously decided, and there would be no need for going through the tedious

and expensive process of obtaining multiple solutions by applying the four criteria above. However, the analysis with integer programming would not supply any information on the optimal path for progressive mechanization. Integer programming would jump directly to the optimal degree of mechanization, but would say nothing about the steps to be taken in order to reach that optimal degree starting from the most simple mechanization. As explained above, this information seems important in the Area of Patacamaya.

Using the results of the linear programming solutions obtained by applying the five criteria above, the objectives established in the first chapter will be approached in the following manner:

First objective. Tables will be constructed showing the maximum income per person that can be obtained by each cooperative size in Table 3-1, at various degrees of mechanization, for the whole range of ha/person ratios. For each cooperative size the highest figure will be selected, which will indicate the optimal ha/person ratio (optimal farm size) and the optimal level and degree of mechanization.

As additional information, Tables will be constructed in the same manner for other measures of efficiency, although the income per person will be the number one criterion of economic optimality, as explained earlier in this chapter.

Inspection of the Tables on income per person will also uncover the path to be followed for progressive mechanization up to the optimal degree.

The same Tables will point out the opportunity cost, in terms of income foregone, incurred by each cooperative size for having a farm size

below the optimal one. A farm size larger than optimal imposes no opportunity cost, since at the present time no expenses are associated with owning farm land. If any day some expenses come into being (such as land tax or mandatory conservation practices), then having a farm larger than optimal will certainly carry an opportunity cost.

Second objective. The quantities of land, labor, capital and water used will be taken from the optimal solutions. By inspecting the various sets of solutions for all the cooperatives, it will be possible to identify any existing patterns of seasonal or overall scarcity of resources.

Third objective. Farm plans and levels of output will be shown for the optimal solutions.

Any observable patterns in activities entering the program or in the shadow-prices of those activities not entering the program may give leads about fields on which research and extension should concentrate.

Fourth objective. Recent information is available on productive performance of two Communities in the Area: Antipampa with 396 persons, and Culli Culli Bajo with 245 persons. Culli Culli Bajo has already begun to organize cooperatively, as shown in Table 2-5. Present income per person, output and other values in the two communities will be compared with the corresponding values in the optimal solutions for the same or the nearest cooperative size.

Before closing this chapter, some remarks seem pertinent on the process of mechanization contained in the model. These remarks deal with the effects that mechanization is likely to have on the level of employment

and on the income shares going to the various factors as return or payment for their services:

(i) It is generally assumed that mechanization of agriculture will reduce the level of employment, since it embodies a substitution of capital for labor. This is certainly true if the level of production remains unchanged, because when using more capital to obtain the same output, less labor will be needed (in terms of economic theory, it is just a movement along the same isoquant). However, if the previous level of production was being determined by a resource bottleneck in a certain time period, the opposite may be true. For example, assume that in a non-mechanized agriculture the quantity of land cultivated is limited by the labor or the bullock-time available during the months of land preparation and planting. In that case, it may well happen that the introduction of machinery in those months remove the bottleneck, so that more land can then be cultivated; farm operations on the additional land during the rest of the year may bring about higher employment on an all-year basis, although employment may have decreased in the months of land preparation and planting.

Such seems to be the case in the DAP, as outlined in consideration 4 at the beginning of this chapter. Therefore, it can be expected that the introduction of machinery in the DAP will increase the level of employment, as compared with the bullock-powered agriculture prevalent at the present time. Once this transition to an elementary mechanization has been accomplished, further advances in mechanization may or may not reduce the level

of employment; it all depends on whether higher degrees of mechanization still remove bottlenecks with the result of attracting more labor on an all-year basis than the labor replaced by the additional machinery. The relative use of labor (in percent of total labor available) for each combination of cooperative size, farm size and degree of mechanization will be among the results of this study.

(ii) A legitimate concern about substitution of capital for labor in agriculture is that it will reduce the share of income going to the farm labor sector as payment for its productive services; in underdeveloped countries, this may cause further deterioration of living conditions for an already impoverished sector of society. If mechanization does lower the level of employment, the return to the labor sector will, obviously, be lower both in absolute terms (wage bill) and in relative terms (as a share of the income generated). In those cases in which mechanization raises the level of employment, return to labor in absolute terms (wage bill) will be higher; but it will most probably be lower as a share of income generated, because the return (interest) to the much greater amount of capital used now will claim a larger share of income than before. The return to management (residual profit) will be higher in absolute terms, if mechanization is profitable at all, since residual profit is the variable being maximized in the objective function; it may also be higher as a share of the income generated, although this cannot be known a priori. Return imputed to land in the owner-operated farm would be the opportunity cost of the land's use, that is, the rent it would provide if it were

rented out instead of cultivated by the owner; mechanization may raise that implicit rental value of the land, if it raises its productive capacity. In the standard maximization models for an owner-operated farm, implicit return to land is lumped together with return to management and they constitute the residual profit being maximized.

In the DAP cooperative, the concern over income shares claimed by the various factors becomes immaterial. As explained at length in this chapter, all returns but the interest to be paid for borrowed capital accrue to the same individuals, the members of the cooperative; in other words, only interest on borrowed capital leaves the cooperative, while the rest of the income generated is available for distribution among the members. Of course, that income can still be viewed as being made up of three components, return to labor, return to land and return to management (and return to any capital owned by the cooperative, which is non-existent in this study); but the crucial point is that the relative magnitude of these three components is irrelevant, provided that their total is the maximum achievable. That total, under the name of income, is what is maximized in the objective function used in this study.

CHAPTER IV. RESOURCE AVAILABILITIES AND CONSTRAINTS

Land

As explained in the previous chapter, under the section on Procedures, the quantity of land (farm size) made available to each cooperative will be increased parametrically in the linear programming model, in order to study a whole range of hectares per person values for each cooperative size.

No complete soil map exists for the DAP, but only four major soil studies and a spot-sampling analysis of the arable soil layer in nine cooperatives. Although land throughout the DAP is fairly homogeneous, its composition by classes still depends on location within the Area. However, for lack of detailed information, this research assumes that the land composition by classes derived from those four soil studies is applicable to the entire DAP. This assumption should be removed in further research, once detailed soil maps are available.

Table 4-1 presents the results of the four major soil studies, whose geographical location can be seen in Map 4-1. Another soil study was done in San José de Llangas in 1967, but no records of it could be found.

The data in Table 4-1 follow the classification criteria developed in the Land Capability Classification of the USDA Soil Conservation Service, first introduced in Bolivia by L. Arce (1960) and now used, with some adaptations, by the Soils Division of the Ministry of Agriculture (Sainz 1968).

Table 4-1. Soil studies in the DAP[a]

Soil classes[b] and subclasses	Soil studies (in ha)[c] Vizcachani[d] 1943	Exp. Station 1959	Ayo-Ayo 1962	French Mission 1967	Total Ha[e]	%[f]
II	1460.6	419.54	120.3	5300.	7300.44	9.28
e			16.5	5300.	5316.5	8.45
s		419.54	5.6		425.14	0.67
es			98.2		98.2	0.16
III	2036.9	463.72	87.7	1550.	4138.32	5.26
e		30.7			30.7	0.08
s		433.02			433.02	1.08
es			87.7	1550.	1637.7	4.1
IV		17.64	227.4	26200.	26445.04	33.61
e				950.	950.	1.21
s		17.64		22150.	22167.64	28.17
es			227.4	3100.	3327.4	4.23
V	1664.4		77.1	16650.	18391.5	23.37
s				16650.	16650.	23.26
es			46.2		46.2	0.06
ews			30.9		30.9	0.05
VI				2950.	2950.	3.75
es				2950.	2950.	3.75
VII				8550.	8550.	10.87
s				4950.	4950.	6.29
es				3600.	3600.	4.58
VIII	915.3		37.	9950.	10902.3	13.86
s			16.1	9950.	9966.1	13.83
es			20.9		20.9	0.03
Total	6077.2	900.9	594.5	71150.	78677.6	100.

[a]Sources: Vizchachani data are from Espinoza 1943; Exp. Station data are from Macías, Mendoza and Baptista 1959; Ayo-Ayo data are from Mendoza and Flores 1962; French Mission data are from Misión Francesa para el Desarrollo del Altiplano 1967.

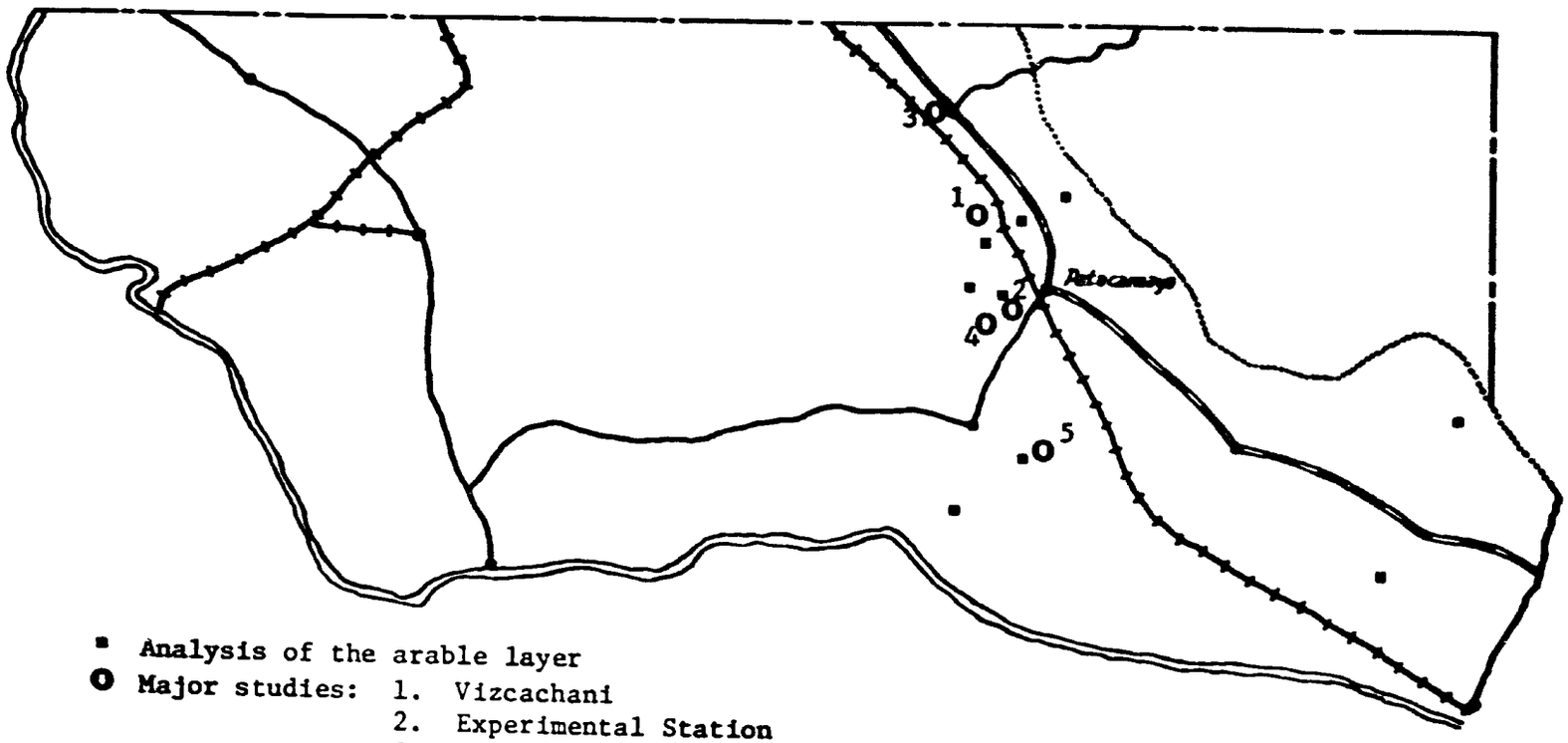
[b]As used by the USDA Soil Conservation Service. The subclasses give the reason for assigning the soil to a particular class: e means danger of erosion, w means wetness, flooding, deficient drainage, s means soil conditions, c means climatic conditions. No c subclasses have been specified here, because the entire Altiplano is actually under climatic limitations.

[c]Below the name of each study, the year is indicated in which the study was made. Only the 1959 study of the area where the Experimental Station was to be established and the 1962 Ayo-Ayo study used the USDA soils classification system. Conversion to this system for the other studies was done in consultation with knowledgeables of the soils in the DAP.

[d]No subclasses are considered in the Vizcachani study nor any other categories that can be converted into subclasses.

[e]Some class totals are higher than the sum of the subclasses, because the Vizcachani study has no subclasses.

[f]The percentages for the class totals are on the basis of all four studies. The percentages for the subclasses have been corrected for the absence of subclasses in the Vizcachani study.



▪ Analysis of the arable layer

O Major studies:
1. Vizcachani
2. Experimental Station
3. Ayo-Ayo
4. French Mission
5. San José de Llangas

Map 4-1. Soil studies in the Development Area of Patacamaya

In 1969, an analysis of the arable soil layer was made at the Experimental Station and on the land used by eight cooperatives: Chiarumani, Patarani, Collpa-Huancarani, San José de Llangas, Santiago de Collana, Huanucollo, Santari-Murmuntani and San Martín de Iquiaca (Quiroga 1969). Their location is also shown in Map 4-1. The information from that study can not be aggregated with the data in Table 4-1, because the study did not cover any large area but was only a spot-sampling. However, it supplied knowledge of the chemistry of the soil which was valuable for deciding the type of fertilizer to be applied. Soils are in general moderately acid (pH 5.3 to 5.9) and low in organic matter (below 2%). Content of available phosphorus is from low to moderate (up to 20 ppm) and that of potassium from moderate to high (above 78 ppm). Little or no process of salinization or alkalinization is present, except where the soil is clearly saline and, therefore, practically useless for agriculture in the near future. Nitrogen is typically very scarce all over the Area.

The studies in Table 4-1 cover only 13.4% of the total area in the DAP, and are all located in the eastern half of the Area. However, the soils in the DAP are fairly homogeneous so that, until more information is available, data in Table 4-1 can be extended to the whole Area. Thus, Table 4-2 presents the land classification which will be used in the linear programming model; each hectare of land made available to the cooperatives by means of parametric programming will have the percentual composition shown in that Table. The specific agricultural activities for which each land class is suited will be examined in Chapter V. No possibility of renting land is included.

Table 4-2. Percent composition of land, by classes[a]

Land classes[b]	Corresponding[c] official classes	Percent
Land 1	II	9
Land 2	III	5
Land 3	IV	34
Land 4	V	23
Land 5	VI	4
Land 6	VII-VIII	25
Total		100

[a]Source: Computed from Table 4-1.

[b]Classes 1, 2 and 3 can be assigned to various rotations; classes 4 and 5 are only appropriate for permanent pastures; class 6 is wasteland and space for roads, buildings, etc.

[c]Classes in Table 4-1.

Labor

Families in the cooperative supply all the labor for farming. The total labor available to the cooperative is, therefore, a function of population age distribution, the efficiency coefficients of the various age groups and the numbers of hours worked per day.

Table 4-3 contains the existing information about relative size of age groups in Communities of the DAP. Since the demographic structure of the Communities of the Area is quite homogeneous, that information is

Table 4-3. Age groups in three Communities of the DAP (in percent)[a]

Age[b]	Patarani	Antipampa	Culli Culli Bajo	Average[c]
0 - 9	33.6	25.51	32.11	30.41
10 - 14	13.4	14.39	12.6	13.46
15 - 19	7.9	11.89	13.01	10.93
20 - 59	38.9	39.9	37.81	38.87
60 or more	6.2	8.33	4.47	6.33
Total	100.	100.	100.	100.

[a]Sources: Figures for Patarani are from Curso Nacional de Planificacion de Proyectos a Nivel de Finca 1968; figures for the other two Communities are from DeLucca 1969b.

[b]The distribution by sex is about 50% male and 50% female.

[c]When these percentages had been already built into the linear programming model (see Table 4-4), results from a 1967 census in the DAP became known to the author (Bolivia 1967a, Table 1). Percentages by age groups in that census do not differ by more than 0.1% from the average percentages shown in this Table; including them in this Table would not make any significant difference.

assumed to be representative of the entire DAP and, therefore, it is used to determine the labor available to the cooperatives in general as a function of their size (number of persons). Table 4-4 presents the number of hours per workday available to a cooperative size 100, that is, the labor supplied by 20 families (100 persons), after efficiency coefficients are applied to account for differences in productivity due to age and sex. The efficiency coefficients are a combination of those used by M. Burke

in his study of farms around Lake Titikaka (Burke 1967, p. 60) and those used by a 1968 planning report for the Patarani and Chiarumani Communities (Curso Nacional de Planificación de Proyectos a Nivel de Finca 1968, p. 9).

Table 4-4. Age group percentages, efficiency coefficients and agricultural labor availability[a]

Age groups	Percent[b]	Efficiency coefficients	Agricultural labor available[c] in hours/100 persons/workday Nov.,Dec.,Jan.	other months
Male and female below 10 years	30.	0.	0.	0.
Male and female between 10 and 14 years	14.	0.5[d]	53.2	10.64
Male between 15 and 59 years	23.	1.	174.8	174.8
Female between 15 and 59 years	23.	0.8	141.74	141.74
Male and female above 59 years	4.	0.4	12.16	12.16
Total	94.[e]		381.9	339.34

[a]Sources: Percents are from Table 4-4; efficiency coefficients are computed from Burke 1967, p. 60 and Curso Nacional de Planificación de Proyectos a Nivel de Finca 1968, p. 9.

[b]The distribution by sex is 50% males and 50% females.

[c]Eight hours per day, minus 5% to account for unforeseen losses.

[d]In December, January, and February, when school is out. During the rest of the year the coefficient is 0.1.

[e]Less than 100%, because 4% of the persons between 15 and 59 years of age and 2% of those above 59 years are left free for non-agricultural occupations.

During the months of slack labor needs for agriculture, many farmers migrate to small towns or urban centers. They take there whatever odd jobs they can secure within the prevalent situation of underemployment, such as porters, street sweepers, musicians, petty traders, etc. For these seasonal migrants, wages and tips ar w and living conditions are very deficient. For the purposes of this study, it is assumed that the seasonal migration does not reduce the labor supply to the cooperatives. This assumption is based on two facts: (i) Historically, seasonal migration is considered by the farmers as the route to be taken only when there is no labor on the farm, and (ii) the tensions brought on these laborers by deficient living conditions and social conflicts are such that seasonal migration never appears as competing with farm labor in their Communities, if available.

From the data in Table 4-4, labor supply by time periods is computed in Table 4-5. The time periods are strictly patterned after the calendars of agricultural and livestock activities in the DAP (see Figures 5-1 to 5-4). This yields 24 half-month periods, 12 whole-month periods, and 7 other periods. Half-month periods correspond to the operations that must be performed within a certain half-month; whole-month periods are for operations that must be executed some time during the month; the other periods reflect operations that must be undertaken some time during the specified dates, for example, the second half of July and the month of August (period July2-August). The reason for breaking down the year in such detail is one of realism. It is a well known fact that in the DAP

Table 4-5. Agricultural labor available, by time periods[a]

Time period[b]	Number of[c] workdays	Labor supplied[d] by 100 persons, in hours
July 1	13	4411.42
July 2	14	4750.76
July	27	9162.18
August 1	12	4072.08
August 2	14	4750.76
August	26	8822.84
September 1	13	4411.42
September 2	13	4411.42
September	26	8822.84
October 1	13	4411.42
October 2	13	4411.42
October	26	8822.84
November 1	13	4964.7
November 2	13	4964.7
November	26	9929.4
December 1	13	4964.7
December 2	14	5346.6
December	27	10311.3
January 1	13	4964.7
January 2	13	4964.7
January	26	9929.4
February 1	12	4072.08
February 2	12	4072.08
February	24	8144.16
March 1	13	4411.42
March 2	14	4750.76
March	27	9162.18
April 1	13	4411.42
April 2	13	4411.42
April	26	8822.84
May 1	13	4411.42
May 2	13	4411.42
May	26	8822.84
June 1	13	4411.42
June 2	13	4411.42
June	26	8822.84
February-March	51	17306.34
May-June	52	17645.68
June 2 - July 1	26	8822.84
June 2 - August	66	22396.44
July 2 - August 1	26	8822.84
July 2 - August	40	13573.6
August 2 - Sept. 1	27	9162.18
Total year	313	109575.66

[a]Source: Computed from Table 4-4.

[b]Number 1 or 2 after the name of the month stands for first or second half. June 2 - July 1 means the period comprising the second half of July and the first half of August, the other periods being defined in the same way.

[c]In months with an even number of days each half-month has the same number of days (14 in February, 15 otherwise); in the other months the first half-month has 15 days and the second half-month has 16 days. The 1971 distribution of Sundays is used.

[d]On the basis of these figures the labor available to each cooperative size in Table 3-1 will be computed. It is not done here because it will be done automatically by the computer through transfer rows in the linear programming matrix.

there is an excess of labor on a year-around basis, but that in some peak seasons labor may become a limiting factor. Unless the time periods for the labor supply are small enough, the seasonal scarcity of labor may easily go undetected and may lead to farm plans which will be actually infeasible if put into practice due to labor shortages.

It is realistic to assume that no labor can be hired by the cooperatives, at least in the near future. First, because the labor peak seasons are common to all farms in the Area; and, second, because of customary autonomy of the Communities.

Presently, one or two young men in each cooperative are trained to operate farm machinery and do some mechanical work. Any number of them could be trained in the future, as required by the specific degrees of mechanization. Therefore, operator's labor (i.e. labor for operating machinery) is assumed to be a non-limiting resource, that is, available in any amount that may be needed.

Capital

Since saving by farmers in the DAP is practically nil, the only significant source of capital funds, at interest rates that can be afforded, is the Agricultural Bank of Bolivia, headquartered in La Paz.

Unlike most of the other Government agencies, the Agricultural Bank is extremely reluctant to supply any data on its operations, and quite suspicious of anybody who tries to study in some detail its policies or its performance.

As indicated earlier, the Agricultural Bank extends no direct individual loans to small farmers in the Altiplano, although the Bank does not prevent the borrowing group from spreading the loan among its individual members. All the information that could be obtained about group loans in the DAP is summarized in Table 4-6. The Aroma province, covered in that Table, does not coincide with the DAP, but Bank officials agree that the Table gives an accurate picture of the capital funds made available by the Bank in the DAP from 1966 to 1969. Out of the 38 loans extended in that period 76% were for crop activities, 5% were for livestock and the rest were for joint crop and livestock enterprises. The loans of working capital for crops have a term of 2 years, those for livestock have a term of 4 years and those for farm machinery have a term of 5 years; however, the repayment periods are easily estended by the Bank in case of meager crops or other unfavorable circumstances. No information could be secured on how many loans have been repaid, or on outstanding debts or delinquent payments.

The three "lines" of credit in Table 4-6 correspond to the various sources of financing available to the Bank. Line 35-SF/BO is financed by a master loan from the Inter-American Bank for Development, line AID-028 is funded through the U.S. Agency for International Development, and the regular BAB line is from the Bank's own funds. Most working capital loans are made from line 35-SF/BO at an official 6% annual rate of interest, which, according to Bank personnel, easily becomes 8% once service charges have been added. The other operating loans are from the regular BAB line at a 12% annual rate.

Table 4-6. Group loans by the Agricultural Bank of Bolivia, in the Province of Aroma, Department of La Paz, 1966-1969[a]

	Lines of credit[b]			Total	Average per year
	35-SF/BO	AID-028	Regular BAB		
Annual rate of interest %	6.	12.	12.		
Number of group loans	25.	10.	3.	38.	9.5
Total number of group members	1043.	454.	87.	1584.	
Total amount of loans in pesos	3256462.	1417569.	226675.	4900706.	1225176.5
Percent	66.	29.	6.	100.	
Average loan, in pesos	130258.48	141756.9	75558.33	128965.94	
Largest loan, in pesos	239340.	168000.	107475.	239340.	
Smallest loan, in pesos	39630.	81369.	58000.	58000.	
Average number of members per group	41.72	45.4	29.	41.68	
Average amount loaned per member, in pesos	3122.21	3122.4	2605.46	3093.88	
Number of loans by activity intended:[c]					
Crops	23.	2.	3.	28.	7.
Livestock	2.			2.	0.5
Both		8.		8.	2.

[a]Source: Computed from letter DCP/14/70 from the Bank to the author.

[b]See explanation in the text, page 80.

[c]Loan term is 2 years for crop loans, 4 years for livestock loans, 5 years for machinery loans.

Loans from the AID-028 line, at a 12% annual rate of interest, are ɜ only loans available for purchasing farm machinery. These loans have l11 the requirement attached that no foreign goods can be bought if ɜy are more than 10% non-U.S. made. On a world-wide basis, it is esti-:ed that such procurement requirement reduces the value of the loan to ɜ borrowing countries by at least 15% (Thorbecke and Timmons 1970, p. 3); ɜ figure for the DAP is not known, but it is probably between 10% and 20%. ɜn the cooperatives in the DAP started to mechanize, Massey-Ferguson ɜ their first choice for a tractor; but they were not allowed to purchase ; Although built in the United States, the tractor had an English-made :kins engine, which, a competitor was able to prove, represented 30% of ɜ tractor value. At stake was an order for twelve tractors.

Officially there is no upper limit for group loans from the Agricul-:al Bank. Some extension agents share the belief that, in practice, ɜre is a tacitly set maximum limit of 250 to 300 dollars (3000 to 3600 ɜos) per member in the borrowing group. This belief could receive some ɔport from the figures, in Table 4-6, on average amount loaned per ɜber.

Based on the preceding description, the supply of capital is approached the following manner in this study:

(i) All capital for farming has to be borrowed.

(ii) The Agricultural Bank is the only lending agency for the DAP, :h no limit to the amount the cooperatives may borrow either for operat-ɜ the farm or for buying machinery.

(iii) The rate of interest is 8% on loans for operating capital, and 12% on loans for purchasing machinery.

(iv) An operating loan must be repaid in full, principal and interest, at the end of each agricultural year. The loan is a variable cost.

(v) That part of a machinery loan to be paid each year, principal and interest, is a fixed cost. It is computed in Chapter VI using standard formulas.

(vi) It is recognized that future research should study the impact on optimal farm plans of changing interest rates. To this effect, when developing the linear programming matrices, the rate of interest on working capital will be treated in such a manner that only one coefficient will need to be changed in order to study parametrically the impact of alternative interest rates.

Water

As explained in Chapter III, water for irrigation in the cooperatives will be provided by a well with motor and pump.

A Deutz motor and a Palmero pump are used, whose characteristics are given in Chapter VI. The maximum pumping capacity is 65 liters per second. With a time loss of 5% for maintenance and repairs, 100 m^3 require 0.45 hours of pumping time. A reservoir is assumed to exist, as it is presently the case at the Experimental Station, which allows around the clock pumping for daytime irrigation. No intermonth transfers of water are considered, because long periods of storage would necessitate taking into account evaporation and other losses about which no research has been made.

Thus, Table 4-7 presents the monthly supply of water available to the cooperative from the well. It is water available at the well site; travel and field losses will be built into the water requirements for each crop.

Table 4-7. Water available from one well, by months

	Monthly supply[a]	
	m^e	Sheet in mm/ha
July	165391.2	16539.12
August	165391.2	16539.12
September	160056.	16005.6
October	165391.2	16539.12
November	160056.	16005.6
December	165391.2	16539.12
January	165391.2	16539.12
February	149385.6	14938.56
March	165391.2	16539.12
April	160056.	16005.6
May	165391.	16539.1
June	160056.	16005.6
	1947348.	194734.8

[a]On the basis of 65 liters per second, with a time loss of 5%.

Machinery

The kinds of machinery available were listed in Chapter III for both the partial and full levels of mechanization.

Farm machinery enters the model under the form of machine time available in the various time periods. As with labor above, the time periods for machinery follow strictly the agricultural calendar. Thus, the following number of time periods is defined: 23 periods for tractor, 11 for plow, 8 for harrow, 7 for potato planter, 7 for grain drill, 7 for cultivator, 4 for sprayer, 2 for forage harvester, 3 for hay rake, 3 for hay baler, 1 for potato digger, 8 for wagon, 1 for sorter and 2 for sprinkler. The specific time periods for each machine are listed in Table G-1.

Worktime losses for travel to and from the fields and for repair and maintenance are built into the coefficients for each operation in which the machine is used. Therefore, the machine time available in each period is computed on the basis of eight hours per workday. Table 4-8 is constructed in that manner; the values shown there will be used in the linear programming model.

Table 4-8. Machine time available, by time periods (in hours)

Time period[a]	Machine[b] time	Time period[a]	Machine[b] time
July 1	104	March 1	104
July 2	112	March 2	112
July	216	March	216
August 1	96	April 1	104
August 2	112	April 2	104
August	208	April	208
September 1	104	May 1	104
September 2	104	May 2	104
September	208	May	208
October 1	104	June 1	104
October 2	104	June 2	104
October	208	June	208
November 1	104		
November 2	104	February-March	408
November	208	May-June	416
December 1	104	June 2 - July 1	208
December 2	112	June 2 - August	528
December	216	July 2 - August 1	208
January 1	104	July 2 - August	320
January 2	104	August 2 - Sept. 1	216
January	208	Total year	2504
February 1	96		
February 2	96		
February	192		

[a]See note a in Table 4-5.

[b]For one piece of machinery. Motor-and-pump are excluded, because their time is embodied in the water availability given in Table 4-7.

CHAPTER V. PROGRAM ACTIVITIES AND THEIR COEFFICIENTS

Crop Activities

The crops included in this study are: bitter potato, quinua, broad beans, barley, alfalfa and weeping lovegrass.

Bitter potato is a highly frost-resistant type of potato (Solanum andigenum Luki) which grows in the Andean regions of South America. It is fit for human consumption only in the form of freeze-dried chuño, obtained by a centuries-old process of trampling and drying the potatoes during alternate freezing and thawing, a sequence made possible by the cold nights and hot days of July and August. The final product is hard as a rock and can be easily stored for as much as five years; historically, storing chuño has been a protection against meager crops and low seasonal prices. Until recently chuño was sold unsorted, mostly to middlemen. In 1970, the Central de Cooperativas started marketing two classes of chuño by size, plus a third class of groung chuño (jarhui) which is widely used for soups. Although no studies exist, it is the belief of extension personnel that there is a growing market for good quality chuño in La Paz, Oruro, the mines and the subtropical areas recently settled by farmers from the Altiplano.

Since its early years, the Experimental Station of Patacamaya has been successful in increasing the yield and the resistance to frost of bitter potato, mainly through the research efforts of S. Alandia, H. Gandarillas and T. Monasterios (Gandarillas 1969; Monasterios 1967). As a result, the four varieties Pala, Sacampa, Runa and Luki are presently

made available to the cooperatives, all four with similar results. In growing bitter potato, the only operation that cannot be possibly mechanized at the present time is the making of chuño; it is a unique manual process for which no machinery has been invented so far.

Common Irish potato can also be grown in the DAP, but it is excludei from this study for two reasons. First, because in most years its yield is virtually wiped out by frosts; second, because other regions of Bolivia (Cochabamba, Chuquisaca and Tarija) have a clear economic advantage in its production (Faison 1967a, p. 67).

Quinua (Chenopodium quinoae) is the second most important crop in the DAP. A cereal with high-quality protein, quinua grows only in the highlands of Bolivia, Perú, Ecuador and Columbia, and is very resistant to frost and drought. It has been a staple food in the Altiplano since the days of the Inca Empire, and is still part of a wide array of dishes in both the urban and rural areas.

It is estimated that there is a potential market for at least eight times the present production of quinua (some twelve thousand tons) because of the multiplicity of its uses (Gandarillas 1968a, p. 1). For human consumption it can be mixed with wheat flour for bakery products, used in many prized dishes and processed into breakfast cereal; its use in feeding sheep, hogs and poultry is still under experimentation but appears to be promising (Camargo, Montaño and Pou 1970). Research by H. Gandarillas at the Experimental Station has isolated the White Sweet variety of quinua now being distributed for seed by the Station; it is the best tasting

variety and the one with the lowest content of saponine among all the varieties of quinua collected so far (Gandarillas 1968b, pp. 16-51).

Traditionally, quinua was sold only as unpolished grain, leaving it to the housewife to process it into flour and other derivatives. Since 1969, the mill operated by the Central de Cooperativas in Patacamaya is marketing quinua as polished grain (for soups and other dishes), as flour (for pastries) and as janckaquipa (for instant soups); bran, a byproduct of milling, cannot be used yet for feed because its nutritional content is unknown.

The experience accumulated so far in La Paz suggests that there is an ample urban market for quinua products if their prices are competitive with the prices of other cereals, wheat flour, etc. (Pou and Waterman, 1970).

Broad beans (Vicia faba) are commonly grown in the DAP and picked either green or dry. The varieties Uchuculu, Francesa and Copacabana have given the best results so far.

Barley has been traditionally grown for grain and for hay, although the yields in grain are often drastically reduced by frost; also, other regions with milder climate, like the Cochabamba valley, have a clear advantage in barley for grain. Therefore, in this study harvesting for grain is excluded and barley is allowed to be harvested only for forage, either as silage or as hay. The variety Bolivia is currently recommended in the DAP.

Alfalfa Ranger and Vernal have emerged from various experiments as the best suited varieties for the Area (Braun 1964; Gandarillas, Durán,

Ríos and Barja 1965; Allred 1969; Estación Experimental de Patacamaya 1970). A five-year alfalfa plantation is considered. Alfalfa can be cut for silage or hay, or it can be pastured in certain months of the year.

Weeping lovegrass (Eragrostis curvula) has given the best results as a green cover for lands of inferior quality, unsuited for any other crop. It is highly resistant to frost and drought, and helps in the slow recovery of eroded and poor soils. Weeping lovegrass is not cut but only pastured, and has a duration of five years.

Besides the six crops mentioned, others are being experimented upon at the Experimental Station, such as gladiola, vegetables and some varieties of trees. They are not included in this study because no conclusions have been reached so far. Other minor native crops (such as oka, izaño and cañahua) are also excluded, because they are very marginal crops and because no technical coefficients are known about them.

Barley, alfalfa and weeping lovegrass may be grown continuously, while potato, quinua and broad beans must enter a rotation. Thus, the crop activities in this study are the following three rotations and three continuous crops:

1. A three-year rotation of potato, quinua and barley (PQB).
2. A four-year rotation of potato, broad beans, quinua and barley (PHQB).
3. An eight-year rotation of potato, quinua, barley and alfalfa (PQBA), where alfalfa is a five-year plantation.

4. Continuous barley (B).

5. Continuous alfalfa (A) for five years.

6. Continuous weeping lovegrass (W) for five years.

Table 5-1 combines these activities with the classes of land for which they are suited. Alfalfa must be irrigated; broad beans, barley and lovegrass are not irrigated; potato and quinua can be irrigated or non-irrigated.

As it will be immediately shown in the crop calendar, potato has four possible planting dates, quinua and broad beans have two planting dates, barley, alfalfa and lovegrass have only one planting date.

Table 5-1. Crop activities and land classes[a]

Land classes[b]	Activities[c]
Land 1	PQB, PHQB, PQBA, A, B
Land 2	PHQB, PQBA, A, B
Land 3	PHQB, PQBA, A
Land 4	W
Land 5	W
Land 6	Wasteland, buildings, roads

[a]Source: Derived from records at the Central de Cooperativas.

[b]As in Table 4-2.

[c]Activities for which each land class is suited. The names of the activities are explained in the text.

Coefficients for Crops

The crop calendar for the DAP is presented in Figures 5-1, 5-2 and 5-3, by operations and planting dates.

Machine time and labor requirements under partial mechanization appear in Tables 5-2 and 5-3. The same information under full mechanization is shown in Tables 5-4 and 5-5. The coefficients in these Tables 5-3 through 5-5 represent the average efficiency in both unskilled labor and operation of machinery. All the coefficients for partial mechanization are taken from direct observation at the farm level; the same is true; under full mechanization for land preparation, insecticide application, plowing under and transportation. The other coefficients are from the Experimental Station, with an added margin of safety to account for lower efficiency under field conditions.

Tables 5-6 and 5-7 give the specific time requirements by operations and levels of mechanization, and the non-labor inputs for operating farm machinery. Physical requirements of seed, fertilizer, chemicals and water are shown in Table 5-8. Figures on water requirements, computed from unpublished research by J. Sejas (1970), represent the best information presently available, but will have to be corrected when experiments in the field are conducted.

Finally, the expected yields to be used in this study are presented in Table 5-9. These yields are certainly higher than those achieved so far in the DAP. The reason for such differential is that better seeds, fertilizer, irrigation and chemicals avoid to a substantial degree the

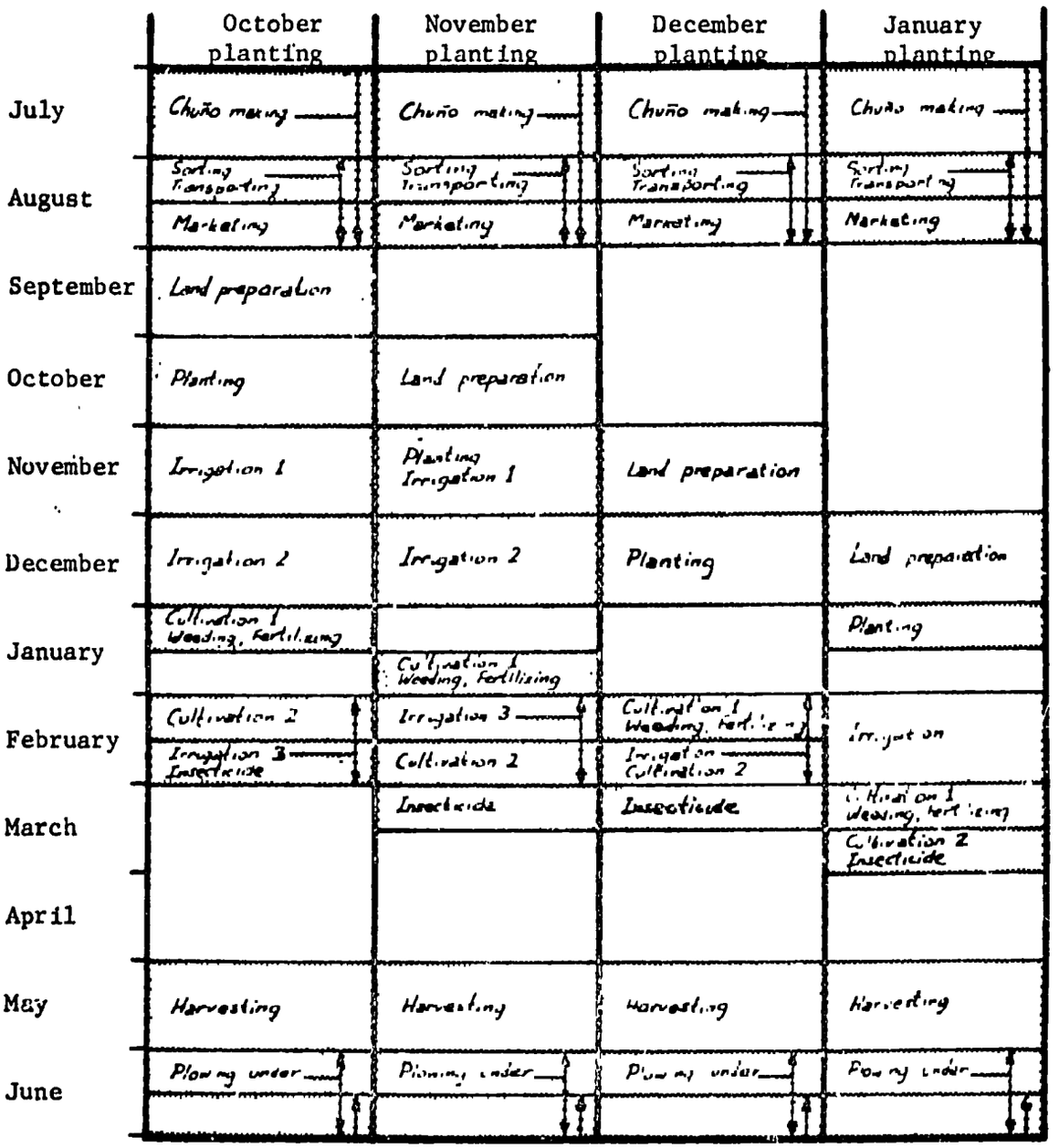
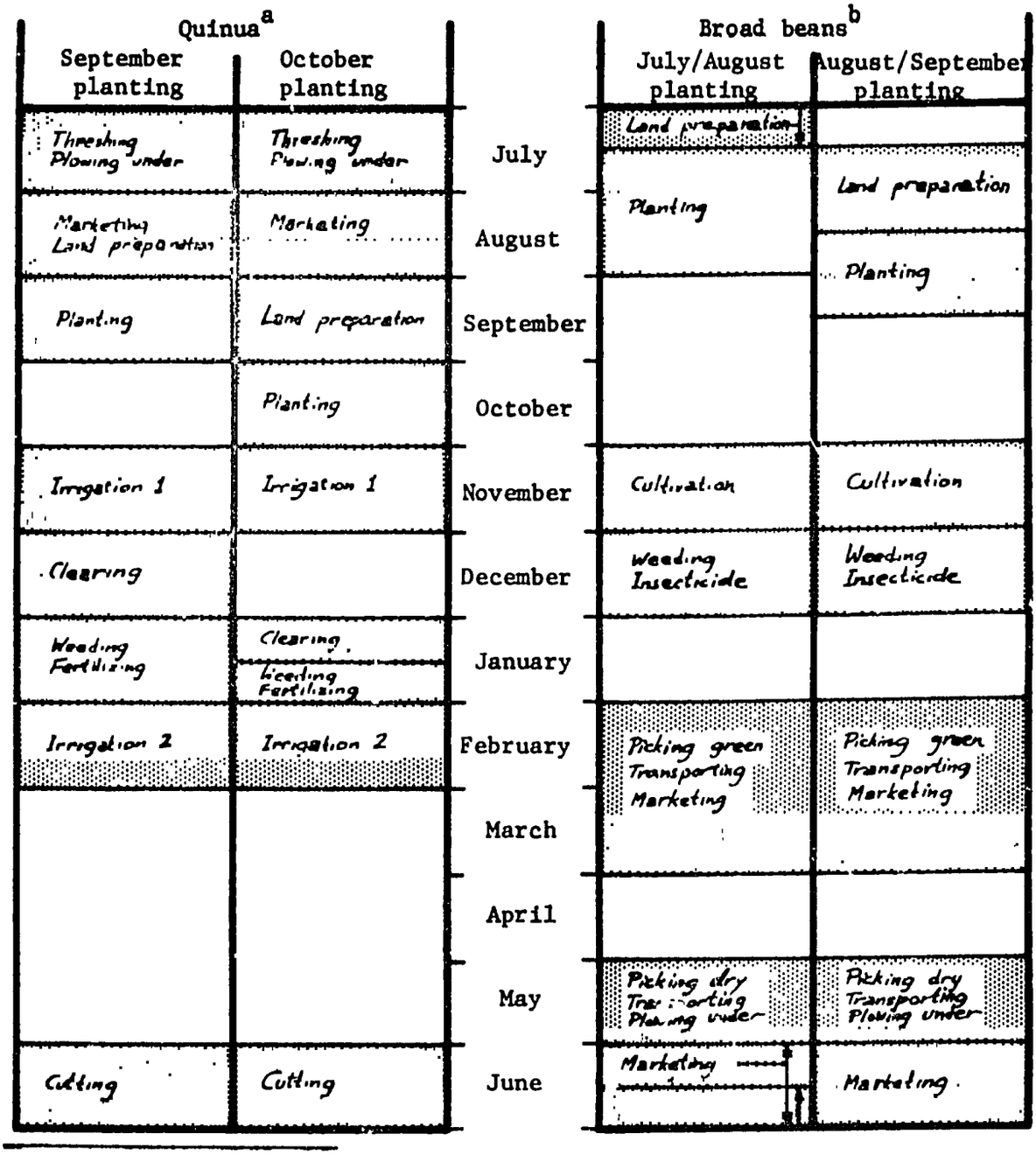


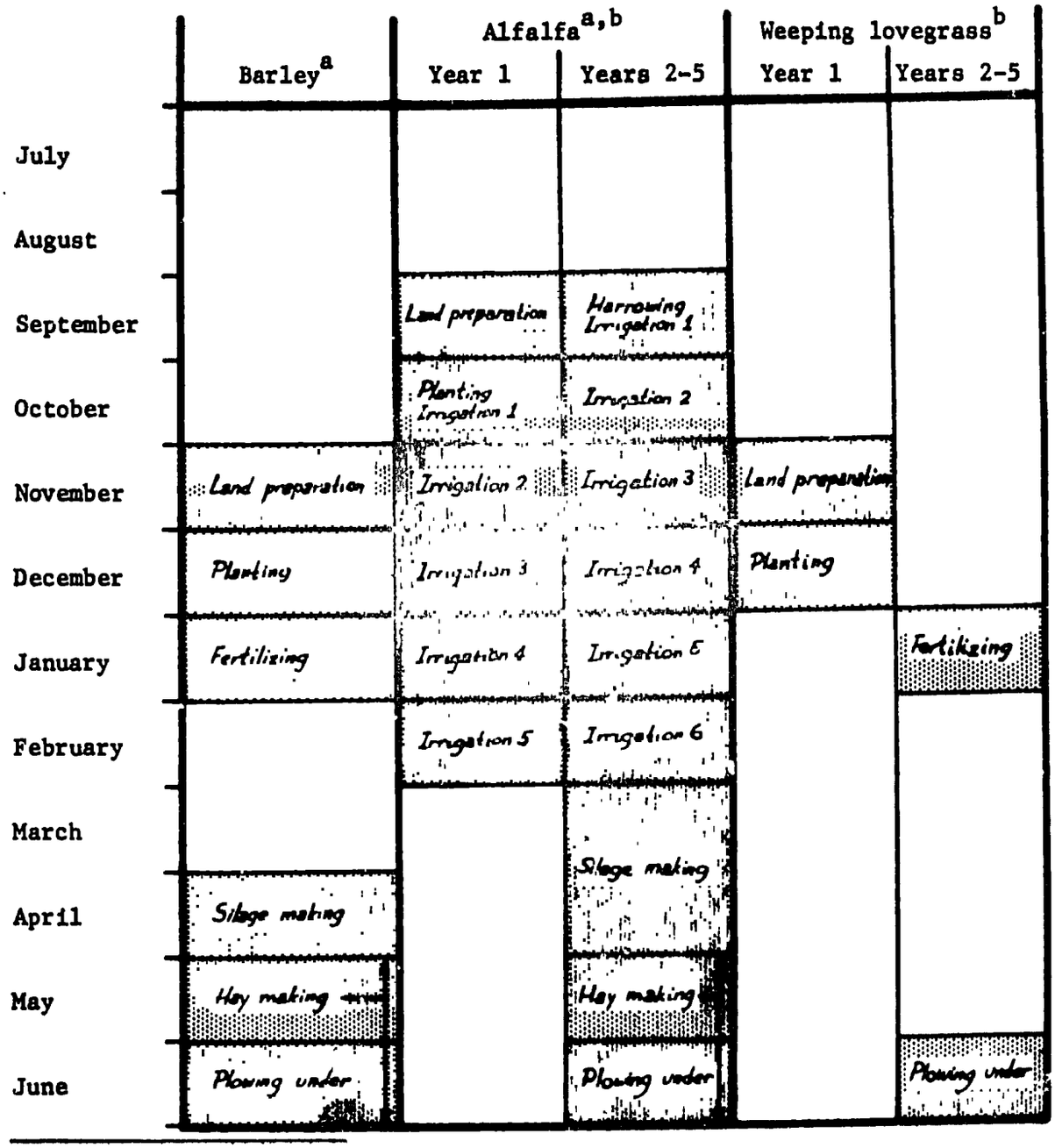
Figure 5-1. Calendar for potato, with four planting dates



[a]If a combine were used for harvesting quinua, cutting and threshing would be replaced by combining in June.

[b]One planting date is July and the first half of August; the other planting date is the second half of August and the first half of September.

Figure 5-2. Calendar for quinua and broad beans, with the planting dates.



[a]Silage making and hay making are alternative operations.

[b]A five-year plantation. Plowing-under only in the fifth year.

Figure 5-3. Calendar for barley, alfalfa and weeping lovegrass

Table 5-2. Machine time and labor requirements, by operations, for growing potato, quinua and broad beans, under partial mechanization (in hours/ha, unless otherwise indicated)[a,b]

	Potato		Quinua		Broad beans	
	Machine	Labor	Machine	Labor	Machine	Labor
Plowing	3.	37.5	3.		3.	
Harrowing	1.5		1.5		1.5	
Leveling	1.		1.		1.	
Planting[c]	2.5	37.5	2.	30.	2.	30.
Clearing				48.		
Cultivating I		56.				56.
Weeding		48.		48.		48.
Fertilizing[d]		32.		32.		
Cultivating II		56.				
Insecticide application (twice)	3.2	9.6			3.2	9.6
Irrigating (per hour)	1.	8.	1.	10.		
Digging		180.[e]				
Picking						40.[e]
Cutting				60.[e]		
Threshing				80.[e]		

Plowing under	3.		3.		3.	
Transportation to storage (per 90 cwt)[f]	1.5	4.5	1.5	4.5	1.5	4.5
Sorting (per 100 cwt)[g]	2.	20.				
Transportation to Central (per 100 cwt)[h]		20.	20.	20.		20.

[a]Source: Derived from records at the Central de Cooperativas, direct observation and interviews with extension personnel.

[b]The labor included in this table is unskilled labor, that is, in addition to the machinery operator's labor. The "machine" mentioned here is the piece or pieces of farm equipment suited for the operation.

[c]Tractor and plow are used to open the rows, while the actual planting (and fertilizing if any) is done by hand.

[d]When fertilizer is applied at a time other than planting time.

[e]This figure is for the highest yield in Table 5-9.

[f]The requirements vary with the distance from the field. Using a tractor-towed wagon of 4.5 tons capacity, an average estimate of the time required is 1.5 hours/90 cwt, three men.

[g]Sorting of chuño into which potato is processed (see note c in Table 5-9).

[h]One trip with a truck belonging to the Central de Cooperativas. Each cooperative farm has to provide the labor for loading and unloading: 4 hours, five men.

Table 5-3. Machine time and labor requirements, by operations, for growing barley, alfalfa and weeping lovegrass, under partial mechanization (in hours/ha, unless otherwise indicated)[a,b]

	Barley		Alfalfa Year 1
	Machine	Labor	Machine
Plowing	3.		3.
Harrowing	1.5		1.5
Leveling	1.		1.
Spring-tooth harrowing			
Planting		48.	
Irrigation (per hour)			1.
Fertilizing		32.	
Cutting for silage		160.[c]	
Silage making		64.[c]	
Hay making		180.[c]	
Plowing under	3.		
Transportation to storage (per 90 cwt)[e]	1.5	4.5	
Transportation to Central (per 100 cwt)[f]		20.	

[a]Sources: Same as Table 5-2.

[b]See note b in Table 5-2.

[c]See note c in Table 5-2.

[d]Only fifth-year alfalfa and weeping lovegrass are plowed under.

[e]See note f in Table 5-2. Transporting of silage or hay.

[f]See note g in Table 5-2. Transporting of hay to be sold.

			Weeping lovegrass			
	Years 2 to 5		Year 1		Years 2 to 5	
Labor	Machine	Labor	Machine	Labor	Machine	Labor
			3.			
			1.5			
			1.			
	1.5					
48.				48.		
8.	1.	8.				
						32.
		160.[c]				
		64.[c]				
		180.[c]				
	3.[d]				3.[d]	
	1.5	4.5				
		20.				

Table 5-4. Machine time and labor requirements, by operations, for growing potato, quinua and broad beans, under full mechanization (in hours/ha, unless otherwise indicated)[a,b]

	Potato		Quinua		Broad beans	
	Machine	Labor	Machine	Labor	Machine	Labor
Plowing	3.		3.		3.	
Harrowing	1.5		1.5		1.5	
Leveling	1.		1.		1.	
Planting	4.	8.	1.	1.	2.	2.
Clearing				48.		
Cultivating I	2.				2.	
Weeding				48.		
Fertilizing[c]	1.	1.	1.	1.		
Cultivating II	2.				2.	
Insecticide application (twice)	3.2	9.6			3.2	9.6
Irrigating (per hour)	1.	8.	1.	10.		
Digging	3.[d]	70.[d]				
Picking						40.[d]
Plowing under	3.		3.		3.	
Transportation to storage (per 90 cwt)[e]	1.5	4.5	1.5	4.5	1.5	4.5
Sorting (per 100 cwt)[f]	2.	20.				
Transportation to Central (per 100 cwt)[g]		20.		20.		20.

[a]Source: Same as Table 5-2.

[b]See note b in Table 5-2.

[c]See note d in Table 5-2.

[d]See note e in Table 5-2.

[e]See note f in Table 5-2.

[f]See note g in Table 5-2.

[g]See note h in Table 5-2.

Table 5-5. Machine time and labor requirements, by operations, for growing barley, alfalfa and weeping lovegrass, under full mechanization (in hours/ha, unless otherwise indicated)[a,b]

	Barley		Alfalfa Year 1
	Machine	Labor	Machine
Plowing	3.		3.
Harrowing	1.5		1.5
Leveling	1.		1.
Spring-tooth harrowing			
Planting	1.	1.	1.
Irrigation (per hour)			1.
Fertilizing	1.	1.	
Harvesting for silage	4.[c]	12.[c]	
Silage making		16.[c]	
Hay raking	2.7[c]		
Hay baling	4.2[c]	12.6[c]	
Plowing under	3.		
Transportation to storage (per 90 cwt)[e]	1.5	4.5	
Transportation to Central (per 100 cwt)[f]		20.	

[a]Source: Same as Table 5-2.

[b]See note a in Table 5-2.

[c]See note d in Table 5-2.

[d]See note c in Table 5-3.

[e]See note e in Table 5-2. Transporting of silage or hay.

[f]See note f in Table 5-2. Transporting of hay to be sold.

			Weeping lovegrass			
	Years 2 to 5		Year 1		Years 2 to 5	
Labor	Machine	Labor	Machine	Labor	Machine	Labor
			3.			
			1.5			
			1.			
	1.5					
1.			1.	1.		
8.	1.	8.				
					1.	1.
	4.[c]	12.[c]				
		16.[c]				
	2.7[c]					
	4.2[c]	12.6[c]				
	3.[d]				3.[d]	
	1.5	4.5				
		20.				

Table 5-6. Machine time requirements, by operations and levels of mechanization (in hours/ha, unless otherwise indicated)[a]

Operation	Machine	Time required[b] by level of mechanization	
		Partial	Full
Land preparation[c]	tractor	6.05	6.05
	plow	3.3	3.3
	harrow	1.65	1.65
Spring-tooth harrowing[d]	tractor	1.65	1.65
Potato planting	tractor	2.75	4.4
	planter		4.4
	plow[e]	2.75	
Broad beans planting	tractor	2.2	2.2
	drill		2.2
	plow[e]	2.2	
Small grains planting[f]	tractor	2.2[g]	1.1
	drill		1.1
	plow[e]	2.2[g]	
Cultivating[h]	tractor		2.2
	cultivator		2.2

[a]Source: Computed from Tables 5-2 through 5-5.

[b]Machine times in Tables 5-2 to 5-5 are increased by 10% for machines that travel to and from the fields.

[c]Plowing, disking and leveling. Leveling is done with a simple homemade device; thus, tractor is the only machinery used.

[d]Alfalfa in years 2 to 5. With a homemade device.

[e]See note b in Table 5-2.

[f]Quinua, barley, alfalfa and weeping lovegrass.

[g]Quinua only.

[h]Potato and broad beans only.

Table 5-6. (continued)

Operation	Machine	Time required[b] by level of mechanization	
		Partial	Full
Fertilizing[i]	tractor		1.1
	planter or drill		1.1
Insecticide application	sprayer	1.6	1.6
Irrigation (per hour)	motor	1.	1.
	pump	1.	1.
	sprinkler	1.[j]	1.[j]
Potato digging[k]	tractor		3.3
	digger		3.3
Forage harvesting[l]	tractor		4.4
	harvester		4.4
	trailer		4.4
Hay raking[l]	tractor		2.97
	rake		2.97
Hay baling[l]	tractor		4.62
	baler		4.62
Plowing under	tractor	3.3	3.3
	plow	3.3	3.3
Sorting (per 100 cwt)[m]	sorter	2.	2.
Transportation to storage (per 90 cwt)	tractor	1.5	1.5
	trailer	1.5	1.5

[i]Potato, quinua and barley; weeping lovegrass in years 2 to 5.

[j]For quinua only.

[k]See note d in Table 5-2.

[l]Figures for each cut. See note d in Table 5-2.

[m]See note f in Table 5-2.

Table 5-7. Non-labor inputs requirements for farm machinery[a]

Machine	Input	Quantity[b] per hour
Tractor	diesel	19.
	oil	0.083
	grease	0.105
	distilled water	0.01
Plow	grease	0.012
Harrow	grease	0.012
Pump	oil	0.042
Motor	diesel	13.
	oil	0.14
Potato planter	grease	0.042
Grain drill	grease	0.042
Cultivator	grease	0.012
Sprayer[c]	gasoline	1.28
	oil	0.067
Forage harvester	grease	0.042
Hay rake	grease	0.042
Hay baler	gasoline	2.5
	grease	0.042
Potato digger	grease	0.042
Wagon	grease	0.021
Sorter	grease	0.01

[a]Source: Computed from records at the Central de Cooperativas and from dealers' information.

[b]Diesel, oil, gasoline and distilled water is measured in liters; grease in kilograms.

[c]Runs on 1:20 mix of oil and gasoline; 990 grams per HP per hour.

Table 5-8. Seed varieties, fertilizer, treatments and water requirements, by crops[a]

Crop	Seed		Fertilizer	Treatments			Irrigation	
	Varieties	Quantity/ha	NPK	Drug	Quantity/ha	Applications	m^3/ha[b]	Number
Bitter potato	Pala, Sacampa, Runa, Luki	20. cwt	80-80-0[c]	Agallol 6%	0.25 kg	1[d]	1219.	3[e]
				Clordano 40%	10. kg	1[f]		
				DDT 50%	1.089 kg	2[g]		
				Metasystox	0.25 lit	2[g]		
Quinua	Blanca dulce	10. lb	45-0-0[h]				1070.	2[i]
Broad beans	Uchuculu, Francesa, Copacabana	6. cwt	13-39-0	DDT 50%	1.089 kg	2[g]		
				Metasystox	0.25 lit	2[g]		
Barley	Bolivia	1. cwt	40-40-0[h]					
Alfalfa	Ranger, Vernal	44. lb					2307.	6[j]
Weeping lovegrass	E.E. Patacamaya	17.5 lb	40-0-0[k]					

[a]Source: Derived from records at the Central de Cooperativas and from Table C-15.

[b]Total required for all irrigations.

[c]50 kg of urea are applied at the first cultivation; the rest is applied at planting time.

[d]For dipping the seed before planting (mixed with 100 lit of water).

[e]Only 2 for potato planted in December or January; water required is then 820 m^3 only.

[f]With the seed at planting time.

[g]DDT and Metasystox are applied together (mixed with 200 lit of water).

[h]Applied when plants are about 10 or 15 cm high.

[i]By aspersion.

[j]First-year alfalfa has only 5 irrigations; water required is then 1850 m^3 only.

[k]Years 2 to 5 only.

Table 5-9. Expected crop yields, by planting dates and land classes (in cwt/ha, unless otherwise indicated)[a,b]

	Planting date	Without irrigation					With irrigation		
		Land 1	Land 2	Land 3	Land 4	Land 5	Land 1	Land 2	Land 3
Bitter potato[c]	October	210	173	100			270	223	130
	November	205	169	98			265	219	127
	December	200	165	96			260	215	125
	January 1	195	161	94			255	211	122
Quinua	Sept. - Oct.[d]	35	30	20			45	38	25
Broad beans, green	July - Aug. 1	160	133	80					
	Aug. 2 - Sept.	155	129	77					
Broad beans, dry	July - Aug. 1	45	37	22					
	Aug. 2 - Sept.	43	36	21					
Barley silage[e]	December	400	330	190					
Barley hay[f]	December	210	173	100					
Alfalfa silage[g]	October						800	667	400
Alfalfa hay[h]	October						430	358	215
Weeping lovegrass[i]	December			0.13	0.125	0.12			

[a]Sources: Alfalfa yields are from Allred 1970; all other yields are derived from the records at the Central de Cooperativas and from estimates by extension personnel. See also note b and notes d and i below.

[b]Yields expected with average weather conditions and under the assumptions of this study: mechanization, use of fertilizer, etc. For all but weeping lovegrass, yields on lands 1 and 3 for the earliest planting date are empirically known. For other planting dates a constant yield shrinkage has been assumed: Yields on land 2 are those on land 1 minus one-third of the difference between yields on lands 1 and 3. For yield of weeping lovegrass see note f below.

[c]Processed into freeze-dried chuño at the ratio of 3 kg of potato for each kg of chuño. The resulting chuño is 40% first class, 57% second class and 3% third class (see Table K-4).

[d]No yield difference between the two planting dates (September and October).

[e]31% dry matter.

[f]87.3% dry matter.

[g]Two cuts, with 50% of the yield in each cut; 32.2% dry matter.

[h]Two cuts, with 40% of the yield in the first cut and 60% in the second cut; 89.2% dry matter.

[i]Yield is given in tons of dry matter, on the basis of the empirically known carrying capacity of the pasture on land 4: approximately 5 head of sheep per hectare in any month from January through May.

losses from drought, frost and disease, as it has already been experienced in some Cooperatives.

Information in Tables 5-2 to 5-6 is rearranged by time periods in Appendix C. Such rearranged coefficients by time periods are the ones that will enter the linear programming matrix.

Livestock Activity

The only livestock activity included in this research is sheep raising. A few llamas are also raised in the DAP at the present time, but on a non-commercial basis and with totally unimproved techniques. In the early 1960's some research was done on feeding and reproduction of llamas, but there is no basis as yet for obtaining reliable coefficients on llama raising. Future efforts will probably be directed toward substituting alpacas for llamas (as Perú already did), since alpaca hair has a strong demand in both the national and the international market and is paid a higher price than llama hair (Faisen 1967b, p. 18).

Sheep presently existing in the Altiplano are degenerate criollo type, descendants from the European breeds brought five centuries ago, except for the few places where cross-breeding with imported animals has taken place.

Management practices are very primitive, seemingly geared not toward productive efficiency but rather toward keeping sheep as a cash reserve for emergencies or for a Community celebration. Death rates are very high, yields are extremely poor for both meat and wool, and marketing is

inefficient (Bolivia 1963, pp. 18-20; Salas, Stokes and Lanfranco 1965, pp. 12-14; Clyburn 1970). The sheep calendar is not determined by technical considerations, but by tradition and social institutions. For example, 45% of lambing in the Altiplano is done in December and another 45% in May-June, two time periods associated respectively with the communal celebrations of Christmas and Saint John's Feast (Salas, Stokes and Lanfranco 1965, p. 12); but these time periods are the worst ones for lambing, because December is too close to the rainy season, and May-June is the beginning of winter when cold nights combine with poor pastures. The recent research by R. S. Sly contains an excellent description of present sheep raising practices in the Altiplano (Sly 1970, pp. 12-16).

As noted in Chapter III, the level of technology and management assumed in this study is the one being promoted at the present time by the Experimental Station. Adoption of that level by the cooperatives requires a greater effort in the case of sheep than in the case of crops, since errors in timing, in doses or in handling can be very costly in any livestock operation.

Traditionally, marketing consists in selling sheep (above 3 or 4 years of age) when a need for cash arises. Then, sheep are either walked to the urban market or slaughtered at home and sold to middlemen at the village faire. In the first case, a substantial loss of weight occurs (no exact figures are known); in the second case, the danger of spoilage in the fresh carcass deprives the farmer of any bargaining power for higher prices.

According to a recent report on mutton consumption (Vanderslice 1970), there is room for increasing the demand in the urban centers, mainly La Paz and Oruro. Presently the two cities consume only 75 thousand heads per year, that is, 600 tons in carcass weight, with the highest consumption from February to June and the lowest in November. On a whole-country basis, mutton consumption is only 730 grams per person per year; this means that mutton consumption is ten times smaller than beef consumption. At the present price, quality and tastes, the annual increase in demand for mutton is estimated at 3.65%. The report points out that larger increases in demand will come about only if these recommendations are followed: sale by weight instead of by carcass unit, official stamp of guaranteed quality and lower price per kilo. In order to reduce costs (so that a lower price be possible), it is strongly suggested that slaughtering facilities be installed in the producing areas, thus avoiding the weight loss incurred by the present custom of selling sheep to the cities.

In line with these recommendations, the Central de Cooperativas has built a slaughterhouse in the town of Patacamaya, which is scheduled to begin functioning in the near future. Mutton will be marketed in La Paz and Oruro, under sanitary conditions and with a quality stamp from the Ministry of Agriculture. Reduction of weight loss and of the farmer-market price differential will bring about higher earnings for the farmer and savings to the consumer (Pou and Chacón 1970). Later on, byproducts such as pelts, tallowed, sweaned and bloodmeal will also be marketed.

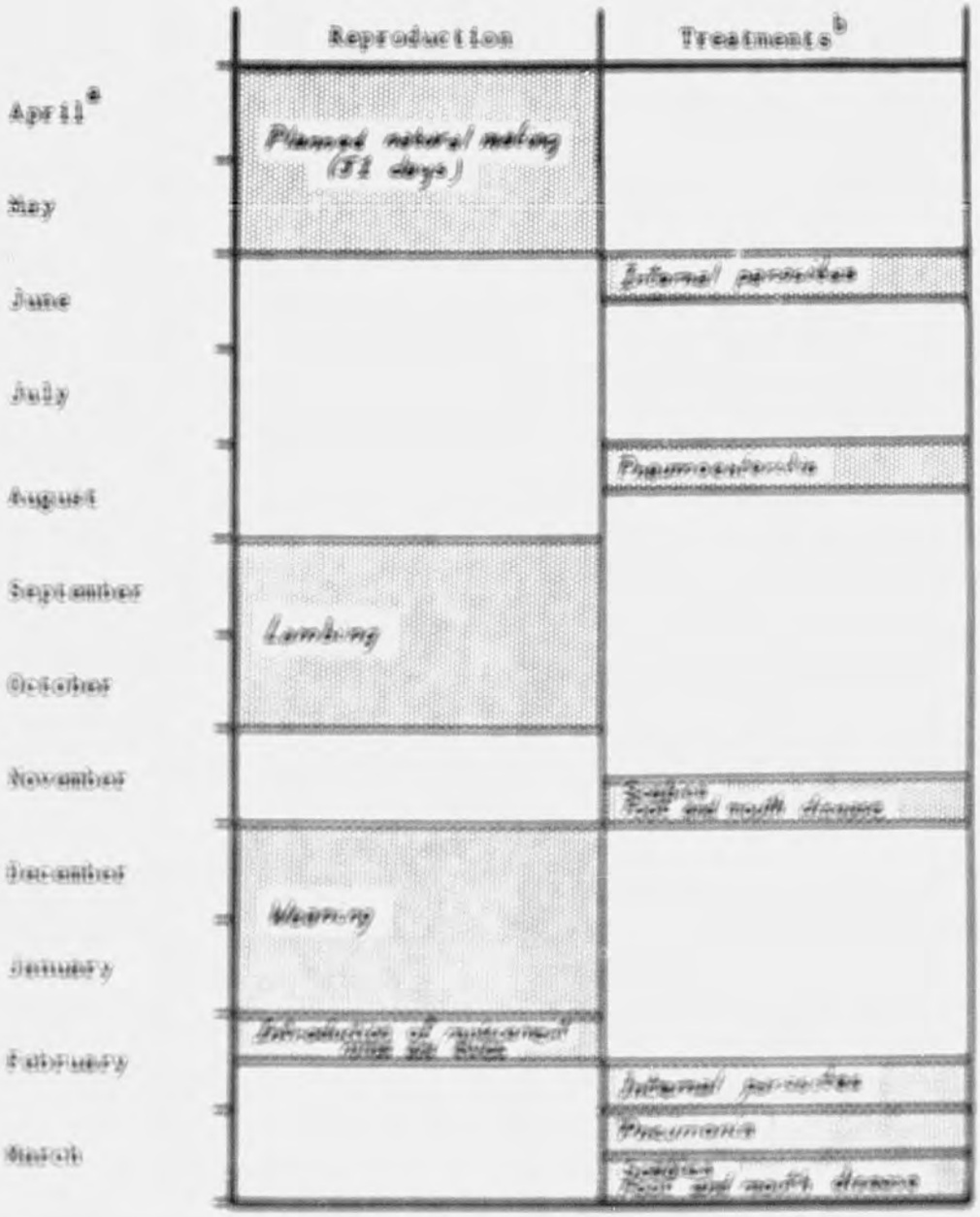
Coefficients for Sheep

The calendar for raising sheep in the DAP is shown in Figure 5-4, where operations are distinguished into five different groups: Reproduction, Treatments, Feeding, Production and Marketing. That calendar brings together information collected by the office for improvement of sheep at the Ministry of Agriculture, after a series of meetings with research and extension personnel in April 1970.

Basic data to develop a model for sheep raising in the DAP were taken from the activities at the Experimental Station, and are contained in Appendix D. From the tables in that appendix and after consultation with experts, the parameters in Table 5-20 were established. These parameters and the calendar in Figure 5-4 were then applied to a unit flock of 200 breeding ewes (that is, 200 ewes lambed in September-October), and the model in Appendix E was developed. The model assumes breeding rams with 31/32 pure blood and breeding ewes with at least 3/4 pure blood.

The 200-ewes unit of activity was chosen for two reasons: (i) resource requirements for a rather large unit can be accurate enough without having to carry many decimal places, a fact which simplifies computation of coefficients, thereby reducing the chance of error; (ii) a 200-ewes unit seems to embody any possible economies of scale in labor for operations like flock feeding, applying treatments, marketing, etc.

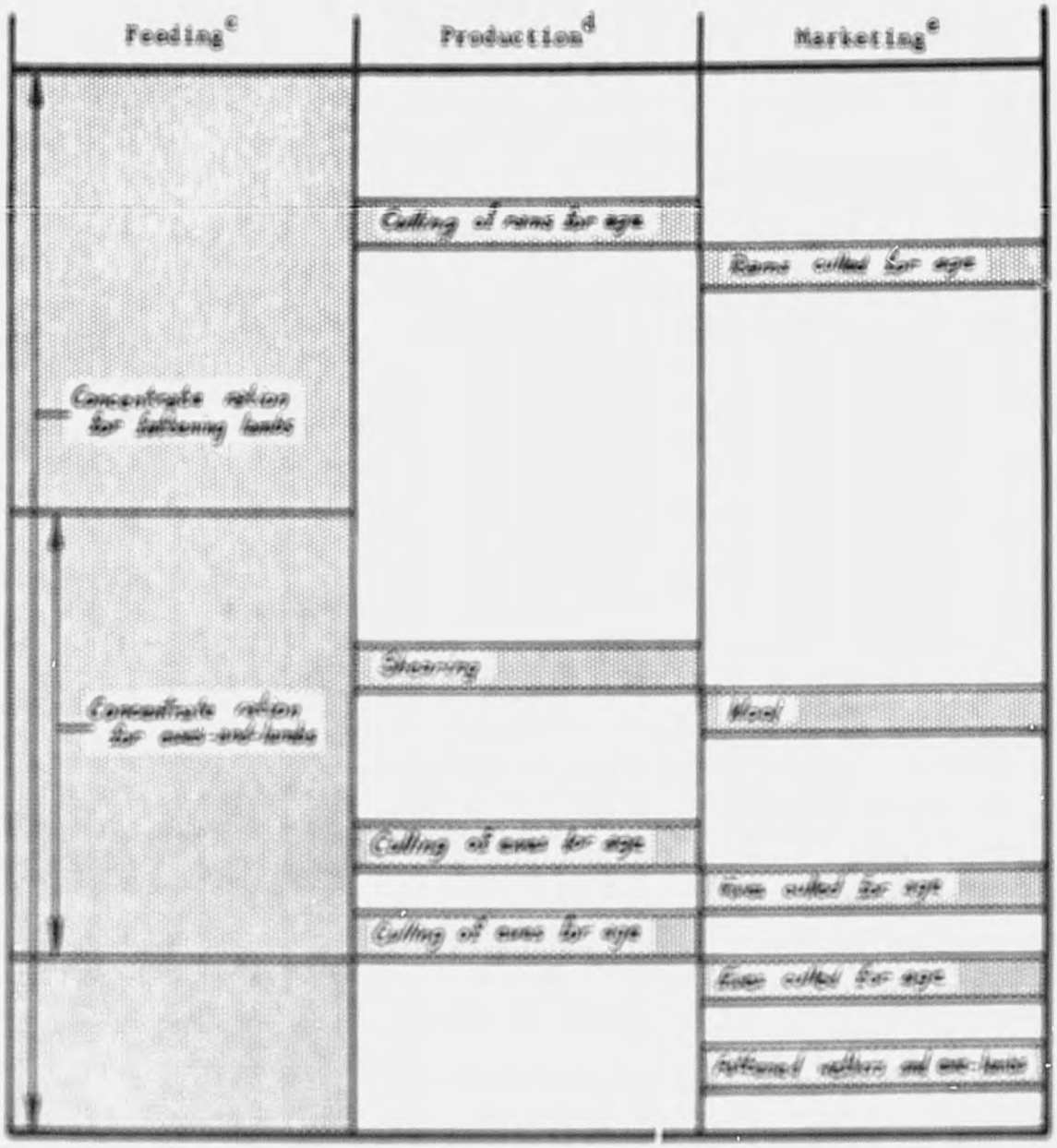
The level of farm mechanization has no direct bearing on sheep raising activity in this study (indirectly, only through related crop activities like hay making or others). Shearing is the only operation which



[a]Some features in this calendar are better understood with the help of the notes in Table 5:1. April is chosen as the starting month because in this month the reproductive cycle begins.

[b]Drenching method for internal parasites; dipping for scabies, vaccination for pneumonenteritis and for foot and mouth disease, and shots for pneumonia. Occasional treatments are given for scrapie, mastitis and diarrhea. Pneumonenteritis vaccine is administered only to pregnant ewes, pneumonia shots only to those animals showing the symptoms, and the other treatments to the entire flock.

Figure 5:4. Calendar for raising sheep



[c]Only the concentrate rations are mentioned here. Table 5-9 presents the complete feeding patterns.

[d]Shearing is done on the entire flock but the suckling lambs.

[e]Rams and ewes will be finished for the market by the Central de Cooperativas.

Table 5-10. Parameters for planning a sheep flock in the DAP

Lambing index (= lambs born/breeding ewes)	107.50%
Weaning index (= lambs weaned/lambs born)	83.03%
Lambs mortality index (= dead until weaning/born)	16.97%
Adult mortality index (= dead after weaning/adult animals)	8.67%
Productive life of breeding rams (from 2 to 6 years of age)	4 years
Productive life of breeding ewes (from 2 to 6 years of age)	4 years
Ratio of rams to breeding ewes (rams/ewes)	1:35
Culling rate of rams for age	25%
Culling rate of ewes for age	25%
Wool production per sheared head	2 kg
Average liveweight of rams culled for age (at sale time)	70 kg
Average liveweight of ewes culled for age (at sale time)	45 kg
Average liveweight of wethers (at sale time)	35 kg
Average liveweight of ewe lambs (at sale time)	35 kg
Average weight of male lambs: at birth	4 kg
second week	8 kg
at weaning (around 12th week)	19 kg
Average weight of female lambs: at birth	3.7 kg
second week	7 kg
at weaning (around 12th week)	17.5 kg

*Source: Derived from Appendix 3 and from Bolivia 1969d, in consultation with experts Rolando Camargo, Luis Chucha, Walter Llanos, Kyle Matthews and Armando Orsa.

can be mechanized; that is, it can be done with manual or with electric shears. In this study we assume manual shearing, but there is open the possibility of electric shearing (as done at the Experimental Station), if manual labor is ever limiting during the second half of October, the time period in which sheep are sheared.

Table 5-11 shows the labor requirements for the various operations other than flock tending. Table 5-12 rearranges the same information into coefficients by half-months according to the calendar in Figure 5-4. Finally, Table 5-13 presents the labor needed, by half-months, for tending to the various flocks. Addition of the requirements in Tables 5-12 and 5-13 results in the labor coefficients to be used in the linear programming matrix; they are presented in Table C-14.

Drugs recommended for the various treatments and their doses are shown in Table 5-14.

Table 3-11. Labor requirements, by operations, for a unit sheep flock of 200 breeding ewes (in hours)[a]

Operations[b]	Month[c]	Number of head	Labor required	
			Total	Adult[d]
Lambing[e]	Sept.-Oct.	215.	215.	215.
Weighing at weaning[f]	Dec.-Jan.	181.	18.1	18.1
Drenching for internal parasites[g]	June	384.5	7.19	2.88
	February	494.	9.23	3.69
Vaccination for pneumenteritis[h]	August	203.	8.46	4.83
Dipping for scabies[i]	November	564.5	15.17	9.48
	March	394.	10.58	6.61
Vaccination for foot and mouth disease[h]	November	564.5	23.53	13.44
	March	394.	16.42	9.38
Pneumonia shots[h]	March	394.	16.42	9.38
Shearing[j]	October	370.5	67.92	67.92
Marketing of rams culled for age[k]	June	1.5	24.	24.
Marketing of wool[k]	November	-[l]	24.	24.
Marketing of ewes culled for age[k]	January	24.	24.	24.
	February	24.	24.	24.
Purchase of replacement rams	February	1.5	-[m]	-[m]

Marketing of wethers and ewe lambs[m]	March	97.	48.	48.

[a]Source: Derived from records and direct observation at the Experimental Station, and from Figure 5-4.

[b]Other than tending the flocks.

[c]The labor required for each operation may be a function of the number of head on the farm in the month when the operation is performed; thus, the same operation may have different labor requirements if performed at different times.

[d]That part of the total labor requirement that must be adult labor.

[e]Parturition, docking, weighing, castration, tagging. Average of 30 minutes per born lamb, 2 adults.

[f]Average of 3 minutes per lamb, 2 adults.

[g]Based on 4 hours for 1070 head, 3 persons (at least 2 adults).

[h]Based on 6.25 hours for 1050 head, 7 persons (at least 4 adults).

[i]Based on 3.38 hours for 1066 head, 8 persons (at least 5 adults).

[j]Average of 11 minutes per head. Shearing with electric shears takes 4 minutes per head, that is, a total of 24.7 hours.

[k]Labor is required to carry the merchandise to the Central de Cooperativas, weight it and record the transaction: 8 hours, 3 adults.

[l]The number of head is irrelevant. Wool to be transported is 741 kg.

[m]The replacement rams are brought when the ewes culled for age are transported to the Central. No additional trip is needed.

[n]Two trips: 16 hours, 3 adults.

Table 5-12. Labor requirements, by half-months, for operations other than tending the flocks, in a unit flock of 200 breeding ewes (in hours)[a]

Half-months	Labor required[b]	
	Total	Adult[c]
June 1	31.19	26.88
August 2	8.46	4.83
September 1	53.75	53.75
September 2	53.75	53.75
October 1	53.75	53.75
October 2	121.67	121.67
November 1	24.	24.
November 2	38.7	22.92
December 1	4.53	4.53
December 2	4.53	4.53
January 1	28.53	28.53
January 2	4.53	4.53
February 1	24.	24.
February 2	9.23	3.69
March 1	64.42	57.38
March 2	27.	15.99

[a]Source: Derived from Table 5-11 and Figure 5-4.

[b]Lambing and weaning, which cover a two-month period, are assumed to be uniformly spread over the period. The two-month labor requirement in Table 5-11 is divided into four equal half-month requirements.

[c]See note d in Table 5-11.

Table 5-13. Labor requirements, by half-months, for tending the flocks in a unit sheep flock of 200 breeding ewes (in hours)[a]

	Number[b] of flocks	Labor required[c] per day		Labor required[d] per half-month	
		Total	Adult[e]	Total	Adult[e]
April 1	4*	32	8	448.	136.
April 2				448.	136.
May 1	4*	32	8	448.	136.
May 2				496.	160.
June 1	3*	24	8	344.	136.
June 2				344.	136.
July 1	3*	24	8	344.	136.
July 2				368.	144.
August 1	3*	24	8	344.	136.
August 2				368.	144.
September 1	4**	47[f]	31[f]	673.	465.
September 2				673.	465.
October 1	4**	47[f]	31[f]	673.	465.
October 2				721.	497.
November 1	3*	24	8	344.	136.
November 2				344.	136.
December 1	3*	24	8	344.	136.
December 2				368.	144.
January 1	3*	24		344.	
January 2				384.	
February 1	3*	24		324.	
February 2				324.	
March 1	3*	24		344.	
March 2				368.	

[a]Source: Derived from Table E-1 and Figure 5-4.

[b]One or two stars mean that one or two of the flocks must have an adult shepherd, while the other flocks may be tended by a child. The need for an adult comes from management requirements (lambing season, etc.). The starred flocks are explained in Table E-6.

[c]The flock is pastured the whole day (8 hours) by one person, with no more than 300 head per shepherd. When the flock is not on direct pasture, the same labor is still needed for feeding and taking care of the feedlot.

[d]Computed from the requirements per day.

[e]See note d in Table 5-11.

[f]During the lambing season (Sept.-Oct.) the flock of pregnant ewes must be watched around the clock (in Patacamaya there are twice as many lambs born at night as there are during the day). Thus the daily labor coefficient is increased by 15 hours (from 5 P.M. till 8 A.M.).

Table 5-14. Drugs for sheep raising[a]

Drug	Operation[b]	Dose
Thibenzole	drenching (lambs)	6.5 cc per head
Coopazine	drenching (sheep)	50 cc per head
Gamatox	dipping	9 kg for whole flock
Nexadip 6%	dipping	25 kg for whole flock
Elmycina	pneumonia	2 cc per head[c]
Negasunt	external wounds	-[d]
Cooper-spray	external wounds	-[e]
Vaccines	pneumoenteritis	1 cc per head[c]
	foot and mouth disease	2 cc per head[c]

[a]Source: Derived from records and direct observation at the Experimental Station.

[b]Complete description in Table 5-11.

[c]The dose is a function of the weight of the animal. The figure given is an average for the whole flock.

[d]Dusted on the wounds.

[e]Sprayed over the wounds.

CHAPTER VI. PRICES, COSTS AND REVENUES

Prices of Inputs

In Chapter IV the five main resources were studied: Land, Labor, Capital, Water and Machinery. Their prices will now be discussed; then, the prices of the other inputs will be given.

No market price can be quoted on land in the DAP because no actual market for land exists. No price can be given on the basis of opportunity cost either, since there are no alternate uses to which land could be allocated in the present time. Neither, as noted in Chapter IV, there is any cost involved in holding land idle. Therefore, no price for land is considered in this study.

The price of labor is the wage paid by the cooperative to its own members. Women's and children's labor is paid less than male adult labor, but these wage differentials were already accounted for when all labor was converted to male adult labor by applying the efficiency coefficients from Table 4-4. Therefore, in this study all unskilled labor is given the same wage, which is the going rate in the DAP and which has been accepted by the cooperatives assembly as binding. This rate is 8 pesos per workday, that is, 1 peso per hour. The only workers who receive a higher wage are the machinery operators and mechanics: They are paid 10 pesos per day, that is, 1.25 pesos per hour. As noted in Chapter IV, no labor can be hired.

The price of capital, already quoted in Chapter IV, is the actual rate of interest presently charged by the Agricultural Bank: 12% on loans

for purchasing machinery, 8% on all other loans.

The price of water is the cost to the cooperative of pumping the water from the well on the farm. Specifically, 100 m^3 take 0.43 hours of motor-and-pump time. As computed later in this chapter (Table 6-12), the variable cost of one hour of motor-and-pump time is 11.122 pesos, which means 5.005 pesos per 100 m^3 of water. That cost includes fuel, lubricant, repairs and operator's labor.

The prices of machinery for both partial and full levels of mechanization are given in Table 6-1. Besides the prices in La Paz and on the farm, the years of useful life and the salvage value are also given for each piece of machinery. For those machines presently existing in the DAP the makes actually used are considered in Table 6-1; for the other machines the makes available in La Paz and well suited to the Area are adopted, that is, John Deere for all machines except electric shears and sprinkler.

The prices of all the other inputs (seeds, fertilizer, etc.) are those at which the cooperatives can buy them at the Central de Cooperativas. As explained in Chapter II, the Central is the buying agency for all the cooperatives.

Table 6-2 gives the prices for tools and other supplies, as well as the years of useful life and average quantity per family.

Prices for seeds recommended in the DAP are given in Table 6-3, fertilizer prices in Table 6-4 and drug prices in Table 6-5.

Table 6-6 shows the prices of drugs recommended for sheep in the DAP.

Table 6-1. Price, years of useful life and salvage value of farm machinery (prices and salvage value in pesos)[a]

Description	Dealer in La Paz	Price in La Paz	Price on the farm[b]	Years of useful life	Salvage value
IH Farmall-706 tractor, diesel, model D-310, 69.83 HP drawbar, 76.09 HP belt	McDonald	70896.[c]	71205.	10	10000.
Athens disk-plow, model 24, 4 disks, 26"	McDonald	9144.[c]	9294.	10	
IH disk-harrow, model 130, 32 disks, 20"	McDonald	9948.[c]	10098.	10	
Palmero pump, model 10P67, 33 to 65 l/s	Deere	29880.	30030.	15	200.
Deutz motor, diesel, model 4CL-1114, direct injection, air-cooled, 75 HP, 1500 rpm in heavy work[d]	Deere	43200.	43350.	17	2000.
John Deere potato planter, 2 rows	CIMO	36500.	36650.	15	200.
John Deere fertilizer grain driller, 12 rows	CIMO	15750.	15900.	15	200.
John Deere cultivator, 2 rows	CIMO	12000.	12150.	10	0.
Kimkaldor 111 sprayer, 3 HP motor[e]	Peñarandis	2606.38	2610.38	4	0.
John Deere forage harvester, 5 feet	CIMO	45750.	45900.	12	200.

John Deere elite delivery sales, 9 foot mower mulch	[illegible]	$11,700,	$13,950,	12	200,
John Deere automatic pickup baler	[illegible]	6,500,	6,650,	12	200,
John Deere potato digger, 1 row	[illegible]	6,900,	7,100,	12	200,
John Deere trailer, 4.5 tons	[illegible]	7,600,[f]	7,600,	12	
Chute motor	Central Corp.,	–[g]	3,500,	12	
Sunbeam Stewart electric shears	Mfrs. Agric.,	1,200,	1,200,	10	
Ames sprinkler and pipe	Mfrs. Agric.,	12,000,	12,050,	10	200,

[a]Source: Derived from Table 4-3 and from a survey of the Bar Harbors, June, 1971.

[b]For machines not used at the present time in the IMP, transportation cost was estimated on the basis of the known cost of transporting tractor, plow and harrow.

[c]Detailed breakdown of the price is given in Table 4-5.

[d]This motor is used with the Delmarva pump.

[e]Including installing and hooking up.

[f]Including 2,000 paid for non-factory-built wooden box.

[g]No price in La Paz is given because the motor is built at the Central de Cooperativas in Paraguayo.

Table 6.2. Prices, years of useful life and average quantity per family, for tools and supplies, 1971 (price in pesos)[a]

Item	Spanish name	Price in[b] La Paz	Price at the Central[c] de Cooperativas	Years of useful life	Average quantity per family
Pick	Picota	20	19	4	1
Shovel	Pala	25	23.75	4	1
Hoe	Azadón	25	23.75	4	1
Fork	Horquita	25	23.75	5	0.5
Metal drum (200 lbs)	Tambor	50	48	3	1
Sickle	Hoz	20	19	3	1
Burlap bag (2 cwt)[d]	Costal yute	10.5	9.975	3	5
Cotton bag (1 cwt)[e]	Costal algodón	3	2.85	2	2
Road tanker[f]	Cisterna	5	4.75	2	1

[a]Sources: Quantity per family is from Bolivia 1969; the other data are from records at the Central de Cooperativas and from a survey of La Paz dealers, June, 1971.

[b]The most common price among many stores in La Paz.

[c]The La Paz retail price minus 10% wholesale reduction, plus 5% for transportation and handling.

[d]For transporting chuño and broad beans to the Central.

[e]For transporting quinua to the Central.

[f]For harvesting potatoes and broad beans.

Table 6-3. Prices of seeds, 1970 (in pesos)[a]

Crop[b]	Price at the Central de Cooperativas[c]
Bitter potato	30.5 per cet
Quinua	80.8 per cet
Broad beans	40.95 per cet
Barley	30.5 per cet
Alfalfa	10.1 per lb
Weeping lovegrass	15.15 per lb

[a]Source: Records of the Central de Cooperativas.

[b]The seed varieties recommended for the IAP were listed in Table 5-8.

[c]This price includes the percent charged by the Central for handling: 5% for seed bought in lots (broad beans), 1% for seed bought at the experimental station (all others).

Table 6-4 presents the price of various supplies used in raising sheep, the years of useful life and the quantity needed for a flock unit (200 ewes).

Finally, Table 6-5 has the prices for the inputs used in operating machinery.

With the prices given in Tables 6-1 to 6-5, fixed costs and variable costs by operations and by activities are computed later in this chapter.

Table 6-6. Prices of chemical fertilizers, 1971 (in pesos)[a]

Formula	Dealer in La Paz[b]	Regular price[c] in La Paz	Wholesale price[d] in La Paz	Price/kg at the[e] Central de Cooperativas
16-20-0	Grace	117 per 50 kg	111.65	2.135
	Dorlan[f]	105 per 50 kg	96.5	1.964
	Servicio Agrícola Comercial	108 per 46 kg	102.	2.328
13-39-0	Grace	113 per 50 kg	107.35	2.296
	Dorlan	120 per 50 kg	108.	2.268
	Servicio Agrícola Comercial	106 per 46 kg	106.	2.226
18-46-0	Grace	118 per 50 kg	112.10	2.354
	Dorlan	130 per 50 kg	117.	2.457
20-20-0	Grace	105 per 50 kg	99.75	2.095
15-15-15	Grace	100 per 50 kg	95.	1.995
	Dorlan	100 per 50 kg	90.	1.890
	Servicio Agrícola Comercial	112 per 46 kg	106.	2.420
11-48-0	Servicio Agrícola Comercial	122 per 46 kg	113.	2.579
Urea 45%	Servicio Agrícola Comercial	112 per 46 kg	106.	2.374
Urea 46%	Grace	96 per 50 kg	91.20	1.915
	Dorlan	120 per 50 kg	108.	2.268
	Ritchie	165 per 50 kg	130.68	2.744

[a]Source: Survey of La Paz dealers, June, 1971.

[b]A few well-known firms in La Paz import fertilizer, mainly from the United States, Germany and Japan. It seems that the feasibility of exchanging rice with fertilizer from Perú has not been seriously explored as yet (Latin American Market Planning Center 1967, p. VIII-32).

[c]Prices are fairly stable throughout the year. The Central de Cooperativas should be able to buy when the price is lowest, usually at the end of the agricultural year.

[d]For quantities above one ton approximately.

[e]The La Paz wholesale price plus 5% for transportation and handling. This is the price to be considered by the Central in obtaining the necessary NPK combinations (Table 5-8) to be made available to the cooperatives (as computed in Table 6-6).

[f]Dorlan considered discontinuing imports of fertilizer by the end of 1971.

Table 6-5. Prices of drugs for crops, 1970 (in pesos)[a]

Drugs	Dealer in La Paz	Regular price La Paz	Wholesale price La Paz	Price at the[b] Central de Cooperatives
Agallol 6% Bayer	Casa Bermudez	96/kg	76.8	80.640 per kg
Metasystox Bayer	Casa Bermudez	122/1 lt	97.6	102.480 per 1 lt
Lindo-Clordano 40%	Grace	507/25 kg	481.65	20.229 per kg
Lindo-Aldrin W.P. 25%	Grace	455/25 kg	432.25	18.156 per kg
DDT 50%	Grace	6/kg	4.80	5.040 per kg

[a]Source: Survey of La Paz dealers, June, 1970.

[b]The La Paz wholesale price plus 5% for transportation and handling.

Table 6-6. Prices of drugs for sheep, 1970 (in pesos)[a]

Drugs	Dealer in La Paz	Regular price in La Paz	Wholesale price in La Paz	Price at the[b] Central de Cooperativas
Thibenzole	Grace	208. //400 gr	18000. //cwt	416.669//kg
Coopazine	Zbinden	48. //kg	2112. //cwt	46.561//kg
Gamatox	Zbinden	117.6 //kg	1058.4 //10 kg	105.84 //kg
Nexadip 6%	Bayer	35.7 //kg	3390.5 //100 kg	33.915//kg
Ethycine	Casa Bernardo	69. // 50 cc	62100. //50 lit	1.242//cc
Negamunt	Casa Bernardo	32. //250 gr	750. //10 kg	75. //kg
Cooper-spray	Zbinden	24. //100 gr	2160. //10 kg	216. //kg
Vaccine neumoenteritis	Vet. San Roque	0.8 //2 cc	720. //2 lit	0.36 //cc
Vaccine foot and mouth disease	S.T.C. Min. Agr.	0.65//5 cc	0.65//5 cc	0.13 //cc

[a]Source: Survey of La Paz dealers, June, 1970.

[b]See note b in Table 6-5.

Table 6-7. Prices, years of useful life and quantity per unit flock, of various supplies for raising sheep, 1970 (prices in pesos)[a]

Item	Dealer in La Paz	Price in La Paz	Price at the Central[b] de Cooperativas	Years of useful life	Quantity per unit flock
Syringe 40 cc	Zbinden	102.	96.9	10.	1.
Needle	Zbinden	6.	5.7	2.	4.
All-in-one pliers	National Sup. Co.	780.	741.	13.	1.
Pistol for drenching	Zbinden	342.	324.9	13.	1
Ear tags (box of 100)	Min. Agriculture	35.	33.25	-[c]	2.
Breeding ram	-[d]	-[e]	230.	4.	6.[f]
Salt	-[g]	-[e]	0.332[h]	-[e]	-[j]
Concentrate for ewes-and-lambs	-[i]	-[e]	0.3 [h]	-[e]	-[k]
Concentrate for fattening lambs	-[i]	-[e]	0.326[h]	-[e]	-[k]

[a]Source: Prices for concentrate are from notes e and cc in Table B-14; all other data are from a survey of La Paz dealers, June, 1970.

[b]See note b in Table 6-5.

[c]Does not apply. An average of 2 tags per head are needed.

[d]Breeding rams, with 31/32 pure blood, are raised at the Experimental Station.

[e]Does not apply.

[f]1.5 rams are replaced each year.

[g]Bought by the Central in the salt producing areas of the Southern Altiplano.

[h]Per kg.

[i]Prepared at the Central.

[j]Daily average of 10 grams per head on the farm.

[k]See Table B-13.

Table 6-8. Price of inputs for operating machinery, 1970[a]

Item	Price	
	in La Paz[b]	at Central de Cooperativas[c]
Gasoline	0.7 per lit	0.735 per lit
Diesel	0.5665 per lit	0.595 per lit
Oil SAE-30	26.82 per gallon	7.44 per lit
Grease	9.58 per kg	10.059 per kg
Distilled water	0.5 per lit	0.525 per lit

[a]Source: Records at the Central de Cooperativas.

[b]In the near future YPFB (the Bolivian oil company) might deliver its products directly to the Central de Cooperativas. Presently it is cheaper to buy in La Paz and transport to Patacamaya than to buy directly from the Patacamaya service stations.

[c]The La Paz price plus 5% for transportation and handling.

Prices of Outputs

Output from both crop activities and sheep raising can be marketed through the Central de Cooperativas. Although such group marketing is optional, it is expected that most cooperatives will adopt it, since it saves time, offers stable prices and guarantees honesty in weights and measures. Therefore, the prices for outputs in this study are those presently offered by the Central de Cooperativas to its member cooperatives.

Table 6-9 lists the prices for crop outputs. These prices are the same as or slightly above the prices generally offered at the village

Table 6-9. Prices at the Central de Cooperativas for output from crop activities (in pesos per cwt)[a]

Item	Price
Chuño class 1	150
Chuño class 2	130
Chuño class 3	110
Quinua, white sweet	60
Green broad beans	25
Dry broad beans	80
Barley hay	10[b]
Alfalfa hay	18[b]

[a]Source: Records at the Central de Cooperativas.

[b]The prices for barley and alfalfa hay actually used in the linear programming model will be 2.45 and 4.41 pesos respectively, as explained in the text, pages 133 and 134.

fairs in the Area. It is thought that the possible range of variability in those prices during the coming years is between 5% down and 30% up. As it markets larger volumes, the Central should realize some economies of scale that could be passed on to the producers.

In this study barley and alfalfa hay are grown for feeding sheep on the farm (since no work-animals are considered), but any surpluses of hay can be sold. The prices of 10 and 18 pesos for barley and alfalfa hay respectively are based on the prices currently paid in the Area. A market for hay exists at the present time mainly because work-animals are still

common in the farms. However, if the entire DAP (and later most of the Altiplano) adopts eventually the level of technology considered in this study, the market for hay will all but disappear. It seems logical that in our linear programming model a low enough price for hay be used which make it more profitable to feed hay to sheep than to sell it. A computer run was made in which prices of hay were parameterized downward starting at the present prices of 10 and 18; the prices at which it became more profitable to feed hay to sheep than to sell it were 2.45 for barley hay and 4.41 for alfalfa hay (the 10/18 ratio among the two prices was maintained because it was assumed to represent a quality differential). These prices will be used in the linear programming model instead of those given in Table 6-9. An optimal plan may still ask for hay to be sold if some scarce factor (probably labor in a certain time period) limits the sheep raising activity and hay or alfalfa have to be planted as part of a rotation. But, in any event, the quantity of hay to be sold will be relatively small. By using the 2.45 and 4.41 prices instead of the 10 and 18 prices, income of the cooperative decreased by 5% to 30% in the solutions from two trial runs under both partial and full mechanization. We think that adopting the 2.45 and 4.41 prices for hay does not distort the problem, but it rather makes our approach to planning in the DAP much more realistic, since the 10 and 18 prices from Table 6-9 should diminish drastically once the Area is mechanized and the demand of hay for feeding work-animals all but disappears.

Table 6-10 gives the prices at the Central de Cooperativas for the output from sheep raising. It is expected that in the coming years the

Table 6-10. Prices at the Central de Cooperativas for output from sheep raising (in pesos)[a]

	Price
Wool class 1[b]	9.025 per kg
Wool class 2	8.55 per kg
Wool class 3	7.6 per kg
Wool class 4	6.555 per kg
Wool class 5 and 6	2.755 per kg
Rams culled for age[c]	4.5 per kg
Ewes culled for age[c]	4.5 per kg
Fattened wethers[c]	5. per kg
Fattened ewe lambs[c]	5. per kg
Adult head	4.75 each
Lamb head	3.8 each
Adult pelt	14.25 each
Lamb pelt	9.5 each

[a]Source: Wool prices are from Table D-6; the rest are from Pou and Chacon, 1970.

[b]Wool prices are those in Table D-6, minus 5% for transportation and handling.

[c]Liveweight price.

liveweight price of sheep will increase to some degree, once the Central improves its slaughtering and marketing efficiency.

On the basis of the prices in Tables 6-9 and 6-10, the revenues from

the various activities are computed at the end of this chapter.

Fixed Costs

Fixed costs considered in this study result mainly from the indivisibility of farm machines and tools. They are the annual costs of machinery and its shelter, small tools, storage building and silo (if the farm plan asks for silage to be made).

Table 6-11 presents the annual fixed costs (depreciation plus interest at 12%) of each machine and its shelter, the storage building and the silo. With the figures in the last column of that Table the annual fixed cost for each degree of mechanization will be computed in Chapter VII.

Table 6-12 shows the annual fixed cost of tools and supplies per person in the cooperative. These tools and supplies are generally owned by the individual families rather than by the cooperative; the members of the cooperative use them when engaged in the common work. However, the cost of these tools and supplies must still be considered a cost to the whole cooperative enterprise. It will be left to the linear programming matrix (by means of a transfer row) to add this cost per person to the fixed costs computed from Table 6-11.

As an additional information, Tables F-4 and F-5, contain annual fixed costs at lower interest rates down to 6%; these two Tables can show how a reduction in the rate of interest of loans for purchasing machinery would affect the profit of the cooperative (since we are dealing with fixed costs, the optimal farm plans would not be altered by those lower interest rates).

Table 6-11. Annual fixed costs, at 12% rate of interest, of farm machinery, storage building and silo, 1970 (in pesos)[a]

	Machine		Shelter		Annual[b]
	Depreciation	Interest cost	Depreciation	Interest cost	fixed cost
Tractor	6120.5	3672.3	17.	25.5	9835.3
Plow	929.4	557.64	19.	28.5	1534.54
Harrow	1009.8	605.88	19.	28.5	1663.18
Pump	1988.667	1789.8	15.	13.5	3806.967
Motor	2432.353	2481.	15.	13.5	4941.853
Potato planter[c]	2296.667	2067.	8.	12.	4383.667
Grain drill[c]	1046.667	942.	17.	25.5	2031.167
Cultivator[c]	1215.	729.	8.	12.	1964.
Sprayer	652.595	156.623	-[d]	-[d]	809.218
Forage harvester[c]	3808.333	2742.	17.	25.5	6592.833
Hay rake[c]	970.833	699.	11.	16.5	1697.333
Hay baler[c]	3370.833	2427.	30.	45.	5872.833
Potato digger[c]	574.167	413.4	8.	12.	1007.567
Wagon	506.667	456.	18.	27.	1007.667
Sorter	300.	216.	-[d]	-[d]	516.
Electric shears[e]	120.3	72.18	-[d]	-[d]	192.48
Sprinkler	1085.	651.	-[d]	-[d]	1736.
Storage building[f]	-[g]	-[g]	300.	450.	750.
Silo[h]	-[g]	-[g]	200.	300.	500.

[a]Source: Derived from Tables F-2, F-3 and F-4.

[b]Summation of the four previous columns. See also Table F-4, note b.

[c]For full mechanization only.

[d]No shelter cost, because it is kept in the storage building.

[e]See explanation in the text, page 116.

[f]150 m^2 for storing supplies, small machines (note d above) and products.

[g]Does not apply.

[h]Volume of 120 m^3.

Table 6-12. Annual fixed costs, at 12% rate of interest, of tools and supplies, 1970 (in pesos)[a]

Item[b]	Annual costs of			Annual fixed costs	
	Depreciation	Interest	Repairs[c]	per family[d]	per person[e]
Pick	4.75	1.14	1.	6.89	1.378
Shovel	5.938	1.425	1.	8.363	1.672
Hoe	5.938	1.425	1.	8.363	1.672
Fork	4.750	1.425	1.	3.588	0.718
Metal drum	16.	2.88		18.88	3.776
Sickle	6.333	1.14		7.473	1.495
Burlap bag	3.325	0.598	0.5	22.118	4.424
Cotton bag	1.425	0.171		3.192	0.638
Reed basket	2.375	0.285		2.66	0.532
Total				81.527	16.305

[a]Source: Computed from Table 6-1.

[b]As described in Table 6-1.

[c]It would be tedious (and irrelevant anyway) to make the repair costs a function of the hours of annual use. On the other hand, the repair costs are so small that no distortion is incurred by simply treating them as a fixed cost.

[d]Per member family in the cooperative. According to the last column in Table 6-1.

[e]These are the important figures from this Table, since the quantity of small tools and supplies is a function of the number of persons in the cooperative. The total in this column will enter the linear programming matrix as fixed cost per person in addition to the fixed costs resulting from Table 6-11.

Housing for sheep is treated as a function of the size of the flock to be raised. Thus, annual costs of housing sheep (shed, feedlot, feed troughs, etc.) will be added to the variable costs of sheep raising.

Variable Costs

Variable costs per hour of operating farm machinery are presented in Table 6-13; they include fuel and lubricants, repair costs and operator's labor.

Tables 6-14 through 6-19 show the variable costs for the several crop activities considered in this study. Since harvesting and marketing coefficients are a function of yield, the activities are broken down into growing activities (Tables 6-14 through 6-17) and harvesting-marketing activities (Tables 6-18 and 6-19). From these Tables, the coefficients in the objective function will be calculated for each activity.

Variable costs of raising a unit sheep flock of 200 breeding ewes are given in Table 6-20.

Additional information on variable costs of both crop and sheep activities is presented in Appendix F. Repair costs for farm machinery are given in Table F-6, variable costs of mechanized operations in Table F-7, and average costs per unit of crop output in Tables F-8 through F-13.

Revenues

Possible sources of revenue for the cooperatives in this study are chuño, quinua, broad beans, hay, mutton, lamb, pelts and wool.

Table 6-13. Variable costs of operating machinery, 1971 (in pesos per hour)[a]

Machine	Non-labor[b] inputs	Repairs	Operator's labor	Total variable costs[c]	
				excluding operator's labor	including operator's labor
Tractor	12.986	1.772	1.375	14.756	16.131
Plow	0.121	3.185	0.025	3.306	3.331
Harrow	0.121	0.711	0.025	0.832	0.857
Motor-and-pump	9.089	1.827	0.206	10.916	11.122
Potato planter	0.422	2.609	0.025	3.031	3.056
Grain drill	0.422	3.89	0.025	4.312	4.337
Cultivator	0.121	1.65	0.025	1.771	1.796
Sprayer	1.439	0.312	0.025	1.751	1.776
Forage harvester	0.422	5.319	0.025	5.741	5.766
Hay rake	0.422	4.138	0.025	4.56	4.565
Hay baler	2.26	5.886	0.025	8.146	8.171
Potato digger	0.422	2.776	0.025	3.198	3.223
Wagon	0.211	1.276	0.025	1.487	1.512
Sorter	0.101	0.012	0.025	0.113	0.138
Sprinkler		0.065	0.025	0.065	0.07

[a]Source: Computed from Tables 5-6 (with note b in Table C-1), 5-7 and F-6.

[b]Machinery listed in Table 5-7.

[c]Including the interest to be paid for working capital.

Table 6-14. Variable costs of growing bitter potato, 1970 (in pesos/ha)[a,b]

	Under partial mechanization		Under full mechanization	
	non-irrigated	irrigated[c]	non-irrigated	irrigated[d]
Unskilled labor	239.1	282.996	17.6	61.496
Operator's labor	17.	18.131	27.002	28.133
Tractor	178.568	178.568	284.053	284.053
Plow	30.911	30.911	21.82	21.82
Harrow	1.373	1.373	1.373	1.373
Planter			16.67	16.67
Cultivator			7.792	7.792
Sprayer	5.603	5.603	5.603	5.603
Motor-and-pump		59.896		59.896
Seed	1010.	1010.	1010.	1010.
Agallol	20.16	20.16	20.16	20.16
Fertilizer	612.11	612.11	612.11	612.11
Chlordane	202.29	202.29	202.29	202.29
DDT 50%	10.977	10.977	10.977	10.977
Sulsuyatox	51.24	51.24	51.24	51.24
Total	2379.312	2624.235	2244.[illegible]	2393.613

[a]Sources: Computed from Tables 5-6, 5-7, 5-8, 6-5, 6-1, 6-7, 6-15 and 4-6.

[b]From land preparation up to excluding harvest, but including the plowing under after harvest. Interest to be paid for working capital is not included among the variable costs here.

[c]For potato planted in December or January, unskilled labor is 268.636 pesos, operator's labor 17.761 pesos, motor-and-pump 60.302 pesos. The total is then 2669.911 pesos.

[d]For potato planted in December or January, unskilled labor is 47.136 pesos, operator's labor 27.763 pesos, motor-and-pump 60.302 pesos. The total is then 2359.289 pesos.

Table 6-15. Variable costs of growing quinua, 1970 (in pesos/ha)[a,b]

	Under partial mechanization		Under full mechanization	
	non-irrigated	irrigated	non-irrigated	irrigated
Unskilled labor	158.	206.13	97.	145.13
Operator's labor	16.142	17.135	16.142	17.135
Tractor	170.432	170.432	170.432	170.432
Plow	29.093	29.093	21.82	21.82
Harrow	1.373	1.373	1.373	1.373
Drill			9.486	9.486
Motor-and-pump		52.539		52.539
Sprinkler		0.217		0.217
Seed	8.08	8.08	8.08	8.08
Fertilizer	187.34	187.34	187.34	187.34
Total	570.46	672.339	511.673	613.552

[a]Sources: Computed from Tables 5-6, 5-7, 5-8, C-2, C-8, C-15 and K-6.

[b]See note b in Table 6-14.

Table 6-16. Variable costs of growing broad beans and barley, 1970 ((in pesos/ha))[a,b]

	Broad beans		Barley	
	under partial mechanization	under full mechanization	under partial mechanization	under full mechanization
Unskilled labor	143.6	11.6	80.	2.
Operator's labor	16.222	19.302	13.062	16.142
Tractor	170.432	202.895	137.969	170.432
Plow	29.083	21.82	21.82	21.82
Harrow	1.373	1.373	1.373	1.373
Drill		9.486		9.486
Cultivator		3.896		
Sprayer	5.603	5.603		
Seed	245.7	245.7	50.5	50.5
Fertilizer	222.6	222.6	306.07	306.07
DDT 50%	10.977	10.977		
Metasystox	51.24	51.24		
Total	896.84	806.492	610.794	577.832

[a]Sources: Computed from Tables 5-6, 5-7, 5-8, 6-5, C-3, C-4, C-9, C-10 and K-6.

[b]See note b in Table 6-14.

Table 6-17. Variable costs of growing alfalfa and weeping lovegrass, 1970 (in pesos/5 ha)[a,b]

	Alfalfa		Weeping lovegrass	
	under partial mechanization	under full mechanization	under partial mechanization	under full mechanization
Unskilled labor	399.138	352.138	176.	5.
Operator's labor	32.54	34.05	13.062	20.762
Tractor	235.358	251.59	137.969	219.127
Plow	20.038	20.038	20.038	20.038
Harrow	1.373	1.373	1.373	1.373
Drill		4.743		23.716
Motor-and-pump	113.308	113.308		
Seed	444.4	444.4	265.125	265.125
Fertilizer			666.12	666.12
Total	1246.125	1221.64	1276.687	1218.261

[a]Sources: Computed from Tables 5-6, 5-7, 5-8, C-4, C-10, C-13 and K-6.

[b]See note b in Table 6-14.

Table 6-18. Variable costs of harvesting potato, quinua and broad beans, and of making chuño, 1970 (in pesos/cwt)[a,b]

	Potato[c] under partial mechanization	Potato[c] under full mechanization	Quinua	Green broad beans	Dry broad beans	Chuño[d] making
Unskilled labor	0.667	0.259	3.341	0.387	1.1	9.41
Operator's labor		0.017	0.024	0.024	0.024	0.024
Tractor		0.177	0.231	0.231	0.231	0.231
Digger		0.038				
Wagon		0.025	0.025	0.025	0.025	0.025
Sorter		0.002				0.002
	0.667	0.518	3.661	0.687	1.4	9.712

[a]Sources: Computed from Tables 5-6, 5-7, 5-9, 6-5, C-5 and C-11.

[b]Including transportation to storage and marketing. Interest to be paid for working capital is not included among the variable costs here.

[c]Transportation to storage and marketing are excluded.

[d]Transportation of chuño to storage and marketing are included. Figures are for one cwt of chuño, which is the result of 3 cwt of potato.

Table 6-19. Variable costs of making silage and hay, 1970 (in pesos/cwt)[a,b]

	Silage		Hay	
	under partial mechanization	under full mechanization	under partial mechanization	under full mechanization
Unskilled labor	0.56	0.119	0.469[c]	0.115[c]
Operator's labor	0.024	0.038	0.024	0.074
Tractor	0.251	0.413	0.251	0.782
Harvester		0.063		
Rake				0.064
Baler				0.179
Wagon	0.025	0.025	0.025	0.025
Molasses[d]	0.091	0.091		
Twine[e]			0.227	0.227

[a]Sources: Computed from Tables 5-6, 5-7, 5-9, 6-5, C-6 and C-12.

[b]Including transportation to silo or storage. Interest to be paid for working capital is not included among the variable costs here.

[c]If hay is sold, 0.2 should be added.

[d]At 2 pesos per ton of silage.

[e]At 5 pesos per ton of hay.

Table 6-20. Variable costs of raising a unit sheep flock of 200 breeding ewes (in pesos per year)[a,b]

	Quantity		Cost
Unskilled labor	10732.06	hours	10732.06
Operator's labor	0.033	hours	0.041
Motor-and-pump	0.208	hours	2.271
Concentrate for fattening lambs	11225.466	kg	3659.502
Concentrate for ewes-and-lambs	10618.45	kg	5309.225
Salt	1673.815	kg	554.033
Thibenzole	0.396	kg	165.001
Coopazine	10.497	kg	488.751
Nexadip	50.	kg	1695.75
Negasunt	0.5	kg	37.5
Ear tags	200.	tags	66.5
Elmycina	200.	cc	248.4
Vaccines: foot and mouth disease	1917.	cc	249.21
neumoenteritis	203.	cc	73.08
Breeding rams	1.5	rams	425.
Housing, etc.	-[c]		6802.274[d]
Total			30308.598

[a]Sources: Computed from Tables 5-14, 6-6, 6-7, C-14, C-16, E-11 and F-14.

[b]Excluding costs of hay, silage and pasture. Interest to be paid for working capital is not included among the variable costs here.

[c]See Table F-14.

[d]Annual costs (at 8%) of all items in Table F-14 and the first four items in Table 6-7. These costs are a function of the flock size; thus they can be included among the variable costs when planning the flock from scratch.

The gross revenue and the revenue over and above variable costs for crop outputs, by level of mechanization and irrigation, by planting dates and by land classes are shown in Table 6-21 through 6-24. As it could be expected, revenue above variable costs is higher for irrigated potato and quinua than for non-irrigated. Green broad beans show a certain advantage over dry beans, and alfalfa hay is significantly more profitable than barley hay (if hay is sold at all, as explained by note b in Table 6-24). Except in the case of hay, revenue above variable costs is consistently higher under full mechanization than under partial mechanization.

Revenues from the sheep raising activity classified by source are given in Table 6-25. It is worth noticing that selling of lambs accounts for 50.15% of the revenue. The fact that selling of lambs is all but non-existent at the present time is an indication of how radical an innovation in management practices our sheep model implies on the part of the cooperatives, as noted in Chapter V.

Classification of revenues from the various activities by the time periods in which they are received is given in Table F-14. That information is not used in this study, but it will be of prime importance in further research when analyzing the pattern of costs and revenues during the agricultural year, in order to establish more accurately the needs for borrowed working capital.

Table 6-21. Gross revenue and revenue above variable costs of producing chuño, 1970[a]

	Gross revenue[b] in pesos/ha	Revenue above variable costs[c] in pesos/ha		Rate of return[d]	
		under partial mechanization	under full mechanization	under partial mechanization	under full mechanization
No irrigation, land 1:					
planted October	9618.	6418.778	6540.69	2.006	2.125
planted November	9389.	6209.3	6330.467	1.953	2.07
planted December	9160.	5999.821	5910.02	1.844	1.956
planted January 1	8931.	5790.343	5910.02	1.844	1.956
No irrigation, land 2:					
planted October	7923.4	4868.638	4985.037	1.594	1.697
planted November	7740.2	4701.056	4816.859	1.547	1.648
planted December	7557.	4533.473	4648.68	1.499	1.598
planted January 1	7373.8	4365.89	4480.501	1.451	1.549
No irrigation, land 3:					
planted October	4580.	1810.255	1915.777	0.654	0.719
planted November	4488.4	1726.463	1831.687	0.625	0.689
planted December	4396.8	1642.672	1747.598	0.596	0.66
planted January 1	4305.2	1558.881	1663.509	0.568	0.63
Irrigation, land 1:					
planted October	12366.	8827.595	8958.447	2.495	2.629
planted November	12137.	8618.117	8748.224	2.449	2.582
planted December	11908.	8442.962	8572.324	2.437	2.57
planted January 1	11679.	8233.484	8362.101	2.39	2.521
Irrigation, land 2:					
planted October	10213.4	6858.499	6982.348	2.044	2.161
planted November	10030.2	6690.916	6814.169	2.004	2.119
planted December	9847.	6557.657	6680.314	1.994	2.11
planted January 1	9663.8	6390.075	6512.136	1.952	2.066
Irrigation, land 3:					
planted October	5954.	2962.202	3072.194	0.99	1.066
planted November	5816.6	2836.515	2946.06	0.952	1.026
planted December	5725.	2787.047	2896.294	0.949	1.024
planted January 1	5587.6	2661.36	2770.16	0.909	0.983

[a]Sources: Computed from Tables 5-9, 6-9, 6-14 and 6-18.

[b]From selling the chuño into which potato is processed.

[c]Above variable costs in Tables 6-14 and 6-18.

[d]This rate of return (so called for lack of a better name) is:

$$R = \frac{\text{Gross revenue}}{\text{Variable costs}} - 1$$

The variable costs considered in this Table exclude any interest to be paid on the working capital and any price to be paid for using the land. Since there is no price on using the land, R is then that rate of interest (per one) which, if it were to be paid on all working capital, would cause the activity to break even, that is, the variable costs would just be covered. At any interest rate below that there would be an excess of gross revenue over variable costs (as it is the case in this Table, where a zero interest rate is considered); at any interest rate above that, variable costs would be higher than gross revenue.

Table 6-22. Gross revenue and revenue above variable cost of producing quinua, 1970[a]

		Gross revenue in pesos/ha	Revenue above variable costs[b] in pesos/ha		Rate of return[c]	
			under partial mechanization	under full mechanization	under partial mechanization	under full mechanization
No irrigation,	land 1	2100.	1401.405	1460.192	2.006	2.282
	land 2	1800.	1119.71	1178.497	1.646	1.896
	land 3	1200.	556.32	615.107	0.864	1.052
Irrigation,	land 1	2700.	1802.916	1921.703	2.225	2.469
	land 2	2280.	1468.543	1527.33	1.81	2.029
	land 3	1500.	736.136	794.923	0.964	1.127

[a]Sources: Computed from Tables 5-9, 6-9, 6-15 and 6-18.

[b]Above variable costs in Tables 6-15 and 6-18.

[c]See note d in Table 6-21.

Table 6-23. Gross revenue and revenue above variable costs of producing green and dry broad beans, 1970[a]

	Gross revenue in pesos/ha	Revenue above variable costs[b] in pesos/ha		Rate of return[c]	
		under partial mechanization	under full mechanization	under partial mechanization	under full mechanization
Green, land 1:					
planted July-Aug.1	4000.	2993.24	3083.588	2.973	3.365
planted Aug.2-Sept.	3875.	2871.675	2962.023	2.862	3.244
Green, land 2:					
planted July-Aug.1	3325.	2336.789	2427.137	2.365	2.703
planted Aug.2-Sept.	3225.	2239.537	2329.885	2.273	2.603
Green, land 3:					
planted July-Aug.1	2000.	1048.2	1138.548	1.101	1.322
planted Aug.2-Sept.	1925.	975.261	1065.609	1.027	1.24
Dry, land 1:					
planted July-Aug.1	3600.	2640.16	2730.508	2.751	3.14
planted Aug.2-Sept.	3440.	2482.96	2573.308	2.594	2.969
Dry, land 2:					
planted July-Aug.1	2960.	2011.36	2101.708	2.12	2.449
planted Aug.2-Sept.	2880.	1932.76	2023.108	2.04	2.361
Dry, land 3:					
planted July-Aug.1	1760.	832.36	922.708	0.897	1.102
planted Aug.2-Sept.	1680.	753.76	844.108	0.814	1.01

[a]Sources: Computed from Tables 5-9, 6-9, 6-16 and 6-18.

[b]Above variable costs in Tables 6-16 and 6-18.

[c]See note c in Table 6-21.

Table 6-24. Gross revenue and revenue above variable costs of making and selling hay, 1970[a]

	Gross revenue in pesos/ha	Revenue above variable costs[b] in pesos/ha		Rate of return[c]	
		under partial mechanization	under full mechanization	under partial mechanization	under full mechanization
Barley hay:					
on land 1	514.5	263.34	164.64	1.048	0.471
on land 2	423.85	216.942	135.632	1.048	0.471
on land 3	245.	125.4	78.4	1.048	0.471
Alfalfa hay:					
on land 1	1896.3	1382.02	1179.92	2.687	1.647
on land 2	1578.78	1150.612	982.352	2.687	1.647
on land 3	948.15	691.01	589.96	2.687	1.647

[a]Sources: Computed from Tables 6-9 and 6-20.

[b]Over variable costs of making, transporting and marketing hay (Table 6-19). Barley and alfalfa are grown for feeding sheep on the farm. However, it may happen that they be grown as part of a rotation and them some limiting factor prevent the sheep activity from entering the plan at a level high enough to consume all hay available; in that case it is still more profitable to sell hay than to leave the barley or alfalfa on the field (even at the low prices assumed here; see note b in Table 6-9); as the figures in this Table show, the marginal gross revenue of making and selling hay is higher than the marginal cost.

[c]See note d in Table 6-21. The rates are constant for the three land classes because the costs are per unit of output and not per unit of land.

Table 6-23. Gross revenue and revenue over variable costs of sheep raising, 1970 (per unit flock of 200 ewes)[a]

	Quantity[b] sold	Revenue[c] in pesos	Return over[d] variable costs in pesos	Rate of[e] return	Revenue as % of total
Rams culled for age	1.5	301.			30.57
Ewes culled for age	48.	10632.			
Wethers	81.	15232.3			50.15
Female lambs	16.	3012.8			
Adult pelts[f]	17.	242.25			1.56
Lamb pelts[f]	34.5	327.75			
Wool class 1	661.49	5969.947			17.72
Wool class 2	25.42	217.341			
Wool class 3	23.93	181.868			
Wool class 6	30.16	83.091			
Total		36420.347	5911.751	0.194	100.00

[a]Source: Computed from Tables 5-10, 6-10, E-3 and E-13.

[b]Rams, ewes, wethers and lambs in number of head. Pelts in units. Wool in kgs.

[c]Price per animal includes the liveweight price plus the price for the head and the pelt. The figures for revenue exclude revenue from wages.

[d]No figures on return for each source of revenue because costs are not broken down by sources.

[e]See note d in Table 6-21.

[f]The pelts of dead animals. It is assumed that the head of dead animals can not be safely used in human consumption, although in certain cases it can. Pelts from suckling lambs are considered as half-pelts.

CHAPTER VII. APPLICATION OF THE MODEL

The Linear Programming Matrices

In order to apply the model explained in Chapter III with the data presented in Chapters IV and VI, two linear programming matrices were developed: one for partial mechanization, with 316 rows and 227 columns, and another for full mechanization, with 351 rows and 234 columns[1].

The rows in the matrices are as follows: (i) The objective function (income) to be maximized, as discussed in Chapter III; (ii) two master rows, the first one specifying the cooperative size and the second the farm size in each particular combination of sizes to be studied, as listed in Table 3-1; (iii) 251 rows containing the quantities of resources available, land, labor, water and machinery; (iv) 113 transfer rows, through which communication is established among columns. A summary of the rows is given in Table 7-1; the total number of rows in that Table is larger than the number of rows in any of the two matrices, because not all of the rows apply to both the partial and the full mechanization situations. A detailed explanation (name, type, unit and RHS value) is presented in Table C-1.

The columns in the matrices are grouped in the following manner: (i) Eight accounting activities, whose only role is to expedite interpretation of the programming results; (ii) a capital-borrowing activity and a

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[1] Linear Programming Applications to Farm Planning, by Boneke and Winterboer (1971) was used as a guideline for the mechanics of preparing the matrices.

Table 7-1. Rows in the linear programming matrices[a]

Rows	Quantity	Identification numbers in Table C-1
Objective function	1	1
Persons in the cooperative (cooperative size)[b]	1	2
Area of the farm (farm size)[c]	1	3
Land	5	4 - 8
Labor	68	9 - 76
Water	12	77 - 88
Machinery[d]	140	89 - 228
Operator's labor[d]	26	229 - 254
Transfer rows[d]	113	255 - 368
Total	367	

[a]Source: Summarized from Table C-1.

[b]Change in the RHS value for this row will be the only change needed to study the various cooperative sizes.

[c]Parametric change in the RHS value for this row will be the only change needed to study the various farm sizes.

[d]Not all of these rows are used in both the partial and the full mechanization matrices.

fixed-cost-paying activity; (iii) 150 real activities (crops and sheep) under various combinations of rotations, land classes, planting dates, irrigation or non-irrigation, harvesting alternatives and final destination of output; (iv) 16 machinery-using activities, which will tell the number of hours each machine is used during the year; (v) 59 transfer activities linking rows among one another. A summary of the columns is offered in Table 7-2, while a full description (name, unit and objective function coefficient) is contained in Table C-2.

A problem was posed by the fact that several time periods in which certain farm operations must be performed overlap with one another. This overlapping required additional rows, which are called "subsidiary" rows in Table C-1 (note j). A detailed exposition of the process followed in determining these rows and their coefficients, is given in Figure C-1 and Table C-3.

In order to make the matrices available for further research, they are reproduced in Tables C-4 and C-5.

Degrees of Mechanization

The degrees of mechanization within the partial and the full levels were successively determined during the computer runs, according to the shadow-price criterion established under the "Procedures to Satisfy the the Objectives" in Chapter III. Appendix B presents the shadow prices of limiting resources in all solutions, which dictated the pieces of machinery to be added to each degree of mechanization.

Table 7-2. Columns in the linear programming matrices[a]

Columns	Quantity	Identification numbers in Table G-2
Overall accounting activities[b]	8	368-375
Capital borrowing activity	1	376
Fixed cost paying activity	1	377
Crop activities[c]	36	378-413
Sheep raising activity	1	414
Growing activities[d]	11	415-425
Auxiliary activities[e]	75	426-500
Harvesting and processing activities	9	501-509
Selling activities	18	510-527
Machinery-using activities	16	528-543
Transfer activities	59	544-602
Total	235	

[a]Source: Summarized from Table G-2.

[b]Activities that count the total amount of land, labor and water used, the revenue from labor (wage bill), and the crop and livestock sales. The role of these activities is to expedite the interpretation of programming results.

[c]Rotations and continuous crops on the various classes of land and by levels of irrigation.

[d]Harvesting, processing and selling are excluded.

[e]Activities that determine the class of land to be destined to each crop and planting date, whether or not there is irrigation, how broad beans will be harvested (green or dry) and the final use of barley and alfalfa (silage, hay or pasture).

Once the analysis was completed, 27 degrees of partial and 27 degrees of full mechanization had been applied, which are described in Tables 7-3 and 7-4. The identification of the degrees, P1 through P27 for partial and F1 through F27 for full mechanization, will be retained throughout the rest of this study. These tables list the pieces of machinery added at each degree of mechanization and describe the composition of the various degrees.

A noticeable feature in Tables 7-3 and 7-4 is that all degrees of mechanization except P3, P8 and F3 include one more tractor than the previous degree. This stems from the fact that most of the other machines must be pulled by a tractor; since the crop calendars (Figures 5-1 through 5-3) may ask for simultaneous use of those machines, there is a higher requirement for tractor-time than for time of the other machines, with the result that tractor time tends to become limiting before other machines do.

Finally, Tables 7-5 and 7-6 show the fixed costs, total and annual, associated with each degree of mechanization. The figure for annual fixed cost entered the linear programming matrices as right-hand-side value of the *FIXCOST row (see Tables C-4 and C-5). However, the final value of the fixed-cost-paying activity mentioned in Table 7-2 is always larger than *FIXCOST, because it also includes the annual fixed cost of the small tools whose quantity is a function of the cooperative size, as explained in Chapter VI (Tables 6-12, note a).

Table 7-3. Degrees of partial mechanisation[a]

Degree	Added machines	Composition[b]								
		T	P	H	K	W	S	Z	Motor pump	Silo
P1[c]		1	1	1	1	1	1	1	1	1
P2	tractor	2	1	1	1	1	1	1	1	1
P3	plow sprayer	2	2	1	2	1	1	1	1	1
P4	tractor	3	2	1	2	1	1	1	1	1
P5	tractor plow sprayer sprinkler	4	3	1	3	1	1	2	1	1
P6	tractor plow	5	4	1	3	1	1	2	1	1
P7	tractor harrow sprayer sprinkler	6	4	2	4	1	1	3	1	1
P8	plow wagon sorter	6	5	2	4	2	2	3	1	1
P9	tractor sprayer	7	5	2	5	2	2	3	1	1
P10	tractor plow sprinkler	8	6	2	5	2	2	4	1	1
P11	tractor plow sprayer	9	7	2	6	2	2	4	1	1
P12	tractor sprayer	10	7	2	7	2	2	4	1	1
P13	tractor plow wagon	11	8	2	7	3	2	4	1	1

[a]Sources: Derived from Tables H-1 to H-46.

[b]Degrees of mechanisation as entered into the model. The composition of each degree as it is actually used in each solution is further determined by the information given in Appendix I, where unused pieces of machinery are listed. The symbols for machinery are the same ones used in the linear programming matrix (see Table G-1): T = tractor, P = plow, H = harrow, K = sprayer, W = wagon, S = sorter, Z = sprinkler.

[c]As in Table 6-11 (taking note c into consideration).

Table 7-3. (Continued)

Degree	Added machines	Composition[b]								
		T	P	H	K	W	S	Z	Motor pump	Silo
P14	tractor plow harrow sprayer	12	9	3	8	3	2	4	1	1
P15	tractor plow harrow sprayer sorter	13	10	4	9	3	3	4	1	1
P16	tractor sprayer wagon	14	10	4	10	4	3	4	1	1
P17	tractor plow	15	11	4	10	4	3	4	1	1
P18	tractor plow sprayer	16	12	4	11	4	3	4	1	1
P19	tractor sprayer wagon	17	12	4	12	5	3	4	1	1
P20	tractor plow	18	13	4	12	5	3	4	1	1
P21	tractor plow sprayer	19	14	4	13	5	3	4	1	1
P22	tractor harrow sorter	20	14	5	13	5	4	4	1	1
P23	tractor plow sprayer	21	15	5	14	5	4	4	1	1
P24	tractor harrow	22	15	6	14	5	4	4	1	1
P25	tractor plow wagon	23	16	6	14	6	4	4	1	1
P26	tractor plow harrow sprayer wagon	24	17	7	15	7	4	4	1	1
P27	tractor wagon	25	17	7	15	8	4	4	1	1

Table 7-4. Degrees of full mechanization[a]

Degree	Added machines	Composition[b]															
		T	P	H	PP	G	C	K	F	R	B	D	W	S	Z	Motor pump	Silo
F1[c]		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
F2	tractor	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
F3	plow sprayer	2	2	1	1	1	1	2	1	1	1	1	1	1	1	1	1
F4	tractor planter	3	2	1	2	1	1	2	1	1	1	1	1	1	1	1	1
F5	tractor plow sprinkler	4	3	1	2	1	1	2	1	1	1	1	1	1	2	1	1
F6	tractor digger wagon	5	3	1	2	1	1	2	1	1	1	2	2	1	2	1	1
F7	tractor plow harrow drill cultivator	6	4	2	2	2	2	2	1	1	1	2	2	1	2	1	1
F8	tractor plow planter sprayer harvester sorter sprinkler	7	5	2	3	2	2	3	2	1	1	2	2	2	3	1	1
F9	tractor plow planter digger wagon	8	6	2	4	2	2	3	2	1	1	3	3	2	3	1	1

[a]Source: Derived from Tables H-47 to H-88.

[b]Degrees of mechanization as entered into the model. The composition of each degree as it is actually applied to each solution is further determined by the information given in Appendix I, where unused pieces of machinery are listed. The symbols for machinery are the same ones used in the linear programming matrix (see Table G-1): T = tractor, P = plow, H = harrow, PP = potato planter, G = grain drill, C = cultivator, K = sprayer, F = forage harvester, R = hay rake, B = hay baler, D = potato digger, W = wagon, S = sorter, Z = sprinkler.

[c]As in Table 6-11.

Table 7-4. (Continued)

Degree	Added machines	Composition[b]															
		T	P	H	PP	G	C	K	F	R	B	D	W	S	Z	Motor pump	Silo
F10	tractor planter wagon sprinkler	9	6	2	5	2	2	3	2	1	1	3	4	2	4	1	1
F11	tractor plow harrow cultivator harvester baler	10	7	3	5	2	3	3	3	1	2	3	4	2	4	1	1
F12	tractor drill sprayer	11	7	3	5	3	3	4	3	1	2	3	4	2	4	1	1
F13	tractor plow cultivator sprayer rake digger	12	8	3	5	3	4	5	3	2	2	4	4	2	4	1	1
F14	tractor plow planter wagon	13	9	3	6	3	4	5	3	2	2	4	5	2	4	1	1
F15	tractor plow harrow sorter	14	10	4	6	3	4	5	3	2	2	4	5	3	4	1	1
F16	tractor drill baler digger	15	10	4	6	4	4	5	3	2	3	5	5	3	4	1	1
F17	tractor plow planter harvester	16	11	4	7	4	4	5	4	2	3	5	5	3	4	1	1
F18	tractor plow planter cultivator sprayer wagon	17	12	4	8	4	5	6	4	2	3	5	6	3	4	1	1

Table 7-4. (Continued)

Degree	Added machines	Composition[b]															
		T	P	H	PP	G	C	K	F	R	B	D	W	S	Z	Motor pump	Silo
F19	tractor harrow planter wagon	18	12	5	9	4	5	6	4	2	3	5	7	3	4	1	1
F20	tractor plow drill harvester digger	19	13	5	9	5	5	6	5	2	3	6	7	3	4	1	1
F21	tractor plow planter wagon	20	14	5	10	5	5	6	5	2	3	6	8	3	4	1	1
F22	tractor sprayer sorter	21	14	5	10	5	5	7	5	2	3	6	8	4	4	1	1
F23	tractor plow harrow planter sprayer baler	22	15	6	11	5	5	8	5	2	4	6	8	4	4	1	1
F24	tractor cultivator rake	23	15	6	11	5	6	8	5	3	4	6	8	4	4	1	1
F25	tractor plow drill sprayer	24	16	6	11	6	6	9	5	3	4	6	8	4	4	1	1
F26	tractor plow cultivator	25	17	6	11	6	7	9	5	3	4	6	8	4	4	1	1
F27	tractor harrow planter cultivator	26	17	6	12	6	8	9	5	3	4	6	8	4	4	1	1

Table 7-5. Fixed cost of the various degrees of partial mechanization (in pesos)[a]

Degrees	Fixed cost		Additional fixed cost[b]	
	Total[c]	Annual	Total	Annual
P1	203612.38	27107.967		
P2	275242.38	36943.267	71630.	9835.3
P3	287621.76	39287.025	12379.38	2343.758
P4	359251.76	49112.325	71630.	9835.3
P5	454311.14	63037.383	95059.38	13915.058
P6	535710.14	74407.223	81399.	11369.84
P7	631573.52	88450.921	95863.38	14043.698
P8	652992.52	91509.128	21419.	3058.207
P9	727232.9	102153.646	74240.38	10644.518
P10	819681.9	115259.486	92449.	13105.84
P11	903691.28	127438.544	84009.38	12179.058
P12	977931.66	138083.062	74240.38	10644.518
P13	150460.569	150460.569	89449.	12377.507
P14	1161963.04	164302.807	94582.38	13842.238
P15	1260145.42	178661.045	98182.38	14358.238
P16	1342435.8	190286.23	82290.38	11625.185
P17	1423834.8	201656.07	81399.	11369.84
P18	1507844.18	213835.07	84099.38	12179.058
P19	1590134.56	225460.153	82290.38	11625.185
P20	1671533.56	236830.153	81399.	11369.24
P21	1755542.94	249009.211	84009.38	12179.058
P22	1841345.94	261023.691	85803.	12014.48
P23	1925355.32	273202.749	84009.	12179.058
P24	2007558.32	284701.229	82203.	11498.48
P25	2097007.32	297078.736	89449.	12377.507
P26	2199639.7	311928.641	102632.38	14849.905
P27	2279319.7	322771.608	79680.	10842.967

[a]Source: Computed from Tables 6-1, 6-11 and 7-3.

[b]Fixed cost of the machines added to each degree of mechanization in Table 7-3.

[c]Investment in machinery (at purchase price).

Table 7-6. Fixed cost of the various degrees of full mechanization (in pesos)[a]

Degrees	Fixed cost		Additional fixed cost[b]	
	Total[c]	Annual	Total	Annual
F1	374227.38	50657.367		
F2	445907.38	60492.667	71630.	9835.3
F3	458286.76	62836.425	12379.38	2343.758
F4	564766.76	77055.392	106480.	14218.967
F5	657215.76	90161.232	92449.	13105.84
F6	744185.76	102011.766	86970.	11850.534
F7	864832.76	119039.953	120647.	17028.187
F8	1044667.14	144447.511	179834.38	25407.558
F9	1176256.14	162216.252	131589.	17768.741
F10	1301836.14	179178.886	125580.	16962.634
F11	1493883.14	206641.572	192047.	27462.686
F12	1584448.52	219317.257	90565.38	12675.685
F13	1700222.9	236165.215	115774.38	16847.958
F14	1824521.9	252926.389	124299.	16761.174
F15	1920093.9	266475.409	95572.	13549.02
F16	2056738.9	285222.276	136645.	18746.867
F17	2219312.9	307568.616	162574.	22346.34
F18	2358572.28	327103.008	139259.38	19534.392
F19	2483675.28	343992.822	125103.	16889.814
F20	2635014.28	364994.229	151339.	21001.407
F21	2759313.28	381755.403	124299.	16761.174
F22	2837153.66	392915.821	77840.38	11160.518
F23	3007986.04	417014.65	170832.38	24098.738
F24	3104091.04	430511.292	96105.	13496.633
F25	3204425.42	444721.517	100334.38	14210.225
F26	3298174.42	458055.357	93749.	13333.84
F27	3427577.42	475901.504	129403.	17846.147

[a]Source: Computed from Tables 6-1, 6-11 and 7-4.

[b]Fixed cost of the machines added to each degree of mechanization in Table 7-4.

[c]Investment in machinery (at purchase price).

Computer Runs

A total of 88 computer runs, 46 under partial and 42 under full mechanization, were required to obtain the solutions for the six cooperative sizes analyzed in the study. Each run combined a certain degree of mechanization with a certain cooperative size, while farm size was parameterized upwards, each step yielding an optimal solution. The overall number of optimal solutions obtained is 780 under partial and 737 under full mechanization, for a total of 1517.

Table 7-7 shows how many solutions (parametric steps) occurred for each combination of cooperative size with each level and degree of mechanization. The starting degree of mechanization for each cooperative size was dictated by the shadow-prices (Appendix H), according to the criteria established under "Procedures to Satisfy the Objectives" in Chapter III.

The 1517 optimal solutions obtained from the computer runs were processed in the following two steps:

1. The slack values in the rows section of each solution were checked in order to detect pieces of machinery which were not used during any time period and must, therefore, be excluded. As a result of these checks, the Tables in Appendix I were constructed which list the farm machinery that is not utilized in each solution. These Tables should be used to determine the exact composition of each degree of mechanization as it actually enters a given solution. For example, Table I-3 says that when the P7 degree of mechanization is applied to cooperative size 625,

Table 7-7. Number of optimal solutions obtained, by cooperative size and by level and degree of mechanization

Degree of mechanization	Cooperative size and level of mechanization[a]												Total
	125		275		425		625		1000		1650		
	P	F	P	F	P	F	P	F	P	F	P	F	
1	9	9											
2	16	16	8	6*									
3	25	24	11	11									
4			18	18	9*	4*							
5			26	25	15	16	9						
6					20	17	13	4*					
7					24	24	17	15*	7*				
8							17	19	9	8*			
9							19	22	11	10*			
10							22	24	13	14			
11							25	24	15	18	4*		
12									17	18	9		
13									20	20	10	7*	
14									21	22	12	9*	
15									23	23	13	11*	
16									25	25	14	12	
17									27	28	15	16	
18											16	17	
19											17	18	
20											18	19	
21											20	20	
22											21	21	
23											22	23	
24											23	23	
25											24	25	
26											26	26	
27											25	24	
Total P	50		63		68		122		188		289		780
Total F		49		62		61		108		186		271	737
Total	99		125		129		230		374		560		1517

[a]The starred figures in the body of the Table mean that the parametric routine does not begin at the 2 ha/person farm size, as it should according to Table 3-1. The farm size at which the routine begins can be seen in Tables 8-1 through 8-8. The starting farm size is chosen according to the shadow-price criteria given under "Procedures to Satisfy the Objectives" in Chapter III, the shadow-prices being presented in Appendix H.

one sprayer is not used in the first five solutions and the silo in the first seven solutions.

The possibility of some pieces of machinery going unused stems from the fact that the degrees of mechanization, as presented in Tables 7-5 and 7-6, are cumulative, that is, each degree includes all the machinery in the previous one plus some additional machines; it may happen, then, that the additional machines permit a reallocation of resources such that some of the previous machines become unnecessary.

2. The second step in processing each optimal solution consisted in obtaining the following 12 values:

Income per person in the cooperative, Average productivities of land, labor and capital, Relative use of land, labor and water, Working capital borrowed per person, Wage bill as a percent of income, Average variable cost, Average total cost, and Crop output as a percent of total output sold. The first one of the 12 values obtained, income per person, is the most important, because it constitutes the criterion for comparing the various optimal solutions within and among cooperatives. The results are discussed in the next Chapter.

CHAPTER VIII. INTERPRETATION OF THE RESULTS

This chapter contains a discussion of the results of this study in terms of optimal solutions and farm plans, productivity of the various resources, paths for mechanization, alternative criteria of optimality and comparison with the present situation. The Tables which support this discussion are reproduced in Appendix J. However, Tables on income per person for all 1517 solutions are included in this Chapter (Tables 8-1 through 8-8), because understanding of their structure is a prerequisite for this entire discussion of the results.

Optimal Solutions

Each one of the solutions obtained is optimal for a given combination of cooperative size, farm size and degree of mechanization, that is, for these three variables fixed at certain levels. The effect on income per person of allowing changes in farm size and degree of mechanization for each cooperative can be seen in Tables 8-1 through 8-8. For example, in Table 8-1 it can be seen that, for cooperative size 125 with 4.5 ha/person, income per person increases from 2083.6 to 2527.3 pesos as mechanization goes from P1 to P3. It can also be seen that, with P3 degree of mechanization, income per person grows from 2461 to 2950.4 pesos as farm size increases up to 16 ha/person and beyond.

Each column in Tables 8-1 through 8-8 is the outcome of a parametric routine on land at a certain degree of mechanization. Therefore, income per person increases down the columns in the Tables, since the value of

Table 8-1. Income per person in the solutions for cooperative size 125 (in pesos)

Farm size in ha/person	Degrees of partial mechanization			Degrees of full mechanization		
	P1	P2	P3	F1	F2	F3
4.	1937.3	2240.2	2461.	1621.	2051.6	2349.4
4.5	2083.6	2365.5	2527.3	1765.3	2201.7	2454.7
5.	2185.6	2487.4	2597.1	1849.8	2351.9	2605.5
5.5	2221.4	2606.3	2666.8	1884.4	2432.4	2671.5
6.	2256.3	2724.1	2735.3	1918.3	2559.1	2742.5
6.5	2290.5	2819.8	2803.8	1952.1	2729.7	2813.
7.	2324.6	2862.9	2861.4	1985.9	2836.5	2882.7
7.5	2358.8	2873.	2871.5	2014.5	2928.8	2918.3
8.	2362.6	2883.	2881.5	2019.2	2939.9	2929.6
8.5		2893.1	2891.6		2950.8	2940.2
9.		2903.1	2901.6		2961.4	2944.
9.5		2913.2	2911.7		2971.9	2954.3
10.		2923.2	2921.7		2982.4	2964.5
10.5		2930.6	2929.1		2992.7	2974.8
11.		2936.	2934.5		3003.	2985.
11.5		2938.1	2931.5		3007.2	2995.3
12.			2936.8			3005.5
12.5			2940.7			3015.8
13.			2943.4			3026.
13.5			2946.1			3034.
14.			2948.8			3048.5
14.5			2951.4			3056.5
15.			2947.6			3064.4
15.5			2950.3			3066.9
16.			2950.4			3066.9

Table 8-2. Income per person in the solutions for cooperative size 275 (in pesos)

Farm size in ha/person	Degrees of partial mechanization				Degrees of full mechanization			
	P2	P3	P4	P5	F2	F3	F4	F5
2.	1080.2	1311.4	1615.8	1707.8		1134.9	1458.8	1536.4
2.5	1231.9	1464.8	1765.9	2083.6		1283.	1606.3	1943.2
3.	1384.2	1617.7	1915.6	2243.2	1278.6	1429.4	1727.2	2090.6
3.5	1484.3	1770.5	2065.	2360.3	1377.5	1575.3	1873.7	2224.9
4.	1521.8	1922.6	2214.5	2478.2	1414.6	1720.9	2019.1	2355.8
4.5	1559.3	2034.6	2352.3	2594.4	1451.7	1798.9	2164.4	2478.6
5.	1596.7	2070.5	2476.1	2674.4	1488.6	1832.9	2309.3	2621.8
5.5	1603.6	2106.3	2594.3	2745.6	1495.4	1866.8	2451.7	2726.3
6.		2142.1	2709.	2815.4		1900.8	2591.2	2845.6
6.5		2177.9	2822.9	2885.1		1934.7	2714.6	2915.6
7.		2200.2	2859.7	2929.6		1957.3	2753.	2958.1
7.5			2887.7	2939.6			2786.6	3019.4
8.			2915.7	2949.7			2820.2	3030.5
8.5			2944.9	2959.7			2851.9	3041.
9.			2970.8	2969.8			2880.4	3051.3
9.5			2995.9	2979.8			2908.9	3061.6
10.			3021.	2989.9			2937.4	3071.8
10.5			3030.4	2997.3			2947.6	3082.1
11.				3002.6				3092.4
11.5				3007.9				3102.6
12.				3013.				3112.9
12.5				3017.1				3123.2
13.				3018.				3133.4
13.5				3022.5				3141.9
14.				3025.2				3145.9
14.5				3025.5				

Table 8.3. Income per person in the solutions for cooperative size 425 (in pesos)

Farm size in ha/person	Degrees of partial mechanization				Degrees of full mechanization			
	P4	P5	P6	P7	F4	F5	F6	F7
2.		1553.	1734.2	1728.3		1377.6	1493.5	1582.9
2.5		1707.9	1931.3	2088.2		1527.1	1643.6	1933.8
3.	1550.2	1859.	2069.3	2212.5		1665.2	1790.6	2082.4
3.5	1696.9	2008.1	2203.8	2334.2		1797.3	1940.	2212.6
4.	1840.6	2154.9	2328.9	2453.8		1939.3	2072.4	2356.2
4.5	1928.	2287.2	2451.1	2572.8		2026.6	2220.2	2485.5
5.	1963.6	2418.8	2570.6	2689.1		2059.2	2367.3	2609.
5.5	1998.6	2547.3	2689.6	2767.9	1842.3	2082.4	2513.2	2739.1
6.	2032.9	2631.8	2807.4	2837.1	1874.6	2100.8	2657.1	2844.3
6.5	2067.2	2660.8	2920.9	2906.9	1906.9	2124.5	2769.5	2948.3
7.	2073.4	2689.8	2981.4	2956.	1912.8	2137.1	2805.4	3019.8
7.5		2718.7	2991.8	2966.1		2149.6	2837.	3049.9
8.		2747.5	3001.9	2976.1		2162.	2867.7	3060.7
8.5		2776.	3012.	2986.2		2167.6	2898.1	3071.5
9.		2803.4	3022.1	2996.2		2170.5	2927.9	3082.3
9.5			3032.2	3004.4		2171.2	2957.7	3093.1
10.			3042.4	3016.3			2980.8	3103.9
10.5			3050.1	3023.7				3114.7
11.			3054.2	3029.1				3124.1
11.5			3056.1	3030.3				3131.9
12.				3035.5				3139.6
12.5				3037.7				3147.3
13.				3040.3				3154.
13.5				3041.3				3154.1

Table 8-4. Income per person in the solutions for cooperative size 625 (in pesos)

Farm size in ha/ person	Degrees of partial mechanization					
	P5	P6	P7	P8	P9	P10
2.	1248.3	1407.2	1526.	1576.7	1727.7	1746.6
2.5	1397.6	1560.6	1676.4	1732.2	1880.4	1994.1
3.	1546.7	1714.	1826.5	1886.5	2029.4	2130.4
3.5	1695.9	1867.4	1976.5	2040.2	2173.2	2253.
4.	1815.5	2017.6	2126.5	2175.4	2305.	2376.2
4.5	1851.3	2162.5	2275.3	2309.9	2427.	2496.2
5.	1887.1	2259.7	2425.3	2443.1	2548.4	2612.8
5.5	1922.9	2295.3	2556.6	2563.9	2667.3	2732.4
6.	1958.3	2331.	2621.9	2671.3	2785.8	2840.5
6.5		2366.	)640.1	2700.4	2904.8	2929.6
7.		2401.	2658.	2729.2	2992.4	2980.1
7.5		2435.2	2674.9	2757.9	3004.3	2990.1
8.		2444.4	2689.8	2786.6	3014.7	3000.2
8.5			2702.6	2815.3	3025.1	3010.2
9.			2706.	2845.6	3035.5	3020.3
9.5			2709.5	2853.3	3047.1	3030.3
10.			2709.8	2850.3	3057.4	3040.4
10.5					3064.6	3047.6
11.					3065.3	3052.6
11.5						3054.2
12.						3056.4
12.5						3059.1
13.						
13.5						
14.						

	Degrees of full mechanisation					
F11	F6	F7	F8	F9	F10	F11
1686.7			1554.4	1604.9	1602.3	1603.6
2015.9		1534.7	1711.5	1812.1	1909.4	1925.2
2140.6		1681.3	1858.	1957.8	2060.1	2100.2
2261.1		1826.7	2004.2	2111.	2204.1	2235.4
2380.5		1972.	2150.2	2255.5	2350.2	2360.1
2493.8		2115.3	2292.9	2400.1	2493.7	2484.3
2612.3		2256.9	2431.3	2543.2	2616.9	2606.6
2702.3	1955.5	2392.3	2563.9	2678.6	2743.6	2735.7
2797.2	1990.7	2450.1	2695.9	2802.9	2849.6	2843.2
2864.7	2023.9	2483.6	2793.5	2927.7	2952.1	2947.4
2932.1	2039.5	2514.3	2794.5	3032.9	3031.6	3028.8
2942.1		2540.	2806.2	3069.5	3061.2	3040.
2952.2		2558.4	2818.	3080.3	3072.5	3058.4
2962.2		2570.1	2829.7	3091.2	3082.8	3072.4
2972.3		2573.	2851.9	3102.	3093.1	3082.6
2982.3		2574.3	2863.5	3113.4	3103.3	3092.9
2992.4			2875.2	3124.2	3113.6	3103.2
2999.6			2882.4	3142.	3123.9	3113.5
3003.6			2884.5	3144.9	3141.2	3120.
2989.3				3150.3	3151.5	3130.2
2995.6				3157.5	3161.7	3140.5
2998.7				3158.3	3172.	3150.7
2999.9					3172.3	3158.2
2997.3					3171.	3156.5
2997.						

Table 8-5. Income per person in the solutions for cooperative size 1000, under partial mechanization (in pesos)

Farm size in ha/person	Degrees of partial mechanization										
	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17
2.		1211.6	1302.5	1380.6	1424.4	1525.1	1594.5	1620.5	1617.7	1608.8	1599.
2.5		1364.1	1451.2	1528.4	1573.8	1673.8	1743.3	1811.6	1879.9	1938.	1956.9
3.		1517.6	1600.4	1677.4	1723.5	1821.7	1890.1	1958.9	2025.8	2069.8	2108.9
3.5	1622.2	1667.5	1749.5	1820.5	1873.1	1970.4	2038.6	2106.3	2157.6	2193.9	2229.7
4.	1664.1	1720.4	1898.7	1972.6	2017.2	2119.	2186.6	2242.6	2280.7	2315.8	2349.4
4.5	1686.5	1756.2	1995.8	2116.7	2161.	2264.5	2323.2	2366.8	2401.7	2433.1	2466.1
5.	1707.8	1791.7	2031.7	2236.9	2296.1	2398.3	2438.	2475.4	2510.	2540.9	2573.8
5.5	1718.2	1826.5	2067.5	2272.5	2425.	2509.3	2545.7	2579.9	2615.	2645.2	2672.5
6.	1722.6	1835.5	2103.3	2308.2	2470.6	2616.	2651.3	2683.3	2717.	2744.8	2764.5
6.5	1723.7		2138.8	2343.7	2503.2	2672.1	2755.1	2784.1	2820.8	2839.2	2838.
7.			2148.7	2377.2	2531.9	2679.	2824.3	2886.9	2915.6	2916.1	2907.2
7.5				2410.	2558.2	2724.	2849.3	2969.4	2980.2	2967.5	2867.5
8.				2420.6	2583.3	2748.	2873.3	2991.5	2989.2	2988.2	2988.2
8.5					2608.	2772.	2897.2	3004.7	2999.	2997.9	2997.9
9.					2613.4	2796.	2922.	3014.9	3008.7	3007.7	3007.7
9.5						2820.	2945.9	3026.	3018.4	3017.4	3017.4
10.						2823.7	2969.7	3036.2	3028.1	3027.1	3027.1
10.5							2992.9	3046.4	3039.4	3036.8	3038.4
11.							2995.	3058.8	3049.1	3046.6	3048.1
11.5								3060.4	3052.	3040.4	3040.4
12.								3060.5	3055.2	3042.5	3032.7
12.5									3056.5	3048.1	3035.9
13.									3056.7	3047.9	3035.6
13.5										3046.6	3039.2
14.										3046.6	3037.
14.5											3037.3
15.											3037.4

Table 8-6. Income per person in the solutions for cooperative size 1000, under full mechanization (in pesos)

Farm size in ha/person	Degrees of full mechanization									
	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17
2.			1317.6	1344.4	1429.6	1492.8	1483.	1486.6	1491.	1481.3
2.5			1462.8	1495.3	1571.5	1653.3	1709.3	1773.9	1808.9	1802.4
3.			1607.6	1642.8	1718.9	1790.9	1853.8	1911.8	1975.9	2031.6
3.5	1610.7	1692.9	1745.	1790.8	1867.4	1937.2	2000.	2059.	2122.6	2175.4
4.	1741.4	1832.1	1890.6	1938.3	2014.8	2082.5	2149.5	2204.2	2259.	2311.9
4.5	1764.2	1975.3	2036.9	2078.	2159.3	2220.7	2292.2	2352.3	2398.7	2435.9
5.	1778.4	2036.4	2163.9	2204.9	2284.7	2343.8	2415.9	2479.3	2511.8	2548.9
5.5	1791.5	2068.7	2242.	2316.9	2410.3	2466.7	2534.4	2590.7	2619.9	2662.2
6.	1800.7	2102.	2275.2	2361.4	2535.3	2595.8	2661.6	2698.8	2736.3	2761.
6.5	1804.3	2135.2	2308.5	2391.6	2612.3	2720.5	2769.2	2806.8	2837.	2852.5
7.	1805.9	2167.5	2339.6	2421.2	2635.1	2829.	2880.3	2914.1	2934.1	2924.5
7.5		2194.9	2362.6	2450.8	2654.2	2861.9	2981.1	3002.6	3002.5	3002.5
8.		2196.1	2390.	2480.3	2671.5	2887.	3020.	3068.3	3060.2	3051.4
8.5			2412.1	2498.3	2687.3	2917.8	3040.8	3068.3	3072.1	3061.7
9.				2502.4	2701.9	2941.9	3061.7	3079.9	3082.1	3071.6
9.5				2506.1	2712.	2966.0	3080.1	3094.3	3092.1	3081.6
10.				2509.9	2716.5	2990.1	3095.9	3104.3	3102.1	3091.6
10.5				2510.5	2719.7	3014.1	3107.4	3114.3	3112.	3101.6
11.						3042.7	3118.5	3125.1	3122.	3123.
11.5						3049.9	3129.5	3135.1	3132.	3133.
12.							3140.	3144.2	3141.1	3142.2
12.5							3144.1	3154.3	3147.7	3138.9
13.								3155.8	3151.8	3152.8
13.5									3158.2	3145.
14.									3159.	3148.8
14.5										3149.5
15.										3154.8
15.5										3154.8

Table 8-7. Income per person in the solutions for cooperative size 1650, under partial mechanization (in pesos)

Farm size in ha/ person	Degrees of partial mechanization							
	P11	P12	P13	P14	P15	P16	P17	P18
2.		1152.2	1196.8	1242.7	1287.8	1329.5	1373.4	1418.5
2.5		1301.	1342.	1388.1	1433.2	1477.1	1519.6	1565.2
3.		1440.3	1483.5	1527.5	1571.7	1615.9	1659.	1704.3
3.5		1569.3	1610.5	1656.6	1701.6	1744.9	1788.	1833.3
4.	1516.6	1650.1	1741.2	1785.	1830.5	1873.9	1917.1	1961.9
4.5	1550.3	1683.8	1794.5	1911.6	1956.7	2000.3	2043.9	2088.7
5.	1583.2	1716.8	1829.5	1945.1	2060.5	2126.4	2169.7	2214.2
5.5	1598.5	1748.1	1857.8	1975.	2091.5	2206.	2293.6	2338.6
6.		1766.9	1886.5	2002.8	2121.3	2235.8	2349.	2458.1
6.5			1907.9	2030.6	2151.1	2265.6	2378.8	2489.3
7.				2053.7	2180.9	2295.4	2408.6	2513.8
7.5				2054.2	2210.7	2325.2	2438.5	2535.9
8.					2215.1	2354.4	2468.3	2561.1
8.5						2363.9	2498.1	2586.1
9.							2512.7	2610.8
9.5								2626.6
10.								
10.5								
11.								
11.5								
12.								
12.5								
13.								
13.5								
14.								
14.5								

P19	P20	P21	P22	P23	P24	P25	P26	P27
1458.7	1501.7	1526.3	1529.7	1527.8	1524.	1518.	1510.3	
1607.4	1648.3	1689.4	1731.3	1770.8	1806.2	1848.5	1866.7	1869.
1747.6	1788.4	1829.7	1871.4	1911.4	1947.	1991.2	2015.6	2037.4
1875.2	1917.3	1958.6	2000.3	2040.4	2075.2	2100.8	2121.9	2144.7
2004.1	2046.3	2087.5	2129.3	2161.7	2185.6	2208.	2230.	2251.1
2130.8	2173.	2214.1	2244.5	2266.3	2290.1	2322.4	2332.1	2352.2
2256.8	2298.8	2324.1	2347.1	2369.	2391.8	2412.1	2431.1	2450.7
2373.6	2404.2	2427.8	2449.5	2470.1	2491.7	2511.1	2530.1	2550.5
2482.9	2505.6	2529.3	2549.9	2569.4	2590.3	2609.5	2629.6	2649.2
2566.4	2606.6	2628.9	2647.7	2667.8	2688.4	2708.4	2727.4	2744.8
2591.2	2670.8	2726.6	2745.4	2766.5	2786.4	2806.4	2821.6	2830.8
2616.	2694.9	2771.6	2842.7	2863.3	2884.1	2898.9	2903.7	2900.6
2640.8	2718.9	2795.6	2870.1	2940.5	2971.6	2968.8	2961.	2961.3
2665.5	2742.9	2819.6	2893.6	2961.6	2982.7	2978.5	2970.7	2971.
2691.2	2767.	2843.6	2917.4	2984.7	2993.1	2988.	2980.4	2980.7
2715.7	2791.	2867.5	2941.2	3004.4	3003.6	2997.4	2997.1	2996.9
2735.5	2814.8	2891.2	2964.8	3015.9	3014.1	3007.6	3007.3	3007.1
	2838.1	2914.7	2986.5	3026.6	3023.5	3017.3	3017.	3016.8
		2937.6	3008.3	3036.8	3034.4	3028.	3027.7	3027.5
		2941.	3029.9	3047.4	3043.9	3037.7	3037.4	3037.2
			3037.1	3054.1	3050.4	3042.3	3034.6	3035.
				3055.1	3051.7	3047.	3037.6	3031.1
					3051.3	3048.9	3040.6	3031.4
						3050.1	3041.3	3034.1
							3043.5	3035.3
							3043.7	3034.

Table 8-8. Income per person in the solutions for cooperative size 1650, under full mechanization (in pesos)

Farm size in ha/ person	Degrees of full mechanization						
	F13	F14	F15	F16	F17	F18	F19
2.					1283.7	1315.4	1353.2
2.5					1422.1	1457.8	1498.7
3.				1521.6	1560.6	1596.2	1634.6
3.5			1611.4	1647.6	1686.7	1724.8	1761.
4.	1661.2	1698.2	1735.9	1768.1	1807.8	1846.7	1887.1
4.5	1728.1	1818.1	1859.6	1890.2	1929.8	1968.7	2004.8
5.	1755.6	1860.6	1957.6	2006.8	2049.2	2089.6	2126.4
5.5	1782.9	1888.2	1985.4	2095.6	2167.3	2205.8	2244.5
6.	1810.3	1912.3	2014.5	2122.9	2226.	2319.8	2363.3
6.5	1837.6	1934.7	2046.3	2150.3	2253.4	2355.3	2453.9
7.	1852.4	1955.8	2075.6	2177.6	2280.7	2382.7	2486.6
7.5		1963.8	2102.5	2205.	2308.1	2410.1	2514.
8.		1966.6	2109.6	2232.3	2335.4	2437.4	2542.
8.5			2109.8	2257.3	2362.8	2464.8	2569.6
9.					2390.1	2491.1	2597.
9.5					2394.1	2518.4	2623.2
10.						2528.7	2649.1
10.5							2659.2
11.							
11.5							
12.							
12.5							
13.							
13.5							
14.							
14.5							

F20	F21	F22	F23	F24	F25	F26	F27
1381.1	1402.2	1402.9	1411.8	1406.7	1407.4	1406.7	
1527.6	1565.4	1598.3	1638.2	1678.6	1711.8	1721.5	
1665.7	1701.4	1730.	1775.	1818.6	1845.3	1880.4	1926.9
1797.4	1830.7	1858.4	1904.1	1949.8	1972.3	2011.1	2057.1
1922.9	1960.	1987.2	2030.3	2069.5	2104.	2140.2	2181.9
2042.4	2079.2	2106.9	2152.7	2194.3	2230.7	2266.8	2303.6
2163.4	2202.4	2229.3	2274.3	2310.8	2348.9	2391.8	2413.3
2279.	2305.4	2352.5	2395.1	2433.3	2470.2	2490.8	2515.5
2400.5	2440.1	2469.4	2509.1	2552.5	2571.6	2593.9	2614.2
2516.8	2557.4	2588.6	2628.2	2653.1	2674.1	2696.5	2725.
2585.4	2673.	2704.	2736.6	2755.9	2776.9	2808.6	2823.3
2613.4	2703.1	2787.1	2838.7	2858.3	2890.6	2901.9	2914.8
2641.3	2730.4	2816.3	2914.7	2969.5	2983.5	2993.2	2991.5
2669.2	2752.7	2844.2	2944.5	3005.1	3060.7	3057.5	3051.
2696.6	2777.7	2868.9	2974.3	3030.2	3069.6	3068.	3860.6
2723.9	2806.6	2893.	2988.1	3051.2	3082.2	3078.	3070.6
2751.3	2831.9	2917.1	3008.3	3072.8	3092.2	3088.	3080.6
2778.6	2863.8	2941.3	3037.3	3093.7	3102.2	3097.9	3090.5
2797.1	2896.5	2965.4	3061.7	3116.2	3112.2	3107.9	3101.4
	2889.	2989.5	3082.6	3129.	3127.4	3122.7	3112.6
		3005.6	3103.4	3140.7	3137.4	3132.2	3122.6
			3124.3	3150.6	3146.8	3141.9	3132.6
			3127.2	3152.	3152.3	3142.1	3142.2
					3148.1	3150.1	3147.9
					3147.5	3147.	3146.3
						3145.1	3148.2

the objective function increases at each parametric step until it reaches the highest possible value for that degree of mechanization and cooperative size (land ceases to be limiting). However, there are a few solutions for which income per person is lower than at the previous step. The explanation for these exceptions lies in the pattern of unused machinery and its impact on the fixed cost to the farm. This happens, for example, in Table 8-4, where the last solution for F11 shows a lower income per person than the previous solution. The last solution employs one more potato planter than the previous one (see Table I-45), but the increase in income thus achieved (marginal revenue) is smaller than the annual fixed cost of the added potato planter (marginal cost), thus resulting in a lower income per person.

Among the three variables, cooperative size, degree of mechanization and farm size, the first one is considered fixed by sociological patterns and historical heritage. The second one can easily be a decision variable; that is, the farm managers may freely decide what degree of mechanization will be applied in order to maximize income. Moving horizontally in each of the Tables 8-1 through 8-8, the highest income per person for each farm size can be found, which indicates the optimal degree of mechanization associated with that farm size and cooperative size. Using this procedure, Table 8-9 was constructed, which presents the optimal income per person for each cooperative size and farm size combination when the degree of mechanization is treated as a variable. In other words, Table 8-9 shows the highest income per person that each cooperative can achieve

Table 8-9. Optimal level of mechanization and income per person for the various farm sizes, by cooperative size[a]

Farm size in ha/ person	Cooperative size 125		275		425		625		1000		1650	
	level of mech.	income per person	level of mech.	income per person	level of mech.	income per person	level of mech.	income per person	level of mech.	income per person	level of mech.	income per person
2.			P5	1707.8	P6	1734.2	P10	1746.6	P14	1620.5	P22	1529.7
2.5			P5	2083.6	P7	2088.2	P11	2015.9	P17	1956.9	P27	1869.
3.			P5	2243.2	P7	2212.5	P11	2140.6	P17	2108.9	P27	2037.4
3.5			P5	2360.3	P7	2334.2	P11	2261.1	P17	2229.7	P27	2144.7
4.	P3	2461.	P5	2478.2	P7	2453.8	P11	2380.5	P17	2349.4	P27	2251.1
4.5	P3	2527.3	P5	2594.4	P7	2572.8	P10	2496.2	P17	2466.1	P27	2352.2
5.	F3	2605.5	P5	2674.4	P7	2689.1	F10	2616.9	P17	2573.8	P27	2450.7
5.5	F3	2671.5	P5	2745.6	P7	2767.9	F10	2743.6	P17	2672.5	P27	2550.5
6.	F3	2742.5	F5	2845.6	F7	2844.3	F10	2849.6	P17	2764.5	P27	2649.2
6.5	F3	2813.	F5	2915.6	F7	2948.3	F10	2952.1	F17	2852.5	P27	2744.8
7.	F3	2882.7	F5	2958.1	F7	3019.8	F9	3032.9	F16	2934.1	P27	2830.8
7.5	F2	2928.8	F5	3019.4	F7	3049.9	F9	3069.5	F15	3002.6	F27	2914.8
8.	F2	2939.9	F5	3030.5	F7	3060.7	F9	3080.3	F15	3068.3	F26	2991.5
8.5	F2	2950.8	F5	3041.	F7	3071.5	F9	3091.2	F16	3072.1	F25	3060.7
9.	F2	2961.4	F5	3051.3	F7	3082.3	F9	3102.	F16	3082.1	F25	3069.6
9.5	F2	2971.9	F5	3061.6	F7	3093.1	F9	3113.4	F15	3094.3	F25	3082.2
10.	F2	2982.4	F5	3071.8	F7	3103.9	F9	3124.2	F15	3104.3	F25	3092.2
10.5	F2	2992.7	F5	3082.1	F7	3114.7	F9	3142.	F15	3114.3	F25	3102.2
11.	F2	3003.	F5	3092.4	F7	3124.1	F9	3144.9	F15	3125.1	F24	3116.2
11.5	F2	3007.2	F5	3102.6	F7	3131.9	F10	3151.5	F15	3135.1	F24	3129.
12.	F2	3007.2	F5	3112.9	F7	3139.6	F10	3161.7	F15	3144.2	F24	3140.7
12.5	F3	3015.8	F5	3123.2	F7	3147.3	F10	3172.	F15	3154.3	F24	3150.6
13.	F3	3026.	F5	3133.4	F7	3154.	F10	3172.3	F15	3154.8	F25	3152.3
13.5	F3	3024.	F5	3141.9	F7	3154.1			F16	3158.2		
14.	F3	3048.5	F5	3145.9					F16	3159.		
14.5	F3	3056.5										
15.	F3	3064.4										
15.5	F3	3066.9										

[a]Source: Derived from Tables 8-1 to 8-8.

with a given farm size, when the managers are free to choose the degree of mechanization with no limitations of capital or mechanical skills.

The third variable, farm size, is an institutional constraint dependent upon certain land tenure arrangements; therefore, it may well remain fixed for many years insofar as it implies land ownership by the Communities. However, without changes in ownership, renting of land among Communities, if allowed by law and sociologically accepted, could change the farm size available to the cooperatives. Optimal income per person for each cooperative size when farm size can be adjusted is also presented in Table 8-9. The last figure in the column for each cooperative size tells the best that the cooperative can do when every resource but its own number of members is variable. Obviously, in this case, labor is the inevitably limiting resource, since it is supplied by the fixed number of members in the cooperative (because, throughout this study, only one motor-and-pump is allowed on each farm, water may also be a limiting resource in large farms, as it will be shown later).

Reading of Table 8-9, whose content is crucial among the results of this study, will be facilitated by the following example: For cooperative size 425, if there are 2 ha per person (farm size 850 ha), the maximum attainable income per person is 1734.2 pesos at the P6 degree of mechanization; if there are 2.5 ha per person (farm size 1062.5 ha), the maximum attainable income per person is 2088.2 pesos at the P7 degree of mechanization, and similarly for the other farm sizes. The highest attainable income per person is 3154.1 pesos at the F7 degree of mechanization, which requires 13.5 ha per person (farm size 5737.5 ha); if farm

size is above 13.5 ha per person, the additional land will go unused and income per person will remain unchanged.

Income per person from Table 8-9 is graphed against farm size for the six cooperative sizes, in Figure 8-1.

Frequent reference will be made throughout the rest of this study to the solutions which provide the highest income per person attainable by each cooperative size, that is, the last solution in the six columns of Table 8-9. It seemed convenient to identify those six solutions with a name which would distinguish them from all the other optimal solutions. They will be called hereinafter the "highest-income optimal solutions". The expression is somewhat redundant, but it conveys the fact that those are the six solutions, among all the optimal solutions, that allow the highest possible income per person for each cooperative size when every resource but number of cooperative members is variable[1].

The results in Table 8-9 and their graph in Figure 8-1 suggest the following interpretations:

First, the highest income per person for each cooperative size and the associated degree of mechanization and farm size are as follows:

Cooperative size 125: 3066.9 pesos per person, with F3 mechanization, on 1937.5 ha of land.

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[1]An alternative would be to call those six solutions the optimal solutions, and to designate all other solutions as "suboptimal". However, suboptimal can easily be equated with non-optimal; and non-optimal implies an inefficient allocation of resources, which is certainly not the case in any of the solutions in this study. Thus the redundancy of "highest-income optimal" was preferred to the ambiguity of "suboptimal".

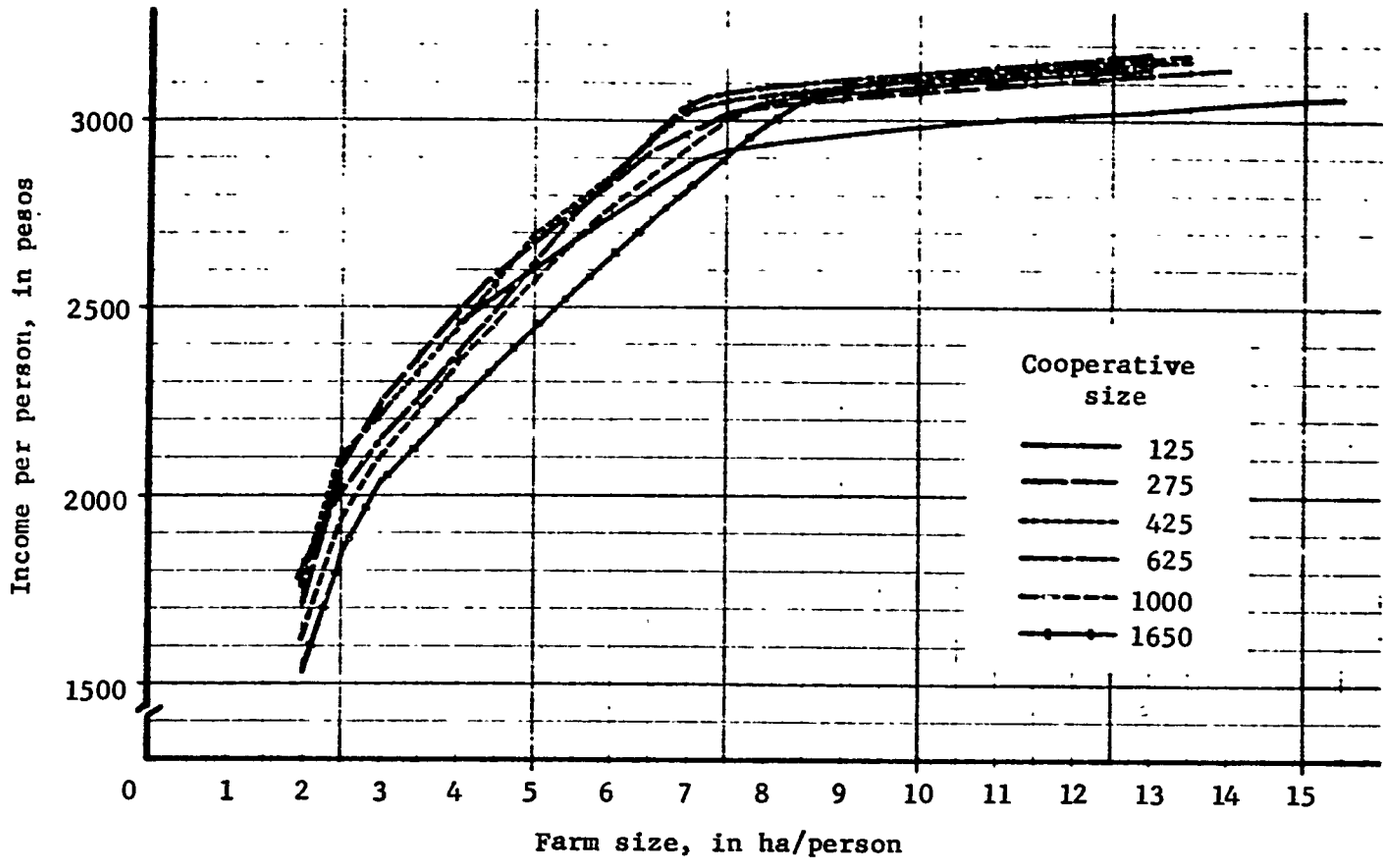

Figure 8-1. Income per person in the optimal solutions for various farm size, for six cooperative sizes

Cooperative size 275: 3145.9 pesos per person, with F5 mechanization, on 3850 ha of land.

Cooperative size 425: 3154.1 pesos per person, with F7 mechanization, on 5737.5 ha of land.

Cooperative size 625: 3172.3 pesos per person, with F10 mechanization, on 8125 ha of land.

Cooperative size 1000: 3159 pesos per person, with F16 mechanization, on 14,000 ha of land.

Cooperative size 1650: 3152.3 pesos per person, with F25 mechanization, on 21,450 ha of land.

It can be noticed that all six highest-income optimal solutions use full mechanization.

Second, as cooperative size increases from 125 to 625, so does the highest income per person; as cooperative size increases above 625, the highest income per person decreases. Thus, among the highest-income optimal solutions, cooperative size 625 achieves the highest income per person (3172.3 pesos) and cooperative size 125 the lowest (3066.9 pesos) although the latter is only 3.32% below the former. The linearity of the model and the identical input-output coefficients for all cooperative sizes tend to equalize the highest income per person among cooperative sizes, since it all becomes a matter of scale of production with constant returns. However, the indivisibility of farm machinery ("lumpy" inputs) with its associated fixed cost causes those small differences.

Third, if an "optimal among optimals" were to be chosen from among all the land-persons combinations considered in this study, it would be

a cooperative with 625 members operating on 3172.5 ha of land (13 ha/person).

Cooperative size 625 is the "optimal among optimals" also at farm sizes above 5.5 ha/person and at 2 ha/person. The first place is taken by cooperative size 275 at farm sizes from 3 to 4.5 ha/person, and by cooperative size 425 at farm sizes 2.5, 5 and 5.5 ha/person.

Fourth, partial mechanization is the optimal level for the smaller farm sizes (lower ha/person ratios), while larger farm sizes require full mechanization as the optimal level. Such patterns in the optimal degrees of mechanization would be due to the fact that small farms have a higher labor/land ratio; on the contrary, labor is not as abundant relative to land in larger farms, so that, at a certain point, the less-labor-using full mechanization becomes more profitable. Specifically, the points at which full mechanization starts being optimal are: 5 ha/person for cooperatives sizes 125 and 625, 6 ha/person for cooperatives sizes 275 and 425, 6.5 ha/person for cooperative size 1000, and 7.5 ha/person for cooperative size 1650. The corresponding farm sizes are: 625 ha for cooperative size 125, 1650 ha for size 275, 2550 ha for size 425, 3125 ha for size 625, 6500 ha for size 100, and 12,375 ha for size 1650.

Fifth, an opportunity cost, which can be measured in lost income, is incurred by cooperatives that have a less-than-optimal farm size. Table 8-10 shows the income per person at those less-than-optimal sizes, expressed as percent of the income per person in the highest-income optimal solutions. If a loss of income of 10% or less were considered "acceptable", then the "acceptable" farm sizes would be: 6 ha/person or more

Table 8-10. Income per person at various farm sizes, as a percent of income per person at the highest-income optimal solutions (in percent)[a]

Farm size in ha/person	Cooperative size					
	125	275	425	625	1000	1650
2.		54.29	54.98	55.06	51.3	48.53
2.5		66.23	66.21	63.55	61.94	59.29
3.		71.31	70.15	67.48	66.76	64.63
3.5		75.03	74.01	71.28	70.58	68.04
4.	80.24	78.78	77.80	75.04	74.37	71.41
4.5	82.41	82.47	81.57	78.69	78.07	74.62
5.	84.96	85.01	85.26	82.49	81.48	77.74
5.5	87.11	87.28	87.76	86.49	84.6	80.91
6.	89.42	90.45	90.18	89.83	87.51	84.04
6.5	91.72	92.68	93.48	93.06	90.3	87.07
7.	93.99	94.03	95.74	95.61	92.88	89.8
7.5	95.5	95.98	96.7	96.76	95.05	92.47
8.	95.86	96.33	97.04	97.1	97.13	94.95
8.5	96.21	96.67	97.38	97.44	97.25	97.09
9.	96.56	97.	97.72	97.78	97.57	97.38
9.5	95.14	97.32	98.07	98.14	97.95	97.78
10.	97.24	97.64	98.41	98.48	98.27	98.09
10.5	97.58	97.97	98.75	99.04	98.58	98.41
11.	97.92	98.3	99.05	99.14	98.93	98.85
11.5	98.05	98.62	99.3	99.34	99.24	99.26
12.	98.05	98.95	99.54	99.67	99.53	99.63
12.5	98.33	99.28	99.78	99.99	99.85	99.95
13.	98.67	99.6	99.99	100.	99.9	100.
13.5	98.93	99.87	100.		99.97	
14.	99.4	100.			100.	
14.5	99.66					
15.	99.92					
15.5	100.					

[a]Source: Computed from Table 8-9.

for cooperative sizes 125, 275 and 425, 6.5 ha/person or more for sizes 625 and 1000, and 7.5 ha/person of more for size 1650. Below these sizes, the opportunity cost increases rapidly so that at the 2 ha/person farm size it represents around 50% of the highest possible income per person. The dividing point between "acceptable" and "non-acceptable" farm sizes can be observed in Figure 8-1 as well: At around 7 ha/person, the curves flatten, indicating that no substantial increases in income are forthcoming with larger farm sizes; below that point, the curves are steeper, implying that a considerable opportunity cost is associated with decreasing farm sizes. The largest opportunity cost is incurred by cooperative size 16 0 operating on 3300 ha of land (2 ha/person), since it only attains 48.53% of the income per person with the optimal farm size (13 ha/person).

Optimal Farm Plans

A farm plan consists of the set of recommended agricultural activities quantities of inputs required, quantities of outputs expected, time schedule for farm operations and, finally, information on income and costs. The farm plans dictated by the optimal solutions are designated optimal farm plans.

The following observations may be inferred from the plans in the six highest-income optimal solutions (Table 8-11):

First, as cooperative size increases, larger absolute amounts of the inputs land, labor, capital, water and machinery are used. The only exception is water in solution for cooperative size 1000, where 11,510 m^3

Table 8-11. Farm plan in the highest-income optimal solution for each cooperative size[a,b]

	Unit	Cooperative size					
		125	275	425	625	1000	1650
Resources used:							
Land[c]	ha	170.448	340.228	497.628	731.248	1259.036	1930.5
Labor	hours	44946.355	95921.406	144907.394	214420.324	342257.613	549267.614
Capital	pesos	222102.822	450111.041	662839.204	976622.138	1645095.383	2546838.785
Water	m^3	45576.481	90974.832	120839.494	199463.338	187953.01	235393.982
Machinery							
Tractors	No.	2.	4.	6.	9.	15.	24.
Plows	No.	2.	3.	4.	6.	10.	16.
Harrows	No.	1.	1.	2.	2.	4.	6.
Motor-and-pump	No.	1.	1.	1.	1.	1.	1.
Potato planter	No.	1.	1.	2.	3.	6.	5.
Grain drills	No.	1.	1.	2.	2.	4.	6.
Cultivators	No.	1.	1.	2.	2.	4.	6.
Sprayers	No.	1.	2.	2.	3.	5.	8.
Potato diggers	No.	1.	1.	2.	3.	4.	6.
Wagons	No.	1.	1.	1.	2.	2.	4.
Sorters	No.	1.	1.	1.	2.	2.	4.
Sprinklers	No.	1.	2.	2.	4.	4.	4.
Activities:[d]							
PHQB rotation	ha			91.676		556.128	996.268
P'HQB rotation	ha				28.342		231.324
PHQ'B rotation	ha	42.612	340.228	346.024	675.125	702.908	702.908
P'HQ'B rotation	ha			59.928	27.783		

[a]Sources: Computed from Tables J-1, 7-4, I-35, I-37, I-39, I-43, I-54, I-65, 5-7 and 5-8.

[b]The meaning of highest-income optimal solutions is explained in the text, page 185.

[c]All land is class 1.

[d]P=potato, H=broad beans, Q=quinua, B=barley. The apostrophe means that the crop is irrigated.

Table 8-11. (Continued)

	Unit	Cooperative size					
		125	275	425	625	1000	1650
Crops:							
Potato, irrigated	ha			14.982	14.031		57.831
Potato, non-irrigated	ha	42.612	85.057	109.425	168.781	314.759	424.794
Quinua, irrigated	ha	42.612	85.057	101.488	175.727	175.727	175.727
Quinua, non-irrigated	ha			22.919	7.085	139.032	306.098
Broad beans	ha	42.612	85.057	124.407	182.812	314.759	482.625
Barley	ha	42.612	85.057	124.407	182.812	314.759	482.625
Land preparation schedule:							
June 2-July 1[e]	ha	42.612	85.057	124.407	182.812	314.759	482.625
September	ha	48.382	95.958	160.089	252.121	386.79	716.381
October	ha	14.648	29.609	50.373	82.681	118.918	191.038
November	ha	42.612	85.057	124.407	182.812	314.759	510.687
December	ha	22.194	44.547	38.352	30.822	123.81	29.769
Planting schedule:							
Potato, irrigated							
December	ha						28.062
January 1[f]	ha			14.982	14.031		29.769
Potato, non-irrigated							
October	ha	5.77	10.901	35.682	69.309	72.031	233.756
November	ha	14.648	29.609	50.373	82.681	118.918	191.038
January 1[f]	ha	22.194	44.547	23.37	16.791	123.81	

[e]Period including the second half of June and the first half of July.

[f]First half of January.

Table 8-11. (Continued)

	Unit	Cooperative size					
		125	275	425	625	1000	1650
Quinua[g]							
October	ha	42.612	85.057	124.407	182.812	314.759	482.625
Broad beans							
July 2-August[h]	ha	42.612	85.057	124.407	182.812	314.759	482.625
Barley							
December	ha	42.612	85.057	124.407	182.812	314.759	482.625
Output sold:							
Chuño[i]	cwt	2485.375	5566.452	8732.42	12785.584	20481.492	34379.59
Quinua	cwt	1917.531	3827.568	5369.129	8155.707	12773.837	18649.145
Green broad beans	cwt	6817.889	13609.131	19905.129	29250.	50361.452	77220.
Variable inputs:							
Machinery							
Tractor	hours	2670.749	5363.148	7871.716	11569.314	19816.803	30527.156
Plow	hours	1124.952	2245.507	3284.346	4826.25	8309.64	12741.3
Harrow	hours	281.238	561.377	821.087	1206.562	2077.41	3185.325
Motor-and-pump	hours	205.094	409.387	543.778	897.585	845.789	1059.273
Potato planter	hours	234.365	467.814	684.239	1005.469	1731.175	2654.438
Grain drill	hours	281.238	561.377	821.087	1206.562	2077.41	3185.325
Cultivator	hours	281.238	561.377	821.087	1206.562	2077.41	3185.325
Sprayer	hours	272.716	544.365	796.205	1170.	2014.458	3088.8
Potato digger	hours	89.474	200.392	314.367	460.281	737.334	1237.665
Wagon	hours	190.754	391.054	578.114	853.252	1421.485	2214.228
Sorter	hours	49.708	111.329	174.648	255.712	409.63	687.592
Sprinkler	hours	205.091	409.38	488.463	845.774	845.774	845.774
Diesel	lit	53410.453	107221.843	156631.718	231485.571	387514.514	593786.513
Gasoline	lit	349.076	696.787	1019.142	1497.6	2578.506	3953.664
Oil	lit	277.263	556.122	805.666	1202.004	1933.697	2933.491
Grease	kg	330.594	664.518	975.962	1434.363	2455.214	3785.321

[g]Both irrigated and non-irrigated.

[h]Period including the second half of July and the month of August.

[i]Three classes of chuño, as explained in Table 5-9, note c.

Table 8-11. (Continued)

	Unit	Cooperative size					
		125	275	425	625	1000	1650
Seed							
Potato	cwt	852.24	1701.14	2488.14	3656.24	6295.18	9652.5
Quinua	lb	426.12	850.57	1244.07	1828.12	3147.59	4826.25
Broad beans	cwt	255.672	510.342	746.442	1096.872	1888.554	2895.75
Barley	cwt	42.612	85.057	124.407	182.812	314.759	482.625
Fertilizer NPK[j]							
18-46-0	kg	11116.619	22189.67	32455.298	47691.995	82114.328	125907.21
13-39-0	kg	4261.2	8505.7	12440.7	18281.2	31475.9	48262.5
Urea 46%	kg	10064.49	21809.465	31899.199	46874.825	80707.355	123749.876
Chemicals							
Agallol 6%	kg	10.653	21.264	31.102	45.703	78.69	120.656
Clordano 40%	kg	426.12	850.57	1244.07	1828.12	3147.59	4826.25
DDT 50%	kg	92.808	185.254	270.958	398.165	685.545	1051.157
Metasystox	lit	21.306	42.528	62.204	91.406	157.38	241.312
Annual fixed cost[k]	pesos	49401.346	76408.354	110208.622	157331.074	255689.144	378435.256
Total fixed cost[l]	pesos	350826.38	528829.26	769417.26	1090573.64	1770413.9	2589796.04
Interest on variable cost[m]	pesos	17768.226	36008.883	53027.136	78129.771	131607.631	203747.103
Wage bill (returns to labor)	pesos	45639.074	97313.782	146949.592	217425.89	347374.191	557144.137
Output sold	pesos	626989.655	1334712.943	2019610.386	2977331.701	4839623.567	7773204.344
Aggregate income	pesos	383362.5	865122.5	1340492.5	1982687.5	3159000.	5201295.
Returns to land and management[n]	pesos	337723.226	767808.718	1193542.908	1765261.61	2811625.809	4644150.863

[j]For obtaining the NPK least-cost combinations as computed in Table K-6.

[k]Interest included.

[l]Investment in machinery, shelter, and tools (at purchase price).

[m]Variable cost equals capital used (above in this Table), which is borrowed in its entirety.

[n]Aggregate income minus wage bill is the return to land and collective management.

less are used than in the solution for size 625. The immediate reason for the lower use of water is that no potatoes are irrigated in the solution for size 1000, although a few more hectares of quinua are irrigated than in solution for size 625.

Second, only class 1 land comes into these plans. This is explained by the fact that, along the parametric steps applied to each cooperative size, there is a reallocation of resources from the lower to the higher classes of land, until all resources available are allocated to class 1 land, at which point the highest-income optimal solution is reached. Any solution below the highest-income optimal uses also land classes other than class 1.

Third, the sheep raising activity does not enter any of the six plans, the reason being its lower profitability and its high labor-intensity. The activity has a revenue of 36,420 pesos against variable costs of 30,509 pesos (Tables 6-19 and 6-24); thus the resulting return over and above variable costs is lower than for any of the crops in this study. On the other hand, the labor required in each month for raising sheep is between 681 and 1569 hours, with a total of 10,732 hours for the entire year (Table G-4). In large farms, where labor is less abundant relative to land, it is more profitable to allocate the labor to crops than to sheep raising; raising sheep would imply giving up more profitable crop activities, due to the scarce labor in certain peak periods of the year. A more detailed discussion on the behavior of the sheep raising activity throughout all the optimal solutions is included in Appendix L.

Fourth, the rotation potato-broad beans-quinua-barley (PHQB), with or without irrigation, is the only crop activity entering the plans. Since no silage or hay is required for feeding sheep, PHQB becomes the most profitable of the three possible rotations; because only one hectare of unneeded forage (barley is left on the field and plowed under as green manure) must be afforded for every three hectares of marketable crops (potatoes, broad beans and quinua). In the PQB rotation one hectare of unneeded forage would accompany every two hectares of marketable crops, and in the PQBA rotation the proportion would increase to six hectares of unneeded forage (one with barley, five with alfalfa) for every two hectares of marketable crops. Barley is not made into hay and sold, because labor is the scarce resource in the highest-income optimal solutions; it is allocated to other crops where it is more productive than in hay making and selling.

Fifth, hectares with irrigated quinua increase as the cooperative size goes from 125 to 625. At size 625, water becomes a scarce resource in November (see Table H-64). Since irrigated quinua has a water requirement in November, the hectares with irrigated quinua are constant through the solutions to sizes 625, 1000 and 1650. At the same time, only late-planting potatoes (planted in December or January) are irrigated, since they do not require any water in November and, therefore, do not compete for the scarce water with the irrigated quinua. While the pattern of irrigated quinua throughout the six solutions appears quite logical, the behavior of irrigated potatoes seems somewhat erratic. No obvious reason

can be found for irrigated potatoes being absent from the solutions to sizes 125, 275 and 1000, while they are present in the other three solutions. In the solutions to sizes 125 and 275 water is not limiting at all, and in the solution to size 1000 water is scarce in February alone; therefore, potatoes could be irrigated in all three solutions, although in the solution to size 1000 they should be late-planting potatoes.

Sixth, a relatively high level of management is implied by the machinery entering the plans, by the volume of output to be handled and by the quantity required of inputs such as fertilizer, chemicals, seed, fuel. Certainly, these managerial skills do not exist at the present time among the Communities in the DAP; in the future, education for farm management must be one of the main goals of the extension services in the Area. More will be said about this in the recommendations in Chapter IX.

Economic relationships can be derived from the farm plans in the highest-income optimal solutions (Table 8-12). Except for relative use of water and investment per person, these relationships tend to take the same values for all six solutions, because of the linearity of the model and of the unique input-output matrix.

The average productivities revolve around the following values: 4000 pesos per hectare of land, 14 pesos per hour of labor, 3 pesos per peso of working capital.

The relative use of resources is measured in percent of the total available. Land used represents 9% of the farm size, that is, all class 1 land, to which the other resources have been shifted at the end of the parametric procedure. Only around 31% of the labor available during the

Table 8-12. Economic relationships in the plans from the highest-income optimal solutions[a]

	Unit	Cooperative size					
		125	275	425	625	1000	1650
Land productivity[b]	pesos/ha	3678.5	3923.	4058.5	4071.6	3843.9	4026.5
Labor productivity[b]	pesos/hour	13.95	13.915	13.937	13.885	14.14	14.152
Capital productivity[b]	pesos/peso[c]	2.823	2.965	3.047	3.049	2.942	3.052
Relative use of land	percent[d]	8.8	8.84	8.67	9.	8.99	9.
Relative use of labor	percent[d]	32.81	31.83	31.12	31.31	31.23	30.38
Relative use of water	percent[d]	2.34	4.67	6.21	10.24	9.65	12.09
Working capital borrowed per person[e]	pesos	1776.8	1636.8	1559.6	1562.6	1645.1	1543.5
Investment per person[f]	pesos	2806.6	1932.	1810.4	1744.9	1770.4	1569.6
Fixed cost as percent of total cost	percent	18.2	14.51	14.26	13.87	13.45	12.94
Wage bill as percent of income	percent	11.91	11.18	10.96	10.97	11.	10.71
Average variable cost	pesos/100 pesos[g]	35.424	33.723	32.82	32.802	33.992	32.764
Average total cost	pesos/100 pesos[g]	43.303	39.388	38.277	38.086	39.185	37.633

[a]Source: Derived from Table 8-11.

[b]Average productivity.

[c]Pesos/peso of working capital.

[d]Percent of total available on an all-year basis.

[e]All working capital is borrowed.

[f]Investment in machinery, shelter and tools.

[g]Pesos/100 pesos of output sold.

year is employed, although there are peak periods when all labor available is utilized, as it will be discussed later in this Chapter. The volume of water used goes from 2.76% to 12.09% of the total; that percentage is directly related to the cooperative size, except for size 1000 in which it decreases slightly.

Working capital to be borrowed per person ranges between 1400 and 1780 pesos approximately, while capital invested in equipment and buildings decreases from some 2800 pesos per person at size 125 to 1570 pesos per person at size 1650. These figures are below the ceiling adopted in practice by the Agricultural Bank for loans to groups of farmers (see Chapter IV). Thus, from the viewpoint of capital availability, there would be no obstacle to the implementation of the highest-income optimal plans.

Wage bill paid by the cooperative to its members through the year represents around 11% of the income, the other 89% being return to land and to collective management. If the Communities were part of an hacienda (as some of them were before the Agrarian Reform), most of that 89% would accrue to the landowner as return to his land and management. The low figure for return to the labor sector (wage bill) is a result of the relatively high degree of mechanization in the highest-income optimal solutions.

Finally, the average variable cost oscillates between 32 and 36 pesos per 100 pesos of output, while average total cost ranges between 37 and 44 pesos. Cooperative size 1650 has the lowest average cost, both variable and total, although the cost differential among cooperatives is

of only a few pesos.

The farm plans of the highest-income optimal solutions discussed so far are all under full mechanization; moreover, Table 8-9 showed that full mechanization is the optimal level in almost two-thirds of all the optimal solutions for the various farm sizes.

The smaller farm sizes use partial mechanization in their optimal solutions. It seems appropriate to include a set of optimal farm plans, one for each cooperative size, under partial mechanization; it should be possible to observe similarities or dissimilarities in the patterns of optimal plans under partial and under full mechanization. The 4.5 ha/person farm size is chosen, because (as shown in Table 8-9) this is the largest relative farm size whose optimal solutions use partial mechanization for all cooperative sizes; at the next larger farm size, the optimal level of mechanization changes to full for cooperative sizes 125 and 625.

The following characteristics are noticed in these farm plans (Tables 8-13 and 8-14) in relation to those in the highest-income optimal solutions:

First, substantially higher percentages of land, labor and water are used in these farm plans than in the highest-income optimal plans. Working capital borrowed per person is also higher, between 2% and 25% higher. The only substantial variation in machinery required by the two sets of plans is in the number of sprayers and wagons for sizes 625, 1000 and 1650.

Second, all six plans use land classes 1, 2 and 3. The lower yields of classes 2 and 3 explain why these plans provide a lower level of output, in spite of the fact that all cooperative sizes but 625 and 125

Table 8-13. Farm plan in the optimal solution for each cooperative size, at the 4.5 ha/person ratio[a]

	Unit	Cooperative size[b]					
		125	275	425	625	1000	1650
Resources used:							
Land	ha	154.316	349.228	504.24	691.4	1289.6	2143.032
Class 1	ha	50.624	111.376	172.124	253.124	405.	668.252
Class 2	ha	28.128	61.876	95.624	140.624	225.	371.248
Class 3	ha	75.564	175.976	236.492	297.652	659.6	1103.532
Labor	hours	63922.459	141954.008	220284.333	327162.352	566449.403	950184.79
Capital	pesos	216610.192	486654.883	730169.584	1048889.683	1879094.575	3197488.342
Water	m^3	88303.115	184611.306	281997.509	296394.911	358742.1	358929.927
Machinery							
Tractors	No.	2.	4.	6.	8.	15.	25.
Plows	No.	2.	3.	4.	6.	11.	17.
Harrows	No.	1.	1.	2.	2.	4.	7.
Motor-and-pump	No.	1.	1.	1.	1.	1.	1.
Sprayers	No.	2.	3.	3.	5.	9.	14.
Wagons	No.	1.	1.	1.	2.	4.	7.
Sorters	No.	1.	1.	1.	2.	2.	3.
Sprinklers	No.	1.	2.	3.	2.	4.	4.
Activities:[c]							
PHQB1 rotation	ha						6.88
PHQB2 rotation	ha						92.812
PHQB3 rotation	ha				3.58	162.219	275.883
P'HQB1 rotation	ha						7.624
P'HQB2 rotation	ha					4.861	
P'HQB3 rotation	ha				70.833	2.681	

[a]Sources: Computed from Tables J-2, 7-3, I-2, I-4, I-6, I-9, I-22, I-33, 5-7, 5-8 and 5-14.

[b]The degrees of mechanization are: P2 for cooperative size 125, P5 for 275, P7 for 425, P10 for 625, P17 for 1000, P27 for 1650.

[c]P=potato, H=broad beans, Q=quinua, B=barley. The apostrophe means that the crop is irrigated.

Table 8-13. (Continued)

	Unit	Cooperative size[b]					
		125	275	425	625	1000	1650
P'HQ'B1 rotation	ha	12.656	27.844	43.031	63.281	101.25	152.559
P'HQ'B2 rotation	ha	7.032	15.469	23.906	35.156	51.389	
P'HQ'B3 rotation	ha	18.891	43.994	59.123			
Sheep raising	ewes[d]			123.	429.	733.	1912.
Silage making	cwt			7845.781	24470.588	46582.074	97882.353
Hay making	cwt				8932.095		15581.366
Crops:							
Potato, irrigated	ha	38.579	87.307	126.06	169.27	160.181	160.183
Potato, non-irrigated	ha				3.58	162.219	375.575
Quinua, irrigated	ha	38.579	87.307	126.06	169.27	169.761	152.559
Quinua, non-irrigated	ha				3.58	152.639	383.199
Broad beans	ha	38.579	87.307	126.06	172.85	322.4	535.758
Barley	ha	38.579	87.307	126.06	172.85	322.4	535.758
Land preparation schedule:							
June 2-July 1[e]	ha			66.937	98.437	157.5	259.875
July 2-Aug. 1[f]	ha	38.579	87.307	59.123	74.413	164.9	275.883
September	ha	68.761	87.421	156.418	183.2	361.532	618.417
October	ha	8.397	49.032	79.23	120.355	164.935	259.875
November	ha	38.579	115.234	142.532	214.995	440.733	728.982
December	ha		10.234				

[d]Breeding ewes, that is, ewes lambed in September-October.

[e]Period including the second half of June and the first half of July.

[f]Period including the second half of July and the first half of August.

Table 8-13. (Continued)

	Unit	Cooperative size[b]					
		125	275	425	625	1000	1650
Planting schedule:							
Potato, irrigated							
October	ha	30.182	0.114	30.358	10.35	39.132	75.779
November	ha	8.397	49.032	79.23	120.355	121.049	84.404
December	ha		27.927	16.472	38.565		
January 1[g]	ha		10.234				
Potato, non-irrigated							
October	ha						6.88
November	ha					43.886	175.471
December	ha				3.58	118.333	193.224
Quinua[h]							
October	ha	38.579	87.307	126.06	172.85	322.4	535.758
Broad beans							
July 2-Aug.[i]	ha			66.937	98.437	157.5	259.875
Aug. 2-Sept.[j]	ha	38.579	87.307	59.123	74.413	164.9	275.883
Barley							
December	ha	38.579	87.307	126.06	172.85	322.4	535.758
Output sold:							
Chuño[k]	cwt	2471.939	5415.688	8088.744	11260.93	18448.958	28869.145
Quinua	cwt	1308.998	2940.637	4322.921	5671.845	9952.853	15674.801

[g]First half of January.

[h]Both irrigated and non-irrigated.

[i]Period including the second half of July and the month of August.

[j]Period including the second half of August and the month of September.

[k]Three classes of chuño as explained in Table 5-9, note c.

Table 8-13. (Continued)

	Unit	Cooperative size[b] 125	275	425	625	1000	1650
Green broad beans	cwt	4323.369	9698.804	14617.01	20530.549	36378.503	60317.021
Barley hay[1]	cwt				8245.976		9658.854
Wethers[m]	No.			50.	174.	297.	774.
Female lambs	No.			10.	34.	59.	153.
Ewes	No.			15.	51.	88.	229.
Rams	No.			1.	3.	5.	14.
Adult pelts	No.			10.	36.	62.	162.
Lamb pelts	No.			21.	74.	126.	330.
Wool							
Class 1	kg			408.364	1418.339	2424.543	6323.123
Class 2	kg			15.693	54.504	93.171	242.988
Class 3	kg			14.773	51.31	87.71	228.745
Class 6	kg			18.619	64.668	110.545	288.297
Variable inputs:							
Machinery							
Tractor	hours	1856.452	4196.451	6208.866	8905.193	16256.054	27579.52
Plow	hours	1294.314	2929.14	4229.333	5799.12	10816.5	17974.667
Harrow	hours	254.619	576.224	832.	1140.81	2127.836	3536.
Motor-and-pump	hours	397.364	830.751	1268.989	1333.777	1614.339	1615.185
Sprayer	hours	246.903	558.763	806.788	1106.24	2063.356	3428.848
Wagon	hours	137.773	306.937	592.866	1204.722	1893.161	3711.52
Sorter	hours	49.439	108.314	161.775	225.219	368.979	577.383
Sprinkler	hours	185.679	420.207	606.73	473.78	736.653	734.265
Diesel	lit	40438.32	90532.332	134465.311	185537.768	329851.433	545008.285
Gasoline	lit	316.036	715.217	1032.689	1415.987	2641.096	4388.925
Oil	lit	242.948	536.939	800.347	1055.997	1781.306	2812.797
Grease	kg	216.902	490.221	726.735	1045.876	1905.664	3237.693

[1] In addition to the hay fed to sheep on the farm.

[m] The number of wethers, lambs, ewes, rams and pelts are rounded to the nearest whole number.

Table 8-13. (Continued)

	Unit	Cooperative size[b]					
		125	275	425	625	1000	1650
Seed							
Potato	cwt	771.58	1746.14	2521.2	3457.	6448.	10715.16
Quinua	lb	385.79	873.07	1260.6	1728.5	3224.	5357.58
Broad beans	cwt	231.474	523.842	756.36	1037.1	1934.4	3214.548
Barley	cwt	38.579	87.307	126.06	172.85	322.4	535.758
Fertilizer NPK[n]							
18-46-0	kg	10926.143	22776.65	32886.533	45093.108	84107.712	139768.547
13-39-0	kg	3857.9	8730.7	12606.	17258.	32240.	53575.8
Urea 46%	kg	9892.041	22386.388	32323.044	44320.468	82666.584	137373.709
Chemicals							
Agallol 6%	kg	9.645	21.827	31.515	43.212	80.6	133.94
Clordano 40%	kg	385.79	873.07	1260.6	1728.5	3224.	5357.58
DDT 50%	kg	84.025	190.155	274.559	376.467	702.187	1166.881
Metasystox	lit	19.29	43.654	63.03	86.425	161.2	267.879
Drugs							
Thibenzole	kg			0.244	0.849	1.451	3.785
Coopazine	kg			6.48	22.507	38.474	100.34
Nexadip 6%	kg			30.867	107.208	183.264	477.946
Negasunt	kg			0.309	1.072	1.833	4.779
Elmycina	cc			123.468	428.832	733.056	1911.782
Foot and mouth disease	cc			1183.441	4110.355	7026.342	18324.43
Pneumoenteritis vaccine	cc			125.32	435.264	744.052	1940.459
Concentrate							
For fattening lambs	tons			6.93	24.069	41.144	107.303
For ewes-and-lambs	tons			6.555	22.768	38.92	101.501

[n]For obtaining the NPK least-cost combinations as computed in Table K-6.

Table 8-13. (Continued)

	Unit	Cooperative size					
		125	275	425	625	1000	1650
Salt	kg			1.033	3.589	6.135	16
Ear tags[o]	No.			123.	429.	733.	1912.
Annual fixed cost[p]	pesos	40825.162	67021.286	95380.588	131867.474	226551.882	346349.805
Total fixed cost[q]	pesos	282621.76	460624.64	646447.64	823294.4	1458764.42	2340990.32
Interest on variable cost[r]	pesos	17328.815	38932.391	58413.567	83911.175	150327.566	255799.067
Wage bill (return to labor)	pesos	64414.205	143049.907	221901.736	329462.867	560670.354	957367.154
Output sold	pesos	526268.458	1163023.782	1755395.905	2487721.439	4155526.626	6736020.74
Aggregate income	pesos	315912.5	713460.	1093440.	1560125.	2466100.	3881130.
Returns to land and management[s]	pesos	251498.295	570410.093	871538.264	1230662.133	1905429.646	2923762.846

[o]Rounded to the nearest whole number.

[p]Interest included.

[q]Investment in machinery, shelter and tools (at purchase price).

[r]Variable cost equals capital used (above in this Table), which is borrowed in its entirety.

[s]Aggregate income minus wage bill is the return to land and collective management.

Table 8-14. Economic relationships in the plans for the 4.5 ha/person farm size[a]

	Unit	Cooperative size					
		125	275	425	625	1000	1650
Land productivity[b]	pesos/ha	3410.4	3330.3	3481.3	3598.2	3222.3	3143.2
Labor productivity[b]	pesos/hour	8.233	8.193	7.969	7.604	7.468	7.089
Capital productivity[b]	pesos/peso[c]	2.322	2.39	2.404	2.372	2.211	2.107
Relative use of land	percent[d]	27.43	28.22	26.37	24.58	28.66	28.86
Relative use of labor	percent[d]	46.67	47.11	47.3	47.77	50.78	52.55
Relative use of water	percent[d]	4.53	9.48	14.48	15.22	18.42	18.43
Working capital borrowed per person[e]	pesos	1812.9	1769.7	1718.	1678.2	1879.1	1937.9
Investment per person[f]	pesos	2261.	1675.	1521.1	1317.3	1458.8	1418.8
Fixed cost as percent of total cost	percent	15.86	12.1	11.55	11.17	10.76	9.82
Wage bill as percent of income	percent	20.39	20.05	20.29	21.25	22.83	24.67
Average variable cost	pesos/100 pesos[g]	41.16	41.844	41.594	42.163	45.219	47.469
Average total cost	pesos/100 pesos[g]	48.917	47.607	46.983	47.463	50.671	52.64
Crop output as percent of total output	percent	100.	100.	98.34	97.32	97.26	95.59

[a]Source: Derived from Table 8-13

[b]Average productivity.

[c]Pesos/peso of working capital.

[d]Percent of total available on an all-year basis.

[e]All working capital is borrowed.

[f]Investment in machinery, shelter and tools.

[g]Pesos/100 pesos of output sold.

cultivate more hectares than the respective highest-income optimal plans.

Third, the sheep raising activity enters the farm plans for sizes 625 and above. The absence of sheep raising in cooperative sizes 125 and 275 would be due to a lower availability of labor.

Fourth, there is no substantial difference in the managerial skills required for the crop activities in the two sets of farm plans. But the presence of the sheep raising activity (on a rather large scale in sizes 1000 and 1650) does imply better management practices than were needed in the highest-income optimal plans.

Fifth, average costs are from 12% to 45% higher than in the highest-income optimal plans. The lowest average variable cost occurs in cooperative size 125, while the lowest average total cost happens in cooperative size 625.

Returns to labor (wage 6000) are from 41% to 72% higher than in the highest-income optimal plans, reflecting the more labor-intensive technology of partial mechanization. Returns to land and collective management are from 26% to 37% lower. The decrease in income per person ranges from 18% to 25% as compared with the highest-income optimal solutions (as already shown in Table 8-10).

Use and scarcity of resources

This section examines simultaneously two aspects of resource use in the optimal solutions: the levels of relative use of land, labor, capital and water, and the scarcity of these resources and of machinery.

For simplification purposes, Table 6-15 was constructed, which contains the relevant information from the solutions to a specific combination of cooperative size and degree of mechanization. Information for all optimal solutions is given in Tables 6-3 through 6-14 and in Appendix H.

The percent of land used, out of the farm size available to the cooperative, typically decreases as farm size increases, because along the parametric routine the limited resources are constantly shifted to the better quality land as it is being made available. The figure for the largest farm size always approaches 100%, which is the proportion of class 1 land in the farm, and to which all resources have been transferred.

The highest amount ever used is 100%, all the class 1, 2 and 3 land, which occurs only in some solutions at the smallest farm sizes of 2 and 2.5 ha/person. No solution goes beyond that 100% since using land classes 4 or 5 not even in those cases in which no other resources is limiting. This simply indicates that, with present assumptions, the only way more output for land classes 4 and 5 is not a profitable activity under any circumstances. In the figures, it has become profitable through improved yields, increased efficiency in using feeding and higher prices for dairy (which are presumed on average).

Information is also supplied on the acreage of land, that is, on the range of farm sizes where land is a limiting (scarce) resource. Land classes 1, 2 and 3 are scarce only at those farm sizes where the 100% of the land available. Based preconceptions some that only classes 1 and 2 are limiting, although part of class 3 is still used, until the 100% figure

Table 8-15. Relative use of resources in the solutions for cooperative size 125 at the 75 degree of mechanization[a]

Farm size in ha/person	Relative use of resources			
	Land[b] in %	Labor[c] in %	Capital[d] in pesos/person	Water[e] in %
4.0	34.24	36.68*	1292.5	4.58
4.5	30.38	33.5	1483.7	4.57
5.0	25.47	32.58	1693.2	4.68
5.5	21.91	32.14	1622.4	4.43
6.0	19.0	31.73	1551.2	4.19
6.5	16.36	31.35	1461.1	3.95
7.0	14.68	30.96	1411.0	3.72
7.5	14.0	30.60	1463.5	3.65
8.0	14.0	31.14	1351.2	2.67
8.5	13.5	31.43	1353.9	2.37
9.0	12.75*	31.66	1350.4	2.0
9.5	12.2	31.43	1368.7	2.27
10.0	11.4	31.4	1377.7	2.25
10.5	11.0	31.35	1371.5	2.22
11.0	11.0	31.14	1361.5	2.14
11.5	10.6	31.23	1361.4	2.14
12.0	9.63	31.23	1361.1	2.14
12.5	9.0	31.14	1356.5	2.14
13.0	9.0	31.14	1356.4	2.14
13.5	9.0	31.14	1356.4	2.14
14.0	9.0	31.14	1356.4	2.14
14.5	9.0	31.14	1356.4	2.14
15.0	9.0	31.14	1356.4	2.14
15.5	9.0	31.14	1356.4	2.14

[a]Source: Summarized from Appendix 6, Tables 6-1 through 6-6.

[b]As a percent of the farm size. The starred figure indicates the farm size at which some 2 land income maximizing, that is, all some 1 land and part of some 2 land are used, but no some 3.

[c]As a percent of the labor available on an all-year basis. The starred figure indicates the farm size at which labor income maximizing (marginal) is one of more than one.

[d]In pesos of working capital borrowed per person.

[e]In percent of total water that can be administered during the year with one water-application.

is reached (for example, the starred figure in the land column of Table 8-15). At that point, only class 1 land is limiting, although part of class 2 is still used (but not class 3), until the figure decreases to around 9%. Land has then become a non-limiting resource, and any additional land would have to be idled for lack of some other resources (labor and water). Since land is the resource being parameterized, at that point, where land ceases to be scarce, the parametric routine stops because the value of the objective function cannot be further increased.

The relative use of labor is computed as a percent of the total labor supplied by the members of the cooperative. Typically, partial mechanization employs more labor than full mechanization in any specific combination of farm and cooperative size. The lowest percent of labor used on an all-year basis is 12.3%, which occurs at cooperative size 273 under 42 mechanization with a 3.3 ha/person farm size. The highest proportion of labor used in any solution is 38.5% of the total available, which happens at cooperative size 1000 under 21% mechanization with a 3 ha/person farm size. This means that in all cooperative farmers 61% and 88% of the members' labor is not needed in the farm phase. Perhaps this surplus labor can be allocated to non-farm occupations (handicrafts) or to farm-related activities not included in this study (such as fishing and livestock raising, etc.). More will be said about this in the recommendations in Chapter 10.

Of course, the fact that there is surplus labor on an all-year basis does not prevent labor from being needed in some specific time periods.

Actually, labor is the resource which eventually becomes limiting with no possibility of being increased, thereby determining the optimal solutions. For example, the starred figure in the labor column of Figure 8-15 indicates the farm size at which labor starts being scarce in one or more time periods.

Under partial mechanization two labor periods alone are ever limiting, the second-half of January (JAN2) and May through August (MY//AU). Under full mechanization, the limiting periods are only two as well, May through August (MY//AU) and from the second-half of June to August inclusive (JN2//AU). The crop calendars in Chapter V (Figures 5-1, 5-2 and 5-3) show the operations performed during the three limiting labor-periods; mechanizing these operations, so that they would require less labor, would remove them as constraints. Two of the operations within the MY//AU and JN2//AU periods, chute making and pulque cutting-and-stripping, are highly labor-intensive under both partial and full mechanization. Cutting and stripping of pulque could be either totally mechanized through some type of combining, or partially mechanized by means of a simple mechanical stripper. In making chute, it seems that a simple machine could be devised to replace the manual stamping and packing operations, the most time-consuming part of the process.

The relative use of <u>capital</u> is expressed in terms of working capital borrowed per person in the comparative, since in the model used in this study all working capital is borrowed annually. The lowest value of capital borrowed per person is 763.8 pesos, in comparative size 2/2 under

P2 mechanization with a 2 ha/person farm size, while the highest value is 2095.8 pesos per person, at cooperative size 1000 under F17 mechanization with a 3.5 ha/person farm size. The vast majority of all other values are within the range of 1100 to 1900 pesos per person. If we consider only the adult members (15 years and older) of the Community, instead of all persons, the lowest and highest values become 1187.3 and 3175.5 pesos per person respectively, and the prevalent range is between 1666.7 and 2078.8 pesos per person. These figures compare favorably with the average amount per member loaned by the Agricultural Bank in the DAP at the present time. As given in Chapter IV (Table 4-6), the average amount per member on most operating loans has been 1122.2 pesos in recent years. Thus, the working capital required by practically all of the optimal solutions in this study is compatible with the Agricultural Bank's practices at the present time.

The relative use of water is a percent of the maximum that can be withdrawn with one motor-and-pump on the farm. The range of relative use extends from 2%, in cooperative size 125 under P2 mechanization with a 12 ha/person farm size, up to 20.66% in cooperative size 1000 under F18 mechanization with a 2 ha/person farm size. That is, at least 79% of the motor time available during the year for pumping water goes unused, even in those solutions where water becomes limiting in one or more months. It would be wise to study the feasibility of using the motor for other purposes, such as generating electricity for farm and home consumption.

Water becomes scarce only in cooperative sizes 625 and above, and then only in November and/or February, with a higher shadow-price in

February, which is the sole month in which all irrigated crops have a water requirement. When water becomes scarce, its relative use decreases until it reaches a minimum of 9.65%; at this point, all the water available in February has been allocated to irrigating quinua. This shift of irrigation from potato to quinua is related to the scarcity of labor during the periods MY/AU under partial mechanization and JN2/AU under full mechanization. A higher yield of potatoes impinges more heavily upon those two labor periods than a high quinua yield does, mainly because of the labor-intensive operation of making chuño to which potato must be submitted. Therefore, the model reacts by reallocating water from potato to quinua, where the scarce labor attains a higher marginal productivity.

As far as machinery is concerned, we simply list those time periods in which the various implements become limiting in any of the optimal solutions obtained in this study. This is done in Table 8-16 for both the partial and the full levels of mechanization. This information will be used in Appendix 8, when discussing the simplification of the linear programming matrices used in the model.

Productivity, costs and Returns

This section deals with average and marginal productivity of land, labor, capital and water, with average costs, and with returns to the factors. Average productivity and average costs are reviewed for intrafarm and interregional comparisons of efficiency, and also for comparisons of efficiency over time if time series are available. Marginal productivity

Table 8-16. Limiting time periods for farm machinery, by level of mechanization[a]

Machinery	Under partial mechanization	Under full mechanization
Tractor	TSEP TNOV TJN/SE	TSEP TNOV TMY/JN TMY/SE TJN/SE
Plow	PJUN PJN/JL1 PJN/AU	PJUN PJN/JL1 PJN/AU
Harrow	HSEP HNOV	HSEP
Potato planter		PPJAN1
Grain drill		GJAN2 GJAN
Cultivator		CFEB1 CFEB2 CMAR1 CNOV
Sprayer	SFEB2 SMAR1	SFEB2 SMAR1 SMAR2 SDEC
Forage harvester		FAPR
Hay rake		RMY/JN
Hay baler		BMY/JN
Potato digger		DMAY
Wagon	WAPR WMY/JN	WAPR
Hoffer	SAUG	SAUG
Sprinkler	SNOV	SNOV

[a]Source: Derived from Appendix B.

is a component of the criterion for deciding on procurement of additional units of the various resources. Returns realized by the various factors have a bearing upon considerations on income distribution, with its welfare and equity implications. The source Tables for this section are Tables J-35 through J-82 and Appendix H.

Average productivity of a resource is defined as the total volume of final output (output sold, in this study) divided by the quantity of the resource used in producing that output.

Average productivity of land ranges from 2899.8 pesos per hectare, in cooperative size 1000 under F17 mechanization with a 3 ha/person farm size, to 5304.4 pesos per hectare, in the same cooperative size under F8 mechanization with a 5.5 ha/person farm size. For any given combination of cooperative size and farm size, average productivity decreases as the degree of mechanization increases. This inverse relationship is due to the fact that additional machinery enables the cooperative to cultivate more of its land; the added land is of lower quality that the land already being used (best land comes first into the program), which results in a lower overall average productivity of land.

Average productivity of labor varies from a value of 6.295 pesos per hour, in cooperative size 1650 under F21 mechanization with a 2 ha/person farm size, up to 14.278 pesos per hour, in cooperative size 1650 under F27 mechanization at a 14.5 ha/person farm size. As it was to be expected, labor productivity is higher under full than under partial mechanization for any given combination of cooperative size, farm size

and degree of mechanization. The reason is that, typically, full mechanization uses relatively less labor than partial mechanization.

Average productivity of capital runs from a minimum of 1.883 pesos per peso of working capital, in cooperative size 1650 under P25 mechanization with a 2.5 ha/person farm size, to a maximum of 3.316 pesos per peso of working capital, in cooperative size 425 under F7 mechanization at a 10.5 ha/person farm size. No pattern of substantial difference in average capital productivity can be observed between partial and full mechanization.

The marginal productivity of the various resources in a linear programming model is reflected in the shadow-prices. More accurately, the shadow-price for a resource is the marginal value product of that resource ceteris paribus; that is, it tells by how much the optimal value of the objective function would increase as a result of making available one more unit of the resource, without introducing any other changes into the model. Obviously, limiting resources alone are given a shadow-price. The common use of shadow-prices is in deciding whether or not it is profitable to procure more units of the scarce resource, the criterion being whether or not the shadow-price exceeds the cost of the added unit. "Range analysis" is a prerequisite to the decision, since it tells how many units of the scarce resource can be added before its shadow-price starts declining; this information is especially relevant when an indivisible ("lumpy") input is under consideration, for example a motor for pumping water.

Each class of land has its own shadow-price because of the different

profitability among land classes. For each cooperative size, shadow-prices of land are highest at the smallest farm size, at which the parametric routine begins, and they decrease as farm size increases, until they reach zero (land classes cease to be scarce) at different points along the routine. The highest shadow-prices for land are at 2 ha/person farm size, with P5 mechanization in cooperative size 275 and with P7 mechanization in cooperative size 425; they are: 4054.722 pesos for class 1, 2991.606 pesos for class 2, and 1356.656 pesos for class 3. Shadow-prices for land classes 4 and 5 are always zero, because they are not used in any optimal solution.

The highest shadow-price for one hour of labor is 11.915 pesos under partial mechanization, and 14.379 pesos under full mechanization. The highest shadow-price for one m^3 of water is 3.357 pesos under partial mechanization and 3.342 pesos under partial mechanization. Capital has no shadow-price, since no constraints on supply of credit by the Agricultural Bank were included in the model.

In this study, both labor and water are treated as fixed. Labor is institutionally limited with no possibility of hiring workers; water is considered limited by the fact that not enough is known about the supply of underground waters in the DAP. Therefore, no discussion is included on the profitability of added labor and water.

Actual farm size available to the cooperatives is fixed at the present time by patterns of community autonomy and by the prohibition in the Law of Agrarian Reform against renting of land. Some day that prohibition could be removed. In that case, the information on shadow-prices of land

(Appendix H) will be useful. If a cooperative rents land from another cooperative, both of them will stand to gain (increase in income), provided that the rent is between the shadow-prices of land in the two cooperatives. For instance, assume that the two cooperatives Y and Z have the same size 125, but own different quantities of land, 5 ha/person in Y and 14 ha/person in Z. If both cooperatives are performing optimally (F3 degree of mechanization, as shown in Table 8-9), the shadow-prices for one hectare of class 1 land is 1213 pesos in Y and 117 pesos in Z. Renting a hectare of land from Z to Y at any rent between 1213 and 117 pesos would benefit both cooperatives; for example, at a rent of 665 pesos, each cooperative will realize an increase of 548 pesos in aggregate income. As land is transferred from Z to Y the gap between the two shadow-prices narrows until it is reduced to zero. To know over how many additional hectares the pair of shadow-prices hold, "range analysis" must be applied.

The shadow-prices on farm machinery were the basis for determining the various degrees of mechanization, as explained in Chapter VII.

Average costs, both variable and total, are quoted in pesos per 100 pesos of final output (output sold); these costs also include the wages paid by the cooperative to its own members, since the wage bill does represent a cost to the cooperative as a producing unit.

The average variable cost ranges from 30.16 pesos, in cooperative size 425 under F7 mechanization with a 10.5 ha/person farm size, up to 53.116 pesos, in cooperative size 1650 under P25 mechanization with a 2.5 ha/person farm size. The average total cost runs from a minimum of 35.443

pesos, in cooperative size 625 under F9 mechanization with a 10.5 ha/person farm size, to a maximum of 59.802 pesos, in cooperative size 1650 under P26 mechanization with a 2 ha/person farm size.

The Tables on average cost (Appendix J) also indicate, for each cooperative size and degree of mechanization, the farm size at which average total cost is lowest. In a competitive framework of perfect mobility of resources, freedom of entry and perfect information, there would be a long-run tendency for the firms to have that cooperative size, that farm size and that degree of mechanization which achieve a minimum average total cost of production. In the DAP, at least two of the required conditions do not exist: Perfect mobility of land and labor resources and freedom of entry. As for mobility of resources, at the present time there is no market for purchasing or renting land, and there is no hiring of labor either, as explained in Chapter IV. Freedom of entry is non-existing for all practical purposes, because of the land tenure arrangements institutionalized by the Agrarian Reform process.

Finally, a few remarks are included on returns to labor, land and management, viewed as income shares for each sector of resources (since all working capital is borrowed, its return is the interest paid).

As explained at the end of Chapter III, the relative size of those returns is not a crucial issue in the DAP cooperative, because, through the wage bill and the profit distribution, in the end the three returns accrue to the same group of individuals, that is, the members of the cooperative.

However, the relative size of the returns can be of some interest, inasmuch as it tells what share of the aggregate income presently received by the cooperative would go to the landowner in the hacienda system of land tenure, which existed before the Agrarian Reform (although the optimal solutions would remain unchanged, according to the discussion on the objective function in Chapter III).

For all the optimal solutions in this study, return to labor (wage bill) as a percent of income ranges from a minimum of 10.02%, in cooperative size 625 under F9 mechanization with 8.5 ha/person, to a maximum of 30.91%, in cooperative size 1650 under F26 mechanization with 2 ha/person. The rest of the income is return to land and collective management. Returns to labor, as compared with returns to land and management, are higher under partial than under full mechanization, reflecting the fact that partial mechanization is more labor-intensive.

Paths for Mechanization

The paths for mechanization in a certain cooperative size are the various sequences of degrees of mechanization under which the cooperative may successively operate, until it reaches its optimal degree. The importance of these paths for the cooperatives in the DAP lies in the fact that the managerial skills required by an increasing mechanization are very scarce in the Area. Thus the paths of mechanization enable the cooperatives to follow a stepwise process for mechanizing their farms, with the assurance that no step misleads them away from the eventual optimal allocation of resources.

Paths for all the cooperative sizes and farm sizes considered in this study have been constructed with two criteria in mind: (i) That the degree of mechanization in each step build upon the previous one, that is, include the previous one plus some other machinery, and (ii) that the income per person in each step be higher than in the previous one.

The resulting paths are shown in Figures 8-2 through 8-14. The minimum or starting degree in each path is the degree below which labor would be in surplus during every time period of the year; it is the lowest degree of partial mechanization for each cooperative and farm size in Tables 8-1 to 8-8. The optimal or final degree for each cooperative and farm size is the degree given in Table 8-9. In those instances where the optimal degree is at the full level of mechanization, the jump for the partial to the full level can be taken at several points in the path, being a managerial decision which point is actually chosen. Once the full level has been entered, there is no return to the partial level, because such a move would force the idling of all planting and harvesting machinery. One or more steps in the path may be skipped, which is again a managerial decision; skipping of one or more steps will usually call for introduction of more than one tractor at the same time, with the corresponding management implications.

The paths shown in Figures 8-2 through 8-14 are an indicative framework for each cooperative size. When the path for a specific cooperative and farm size combination has to be designed, then the information on unused machinery (Appendix I) must also be taken into consideration. That information may cause an intermediate step in the path to be undesirable,

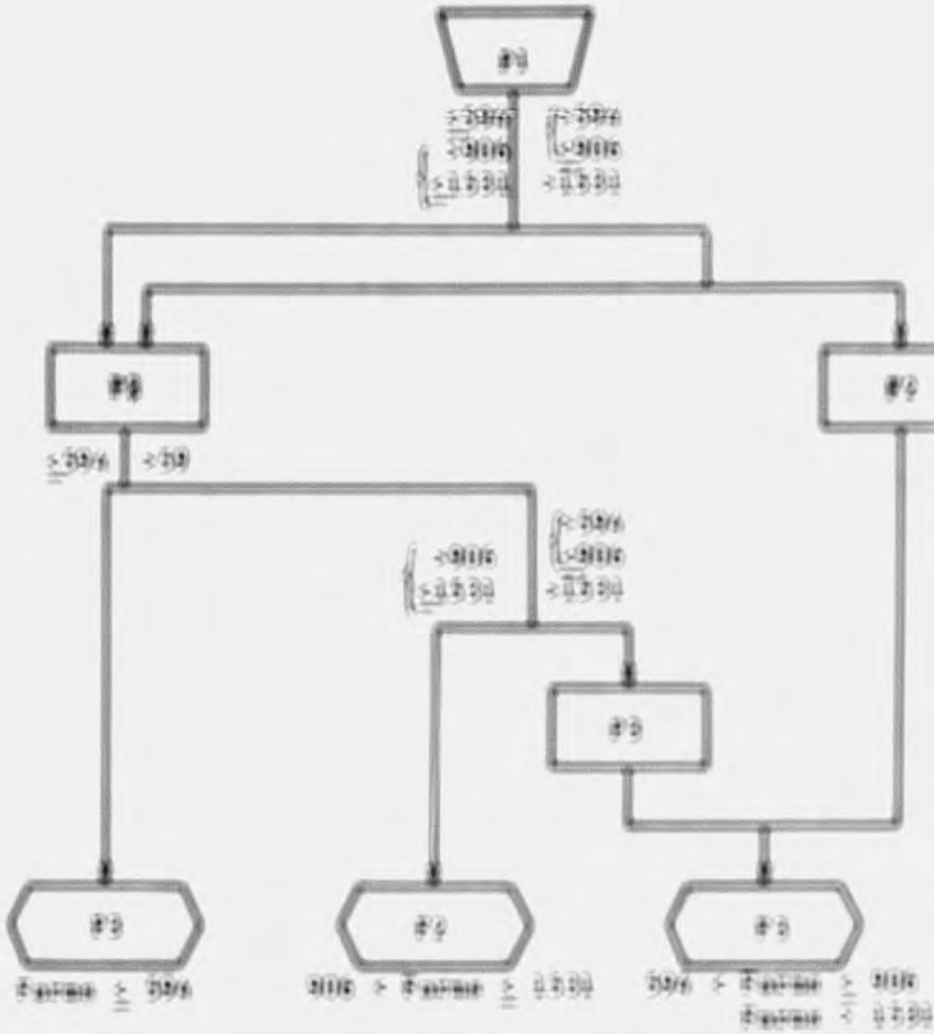

Figure 8-2. Paths of mechanization for comparative size 12[a,b]

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[a]Source: Figures 8-2 through 8-14 are derived from Tables 8-1 through 8-9.

[b]

starting degree of mechanization

intermediate degree of mechanization

optimal degree of mechanization

interpage connector

프로그램 8.3. 하이브리드 MPI 프로그램에서 동적 스케줄링을 사용한 순차적 순서화

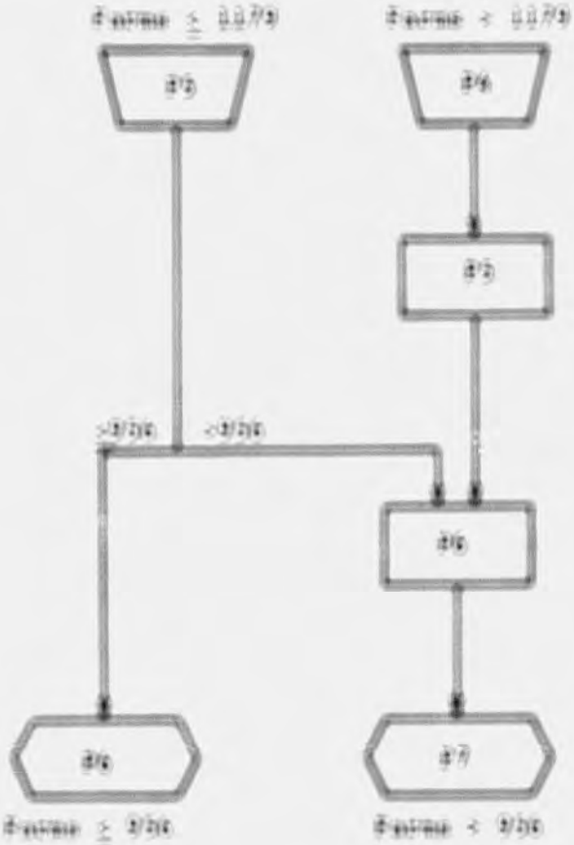


Figure 8-4. Flowchart of conditional execution of consequent blocks 73–77 which depend upon the value of argument 5a field 4*

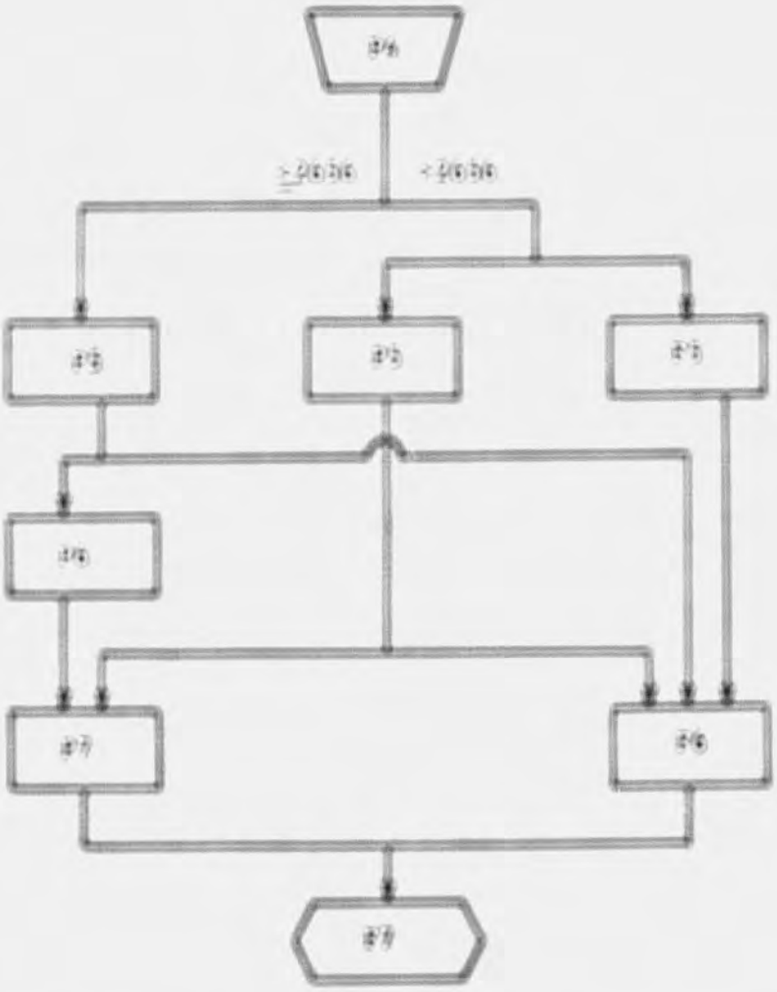
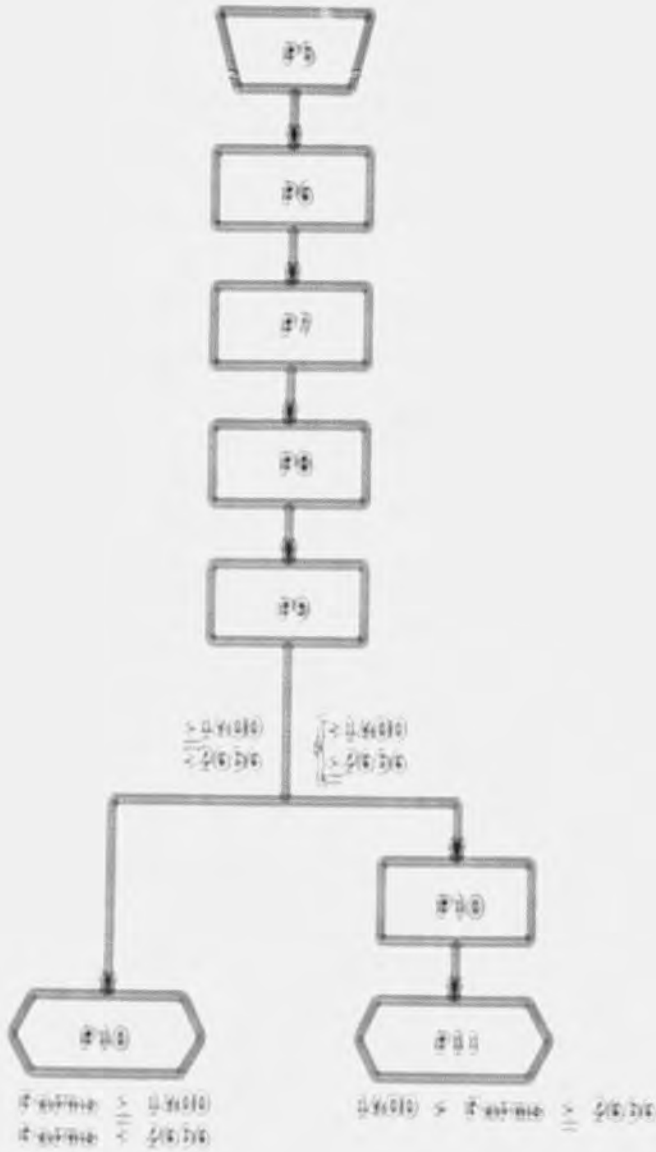


Figure 8-5. Profile of mechanisms for comparative cross 8/2 with Kaiser Lorgan sinus 2016.06 hp^{3}



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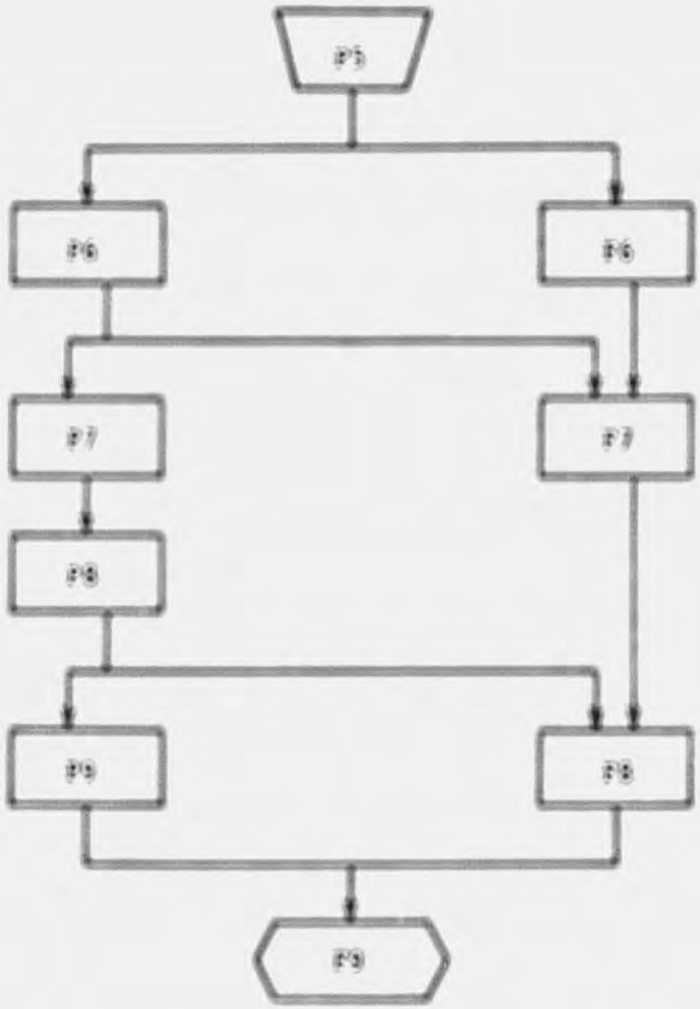

Figure 6-7. Paths of mechanization for computed use size 625 with forms larger than 6203 in but smaller than or equal to 6983 in²

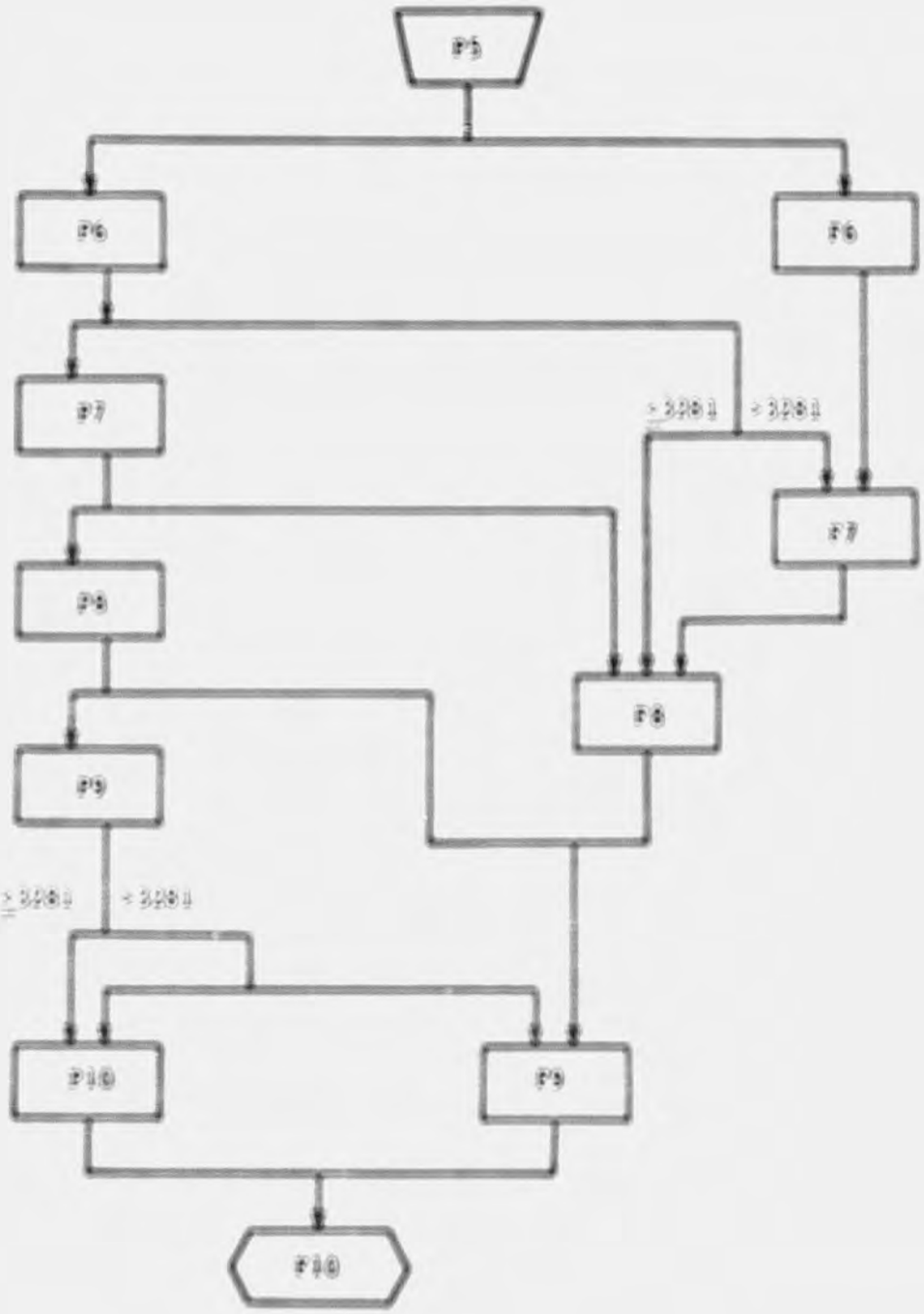

Figure 8-8. Path of mechanization for computation size 625 with farms larger than 2369 ha but smaller than or equal to 6253 ha, and farms larger than 6253 ha*

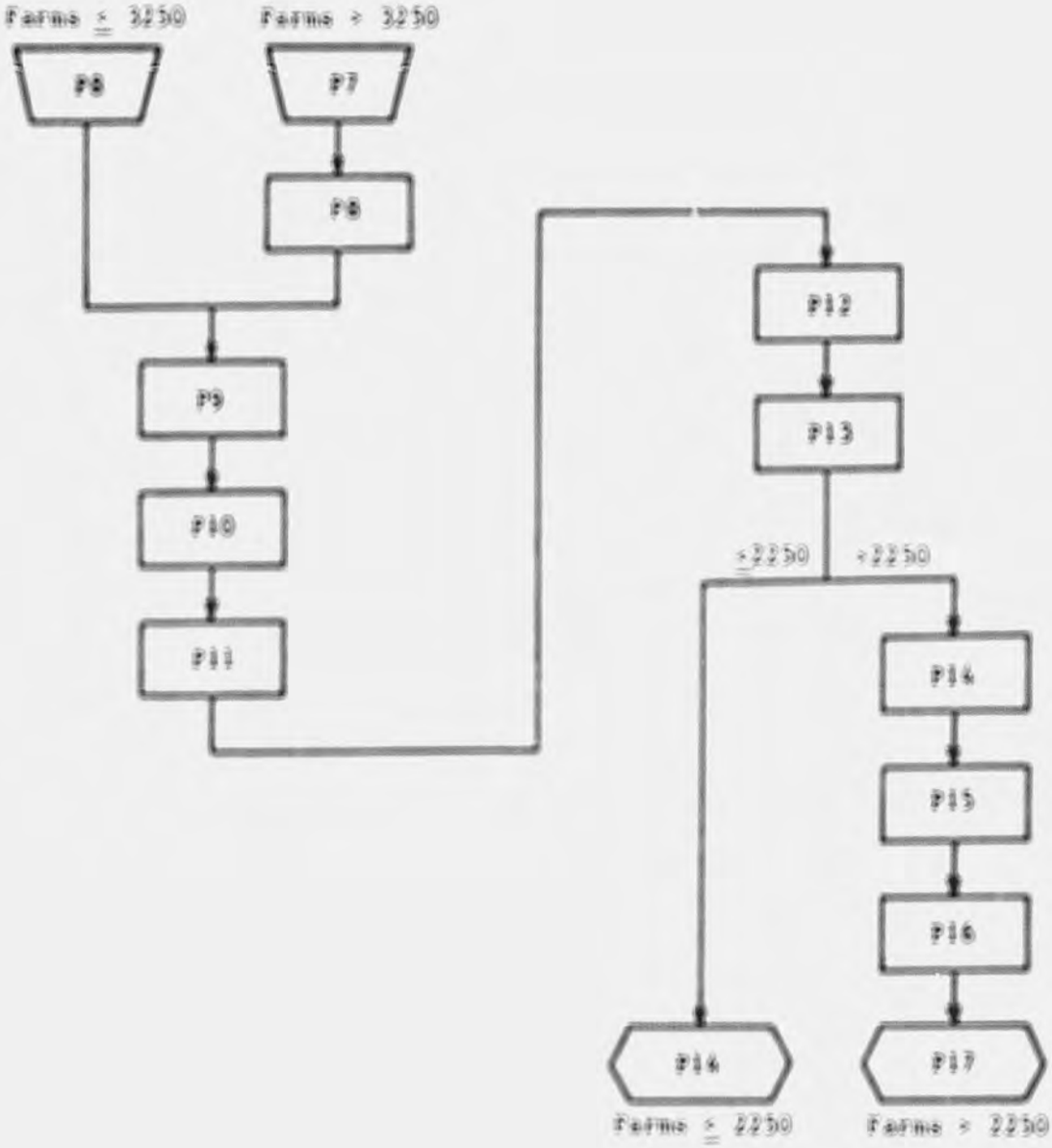

Figure 6-9. Paths of mechanisation for cooperative size 1000 with farms smaller than or equal to 6250 km^2

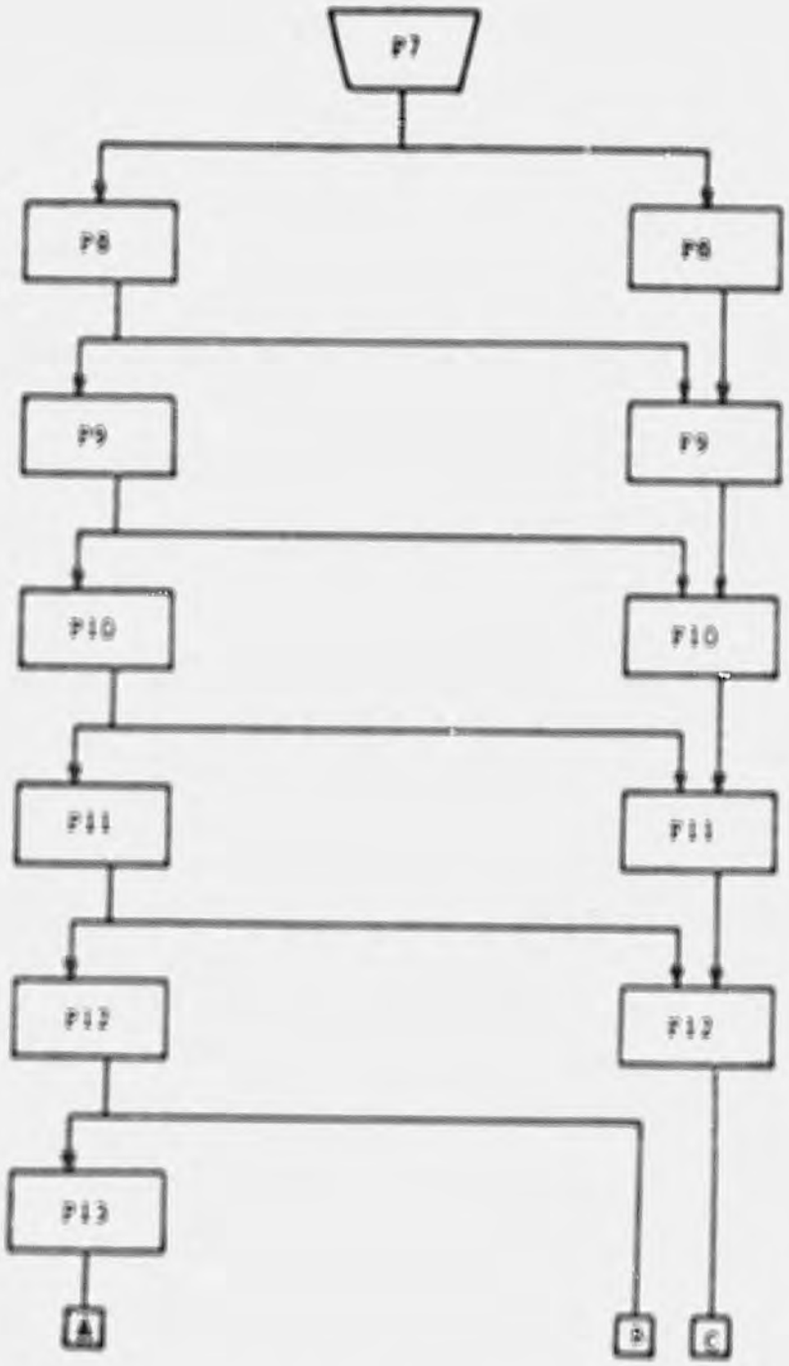

Figure 8-10. Paths of mechanization for cooperative size 1000 with farms larger than 6250 ha but smaller than or equal to 7250 ha, farms larger than 8250 ha but smaller than or equal to 9250 ha, and farms larger than 12250 ha*

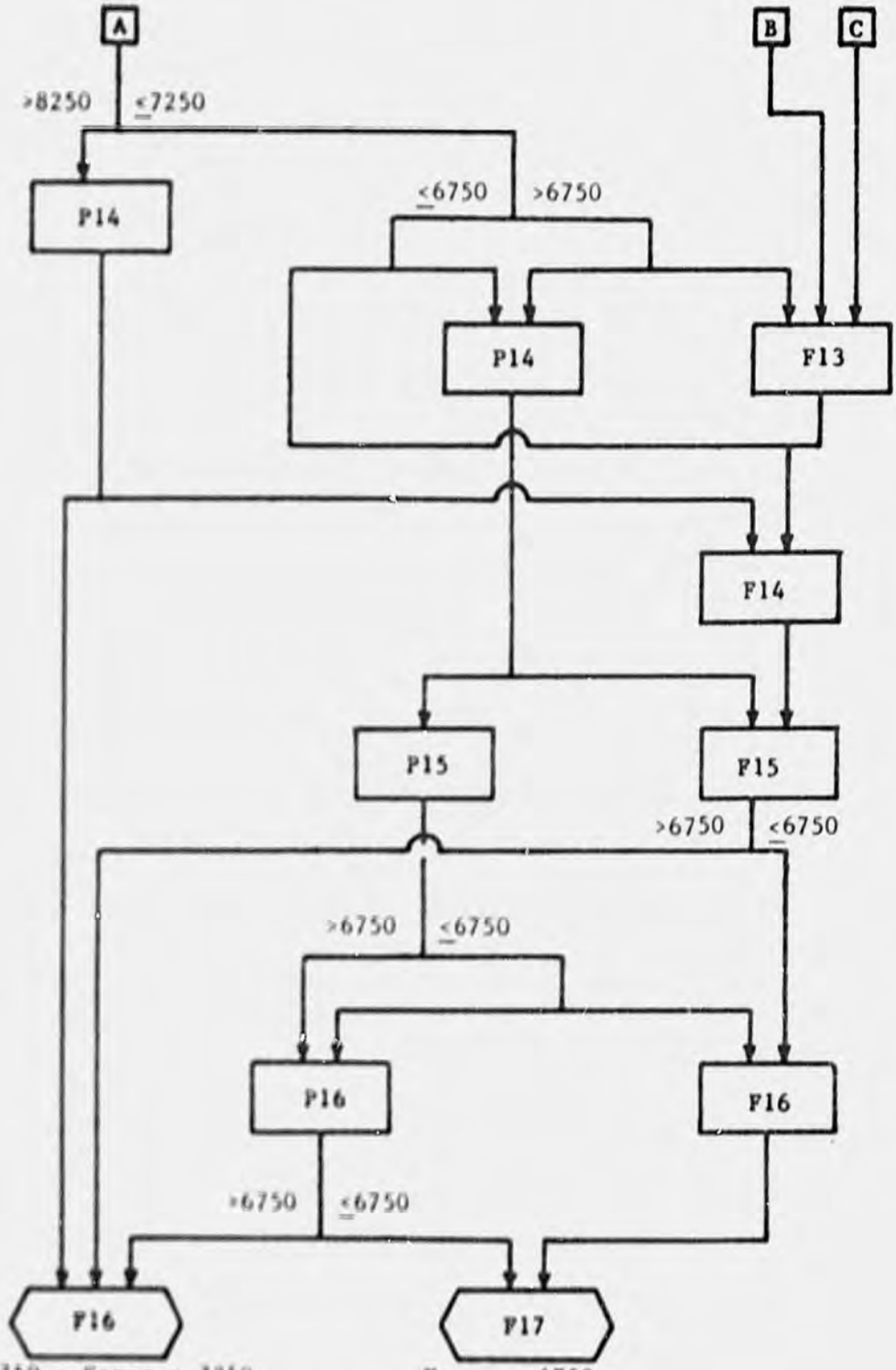

Figure 8-10. (Continued)

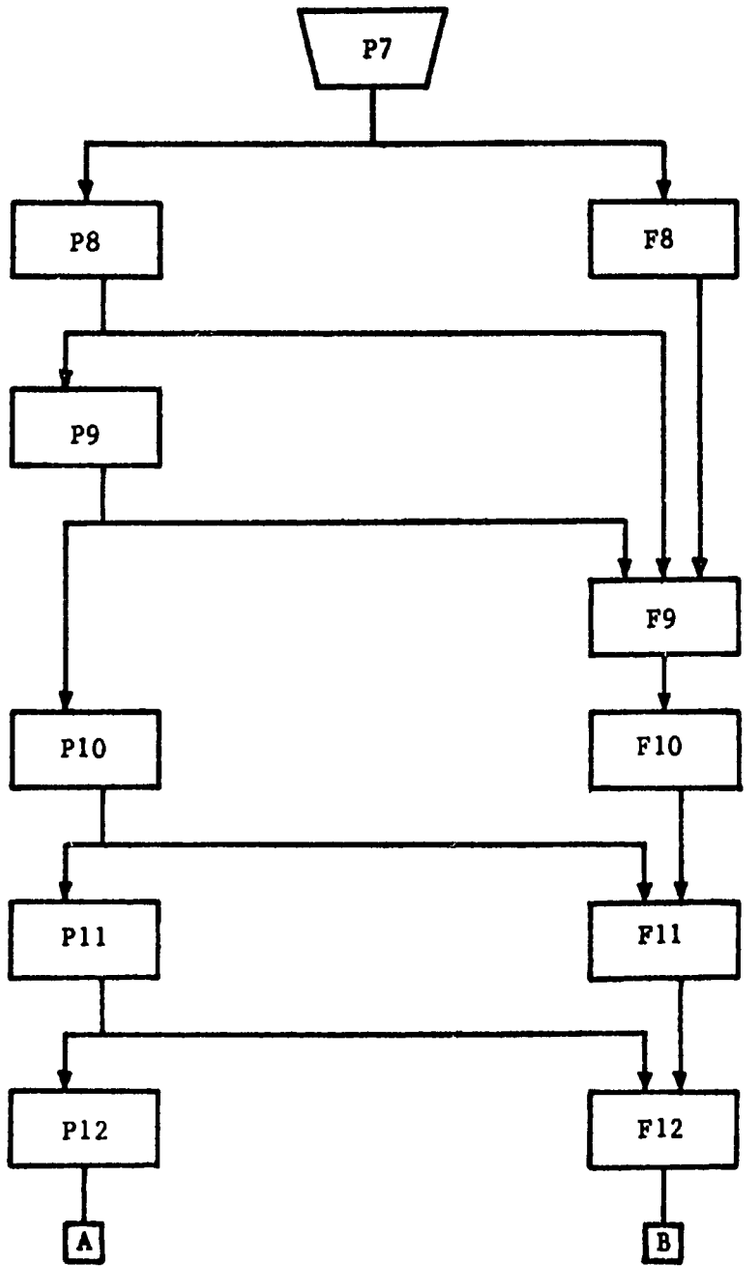

Figure 8-11. Paths of mechanization for cooperative size 1000 with farms larger than 7250 ha but smaller than or equal to 8250 ha, and farms larger than 9250 ha but smaller than or equal to 13250 ha[a]

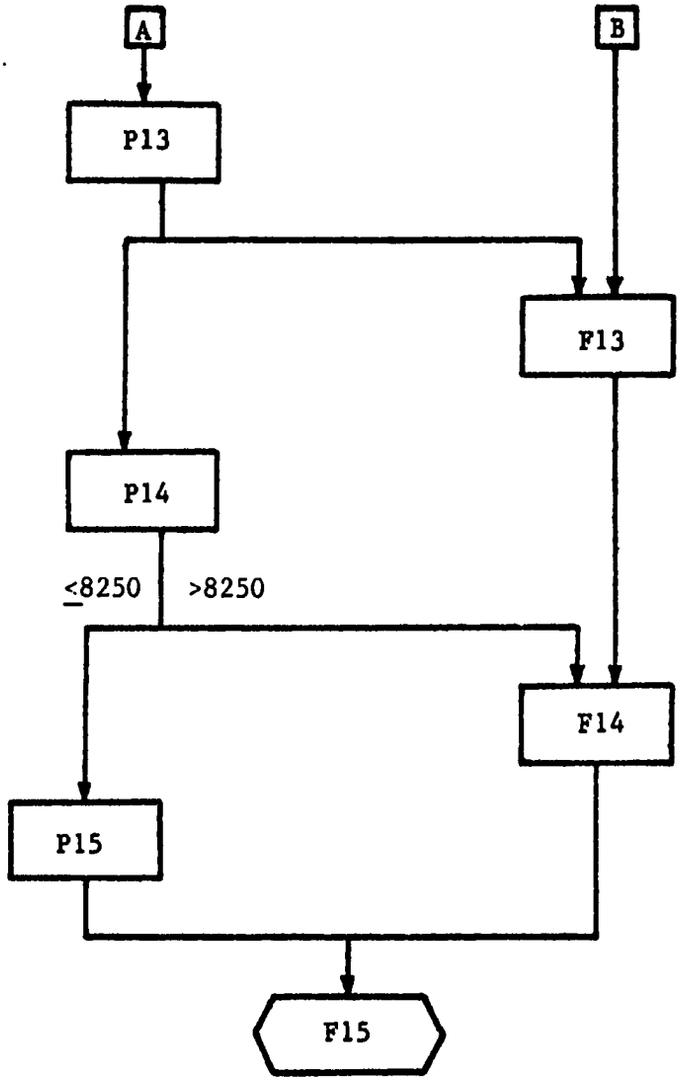

Figure 8-11. (Continued)

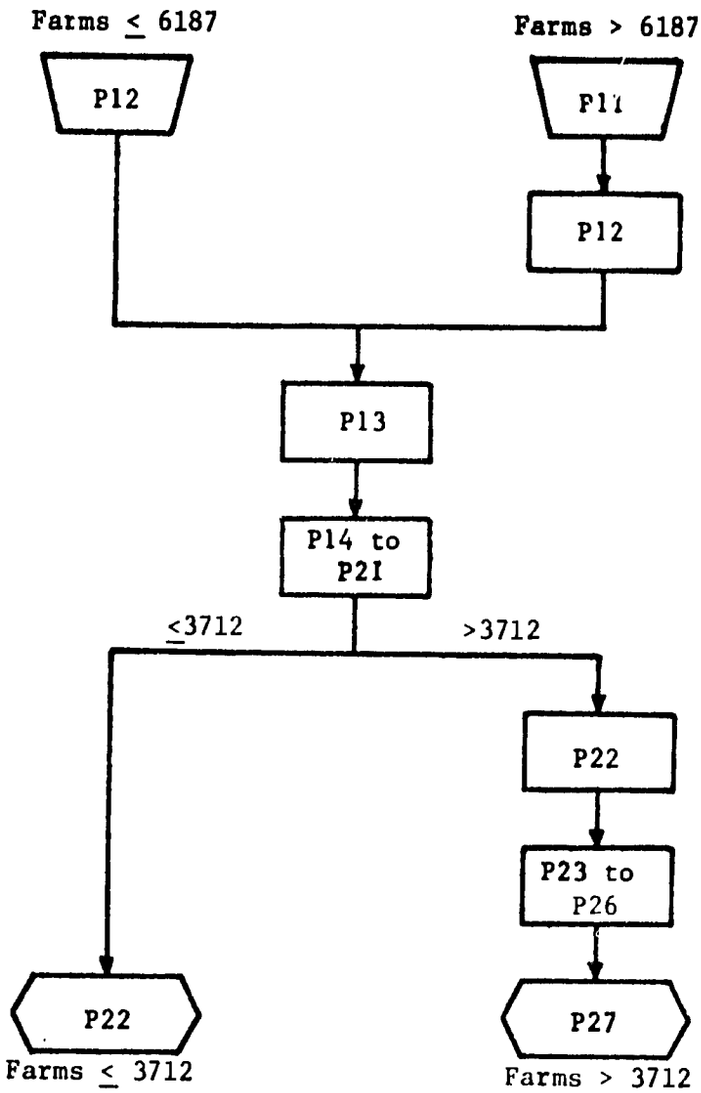

Figure 8-12. Paths of mechanization for cooperative size 1650 with farms smaller than or equal to 11962 ha[a]

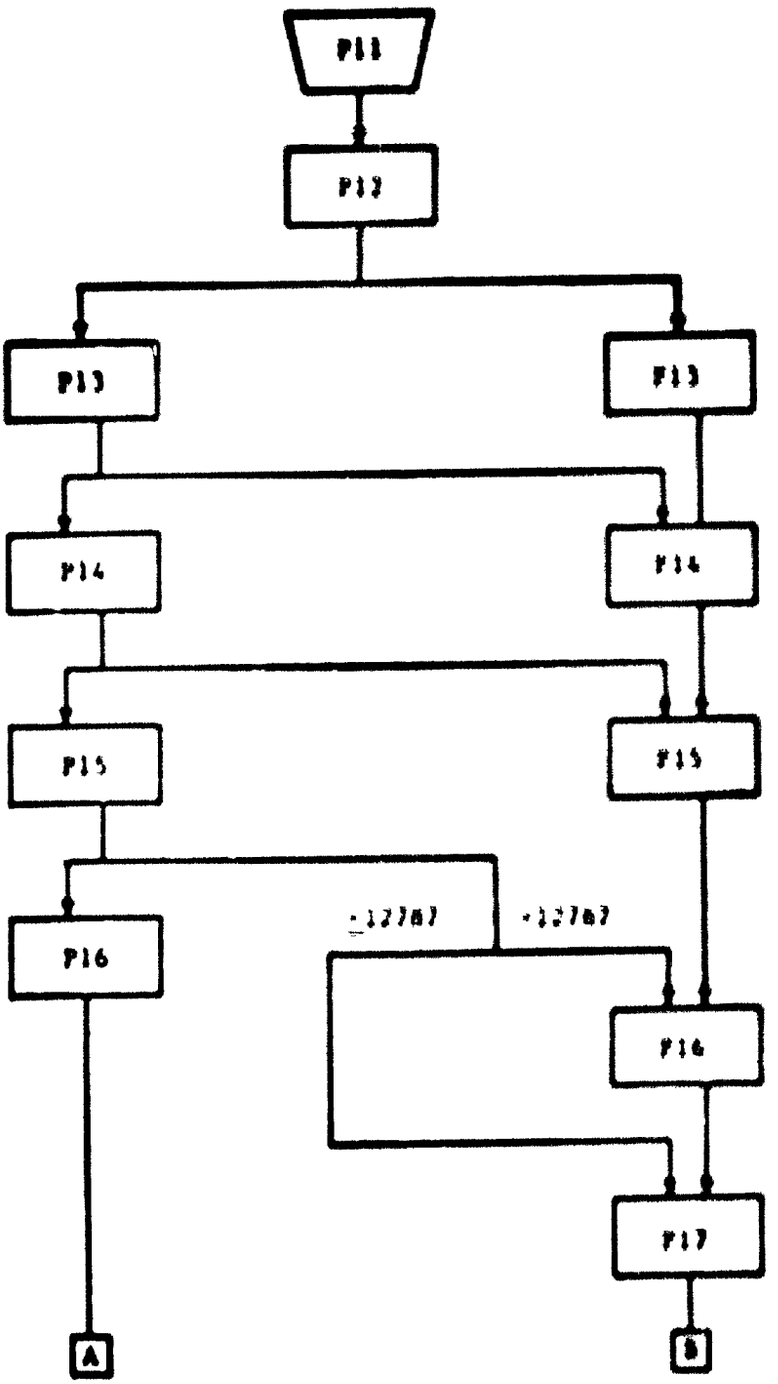

Figure 8-13. Paths of mechanisation for cooperative size 1650 ha with farms larger than 11962 ha but smaller than or equal to 13612 ha"

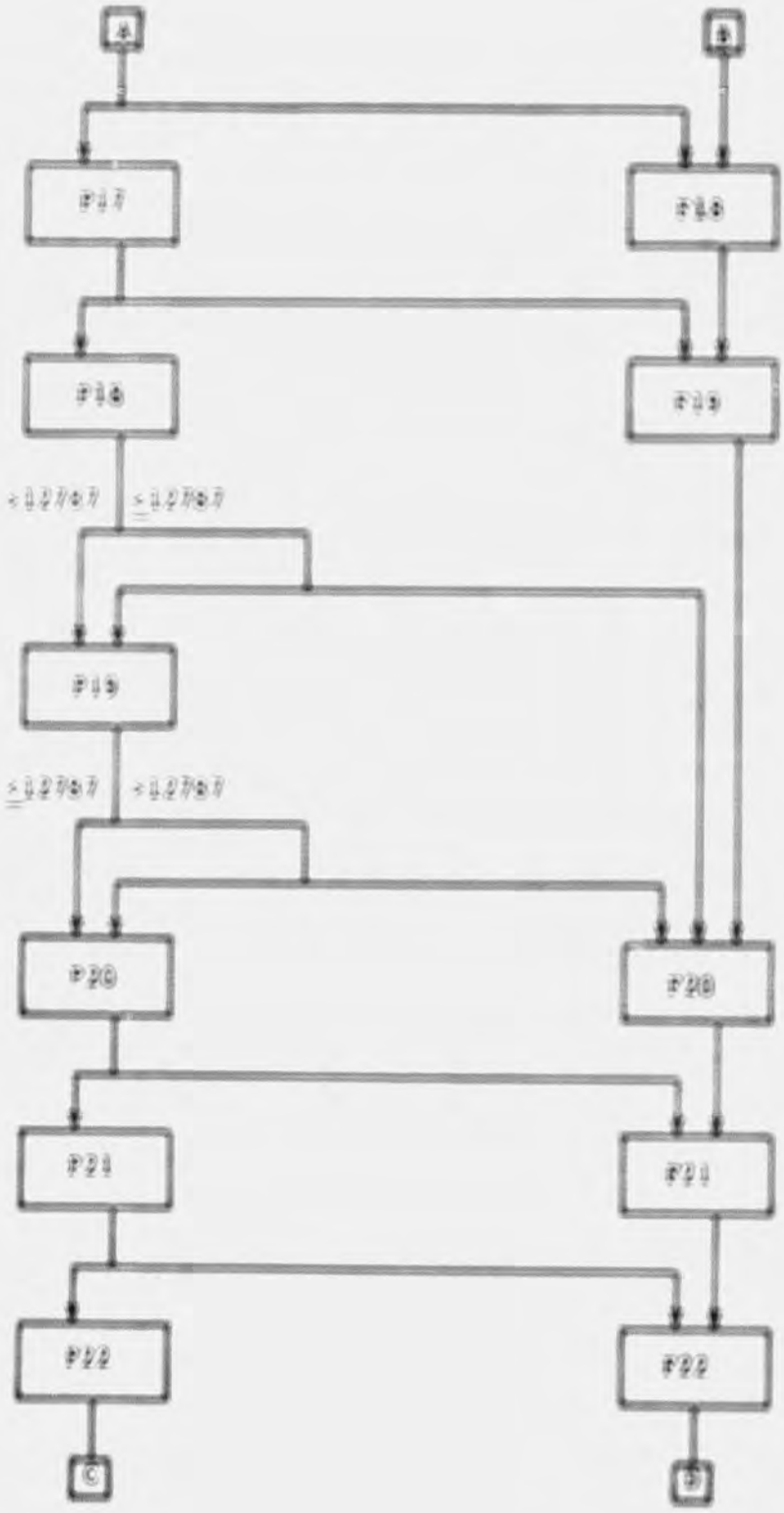

Figure 8-13. (Continued)

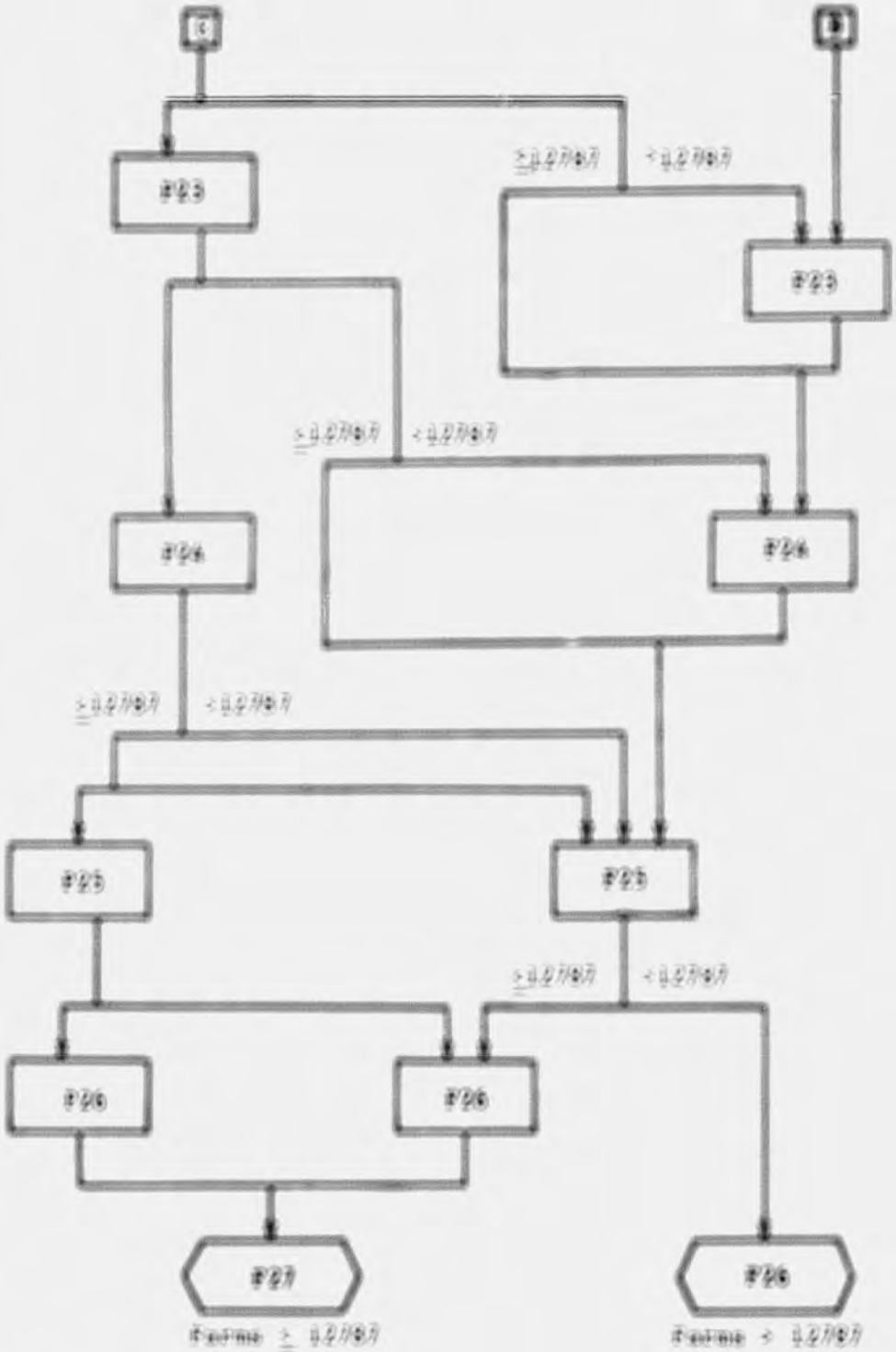

Figure 8-13. (Close Ground)

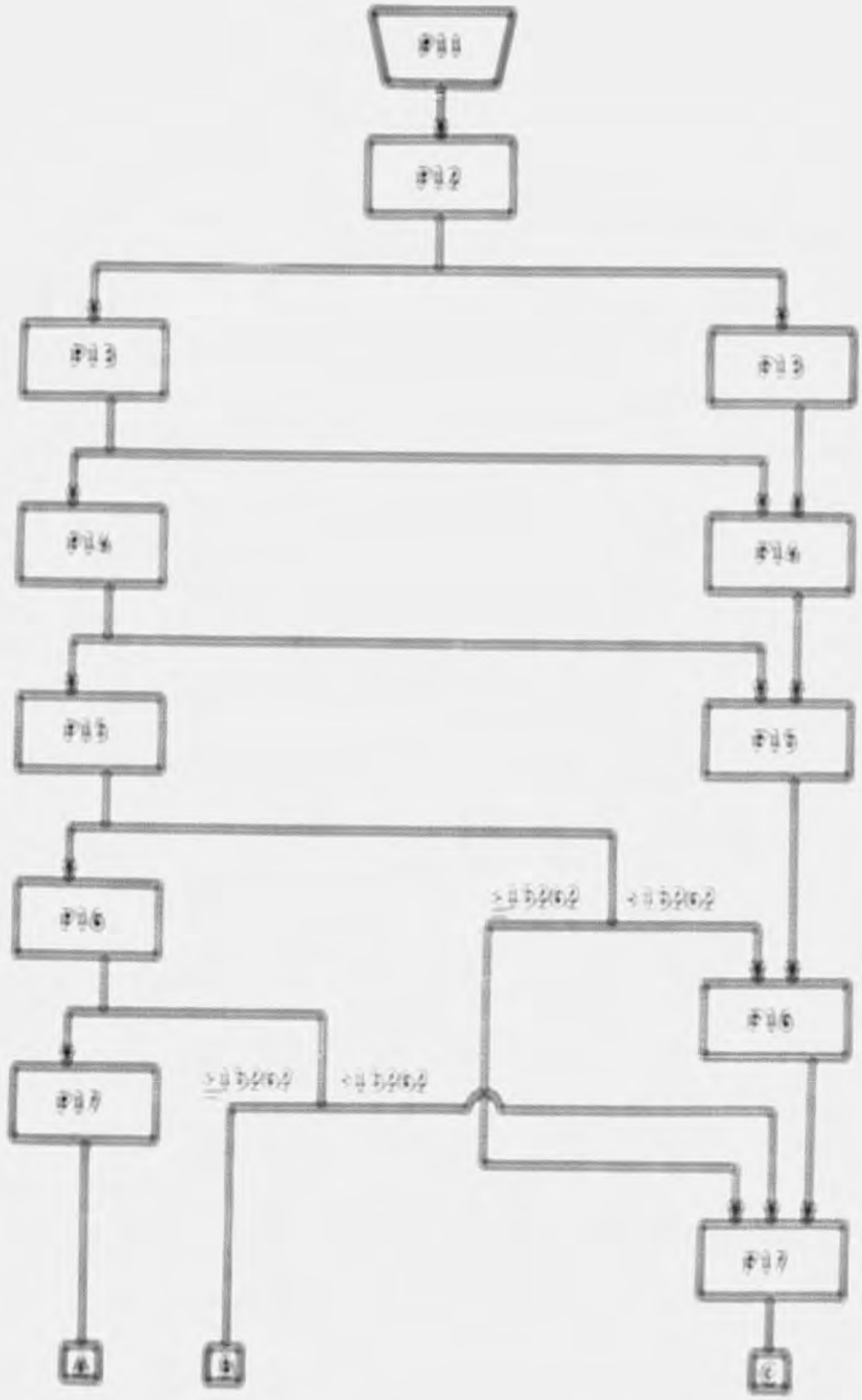

Figure 8-14. Paths of mechanization for cooperative size [illegible] with farms larger than [illegible] ha

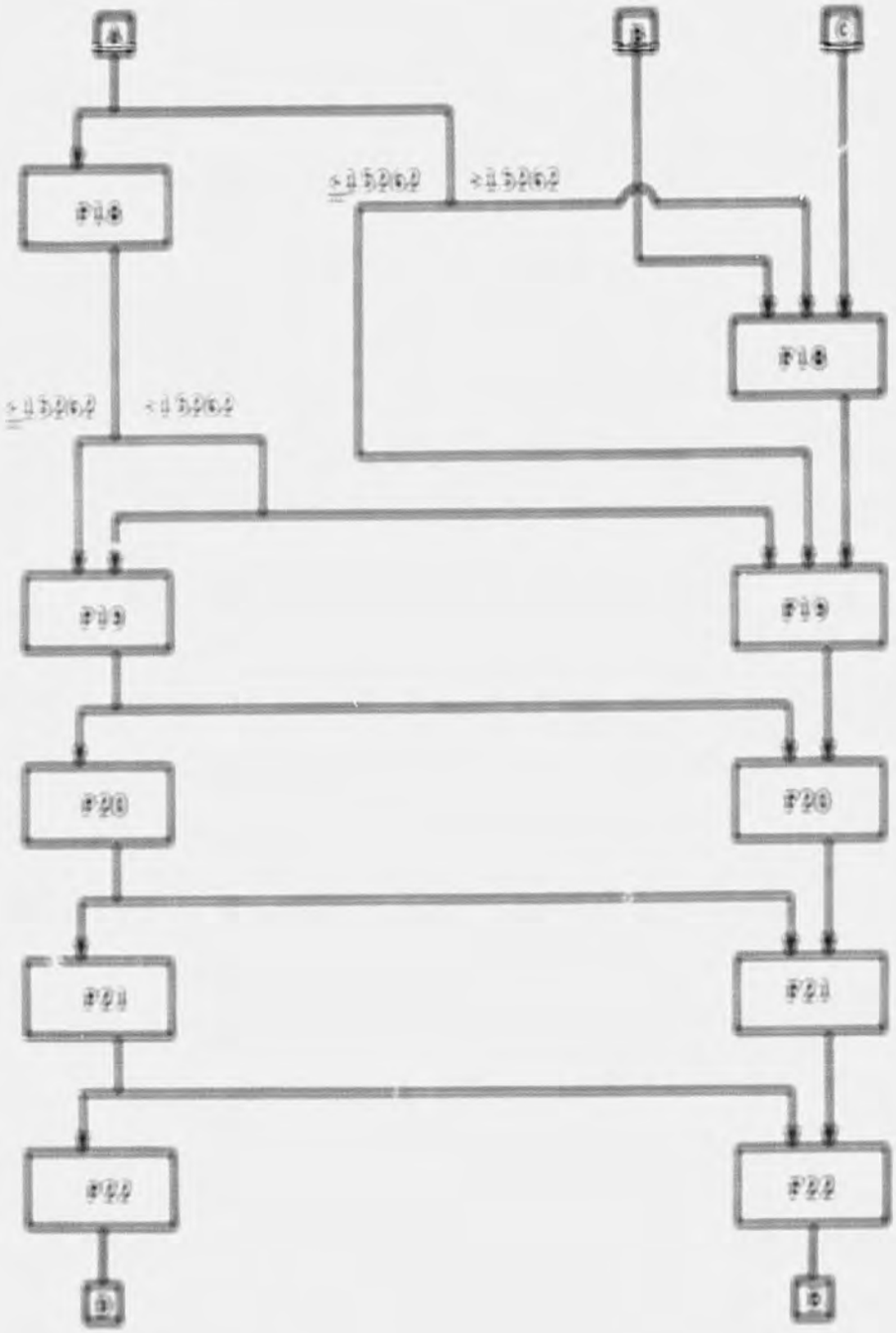

Figure B-44. (Continued)

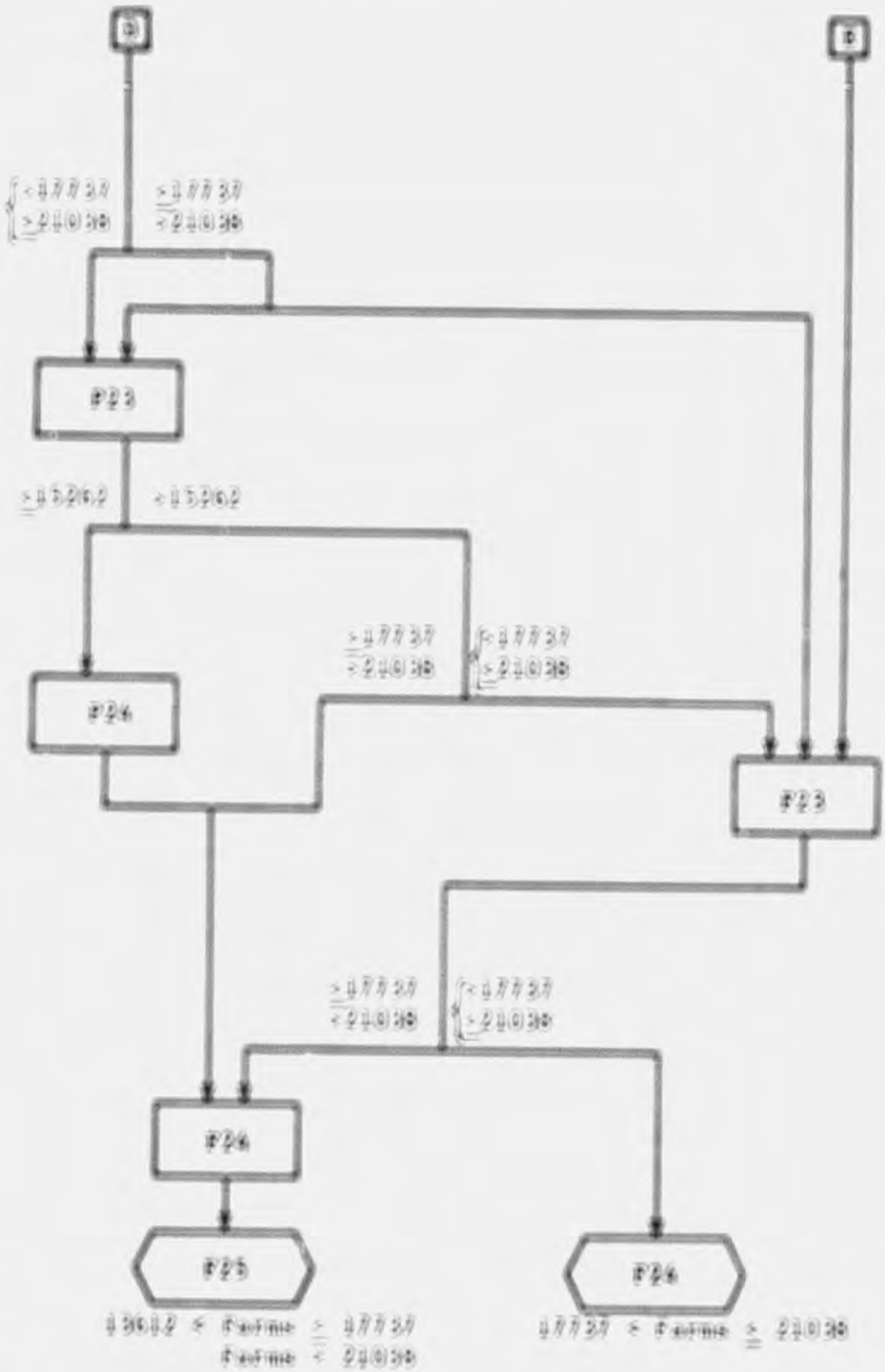

Figure 6-46. (Cont'd)

If it implies dropping major pieces of machinery, such as a tractor or a grain drill, which must be acquired again later on at an ulterior step.

As an example, a specific path is provided: the path of mechanization for a comparative size 625 with a farm of 3125 ha, that is, 5 ha/person. Table 8-17 lists and describes the degrees of mechanization that may apply to the case (according to Figure 8-8). Figure 8-15 presents the feasible path, where the capital letters A through E identify the five possible jumping points from partial to full mechanization.

As it was said above, where the jumping point from partial to full mechanization will be and whether any steps will be skipped are practical decisions based on management considerations. The heavy line in Figure 8-15 defines a path that may be preferred by the manager, inasmuch as it provides for a relatively smooth progression in the machinery required, in the sense that not more than one tractor, the most sophisticated piece of equipment, is added at any step. The reasons for choosing jumping point C are of the kind a manager would consider: Point A happens too early in the path, when managerial and mechanical skills may be deficient; points B and D require two tractors each among the additional machinery, which may impose difficult adjustments in management; as for point E, unless management and mechanical abilities are too low, there would be no reason for waiting until the very end of the path. Inevitably, however, at the selected jumping point C there is still a large additional block of machinery. Two steps call for disposing of some equipment: in jumping from F7 to F8 one sprayer becomes surplus, and in going from F9 to F10 two wagons are idled. Sprayer and wagons are small pieces of equipment

Table 8-27. Degrees of mechanization and their composition on the path for cooperative size 623 with farm size of 312.5 ha[a,b]

Degrees	Composition[c]																Source tables
	U	P	H	HP	C	C	K	T	R	B	D	W	S	Z	Motor pump	Sills	
P5	4	3	2				3					2	2	2	2		7=3 and 2=2
P6	5	4	2				3					2	2	2	2		7=3 and 2=2
P7	6	4	2				4					2	2	3	2		7=3 and 2=3
P8	6	5	2				4					2	2	3	2		7=3 and 2=7
P9	7	5	2				5					2	2	3	2	2	7=3 and 2=8
P10	8	6	2				5					2	2	3	2	2	7=3 and 2=9
P6	5	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	7=4 and 2=4
P7	6	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	7=4 and 2=5
P8	7	5	2	2	2	2	3	2	2	2	2	2	2	3	2	2	7=4 and 2=6
P9	8	6	2	2	2	2	3	2	2	2	2	3	2	3	2	2	7=4 and 2=4.2
P10	9	6	2	2	2	2	3	2	2	2	3	2	2	4	2	2	7=4 and 2=4.3

[a]Sources: The degrees of mechanization are taken from Figure 8-8. The sources for the composition of each degree are given in the last column of the table.

[b]Farm size is 5 ha/person.

[c]The symbols for machinery were explained in Table 7-4, note b.

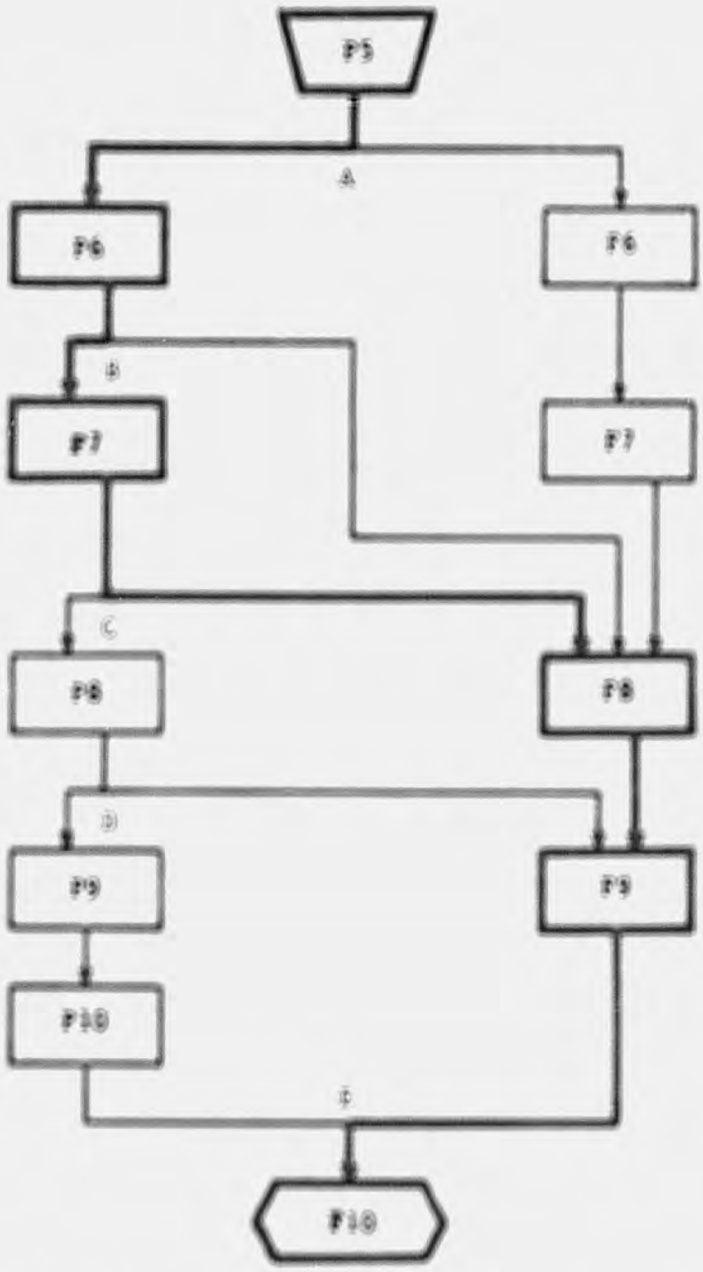

Figure 8-15. Paths of mechanization for comparative size 625 with farm size of 2125 ha[a,b]

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[a]Source: Derived from Figure 8-8.

[b]The meaning of the heavy line and the capital letters is explained in the text.

and their sale should not be any problem; perhaps they will rather be kept on the farm, since they represent such a small annual fixed cost. Keeping the three machines reduces the income per person by 3.5 pesos only.

Seldom will a Community in the DAP begin to organize cooperatively with all of its members. Rather, the membership will grow over time until all the families have joined. Figures 8-2 through 8-14 and Tables 8-1 through 8-8 are also of assistance in deciding the path of mechanization as a function of the changing cooperative size. We do not go into details, but we present Table 8-18 as an illustration. It shows one possible path of mechanization for a cooperative whose size increases from 125 to 625 with a farm size of 5 ha/person.

No time dimension is attached to the mechanization paths in this study. Timing of the various degrees of mechanization is a policy decision to be taken by the management at the firm level, and nothing can be said a priori about the time span required to cover a whole path or the various possible branches of a path. If some day studies are made on adoption rates of mechanization in the DAP, then it should be possible to attach a time component to each step in the paths, so that an optimal (efficient) path of mechanization can be determined.

Alternative Criteria of Optimality

In an underdeveloped economy, such as Bolivia's, where the development process involves a substantial share of governmental action, it is conceivable that the Government may have goals other than the highest income per capita.

Table 8-18. Path of mechanization for a cooperative with increasing size from 125 to 625, with a 5 ha/person farm size[a]

Cooperative size	Farm size in ha	Path of[b] mechanization	Income per person
125	625	P1	2185.6
		P2	2487.4
		P3	2597.1
275	1375	P5	2674.4
425	2125	P7	2689.1
625	3125	F8	2695.9
		F9	2802.9
		F10	2849.6

[a]Source: Derived from Figures 8-2, 8-3, 8-4 and 8-8, and from Tables 8-1 through 8-4.

[b]Successive degrees are chosen in such a way that income per person be increasing.

Then, the optimality criterion to be considered at the farm level would not be any more the highest income per person. For example, the criterion of optimality could be the highest relative use of labor, if labor is the abundant resource; or it could be the highest productivity of land, in a context of land scarcity; or it could be the lowest use of capital, if loanable funds are in short supply; or it could be a constrained optimum, such as, for example, the lowest use of capital provided that income per person is not below a certain figure. Then, obtaining

optimal solutions would call for (i) a new objective function embodying the selected criterion, (ii) additional rows with the minimum or maximum constraints, if any, to the selected criterion, and (iii) the optimization of the new objective function.

In the case of Bolivian agriculture, a detailed government planning that would dictate farm size, degree of mechanization, use of resources and level of output, appears as quite unfeasible, because it would be violently rejected by the farmers themselves. The only indirect approach the Government could use to bring about the optimization of a variable other than income, would be to institutionalize a certain farm size through the Agrarian Reform process. Then, the cooperatives would be left free to maximize income per person with the constrained farm size and, in so doing, they would optimize the variable selected as a goal by the Government. In most cases, the cooperatives would incur an opportunity cost in terms of lost income per person, as compared to the highest optimal solutions that were explained at the beginning of this chapter.

Assuming such indirect policy approach by the Government, the results of this study provide information to trace the effects on the cooperatives of establishing criteria of optimality other than the highest income per person, that has been used throughout this research.

The alternative criteria of optimality that might be chosen are: Highest land, labor or capital productivity, highest relative use of labor, lowest capital borrowed per person and lowest average total cost. Table 8-19 contains the following information for each one of the six criteria

Table 8-19a. Farm sizes and trade-offs under alternative criteria of optimality, in cooperative sizes 125, 275 and 425[a]

Alternative[b] of criteria optimality	Cooperative size[c]								
	125			275			425		
	Ha/ person	% gain	% lost income	Ha/ person	% gain	% lost income	Ha/ person	% gain	% lost income
Highest land productivity[d]	12.	22.91	1.95	7.	10.96	5.97	10.5	14.47	1.25
Highest labor productivity[d]									
Highest capital productivity[d]	12.	15.62	1.95	7.	5.9	5.97	10.5	8.83	1.25
Highest relative use of labor[e]	4.	45.87	17.59	2.5	66.86	33.77	2.5	68.67	33.79
Lowest capital borrowed/person	12.	21.37	1.95	8.	7.44	3.67	10.5	12.92	1.25
Lowest average total cost	12.	9.85	1.95	7.5	2.77	4.02	10.5	6.04	1.25

[a]Sources: Computed from Appendix J and Table 8-10.

[b]Other than the criterion of highest income per person used throughout this study. It is assumed that these criteria would be applied by merely enforcing a certain farm size and letting the cooperative maximize income per person; in so doing the cooperative would be achieving the optimality under consideration, for example, the highest relative use of labor.

[c]The kind of information provided by this Table can be best understood with the following example on how to read it: For cooperative size 125, if the criterion of highest land productivity is chosen, the farm size corresponding to 12 ha/person (1500 ha) must be enforced; as compared with the highest-income optimal solution, there will be a gain of 22.91% in land productivity; such gain will be achieved at the expense of a 1.95% reduction in income per person, there being a trade-off between productivity and income. A blank means that the farm size need not be changed because the alternative optimality being considered is already achieved in the highest-income optimal solution (determined by the criterion of highest income per person).

[d]Average productivity.

[e]As a percent of total labor available on an all-year basis.

Table 8-19b. Farm sizes and trade-offs under alternative criteria of optimality, in cooperative sizes 625, 1000 and 1650[a]

Alternative[b] of criteria optimality	Cooperative size[c]								
	625			1000			1650		
	Ha/ person	% gain	% lost income	Ha/ person	% gain	% lost income	Ha/ person	% gain	% lost income
Highest land productivity[d]	10.5	13.39	0.96	11.5	11.97	0.76	12.5	2.8	0.05
Highest labor productivity[d]									
Highest capital productivity[d]	10.5	8.27	0.96	11.5	7.85	0.76	12.5	1.8	0.05
Highest relative use of labor[e]	2.5	64.93	36.45	3.	74.58	38.05	3.5	78.87	31.96
Lowest capital borrowed/person	10.5	12.52	0.96	11.5	11.82	0.76	12.5	2.91	0.05
Lowest average total cost	10.5	6.94	0.96	11.5	6.32	0.76	12.5	1.52	0.05

[a]Sources: Computed from Appendix J and Table 8-10.

[b]Other than the criterion of highest income per person used throughout this study. It is assumed that these criteria would be applied by merely enforcing a certain farm size and letting the cooperative maximize income per person; in so doing the cooperative would be achieving the optimality under consideration, for example, the highest relative use of labor.

[c]See note c, Table 8-19a.

[d]Average productivity.

[e]As a percent of total labor available on an all-year basis.

and each one of the cooperative sizes: (i) The farm size (ha/person) that should be enforced, (ii) the gain achieved in the value of the variable being optimized, and (iii) the resulting loss in income per person as compared to the highest-income optimal solution for the same cooperative

size. The trade-off between gain in the optimized variable and loss in income must be considered by the policy-maker, in deciding whether to select an alternative criterion of optimality. The decision will involve a value judgement on the "desirability" or "acceptability" of the trade-off. For example, if the criterion of highest relative use of labor is under discussion, the policy-maker will have to evaluate whether it is "worth" and "sociologically feasible" to impose a reduction in income per person in the range of 18% to 38%, in order to achieve a 46% to 79% higher use of labor.

Some patterns may be noticed among the farm sizes indicated by Table 8-19:

First, selecting the criterion of highest labor productivity would not call for any policy of reducing farm sizes below the highest-income optimal sizes that were given in Table 8-9. That is, highest labor productivity was already achieved in the highest-income optimal solutions for all cooperative sizes.

Second, if highest relative use of labor is chosen as the optimality criterion, farm sizes must be reduced to between 2.5 and 4 ha/person. Of course, partial mechanization is then used by all cooperative sizes, because it is more labor-intensive.

Third, optimality in the other four criteria happens at the same farm size within each cooperative, with only slight variations within cooperative size 275. The income loss associated with these farm sizes is between 4% and 6% for cooperative size 275, between 1% and 7% for cooperative sizes 125 and 425, and below 1% for cooperative sizes 625, 1000 and

1650. Such trade-offs would not seem "intolerable" by any standards.

Comparisons with the Present Situation

In order to see the results of this research in the right perspective, this last section compares two sets of information in the optimal solutions with the corresponding data from the present situation. First, the farm sizes in the optimal solutions are compared with the actual farm sizes of the Communities in the DAP which have begun to organize as a cooperative. Second, the optimal farm plans are compared with the productive performance of two Communities at the present time.

1. In Chapter II of this study, Table 2-6 showed the farm size of the Communities in the DAP which have started a cooperative among their members (with the exception of Huanucollo where data on farm size is not available). In Table 8-20 these present farm sizes are compared with the farm sizes that provide the highest possible income per person; the difference (surplus or deficit) between the two sizes is also shown for each cooperative, as well as the maximum income per person achievable with the present farm size as a percent of the income per person with the highest optimal farm size.

It can be seen that eleven out of the twenty Communities listed own enough land to be capable of achieving the highest possible income per member. The other nine Communities own insufficient land as compared with the optimal farm size. The reduction in income caused by the insufficient farm size is 2% or less in Chiarumani, Liojila, Huayllaroco,

Table 8-20. Comparison of optimal with present farm size in the communities in the DAP[a]

Communities[b]	Present size		Optimal farm size[c]			Income[f] as % of highest
	Has.	Persons	In has./[d] person	In has	Surplus (+)[e] or deficit (-)	
Patarani	8000.	250	14.	4900.	- 4100.	66.21
Colipa-Huarcatani	30000.	250	14.	3500	+ 1500.	100.
San Martín de Tequeca	1200000.	300	14.	4200	+ 7800.	100.
Chilcatumani	80000.	650	13.	8450.	- 450.	99.67
Pomani	110000.	700	13.	9100.	+ 1900.	100.
San José de Llanigas	180000.	600	13.	7800.	+10200.	100.
Santiago de Collana	120000.	800	14.	11200.	+ 800.	100.
Llojlla	13000.	1300	13.5	2092.5	- 592.5	97.92
Laguna Blanca	200000.	400	13.5	5400.	+14600.	100.
Huayllatrece	25000.	200	13.5	300.	- 600.	98.35
Sorasora	30000.	200	13.5	300.	- 100.	99.92
Pujtani	320000.	200000	13.	2600000.	+ 600000.	100.
Huarace	80000.	400	13.5	5400.	+ 2600.	100.
Chiara Belén	150000.	1100	14.	15400.	- 400.	99.97
Santiago-Marmutani	130000.	400	13.5	5400.	- 2900.	77.8
Tauca Pampa	60000.	400	13.5	5400.	+ 600.	100.
Achaya	20000.	400	13.5	5400.	+ 3400.	100.
Queñuata	92000.	1500	13.	19500.	-10500.	84.04
Cullí Cullí Baja	2695.	243	14.	3430.	- 735.	98.3
Cullí Cullí Alta	9000.	335	14.	4900.	+ 4100.	100.

[a] Sources: Present sizes are taken from Table 2-6; all other figures are derived from Tables 2-9, 3-1 and 8-10.

[b] Huancollo is omitted because its farm size is unknown.

[c] Farm size corresponding to the highest-income optimal solution.

[d] Taking into consideration the classification in Table 2-9.

[e] Present minus optimal farm size in number of hectares. A surplus means that the farm size is larger than the optimal. A deficit means that the farm size is below the optimal.

[f] Maximum achievable income per person with the present farm size, as a percent of the income per person from the highest-income optimal solution.

Sotacote, Chica Belén and Culli Culli Bajo, 16% in Quicata, 22% in Santari-Murmuntani and 44% in Patarani. For all practical purposes, it can be said that only three out of the twenty Communities considered, that is, 15% of them, experience a scarcity of land. The land they own would be insufficient even if a 10% reduction in income from the highest-income optimal solution were considered "acceptable".

2. The second part of this section compares the present performance of two Communities with the optimal performance determined in this study, in an attempt to offer a preliminary evaluation of the developmental potential in the DAP.

Information on productive performance of the Antipampa and Culli Culli Bajo Communities is available for the year 1968 (Bolivia 1969a, Bolivia 1969b), without any substantial changes having occurred since then. The optimal solutions for the nearest cooperative sizes considered in this study could be legitimately applied to the two Communities; however, for the sake of convenience, optimal solutions were obtained for the exact number of persons in the Communities, 296 persons in Antipampa and 243 persons in Culli Culli Bajo, under the degree of mechanization which is optimal for the nearest cooperative size. After a first solution with the present farm size, land was parcelized upwards until the highest-income optimal solution was reached. Thus, two optimal solutions are inspected for each Community, the optimal solution with the present farm size and the optimal solution with the optimal (non-limiting) farm size, the results being used to construct Tables 8-21, 8-22 and 8-23.

Table 8-21. Comparable information on present and optimal performance in the Antipanga Community[a]

	Unit	Present[b] performance	Optimal performance[c] With the present farm size	Optimal performance[c] With the optimal farm size
Aggregate income	pesos	301990.95	1148517.22	1248366.28
Total output	pesos	3190387.1	1770769.295	1923903.14
Land used	ha	424.063	443.779	498.403
as a percent of farm size	percent	17.01	17.72	9.
Working capital	pesos	363019.4	602732.428	654911.871
per person	pesos	142.701	1522.052	1653.816
Total fixed cost	pesos	1389310.05	769417.26[d]	769417.26[d]
Income per person	pesos	762.603	2901.296	3152.39
Land productivity	pesos/ha	712.432	4008.272	3964.151
Capital productivity	pesos/pesos	3.647	2.938	2.941
Investment per person	pesos	308.713	1942.973	1942.973
Fixed cost as percent of total cost	percent	30.39[e]	15.4	14.41
Average variable cost	pesos/1000 pesos	18.712	34.038	34.005
Average total cost	pesos/1000 pesos	23.428	40.235	39.703

[a] Source: Present performance is computed from Table 4-4.

[b] In 1968.

[c] A specific set of optimal solutions was obtained for the cooperative size of the Community (396 persons). The first solution considered the present farm size (2493 ha, equivalent to 6.293 ha/person); in the other solutions land was parametrized from 6.3 ha/person up to the optimal farm size (5544 ha, equivalent to 14 ha/person). The 17 degree of mechanization was used, because it is the optimal one for the nearest cooperative size (423) in Table 8-9.

[d] Unused machinery is the same as in the highest-income optimal solution for cooperative size 423.

[e] Annual fixed cost was computed on the assumption of 10 years of useful life and 12% rate of interest, resulting in 246728.96 pesos.

Table 8-22. Comparable information on present and optimal performance in the Cuijia Cuijia Village Community[a]

	Unit	Present[b] performance	Optimal performance	
			With the present farm size	With the optimal farm size
Aggregate income	pesos	23,326,7.93	754,362,.307	772,303,.82
Total output	pesos	32,463,9	1,170,396,.48	1,224,624,.764
Land used	ha	=d	297,.833	330,.73
as a percent of farm size	percent	=d	11,.05	9,
Working capital	pesos	76,536,	394,807,.4	4,306,33,.124
per person	pesos	342,.382	1,643,.439	1,761,.776
Total fixed cost	pesos	1,435,577,.3	5,288,29,.26[e]	5,288,29,.26[e]
Income per person	pesos	1,033,.747	30,79,.647	31,33,.1083
Land productivity	pesos//ha	=d	39,28,.438	37,12,.369
Capital productivity	pesos//pesos	4,.212	2,.964	2,.837
Investment per person	pesos	394,.193	2,138,.487	2,138,.487
Fixed cost as percent of total cost	percent	23,.33[f]	13,.98	14,.82
Average variable cost	pesos//100 pesos	23,.796	33,.741	35,.246
Average total cost	pesos//100 pesos	31,.137	46,.161	41,.38

[a] Sources: Present performance is computed from Table 4-8.

[b] In 1968.

[c] A specific set of optimal solutions was obtained for the comparative size of the Community (243 persons). The first solution considered the present farm size (269.5 ha, equivalent to 11 ha/person); in the other solution land was parameterized from 11.5 ha/person up to the optimal farm size (36.75 ha, equivalent to 15 ha/person). The 75 degree of mechanization was used, because it is the optimal one for the nearest comparative size (275) in Table 8-9.

[d] Not available.

[e] Unused machinery is the same as in the highest-income optimal solution for comparative size 275.

[f] Annual fixed cost was computed on the assumption of 10 years of useful life and 12% rate of interest, resulting in 22,242,368 pesos.

Table 8-23. Percent changes from the present to the optimal performance in the Antipampu and Chuqui Chuqui Baja Communities (in percent)[a]

	Antipampu		Chuqui Chuqui Baja	
	With the[b] present farm size	With the[c] optimal farm size	With the[b] present farm size	With the[c] optimal farm size
Total output	4,346.95	3013.57	263.79	280.74
Land used	6.08	47.53	-[d]	-[d]
as a percent of farm size	6.07	-47.09	-[d]	-[d]
Working capital	966.63	1058.94	415.85	463.96
Total fixed cost	399.85	399.85	263.27	263.27
Income per person	280.32	323.37	199.67	203.02
Land productivity	432.69	423.34	-[d]	-[d]
Capital productivity	-47.97	-47.92	-29.46	-32.48
Fixed cost as percent of total cost	-49.26	-52.52	-31.5	-36.48
Average variable cost	83.9	83.73	43.79	48.33
Average total cost	58.23	56.24	29.4	33.32

[a]Sources: Compiled from Tables 8-21 and 8-22.

[b]The figures in this column measure the percent change (increase or decrease) in the optimal performance with the present farm size as compared to the present performance.

[c]The figures in this column measure the percent change (increase or decrease) in the optimal performance with the optimal farm size as compared to the present performance.

[d]Not available.

Comparing the present and the optimal performances for the two Communities, the following features are worth noticing:

(i) Increases in income per person in the optimal solutions are from 200% to 1000 above the present performance.

(ii) Use of land and capital, the only inputs compared, is higher in the optimal solutions, by as much as ten times in the case of capital in Antipampa.

(iii) Total value of output grows by as much as 300% as a result of irrigation, improved seeds, fertilizer and chemicals and as a consequence of more land being used.

(iv) Average productivity of land more than triples in Antipampa (the data for Cullu Cullu Bajo), a result of improved inputs. Average productivity of capital decreases by 30% to 50%, reflecting the fact that present methods of production are more labor-intensive than the technology considered in this study.

(v) Average costs are higher in the optimal solutions by as much as 60%. This is partly due to the fact that the costs under the present situation do not include any payments for labor, while the costs in the optimal solutions do include wages.

This preliminary evaluation suggests that substantial gains in income and output can be achieved through the developmental efforts in the DAP.

The interpretation of the results of this study is now complete, although some considerations on the behavior of the sheep raising activity are included in Appendix 5. The following final section in this Chapter

deals with the related problem of expanding the results to the entire DAP.

Expanding the Results to the Entire Development Area of Patacamaya

A warning is in order against attempting a simplistic expansion of the results of this study to the entire DAP. Three major objections exist: Insufficient information, Assumptions at the firm level and Fallacy of composition.

1. Insufficient Information. It was noted at the end of Chapter II that the sample of 22 Communities listed in Table 2-6 was not randomly selected from among all the Communities in the Area, but it is simply the set of Communities that have chosen to organize cooperatively. Therefore, there is no assurance that the sample is representative of the true distribution of Community sizes in the DAP.

An acceptable method of checking for representativeness would be to group the 22 Communities in classes and compare the frequencies with those from the last Agricultural Census. However, the last (and only) Agricultural Census, taken in 1950, did not enter into much geographical detail and contains obviously pre-Reform data, two circumstances that make it of little use for our purpose.

The problem could also be approached by exclusion. The number of persons in the Community (the variable we are concerned with) is not a determining factor in the Community's decision to become organized cooperatively thus being included in our set of 22 Communities. Rather, the main factors impelling a Community to start a cooperative seem to be the

drive for progress, its awareness of more profitable alternatives, its readiness for change and risk-taking. These factors may be related to the pre-Reform status of the Community (Table 2-5) but they certainly do not seem to depend upon the number of persons forming the Community. This fact shows only that there is no obvious reason for bias in our sample; but it does not necessarily exclude other possible causes of bias.

The only course of action left would be to treat the sample as if it actually were a random sample and, being fully aware of the inherent weaknesses, proceed to expand the results to the entire universe of Communities in the DAP. This approach would obviate the risk of letting a reader of this study to undertake on his own the induction for the entire Area. The reader might overlook the necessary cautions and qualifications more easily than will the researcher, who has been in close contact with the data sources and with the process of research (Table 4-9 gives some statistics of the sample when treated as a random sample).

However, two more pieces of information, essential for expanding the results to the entire DAP, are very unreliable.

The first, and most crucial, piece of information is the total number of Communities existing in the DAP at the present time. The only estimate available, published in 1966 by the staff at the Experimental Station, puts the number of Communities at 600 (Cardoso, Candarillas and Chacón 1966). It is a figure drawn exclusively from informal contact with the population and from traveling through the area. The true figure could well deviate substantially from 600.

The second important piece of information is the total extension of

the DAP. As we said in Chpater II, the figure based on estimates by the National Commission of Agrarian Reform is 7010 km^2. However, careful planimetry of the map supplied by the same Commission gave an extension of 11,507 km^2. The exact figure must be known before the results of this study can be expanded to the entire DAP, in order to answer questions on land scarcity in the Area as a whole.

After the data collected by the Agrarian Reform mobile teams are released, both the number of Communities and the extension of the DAP will be reliably known. Moreover, the data from the mobile teams will also yield a distribution of all the Communities in the DAP by number of persons and by number of hectares they own.

2. Assumptions at the firm level. Some assumptions are made in this study which should be removed before the results are legitimally extended to the entire DAP. These assumptions (from Chapter IV) are: (i) Homogeneity of land distribution in classes throughout the Area, (ii) uniform availability of water to all farms, and (iii) unlimited supply of capital.

3. Fallacy of composition. Whenever firm level (micro) conclusions are extended to the area or region level (macro), a fallacy of composition may occur. Specifically, in this study the fallacy may occur for lack of knowledge on the following: (i) the response of output prices to sharp increases in supply and the effective demand for agricultural output produced in the Area, (ii) the response of input prices to increased demand by the firms in the Area, and (iii) comparisons of capital productivity

in agriculture and in other sectors, with the resulting impact on supply of capital and rates of interest.

These three objections to an expansion of the results to the DAP prevent a fortiori any indiscriminate application to the entire Altiplano region. In Chapter IX, suggestions are made for further research which will help in the removal of these objections, thereby opening the way for a legitimate expansion of the results of this study to larger geographical areas.

CHAPTER IX. CONCLUSIONS AND RECOMMENDATIONS

Conclusions Related to the Objectives

The results presented and interpreted in the preceding chapter fulfill in the following manner the four objectives specified in Chapter I:

1. The first objective dealt with optimal land/person ratios, optimal degrees of mechanization and paths for mechanizing the farms.

The optimal land/person ratios, that is, those which provide the cooperatives with the highest possible income per person, are the following ones in ascending order: 13 ha/person for cooperatives with 625 and 1650 members, 13.5 ha/person for cooperatives with 425, 14 ha/person for cooperatives with 275 and 1000, and 15.5 ha/person for cooperatives with 125 members. Thus, the range of optimal land/person ratios is between 13 and 15.5 ha/person. The solutions corresponding to these land/person ratios are called in this study the highest-income optimal solutions.

The optimal degrees of mechanization are those required by the highest-income optimal solutions. They are all under full mechanization (as defined in Chapter III, in section "Basic Considerations"): F3 degree for cooperative size 125, F5 for size 275, F7 for size 425, F10 for size 625, F10 for size 1000 and F27 for size 1650 (the kind and number of farm machinery entering each optimal degree can be seen in Table 7-4).

The paths for mechanization were derived so that, in the ascending sequence of degrees of mechanization up to the optimal degree, the cooperative would never experience a decline in income per person. The paths

for each cooperative size were shown in Figures 8-2 through 8-14. The paths branch at various steps, indicating the feasible jumping points from partial to full mechanization. Since the jump involves a higher level of mechanical and administrative skills (mainly maintenance, timing of operations and loan repayment), the selection of a specific jumping point is a management decision, to be taken at the farm level according to the progress of the cooperative in acquiring those skills.

The optimal land/person ratios and optimal degrees of mechanization listed above resulted from treating land parametrically in the linear programming model, that is, from considering the amount of land owned by the cooperative as a variable that can be increased until the highest-income optimal solution is reached; this is the point where land ceases to be a limiting factor.

However, cooperatives may be unable to have at their disposal as much land as dictated by the optimal land/person ratios. The results of this study contain information for these cases too. The optimal degree of mechanization for their fixed land/person ratios can be determined from studying Tables 8-1 through 8-8, or it can be directly observed in Figures 8-2 through 8-14.

The results of this study also provide information on the opportunity cost, in terms of income foregone, of having a farm size below the optimal land/person ratio. Such opportunity cost is not more than 10% of the highest possible income for land/person ratios larger than 6 to 7 ha/person; below that ratio, the cost increases rapidly until it reaches from 45 to 51% at the lowest ratio of 2 ha/person (Table 8-10).

Information is also obtained on the trade-offs, that would be forced by the selection of an optimality criterion other than the income per person criterion used throughout this study. The criterion of highest relative use of labor (in percent of total available) has the costliest trade-off: When the relative use of labor is maximized, 18% to 38% of income has to be given up in exchange for an increase of 46% to 79% in labor used, as compared with the highest optimal solutions. A much smaller loss of income results from choosing four other criteria: land and capital productivities, lowest use of capital per person and lowest average total cost. The loss of income is then between 3% and 6% for cooperatives size 275, and below 2% for all other cooperative sizes. Furthermore, all four criteria are optimized at the same land/person ratio within each cooperative size, except for cooperative size 275. Labor productivity is already maximized at the optimal land/person ratios, so that its choice as a criterion of optimality would not entail any trade-off.

2. The second objective referred to use and scarcity of resources. In the highest-income optimal solutions, the land actually cultivated is around 9% of the total farm area, which is the all class 1 land available (the reason why all and only class 1 land is used was given in the third section of Chapter VIII). The number of hectares cultivated in those solutions increases with the cooperative size, and ranges from 170 to 1930 has.

The labor used in the highest-income optimal solutions is between 30% and 32% of the total available. In man-hours per year, labor required,

both unskilled and machinery operator's, runs from 45,000 hours in cooperative size 125 up to 550,000 hours in cooperative size 1650. Labor shortages, under both partial and full mechanization, occur mainly during the peak labor-using season from May through August, when highly labor-intensive harvesting and chuño-making are scheduled.

Relative use of water runs between 2% and 12% of the total that can be extracted on the farm with one motor-and-pump. Water shortages exist only in November and February, and then only in cooperatives with 625 members or more.

Working capital required by the highest optimal solutions increases directly with the cooperative size, ranging from 222,000 pesos up to 2,547,000 pesos. However, the relationship is inverse when capital is considered on a per capita basis, with a maximum of 1777 pesos per person in cooperative size 125 and a minimum of 1544 pesos in cooperative size 1650. No capital shortages can develop, because our model has considered the supply of capital as unlimited.

Similar information on use and shortage of resources for land/person ratios below the optimal one was also obtained. It is presented in Appendices H and J.

Whether or not there is a shortage of land in the DAP as a whole cannot be answered until the results of this research are expanded to the entire Area. The reason why this cannot be done at the present time was discussed at the end of Chapter VIII.

3. The <u>third objective</u> addressed itself to the optimal farm plans. The farm plans for the six highest-income optimal solutions were

presented in detail (Table 8-11). No sheep raising is called for in these plans, and all resources are allocated to the rotation PHQB (potato-broad beans-quinua-barley). Quinua is irrigated in its entirety in farm plans for cooperatives with 125 and 275 members, and partially in the other four solutions. Only non-irrigated potatoes enter the solutions for cooperative sizes 125, 275 and 1000, while both irrigated and non-irrigated potatoes enter the other three solutions. Barley, a rotational requirement, is not harvested but left on the field and plowed under as green manure. Total output consists of chuño, quinua grain and green broad beans, ranging in market value from 627 to 7773 thousands of pesos. The fact that no sheep are raised in any of the six farm plans is discussed in Appendix L. The farm plans presented contain also information on pieces of machinery and number of hours required, time schedules for land preparation and planting, quantities needed of fertilizer, seeds, chemicals and fuel.

Since all six highest-income optimal solutions are under full mechanization, it seemed to appropriate show also some farm plans under partial mechanization. The set of the six optimal farm plans at 4.5 ha/person was chosen, because this is the highest land/person ratio at which partial mechanization is optimal for all six cooperative sizes (these farm plans were shown in Table 8-12).

4. The fourth objective intended to evaluate, as far as possible, the developmental potential of the DAP, by comparing optimal solutions with the present situation.

Nine out of 20 Communities with a cooperative at the present time own insufficient land to apply the highest-income optimal solutions, although in only three of them the shortage can be considered substantial (Table 8-20).

Information exists on the recent performance of two Communities in the DAP, Antipampa and Culli Culli Bajo. Two optimal solutions for each of the two Communities were compared with that information: one solution with the present farm size, a second solution with the optimal (unlimited) farm size. Income increases by 200% to 313%, and total output value is 263% to 400% higher. Increases in land productivity are around 425%, but capital productivity decreases by 30% to 40%, due to the fact that present methods of production are more labor-intensive than the level of technology considered in this study. No comparisons on labor productivity can be made because no figures are available on labor used at the present time (the entire set of comparisons was given in Tables 8-21, 8-22 and 8-23).

Information on potential levels of aggregate income, output and use of resources in the entire DAP will only be available after the results of this study are extended to the entire Area. The last section of Chapter VIII discusses why this cannot be done at the present time.

Policy Recommendations

The results of this study, presented in Chapter VIII, lead to the following policy recommendations:

1. The Law of Agrarian Reform should be reconsidered in that part which indiscriminately forbids the renting of land. It was explained in Chapter VIII (page 219) that renting of land between two Communities can be profitable to both transacting parts, if the rent is between the marginal productivities (shadow-prices) of land in the two Communities. It may take a few years for the Communities to accept that renting of land is not an invasion of their autonomy, but extension programs cannot move in that direction until the legal prohibition has been removed. If the Law is revised to allow such rental agreements, care must be taken to prevent the revival of the pre-Reform hacienda system of land tenure.

2. Together with the diffusion of technology, extension personnel should concentrate on upgrading the managerial and mechanical skills of the cooperatives, since all optimal solutions require the handling of large volumes of inputs and outputs and the satisfactory maintenance of farm machinery. At the present time, management and mechanics are taught in short courses at the Experimental Station, which is the most it can be done with the low budget available. In the future, the feasibility must be explored of longer and more comprehensive courses for selected officers of each cooperative, with the financial and technical cooperation of international agencies. In early 1970, high-level personnel at the Ministry of Agriculture entertained the idea of establishing a technical school of agriculture at the Experimental Station, which would prepare young men from the Communities to become cooperative farm managers. The feasibility of the project merits the attention of CODAPA, the advisory board for the development of the DAP.

3. Standardized easy methods of accounting and keeping records should be made available to all cooperatives, so that the information may be utilized in further research on farm management, which is practically non-existent at the present time. Extension agents would check the accounting and the record keeping during their visits to the cooperatives and at the periodic meetings at the Central de Cooperativas. The records would be transfered, on a quarterly or semiannually basis, to CODAPA for tabulation, elaboration and storage; only this arrangement will prevent valuable information from being lost. Provisions must be taken to ensure that feedback from ensuing research on farm management will benefit the cooperatives themselves.

4. A statistician and an agricultural economist should work closely with the staff at the Experimental Station, so that the data collected, both at the station and in the field, may be usuable in economic analysis. The statistician and the economist do not have to be on a permanent full-time basis, but they could function as part-time associate members of the staff. An agricultural economist should also be included in CODAPA, the technical board that oversees the development of the DAP.

Suggestions for Further Research

Within the discipline of agricultural economics and as a follow-up of this study, the following areas are suggested for further research.

1. Processing of land tenure information being collected by the Agrarian Reform Mobile Teams operating in the DAP as well as in the rest of the Altiplano. A reliable quantitative description of the DAP will

them be available, in terms of farm size, land uses and population.

2. Intermediate levels of mechanization, consisting of a mix of the two levels of mechanization (partial and full) considered in this study. That is, the model should be allowed to choose whether or not each particular operation will be mechanized.

Because of the indivisibility of farm machinery ("lumpy" inputs), the truly appropriate method is integer programming, in which the farm machines are allowed to enter the solutions in whole units only; the respective annual fixed cost of each machine is then entered into the maximization process by means of transfer activities.

However, integer programming is quite an expensive method and is unavailable at most computation centers. An alternative approach within a reasonable budget could run along the following lines: (i) Define a few representative farms in the DAP, on the basis of criteria to be determined, (ii) obtain a set of non-integer programming solutions with various combinations of mechanized and non-mechanized operations, and (iii) compare these solutions with one another.

3. The stability of the optimal farm plans in face of changing prices of inputs and outputs (see Chapter I, page 4). The method to be used in sensitivity analysis by applying parametric programming to the objective function. Before this can be done, the following reliable estimates are required: (i) On the output side, the expected range of price variation in the urban and mining markets, taking into consideration that the only buyer for the mines in COMIBOL, the Government mining corporation, and (ii) on the input side, the range of price variation for fertilizer, which

at the present time is imported in its entirety from Germany, Japan and the United States by private firms, but which in the future might be bought advantageously in neighboring Latin American countries or even produced at home.

4. A multi-year approach with the possibility of capital accumulation through the period, which would make unnecessary to borrow all the working capital every year.

5. Projections of demand for the outputs produced in the area, including estimates of income elasticity and changes in tastes. Studies in this area should be closely connected with research on foreign markets for quinua and on new ways of processing chuño and quinua for the urban markets. On a modest scale, the Central de Cooperativas at Patacamaya has begun to process chuño into jarhui (ground chuño for soups) and quinua into flour (for pastries) and into janckaquipa (for instant soups); but more needs to be done with the assistance of nutritionists and home economists.

6. Costs of generating electricity on the farm during the time when the motor is not used for pumping water. As noted in Chapter VIII (page 213), motor and pump are idled 79% or more of the time on al all-year basis, although in large farms they are used full-time during November and February. The cost of on-the-farm generation of electricity will then be compared with the cost of bringing electricity from the commerical power companies.

Suggestions are made also for research in agricultural disciplines other than agricultural economics. These suggestions stem from the results

of this study and from the lack of data encountered at various points.

1. A map of soils in the DAP. Such a map is badly needed, since the soil studies undertaken so far are sketchy and limited to small sections of the Area (see Table 4-1). Once the ECS is available, the assumption of homogeneity of soil quality made in Chapter IV (page 72) can be removed.

2. Information on crop yields. Existing data should be refined, especially the data on yield response to levels of fertilization, land classes, planting dates and rotational patterns (see Table 5-9, note b). Accurate record keeping in the cooperatives, as mentioned among the recommendations above, should play an important role in determining yield response under field conditions.

3. Labor-intensive small-scale activities. Those activities should be innovated which have labor requirements outside the May through August period (such as handicrafts, flowers, raising small animals, etc.). As indicated in Chapter VIII (page 212), in months other than the peak period of May through August, part of the labor available is not needed for the operations in the cooperative farm. Employing that surplus labor would increase the farmers' income.

4. Yield of weeping lovegrass. Yields must improve if this forage has to be profitable at all (see Chapter VIII, page 209). Besides its use for pasturing sheep, lovegrass has the peculiar importance of being helpful in the recovery of poor and eroded soils.

5. Efficiency in sheep raising. With increased efficiency, this activity will have a larger share in the optimal farm plans (see Appendix L). The ensuing diversification will provide some protection against bad years in crop yields and against price fluctuations in crop outputs.

6. Alternative sources of water for irrigation. Underground waters could be complemented by other sources, such as canals from the relatively close mountain range West of the DAP or earthen dams like the one planned for the Achaya cooperative.

7. Machinery for threshing quinua and peeling chuño. These two operations are totally manual at the present time, and are partly responsible for the shortage of labor during the peak season of May through August.

8. Efficient handling and marketing by the Central de Cooperativas of the large volumes of inputs and outputs required by the development of the Area (see Tables 8-13 and 8-15). Such studies will necessitate the collaboration of experts on business administration and management.

CHAPTER X. SUMMARY

In 1966, the Bolivian Government established the Development Area of Patacamaya (DAP), located in the high plateau known as the Altiplano, halfway between the cities of La Paz and Oruro. A leading role in the development of the Area was assigned to the Experimental Station of Patacamaya, whose research and extension activities were to be a catalyzer for the transformation of agriculture in the Area. Such transformation was to be based on the following package: improved seeds, fertilizer, irrigation and some machinery, all within the framework of cooperative organization.

This study answers economic questions relevant to the research and extension activities. Specific objectives are: (1) To determine optimal land/person ratios, optimal degrees of mechanization and paths for mechanization in the Area; (2) to determine the quantities of land, labor, capital and water required under the optimal conditions in objective one; (3) to determine the composition of crop and livestock activities and the level of output under the optimal conditions; (4) to estimate changes in per capita income, and productivity of the Area to be realized under the optimal conditions, as compared with the present situation.

The cooperative being promoted at the present time in the DAP, based on collective production and marketing, is taken as the only form of farm organization. Essentially, the DAP cooperative is a farm owned and operated by the members of a Community, who receive a wage during the year for the labor they contribute and who share in the profit realized at the end of the year. Thus income consists of wage plus distributed profit.

Two levels of mechanization are considered, partial and full. In the partial level, only land preparation, part of the planting and plowing-under are mechanized. In the full level, mechanization extends also to planting, potato digging and silage and hay making. A one-year period is used. The level of technology assumed is the one being promoted at the present time by the extension services. No allowance is made for on-the-farm consumption of part of the output produced.

Three main variables are considered: Cooperative size (number of persons in the cooperative), farm size (number of hectares at the cooperative's disposal, often quoted in ha/person) and degree of mechanization (set of machinery within the partial or full levels of mechanization). For each cooperative size, different combinations of farm sizes and degrees of mechanization are studied.

The method chosen for the analysis is linear programming, with its variable-resource and parametric modalities. With the variable-resource modality various degrees of mechanization are applied. The parametric modality allows to change the farm size available in equal steps over a prespecified range.

The data needed were collected, in La Paz and within the DAP, from research and descriptive papers, from field-notebooks at the Experimental Station, from direct observation and from records at the Central de Cooperativas (the central agency which groups all cooperatives for marketing and educational purposes). These data represent the most reliable information available at the present time.

The cooperative sizes to be analyzed are chosen from a frequency distribution of the 21 cooperatives presently existing. The sizes are 125, 275, 425, 625, 1000 and 1650. The farm sizes to be allowed to each cooperative start at 2 ha/person and increase in steps of 0.5 ha up to a possible maximum of 25 ha/person. The degrees of mechanization applied are successively determined during the process of solution, by means of the shadow-prices of machinery.

The four main resources are described. Land is assumed to be homogeneous throughout the DAP, so that the land classes from the few soil studies available may be generalized. Labor is exclusively the labor supplied by the members of the cooperatives. Water is limited to the maximum that can be extracted with one motor and pump from one well on the farm. Capital is assumed to be non-limiting, that is, available in any amount needed from the Agricultural Bank of Bolivia, at 8% on loans for working capital and at 12% on loans for purchasing machinery. No renting of land or hiring of outside labor are considered.

The linear programming model is processed with the IBM-MPSX routine, at the Computation Center at Iowa State University. The number of solutions obtained is 1517, and the degrees of mechanization applied are 27 under partial and 27 under full mechanization.

The results can be summarized in the following way:

1. The optimal farm size (farm size which provides the highest income per person in the cooperative) for the six cooperative sizes is found to be between 13 and 15.5 ha/person. Income per person ranges then from

3066.9 pesos to 3172.3 pesos. All these six solutions use full mechanization at different degrees.

2. The opportunity cost (loss of income) incurred when having a farm size below the optimal, is not more than 10% of the highest income when farm sizes is 7 ha/person or more. Below that land/person ratio, the opportunity cost increases faster, until, at 2 ha/person, it represents around 50% of the highest income (income at the optimal farm size). Thus, if a loss of 10% in income is deemed "acceptable", the "acceptable" farm sizes are around 7 ha/person or more.

3. The optimal farm plans are presented for the six cooperative sizes with the optimal farm size. Only rotation PHQP (potato-broad beans-quinua-barley) enters the plan, under various arrangements of irrigation or non-irrigation and of planting dates. Sheep raising enters most solutions below the optimal farm sizes, but not the solutions at the optimal farm sizes. This behavior of the sheep raising activity is due to its relatively low profitability and its high use of labor; when labor becomes scarce in certain periods (at large farm sizes mainly) it is more profitably allocated to crops than to sheep, even it it implies that barley is plowed under as green manure. (Optimal plans for the 4.5 ha/person farm size are also discussed in the report, because that is the highest farm size at which all six cooperative sizes still use partial mechanization. The discussion is omitted from this summary.)

4. The relative use of land in the solutions for the six cooperative sizes with the optimal farm size amounts to around 9% of the land available, that is, all class 1 land; this is simply the result of all resources

being transfered from other land classes to class 1 along the parametric routine, up to the point where land ceases to be limiting. Labor employed is around 31% of the labor available on an all-year basis. Water used goes from 2.76% to 12.09% of the total, and it is directly related to the cooperative size. Working capital (all borrowed) per person ranges between 1400 pesos and 1780 pesos approximately, while capital invested in equipment and buildings decreases from 2800 pesos per person at cooperative size 125 and 1590 pesos per person at size 1650.

5. Average variable cost oscillates between 32 and 36 pesos per 100 pesos of output, while average total cost ranges between 37 and 44 pesos.

6. Looking at all optimal solutions (and not just at the six solutions providing the highest income), it is observed that partial mechanization is the optimal level for the smaller farm sizes, while full mechanization is more profitable in larger farms. Such pattern is due to the fact that the smaller farm sizes have a higher labor/land ratio.

7. The range of resource use from all optimal solutions is as follows. Land use ranges from 9% to 48% of the farm size. The first figure has been explained above. The 48% figure represents all land classes 1, 2 and 3; no plan goes above that percentage into using land classes 4 and 5, not even when no other resource is limiting; this indicates that weeping lovegrass (the only crop suited for classes 4 and 5) is not profitable with present yields. Labor employed is between 19.53% and 54.52% of the total available on an all-year basis, meaning that between 45% and 80% of the labor supplied by the cooperative members goes unemployed in the optimal solutions. Working capital (borrowed) per adult person ranges

between 1187 pesos and 3176; these figures are below the ceiling that the Agricultural Bank is thought to set in practice for loans to groups of farmers. Relative use of water goes from 2% to 20.66%; this implies that at least 79% of the motor time available during the year goes unused, even in those solutions where water becomes scarce in some time periods.

8. The various resources are limiting during different time periods. Land is limiting at any solution below the optimal farm size, its highest shadow-prices per hectare being 4055 pesos for class 1, 2992 pesos for class 2, and 1357 pesos for class 3 land. Labor is limiting mainly in the months of May through August, which are the harvest and processing time; its highest shadow-price per hour is 14 pesos. Water becomes scarce only in November and February, with higher shadow-prices in February, when all irrigated crops have a water requirement; the highest shadow-price per m^3 is 3 pesos.

9. Paths for mechanization in each cooperative and farm size combination are designed and diagrammed, on the basis of two criteria: (i) That the degree of mechanization in each step of the path build upon the previous one, so that no or very few pieces of equipment have to be disposed of, and (ii) that income per person in each step be higher than in the previous one. An example of the path for mechanization in a specific combination and farm size is given in the report.

10. The trade-off implied in choosing alternative criteria of optimality is computed. The trade-off is between percent gain in the variable being optimized and the percent loss in income incurred, as compared with

the situation where maximization of income is the criterion. Six alternative criteria are examined. Highest average productivity of labor already happens at the six optimal farm sizes, so that no trade-off is involved in choosing it as the criterion of optimality. Choosing the criterion of highest relative use of labor causes an increase of 46% to 79% in labor used, in exchange for a reduction of 18% to 38% in income per person. An income loss of 6% or less is associated with the other four criteria, highest productivity of land and capital, lowest capital used per person, lowest average total cost. These trade-offs are computed on the assumption that the farm size is manipulated to the appropriate size and the cooperatives are then left free to maximize income per person; in so doing, they will optimize the preselected criterion variable.

11. A comparison of the results of this study with the present situation yields the following conclusions: (i) Eleven out of twenty Communities with a cooperative at the present time own land above the optimal farm size, that is they own enough land to apply the solutions providing the highest possible income; (ii) the reduction in income caused by the insufficient land in the other Communities would be 2% for six of them, and from 16% to 44% for the other three, so that it can be said that only three Communities out of the twenty (15%) experience a substantial shortage of land; (iii) in two Communities, Antipampa and Culli Culli Bajo, for which data on present performance exist, the optimal solutions obtained in this study provide increases in income of 200% to 314% and increases in output of up to 500%.

The results of this study cannot be expanded to the entire DAP at the present time, because the information on Community size distribution is from a non-random sample, the number of Communities in the DAP is not reliably known, and the total extension of the Area can be only roughly estimated. Expansion of the results will be in order when the Commission for the Agrarian Reform publishes the information which is presently collecting through Agrarian Reform Mobile Teams.

Policy recommendations are made on the following issues: (i) Revision of the Law of Agrarian Reform in that section which indiscriminately forbids renting of land, (ii) upgrading of managerial and mechanical skills in the cooperatives, (iii) standardized accounting and record keeping procedures in the cooperatives, and (iv) the role of an agricultural economist at the Experimental Station and at CODAPA, the advisory board for the development of the DAP.

Suggestions for further research in agricultural economics deal with: (i) Intermediate levels of mechanization, a mix of the partial and full levels, (ii) the stability of the farm plans in face of changing prices of inputs and outputs, (iii) a multi-year approach as opposed to the one-year approach taken in this study, (iv) projections of demand for output produced in the Area, and (v) cost of generating electricity on the farm when the motor is not needed for pumping water.

Topics for research in other agricultural disciplines are also indicated: (i) A map of soils in the DAP, (ii) yield response to levels of fertilizer, irrigation, planting dates and rotations, (iii) additional

labor-intensive small-scale activities, (iv) higher yields of weeping lovegrass, (v) improved efficiency in sheep raising, (vi) alternative sources of water for irrigation, (vii) mechanization of quinua threshing and chuño peeling operations, and (viii) efficient handling of large volumes of inputs and outputs by the Central de Cooperativas.

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APPENDIX A. UNITS OF MEASUREMENT

Table A-1. Units of measurement used in this study, their abbreviation and equivalence

Units of measurement[a]	Abbreviation	U.S. equivalence
Length:		
Milimeter	mm	0.03937 inches
Centimeter (= 10 mm)	cm	0.3937 inches
		0.032808 feet
Meter (= 100 cm)	m	39.37 inches
		3.280833 feet
		1.093611 yards
Kilometer (= 1000 m)	km	1093.611 yards
		0.62137 miles
Surface:		
Square meter	m^2	10.76387 square feet
Square kilometer (= 10^6 m^2)	km^2	0.3861 square miles
Hectare (= 10000 m^2)	ha	2.471044 acres
Volume:		
Cubic centimeter	cc	0.061023 cubic inches
Cubic meter	m^3	35.314445 cubic feet
		264.173 gallons
		28.37765 bushels
Liter (= 1000 cc)	lit	0.035316 cubic feet
		0.264178 gallons
Weight:		
Gram	gr	0.035274 ounces
Kilogram (= 1000 gr)	kg	2.2046233 pounds
Metric ton (= 1000 kg)	ton	2204.6223 pounds
Pound	lb	1. pound
Hundredweight (= 100 lb)	cwt	100. pounds
Money:		
Peso boliviano	peso	0.08333[b] US$

[a]For measures of temperature see Table A-2.

[b]12 pesos = US$ 1.

Table A-2. Equivalence between degrees centigrade and Farenheit, from 30°C to -30°C[a]

Centigrade	Farenheit	Centigrade	Farenheit
30	86.	- 1	30.2
29	84.2	- 2	28.4
28	82.4	- 3	26.6
27	80.6	- 4	24.8
26	78.8	- 5	23.
25	77.	- 6	21.2
24	75.2	- 7	19.4
23	73.4	- 8	17.6
22	71.6	- 9	15.8
21	69.8	-10	14.
20	68.	-11	12.2
19	66.2	-12	10.4
18	64.4	-13	8.6
17	62.6	-14	6.8
16	60.8	-15	5.
15	59.	-16	3.2
14	57.2	-17	1.4
13	55.4	-18	- 0.4
12	53.6	-19	- 2.2
11	51.8	-20	- 4.
10	50.	-21	- 5.8
9	48.2	-22	- 7.6
8	46.4	-23	- 9.4
7	44.6	-24	-11.2
6	42.8	-25	-13.
5	41.	-26	-14.8
4	39.2	-27	-16.6
3	37.4	-28	-18.4
2	35.6	-29	-20.2
1	33.8	-30	-22.
0	32.		

[a]Formula: $F = 1.8\ C + 32$, where F is degrees Farenheit and C is degrees Centigrade.

APPENDIX B. MONTHLY WEATHER DATA FROM METEOROLOGICAL STATIONS IN THE DEVELOPMENT AREA OF PATACAMAYA

The complete version of this Appendix contains 45 Tables. To conserve space, only the Tables on rainfall and rainless days in Patacamaya are included here. Copies of the complete version are on file at:

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Centro de Investigación y Promoción del Campesino
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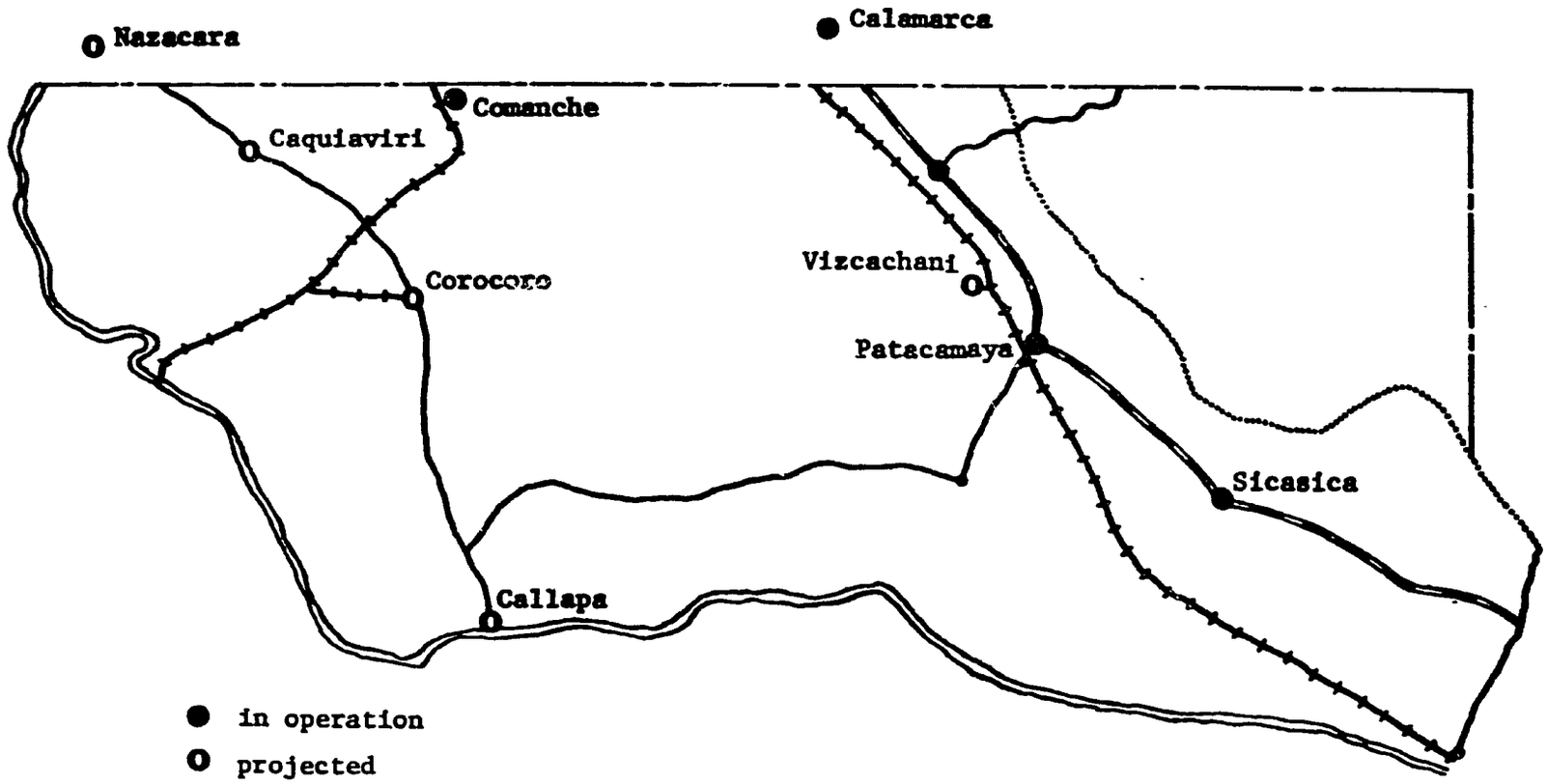

Map B-1. Meteorological stations in the Development Area of Patacamaya, 1970

Table B-1. Rainfall at Patacamaya, 1958-1968 (in mm)[a,b]

Year[c]	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Total	% Dec.[d] to Mar.
1957-58							102.6	85.3	62.0	2.3	27.2	0.0		
1958-59	1.0	0.0	14.0	9.0	31.0	44.9	79.2	59.1	128.3	12.0	6.0	3.1	387.6	80.37
1959-60	0.0	0.0	46.3	16.1	20.1	117.4	183.5	72.1	29.5	7.0	8.1	0.0	500.1	80.48
1960-61	0.0	32.5	101.2	39.5	56.0	37.2	87.8	45.3	21.7	50.1	9.1	0.0	480.4	39.97
1961-62	0.0	20.0	45.9	15.7	25.5	112.4	102.7	47.5	68.1	13.6	8.4	0.0	459.8	71.92
1962-63	0.0	0.0	31.8	10.6	14.4	107.7	71.6	91.6	30.2	18.3	16.0	0.0	32.2	76.77
1963-64	0.0	1.0	23.0	13.3	19.9	59.1	72.3	60.3	130.7	4.5	8.5	0.0	..6	82.12
1964-65	0.0	37.2	12.0	2.0	22.1	53.8	118.3	27.2	67.4	17.0	4.5	0.0	.5	73.78
1965-66	3.5	0.0	33.3	8.7	39.1	58.5	58.6	44.2	9.4	1.6	4.2	0.0	261.1	65.38
1966-67	0.0	1.0	1.0	13.2	25.9	62.3	27.6	58.5	50.1	1.2	6.0	0.0	246.8	80.43
1967-68	5.7	20.0	34.0	22.9	2.5	98.9	64.6	175.8	28.5	16.9	6.2	4.3	446.3	82.41
1968-69	0.0	1.6	14.5	17.4	95.7	29.8								
	0.9	10.3	32.5	15.3	77.9	71.1	88.1	69.7	56.9	13.1	9.4	0.7	392.8	73.36

[a]Source: The monthly figures are from Bolivia 1969e and Bolivia 1970. These sources organize the figures by calendar years (January to December). For this study the figures were rearranged by agricultural years (July to June) and the totals and averages were recomputed.

[b]This Table appears as Table B-4 in the complete version of Appendix B.

[c]Since the sources give the data by calendar years, the first and the last half-years in the Table are missing. The totals for those years have not been computed.

[d]Rainfall in December, January, February and March as a percent of annual rainfall.

Table B-2. Rainless days at Patacamaya, 1958-1968[a,b]

Year[c]	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Total	Percent[d]
1957-58							11	18	22	28	29	30		
1958-59	30	31	27	28	25	22	19	14	11	26	29	28	290	79.45
1959-60	31	31	27	27	25	19	10	16	28	24	28	30	296	80.87
1960-61	31	25	20	25	20	23	11	17	26	26	28	30	282	77.26
1961-62	31	29	21	28	23	15	17	17	14	25	27	30	277	75.89
1962-63	31	31	21	27	24	11	16	16	21	26	30	30	284	77.81
1963-64	31	30	25	26	28	22	21	12	17	27	28	30	297	81.15
1964-65	31	26	27	29	22	21	16	18	29	27	29	30	305	83.56
1965-66	30	31	26	27	25	27	18	22	26	29	29	30	320	87.67
1966-67	31	30	29	27	23	22	24	14	21	29	29	30	309	84.66
1967-68	29	27	22	22	28	14	19	7	27	23	27	28	273	74.59
1968-69	31	30	27	25	17	21								
	30.6	29.2	24.7	26.5	23.6	17.7	16.5	15.5	22.0	26.4	28.5	29.6	293.3	80.29

[a]Source: Same as Table B-1.

[b]This Table appears as Table B-9 in the complete version of Appendix B.

[c]See note c, Table B-1.

[d]Rainless days as a percent of the days in the year.

APPENDIX C. LABOR, WATER AND MACHINE TIME REQUIREMENTS, BY TIME PERIODS

The complete version of this Appendix consists of 22 Tables. To conserve space, only a sample of 5 Tables is included here. Copies of the complete version are on file at:

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Table C-1. Operator's labor requirements, by time periods, planting dates and level of mechanization for growing potato (in hours/ha)[a,b]

Time periods	Under partial mechanization by planting dates				Under full mechanization by planting dates			
	Oct.	Nov.	Dec.	Jan. 1	Oct.	Nov.	Dec.	Jan. 1
September	6.754				6.754			
October	3.086	6.754			4.928	6.754		
November	_[c]	3.086[c]	6.754		_[c]	4.928[c]	6.754	
December	_[d]	_[d]	3.086	6.754	_[d]	_[d]	4.928	6.754
January 1				3.086	3.696			4.928
January 2						3.696		
February 1					2.464		3.696	
February 2	0.064				0.064	2.464	2.464	
February	_[e]	_[e]	_[f]	_[f]	_[e]	_[e]	_[f]	_[f]
March 1		0.064	0.064			0.064	0.064	3.696
March 2				0.064				2.528
June	3.696	3.696	3.696	3.696	3.696	3.696	3.696	3.696
Total	13.600[g]	13.600[g]	13.600[f]	13.600[f]	21.602[g]	21.602[g]	21.602[f]	21.602[f]

[a]Source: Computed from Figure 5-1 and Table 5-6.

[b]Labor for operating machinery, from land preparation up to excluding harvest, but including the plowing under after harvest. To allow time for maintenance, repair and record-keeping, the figures from Table 5-6 have been increased by 10% for the tractor, 12% for the motor, 4.5% for the pump and 2% for all the other machinery.

[c]For irrigated potato add 0.097.

[d]For irrigated potato add 0.228.

[e]For irrigated potato add 0.580.

[f]For irrigated potato add 0.609.

[g]For irrigated potato add 0.905.

Table C-2. Labor requirements, by time periods, planting dates and level of mechanization for growing potato (in hours/ha)[a,b]

Time periods	Under partial mechanization by planting dates				Under full mechanization by planting dates			
	Oct.	Nov.	Dec.	Jan. 1	Oct.	Nov.	Dec.	Jan. 1
September	6.754				6.754			
October	40.586	6.754			12.928	6.754		
November	-[c]	40.586[c]	6.754		-[c]	12.928[c]	6.754	
December	-[d]	-[d]	40.586	6.754	-[d]	-[d]	12.928	6.754
January 1	136.			40.586	3.696			12.928
January 2		136.				3.696		
February 1	56.		136.		2.464		3.696	
February 2	0.664	56.	56.		9.664	2.464	2.464	
February	-[e]	-[e]	-[f]	-[f]	-[e]	-[e]	-[f]	-[f]
March 1		9.664	9.664	136.		9.664	9.664	3.696
March 2				65.664				12.128
June	3.696	3.696	3.696	3.696	3.696	3.696	3.696	3.696
Total	252.7[g]	252.7[g]	252.7[f]	252.7[f]	39.202[g]	39.202[g]	39.202[f]	39.202[f]

[a]Source: Computed from Figure 5-1 and Tables 5-2, 5-4 and C-1.

[b]Labor in this table includes both unskilled labor and operator's labor from land preparation up to excluding harvest, but including the plowing under after harvest. This Table appears as Table C-7 in the complete version of Appendix C.

[c]For irrigated potato add 4.809.

[d]For irrigated potato add 11.284.

[e]For irrigated potato add 28.708.

[f]For irrigated potato add 30.145.

[g]For irrigated potato add 44.801.

Table C-3. Operator's, total and adult labor, by time periods, for raising sheep (in hours/flock unit of 200 breeding ewes)[a,b]

Time periods	Operator's labor[c]	Total labor	Adult labor[d]
July 1		344.	136.
July 2		368.	144.
July	0.002	0.002	0.002
August 1		344.	136.
August 2		376.46	148.
August	0.002	0.002	0.002
September 1		726.75	518.75
September 2		726.75	518.75
September	0.001	0.001	0.001
October 1		726.75	518.75
October 2		842.67	618.67
October	0.002	0.002	0.002
November 1		368.	160.
November 2		382.72	158.92
November	0.009	0.009	0.009
December 1		348.53	140.53
December 2		372.53	148.53
December	0.002	0.002	0.002
January 1		372.53	28.53
January 2		388.53	4.53
January	0.001	0.001	0.001
February 1		348.	24.
February 2		333.23	3.69
February	0.001	0.001	0.001
March 1		408.42	57.38
March 2		395.	15.99
March	0.009	0.009	0.009
April 1		448.	136.
April 2		448.	136.
April	0.001	0.001	0.001
May 1		448.	136.
May 2		496.	160.
May	0.001	0.001	0.001
June 1		375.19	162.88
June 2		344.	136.
June	0.002	0.002	0.002
Total	0.033	10732.093	4347.933

[a]Source: Computed from Tables 5-12, 5-13 and C-16.

[b]This Table is Table C-14 in the complete version of Appendix C.

[c]Corresponding to the motor-and-pump time for extracting the water required each month (Table C-16).

[d]That part of the total labor that must be adult labor. These figures are given here as additional information, although they do not enter the linear programming model because all labor available was reduced to male adult labor (Table 4-4).

Table C-4. Water and machine time requirements, by months, for irrigating crops[a,b]

Time periods	Volume of water in m^3/ha[c]				Machine time in hours/ha[d]			
	Potato		Quinua	Alfalfa	Potato		Quinua	Alfalfa
	planted Oct.&Nov.	planted Dec.&Jan.			planted Sep.&Oct.	planted Nov.&Dec.		
September				452.597[e]				2.037[e]
October				607.911				2.736
November	130.997		910.822	409.483	0.589		4.099	1.843
December	307.054			346.397	1.382			1.559
January				113.460				0.510
February	[illegible]1.286	820.337[f]	158.752	376.740	3.516	3.692	0.714	1.695
Total	1219.337	820.337	1069.574	2306.588	5.487	3.692	4.813	10.380

[a]Source: Computed from Tables K-1, K-2 and K-3.

[b]A 70% efficiency is assumed for potato and alfalfa; 80% for quinua, since its irrigation is done with sprinkler. This Table appears as Table C-15 in the complete version of Appendix C.

[c]The figures are the average of the requirements in Tables K-1, K-2 and K-3 for the same month (see note f below for an exception) corrected for the different efficiency.

[d]This is the motor-and-pump time required to extract the water, on the basis of 0.45 hours per 200 m^3.

[e]No irrigation in September of the year alfalfa is seeded (year 1).

[f]Average for February-and-March in Tables K-1, K-2 and K-3.

Table C-5. Machine time requirements, by time periods, planting dates and levels of mechanization for growing quinua (in hours/ha)[a,b]

Machine[c]	Time periods	Under partial mechanization by planting dates		Under full mechanization by planting dates	
		Sep.	Oct.	Sep.	Oct.
Tractor	July	3.3	3.3	3.3	3.3
	August	6.05		6.05	
	September	2.2	6.05	4.4	6.05
	October		2.2		4.4
	January 2				4.4
	January			4.4	
Plow	July	3.3	3.3	3.3	3.3
	August	3.3		3.3	
	September	2.2	3.3		3.3
	October		2.2		
Harrow	August	4.65		4.65	
	September		4.65		4.65
Drill	September			4.4	
	October				4.4
	January 2				4.4
	January			4.4	

[a]Source: Computed from Figure 5-2 and Table 5-6.

[b]From land preparation up to excluding harvest, but including the plowing under after harvest. This table appears as Table C-48 in the complete version of Appendix C.

[c]Motor-and-pump are not included, because their time requirement is already embodied in the water requirement (Table C-43).

APPENDIX D. INFORMATION RELEVANT FOR PLANNING A SHELLFISH RAISING ACTIVITY ON THE DEVELOPMENT AREA OF PANAMARA

Table D-1. Fertility at the Petaumaye Experimental Station, 1966-1969[a]

	Ewes		Lambs			Fertility indices[b]							
	exposed A	limited B	born C	registered D	weaned E	D/A %	C/A %	C/B %	D/A %	D/B %	E/A %[c]	E/B %
1966-65	410	369	371	350	295	91.22	91.36	100.27	86.42	94.85	72.84	79.94
1965-66	419	379	397	362	365	92.66	97.97	104.75	88.54	95.54	84.35	91.03
1966-67	375	319	319	307	223	85.07	85.07	100.00	81.87	96.24	59.47	69.90
1967-68	285	268	252	241	228	87.02	88.07	101.23	84.56	97.18	80.00	91.94
1968-69	313	276	307	286	276	88.18	98.08	111.23	90.73	102.90	87.54	99.28
Total	1787	1591	1646	1546	1365	89.05	92.08	103.33	86.40	97.05	76.38	85.80

[a]Source: Derived from Seleucia Experimental de Petaumaye 1965 through 1969 and from field notebooks at the Experimental Station.

[b]The fertility index used by the Station's annual reports is not included here. It seems to be defined as: (registered lambs × mature lambs)//limited ewes. For a treatment on the relative merits of the various indices, see Kibe 1966, pp. 407-408.

[c]This index (weaned lambs//exposed ewes) and to a lesser extent the following one (weaned lambs//limited ewes) are the best indicators of the actual productivity of the flock.

Table D-2. Weaning at the Petacamaya Experimental Station, 1966-1969[a]

	Number of Lambs			Weaning Indices[b]	
	born	registered	weaned	% weaned/ born	% weaned/ registered
1966-65	371	350	295	79.73	84.28
1965-66	397	362	345	86.90	95.30
1966-67	319	307	223	69.90	72.64
1967-68	253	241	228	90.86	94.60
1968-69	307	286	274	89.25	96.48
Total	1646	1546	1365	83.03	88.41

[a]Source: Same as Table D-1.

[b]The weaned/born index is more meaningful, since it takes into consideration all the deaths during lactation.

Table D-3. Mortality at the Potamanya Experimental Station, 1966-1969[a]

	Deaths			Yearly stock			Mortality indices[f]		
	Adults[b]	Lambs[c]	Total	Adults[d]	Lambs[e]	Total	Adults	Lambs	Total
1966-65	65	55	120	869	350	1219	7.66	15.71	10.01
1965-66	72	17	88	926	362	1288	7.67	4.70	6.83
1966-67	92	84	176	742	307	1049	12.40	27.36	16.78
1967-68	65	13	78	691	241	932	9.41	5.39	8.37
1968-69	45	10	55	691	284	975	6.51	3.52	5.64
Total	338	179	517	3899	1544	5443	8.67	11.59[g]	9.50

[a]Source: Same as Table D-1.

[b]In 1968-69, deaths were mainly from old age and weakness (20%), coenurosis (18%), timpanization and pneumonia (15% each).

[c]In 1968-69, deaths were mainly from weakness and intoxication (27% each) and accidents (18%).

[d]All adult animals on the farm at any time during the year.

[e]Registered lambs.

[f]Percent of deaths over the yearly stock.

[g]If born lambs instead of only registered lambs were considered, the mortality index would be 16.37% (= 1 - weaning index).

Table D-4. Lambs' average birth weight at the Patacamaya Experimental Station, 1964-1969[a]

	Average weight in kg
1964-65	3.64
1965-66	3.88
1966-67	3.36
1967-68	3.77
1968-69	4.34
Total	3.8

[a]Source: Same as Table D-1.

Table D-5. Wool production at the Patacamaya Experimental Station, 1964-69[a]

	Head sheared	Total production in kg	Kg per head[b]
1964-65	613	1311.42	2.14
1965-66	839	1957.57	2.33
1966-67	505	1375.04	2.72
1967-68	490	1526.99	3.11
1968-69	535	2201.57	4.12
Total	2982	8370.56	2.81

[a]Source: Same as Table D-1.

[b]The average production of wool by purebred rams was: Ideal (Uruguay) 9.72 kg, Targhee (USA) 8.38 kg, Corriedale (USA) 8.06 kg.

Table D-6. Sheep wool classes, their characteristics and prices, as established by COMBOFLA, 1970[a,b]

Classes	Characteristics	Price in[c] pesos/kg
1	White, improved,[d] 5 or more cm long	9.5
2	White, improved,[d] less than 5 cm long	9.
3	White, criolla,[e] 5 or more cms long	8.
4	White, criolla,[e] less than 5 cm long	6.9
5	Colored (brown, black, gray)	2.9
6	Pieces, dirty, wet	2.9

[a]Source: Information supplied by COMBOFLA in June, 1970.

[b]COMBOFLA (Consorcio Boliviano de Fomento Lanero) is the Bolivian Government's agency in charge of fostering improved production and marketing of sheep wool and of llama and alpaca hair.

[c]Price at which COMBOFLA buys in La Paz from producers.

[d]Improved means at least 3/4 pure blood.

[e]Unimproved, that is, below 3/4 pure blood.

Table D-7. Wool sales, by classes, at the Patacamaya Experimental Station, 1968-1969 (in kg)[a,b]

Classes[c]	Year[d] 1968	1969	Total	%
1	2132.	2151.5	4283.5	89.27
2	20.	144.5	164.5	3.43
3	13.	142.	155.	3.23
4				0.
5				0.
6	103.5	92.	195.5	4.07
Total	2268.5	2530.	4798.5	100.

[a]Source: Derived from files at the Experimental Station.

[b]There are no records on breakdown by classes of the wool produced each year. The only information available are the sales receipts for wool sold in 1968 and 1969. No substantial error should be involved in taking the classification of wool sold as a proxy for the classification of wool produced.

[c]As established by COMBOFLA (Table D-6).

[d]The records seem to suggest that this is the year in which the wool was sold rather than the year in which it was produced (shearing in October). This would explain why the totals for each year differ from those in Table D-5. Since the information relevant for our purpose are the percentages in the last column, that divergence should not be of much concern here.

APPENDIX E. MODEL FOR A SHEEP FLOCK UNIT OF 200 BREEDING EWES, IN THE DEVELOPMENT AREA OF PATACAMAYA

Table E-1. Number of head in the farm, by flocks and months[a*,b]

	Ewes[c]	Rams[d]	Suckling[e] lambs	Weaned[f] lambs
April	211 -2	6		
May	209 -2	6 -1.5		
June	207 -2	4.5		
July	205 -2	4.5		
August	203 -2	4.5	+108	
Sept.	201 -1	4.5	108 +107 -7	
October	200 -1	4.5	208 -11	
Nov.	199 -1	4.5	197 -10	
Dec.	198 -24 -1	4.5	187 -88 -9	+88
Jan.	173 -24 +65 -1	4.5 +1.5	90 -90	88 -88
Feb.	213 -1	6		
March	212 -1	6		

*The symbols in this appendix are explained in Table E-14.

Fattening[g] wethers	Fattening[h] ewe lambs	Replacement[i] ewe lambs	Total[j]
88 -1	18	70 -1	393
87 -1	18	69	389
86 -1	18	69 -1	384.5
85 -1	18 -1	68	380.5
84 -1	17	68 -1	376.5
83	17 -1	67	480.5
83 -1	16	67 -1	578.5
82	16	66	564.5
82 1	16	66 1	553.5
81 [illegible]	16 [illegible]	[illegible] 65 [illegible]	517.5
170 [illegible] 1	34 [illegible]	71 -1	494
88	18	70	394

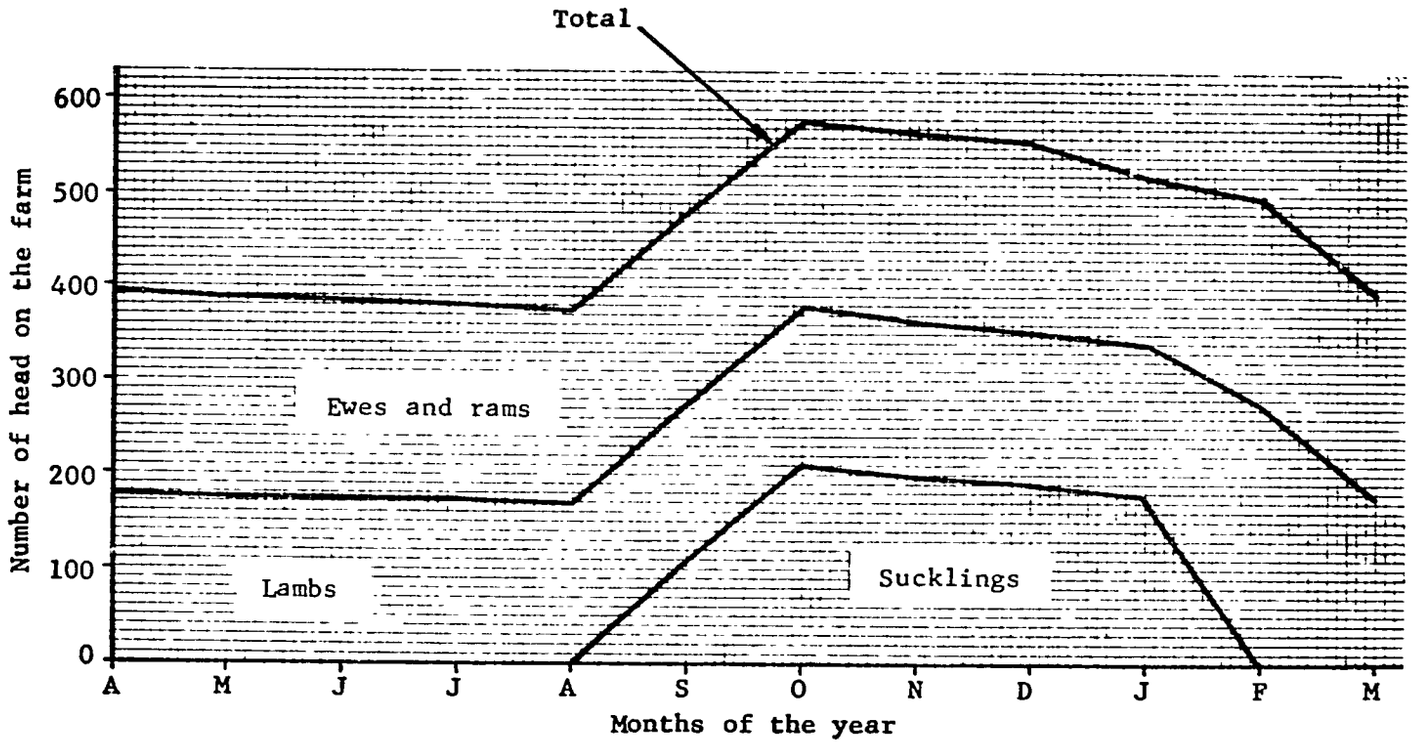

Figure E-1. Number of head on the farm, by months

Table E-2. Composition of the breeding ewes flock, by months

	Pregnant	Lactating	Open	Total[k]
April	106		105	211
May	209			209
June	207			207
July	205			205
August	203			203
September	101	100		201
October		196	4	200
November		188	11	199
December		92	106	198
January			173	173
February			213	213
March			212	212

Table E-3. Lamb stock from birth to weaning, by months[l]

	Lambs born September	Lambs born October	Deaths	Total lambs[m] living
September	108		7	108
October	101	107	11	208
November	97	100	10	197
December	91[n]	96	9	187
January	88	90[n]		178[o]

Table E-4. Deaths, by flocks and months[P]

	Ewes	Lambs until the end of weaning period	Fattening lambs	Replacement female lambs	Total
April	2		1	1	4
May	2		1		3
June	2		1	1	4
July	2		2		4
August	2		1	1	4
September	1	7	1		9
October	1	11	1	1	14
November	1	10			11
December	1	9	1	1	12
January	1				1
February	1		1	1	3
March	1				1
Total	17	37	10	6	70

Table E-5. Number of head marketed, by class and months

	Ewes culled for age	Rams culled for age	Wethers	Female lambs	Total
April					
May					
June		1.5			1.5
July					
August					
September					
October					
November					
December					
January	24				24
February	24				24
March			81	16	97
Total	48	1.5	81	16	146.5

Table E-6. Number of separate flocks, by months[1]

	Number of flocks				Total	Number of head per flock		
	Rams	Ewes[2]		Lambs		Rams	Ewes[2]	Lambs
April	1	2	Exposed ewes* Open ewes	1	4	6	106 105	176
May	1	2	Exposed ewes* Open ewes	1	4	6	101 104	174
June	1	1*		1	3	4.5	207	173
July	1	1*		1	3	4.5	205	172
August	1	1*		1	3	4.5	203	169
September	1	2	Non-lambed ewes* Lambed ewes and lambs*	1	4	4.5	101 101	167
October	1	2	Non-lambed ewes* Lambed ewes and lambs*	1	4	4.5	101 101	166
November	1	1*		1	3	4.5	199	164
December	1	1*		1	3	4.5	198	166
January	1	1		1	3	4.5	173	250
February	1	1		1	3	6	2.3	275
March	1	1		1	3	6	232	176

Table 6.7. Average liveweights of ewes and rams, and daily feed requirements per head, by months

	Ewes			Rams		
	Average[a] weight in kg	Daily[b] feed as % of weight	Daily feed[b] in kg/head	Average[a] weight in kg	Daily[b] feed as % of weight	Daily feed[b] in kg/head
Feb 21	39.0	2.7	1.053	50.5	3.4	2.025
May	39.5	2.7	1.066	60.0	3.4	2.04
June	40.0	2.6	1.04	57.0	3.4	1.938
July	41.0	2.6	1.066	57.0	3.4	1.938
August	42.0	3.0	1.260	57.5	3.4	1.955
September	42.0	3.0	1.260	57.5	3.4	1.955
October	41.0	4.0	1.640	58.0	3.4	1.972
November	41.5	4.0	1.660	58.0	3.4	1.972
December	42.0	3.0	1.26	58.5	3.4	1.989
January	42.5	2.6	1.105	58.5	3.4	1.989
February	38.0	2.7	1.026	58.5	3.4	1.989
March	38.5	2.7	1.04	59.0	3.4	2.006

Table 5-8. Average liveweight of lambs, and daily feed requirement per head, by months

	Fattening wether lambs			
	Average* weight in kg	Daily* feed/head as % of weight	Daily feed* in kg/head	Average* weight in kg
February	19.5	4.5	0.877	18.
March	20.5	4.5	0.922	19.5
April	21.5	4.4	0.946	21.
May	22.5	4.4	0.99	22.5
June	23.5	4.4	1.034	23.5
July	24.5	4.5	1.103	24.5
August	25.5	4.5	1.148	25.5
September	27.	4.2	1.134	27.
October	28.5	4.2	1.197	28.5
November	30.	4.1	1.23	30.0
December	31.5	4.	1.26	31.5
January	33.	3.9	1.287	33.
February	34.5	3.9	1.346	34.5

Fattening ewe lambs		Replacement ewe lambs		
Daily* feed/head as % of weight	Daily feed* in kg feed	Average* weight in kg	Daily* feed/head as % of weight	Daily feed* in kg feed
4.3	0.442	18.	4.5	0.21
4.4	0.336	19.	4.5	0.255
4.5	0.565	20.	4.4	0.48
4.4	0.39	22.	4.4	0.326
4.4	0.436	22.	4.3	0.366
4.3	0.556	22.5	4.3	0.368
4.3	0.565	23.	4.3	0.389
4.2	0.336	24.	4.2	0.408
4.2	0.327	25.5	4.2	0.472
4.1	0.23	27.	4.2	0.336
4.	0.26	28.5	4.1	0.469
3.9	0.287	30.	4.1	0.23
3.9	0.366			

Table 5-9. Feeding patterns, by months

	Pasture		Hay	Silage	Concentrate ration	
	Alfalfa	Weeping lovegrass			Ewes-and -lambs	Fattening lambs
April	*	*	*	*		*
May	*	*	*	*		*
June	*		*	*		*
July			*	*		*
August			*	*		*
September			*	*	*	*
October			*	*	*	*
November			*	*	*	*
December			*	*	*	*
January		*	*	*		*
February		*	*	*		*
March	*	*	*	*		*
			*	*		*

Table 5-11. Concentrate ration requirement for ewe-and-lambs from birth to weaning, by months[a]

	Lactating ewes				Lambs				Daily total in kg	Monthly total in kg	Monthly total in kg of dry matter
	Lambed Sept.		Lambed Oct.		Born Sept.		Born Oct.				
	head on the farm	gr[ms] per head daily	head on the farm	gr[ms] per head daily	head on the farm	gr[ms] per head daily	head on the farm	gr[ms] per head daily			
Sept.	100	320			108	100			42.8	1286.	1153.032
Oct.	96	360	100	320	103	250	107	100	100.59	3118.29	2800.224
Nov.	92	380	96	360	97	400	100	250	133.4	3962.	3539.926
Dec.			92	380			96	400	73.36	2274.16	2042.196
Total										10648.45	

Table E-11. Concentrate ration requirement, by months, for fattening lambs[cc]

	Fattening lambs (wethers)		
	Head on the farm	Daily dry matter[dd] in concentrate in kg/head	Daily concentrate[ee] required in kg/head
February[y]	89	0.198	0.224
March	88	0.207	0.235
April	88	0.213	0.241
May	87	0.223	0.253
June	86	0.233	0.264
July	85	0.237	0.269
August	84	0.247	0.28
September	83	0.255	0.289
October	83	0.269	0.305
November	82	0.277	0.314
December	82	0.284	0.322
January	81	0.29	0.329
February	81	0.303	0.344
Total			

Fattening lambs (ewes)			
Head on the farm	Daily dry matter[dd] in concentrate in kg/head	Daily concentrate[ee] required in kg/head	Total in kg/month
18	0.198	0.244	1605.408[ff]
18	0.211	0.239	774.442
18	0.217	0.246	769.08
18	0.223	0.253	823.515
18	0.233	0.264	823.68
18	0.237	0.269	858.917
17	0.247	0.28	876.68
17	0.255	0.289	867.
16	0.269	0.305	936.045
16	0.277	0.314	923.16
16	0.284	0.322	978.236
16	0.290	0.329	989.303
16	0.303	0.344	
			11225.466

Table #12. Feed requirement, other than concentrate ration, for the whole flock, by months

	Head on the farm			
	Ewes	Rams	Fattening lambs	Replacement lambs
April	211	6	106	70
May	209	6	105	69
June	207	4.5	104	69
July	205	4.5	103	68
August	203	4.5	101	68
September	201	4.5	100	67
October	200	4.5	99	67
November	199	4.5	98	66
December	198	4.5	98	66
January	173	4.5	97	153[11]
February	213	6	204	71
March	212	6	106	70
Total				

Table B-12. (Continued)

Feed required in tons/month[84]				
Ewes	Rams	Fattening lambs	Replacement lambs	Total
6.645	0.364	3.019	1.701	11.749
6.907	0.379	3.222	1.829	12.337
6.458	0.262	3.226	1.948	11.768
6.774	0.27	3.365	1.948	12.357
10.044	0.273	3.432	1.994	15.743
9.624	0.264	3.402	1.946	15.236
11.923	0.275	3.562	2.054	17.814
11.397	0.266	3.616	1.996	17.275
7.734	0.277	3.828	2.191	14.03
5.926	0.277	3.87	5.378	15.451
6.119	0.334	6.288	2.324	14.065
6.835	0.373	3.038	2.669	12.933

Table E-12. (Continued)

Feed required in tons/month[hh] corrected for concentrate			Total dry[ii] matter required in tons/month
Ewes	Fattening lambs	Total flock	
6.665	2.264	10.994	9.8946
6.907	2.616	11.549	10.3491
6.458	2.42	10.962	9.8658
6.774	2.524	11.516	10.3644
10.044	2.574	14.885	13.3965
8.343	2.552	13.105	11.7945
8.812	2.672	13.813	12.4317
7.464	2.712	12.438	11.1942
5.465	2.871	10.804	9.7236
5.926	2.902	14.483	13.0347
6.119	4.716	13.493	12.1437
6.835	2.278	12.173	10.9557
			135.1485

Table E-13. Annual figures resulting from Tables E-1 through E-12

Breeding ewes	200
Starting number of ewes[kk]	213
Rams in production	6
Lambs crop at birth	215
Dead lambs[ll]	37
Dead adults[mm]	33
Lambs weaned	178
Wethers to be fed and sold	89
Ewe lambs to be fed and sold	18
Ewe lambs to be grown for replacement	71
Wool production (in kg)	741
Ewes culled for age and sold	48
Rams culled for age and sold	1.5
Wethers sold	81
Ewe lambs sold	16
Maximum number of head on the farm in any one month (October)	578.5
Minimum number of head on the farm in any one month (August)	376.5
Average number of head on the farm	458.8
Concentrate ration required for ewes-and-lambs (in tons)	10.618
Concentrate ration required for fattening lambs (in tons)	11.2255
Feed required, other than concentrate ration (in tons of dry matter)	135.1485

Table E-14. Symbols and notes to Tables E-1 through E-13.

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[a]Sources: This Table results from applying the parameters in Table 5-10 and the calendar in Figure 5-4 to a flock of 200 breeding ewes (that is, lambed in September-October), assuming breeding rams with 31/32 pure blood and breeding ewes with at least 3/4 pure blood. This Table is the source for the other Tables in this Appendix. The source United States Academy of Science, Committee on Animal Nutrition, 1968 is also used for Tables E-7 and E-8.

[b]The main figure in each box indicates the number of head on the farm during that month. Many boxes have also figures at the lower corners, which indicate the changes in the number of head at the end of the month; figures with a negative sign are losses, figures with a positive sign are gains. The figures at the right corner are deaths. The figures at the left corner with a negative sign are losses either to sales or to other columns in the Table; those with a positive sign are gains either through purchase or from birth or from another column in the Table. The main figure in each box is obtained by performing the additions and/or subtractions indicated in the box immediately above (previous month); for example, the figure for ewes in February is: 173 - 24 + 65 - 1 = 213. Some changes in the stock (mainly deaths and births) are actually spread during the month, but here all changes are treated as happening at the end of the month, except births which are assumed at the beginning of the month. This procedure makes calculation of labor, feed and capital coefficients easier and provides these coefficients with a desirable margin of safety.

[c]The figures for September-October are the starting point of the whole Table, since the unit flock is defined as having 200 ewes lambed in September-October. In December-January, 25% ewes are culled for age, and at the end of January the replacement ewes are brought in; they are 65, so as to ensure 200 ewes in September-October. Planned natural mating is done during 51 days (three estrous cycles) in April-May.

[d]At the end of May, 1.5 rams are culled for age. The replacement 1.5 rams are introduced at the end of January.

[e]Lambing period is September-October. Deaths reduce the 215 lamb crop at the rate shown in Table E-3.

[f]The 178 lambs living at the conclusion of the weaning period (Table E-3) are distributed at the end of January in the following manner: 89 wethers and 18 ewe-lambs to be fed and sold, 71 ewe-lambs kept for replacement.

[g]Wethers are fattened from the end of January until the end of February of the following year. They are sold in the first half of March, at the age of 16 to 17 months.

Table E-14. (Continued)

[h]Ewe-lambs are fattened and sold according to the same time sequence as wethers (note g above).

[i]Ewe-lambs for replacement are grown during one year, starting in January, and then transferred to the flock of breeding ewes.

[j]The totals are the horizontal addition of all the main figures for each month.

[k]This column is the first column in the previous Table.

[l]The Table shows how the stock of 215 lambs born is reduced by deaths until the end of the weaning period. As explained in note b above, all births are treated as happening at the beginning of the month.

[m]This column is the addition of the third and fourth columns in Table E-1.

[n]Ninety-one lambs from the September crop are weaned during December, and 90 lambs from the October crop are weaned in January.

[o]The 178 lambs living at the end of the weaning period are transfered according to note f above.

[p]The figures in this Table (other than the totals) are taken from the right hand side corners of the boxes in Table E-1.

[q]Flocks that must be pastured and housed separately.

[r]When there are two flocks, the description of each flock is given. Starred flocks must be tended by an adult.

[s]When there are two flocks, there is a continuous transfer of animals between flocks, according to the patterns of mating and lambing. Here each flock is assumed to contain half the number of ewes existing at the time.

[t]Differences in average weights reflect the periods of gestation, lactation, culling and replacement.

[u]Based on feed containing 90% dry matter. Lactating ewes receive concentrate ration as part of their requirement (Table E-10).

[v]Differences in average weights are due to the fact that older rams are culled at the end of May.

Table E-14. (Continued)

[w]The initial and final weights are known, but no exact information exists on the trend of growth. The monthly average gain is assumed constant, with a higher gain during the months of milder weather.

[x]Based on feed containing 90% dry matter. Fattening lambs are given concentrate ration in an amount that covers 25% of the dry matter required (Table E-11).

[y]The cycle starts in February, just after the weaning period. Fattening continues till the end of the next February, while replacement ewes are transfered to the breeding flock at the end of January.

[z]The concentrate being used at the present time at the Experimental Station consists of 20% alfalfa hay, 30% barley grain, 20% wheat bran and 20% cottonmeal. This formula is just the result of some years' experience. Its price is 0.657 pesos per kg at the present time, but it is expected that by using cost-minimizing linear programming the price can be lowered at least to 0.5 pesos; this is the price used here in computing costs. The ration contains 89.8% dry matter.

[aa]Estimated from the known fact that daily consumption goes from 300 to 400 grams during the three months period.

[bb]Estimated from the known fact that daily consumption goes from 0 to 500 grams during the three months period.

[cc]The ration to be used has not been finally determined as yet. The formula will be close to the one determined with cost-minimizing linear programming for a digestibility experiment at the Experimental Station in March, 1970 (Camargo, Montaño and Pou 1970). The cost of that ration was 0.326 pesos per kg. This price is used here, although it can be still lowered, since the ration was forced to contain certain ingredients in predetermined amounts for the purposes of the experiment. The ration contains 88.2% dry matter.

[dd]The dry matter contained in the daily ration of concentrate. It is 25% of the total dry matter required daily (Table E-8).

[ee]Ration which supplies the dry matter indicated in the previous column.

[ff]Includes the feed required for the lambs which are at the end of the cycle.

[gg]Based on feed containing 90% dry matter.

Table E-14. (Continued)

[hh] The correction consists in excluding that part of the requirement, for lactating ewes and fattening lambs, which is given as concentrate fraction (Tables E-10 and E-11). No correction is needed for rams and replacement ewe-lambs.

[ii] 100% matter. Corrected for concentrate, as explained in note hh.

[jj] Includes 68 lambs just weaned and waiting to be assigned to either the fattening or the replacement flocks.

[kk] Ewes needed in February, in order to have 200 breeding ewes in September-October.

[ll] From birth until the end of the weaning period.

[mm] Deaths in the flock above weaning age.

APPENDIX F. FIXED COSTS, VARIABLE COSTS, REVENUES

The complete version of this Appendix consists of 15 Tables. To conserve space, only a sample of 3 Tables is included here. Copies of the complete version are on file at:

Library
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Table 4-4. Space requirements, construction cost and years of useful life of shelter for farm machinery, 1970 (in pesos)[a]

	Space requirements	Construction[b] cost in pesos	Years of useful life
Tractor	8.5	425.	25
Plow	9.5	472	25
Harrow	9.5	475.	25
Pump	4.5[c]	225.	15
Motor	4.5[c]	225.	15
Potato planter	4.	200.	25
Grain drill	8.5	425.	25
Cultivator	4.	200.	25
Forage harvester	8.5	425.	25
Hay rake	5.5	275.	25
Hay baler	15.	750.	25
Potato digger	4.	200.	25
Trailer	9.	450.	25
Storage building[d]	150.	7500.	25
Silo	-[e]	5000.	25

[a]Source: Computed from Grant, Henderson and Shaplin 1969.

[b]All construction is done with adobe and local labor at a low cost; this cost is estimated at 50 pesos/m^2.

[c]Pump and motor are housed under the same roof. The 7 m^2 of required space have been equally allocated among them.

[d]For inputs and outputs in general, among them the small equipment not listed in this table: sprayer, sorter, sprinkler and electric motors (if any).

[e]Volume of 120 m^3.

Table F-2. Non-labor variable costs of mechanized farm operations, 1970 (in pesos/ha unless otherwise indicated)[a,b]

Operations[c]	Non-labor[d] variable costs
Land preparation	101.556
Spring-tooth harrowing	24.347
Potato planting	78.263
Broad beans planting	41.95
Small grains planting[e]	20.975
Cultivating	36.359
Fertilizing	20.975[f]
Insecticide application	2.802
Irrigation	10.916[g]
Potato harvesting[h] (pesos/cwt)	4.918
Silage making[i] (pesos/cwt)	0.501
Hay making[i] (pesos/cwt)	1.05
Plowing under	59.605

[a]Source: Computed from Tables 5-6 and 6-13.

[b]This Table appears as Table F-7 in the complete version of Appendix F.

[c]As performed under full mechanization.

[d]Excluding interest to be paid for working capital.

[e]Quinua, barley, alfalfa, weeping lovegrass.

[f]Quinua and barley. For potatoes, the cost is 19.566.

[g]For quinua, the cost is 10.961 because sprinkler is also used.

[h]Includes chuño sorting and transportation to storage.

[i]Includes transportation to silo or storage.

Table F-3. Average variable cost of chuño, by levels of mechanization, irrigation, land classes and planting dates, 1970 (in pesos/cwt)[a,b]

	Under partial mechanization[c]		Under full mechanization[c]		Average[d]
	non-irrigated	irrigated	non-irrigated	irrigated	
From Land 1:					42.635
planted October	43.703	39.326	43.962	37.862	
planted November	46.332	39.836	44.739	38.364	
planted December	47.403	39.984	43.396	38.489	
planted January 1	48.338	40.323	46.477	39.022	
From Land 2:					49.214
planted October	52.973	43.133	50.936	43.467	
planted November	53.969	43.744	51.894	44.055	
planted December	54.973	43.898	52.879	44.386	
planted January 1	56.068	46.546	53.912	44.830	
From Land 3:					76.443
planted October	83.092	69.042	79.927	66.303	
planted November	84.569	70.396	81.328	67.808	
planted December	86.066	70.511	82.788	67.889	
planted January 1	87.648	73.957	84.309	69.281	
Average[e]	62.271	52.075	59.899	50.143	56.097

[a]Sources: Computed from Tables 5-9, 6-14 and 6-18.

[b]This Table appears as Table F-8 in the complete version of Appendix F.

[c]The formula for these averages is: $\left(\frac{C_g}{Y} + C_h\right) 3 + C_c$

where C_g is variable cost per hectare of growing potatoes (Table 6-14), Y is yield in cwt (Table 5-9), C_h is variable cost per cwt of harvesting potato (Table 6-18) and C_c is variable cost per cwt of making, transporting and marketing chuño (Table 6-18). The parenthesis is multiplied times 3 because making one cwt of chuño requires 3 cwt of potato. See also note b in Table F-7.

[d]Average for each land class from all planting dates.

[e]Average for each level of mechanization and irrigation from all planting dates and land classes.

APPENDIX C. THE LINEAR PROGRAMMING MODEL

Table C-1. Identification number, type, name, unit, RHS value and description of the rows

Identification number	Row[a] type	Row name[b]	Unit[c]	RHS[d] value	Row description
1	N	INCOME	1 peso	-e	Objective function to be maximized.
2	E	PEOPLE	1 person	-f	Cooperative size.
3	E	LAND	1 ha	-g	Farm size.
4	L	LAND1		-h	Class 1 land available.
5	L	LAND2			Class 2 land available.
6	L	LAND3			Class 3 land available.
7	L	LAND4			Class 4 land available.
8	L	LAND5			

[a]In the terminology of the IBM-MPS routine, N identifies the function to be optimized, E means equality restraint, L means maximum restraint (less than or equal to) and G means minimum restraint (greater than or equal to).

[b]Some of the rows apply only to partial or to full mechanization. Starred row names belong to transfer rows.

[c]Blank means that the unit in the previous row also applies. For example, 1 ha is the unit for rows 3 through 7.

[d]RHS values are the right-hand-side values in the equations that make up the matrix. All transfer rows have a zero (blank) value. Also, those rows which are real constraints but whose RHS value is supplied by a transfer activity have a zero RHS value (see note 1 below).

[e]Does not apply.

[f]This value will be changed as the various cooperative sizes are studied.

[g]This value will be changed parametrically as the various farm sizes are analyzed.

[h]The RHS value for rows 4 through 8 is supplied by column 344, according to the value in row 3.

Table G-1. (Continued)

Identification number	Row[a] type	Row name[b]	Unit[c]	RHS[d] value	Row description
9	L	JUL1	1 hour	-[e]	Labor available in first-half of July (corresponding description applies to rows 10 through 76).
10	L	JUL2			
11	L	AUG1			
12	L	AUG2			
13	L	SEP1			
14	L	SEP2			
15	L	OCT1			
16	L	OCT2			
17	L	NOV1			
18	L	NOV2			
19	L	DEC1			
20	L	DEC2			
21	L	JAN1			
22	L	JAN2			
23	L	FEB1			
24	L	FEB2			
25	L	MAR1			
26	L	MAR2			
27	L	APR1			
28	L	APR2			
29	L	MAY1			
30	L	MAY2			
31	L	JUN1			
32	L	JUN2			
33	L	JUL			
34	L	AUG			
35	L	SEP			

[e]The RHS value for rows 9 through 76 is supplied by column 545, according to the RHS value in row 2.

Table C-1. (Continued)

Identification number	Row[a] type	Row name[b]	Unit[c]	RHS[d] value	Row description
36	L	OCT			
37	L	NOV			
38	L	DEC			
39	L	JAN			
40	L	FEB			
41	L	MAR			
42	L	APR			
43	L	MAY			
44	L	JUN			
45	L	FE/MA			
46	L	MT//JN			
47	L	JN2//JL2			
48	L	JN2//AU			
49	L	JL2//AU2			
50	L	JL2//AU			
51	L	AU2//SE2			
52	L	MT//JL2			
53	L	MT//JL			
54	L	MT//AU2			
55	L	MT//AU			
56	L	MT//SE2			
57	L	MT//SE			
58	L	JN//JL2			
59	L	JN//JL			
60	L	JN//AU2			
61	L	JN//AU			
62	L	JN//SE2			

[a]Rows 32 through 76, 112 through 137, 151 through 171, 179 and 194 through 196 are "subsidiary" rows, that is, rows needed to take care of the overlapping of some of the time periods in which the farm operations must be performed (see Figure C-1 and Table C-3).

Table G-1. (Continued)

Identification number	Row[a] type	Row name[b]	Unit[c]	RHS[d] value	Row description
63	L	JN/SE			
64	L	JN2/JL			
65	L	JN2/AU1			
66	L	JN2/SE1			
67	L	JN2/SE			
68	L	JL/AU1			
69	L	JL/AU			
70	L	JL/SE1			
71	L	JL/SE			
72	L	JL2/SE1			
73	L	JL2/SE			
74	L	/AU/SE1			
75	L	AU/SE			
76	L	AU2/SE			
77	L	WATJUL	1 m^3	165391.2	Water available in July (corresponding description applies to rows 78 through 88).
78	L	WATAUG		165391.2	
79	L	WATSEP		160056.	
80	L	WATOCT		165391.2	
81	L	WATNOV		160056.	
82	L	WATDEC		165391.2	
83	L	WATJAN		165391.2	
84	L	WATFEB		149385.6	
85	L	WATMAR		165391.2	
86	L	WATAPR		160056.	
87	L	WATMAY		165391.2	
88	L	WATJUN		160056.	
89	L	TJAN1	1 hour	104.[k]	Tractor time available in first-half of January

[k]These RHS values for rows 89 through 228 are for one piece of each machine, that is, for the first degree of partial or full mechanization. When more than one machine is allowed, the corresponding values must be changed.

Table G-1. (Continued)

Identification number	Row type[a]	Row name[b]	Unit[c]	RHS[d] value	Row description
90	L	TJAN2		104.	(corresponding description applies to rows 90 through 137).
91	L	TFEB1		96.	
92	L	TFEB2		96.	
93	L	TMAR1		104.	
94	L	TMAR2		112.	
95	L	TJUL		216.	
96	L	TAUG		208.	
97	L	TSEP		208.	
98	L	TOCT		208.	
99	L	TNOV		208.	
100	L	TDEC		216.	
101	L	TJAN		208.	
102	L	TMAR		216.	
103	L	TAPR		208.	
104	L	TMAY		208.	
105	L	TJUN		208.	
106	L	TFE/MA		408.	
107	L	TMY/JN		416.	
108	L	TJN2/JL1		208.	
109	L	TJL2/AU1		208.	
110	L	TJL2/AU		320.	
111	L	TAU2/SE1		216.	
112	L	TMY/JL1		520.	
113	L	TMY/JL		632.	
114	L	TMY/AU1		728.	
115	L	TMY/AU		840.	
116	L	TMY/SE1		944.	
117	L	TMY/SE		1048.	
118	L	TJN/JL1		312.	
119	L	TJN/JL		424.	
120	L	TJN/AU1		520.	

Table G-1. (Continued)

Identification number	Row[a] type	Row name[b]	Unit[c]	RHS[d] value	Row description
121	L	TJN/AU		632.	
122	L	TJN/SE1		736.	
123	L	TJN/SE		840.	
124	L	TJN2/JL		320.	
125	L	TJN2/AU1		416.	
126	L	TJN2/AU		528.	
127	L	TJN2/SE1		632.	
128	L	TJN2/SE		736.	
129	L	TJL/AU1		312.	
130	L	TJL/AU		424.	
131	L	TJL/SE1		528.	
132	L	TJL/SE		632.	
133	L	TJL2/SE1		424.	
134	L	TJL2/SE		528.	
135	L	TAU/SE1		312.	
136	L	TAU/SE		416.	
137	L	TAU2/SE		320.	
138	L	PJAN1		104.	Plow time available in first-half of January (corresponding description applies to rows 139 through 171)
139	L	PJUL		216.	
140	L	PAUG		208.	
141	L	PSEP		208.	
142	L	POCT		208.	
143	L	PNOV		208.	
144	L	PDEC		216.	
145	L	PJAN		208.	
146	L	PMAY		208.	
147	L	PJUN		208.	
148	L	PJN2/JL1		208.	
149	L	PJL2/AU1		208.	
150	L	PAU2/SE1		216.	
151	L	PJN/JL1		312.	

Table G-1. (Continued)

Identification number	Row[a] type	Row name[b]	Unit[c]	RHS[d] value	Row description
152	L	PJN/JL		424.	
153	L	PJN/AU1		520.	
154	L	PJN/AU		632.	
155	L	PJN/SE1		736.	
156	L	PJN/SE		840.	
157	L	PJN2/JL		320.	
158	L	PJN2/AU1		416.	
159	L	PJN2/AU		528.	
160	L	PJN2/SE1		632.	
161	L	PJN2/SE		736.	
162	L	PJL/AU1		312.	
163	L	PJL/AU		424.	
164	L	PJL/SE1		528.	
165	L	PJL/SE		632.	
166	L	PJL2/AU		320.	
167	L	PJL2/SE1		424.	
168	L	PJL2/SE		528.	
169	L	PAU/SE1		312.	
170	L	PAU/SE		416.	
171	L	PAU2/SE		320.	
172	L	HAUG		208.	Harrow time available in August (corresponding description applies to rows 173 through 179).
173	L	HSEP		208.	
174	L	HOCT		208.	
175	L	HNOV		208.	
176	L	HDEC		216.	
177	L	HJN2/JL1		208.	
178	L	HJL2/AU1		208.	
179	L	HJL2/AU		320.	
180	L	PPJAN1		104.	Potato planter time available in first-half of January (corresponding description applies to rows 181 through 186).
181	L	PPJAN2		104.	
182	L	PPFEB1		96.	

Table G-1. (Continued)

Identification number	Row type[a]	Row name[b]	Unit[c]	RHS value[d]	Row description
183	L	PPMAR1		104.	
184	L	PPOCT		208.	
185	L	PPNOV		208.	
186	L	PPDEC		216.	
187	L	GJAN2		104.	Grain drill time available in second-half of
188	L	GSEP		208.	January (corresponding description applies to
189	L	GOCT		208.	rows 188 through 196).
190	L	GDEC		216.	
191	L	GJAN		208.	
192	L	GJL2/AU		320.	
193	L	GAU2/SE1		216.	
194	L	GJL2/SE1		424.	-J
195	L	GJL2/SE		528.	
196	L	GAU2/SE1		320.	
197	L	CJAN1		104.	Cultivator time available in first-half of
198	L	CJAN2		104.	January (corresponding description applies to
199	L	CFEB1		96.	rows 198 through 203).
200	L	CFEB2		96.	
201	L	CMAR1		104.	
202	L	CMAR2		112.	
203	L	CNOV		208.	
204	L	KFEB2		96.	Sprayer time available in second-half of Feb-
205	L	KMAR1		104.	ruary (corresponding description applies to
206	L	KMAR2		112.	rows 205 through 207).
207	L	KDEC		116.	
208	L	FMAR		216.	Forage harvester time available in March.
209	L	FAPR		208.	Forage harvester time available in April.
210	L	RMAY		208.	Hay rake time available in May.
211	L	RJUN		208.	Hay rake time available in June.
212	L	RMY/JN		312.	Hay rake time available in May-June.
213	L	BMAY		208.	Hay baler time available in May.

Table C-1. (Continued)

Identification number	Row[a] type	Row name[b]	Unit[c]	RHS[d] value	Row description
214	L	BJUN		208.	Hay baler time available in June.
215	L	BMY//JN		312.	Hay baler time available in May-June.
216	L	DMAY		208.	Potato digger time available in May.
217	L	WJUL		216.	Wagon time available in July (corresponding
218	L	WAUG		208.	description applies to rows 218 through 224).
219	L	WMAR		216.	
220	L	WAPR		208.	
221	L	WMAY		208.	
222	L	WJUN		208.	
223	L	WFE/MA		408.	
224	L	WMY//JN		416.	
225	L	SAUG		208.	Setter time available in August.
226	L	SNOV		208.	Sprinkler time available in November.
227	L	SFEB		192.	Sprinkler time available in February.
228	L	EOCT2		104.	Electric sheers time available in second-half
229	L	OOCT2		-[e]	of October.
230	L	OLABO			Operator's labor in second-half of October
231	L	OLABR2			(corresponding description applies to rows
232	L	OFEB1			230 through 234).
233	L	OFEB2			
234	L	OMAR1			
235	L	OMAR2			
236	L	OJUL			
237	L	OAUG			

[a]Rows 229 through 234 have a mere computational objective. The hours of operator's labor needed in each time period will accumulate in the RHS's, since a negative sign will be attached to all the requirement coefficients in these rows. The final values for the RHS's will allow to determine how many machinery operators the cooperative should train so that no shortage exists in any period. Subsidiary (overlapping) rows have been omitted for simplicity's sake; this should not be of major concern, since only a rough approximation is desired on the number of operator's labor hours needed.

Table C-1. (Continued)

Identification number	Row[a] type	Row name[b]	Unit[c]	RHS[d] value	Row description
238	L	OSEP			
239	L	OOCT			
240	L	ONOV			
241	L	ODEC			
242	L	OJAN			
243	L	OFEB			
244	L	OMAR			
245	L	OAPR			
246	L	OMAY			
247	L	OJUN			
248	L	OFE1/MA			
249	L	OMY//JN			
250	L	OJN2//JL1			
251	L	OJN2//AU			
252	L	OJL2//AU1			
253	L	OJL2//AU			
254	L	OAU2//SE2			
255	E	*POCT	1 ha		Potato planted in October.
256	E	*PNOV			Potato planted in November.
257	E	*PDEC			Potato planted in December.
258	E	*PJAN			Potato planted in first-half of January.
259	E	*QSEP			Quinua planted in September.
260	E	*QOCT			Quinua planted in October.
261	E	*BJUAU			Broad beans planted in July and first-half of
262	E	*BASEE			Broad beans planted in second-half August.
263	E	*B			Planted barley. of August and September.
264	E	*A	5 ha		Planted alfalfa.
265	E	*P1	1 ha		Non-irrigated potato on land 1.
266	E	*P2			Non-irrigated potato on land 2.
267	E	*P3			Non-irrigated potato on land 3.
268	E	*P"1			Irrigated potato on land 1.

Table C-1. (Continued)

Identification number	Row type[a]	Row name[b]	Unit[c]	RHS value[d]	Row description
269	E	*P"2			Irrigated potato on land 2.
270	E	*P"3			Irrigated potato on land 3.
271	E	*Q1			Non-irrigated quinua on land 1.
272	E	*Q2			Non-irrigated quinua on land 2.
273	E	*Q3			Non-irrigated quinua on land 3.
274	E	*Q"1			Irrigated quinua on land 1.
275	E	*Q"2			Irrigated quinua on land 2.
276	E	*Q"3			Irrigated quinua on land 3.
277	E	*H1			Broad beans on land 1.
278	E	*H2			Broad beans on land 2.
279	E	*H3			Broad beans on land 3.
280	E	*B1			Barley on land 1.
281	E	*B2			Barley on land 2.
282	E	*B3			Barley on land 3.
283	E	*A1	5 ha		Alfalfa on land 1.
284	E	*A2			Alfalfa on land 2.
285	E	*A3			Alfalfa on land 3.
286	L	*WEEP			Planted weeping lovegrass.
287	L	*PHARV	1 cwt		Potato to be harvested.
288	L	*QHARV			Quinua to be harvested.
289	L	*HJLA1	1 ha		Broad beans planted in July and first-half of
290	L	*HJLA2			August on land 1, to be harvested (correspond-
291	L	*HJLA3			ing description applies to rows 290 through 294).
292	L	*HAUG1			
293	L	*HAUG2			
294	L	*HAUG3			
295	L	*HFORGR	1 cwt		Broad beans to be harvested green.
296	L	*HFORDR			Broad beans to be harvested dry.
297	L	*BHARV1	1 ha		Barley on land 1 to be harvested.
298	L	*BHARV2			Barley on land 2 to be harvested.
299	L	*BHARV3			Barley on land 3 to be harvested.

Table C-1. (Continued)

Identification number	Row[a]	Row name[b]	Unit[c]	RHS[d] value	Row description
300	L	*BFORSIL	1 cwt		Barley to be made into silage.
301	L	*BFORHAY			Barley to be made into hay.
302	L	*ABARV1	1 ha		Alfalfa on land 1 to be harvested.
303	L	*ABARV2			Alfalfa on land 2 to be harvested.
304	L	*ABARV3			Alfalfa on land 3 to be harvested.
305	L	*AFORSIL	1 cwt		Alfalfa to be made into silage.
306	L	*AFORHAY			Alfalfa to be made into hay.
307	L	*POTATO			Potato to be processed into chuño.
308	L	*CHUNO1			First-class chuño to be sold.
309	L	*CHUNO2			Second-class chuño to be sold.
310	L	*CHUNO3			Third-class chuño to be sold.
311	L	*QUINUA			Quinua to be sold.
312	L	*GBEANS			Green beans to be sold.
313	L	*DBEANS			Dry beans to be sold.
314	E	*BARSIL			Barley silage for sheep feeding.
315	L	*BARHAY			Barley hay for sheep or to be sold.
316	E	*ALFSIL			Alfalfa silage for sheep feeding.
317	L	*ALFHAY			Alfalfa hay for sheep or to be sold.
318	E	*LPELTS	1 pelt		Lamb pelts to be sold.
319	E	*APELTS			Adult pelts to be sold.
320	E	*WOOL1	1 kg		First-class wool to be sold.
321	E	*WOOL2			Second-class wool to be sold.
322	E	*WOOL3			Third-class wool to be sold.
323	E	*WOOL6			Sixth-class wool to be sold.
324	E	*RAMS	1 head		Culled rams to be sold.
325	E	*EWES			Culled ewes to be sold.
326	E	*WETHERS			Fattened wethers to be sold.
327	E	*FLAMBS			Fattened female lambs to be sold.
328	E	*SALEAGR	1 peso		Sales of agricultural products.
329	E	*SALELIV			Sales of livestock products.
330	E	*TOTSALE			Total sales.

Table C-1. (Continued)

Identification number	Row[a] type	Row name[b]	Unit[c]	RHS[d] value	Row description
331	E	*REVLAB			Revenue from labor.
332	E	*TRLABOR	1 hour		Labor hours needed all year.
333	E	*OTLABOR			Operator's labor hours needed all year.
334	E	*TRWATER	1 m^3		Water needed all year.
335	E	*CAPITAL	1 peso		Working capital needed.
336	E	*FIXCOST		[e]	Fixed cost to be paid.
337	E	*LANDUSE	1 ha		Land needed.
338	E	*TRACTOR	1 hour		Tractor time needed.
339	E	*PLOW			Plow time needed.
340	E	*HARROW			Harrow time needed.
341	E	*MOTPUMP			Motor-and-pump time needed.
342	E	*PLANTER			Planter time needed.
343	E	*DRILL			Drill time needed.
344	E	*CULTIV			Cultivator time needed.
345	E	*SPRAY			Sprayer time needed.
346	E	*HARVEST			Harvester time needed.
347	E	*RAKE			Rake time needed.
348	E	*BALER			Baler time needed.
349	E	*DIGGER			Potato digger time needed.
350	E	*WAGON			Wagon time needed.
351	E	*SORTER			Sorter time needed.
352	E	*SPRINK			Sprinkler time needed.
353	E	*ELSHEAR			Electric shears time needed.
354	E	*ALFDMAT	1 ton		Dry matter in alfalfa for pasture.
355	E	*WEDMAT			Dry matter in weeping lovegrass for pasture.
356	L	*DRYMJUL			Dry matter in July (corresponding description

[a]This RHS value differs for each degree and level of mechanization (see Tables 7-3 and 7-4).

Table G-1. (Continued)

Identification number	Row# type	Row name[b]	Unit[c]	RHS[d] value	Row description
357	L	*DECEMBER			applies to rows 357 through 367).
358	L	*DECEMBER			
359	L	*DECEMBER			
360	L	*DECEMBER			
361	L	*DECEMBER			
362	L	*DECEMBER			
363	L	*DECEMBER			
364	L	*DECEMBER			
365	L	*DECEMBER			
366	L	*DECEMBER			
367	L	*DECEMBER			

Table C-2. Identification number, name, unit, objective function coefficient and description of the columns

Identification number[a]	Column name[b]	Unit	Objective function coefficient[c]	Column description
368	LANDUSED	1 ha		Total land used.
369	LABOR	1 hour		Total labor used.
370	OLABOR	1 hour		Operator's labor used.
371	WATER	1 m^3		Total water used.
372	REVLABOR	1 peso		Revenue from labor (wage bill).
373	TOTSALES			Total sales.
374	SALESCROP			Sales from crops.
375	SALESLIV			Sales from livestock.
376	CAPITAL		-0.8	Borrowing capital.
377	FCONTRACT		-1.	Paying fixed cost.
378	PQB1	3 ha		Non-irrigated potato-quinua-barley rotation on land 1 (corresponding description applies to columns 379 through 405)[d].
379	P"QB1			
380	PQ"B1			
381	P"Q"B1			
382	PMQB1	4 ha		
383	PMQB2			
384	PMQB3			

[a]Continuation of identification numbers in Table C-1.

[b]Starred column names belong to transfer activities.

[c]Negative values are net cost of the activity; positive figures are revenue from the activity. A zero (blank) value indicates that the cost-revenue of the activity is accounted for somewhere else in the model or that the column is only an accounting activity.

[d]According to the following code: P = potato, Q = quinua, B = broad beans, B = barley, A = alfalfa, " = irrigated, 1 or 2 or 3 = land class. Alfalfa is always irrigated, broad beans and barley are non-irrigated.

Table G-2. (Continued)

Identification number[a]	Column name[b]	Unit	Objective function coefficient[c]	Column description
3875	P''HQ3K1			
3876	P''HQ3K2			
3877	P''HQ3K3			
3878	PHQ''K1			
3879	PHQ''K2			
3880	PHQ''K3			
3881	P''HQ''K1			
3882	P''HQ''K2			
3883	P''HQ''K3			
3884	PQBA.1	$ ha		
3885	PQBA.2			
3886	PQBA.3			
3887	P''QBA.1			
3888	P''QBA.2			
3889	P''QBA.3			
4380	PQ''BA.1			
4381	PQ''BA.2			
4382	PQ''BA.3			
4383	P''Q''BA.1			
4384	P''Q''BA.2			
4385	P''Q''BA.3			
4386	BARCION1			Continuous barley on Land 1.
4387	BARCION2			Continuous barley on Land 2.
4388	ALFCION1	$ ha		Continuous alfalfa on Land 1.
4389	ALFCION2			Continuous alfalfa on Land 2.
4390	ALFCION3			Continuous alfalfa on Land 3.
4391	WEEP'3			Weeping Lovegrass on Land 3.
4392	WEEP'4			Weeping Lovegrass on Land 4.
4393	WEEP'5			Weeping Lovegrass on Land 5.

Table G-2. (Continued)

Identification number[a]	Column[b] name	Unit	Objective[c] function coefficient	Column description
414	SHEEP	200 ewes	184646.121[d]	Raising sheep.
415	POCT	1 ha	-1906.777[d]	Growing potato, planted in October.
416	PNOV		-1906.777	Growing potato, planted in November.
417	PDEC		-1906.777	Growing potato, planted in December.
418	PJAN		-1906.777	Growing potato, planted in first-half of January.
419	QSEP		- 195.42	Growing quinua, planted in September.
420	QOCT		- 195.42	Growing quinua, planted on October.
421	HJULAU		- 130.317	Growing broad beans, planted in July and first-half
422	HAUGSE		- 130.317	Growing broad beans, planted in of August.
423	BARL		- 356.57	Growing barley. second-half of Aug. and Sept.
424	ALFAL		- 444.4	Growing alfalfa.
425	WEEP		- 921.243	Growing weeping lovegrass.
426	POCT1			Non-irrigated potato, planted in October, on land 1
427	POCT2			(corresponding description applies to columns 427
428	POCT3			through 447)
429	PNOV1			
430	PNOV2			
431	PNOV3			
432	PDEC1			
433	PDEC2			
434	PDEC3			
435	PJAN1			
436	PJAN2			
437	PJAN3			

[a]Gross revenue minus costs other than labor, water, interest on working capital, hay, silage, pasture (see note b below).

[b]Values for columns 415 to 425 and 501 to 509 do not include the costs of labor, water, capital and machinery. These costs, as well as the revenue from the activities, are accounted for somewhere else in the model.

Table G-2. (Continued)

Identification number[a]	Column name[b]	Unit	Objective function coefficient[c]	Column description
438	P'OCT1			
439	P'OCT2			
440	P'OCT3			
441	P'NOV1			
442	P'NOV2			
443	P'NOV3			
444	P'DEC1			
445	P'DEC2			
446	P'DEC3			
447	P'JAN1			
448	P'JAN2			
449	P'JAN3			
450	QSEP1			
451	QSEP2			
452	QSEP3			
453	Q'SEP1			
454	Q'SEP2			
455	Q'SEP3			
456	QOCT1			
457	QOCT2			
458	QOCT3			
459	Q'OCT1			
460	Q'OCT2			
461	Q'OCT3			
462	RJLAU1			
463	RJLAU2			
464	RJLAU3			
465	RAUSE1			
466	RAUSE2			
467	RAUSE3			
468	BAR1			Barley on land 1.

Table G-2. (Continued)

Identification number[a]	Column name[b]	Unit	Objective function coefficient[c]	Column description
469	BAR2			Barley on land 2.
470	BAR3			Barley on land 3.
471	ALF1	5 ha		Alfalfa on land 1.
472	ALF2			Alfalfa on land 2.
473	ALF3			Alfalfa on land 3.
474	GHBJLAU1	1 ha		Broad beans, planted in July and first-half of August, on land 1, to be harvested green (corresponding description applies to columns 475 through 479).
475	GHBJLAU2			
476	GHBJLAU3			
477	GHHAUSE1			
478	GHHAUSE2			
479	GHHAUSE3			
480	DHBJLAU1			Broad beans, planted in July and first-half of August, to be harvested dry (corresponding description applies to columns 481 through 485).
481	DHBJLAU2			
482	DHBJLAU3			
483	DHHAUSE1			
484	DHHAUSE2			
485	DHHAUSE3			
486	BSIL1			Barley, on land 1, to be made into silage.
487	BSIL2			Barley, on land 2, to be made into silage.
488	BSIL3			Barley, on land 3, to be made into silage.
489	BHAY1			Barley, on land 1, to be made into hay.
490	BHAY2			Barley, on land 2, to be made into hay.
491	BHAY3			Barley, on land 3, to be made into hay.
492	ASIL1			Alfalfa, on land 1, to be made into silage.
493	ASIL2			Alfalfa, on land 2, to be made into silage.
494	ASIL3			Alfalfa, on land 3, to be made into silage.
495	AHAY1			Alfalfa, on land 1, to be made into hay.
496	AHAY2			Alfalfa, on land 2, to be made into hay.
497	AHAY3			Alfalfa, on land 3, to be made into hay.
498	APAST1			Alfalfa, on land 1, to be pastured.
499	APAST2			Alfalfa, on land 2, to be pastured.

Table G-2. (Continued)

Identification number[a]	Column name[b]	Unit	Objective function coefficient[c]	Column description
500	APAST3			Alfalfa, on land 3, to be pastured.
501	POTHARV	1 cwt		Harvesting potato.
502	QUIHARV			Harvesting quinua.
503	GHHARV			Harvesting green beans.
504	DHHARV			Harvesting dry beans.
505	BSILMAK		- .091	Making barley silage.
506	BHAYMAK		- .227	Making barley hay.
507	ASILMAK		- .091	Making alfalfa silage.
508	AHAYMAK		- .227	Making alfalfa hay.
509	CHUMAK			Making chuño.
510	SELCHU1		150.[g]	Selling first-class chuño.
511	SELCHU2		130.	Selling second-class chuño.
512	SELCHU3		110.	Selling third-class chuño.
513	SELQUIN		60.	Selling quinua.
514	SELGBEAN		25.	Selling green beans.
515	SELDBEAN		80.	Selling dry beans.
516	SELBHAY		10.	Selling barley hay.
517	SELAHAY		18.	Selling alfalfa hay.
518	SELLPELT		-[h]	Selling lamb pelts.
519	SELAPELT			Selling adult pelts.
520	SELWOOL1			Selling first-class wool.
521	SELWOOL2			Selling second-class wool.
522	SLEWOOL3			Selling third-class wool.
523	SELWOOL6			Selling sixth-class wool.
524	SELRAMS			Selling culled rams.

[g]Values for columns 510 to 517 are the prices per cwt received at the Central de Cooperativas.

[h]Values are zero for columns 518-527 because the sale prices are included in the value for column 414, in an effort to obtain a meaningful shadow price for sheep raising activity when it does not enter the optimal program. Columns 518-527 are then mere accounting activities.

Table G-2. (Continued)

Identification number[a]	Column name[b]	Unit	Objective function coefficient[c]	Column description
525	SELEWES			Selling culled ewes.
526	SELWETH			Selling fattened wethers.
527	SELFLAMB			Selling fattened female lambs.
528	TRACTOR	1 hour	- 14.756	Using tractor.
529	PLOW		- 3.306	Using plow.
530	HARROW		- .832	Using harrow.
531	MOTORPUM		- 10.916	Using motor-and-pump.
532	PPLANTER		- 3.031	Using potato planter.
533	DRILL		- 4.312	Using grain drill.
534	CULTIVAT		- 1.771	Using cultivator.
535	SPRAYER		- 1.751	Using sprayer.
536	HARVESTR		- 5.471	Using forage harvester.
537	RAKE		- 4.54	Using hay rake.
538	BALER		- 8.146	Using hay baler.
539	PDIGGER		- 3.198	Using potato digger.
540	WAGON		- 1.487	Using farm wagon.
541	SORTER		- .113	Using sorter for chuño.
542	SPRINKLR		- .045	Using sprinkler.
543	ELSHEARS		- .25	Using electric shears
544	*LANDTR	1 ha		Transfer of land fromorow 3 to rows 4 through 8.
545	*LABORTR	1 hour		Transfer of labor from row 2 to rows 9 through 76.
546	*BSILJUL	1 ton		Transfering dry matter from row 314 to row 356
547	*BSILAUG			(corresponding description applies to rows 547
548	*BSILSEP			through 557).
549	*BSILOCT			
550	*BSILNOV			
551	*BSILDEC			
552	*BSILJAN			
553	*BSILFEB			

Table G-2. (Continued)

Identification number[a]	Column name[b]	Unit	Objective function coefficient[c]	Column description
554	*BSILMAR			
555	*BSILAPR			
556	*BSILMAY			
557	*BSILJUN			
558	*ASILJUL			Transfer of dry matter from row 316 to row 356 (corresponding description applies to rows 558 through 569).
559	*ASILAUG			
560	*ASILSEP			
561	*ASILOCT			
562	*ASILNOV			
563	*ASILDEC			
564	*ASILJAN			
565	*ASILFEB			
566	*ASILMAR			
567	*ASILAPR			
568	*ASILMAY			
569	*ASILJUN			
570	*BHAYJUL			Transfer of dry matter from row 315 to row 356 (corresponding description applies to rows 571 through 581).
571	*BHAYAUG			
572	*BHAYSEP			
573	*BHAYOCT			
574	*BHAYNOV			
575	*BHAYDEC			
576	*BHAYJAN			
577	*BHAYFEB			
578	*BHAYMAR			
579	*BHAYAPR			
580	*BHAYMAY			
581	*BHAYJUN			

Table G-2. (Continued)

Identification number[a]	Column name[b]	Unit	Objective function coefficient[c]	Column description
582	*AHAYJUL			Transfer of dry matter from row 317 to row 356 (corresponding description applies to rows 583 through 593).
583	*AHAYAUG			
584	*AHAYSEP			
585	*AHAYOCT			
586	*AHAYNOV			
587	*AHAYDEC			
588	*AHAYJAN			
589	*AHAYFEB			
590	*AHAYMAR			
591	*AHAYAPR			
592	*AHAYMAY			
593	*AHAYJUN			
594	*WETRJAN			Transfer of dry matter from row 355 to row 362 (corresponding description applies to rows 595 through 598).
595	*WETRFEB			
596	*WETRMAY			
597	*WETRAPR			
598	*WETRMAY			
599	*ALTRMAR			Transfer of dry matter from row 354 to row 364 (corresponding description applies to rows 600 through 602).
600	*ALTRAPR			
601	*ALTRMAY			
602	*ALTRJUN			

Figure G-1. Graphic procedure for determining subsidiary constraints needed to handle overlapping time periods[a,b]

---

[a]Source: Based on Figures 5-1, 5-2 and 5-3.

[b]Some of the time periods in which farm operations must be performed overlap with one another, as presented in Figures 5-1 to 5-3. This Table shows how the overlapping is approached by means of so-called subsidiary constraints. The tractor time constraints from May to September are used as an example here. Subsidiary rows for all resources are listed in note j of Table G-1.

[c]The tractor time periods from May to September dictated by Figures 5-1 through 5-3.

[d]The tractor time periods needed to take care of the overlapping of original time periods. Unless these subsidiary constraints are added, potential infeasibilities are built into the linear programming matrix. Note e below shows how the time span of the subsidiary constraints is rea

[e]As an example, the span of the three last periods is read this way: August - first half of September, August-September, second half of August September, respectively.

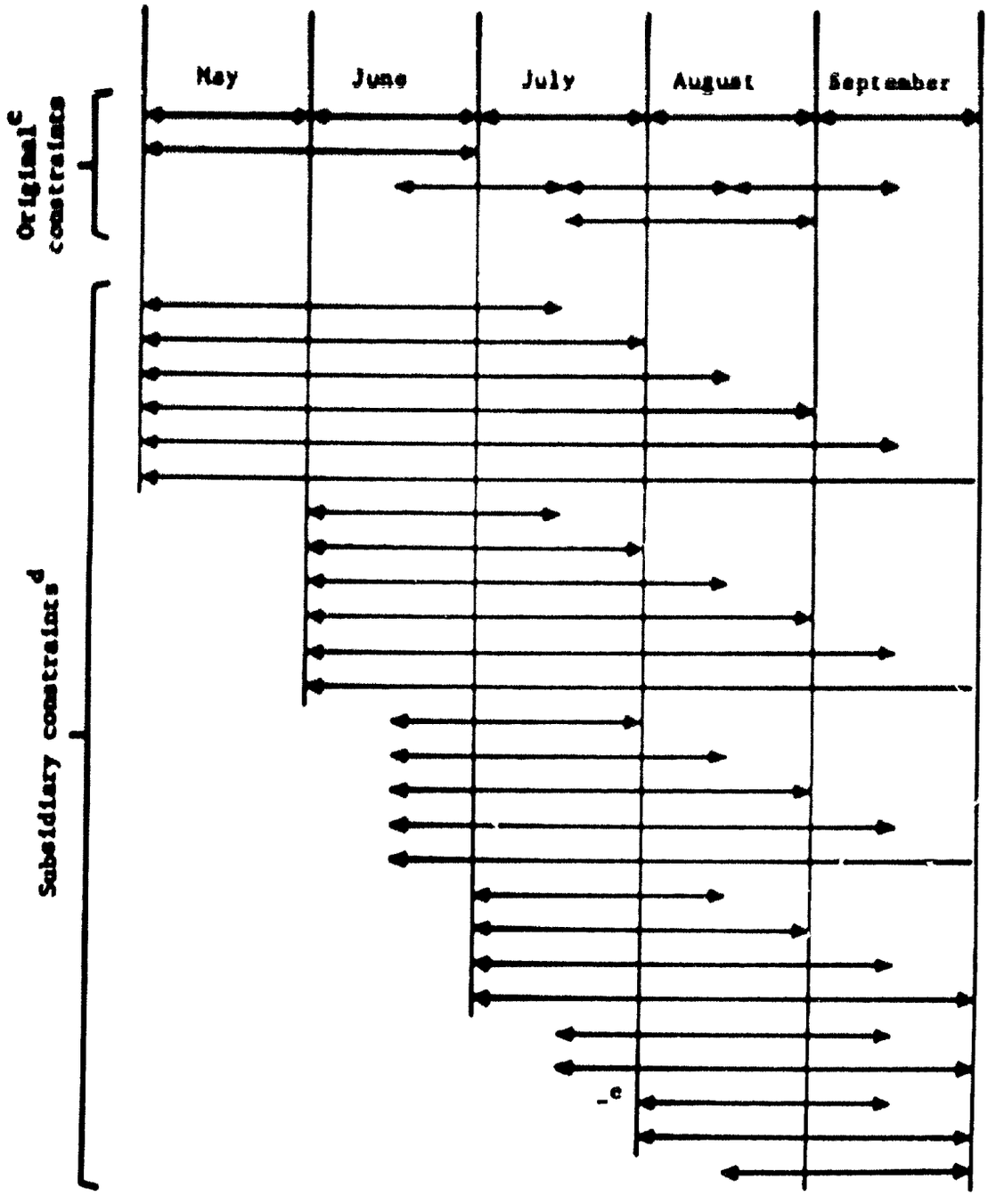
May
June
July
August
September
Original[c] constraints
Subsidiary constraints[d]
-[e]

Table G-3. Tractor time constraints from May to September, and derivation of RHS values and requirement coefficients[a,b]

	Row names	Derivation of RHS values: procedure[d]	Derivation of RHS values: example for one tractor	Derivation of requirement coefficients: procedure[f]	Examples[g]: QSEP	Examples[g]: HJLAU	Examples[g]: HALSE	Examples[g]: ABAYMAK
Original constraints	TMAY	A	208.	A		3.3	3.3	0.212
	TJUN	B	208.	B				0.318
	TJUL	C	216.	C	3.3			
	TAUG	D	208.	D	6.05			
	TSEP	E	208.	E	1.1			
	TMY/JN	A + B	416.	M + A + B		3.3	3.3	0.53
	TJN2/JL1	F + G	208.	N		6.05		
	TJL2/AU1	H + I	208.	P			6.05	
	TJL2/AU	H + D	320.	Q + D + P	6.05	2.2	6.05	
	TAU2/SE1	J + K	216.	R			2.2	
Subsidiary constraints	TMY/JL1	A + B + G	520.	A + B + M + N		9.35	3.3	0.53
	TMY/JL	A + B + C	632.	previous + C	3.3	9.35	3.3	0.53
	TMY/AU1	previous + I	728.	previous + P	3.3	9.35	9.35	0.53
	TMY/AU	A + B + C + D	840.	previous + D + Q	9.35	11.55	9.35	0.53
	TMY/SE1	previous + K	944.	previous + R	9.35	11.55	11.55	0.53
	TMY/SE	A + B + C + D + E	1048.	previous + E	10.45	11.55	11.55	0.53
	TJN/JL1	B + G	312.	B + N		6.05		0.318
	TJN/JL	B + C	424.	previous + C	3.3	6.05		0.318
	TJN/AU1	previous + I	520.	previous + P	3.3	6.05	6.05	0.318
	TJN/AU	B + C + D	632.	previous + D + Q	9.35	8.25	6.05	0.318
	TJN/SE1	previous + K	736.	previous + R	0.35	8.25	8.25	0.318
	TJN/SE	B + C + D + E	840.	previous + E	10.45	8.25	8.25	0.318
	TJN2/JL	F + C	320.	C + N	3.3	6.05		
	TJN2/AU1	previous + I	416.	previous + P	3.3	6.05	6.05	
	TJN2/AU	F + C + D	528.	previous + D + Q	9.35	8.25	6.05	
	TJN2/SE1	previous + K	632.	previous + R	9.35	8.25	8.25	
	TJN2/SE	F + C + D + E	736.	previous + E	10.45	8.25	8.25	

TJL/AU1	C + I	312.	C + P	3.3		6.05
TJL/AU	C + D	424.	previous + D + Q	9.35	2.2	6.05
TJL/SE1	previous + K	528.	previous + R	9.35	2.2	8.25
TJL/SE	C + D + E	632.	previous + E	10.45	2.2	8.25
TJL2/SE1	H + D + K	424.	D + P + Q + R	6.05	2.2	8.25
TJL2/SE	H + D + E	528.	previous + E	7.15	2.2	8.25
TAU/SE1	D + K	312.	D + R	6.05		2.2
TAU/SE	D + E	416.	previous + E	7.15		2.2
TAU2/SE	J + E	320.	E + R	1.1		2.2

[a]Sources: Rows and procedures are based on Figure G-1; for the original constraints, RHS values are from Table 4-8 and requirement coefficients are from Tables C-18, C-19 and C-22.

[b]This Table shows how the coefficients for the original and subsidiary constraints from Figure G-1 are computed. Although the computations were done manually in this study, a simple computer program can be devised for the task.

[c]Described in Table G-1, identification numbers 104-105, 95-97, 107-137.

[d]Each letter represents the hours of tractor time available in a certain time period: A=May (208 hours for one tractor), B=June (208), C=July (216), D=August (208), F=second half of June (104), G=first half of July (104), H=second half of July (112), I=first half of August (96), J=second half of August (112), K=first half of September (104).

[e]Each letter represents the requirement of tractor hours during a certain time period: A=May, B=June, C=July, D=August, E=September, M=May and June, N=second half of June and first half of July, P=second half of July and first half of August, Q=second half of July and August, R=second half of August and first half of September.

[f]Under full mechanization. The four activities are described in Table G-2, identification numbers 419, 421, 422 and 508.

Table G-4. Linear programming matrix for partial mechanization[a]

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[a]In the RHS section of the matrix only the vector for the first degree of partial mechanization is reproduced. The RHS values for the other 26 degrees are computed on the basis of Table 7-3.

```
NAME          PARTIAL
ROWS
 N  INCOME
 E  PEOPLE
 E  LAND
 L  LAND1
 L  LAND2
 L  LAND3
 L  LAND4
 L  LAND5
 L  JUL1
 L  JUL2
 L  AUG1
 L  AUG2
 L  SEP1
 L  SEP2
 L  OCT1
 L  OCT2
 L  NOV1
 L  NOV2
 L  DEC1
 L  DEC2
 L  JAN1
 L  JAN2
 L  FEB1
 L  FEB2
 L  MAR1
 L  MAR2
 L  APR1
 L  APR2
 L  MAY1
 L  MAY2
 L  JUN1
 L  JUN2
 L  JUL
 L  AUG
 L  SEP
 L  OCT
 L  NOV
 L  DEC
 L  JAN
 L  FEB
 L  MAR
 L  APR
 L  MAY
 L  JUN
 L  FE/MA
 L  MY/JN
 L  JN2/JL1
 L  JN2/AU
```

```
L   JL2/AU1
L   JL2/AU
L   AU2/SE1
L   MY/JL1
L   MY/JL
L   MY/AU1
L   MY/AU
L   MY/SE1
L   MY/SE
L   JN/JL1
L   JN/JL
L   JN/AU1
L   JN/AU
L   JN/SE1
L   JN/SE
L   JN2/JL
L   JN2/AU1
L   JN2/SE1
L   JN2/SE
L   JL/AU1
L   JL/AU
L   JL/SE1
L   JL/SE
L   JL2/SE1
L   JL2/SE
L   TMY/AU1
L   AU/SE1
L   AU/SE
L   AU2/SE
L   WATJUL
L   WATAUG
L   WATSEP
L   WATOCT
L   WATNOV
L   WATDEC
L   WATJAN
L   WATFEB
L   WATMAR
L   WATAPR
L   WATMAY
L   WATJUN
L   TJAN1
L   TJUL
L   TAUG
L   TSEP
L   TOCT
L   TNOV
L   TDEC
L   TJAN
L   TMAR
L   TAPR
```

```
L   TMAY
L   TJUN
L   TFE/MA
L   TMY/JN
L   TJN2/JL1
L   TJL2/AU1
L   TJL2/AU
L   TAU2/SE1
L   TMY/JL1
L   TMY/JL
L   TMY/AU
L   TMY/SE1
L   TMY/SE
L   TJN/JL1
L   TJN/JL
L   TJN/AU1
L   TJN/AU
L   TJN/SE1
L   TJN/SE
L   TJN2/JL
L   TJN2/AU1
L   TJN2/AU
L   TJN2/SE1
L   TJN2/SE
L   TJL/AU1
L   TJL/AU
L   TJL/SE1
L   TJL/SE
L   TJL2/SE1
L   TJL2/SE
L   TAU/SE1
L   TAU/SE
L   TAU2/SE
L   PJAN1
L   PJUL
L   PAUG
L   PSEP
L   PDEC
L   PNOV
L   PDEC
L   PJAN
L   PMAY
L   PJUN
L   PJN2/JL1
L   PJL2/AU1
L   PAU2/SE1
L   PJN/JL1
L   PJN/JL
L   PJN/AU1
L   PJN/AU
L   PJN/SE1
```

```
L    PJN/SE
L    PJN2/JL
L    PJN2/AU1
L    PJN2/AU
L    PJN2/SE1
L    PJN2/SE
L    PJL/AU1
L    PJL/AU
L    PJL/SE1
L    PJL/SE
L    PJL2/AU
L    PJL2/SE1
L    PJL2/SE
L    PAUZ/SE1
L    PAUZ/SE
L    PAUZ/SE
L    MAUG
L    MSEP
L    MOCT
L    MNOV
L    MDEC
L    MJAN2/JL1
L    MJL2/AU1
L    MJL2/AU
L    VFEB2
L    KMAR1
L    KMAR2
L    KDEC
L    WJUN
L    WAUG
L    WMAR
L    WAPR
L    WMAY
L    WJUN
L    WFE/MA
L    WMY/JN
L    SAUG
L    ZNOV
L    ZFEB
L    CJAN1
L    CMAR1
L    CMAR2
L    GJUN
L    GAUG
L    GSEP
L    GOCT
L    GNOV
L    GDEC
L    GJAN
L    GFEB
L    GMAR
```

```
L   OAPR
L   OMAY
L   OJUN
L   OFE/MA
L   OMY/JN
L   OJN2/JL1
L   OJN2/AU
L   OJL2/AU1
L   OJL2/AU
L   OAU2/SE1
E   *POCT
E   *PNOV
E   *PDEC
E   *PJAN
E   *QSEP
E   *QOCT
E   *HJLAU
E   *HAUSE
E   *A
E   *A
E   *P1
E   *P2
E   *P3
E   *P*1
E   *P*2
E   *P*3
E   *Q1
E   *Q2
E   *Q3
E   *Q*1
E   *Q*2
E   *Q*3
E   *H1
E   *H2
E   *H3
E   *R1
E   *R2
E   *R3
E   *A1
E   *A2
E   *A3
L   *WEEP
L   *PHARV
L   *QHARV
L   *HJLAU1
L   *HJLAU2
L   *HJLAU3
L   *HAUSE1
L   *HAUSE2
L   *HAUSE3
L   *HFORGH
```

```
L   *HFORDH
L   *BHARV1
L   *BHARV2
L   *BHARV3
L   *BFORSIL
L   *BFORHAY
L   *AHARV1
L   *AHARV2
L   *AHARV3
L   *AFORSIL
L   *AFORHAY
L   *POTATO
L   *CHUNO1
L   *CHUNO2
L   *CHUNO3
L   *QUINUA
L   *GBEANS
L   *DBEANS
E   *BARSIL
L   *BARHAY
E   *APSIL
L   *APHAY
E   *LPELTS
E   *APELTS
E   *WOOL1
E   *WOOL2
E   *WOOL3
E   *WOOL6
E   *RAMS
E   *EWES
E   *WETHERS
E   *FLAMBS
E   *SALEACR
E   *SALELIV
E   *TOTSAL
E   *REVLAB
E   *YRLABOR
E   *OYLABOR
E   *YRWATER
E   *CAPITAL
E   *FIXCOST
E   *LANDUSE
E   *TRACTOR
E   *PLOW
E   *HARROW
E   *MOTPUMP
E   *KINK
E   *WAGON
E   *SORTER
E   *ZPRINK
E   *ALFDMAT
```

```
 E  *WEDMAT
 L  *DRYMJUL
 L  *DRYMAUG
 L  *DRYMSEP
 L  *DRYMOCT
 L  *DRYMNOV
 L  *DRYMDEC
 L  *DRYMJAN
 L  *DRYMFEB
 L  *DRYMMAR
 L  *DRYMAPR
 L  *DRYMMAY
 L  *DRYMJUN
COLUMNS
    LANDUSED  *LANDUSE  -   1.00000
    LABOR     *YRLABOR  -   1.00000   *CAPITAL        1.00000
    LABOR     *REVLAB   -   1.00000
    OLABOR    *OYLABOR  -   1.00000   *CAPITAL         .25000
    OLABOR    *REVLAB   -    .25000
    WATER     *YRWATER  -   1.00000   *MOTPUMP         .00450
    CAPITAL   *CAPITAL  -   1.00000   INCOME    -       .08000
    FCOSTPAY  *FIXCOST      1.00000   INCOME    -      1.00000
    REVLABOR  *REVLAB       1.00000
    TOTSALES  *TOTSALE  -   1.00000
    SALESAGR  *TOTSALE      1.00000   *SALEAGR  -      1.00000
    SALESLIV  *TOTSALE      1.00000   *SALELIV  -      1.00000
    PQB1      *P1           1.00000   *Q1              1.00000
    PQB1      *B1           1.00000   *BHARV1   -      1.00000
    P'QB1     *P'1          1.00000   *Q1              1.00000
    P'QB1     *B1           1.00000   *BHARV1   -      1.00000
    PQ'B1     *P1           1.00000   *Q'1             1.00000
    PQ'B1     *B1           1.00000   *BHARV1   -      1.00000
    P'Q'B1    *P'1          1.00000   *Q'1             1.00000
    P'Q'B1    *B1           1.00000   *BHARV1   -      1.00000
    PHQB1     *P1           1.00000   *Q1              1.00000
    PHQB1     *H1           1.00000   *B1              1.00000
    PHQB1     *BHARV1   -   1.00000
    PHQB2     *P2           1.00000   *Q2              1.00000
    PHQB2     *H2           1.00000   *B2              1.00000
    PHQB2     *BHARV2   -   1.00000
    PHQB3     *P3           1.00000   *Q3              1.00000
    PHQB3     *H3           1.00000   *B3              1.00000
    PHQB3     *BHARV3   -   1.00000
    P'HQB1    *P'1          1.00000   *Q1              1.00000
    P'HQB1    *H1           1.00000   *B1              1.00000
    P'HQB1    *BHARV1   -   1.00000
    P'HQB2    *P'2          1.00000   *Q2              1.00000
    P'HQB2    *H2           1.00000   *B2              1.00000
    P'HQB2    *BHARV2   -   1.00000
    P'HQB3    *P'3          1.00000   *Q3              1.00000
    P'HQB3    *H3           1.00000   *B3              1.00000
```

P'HQB3	*BHARV3	-	1.00000			
PHQ'B1	*P1		1.00000	*Q'1		1.00000
PHQ'B1	*H1		1.00000	*B1		1.00000
PHQ'B1	*BHARV1	-	1.00000			
PHQ'B2	*P2		1.00000	*Q'2		1.00000
PHQ'B2	*H2		1.00000	*B2		1.00000
PHQ'B2	*BHARV2	-	1.00000			
PHQ'B3	*P3		1.00000	*Q'3		1.00000
PHQ'B3	*H3		1.00000	*B3		1.00000
PHQ'B3	*BHARV3	-	1.00000			
P'HQ'B1	*P'1		1.00000	*Q'1		1.00000
P'HQ'B1	*H1		1.00000	*B1		1.00000
P'HQ'B1	*BHARV1	-	1.00000			
P'HQ'B2	*P'2		1.00000	*Q'2		1.00000
P'HQ'B2	*H2		1.00000	*B2		1.00000
P'HQ'B2	*BHARV2	-	1.00000			
P'HQ'B3	*P'3		1.00000	*Q'3		1.00000
P'HQ'B3	*H3		1.00000	*B3		1.00000
P'HQ'B3	*BHARV3	-	1.00000			
PQBA1	*P1		1.00000	*Q1		1.00000
PQBA1	*B1		1.00000	*A1		1.00000
PQBA1	*BHARV1	-	1.00000	*AHARV1	-	4.00000
PQBA2	*P2		1.00000	*Q2		1.00000
PQBA2	*B2		1.00000	*A2		1.00000
PQBA2	*BHARV2	-	1.00000	*AHARV2	-	4.00000
PQBA3	*P3		1.00000	*Q3		1.00000
PQBA3	*B3		1.00000	*A3		1.00000
PQBA3	*BHARV3	-	1.00000	*AHARV3	-	4.00000
P'QBA1	*P'1		1.00000	*Q1		1.00000
P'QBA1	*B1		1.00000	*A1		1.00000
P'QBA1	*BHARV1	-	1.00000	*AHARV1	-	4.00000
P'QBA2	*P'2		1.00000	*Q2		1.00000
P'QBA2	*B2		1.00000	*A2		1.00000
P'QBA2	*BHARV2	-	1.00000	*AHARV2	-	4.00000
P'QBA3	*P'3		1.00000	*Q3		1.00000
P'QBA3	*B3		1.00000	*A3		1.00000
P'QBA3	*BHARV3	-	1.00000	*AHARV3	-	4.00000
PQ'BA1	*P1		1.00000	*Q'1		1.00000
PQ'BA1	*B1		1.00000	*A1		1.00000
PQ'BA1	*BHARV1	-	1.00000	*AHARV1	-	4.00000
PQ'BA2	*P2		1.00000	*Q'2		1.00000
PQ'BA2	*B2		1.00000	*A2		1.00000
PQ'BA2	*BHARV2	-	1.00000	*AHARV2	-	4.00000
PQ'BA3	*P3		1.00000	*Q'3		1.00000
PQ'BA3	*B3		1.00000	*A3		1.00000
PQ'BA3	*BHARV3	-	1.00000	*AHARV3	-	4.00000
P'Q'BA1	*P'1		1.00000	*Q'1		1.00000
P'Q'BA1	*B1		1.00000	*A1		1.00000
P'Q'BA1	*BHARV1	-	1.00000	*AHARV1	-	4.00000
P'Q'BA2	*P'2		1.00000	*Q'2		1.00000
P'Q'BA2	*B2		1.00000	*A2		1.00000

P'Q'BA2	*BHARV2	-	1.00000	*AHARV2	-	4.00000
P'Q'BA3	*P'3		1.00000	*Q'3		1.00000
P'Q'BA3	*B3		1.00000	*A3		1.00000
P'Q'BA3	*BHARV3	-	1.00000	*AHARV3	-	4.00000
BARCON1	*B1		1.00000	*BHARV1	-	1.00000
BARCON2	*B2		1.00000	*BHARV2	-	1.00000
ALFCCN1	*A1		1.00000	*AHARV1	-	4.00000
ALFCON2	*A2		1.00000	*AHARV2	-	4.00000
ALFCON3	*A3		1.00000	*AHARV3	-	4.00000
WEEP3	*WEEP		1.00000	*WEDMAT	-	.13000
WEEP4	*WEEP		1.00000	*WEDMAT	-	.12500
WEEP5	*WEEP		1.00000	*WEDMAT	-	.12000
SHEEP	JUL1		344.00000	JUL2		368.00000
SHEEP	AUG1		344.00000	AUG2		376.46000
SHEEP	SEP1		726.75000	SEP2		726.75000
SHEEP	OCT1		726.75000	OCT2		842.67000
SHEEP	NOV1		368.00000	NOV2		382.72000
SHEEP	DEC1		348.53000	DEC2		372.53000
SHEEP	JAN1		372.53000	JAN2		388.53000
SHEEP	FEB1		348.00000	FEB2		333.23000
SHEEP	MAR1		408.42000	MAR2		395.00000
SHEEP	APR1		448.00000	APR2		448.00000
SHEEP	MAY1		448.00000	MAY2		496.00000
SHEEP	JUN1		375.19000	JUN2		344.00000
SHEEP	JUL		712.00200	AUG		720.46200
SHEEP	SEP		1453.50100	OCT		1569.42200
SHEEP	NOV		750.72900	DEC		721.06200
SHEEP	JAN		761.06200	FEB		681.23100
SHEEP	MAR		803.42900	APR		896.00100
SHEEP	MAY		944.00100	JUN		719.19200
SHEEP	FE/MA		1484.66000	MY/JN		1663.19300
SHEEP	JN2/JL1		688.00000	JN2/AU		1776.46400
SHEEP	JL2/AU1		712.00000	JL2/AU		1088.46200
SHEEP	AU2/SE1		1103.21000	MY/JL1		2007.19300
SHEEP	MY/JL		2375.19500	MY/AU1		2719.19500
SHEEP	MY/AU		3096.65700	MY/SE1		3832.40700
SHEEP	MY/SE		4559.15800	JN/JL1		1063.19200
SHEEP	JN/JL		1431.19400	JN/AU1		1775.1[illegible]400
SHEEP	JN/AU		2151.65600	JN/SE1		2878.40600
SHEEP	JN/SE		3605.15700	JN2/JL		1056.00200
SHEEP	JN2/AU1		1398.00200	JN2/SE1		1503.21400
SHEEP	JN2/SE		2229.96500	JL/AU1		1056.00200
SHEEP	JL/AU		1432.46400	JL/SE1		2159.21400
SHEEP	JL/SE		2885.96500	JL2/SE1		1815.21200
SHEEP	JL2/SE		2541.96300	AU/SE1		1447.21260
SHEEP	AU/SE		2173.96300	AU2/SE		1829.96100
SHEEP	*YRLABOR		10732.09300	OJUL	-	.00200
SHEEP	OAUG	-	.00200	OSEP	-	.00100
SHEEP	OOCT	-	.00200	ONOV	-	.00900
SHEEP	ODEC	-	.00200	OJAN	-	.00100
SHEEP	OFEB	-	.00100	OMAR	-	.00900

SHEEP	OAPR	-	.00100	OMAY	-	.00100
SHEEP	OJUN	-	.00200	OFE/MA	-	.01000
SHEEP	OMY/JN	-	.00300	OJN2/AU	-	.00400
SHEEP	OJL2/AU	-	.00200	*OYLABOR		.03300
SHEEP	WATJUL		2.88100	WATAUG		2.85000
SHEEP	WATSEP		1.97000	WATOCT		2.48700
SHEEP	WATNOV		12.42100	WATDEC		2.24300
SHEEP	WATJAN		1.95900	WATFEB		1.88200
SHEEP	WATMAR		11.49100	WATAPR		1.48800
SHEEP	WATMAY		1.47200	WATJUN		2.92300
SHEEP	*YRWATER		46.05800	*CAPITAL		13344.95200
SHEEP	*LPELTS	-	34.50000	*APELTS	-	17.00000
SHEEP	*WOOL1	-	661.49000	*WOOL2	-	25.42000
SHEEP	*WOOL3	-	23.93000	*WOOL6	-	30.16000
SHEEP	*RAMS	-	1.50000	*EWES	-	24.00000
SHEEP	*WETHERS	-	81.00000	*FLAMBS	-	16.00000
SHEEP	*DRYMJUL		10.36440	*DRYMAUG		13.39650
SHEEP	*DRYMSEP		11.79450	*DRYMOCT		12.43170
SHEEP	*DRYMNOV		11.19420	*DRYMDEC		9.72360
SHEEP	*DRYMJAN		13.03470	*DRYMFEB		12.14370
SHEEP	*DRYMMAR		10.95570	*DRYMAPR		9.89460
SHEEP	*DRYMMAY		10.34910	*DRYMJUN		9.86580
SHEEP	INCOME		16646.12100			
POCT	JAN1		136.00000	FEB1		56.00000
POCT	FEB2		9.66400	SEP		6.75400
POCT	OCT		40.58600	JAN		136.00000
POCT	FEB		65.66400	JUN		3.69600
POCT	FE/MA		65.66400	MY/JN		3.69600
POCT	MY/JL1		3.69600	MY/JL		3.69600
POCT	MY/AU1		3.69600	MY/AU		3.69600
POCT	MY/SE1		3.69600	MY/SE		10.45000
POCT	JN/JL1		3.69600	JN/JL		3.69600
POCT	JN/AU1		3.69600	JN/AU		3.69600
POCT	JN/SE1		3.69600	JN/SE		10.45000
POCT	JL/SE		6.75400	JL2/SE		6.75400
POCT	AU/SE		6.75400	AU2/SE		6.75400
POCT	*YRLABOR		252.70000	OSEP	-	6.75400
POCT	OOCT	-	3.08600	OFEB	-	.06400
POCT	OJUN	-	3.69600	OFE/MA	-	.06400
POCT	OMY/JN	-	3.69600	*OYLABOR		13.60000
POCT	TSEP		6.05000	TOCT		2.75000
POCT	TJUN		3.30000	TMY/JN		3.30000
POCT	TMY/AU1		3.30000	TMY/AU		3.30000
POCT	TMY/SE1		3.30000	TMY/SE		3.30000
POCT	TJN/JL1		3.30000	TJN/JL		3.30000
POCT	TJN/AU1		3.30000	TJN/AU		3.30000
POCT	TJN/SE1		3.30000	TJN/SE		9.35000
POCT	TJN2/SE		6.05000	TJL/SE		6.05000
POCT	TJL2/SE		6.05000	TAU/SE		6.05000
POCT	TAU2/SE		6.05000	PSEP		3.30000
POCT	POCT		2.75000	PJUN		3.30000

POCT	PJN/JL1		3.30000	PJN/JL	3.30000
POCT	PJN/AU1		3.30000	PJN/AU	3.30000
POCT	HSEP		1.65000	KFEB2	3.20000
POCT	*CAPITAL		1906.77700	*POCT	- 1.00000
POCT	*TRACTOR		12.10000	*PLOW	9.35000
POCT	*HARROW		1.65000	*KINK	3.20000
POCT	INCOME	-	1906.77700		
PNOV	JAN2		136.00000	FEB2	56.00000
PNOV	MAR1		9.66400	OCT	6.75400
PNOV	NOV		40.58600	JAN	136.00000
PNOV	FEB		56.00000	MAR	9.66400
PNOV	JUN		3.69600	FE/MA	65.66400
PNOV	MY/JN		3.69600	MY/JL1	3.69600
PNOV	MY/JL		3.69600	MY/AU1	3.69600
PNOV	MY/AU		3.69600	MY/SE1	3.69600
PNOV	MY/SE		3.69600	JN/JL1	3.69600
PNOV	JN/JL		3.69600	JN/AU1	3.69600
PNOV	JN/AU		3.69600	JN/SE1	3.69600
PNOV	JN/SE		3.69600	*YRLABOR	252.70000
PNOV	OMAR1	-	.06400	OOCT	- 6.75400
PNOV	ONOV	-	3.08600	OMAR	- .06400
PNOV	OJUN	-	3.69600	OFE/MA	- .06400
PNOV	OMY/JN	-	3.69600	*OYLABOR	13.60000
PNOV	TOCT		6.05000	TNOV	2.75000
PNOV	TJUN		3.30000	TMY/JN	3.30000
PNOV	TMY/JL1		3.30000	TMY/JL	3.30000
PNOV	TMY/AU1		3.30000	TMY/AU	3.30000
PNOV	TMY/SE1		3.30000	TMY/SE	3.30000
PNOV	TJN/JL1		3.30000	TJN/JL	3.30000
PNOV	TJN/AU1		3.30000	TJN/AU	3.30000
PNOV	TJN/SE1		3.30000	TJN/SE	3.30000
PNOV	POCT		3.30000	PNOV	2.75000
PNOV	PJUN		3.30000	PJN/JL1	3.30000
PNOV	PJN/JL		3.30000	PJN/AU1	3.30000
PNOV	PJN/AU		3.30000	HOCT	1.65000
PNOV	KMAR1		3.20000	*CAPITAL	1906.77700
PNOV	*PNOV	-	1.00000	*TRACTOR	12.10000
PNOV	*PLOW		9.35000	*HARROW	1.65000
PNOV	*KINK		3.20000	INCOME	- 1906.77700
PDEC	FEB1		136.00000	FEB2	56.00000
PDEC	MAR1		9.66400	NOV	6.75400
PDEC	DEC		40.58600	FEB	192.00000
PDEC	MAR		9.64400	JUN	3.69600
PDEC	FE/MA		201.66400	MY/JN	3.69600
PDEC	MY/JL1		3.69600	MY/JL	3.69600
PDEC	MY/AU1		3.69600	MY/AU	3.69600
PDEC	MY/SE1		3.69600	MY/SE	3.69600
PDEC	JN/JL1		3.69600	JN/JL	3.69600
PDEC	JN/AU1		3.69600	JN/AU	3.69600
PDEC	JN/SE1		3.69600	JN/SE	3.69600
PDEC	*YRLABOR		252.70000	ONOV	- 6.75400

PDEC	ODEC	-	3.08600	OMAR	-	.06400
PDEC	OJUN	-	3.69600	OFE/MA	-	.06400
PDEC	OMY/JN	-	3.69600	*OYLABOR		13.60000
PDEC	TNOV		6.05000	TDEC		2.75000
PDEC	TJUN		3.30000	TMY/JN		3.30000
PDEC	TMY/JL1		3.30000	TMY/JL		3.30000
PDEC	TMY/AU1		3.30000	TMY/AU		3.30000
PDEC	TMY/SE1		3.30000	TMY/SE		3.30000
PDEC	TJN/JL1		3.30000	TJN/JL		3.30000
PDEC	TJN/AU1		3.30000	TJN/AU		3.30000
PDEC	TJN/SE1		3.30000	TJN/SE		3.30000
PDEC	PNOV		3.30000	PDEC		2.75000
PDEC	PJUN		3.30000	PJN/JL1		3.30000
PDEC	PJN/JL		3.30000	PJN/AU1		3.30000
PDEC	PJN/AU		3.30000	HNOV		1.65000
PDEC	KMAR1		3.20000	*CAPITAL		1906.77700
PDEC	*PDEC	-	1.00000	*TRACTOR		12.10000
PDEC	*PLOW		9.35000	*HARROW		1.65000
PDEC	*KINK		3.20000	INCOME	-	1906.77700
PJAN	JAN1		40.58600	MAR1		136.00000
PJAN	MAR2		65.66400	DEC		6.75400
PJAN	JAN		40.58600	MAR		201.66400
PJAN	JUN		3.69600	FE/MA		201.66400
PJAN	MY/JN		3.69600	MY/JL1		3.69600
PJAN	MY/JL		3.69600	MY/AU1		3.69600
PJAN	MY/AU		3.69600	MY/SE1		3.69600
PJAN	MY/SE		3.69600	JN/JL1		3.69600
PJAN	JN/JL		3.69600	JN/AU1		3.69600
PJAN	JN/AU		3.69600	JN/SE1		3.69600
PJAN	JN/SE		3.69600	*YRLABOR		252.70000
PJAN	OJAN1	-	3.08600	OMAR2	-	.06400
PJAN	ODEC	-	6.75400	OJAN	-	3.08600
PJAN	OMAR	-	.06400	OJUN	-	3.69600
PJAN	OFE/MA	-	.06400	OMY/JN	-	3.69600
PJAN	*OYLABOR		13.60000	TJAN1		2.75000
PJAN	TDEC		6.05000	TJAN		2.75000
PJAN	TJUN		3.30000	TMY/JN		3.30000
PJAN	TMY/JL1		3.30000	TMY/JL		3.30000
PJAN	TMY/AU1		3.30000	TMY/AU		3.30000
PJAN	TMY/SE1		3.30000	TMY/SE		3.30000
PJAN	TJN/JL1		3.30000	TJN/JL		3.30000
PJAN	TJN/AU1		3.30000	TJN/AU		3.30000
PJAN	TJN/SE1		3.30000	TJN/SE		3.30000
PJAN	PJAN1		2.75000	PDEC		3.30000
PJAN	PJAN		2.75000	PJUN		3.30000
PJAN	PJN/JL1		3.30000	PJN/JL		3.30000
PJAN	PJN/AU1		3.30000	PJN/AU		3.30000
PJAN	HDEC		1.65000	KMAR2		3.20000
PJAN	*CAPITAL		1906.77700	*PJAN	-	1.00000
PJAN	*TRACTOR		12.10000	*PLOW		9.35000
PJAN	*HARROW		1.65000	*KINK		3.20000

PJAN	INCOME	-	1906.77700		
QSEP	JUL		3.69600	AUG	6.75400
QSEP	SEP		32.46400	DEC	48.00000
QSEP	JAN		80.00000	JN2/AU	3.69600
QSEP	MY/JL		3.69600	MY/AU1	3.69600
QSEP	MY/AU		10.45000	MY/SE1	10.45000
QSEP	MY/SE		42.41900	JN/JL	3.69600
QSEP	JN/AU1		3.69600	JN/AU	10.45000
QSEP	JN/SE1		10.45000	JN/SE	42.91400
QSEP	JN2/JL		3.69600	JN2/AU1	3.69600
QSEP	JN2/SE1		10.45000	JN2/SE	42.91400
QSEP	JL/AU1		3.69600	JL/AU	10.45000
QSEP	JL/SE1		10.45000	JL/SE	42.91400
QSEP	JL2/SE1		6.75400	JL2/SE	32.46400
QSEP	AU/SE1		6.75400	AU/SE	32.46400
QSEP	AU2/SE		32.46400	*YRLABOR	170.91400
QSEP	OJUL	-	3.69600	OAUG	- 6.75400
QSEP	OSEP	-	2.46400	OJN2/AU	- 10.45000
QSEP	OJL2/AU	-	6.75400	*OYLABOR	12.91400
QSEP	TJUL		3.30000	TAUG	6.05000
QSEP	TSEP		2.20000	TJL2/AU	6.05000
QSEP	TMY/JL		3.30000	TMY/AU1	3.30000
QSEP	TMY/AU		9.35000	TMY/SE1	9.35000
QSEP	TMY/SE		11.55000	TJN/JL	3.30000
QSEP	TJN/AU1		3.30000	TJN/AU	9.35000
QSEP	TJN/SE1		9.35000	TJN/SE	11.55000
QSEP	TJN2/JL		3.30000	TJN2/AU1	3.30000
QSEP	TJN2/AU		9.35000	TJN2/SE1	9.35000
QSEP	TJN2/SE		11.55000	TJL/AU1	3.30000
QSEP	TJL/AU		9.35000	TJL/SE1	9.35000
QSEP	TJL/SE		11.55000	TJL2/SE1	6.05000
QSEP	TJL2/SE		8.25000	TAU/SE1	6.05000
QSEP	TAU/SE		8.25000	TAU2/SE	2.20000
QSEP	PJUL		3.30000	PAUG	3.30000
QSEP	PSEP		2.20000	PJN/JL	3.30000
QSEP	PJN/AU1		3.30000	PJN/AU	6.60000
QSEP	PJN/SE1		6.60000	PJN/SE	8.80000
QSEP	PJN2/JL		3.30000	PJN2/AU1	3.30000
QSEP	PJN2/AU		6.60000	PJN2/SE1	6.60000
QSEP	PJN2/SE		8.80000	PJL/AU1	3.30000
QSEP	PJL/AU		6.60000	PJL/SE1	6.60000
QSEP	PJL/SE		8.80000	PJL2/AU	3.30000
QSEP	PJL2/SE1		3.30000	PJL2/SE	5.50000
QSEP	PAU/SE1		3.30000	PAU/SE	5.50000
QSEP	PAU2/SE		2.20000	HAUG	1.65000
QSEP	HJL2/AU		1.65000	*CAPITAL	195.42000
QSEP	*QSEP	-	1.00000	*TRACTOR	11.55000
QSEP	*PLOW		8.80000	*HARROW	1.65000
QSEP	INCOME	-	195.42000		
QOCT	JAN1		48.00000	JAN2	80.00000
QOCT	JUL		3.69600	SEP	6.75400

QOCT	OCT		32.46400	JAN	128.00000
QOCT	JN2/AU		3.69600	MY/JL	3.69600
QOCT	MY/AU1		3.69600	MY/AU	3.69600
QOCT	MY/SE1		3.69600	MY/SE	10.45000
QOCT	JN/JL		3.69600	JN/AU1	3.69600
QOCT	JN/AU		3.69600	JN/SE1	3.69600
QOCT	JN/SE		10.45000	JN2/JL	3.69600
QOCT	JN2/AU1		3.69600	JN2/SE1	3.69600
QOCT	JN2/SE		10.45000	JL/AU1	3.69600
QOCT	JL/AU		3.69600	JL/SE1	3.69600
QOCT	JL/SE		10.45000	JL2/SE	6.75400
QOCT	AU/SE		6.75400	AU2/SE	6.75400
QOCT	*YRLABOR		170.91400	OJUL	- 3.69600
QOCT	OSEP	-	6.75400	OOCT	- 2.46400
QOCT	OJN2/AU	-	3.69600	*OYLABOR	12.91400
QOCT	TJUL		3.30000	TSEP	6.05000
QOCT	TOCT		2.20000	TMY/JL	3.30000
QOCT	TMY/AU1		3.30000	TMY/AU	3.30000
QOCT	TMY/SE1		3.30000	TMY/SE	9.35000
QOCT	TJN/JL		3.30000	TJN/AU1	3.30000
QOCT	TJN/AU		3.30000	TJN/SE1	3.30000
QOCT	TJN/SE		9.35000	TJN2/JL	3.30000
QOCT	TJN2/AU1		3.30000	TJN2/AU	3.30000
QOCT	TJN2/SE1		3.30000	TJN2/SE	9.35000
QOCT	TJL/AU1		3.30000	TJL/AU	3.30000
QOCT	TJL/SE1		3.30000	TJL/SE	9.35000
QOCT	TJL2/SE		6.05000	TAU/SE	6.05000
QOCT	TAU2/SE		6.05000	PJUL	3.30000
QOCT	PSEP		3.30000	POCT	2.20000
QOCT	PJN/AU1		3.30000	PJN/AU	3.30000
QOCT	PJN2/JL		3.30000	PJN2/AU1	3.30000
QOCT	PJN2/AU		3.30000	PJL/AU1	3.30000
QOCT	PJL/AU		3.30000	HSEP	1.65000
QOCT	*CAPITAL		195.42000	*QOCT	- 1.00000
QOCT	*TRACTOR		11.55000	*PLOW	8.80000
QOCT	*HARROW		1.65000	INCOME	- 195.42000
HJLAU	NOV		56.00000	DEC	57.66400
HJLAU	MAY		3.69600	MY/JN	3.69600
HJLAU	JN2/JL1		6.75400	JN2/AU	39.21800
HJLAU	JL2/AU		32.46400	MY/JL1	6.75400
HJLAU	MY/JL		10.45000	MY/AU1	10.45000
HJLAU	MY/AU		43.91400	MY/SE1	43.91400
HJLAU	MY/SE		43.91400	JN/JL1	6.75400
HJLAU	JN/JL		6.75400	JN/AU1	6.75400
HJLAU	JN/AU		39.21800	JN/SE1	39.21800
HJLAU	JN/SE		39.21800	JN2/JL	6.75400
HJLAU	JN2/AU1		6.75400	JN2/SE1	39.21800
HJLAU	JN2/SE		39.21800	JL/AU	32.46400
HJLAU	JL/SE1		32.46400	JL/SE	32.46400
HJLAU	JL2/SE1		32.46400	JL2/SE	32.46400
HJLAU	*YRLABOR		156.57800	ODEC	- .06400

HJLAU	OMAY	-	3.69600	OMY/JN	-	3.69600
HJLAU	OJN2/JL1	-	6.75400	OJN2/AU	-	6.75400
HJLAU	OJL2/AU	-	2.46400	*OYLABOR		12.97800
HJLAU	TMAY		3.30000	TMY/JN		3.30000
HJLAU	TJN2/JL1		6.05000	TJL2/AU		2.20000
HJLAU	TMY/JL1		9.35000	TMY/JL		9.35000
HJLAU	TMY/AU1		9.35000	TMY/AU		11.55000
HJLAU	TMY/SE1		11.55000	TMY/SE		11.55000
HJLAU	TJN/JL1		6.05000	TJN/JL		6.05000
HJLAU	TJN/AU1		6.05000	TJN/AU		8.25000
HJLAU	TJN/SE1		8.25000	TJN/SE		8.25000
HJLAU	TJN2/JL		6.05000	TJN2/AU1		6.05000
HJLAU	TJN2/AU		8.25000	TJN2/SE1		8.25000
HJLAU	TJN2/SE		8.25000	TJL/AU		2.20000
HJLAU	TJL/SE1		2.20000	TJL/SE		2.20000
HJLAU	TJL2/SE1		2.20000	TJL2/SE		2.20000
HJLAU	PMAY		3.30000	PJN2/JL1		3.30000
HJLAU	PJL2/AU		2.20000	PJN/JL1		3.30000
HJLAU	PJN/JL		3.30000	PJN/AU1		3.30000
HJLAU	PJN/AU		5.50000	PJN/SE1		5.50000
HJLAU	PJN/SE		5.50000	PJN2/JL		3.30000
HJLAU	PJN2/AU1		3.30000	PJN2/AU		5.50000
HJLAU	PJN2/SE1		5.50000	PJN2/SE		5.50000
HJLAU	HJN2/JL1		1.65000	KDEC		3.20000
HJLAU	*CAPITAL		530.51700	*HJLAU	-	1.00000
HJLAU	*TRACTOR		11.55000	*PLOW		8.80000
HJLAU	*HARROW		1.65000	*KINK		3.20000
HJLAU	INCOME	-	530.51700			
HAUSE	NOV		56.00000	DEC		57.66400
HAUSE	MAY		3.69600	MY/JN		3.69600
HAUSE	JN2/AU		6.75400	JL2/AU1		6.75400
HAUSE	JL2/AU		6.75400	AU2/SE1		32.46400
HAUSE	MY/AU1		10.45000	MY/AU		10.45000
HAUSE	MY/SE1		43.91400	MY/SE		43.91400
HAUSE	JN/AU1		6.75400	JN/AU		6.75400
HAUSE	JN/SE1		39.21800	JN/SE		39.21800
HAUSE	JN2/AU1		6.75400	JN2/SE1		39.21800
HAUSE	JN2/SE		39.21800	JL/AU1		6.75400
HAUSE	JL/AU		6.75400	JL/SE1		39.21800
HAUSE	JL/SE		39.21800	JL2/SE1		39.21800
HAUSE	JL2/SE		39.21800	AU/SE1		32.46400
HAUSE	AU/SE		32.46400	AU2/SE		32.46400
HAUSE	*YRLABOR		155.57800	ODEC	-	.06400
HAUSE	OMAY	-	3.69600	OMY/JN	-	3.69600
HAUSE	OJN2/AU	-	6.75400	OJL2/AU1	-	6.75400
HAUSE	OJL2/AU	-	6.75400	OAU2/SE1	-	2.46400
HAUSE	*OYLABOR		12.97800	TMAY		3.30000
HAUSE	TMY/JN		3.30000	TJL2/AU1		6.05000
HAUSE	TJL2/AU		6.05000	TAU2/SE1		2.20000
HAUSE	TMY/JL1		3.30000	TMY/JL		3.30000
HAUSE	TMY/AU1		9.35000	TMY/AU		9.35000

HAUSE	TMY/SE1		11.55000	TMY/SE	11.55000
HAUSE	TJN/AU1		6.05000	TJN/AU	6.05000
HAUSE	TJN/SE1		8.25000	TJN/SE	8.25000
HAUSE	TJN2/AU1		6.05000	TJN2/AU	6.05000
HAUSE	TJN2/SE1		8.25000	TJN2/SE	8.25000
HAUSE	TJL/AU1		6.05000	TJL/AU	6.05000
HAUSE	TJL/SE1		8.25000	TJL/SE	8.25000
HAUSE	TJL2/SE1		8.25000	TJL2/SE	8.25000
HAUSE	TAU/SE1		2.20000	TAU/SE	2.20000
HAUSE	TAU2/SE		2.20000	PMAY	3.30000
HAUSE	PJL2/AU1		3.30000	PAU2/SE1	2.20000
HAUSE	PJN/AU1		3.30000	PJN/AU	3.30000
HAUSE	PJN/SE1		5.50000	PJN/SE	5.50000
HAUSE	PJN2/AU1		3.30000	PJN2/AU	3.30000
HAUSE	PJN2/SE1		5.50000	PJN2/SE	5.50000
HAUSE	PJL/AU1		3.30000	PJL/AU	3.30000
HAUSE	PJL/SE1		5.50000	PJL/SE	5.50000
HAUSE	PJL2/AU		3.30000	PJL2/SE1	5.50000
HAUSE	PJL2/SE		5.50000	HJL2/AU1	1.65000
HAUSE	HJL2/AU		1.65000	KDEC	3.20000
HAUSE	*CAPITAL		530.51700	*HAUSE	- 1.00000
HAUSE	*TRACTOR		11.55000	*PLOW	8.80000
HAUSE	*HARROW		1.65000	*KINK	3.20000
HAUSE	INCOME	-	530.51700		
BARL	NOV		6.75400	DEC	48.00000
BARL	JAN		32.00000	JUN	3.69600
BARL	MY/JN		3.69600	JN2/JL1	3.69600
BARL	JN2/AU		3.69600	MY/JL1	3.69600
BARL	MY/JL		3.69600	MY/AU1	3.69600
BARL	MY/AU		3.69600	MY/SE1	3.69600
BARL	MY/SE		3.69600	JN/JL1	3.69600
BARL	JN/JL		3.69600	JN/AU1	3.69600
BARL	JN/AU		3.69600	JN/SE1	3.69600
BARL	JN/SE		3.69600	*YRLABOR	90.45000
BARL	ONOV	-	6.75400	OJUN	- 3.69600
BARL	OMY/JN	-	3.69600	*OYLABOR	10.45000
BARL	TNOV		6.05000	TJUN	3.30000
BARL	TMY/JN		3.30000	TMY/JL1	3.30000
BARL	TMY/JL		3.30000	TMY/AU1	3.30000
BARL	TMY/AU		3.30000	TMY/SE1	3.30000
BARL	TMY/SE		15.95000	TJN/JL1	3.30000
BARL	TJN/JL		3.30000	TJN/AU1	3.30000
BARL	TJN/AU		3.30000	TJN/SE1	3.30000
BARL	TJN/SE		15.95000	PNOV	3.30000
BARL	PJUN		3.30000	PJN/JL1	3.30000
BARL	PJN/JL		3.30000	PJN/AU1	3.30000
BARL	PJN/AU		3.30000	PJN2/JL	3.30000
BARL	PJN/SE1		3.30000	PJN/SE	3.30000
BARL	HNOV		1.65000	*CAPITAL	356.57000
BARL	*B	-	1.00000	*TRACTOR	9.35000
BARL	*PLOW		6.60000	*HARROW	1.65000

BARL	INCOME	-	356.57000		
ALFAL	SEP		80.67400	OCT	111.69700
ALFAL	NOV		75.24000	DEC	63.88000
ALFAL	JAN		20.82100	FEB	69.13800
ALFAL	JUN		3.69600	FE/MA	69.13800
ALFAL	MY/JN		3.69600	MY/JL1	3.69600
ALFAL	MY/JL		3.69600	MY/AU1	3.69600
ALFAL	MY/AU		3.69600	MY/SE1	3.69600
ALFAL	MY/SE		84.37000	JN/JL1	3.69600
ALFAL	JN/JL		3.69600	JN/AU1	3.69600
ALFAL	JN/SE		84.37000	JN2/SE	80.67400
ALFAL	JL/SE		80.67400	JL2/SE	80.67400
ALFAL	AU/SE		80.67400	JN/AU	3.69600
ALFAL	JN/SE1		3.69600	AU2/SE	80.67400
ALFAL	*YRLABOR		425.14600	OSEP	- 15.49000
ALFAL	OOCT	-	2.25700	ONOV	- 1.52000
ALFAL	ODEC	-	1.28600	OJAN	- .42100
ALFAL	OFEB	-	1.33800	OJUN	- 3.69600
ALFAL	OMY/JN	-	3.69600	*OYLABOR	26.00800
ALFAL	WATSEP		452.59700	WATOCT	607.91100
ALFAL	WATNOV		409.48300	WATDEC	346.39700
ALFAL	WATJAN		113.46000	WATFEB	376.74000
ALFAL	*YRWATER		2306.58800	TSEP	12.65000
ALFAL	TJUN		3.30000	TMY/JN	3.30000
ALFAL	TMY/JL1		3.30000	TMY/JL	3.30000
ALFAL	TMY/AU1		3.30000	TMY/AU	3.30000
ALFAL	TMY/SE1		3.30000	TMY/SE	15.95000
ALFAL	TJN/JL1		3.30000	TJN/JL	3.30000
ALFAL	TJN/AU1		3.30000	TJN/AU	3.30000
ALFAL	TJN/SE1		3.30000	TJN/SE	15.95000
ALFAL	TJN2/JL		3.30000	TJN2/AU1	3.30000
ALFAL	TJN2/AU		3.30000	TJN2/SE1	3.30000
ALFAL	TJN2/SE		15.95000	TJL/SE	12.65000
ALFAL	TJL2/SE		12.65000	TAU/SE	12.65000
ALFAL	TAU2/SE		12.65000	PSEP	3.30000
ALFAL	PJUN		3.30000	PJN/JL1	3.30000
ALFAL	PJN/JL		3.30000	PJN/AU1	3.30000
ALFAL	PJN/AU		3.30000	HSEP	1.65000
ALFAL	*CAPITAL		444.40000	*A	- 1.00000
ALFAL	*TRACTOR		15.95000	*PLOW	6.60000
ALFAL	*HARROW		1.65000	INCOME	- 444.40000
WEEP	NOV		6.75400	DEC	48.00000
WEEP	JAN		128.00000	JUN	3.69600
WEEP	MY/JN		3.69600	MY/JL1	3.69600
WEEP	MY/JL		3.69600	MY/AU1	3.69600
WEEP	MY/AU		3.69600	MY/SE1	3.69600
WEEP	MY/SE		3.69600	JN/JL1	3.69600
WEEP	JN/JL		3.69600	JN/AU1	3.69600
WEEP	JN/AU		3.69600	JN/SE1	3.69600
WEEP	JN/SE		3.69600	*YRLABOR	186.45000
WEEP	ONOV	-	6.75400	OJUN	- 3.69600

WEEP	OMY/JN	-	3.69600	*DYLABOR		10.45000
WEEP	TNOV		6.05000	TJUN		3.30000
WEEP	TMY/JN		3.30000	TMY/JL1		3.30000
WEEP	TMY/JL		3.30000	TMY/AU1		3.30000
WEEP	TMY/AU		3.30000	TMY/SE1		3.30000
WEEP	TMY/SE		3.30000	TJN/JL1		3.30000
WEEP	TJN/JL		3.30000	TJN/AU1		3.30000
WEEP	TJN/AU		3.30000	TJN/SE1		3.30000
WEEP	TJN/SE		3.30000	PNOV		3.30000
WEEP	PJUN		3.30000	PJN/JL1		3.30000
WEEP	PJN/JL		3.30000	PJN/AU1		3.30000
WEEP	PJN/AU		3.30000	HNOV		1.65000
WEEP	*CAPITAL		931.24500	*WEEP	-	1.00000
WEEP	*TRACTOR		9.35000	*PLOW		6.60000
WEEP	*HARROW		1.65000	INCOME	-	931.24500
POCT1	LAND1		1.00000	*POCT		1.00000
POCT1	*P1	-	1.00000	*PHARV	-	210.00000
POCT1	*LANDUSE		1.00000			
POCT2	LAND2		1.00000	*POCT		1.00000
POCT2	*P2	-	1.00000	*PHARV	-	173.00000
POCT2	*LANDUSE		1.00000			
POCT3	LAND3		1.00000	*POCT		1.00000
POCT3	*P3	-	1.00000	*PHARV	-	100.00000
POCT3	*LANDUSE		1.00000			
PNOV1	LAND1		1.00000	*PNOV		1.00000
PNOV1	*P1	-	1.00000	*PHARV	-	205.00000
PNOV1	*LANDUSE		1.00000			
PNOV2	LAND2		1.00000	*PNOV		1.00000
PNOV2	*P2	-	1.00000	*PHARV	-	169.00000
PNOV2	*LANDUSE		1.00000			
PNOV3	LAND3		1.00000	*PNOV		1.00000
PNOV3	*P3	-	1.00000	*PHARV	-	98.00000
PNOV3	*LANDUSE		1.00000			
PDEC1	LAND1		1.00000	*PDEC		1.00000
PDEC1	*P1	-	1.00000	*PHARV	-	200.00000
PDEC1	*LANDUSE		1.00000			
PDEC2	LAND2		1.00000	*PDEC		1.00000
PDEC2	*P2	-	1.00000	*PHARV	-	165.00000
PDEC2	*LANDUSE		1.00000			
PDEC3	LAND3		1.00000	*PDEC		1.00000
PDEC3	*P3	-	1.00000	*PHARV	-	96.00000
PDEC3	*LANDUSE		1.00000			
PJAN1	LAND1		1.00000	*PJAN		1.00000
PJAN1	*P1	-	1.00000	*PHARV	-	195.00000
PJAN1	*LANDUSE		1.00000			
PJAN2	LAND2		1.00000	*PJAN		1.00000
PJAN2	*P2	-	1.00000	*PHARV	-	161.00000
PJAN2	*LANDUSE		1.00000			
PJAN3	LAND3		1.00000	*PJAN		1.00000
PJAN3	*P3	-	1.00000	*PHARV	-	94.00000
PJAN3	*LANDUSE		1.00000			

P*OCT1	LAND1	1.00000	[illegible]	1.00000
P*OCT1	*P*1	1.00000	[illegible]	270.00000
P*OCT1	*LANDUSE	1.00000	NOW	4.80900
P*OCT1	DEC	11.28400	FER	28.70800
P*OCT1	FERMA	28.70800	[illegible]	44.80100
P*OCT1	ONGV	.09700	DEC	.22900
P*OCT1	OFER	.58000	[illegible]	.90500
P*OCT1	WATNOW	130.99700	WATDEC	107.05400
P*OCT1	WATFER	781.28600	[illegible]	1219.33700
P*OCT2	LAND2	1.00000	[illegible]	1.00000
P*OCT2	*P*2	1.00000	[illegible]	270.00000
P*OCT2	*LANDUSE	1.00000	NOW	4.80900
P*OCT2	DEC	11.28400	FER	28.70800
P*OCT2	FERMA	28.70800	[illegible]	44.80100
P*OCT2	ONGV	.09700	DEC	.22900
P*OCT2	OFER	.58000	[illegible]	.90500
P*OCT2	WATNOW	130.99700	WATDEC	107.05400
P*OCT2	WATFER	781.28600	[illegible]	1219.33700
P*OCT3	LAND3	1.00000	[illegible]	1.00000
P*OCT3	*P*3	1.00000	[illegible]	270.00000
P*OCT3	*LANDUSE	1.00000	NOW	4.80900
P*OCT3	DEC	11.28400	FER	28.70800
P*OCT3	FERMA	28.70800	[illegible]	44.80100
P*OCT3	ONGV	.09700	DEC	.22900
P*OCT3	OFER	.58000	[illegible]	.90500
P*OCT3	WATNOW	130.99700	WATDEC	107.05400
P*OCT3	WATFER	781.28600	[illegible]	1219.33700
P*NOV1	LAND1	1.00000	[illegible]	1.00000
P*NOV1	*P*1	1.00000	[illegible]	270.00000
P*NOV1	*LANDUSE	1.00000	NOW	4.80900
P*NOV1	DEC	11.28400	FER	28.70800
P*NOV1	FERMA	28.70800	[illegible]	44.80100
P*NOV1	ONGV	.09700	DEC	.22900
P*NOV1	OFER	.58000	[illegible]	.90500
P*NOV1	WATNOW	130.99700	WATDEC	107.05400
P*NOV1	WATFER	781.28600	[illegible]	1219.33700
P*NOV2	LAND2	1.00000	[illegible]	1.00000
P*NOV2	*P*2	1.00000	[illegible]	270.00000
P*NOV2	*LANDUSE	1.00000	NOW	4.80900
P*NOV2	DEC	11.28400	FER	28.70800
P*NOV2	FERMA	28.70800	[illegible]	44.80100
P*NOV2	ONGV	.09700	DEC	.22900
P*NOV2	OFER	.58000	[illegible]	.90500
P*NOV2	WATNOW	130.99700	WATDEC	107.05400
P*NOV2	WATFER	781.28600	[illegible]	1219.33700
P*NOV3	LAND3	1.00000	[illegible]	1.00000
P*NOV3	*P*3	1.00000	[illegible]	270.00000
P*NOV3	*LANDUSE	1.00000	NOW	4.80900
P*NOV3	DEC	11.28400	FER	28.70800
P*NOV3	FERMA	28.70800	[illegible]	44.80100
P*NOV3	ONGV	.09700	DEC	.22900

P'NOV3	OFEB	-	.58000	*OYLABOR	-	.90500
P'NOV3	WATNOV		130.99700	WATDEC		307.05400
P'NOV3	WATFEB		781.28600	*YRWATER		1219.33700
P'DEC1	LAND1		1.00000	*P'1	-	1.00000
P'DEC1	*PHARV	-	260.00000	*LANDUSE		1.00000
P'DEC1	FEB		30.14500	FE/MA		30.14500
P'DEC1	*YRLABOR		30.14500	OFEB	-	.60900
P'DEC1	*OYLABOR		.60900	WATFEB		820.33700
P'DEC1	*YRWATER		820.33700	*PDEC		1.00000
P'DEC2	LAND2		1.00000	*P'2	-	1.00000
P'DEC2	*PHARV	-	215.00000	*LANDUSE		1.00000
P'DEC2	FEB		30.14500	FE/MA		30.14500
P'DEC2	*YRLABOR		30.14500	OFEB	-	.60900
P'DEC2	*OYLABOR		.60900	WATFEB		820.33700
P'DEC2	*YRWATER		820.33700	*PDEC		1.00000
P'DEC3	LAND3		1.00000	*P'3	-	1.00000
P'DEC3	*PHARV	-	125.00000	*LANDUSE		1.00000
P'DEC3	FEB		30.14500	FE/MA		30.14500
P'DEC3	*YRLABOR		30.14500	OFEB	-	.60900
P'DEC3	*OYLABOR		.60900	WATFEB		820.33700
P'DEC3	*YRWATER		820.33700	*PDEC		1.00000
P'JAN1	LAND1		1.00000	*P'1	-	1.00000
P'JAN1	*PHARV	-	255.00000	*LANDUSE		1.00000
P'JAN1	FEB		30.14500	FE/MA		30.14500
P'JAN1	*YRLABOR		30.14500	OFEB	-	.60900
P'JAN1	*OYLABOR		.60900	WATFEB		820.33700
P'JAN1	*YRWATER		820.33700	*PJAN		1.00000
P'JAN2	LAND2		1.00000	*P'2	-	1.00000
P'JAN2	*PHARV	-	211.00000	*LANDUSE		1.00000
P'JAN2	FEB		30.14500	FE/MA		30.14500
P'JAN2	*YRLABOR		30.14500	OFEB	-	.60900
P'JAN2	*OYLABOR		.60900	WATFEB		820.33700
P'JAN2	*YRWATER		820.33700	*PJAN		1.00000
P'JAN3	LAND3		1.00000	*P'3	-	1.00000
P'JAN3	*PHARV	-	122.00000	*LANDUSE		1.00000
P'JAN3	FEB		30.14500	FE/MA		30.14500
P'JAN3	*YRLABOR		30.14500	OFEB	-	.60900
P'JAN3	*OYLABOR		.60900	WATFEB		820.33700
P'JAN3	*YRWATER		820.33700	*PJAN		1.00000
QSEP1	LAND1		1.00000	*QSEP		1.00000
QSEP1	*Q1	-	1.00000	*QHARV	-	35.00000
QSEP1	*LANDUSE		1.00000			
QSEP2	LAND2		1.00000	*QSEP		1.00000
QSEP2	*Q2	-	1.00000	*QHARV	-	30.00000
QSEP2	*LANDUSE		1.00000			
QSEP3	LAND3		1.00000	*QSEP		1.00000
QSEP3	*Q3	-	1.00000	*QHARV	-	20.00000
QSEP3	*LANDUSE		1.00000			
QOCT1	LAND1		1.00000	*QOCT		1.00000
QOCT1	*Q1	-	1.00000	*QHARV	-	35.00000
QOCT1	*LANDUSE		1.00000			

QOCT2	LAND2		1.00000	*QOCT		1.00000
QOCT2	*Q2	-	1.00000	*QHARV	-	30.00000
QOCT2	*LANDUSE		1.00000			
QOCT3	LAND3		1.00000	*QOCT		1.00000
QOCT3	*Q3	-	1.00000	*QHARV	-	20.00000
QOCT3	*LANDUSE		1.00000			
Q'SEP1	LAND1		1.00000	*QSEP		1.00000
Q'SEP1	*Q'1	-	1.00000	*QHARV	-	45.00000
Q'SEP1	*LANDUSE		1.00000	NOV		41.66600
Q'SEP1	FEB		7.25800	FE/MA		7.25800
Q'SEP1	*YRLABOR		48.92400	ONOV	-	.67600
Q'SEP1	OFEB	-	.11800	OFE/MA	-	.11800
Q'SEP1	*OYLABOR		.79400	WATNOV		910.82200
Q'SEP1	WATFEB		158.75200	*YRWATER		1069.57400
Q'SEP1	ZNOV		4.09900	ZFEB		.71400
Q'SEP1	*ZPRINK		4.81300			
Q'SEP2	LAND2		1.00000	*QSEP		1.00000
Q'SEP2	*Q'2	-	1.00000	*QHARV	-	38.00000
Q'SEP2	*LANDUSE		1.00000	NOV		41.66600
Q'SEP2	FEB		7.25800	FE/MA		7.25800
Q'SEP2	*YRLABOR		48.92400	ONOV	-	.67600
Q'SEP2	OFEB	-	.11800	OFE/MA	-	.11800
Q'SEP2	*OYLABOR		.79400	WATNOV		910.82200
Q'SEP2	WATFEB		158.75200	*YRWATER		1069.57400
Q'SEP2	ZNOV		4.09900	ZFEB		.71400
Q'SEP2	*ZPRINK		4.81300			
Q'SEP3	LAND3		1.00000	*QSEP		1.00000
Q'SEP3	*Q'3	-	1.00000	*QHARV	-	25.00000
Q'SEP3	*LANDUSE		1.00000	NOV		41.66600
Q'SEP3	FEB		7.25800	FE/MA		7.25800
Q'SEP3	*YRLABOR		48.92400	ONOV	-	.67600
Q'SEP3	OFEB	-	.11800	OFE/MA	-	.11800
Q'SEP3	*OYLABOR		.79400	WATNOV		910.82200
Q'SEP3	WATFEB		158.75200	*YRWATER		1069.57400
Q'SEP3	ZNOV		4.09900	ZFEB		.71400
Q'SEP3	*ZPRINK		4.81300			
Q'OCT1	LAND1		1.00000	*QOCT		1.00000
Q'OCT1	*Q'1	-	1.00000	*QHARV	-	45.00000
Q'OCT1	*LANDUSE		1.00000	NOV		41.66600
Q'OCT1	FEB		7.25800	FE/MA		7.25800
Q'OCT1	*YRLABOR		48.92400	ONOV	-	.67600
Q'OCT1	OFEB	-	.11800	OFE/MA	-	.11800
Q'OCT1	*OYLABOR		.79400	WATNOV		910.82200
Q'OCT1	WATFEB		158.75200	*YRWATER		1069.57400
Q'OCT1	ZNOV		4.09900	ZFEB		.71400
Q'OCT1	*ZPRINK		4.81300			
Q'OCT2	LAND2		1.00000	*QOCT		1.00000
Q'OCT2	*Q'2	-	1.00000	*QHARV	-	38.00000
Q'OCT2	*LANDUSE		1.00000	NOV		41.66600
Q'OCT2	FEB		7.25800	FE/MA		7.25800
Q'OCT2	*YRLABOR		48.92400	ONOV	-	.67600

Q'OCT2	OFEB	-	.11800	OFE/MA	-	.11800
Q'OCT2	*OYLABOR		.79400	WATNOV		910.82200
Q'OCT2	WATFEB		158.75200	*YRWATER		1069.57400
Q'OCT2	ZNOV		4.09900	ZFEB		.71400
Q'OCT2	*ZPRINK		4.81300			
Q'OCT3	LAND3		1.00000	*QOCT		1.00000
Q'OCT3	*Q'3	-	1.00000	*QHARV	-	25.00000
Q'OCT3	*LANDUSE		1.00000	NOV		41.66600
Q'OCT3	FEB		7.25800	FE/MA		7.25800
Q'OCT3	*YRLABOR		48.92400	ONOV	-	.67600
Q'OCT3	OFEB	-	.11800	OFE/MA	-	.11800
Q'OCT3	*OYLABOR		.79400	WATNOV		910.82200
Q'OCT3	WATFEB		158.75200	*YRWATER		1069.57400
Q'OCT3	ZNOV		4.09900	ZFEB		.71400
Q'OCT3	*ZPRINK		4.81300			
HJLAU1	LAND1		1.00000	*HJLAU		1.00000
HJLAU1	*H1	-	1.00000	*HJLAU1	-	1.00000
HJLAU1	*LANDUSE		1.00000			
HJLAU2	LAND2		1.00000	*HJLAU		1.00000
HJLAU2	*H2	-	1.00000	*HJLAU2	-	1.00000
HJLAU2	*LANDUSE		1.00000			
HJLAU3	LAND3		1.00000	*HJLAU		1.00000
HJLAU3	*H3	-	1.00000	*HJLAU3	-	1.00000
HJLAU3	*LANDUSE		1.00000			
HAUSE1	LAND1		1.00000	*HAUSE		1.00000
HAUSE1	*H1	-	1.00000	*HAUSE1	-	1.00000
HAUSE1	*LANDUSE		1.00000			
HAUSE2	LAND2		1.00000	*HAUSE		1.00000
HAUSE2	*H2	-	1.00000	*HAUSE2	-	1.00000
HAUSE2	*LANDUSE		1.00000			
HAUSE3	LAND3		1.00000	*HAUSE		1.00000
HAUSE3	*H3	-	1.00000	*HAUSE3	-	1.00000
HAUSE3	*LANDUSE		1.00000			
BAR1	LAND1		1.00000	*B		1.00000
BAR1	*B1	-	1.00000	*LANDUSE		1.00000
BAR2	LAND2		1.00000	*B		1.00000
BAR2	*B2	-	1.00000	*LANDUSE		1.00000
BAR3	LAND3		1.00000	*B		1.00000
BAR3	*B3	-	1.00000	*LANDUSE		1.00000
ALF1	LAND1		5.00000	*A		1.00000
ALF1	*A1	-	1.00000	*LANDUSE		5.00000
ALF2	LAND2		5.00000	*A		1.00000
ALF2	*A2	-	1.00000	*LANDUSE		5.00000
ALF3	LAND3		5.00000	*A		1.00000
ALF3	*A3	-	1.00000	*LANDUSE		5.00000
GHHJLAU1	*HJLAU1		1.00000	*HFORGH	-	160.00000
GHHJLAU2	*HJLAU2		1.00000	*HFORGH	-	133.00000
GHHJLAU3	*HJLAU3		1.00000	*HFORGH	-	80.00000
GHHAUSE1	*HAUSE1		1.00000	*HFORGH	-	155.00000
GHHAUSE2	*HAUSE2		1.00000	*HFORGH	-	129.00000
GHHAUSE3	*HAUSE3		1.00000	*HFORGH	-	77.00000

DHHJLAU1	*HJLAU1	1.00000	*HFORDH	-	45.00000
DHHJLAU2	*HJLAU2	1.00000	*HFORDH	-	37.00000
DHHJLAU3	*HJLAU3	1.00000	*HFORDH	-	22.00000
DHHAUSE1	*HAUSE1	1.00000	*HFORDH	-	43.00000
DHHAUSE2	*HAUSE2	1.00000	*HFORDH	-	36.00000
DHHAUSE3	*HAUSE3	1.00000	*HFORDH	-	21.00000
BSIL1	*BHARV1	1.00000	*BFORSIL	-	400.00000
BSIL2	*BHARV2	1.00000	*BFORSIL	-	330.00000
BSIL3	*BHARV3	1.00000	*BFORSIL	-	190.00000
BHAY1	*BHARV1	1.00000	*BFORHAY	-	210.00000
BHAY2	*BHARV2	1.00000	*BFORHAY	-	173.00000
BHAY3	*BHARV3	1.00000	*BFORHAY	-	100.00000
ASIL1	*AHARV1	1.00000	*AFORSIL	-	800.00000
ASIL2	*AHARV2	1.00000	*AFORSIL	-	667.00000
ASIL3	*AHARV3	1.00000	*AFORSIL	-	400.00000
AHAY1	*AHARV1	1.00000	*AFORHAY	-	430.00000
AHAY2	*AHARV2	1.00000	*AFORHAY	-	358.00000
AHAY3	*AHARV3	1.00000	*AFORHAY	-	215.00000
APAST1	*AHARV1	1.00000	*ALFDMAT	-	9.34700
APAST2	*AHARV2	1.00000	*ALFDMAT	-	7.94600
APAST3	*AHARV3	1.00000	*ALFDMAT	-	6.07700
POTHARV	*PHARV	1.00000	*POTATO	-	1.00000
POTHARV	MAY	.66700	MY/JN		.66700
POTHARV	MY/JL1	.66700	MY/JL		.66700
POTHARV	MY/AU1	.66700	MY/AU		.66700
POTHARV	MY/SE1	.66700	MY/SE		.66700
POTHARV	*YRLABOR	.66700			
QUIHARV	*QHARV	1.00000	*QUINUA	-	1.00000
QUIHARV	JUN	1.33300	JUL		1.84700
QUIHARV	MY/JN	1.33300	JN2/AU		1.84700
QUIHARV	MY/JL1	1.33300	MY/JL		3.18000
QUIHARV	MY/AU1	3.18000	MY/AU		3.18000
QUIHARV	MY/SE1	3.18000	MY/SE		3.18000
QUIHARV	JN/JL1	1.33300	JN/JL		3.18000
QUIHARV	JN/AU1	3.18000	JN/AU		3.18000
QUIHARV	JN/SE1	3.18000	JN/SE		3.18000
QUIHARV	JN2/JL	1.84700	JN2/AU1		1.84700
QUIHARV	JN2/SE1	1.84700	JN2/SE		1.84700
QUIHARV	JL/AU1	1.84700	JL/AU		1.84700
QUIHARV	JL/SE1	1.84700	JL/SE		1.84700
QUIHARV	*YRLABOR	3.18000	OJUL	-	.01900
QUIHARV	OJN2/AU	- .01900	*OYLABOR		.01900
QUIHARV	TJUL	.01700	TMY/JL		.01700
QUIHARV	TMY/AU1	.01700	TMY/AU		.01700
QUIHARV	TMY/SE1	.01700	TMY/SE		.01700
QUIHARV	TJN/JL	.01700	TJN/AU1		.01700
QUIHARV	TJN/AU	.01700	TJN/SE1		.01700
QUIHARV	TJN/SE	.01700	TJN2/JL		.01700
QUIHARV	TJN2/AU1	.01700	TJN2/AU		.01700
QUIHARV	TJN2/SE1	.01700	TJN2/SE		.01700
QUIHARV	TJL/AU1	.01700	TJL/AU		.01700

QUIHARV	TJL/SE1		.01700	TJL/SE		.01700
QUIHARV	WJUL		.01700	*TRACTOR		.01700
QUIHARV	*WAGON		.01700			
GHHARV	*HFORGH		1.00000	*GBEANS	-	1.00000
GHHARV	FE/MA		.20600	*YRLABOR		.20600
GHHARV	OFE/MA	-	.01900	*OYLABOR	-	.01900
GHHARV	TFE/MA		.01700	WFE/MA		.01700
GHHARV	*TRACTOR		.01700	*WAGON		.01700
DHHARV	*HFORDH		1.00000	*DBEANS	-	1.00000
DHHARV	MAY		.91900	MY/JN		.91900
DHHARV	MY/JL1		.91900	MY/JL		.91900
DHHARV	MY/AU1		.91900	MY/AU		.91900
DHHARV	MY/SE1		.91900	MY/SE		.91900
DHHARV	*YRLABOR		.91900	OMAY	-	.01900
DHHARV	OMY/JN	-	.01900	*OYLABOR		.10900
DHHARV	TMAY		.01700	TMY/JN		.01700
DHHARV	TMY/JL1		.01700	TMY/JL		.01700
DHHARV	TMY/AU1		.01700	TMY/AU		.01700
DHHARV	TMY/SE1		.01700	TMY/SE		.01700
DHHARV	WMAY		.01700	WMY/JN		.01700
DHHARV	*TRACTOR		.01700	*WAGON		.01700
BSILMAK	APR		.57900	*YRLABOR		.57900
BSILMAK	OAPR	-	.01900	*OYLABOR		.01900
BSILMAK	TAPR		.01700	WAPR		.01700
BSILMAK	*BFORSIL		1.00000	*CAPITAL		.09100
BSILMAK	*BARSIL	-	1.00000	*TRACTOR		.01700
BSILMAK	*WAGON		.01700	INCOME	-	.09100
BHAYMAK	MY/JN		.48800	MY/JL1		.48800
BHAYMAK	MY/JL		.48800	MY/AU1		.48800
BHAYMAK	MY/AU		.48800	MY/SE1		.48800
BHAYMAK	MY/SE		.48800	*YRLABOR		.48800
BHAYMAK	OMY/JN	-	.01900	*OYLABOR		.01900
BHAYMAK	TMY/JN		.01700	TMY/JL1		.01700
BHAYMAK	TMY/JL		.01700	TMY/AU1		.01700
BHAYMAK	TMY/AU		.01700	TMY/SE1		.01700
BHAYMAK	TMY/SE		.01700	WMY/JN		.01700
BHAYMAK	*BFORHAY		1.00000	*CAPITAL		.22700
BHAYMAK	*BARHAY	-	1.00000	*TRACTOR		.01700
BHAYMAK	*WAGON		.01700	INCOME	-	.22700
ASILMAK	MAR		.28950	APR		.26000
ASILMAK	FE/MA		.26000	*YRLABOR		.52000
ASILMAK	OMAR	-	.00950	OAPR	-	.00950
ASILMAK	OFE/MA	-	.00950	*OYLABOR		.01900
ASILMAK	TMAR		.00850	TAPR		.00850
ASILMAK	TFE/MA		.00850	WMAR		.00850
ASILMAK	WAPR		.00850	WFE/MA		.00850
ASILMAK	*AFORSIL		1.00000	*CAPITAL		.09100
ASILMAK	*ALFSIL	-	.10000	*TRACTOR		.01700
ASILMAK	*WAGON		.01700	INCOME	-	.09100
AHAYMAK	MAY		.19500	JUN		.29300
AHAYMAK	MY/JN		.48800	MY/JL1		.48800

AHAYMAK	MY/JL		.48800	MY/AU1		.48800
AHAYMAK	MY/AU		.48800	MY/SE1		.48800
AHAYMAK	MY/SE		.48800	JN/JL1		.29300
AHAYMAK	JN/JL		.29300	JN/AU1		.29300
AHAYMAK	JN/AU		.29300	JN/SE1		.29300
AHAYMAK	JN/SE		.29300	*YRLABOR		.48800
AHAYMAK	OMAY	-	.00760	OJUN	-	.01140
AHAYMAK	OMY/JN	-	.01900	*OYLABOR		.01900
AHAYMAK	TMAY		.00680	TJUN		.01020
AHAYMAK	TMY/JN		.01700	TMY/JL1		.01700
AHAYMAK	TMY/JL		.01700	TMY/AU1		.01700
AHAYMAK	TMY/AU		.01700	TMY/SE1		.01700
AHAYMAK	TMY/SE		.01700	TJN/JL1		.01020
AHAYMAK	TJN/JL		.01020	TJN/AU1		.01020
AHAYMAK	TJN/AU		.01020	TJN/SE1		.01020
AHAYMAK	TJN/SE		.01020	WMAY		.00700
AHAYMAK	WJUN		.01000	WMY/JN		.01700
AHAYMAK	*AFORHAY		1.00000	*CAPITAL		.22700
AHAYMAK	*ALFHAY	-	1.00000	*TRACTOR		.01700
AHAYMAK	*WAGON		.01700	INCOME	-	.22700
CHUMAK	*POTATO		3.00000	*CHUNO1	-	.40000
CHUMAK	*CHUNO2	-	.57000	*CHUNO3	-	.03000
CHUMAK	AUG		.22910	JN2/AU		9.22910
CHUMAK	MY/AU		9.22910	MY/SE1		9.22910
CHUMAK	MY/SE		9.22910	JN/AU		9.22910
CHUMAK	JN/SE1		9.22910	JN/SE		9.22910
CHUMAK	JN2/SE1		9.22910	JN2/SE		9.22910
CHUMAK	JL/AU		.22910	JL/SE1		.22910
CHUMAK	AU/SE		.22910	*YRLABOR		9.22910
CHUMAK	OAUG	-	.01910	*OYLABOR		.01910
CHUMAK	TAUG		.01700	TMY/JN		.01700
CHUMAK	TMY/SE1		.01700	TMY/SE		.01700
CHUMAK	TJN/AU		.01700	TJN/SE1		.01700
CHUMAK	TJN/SE		.01700	TJN2/SE1		.01700
CHUMAK	TJN2/SE		.01700	TJL/SE1		.01700
CHUMAK	TJL/SE		.01700	TJL2/SE1		.01700
CHUMAK	TJL2/SE		.01700	TAU/SE1		.01700
CHUMAK	TAU/SE		.01700	TAU2/SE1		.01700
CHUMAK	TAU2/SE		.01700	SAUG		.02000
CHUMAK	WAUG		.01700	*TRACTOR		.01700
CHUMAK	*SORTER		.02000	*WAGON		.01700
SELCHU1	*CHUNO1		1.00000	AUG2		.20000
SELCHU1	AUG		.20000	MY/AU		.20000
SELCHU1	MY/SE1		.20000	MY/SE		.20000
SELCHU1	JN/AU		.20000	JN/SE1		.20000
SELCHU1	JN/SE		.20000	JN2/AU		.20000
SELCHU1	JN2/SE1		.20000	JN2/SE		.20000
SELCHU1	JL/AU		.20000	JL/SE1		.20000
SELCHU1	JL/SE		.20000	JL2/AU		.20000
SELCHU1	JL2/SE1		.20000	JL2/SE		.20000
SELCHU1	AU/SE1		.20000	AU/SE		.20000

SELCHU1	AU2/SE1	.20000	AU2/SE	.20000
SELCHU1	*YRLABOR	.20000	*SALEAGR	150.00000
SELCHU1	INCOME	150.00000		
SELCHU2	*CHUNO2	1.00000	AUG2	.20000
SELCHU2	AUG	.20000	MY/AU	.20000
SELCHU2	MY/SE1	.20000	MY/SE	.20000
SELCHU2	JN/AU	.20000	JN/SE1	.20000
SELCHU2	JN/SE	.20000	JN2/AU	.20000
SELCHU2	JN2/SE1	.20000	JN2/SE	.20000
SELCHU2	JL/AU	.20000	JL/SE1	.20000
SELCHU2	JL/SE	.20000	JL2/AU	.20000
SELCHU2	JL2/SE1	.20000	JL2/SE	.20000
SELCHU2	AU/SE1	.20000	AU/SE	.20000
SELCHU2	AU2/SE1	.20000	AU2/SE	.20000
SELCHU2	*YRLABOR	.20000	*SALEAGR	130.00000
SELCHU2	INCOME	130.00000		
SELCHU3	*CHUNO3	1.00000	AUG2	.20000
SELCHU3	AUG	.20000	MY/AU	.20000
SELCHU3	MY/SE1	.20000	MY/SE	.20000
SELCHU3	JN/AU	.20000	JN/SE1	.20000
SELCHU3	JN/SE	.20000	JN2/AU	.20000
SELCHU3	JN2/SE1	.20000	JN2/SE	.20000
SELCHU3	JL/AU	.20000	JL/SE1	.20000
SELCHU3	JL/SE	.20000	JL2/AU	.20000
SELCHU3	JL2/SE1	.20000	JL2/SE	.20000
SELCHU3	AU/SE1	.20000	AU/SE	.20000
SELCHU3	AU2/SE1	.20000	AU2/SE	.20000
SELCHU3	*YRLABOR	.20000	*SALEAGR	110.00000
SELCHU3	INCOME	110.00000		
SELQUIN	*QUINUA	1.00000	AUG	.20000
SELQUIN	MY/AU	.20000	MY/SE1	.20000
SELQUIN	MY/SE	.20000	JN/AU	.20000
SELQUIN	JN/SE1	.20000	JN/SE	.20000
SELQUIN	JN2/AU	.20000	JN2/SE1	.20000
SELQUIN	JN2/SE	.20000	JL/AU	.20000
SELQUIN	JL/SE1	.20000	JL/SE	.20000
SELQUIN	JL2/AU	.20000	JL2/SE1	.20000
SELQUIN	JL2/SE	.20000	AU/SE1	.20000
SELQUIN	AU/SE	.20000	*YRLABOR	.20000
SELQUIN	*SALEAGR	60.00000	INCOME	60.00000
SELGBEAN	*GBEANS	1.00000	MAR	.20000
SELGBEAN	FE/MA	.20000	*YRLABOR	.20000
SELGBEAN	*SALEAGR	25.00000	INCOME	25.00000
SELDBEAN	*DBEANS	1.00000	JUN	.20000
SELDBEAN	MY/JN	.20000	MY/AU	.20000
SELDBEAN	MY/SE1	.20000	MY/SE	.20000
SELDBEAN	JN/AU	.20000	JN/SE1	.20000
SELDBEAN	JN/SE	.20000	*YRLABOR	.20000
SELDBEAN	*SALEAGR	80.00000	INCOME	80.00000
SELBHAY	JN2/AU	.20000	*YRLABOR	.20000
SELBHAY	*BARHAY	1.00000	*SALEAGR	2.45000

SELBHAY	MY/AU		.20000	MY/SE1		.20000
SELBHAY	MY/SE		.20000	JN/AU		.20000
SELBHAY	JN/SE1		.20000	JN/SE		.20000
SELBHAY	JN2/SE1		.20000	JN2/SE		.20000
SELBHAY	INCOME		2.45000			
SELAHAY	JN2/AU		.20000	*YRLABOR		.20000
SELAHAY	*ALFHAY		1.00000	*SALEAGR		4.41000
SELAHAY	MY/AU		.20000	MY/SE1		.20000
SELAHAY	MY/SE		.20000	JN/AU		.20000
SELAHAY	JN/SE1		.20000	JN/SE		.20000
SELAHAY	JN2/SE1		.20000	JN2/SE		.20000
SELAHAY	INCOME		4.41000			
SELLPELT	*LPELTS		1.00000	*SALELIV		9.50000
SELAPELT	*APELTS		1.00000	*SALELIV		14.25000
SELWOOL1	*WOOL1		1.00000	*SALELIV		9.02500
SELWOOL2	*WOOL2		1.00000	*SALELIV		8.55000
SELWOOL3	*WOOL3		1.00000	*SALFLIV		7.60000
SELWOOL6	*WOOL6		1.00000	*SALELIV		2.75500
SELRAMS	*RAMS		1.00000	*SALELIV		334.00000
SELEWES	*EWES		1.00000	*SALELIV		221.50000
SELWETH	*WETHERS		1.00000	*SALFLIV		188.30000
SELFLAMB	*FLAMBS		1.00000	*SALELIV		188.30000
TRACTOR	*TRACTOR	-	1.00000	*CAPITAL		14.75600
TRACTOR	INCOME	-	14.75600			
PLOW	*PLOW	-	1.00000	*CAPITAL		3.30600
PLOW	INCOME	-	3.30600			
HARROW	*HARROW	-	1.00000	*CAPITAL		.83200
HARROW	INCOME	-	.83200			
MOTORPUM	*MOTPUMP	-	1.00000	*CAPITAL		10.91600
MOTORPUM	INCOME	-	10.91600			
SPRAYER	*KINK	-	1.00000	*CAPITAL		1.75100
SPRAYER	INCOME	-	1.75100			
WAGON	*WAGCN	-	1.00000	*CAPITAL		1.48700
WAGON	INCOME	-	1.48700			
SORTER	*SORTER	-	1.00000	*CAPITAL		.11300
SORTER	INCOME	-	.11300			
SPRINKLR	*ZPRINK	-	1.00000	*CAPITAL		.04500
SPRINKLR	INCOME	-	.04500			
*LANDTR	LAND		1.00000	LAND1	-	.09000
*LANDTR	LAND2	-	.05000	LAND3	-	.34000
*LANDTR	LAND4	-	.23000	LAND5	-	.04000
*LABORTR	PEOPLE		1.00000	JUL1	-	44.11420
*LABORTR	JUL2	-	47.50760	AUG1	-	40.72080
*LABORTR	AUG2	-	47.50760	SEP1	-	44.11420
*LABORTR	SEP2	-	44.11420	OCT1	-	44.11420
*LABORTR	OCT2	-	44.11420	NOV1	-	49.64700
*LABORTR	NOV2	-	49.64700	DEC1	-	49.64700
*LABORTR	DEC2	-	53.46600	JAN1	-	49.64700
*LABORTR	JAN2	-	49.64700	FEB1	-	40.72080
*LABORTR	FEB2	-	40.72080	MAR1	-	44.11420
*LABORTR	MAR2	-	47.50760	APR1	-	44.11420

*LABORTR	APR2	-	44.11420	MAY1	-	44.11420
*LABORTR	MAY2	-	44.11420	JUN1	-	44.11420
*LABORTR	JUN2	-	44.11420	JUL	-	91.62180
*LABORTR	AUG	-	88.22840	SEP	-	88.22840
*LABORTR	OCT	-	88.22840	NOV	-	99.29400
*LABORTR	DEC	-	103.11300	JAN	-	99.29400
*LABORTR	FEB	-	81.44160	MAR	-	91.62180
*LABORTR	APR	-	88.22840	MAY	-	88.22840
*LABORTR	JUN	-	88.22840	FE/MA	-	173.06340
*LABORTR	MY/JN	-	176.45680	JN2/JL1	-	88.22840
*LABORTR	JN2/AU	-	223.96440	JL2/AU1	-	88.22840
*LABORTR	JL2/AU	-	135.73600	AU2/SF1	-	91.62180
*LABORTR	*FIXCOST	-	16.30510	MY/JL1	-	132.34260
*LABORTR	MY/JL	-	179.85020	MY/AU1	-	220.57100
*LABORTR	MY/AU	-	268.07860	MY/SE1	-	312.19280
*LABORTR	MY/SE	-	356.30700	JN/JL1	-	132.34260
*LABORTR	JN/JL	-	179.85020	JN/AU1	-	220.57100
*LABORTR	JN/AU	-	268.07860	JN/SE1	-	312.19280
*LABORTR	JN/SE	-	356.30700	JN2/JL	-	135.73600
*LABORTR	JN2/AU1	-	176.45680	JN2/SE1	-	268.07860
*LABORTR	JN2/SE	-	312.19280	JL/AU1	-	132.34260
*LABORTR	JL/AU	-	179.85020	JL/SE1	-	223.96440
*LABORTR	JL/SE	-	268.07860	JL2/SE1	-	179.85020
*LABORTR	JL2/SE	-	223.96440	AU/SE1	-	132.34260
*LABORTR	AU/SE	-	176.45680	AU2/SE	-	135.73600
*BSILJUL	*DRYMJUL	-	.29400	*BARSIL		22.04600
*BSILAUG	*DRYMAUG	-	.28000	*BARSIL		22.04600
*BSILSEP	*DRYMSEP	-	.26600	*BARSIL		22.04600
*BSILOCT	*DRYMOCT	-	.25200	*BARSIL		22.04600
*BSILNOV	*DRYMNOV	-	.24000	*BARSIL		22.04600
*BSILDEC	*DRYMDEC	-	.28800	*BARSIL		22.04600
*BSILJAN	*DRYMJAN	-	.21600	*BARSIL		22.04600
*BSILFEB	*DRYMFEB	-	.20600	*BARSIL		22.04600
*BSILMAR	*DRYMMAR	-	.19500	*BARSIL		22.04600
*BSILAPR	*DRYMAPR	-	.18600	*BARSIL		22.04600
*BSILMAY	*DRYMMAY	-	.17600	*BARSIL		22.04600
*BSILJUN	*DRYMJUN	-	.31000	*BARSIL		22.04600
*ASILJUL	*DRYMJUL	-	.30600	*ALFSIL		22.04600
*ASILAUG	*DRYMAUG	-	.29100	*ALFSIL		22.04600
*ASILSEP	*DRYMSEP	-	.27600	*ALFSIL		22.04600
*ASILOCT	*DRYMOCT	-	.26200	*ALFSIL		22.04600
*ASILNOV	*DRYMNOV	-	.24900	*ALFSIL		22.04600
*ASILDEC	*DRYMDEC	-	.23700	*ALFSIL		22.04600
*ASILJAN	*DRYMJAN	-	.22500	*ALFSIL		22.04600
*ASILFEB	*DRYMFEB	-	.21400	*ALFSIL		22.04600
*ASILMAR	*DRYMMAR	-	.20300	*ALFSIL		22.04600
*ASILAPR	*DRYMAPR	-	.19300	*ALFSIL		22.04600
*ASILMAY	*DRYMMAY	-	.18300	*ALFSIL		22.04600
*ASILJUN	*DRYMJUN	-	.32200	*ALFSIL		22.04600
*BHAYJUL	*BARHAY		22.04600	*DRYMJUL	-	.87300
*BHAYAUG	*BARHAY		22.04600	*DRYMAUG	-	.85600

*BHAYSEP	*BARHAY	22.04600	*DRYMSEP	-	.83800
*BHAYOCT	*BARHAY	22.04600	*DRYMOCT	-	.82200
*BHAYNOV	*BARHAY	22.04600	*DRYMNOV	-	.80500
*BHAYDEC	*BARHAY	22.04600	*DRYMDEC	-	.78900
*BHAYJAN	*BARHAY	22.04600	*DRYMJAN	-	.73300
*BHAYFEB	*BARHAY	22.04600	*DRYMFEB	-	.75800
*BHAYMAR	*BARHAY	22.04600	*DRYMMAR	-	.74300
*BHAYAPR	*BARHAY	22.04600	*DRYMAPR	-	.72800
*BHAYMAY	*BARHAY	22.04600	*DRYMMAY	-	.71300
*BHAYJUN	*BARHAY	22.04600	*DRYMJUN	-	.69900
*AHAYJUL	*ALFHAY	22.04600	*DRYMJUL	-	.89200
*AHAYAUG	*ALFHAY	22.04600	*DRYMAUG	-	.87400
*AHAYSEP	*ALFHAY	22.04600	*DRYMSEP	-	.85700
*AHAYOCT	*ALFHAY	22.04600	*DRYMOCT	-	.84000
*AHAYNOV	*ALFHAY	22.04600	*DRYMNOV	-	.82300
*AHAYDEC	*ALFHAY	22.04600	*DRYMDEC	-	.80600
*AHAYJAN	*ALFHAY	22.04600	*DRYMJAN	-	.79000
*AHAYFEB	*ALFHAY	22.04600	*DRYMFEB	-	.77400
*AHAYMAR	*ALFHAY	22.04600	*DRYMMAR	-	.75900
*AHAYAPR	*ALFHAY	22.04600	*DRYMAPR	-	.74400
*AHAYMAY	*ALFHAY	22.04600	*DRYMMAY	-	.72900
*AHAYJUN	*ALFHAY	22.04600	*DRYMJUN	-	.71400
*WETRJAN	*DRYMJAN	- 1.00000	*WEDMAT		1.00000
*WETRFEB	*DRYMFEB	- 1.00000	*WEDMAT		1.00000
*WETRMAR	*DRYMMAR	- 1.00000	*WEDMAT		1.00000
*WETRAPR	*DRYMAPR	- 1.00000	*WEDMAT		1.00000
*WETRMAY	*DRYMMAY	- 1.00000	*WEDMAT		1.00000
*ALTRMAR	*DRYMMAR	- 1.00000	*ALFDMAT		1.00000
*ALTRAPR	*DRYMAPR	- 1.00000	*ALFDMAT		1.00000
*ALTRMAY	*DRYMMAY	- 1.00000	*ALFDMAT		1.00000
*ALTRJUN	*DRYMJUN	- 1.00000	*ALFDMAT		1.00000

RHS

CHGCOL	LAND	1.00000		
P1	PEOPLE	125.00000	LAND	500.00000
P1	WATJUL	165391.2000	WATAUG	165391.2000
P1	WATSEP	160056.0000	WATOCT	165391.2000
P1	WATNOV	160056.0000	WATDEC	165391.2000
P1	WATJAN	165391.2000	WATFEB	149385.6000
P1	WATMAR	165391.2000	WATAPR	160056.0000
P1	WATMAY	165391.2000	WATJUN	160056.0000
P1	TJAN1	104.00000	TJUL	216.00000
P1	TAUG	208.00000	TSEP	208.00000
P1	TOCT	208.00000	TNOV	208.00000
P1	TDEC	216.00000	TJAN	208.00000
P1	TMAR	216.00000	TAPR	208.00000
P1	TMAY	208.00000	TJUN	208.00000
P1	TFE/MA	408.00000	TMY/JN	416.00000
P1	TJN2/JL1	208.00000	TJL2/AU1	208.00000
P1	TJL2/AU	320.00000	TAU2/SE1	216.00000
P1	TMY/JL1	520.00000	TMY/JL	632.00000
P1	TMY/AU1	728.00000	TMY/AU	840.00000

P1	TMY/SE1	944.00000	TMY/SE	1048.00000
P1	TJN/JL1	312.00000	TJN/JL	424.00000
P1	TJN/AU1	520.00000	TJN/AU	632.00000
P1	TJN/SE1	736.00000	TJN/SE	840.00000
P1	TJN2/JL	320.00000	TJN2/AU1	416.00000
P1	TJN2/AU	528.00000	TJN2/SE1	632.00000
P1	TJN2/SE	736.00000	TJL/AU1	312.00000
P1	TJL/AU	424.00000	TJL/SE1	528.00000
P1	TJL/SE	632.00000	TJL2/SE1	424.00000
P1	TJL2/SE	528.00000	TAU/SE1	312.00000
P1	TAU/SE	416.00000	TAU2/SE	320.00000
P1	PJAN1	104.00000	PJUL	216.00000
P1	PAUG	208.00000	PSEP	208.00000
P1	POCT	208.00000	PNOV	208.00000
P1	PDEC	216.00000	PJAN	208.00000
P1	PMAY	208.00000	PJUN	208.00000
P1	PJN2/JL1	208.00000	PJL2/AU1	208.00000
P1	PAU2/SE1	216.00000	PJN/JL1	312.00000
P1	PJN/JL	424.00000	PJN/AU1	520.00000
P1	PJN/AU	632.00000	PJN/SE1	736.00000
P1	PJN/SE	840.00000	PJN2/JL	320.00000
P1	PJN2/AU1	416.00000	PJN2/AU	528.00000
P1	PJN2/SE1	632.00000	PJN2/SE	736.00000
P1	PJL/AU1	312.00000	PJL/AU	424.00000
P1	PJL/SE1	528.00000	PJL/SE	632.00000
P1	PJL2/AU	320.00000	PJL2/SE1	424.00000
P1	PJL2/SE	528.00000	PAU/SE1	312.00000
P1	PAU/SE	416.00000	PAU2/SE	320.00000
P1	HAUG	208.00000	HSEP	208.00000
P1	HOCT	208.00000	HNOV	208.00000
P1	HDEC	216.00000	HJN2/JL1	208.00000
P1	HJL2/AU1	208.00000	HJL2/AU	320.00000
P1	KFEB2	96.00000	KMAR1	104.00000
P1	KMAR2	112.00000	KDEC	216.00000
P1	WJUL	216.00000	WAUG	208.00000
P1	WMAR	216.00000	WAPR	208.00000
P1	WMAY	208.00000	WJUN	208.00000
P1	WFE/MA	408.00000	WMY/JN	416.00000
P1	SAUG	208.00000	ZNOV	208.00000
P1	ZFEB	192.00000	OMAR1	.01000
P1	OMAR2	.01000	OJUL	.01000
P1	OAUG	.01000	OSEP	.01000
P1	OOCT	.01000	ONOV	.01000
P1	ODEC	.01000	OJAN	.01000
P1	OFEB	.01000	OMAR	.01000
P1	OAPR	.01000	OMAY	.01000
P1	OJUN	.01000	OFE/MA	.01000
P1	OMY/JN	.01000	OJN2/JL1	.01000
P1	OJN2/AU	.01000	OJL2/AU1	.01000
P1	OJL2/AU	.01000	OAU2/SE1	.01000
P1	*FIXCOST	27107.96700		

Table G-5. Linear programming matrix for full mechanization[a]

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[a]In the RHS section of the matrix only the vector for the first degree of full mechanization is reproduced. The RHS values for the other 26 degrees are computed on the basis of Table 7-4.

```
NAME          FULL
ROWS
 N  INCOME
 E  PEOPLE
 E  LAND
 L  LAND1
 L  LAND2
 L  LAND3
 L  LAND4
 L  LAND5
 L  JUL1
 L  JUL2
 L  AUG1
 L  AUG2
 L  SEP1
 L  SEP2
 L  OCT1
 L  OCT2
 L  NOV1
 L  NOV2
 L  DEC1
 L  DEC2
 L  JAN1
 L  JAN2
 L  FEB1
 L  FEB2
 L  MAR1
 L  MAR2
 L  APR1
 L  APR2
 L  MAY1
 L  MAY2
 L  JUN1
 L  JUN2
 L  JUL
 L  AUG
 L  SEP
 L  OCT
 L  NOV
 L  DEC
 L  JAN
 L  FEB
 L  MAR
 L  APR
 L  MAY
 L  JUN
 L  FE/MA
 L  MY/JN
 L  JN2/JL1
 L  JN2/AU
```

```
L   JL2/AU1
L   JL2/AU
L   AU2/SE1
L   MY/JL1
L   MY/JL
L   MY/AU1
L   MY/AU
L   MY/SE1
L   MY/SE
L   JN/JL1
L   JN/JL
L   JN/AU1
L   JN/AU
L   JN/SE1
L   JN/SE
L   JN2/JL
L   JN2/AU1
L   JN2/SE1
L   JN2/SE
L   JL/AU1
L   JL/AU
L   JL/SE1
L   JL/SE
L   JL2/SE1
L   JL2/SE
L   AU/SE1
L   AU/SE
L   AU2/SE
L   WATJUL
L   WATAUG
L   WATSEP
L   WATOCT
L   WATNOV
L   WATDEC
L   WATJAN
L   WATFEB
L   WATMAR
L   WATAPR
L   WATMAY
L   WATJUN
L   TJAN1
L   TJAN2
L   TFEB1
L   TFEB2
L   TMAR1
L   TMAR2
L   TJUL
L   TAUG
L   TSEP
L   TOCT
L   TNOV
```

```
L   TDEC
L   TJAN
L   TMAR
L   TAPR
L   TMAY
L   TJUN
L   TFE/MA
L   TMY/JN
L   TJN2/JL1
L   TJL2/AU1
L   TJL2/AU
L   TAU2/SE1
L   TMY/JL1
L   TMY/JL
L   TMY/AU1
L   TMY/AU
L   TMY/SE1
L   TMY/SE
L   TJN/JL1
L   TJN/JL
L   TJN/AU1
L   TJN/AU
L   TJN/SE1
L   TJN/SE
L   TJN2/JL
L   TJN2/AU1
L   TJN2/AU
L   TJN2/SE1
L   TJN2/SE
L   TJL/AU1
L   TJL/AU
L   TJL/SE1
L   TJL/SE
L   TJL2/SE1
L   TJL2/SE
L   TAU/SE1
L   TAU/SE
L   TAU2/SE
L   PJUL
L   PAUG
L   PSEP
L   POCT
L   PNOV
L   PDEC
L   PMAY
L   PJUN
L   PJN2/JL1
L   PJN/JL1
L   PJN/JL
L   PJN/AU1
L   PJN/AU
```

```
L   PJN/SE1
L   PJN/SE
L   PJN2/JL
L   PJN2/AU1
L   PJN2/AU
L   PJL/AU1
L   PJL/AU
L   PJL2/AU
L   HAUG
L   HSEP
L   HOCT
L   HNOV
L   HDEC
L   HJN2/JL1
L   HJL2/AU1
L   HJL2/AU
L   PPJAN1
L   PPJAN2
L   PPFEB1
L   PPMAR1
L   PPOCT
L   PPNOV
L   PPDEC
L   GJAN2
L   GSEP
L   GOCT
L   GDEC
L   GJAN
L   GJL2/AU
L   GAU2/SE1
L   GJL2/SE1
L   GJL2/SE
L   GAU2/SE
L   CJAN1
L   CJAN2
L   CFEB1
L   CFEB2
L   CMAR1
L   CMAR2
L   CNOV
L   KFEB2
L   KMAR1
L   KMAR2
L   KDEC
L   FMAR
L   FAPR
L   RMAY
L   RJUN
L   RMY/JN
L   BMAY
L   BJUN
```

```
L   BMY/JN
L   DMAY
L   WJUL
L   WAUG
L   WMAR
L   WAPR
L   WMAY
L   WJUN
L   WFE/MA
L   WMY/JN
L   SAUG
L   ZNOV
L   ZFEB
L   OJAN1
L   OJAN2
L   OFEB1
L   OFEB2
L   CMAR1
L   CMAR2
L   OJUL
L   OAUG
L   OSEP
L   OOCT
L   ONOV
L   ODEC
L   CJAN
L   CFEB
L   CMAR
L   CAPR
L   CMAY
L   OJUN
L   CFE/MA
L   CMY/JN
L   CJN2/JL1
L   CJN2/AU
L   CJL2/AU1
L   CJL2/AU
L   CAU2/SE1
E   *POCT
E   *PNOV
E   *PDEC
E   *PJAN
E   *QSEP
E   *QOCT
E   *HJLAU
E   *HAUSE
E   *B
E   *A
E   *P1
E   *P2
E   *P3
```

```
E   *P'1
E   *P'2
E   *P'3
E   *Q1
E   *Q2
E   *Q3
E   *Q'1
E   *Q'2
E   *Q'3
E   *H1
E   *H2
E   *H3
E   *B1
E   *B2
E   *B3
E   *A1
E   *A2
E   *A3
L   *WEEP
L   *PHARV
L   *QHARV
L   *HJLAU1
L   *HJLAU2
L   *HJLAU3
L   *HAUSE1
L   *HAUSE2
L   *HAUSE3
L   *HFORGH
L   *HFORDH
L   *BHARV1
L   *BHARV2
L   *BHARV3
L   *BFORSTL
L   *BFORMAY
L   *AHARV1
L   *AHARV2
L   *AHARV3
L   *AFORSTL
L   *AFORMAY
L   *POTATO
L   *CHUNG1
L   *CHUNG2
L   *CHUNG3
L   *GUINDA
L   *GBEANS
L   *CBEANS
E   *BARSTL
L   *BARMAY
E   *ALFSTL
L   *ALFMAY
E   *LPELTS
```

```
 E   *APELTS
 E   *WOOL1
 E   *WOOL2
 E   *WOOL3
 E   *WOOL6
 E   *RAMS
 E   *EWES
 E   *WETHERS
 E   *FLAMBS
 E   *SALEAGR
 E   *SALELIV
 E   *TOTSALE
 E   *REVLAB
 E   *YRLABOR
 E   *OYLABOR
 E   *YRWATER
 E   *CAPITAL
 E   *FIXCOST
 E   *LANDUSE
 E   *TRACTOR
 E   *PLOW
 E   *HARROW
 E   *MOTPUMP
 E   *PLANTER
 E   *DRILL
 E   *CULTIV
 E   *KINK
     *HARVEST
 E   *RAKE
 E   *BALER
 E   *DIGGER
 E   *WAGON
 E   *SORTER
 E   *ZPRINK
 E   *ALFDMAT
 E   *WEDMAT
 L   *DRYMJUL
 L   *DRYMAUG
 L   *DRYMSEP
 L   *DRYMOCT
 L   *DRYMNOV
 L   *DRYMDEC
 L   *DRYMJAN
 L   *DRYMFEB
 L   *DRYMMAR
 L   *DRYMAPR
 L   *DRYMMAY
 L   *DRYMJUN
COLUMNS
    LANDUSED   *LANDUSE   -    1.00000
    LABOR      *YRLABOR   -    1.00000    *CAPITAL        1.00000
```

LABOR	*REVLAB	-	1.00000			
OLABOR	*OYLABOR	-	1.00000	*CAPITAL		.25000
OLABOR	*REVLAB	-	.25000			
WATER	*YRWATER	-	1.00000	*MOTPUMP		.00450
CAPITAL	*CAPITAL	-	1.00000	INCOME	-	.08000
FCOSTPAY	*FIXCOST		1.00000	INCOME	-	1.00000
REVLABOR	*REVLAB		1.00000			
TOYSALES	*TOTSALE	-	1.00000			
SALESAGR	*TOTSALE		1.00000	*SALEAGR	-	1.00000
SALESLIV	*TOTSALE		1.00000	*SALELIV	-	1.00000
PQB1	*P1		1.00000	*Q1		1.00000
PQB1	*B1		1.00000	*BHARV1	-	1.00000
P*QB1	*P*1		1.00000	*Q1		1.00000
P*QB1	*B1		1.00000	*BHARV1	-	1.00000
PQ*B1	*P1		1.00000	*Q*1		1.00000
PQ*B1	*B1		1.00000	*BHARV1	-	1.00000
P*Q*B1	*P*1		1.00000	*Q*1		1.00000
P*Q*B1	*B1		1.00000	*BHARV1	-	1.00000
PHQB1	*P1		1.00000	*Q1		1.00000
PHQB1	*H1		1.00000	*B1		1.00000
PHQB1	*BHARV1	-	1.00000			
PHQB2	*P2		1.00000	*Q2		1.00000
PHQB2	*H2		1.00000	*B2		1.00000
PHQB2	*BHARV2	-	1.00000			
PHQB3	*P3		1.00000	*Q3		1.00000
PHQB3	*H3		1.00000	*B3		1.00000
PHQB3	*BHARV3	-	1.00000			
P*HQB1	*P*1		1.00000	*Q1		1.00000
P*HQB1	*H1		1.00000	*B1		1.00000
P*HQB1	*BHARV1	-	1.00000			
P*HQB2	*P*2		1.00000	*Q2		1.00000
P*HQB2	*H2		1.00000	*B2		1.00000
P*HQB2	*BHARV2	-	1.00000			
P*HQB3	*P*3		1.00000	*Q3		1.00000
P*HQB3	*H3		1.00000	*B3		1.00000
P*HQB3	*BHARV3	-	1.00000			
PHQ*B1	*P1		1.00000	*Q*1		1.00000
PHQ*B1	*H1		1.00000	*B1		1.00000
PHQ*B1	*BHARV1	-	1.00000			
PHQ*B2	*P2		1.00000	*Q*2		1.00000
PHQ*B2	*H2		1.00000	*B2		1.00000
PHQ*B2	*BHARV2	-	1.00000			
PHQ*B3	*P3		1.00000	*Q*3		1.00000
PHQ*B3	*H3		1.00000	*B3		1.00000
PHQ*B3	*BHARV3	-	1.00000			
P*HQ*B1	*P*1		1.00000	*Q*1		1.00000
P*HQ*B1	*H1		1.00000	*B1		1.00000
P*HQ*B1	*BHARV1	-	1.00000			
P*HQ*B2	*P*2		1.00000	*Q*2		1.00000
P*HQ*B2	*H2		1.00000	*B2		1.00000
P*HQ*B2	*BHARV2	-	1.00000			

P'HQ'B3	*P'3		1.00000	*Q'3		1.00000
P'HQ'B3	*H3		1.00000	*B3		1.00000
P'HQ'B3	*BHARV3	-	1.00000			
PQBA1	*P1		1.00000	*Q1		1.00000
PQBA1	*B1		1.00000	*A1		1.00000
PQBA1	*BHARV1	-	1.00000	*AHARV1	-	4.00000
PQBA2	*P2		1.00000	*Q2		1.00000
PQBA2	*B2		1.00000	*A2		1.00000
PQBA2	*BHARV2	-	1.00000	*AHARV2	-	4.00000
PQBA3	*P3		1.00000	*Q3		1.00000
PQBA3	*B3		1.00000	*A3		1.00000
PQBA3	*BHARV3	-	1.00000	*AHARV3	-	4.00000
P'QBA1	*P'1		1.00000	*Q1		1.00000
P'QBA1	*B1		1.00000	*A1		1.00000
P'QBA1	*BHARV1	-	1.00000	*AHARV1	-	4.00000
P'QBA2	*P'2		1.00000	*Q2		1.00000
P'QBA2	*B2		1.00000	*A2		1.00000
P'QBA2	*BHARV2	-	1.00000	*AHARV2	-	4.00000
P'QBA3	*P'3		1.00000	*Q3		1.00000
P'QBA3	*B3		1.00000	*A3		1.00000
P'QBA3	*BHARV3	-	1.00000	*AHARV3	-	4.00000
PQ'BA1	*P1		1.00000	*Q'1		1.00000
PQ'BA1	*B1		1.00000	*A1		1.00000
PQ'BA1	*BHARV1	-	1.00000	*AHARV1	-	4.00000
PQ'BA2	*P2		1.00000	*Q'2		1.00000
PQ'BA2	*B2		1.00000	*A2		1.00000
PQ'BA2	*BHARV2	-	1.00000	*AHARV2	-	4.00000
PQ'BA3	*P3		1.00000	*Q'3		1.00000
PQ'BA3	*B3		1.00000	*A3		1.00000
PQ'BA3	*BHARV3	-	1.00000	*AHARV3	-	4.00000
P'Q'BA1	*P'1		1.00000	*Q'1		1.00000
P'Q'BA1	*B1		1.00000	*A1		1.00000
P'Q'BA1	*BHARV1	-	1.00000	*AHARV1	-	4.00000
P'Q'BA2	*P'2		1.00000	*Q'2		1.00000
P'Q'BA2	*B2		1.00000	*A2		1.00000
P'Q'BA2	*BHARV2	-	1.00000	*AHARV2	-	4.00000
P'Q'BA3	*P'3		1.00000	*Q'3		1.00000
P'Q'BA3	*B3		1.00000	*A3		1.00000
P'Q'BA3	*BHARV3	-	1.00000	*AHARV3	-	4.00000
BARCON1	*B1		1.00000	*BHARV1	-	1.00000
BARCON2	*B2		1.00000	*BHARV2	-	1.00000
ALFCON1	*A1		1.00000	*AHARV1	-	4.00000
ALFCON2	*A2		1.00000	*AHARV2	-	4.00000
ALFCON3	*A3		1.00000	*AHARV3	-	4.00000
WEEP3	*WEEP		1.00000	*WEDMAT	-	.13000
WEEP4	*WEEP		1.00000	*WEDMAT	-	.12500
WEEP5	*WEEP		1.00000	*WEDMAT	-	.12000
SHEEP	JUL1		344.00000	JUL2		368.00000
SHEEP	AUG1		344.00000	AUG2		376.46000
SHEEP	SEP1		726.75000	SEP2		726.75000
SHEEP	OCT1		726.75000	OCT2		842.67000

SHEEP	NOV1		368.00000	NOV2	382.72000
SHEEP	DEC1		348.53000	DEC2	372.53000
SHEEP	JAN1		372.53000	JAN2	388.53000
SHEEP	FEB1		348.00000	FEB2	333.23000
SHEEP	MAR1		408.42000	MAR2	395.00000
SHEEP	APR1		448.00000	APR2	448.00000
SHEEP	MAY1		448.00000	MAY2	496.00000
SHEEP	JUN1		375.19000	JUN2	344.00000
SHEEP	JUL		712.00200	AUG	720.46200
SHEEP	SEP		1453.50100	OCT	1569.42200
SHEEP	NOV		750.72900	DEC	721.06200
SHEEP	JAN		761.06200	FEB	681.23100
SHEEP	MAR		803.42900	APR	896.00100
SHEEP	MAY		944.00100	JUN	719.19200
SHEEP	FE/MA		1484.66000	MY/JN	1663.19300
SHEEP	JN2/JL1		688.00000	JN2/AU	1776.46400
SHEEP	JL2/AU1		712.00000	JL2/AU	1088.46200
SHEEP	AU2/SE1		1103.21000	MY/JL1	2007.19300
SHEEP	MY/JL		2375.19500	MY/AU1	2719.19500
SHEEP	MY/AU		3096.65700	MY/SE1	3832.40700
SHEEP	MY/SE		4559.15800	JN/JL1	1063.19200
SHEEP	JN/JL		1431.19400	JN/AU1	1775.19400
SHEEP	JN/AU		2151.65600	JN/SE1	2878.40600
SHEEP	JN/SE		3605.15700	JN2/JL	1056.00200
SHEEP	JN2/AU1		1398.00200	JN2/SE1	1503.21400
SHEEP	JN2/SE		2229.96500	JL/AU1	1056.00200
SHEEP	JL/AU		1432.46400	JL/SE1	2159.21400
SHEEP	JL/SE		2885.96500	JL2/SE1	1815.21200
SHEEP	JL2/SE		2541.96300	AU/SE1	1447.21260
SHEEP	AU/SE		2173.96300	AU2/SE	1829.96100
SHEEP	*YRLABOR		10732.09300	OJUL	- .00200
SHEEP	OAUG	-	.00200	OSEP	- .00100
SHEEP	OOCT	-	.00200	ONOV	- .00900
SHEEP	ODEC	-	.00200	OJAN	- .00100
SHEEP	OFEB	-	.00100	OMAR	- .00900
SHEEP	OAPR	-	.00100	OMAY	- .00100
SHEEP	OJUN	-	.00200	OFE/MA	- .01000
SHEEP	OMY/JN	-	.00300	OJN2/AU	- .00400
SHEEP	OJL2/AU	-	.00200	*OYLABOR	.03300
SHEEP	WATJUL		2.88100	WATAUG	2.85000
SHEEP	WATSEP		1.97000	WATOCT	2.48700
SHEEP	WATNOV		12.42100	WATDEC	2.24300
SHEEP	WATJAN		1.95900	WATFEB	1.88200
SHEEP	WATMAR		11.49100	WATAPR	1.48800
SHEEP	WATMAY		1.47200	WATJUN	2.92300
SHEEP	*YRWATER		46.05800	*CAPITAL	13344.95200
SHEEP	*LPELTS	-	34.50000	*APELTS	- 17.00000
SHEEP	*WOOL1	-	661.49000	*WOOL2	- 25.42000
SHEEP	*WOOL3	-	23.93000	*WOOL6	- 30.16000
SHEEP	*RAMS	-	1.50000	*EWES	- 24.00000
SHEEP	*WETHERS	-	81.00000	*FLAMBS	- 16.00000

SHEEP	*DRYMJUL		10.36440	*DRYMAUG	13.39650
SHEEP	*DRYMSEP		11.79450	*DRYMOCT	12.43170
SHEEP	*DRYMNCV		11.19420	*DRYMDEC	9.72360
SHEEP	*DRYMJAN		13.03470	*DRYMFEB	12.14370
SHEEP	*DRYMMAR		10.95570	*DRYMAPR	9.89460
SHEEP	*DRYMMAY		10.34910	*DRYMJUN	9.86580
SHEEP	INCOME		16646.12100		
POCT	JAN1		3.69600	FEB1	2.46400
POCT	FEB2		9.66400	SEP	6.75400
POCT	OCT		12.92800	JAN	3.69600
POCT	FEB		12.12800	JUN	3.69600
POCT	FE/MA		12.12800	MY/JN	3.69600
POCT	MY/JL1		3.69600	MY/JL	3.69600
POCT	MY/AU1		3.69600	MY/AU	3.69600
POCT	MY/SE1		3.69600	MY/SE	10.45000
POCT	JN/JL1		3.69600	JN/JL	3.69600
POCT	JN/AU1		3.69600	JN/AU	3.69600
POCT	JN/SE1		3.69600	JN/SE	10.45000
POCT	JL/SE		6.75400	JL2/SE	6.75400
POCT	AU/SE		6.75400	AU2/SE	6.75400
POCT	*YRLABOR		39.20200	OJAN1	- 3.69600
POCT	OFEB1	-	2.46200	OFEB2	- .06400
POCT	OSEP	-	6.75400	OOCT	- 4.92800
POCT	OJAN	-	3.69600	OFEB	- 2.52800
POCT	OJUN	-	3.69600	OFE/MA	- 2.52800
POCT	OMY/JN	-	3.69600	*OYLABOR	21.60200
POCT	TJAN1		3.30000	TFEB1	2.20000
POCT	TSEP		6.05000	TOCT	4.40000
POCT	TJAN		3.30000	TJUN	3.30000
POCT	TFE/MA		2.20000	TMY/JN	3.30000
POCT	TMY/AU1		3.30000	TMY/AU	3.30000
POCT	TMY/SE1		3.30000	TMY/SE	3.30000
POCT	TJN/JL1		3.30000	TJN/JL	3.30000
POCT	TJN/AU1		3.30000	TJN/AU	3.30000
POCT	TJN/SE1		3.30000	TJN/SE	9.35000
POCT	TJN2/SE		6.05000	TJL/SE	6.05000
POCT	TJL2/SE		6.05000	TAU/SE	6.05000
POCT	TAU2/SE		6.05000	PSEP	3.30000
POCT	PJUN		3.30000	PJN/JL1	3.30000
POCT	PJN/JL		3.30000	PJN/AU1	3.30000
POCT	PJN/AU		3.30000	HSEP	1.65000
POCT	PPOCT		4.40000	PPJAN1	1.10000
POCT	CJAN1		2.20000	CFEB1	2.20000
POCT	KFEB2		3.20000	*CAPITAL	1906.77700
POCT	*POCT	-	1.00000	*TRACTOR	19.25000
POCT	*PLOW		6.60000	*HARROW	1.65000
POCT	*PLANTER		5.50000	*CULTIV	4.40000
POCT	*KINK		3.20000	INCOME	- 1906.77700
PNOV	JAN2		3.69600	FEB2	2.46400
PNOV	MAR1		9.66400	OCT	6.75400
PNOV	NOV		12.92800	JAN	3.69600

PNOV	FEB		2.46400	MAR		9.66400
PNOV	JUN		3.69600	FE/MA		12.12800
PNOV	MY/JN		3.69600	MY/JL1		3.69600
PNOV	MY/JL		3.69600	MY/AU1		3.69600
PNOV	MY/AU		3.69600	MY/SE1		3.69600
PNOV	MY/SE		3.69600	JN/JL1		3.69600
PNOV	JN/JL		3.69600	JN/AU1		3.69600
PNOV	JN/AU		3.69600	JN/SE1		3.69600
PNOV	JN/SE		3.69600	*YRLABOR		39.20200
PNOV	OJAN2	-	3.69600	OFEB2	-	2.46400
PNOV	OMAR1	-	.06400	OOCT	-	6.75400
PNOV	ONOV	-	4.92800	OJAN	-	3.69600
PNOV	OFEB	-	2.46400	OMAR	-	.06400
PNOV	OJUN	-	3.69600	OFE/MA	-	2.52800
PNOV	OMY/JN	-	3.69600	*OYLABOR		21.60200
PNOV	TJAN2		3.30000	TFEB2		2.20000
PNOV	TOCT		6.05000	TNOV		4.40000
PNOV	TJAN		3.30000	TJUN		3.30000
PNOV	TFE/MA		2.20000	TMY/JN		3.30000
PNOV	TMY/JL1		3.30000	TMY/JL		3.30000
PNOV	TMY/AU1		3.30000	TMY/AU		3.30000
PNOV	TMY/SE1		3.30000	TMY/SE		3.30000
PNOV	TJN/JL1		3.30000	TJN/JL		3.30000
PNOV	TJN/AU1		3.30000	TJN/AU		3.30000
PNOV	TJN/SE1		3.30000	TJN/SE		3.30000
PNOV	POCT		3.30000	PJUN		3.30000
PNOV	PJN/JL1		3.30000	PJN/JL		3.30000
PNOV	PJN/AU1		3.30000	PJN/AU		3.30000
PNOV	HOCT		1.65000	PPNOV		4.40000
PNOV	PPJAN2		1.10000	CJAN2		2.20000
PNOV	CFEB2		2.20000	KMAR1		3.20000
PNOV	*CAPITAL		1906.77700	*TRACTOR		19.25000
PNOV	*PLOW		6.60000	*HARROW		1.65000
PNOV	*PLANTER		5.50000	*CULTIV		4.40000
PNOV	*KINK		3.20000	*PNOV	-	1.00000
PNOV	INCOME	-	1906.77700			
PDEC	FEB1		3.69600	FEB2		2.46400
PDEC	MAR1		9.66400	NOV		6.75400
PDEC	DEC		12.92800	FEB		6.15000
PDEC	MAR		9.64400	JUN		3.69600
PDEC	FE/MA		15.82400	MY/JN		3.69600
PDEC	MY/JL1		3.69600	MY/JL		3.69600
PDEC	MY/AU1		3.69600	MY/AU		3.69600
PDEC	MY/SE1		3.69600	MY/SE		3.69600
PDEC	JN/JL1		3.69600	JN/JL		3.69600
PDEC	JN/AU1		3.69600	JN/AU		3.69600
PDEC	JN/SE1		3.69600	JN/SE		3.69600
PDEC	*YRLABOR		39.20200	OFEB1	-	3.69600
PDEC	OFEB2	-	2.46400	OMAR1	-	.06400
PDEC	ONOV	-	6.75400	ODEC	-	4.92800
PDEC	OFEB	-	6.16000	OMAR	-	.06400

PDEC	OJUN	-	3.69600	OFE/MA	-	6.22400
PDEC	OMY/JN	-	3.69600	*OYLABOR		21.60200
PDEC	TFEB1		3.30000	TFEB2		2.20000
PDEC	TNOV		6.05000	TDEC		4.40000
PDEC	TJUN		3.30000	TFE/MA		5.50000
PDEC	TMY/JN		3.30000	TMY/JL1		3.30000
PDEC	TMY/JL		3.30000	TMY/AU1		3.30000
PDEC	TMY/AU		3.30000	TMY/SE1		3.30000
PDEC	TMY/SE		3.30000	TJN/JL1		3.30000
PDEC	TJN/JL		3.30000	TJN/AU1		3.30000
PDEC	TJN/AU		3.30000	TJN/SE1		3.30000
PDEC	TJN/SE		3.30000	PNOV		3.30000
PDEC	PJUN		3.30000	PJN/JL1		3.30000
PDEC	PJN/JL		3.30000	PJN/AU1		3.30000
PDEC	PJN/AU		3.30000	HNOV		1.65000
PDEC	PPDEC		4.40000	PPFEB1		1.10000
PDEC	CFEB1		2.20000	CFEB2		2.20000
PDEC	KMAR1		3.20000	*CAPITAL		1906.77700
PDEC	*PDEC	-	1.00000	*TRACTOR		19.25000
PDEC	*PLOW		6.60000	*HARROW		1.65000
PDEC	*PLANTER		5.50000	*CULTIV		4.40000
PDEC	*KINK		3.20000	INCOME	-	1906.77700
PJAN	JAN1		12.92800	MAR1		3.69600
PJAN	MAR2		12.12800	DEC		6.75400
PJAN	JAN		12.92800	MAR		15.82400
PJAN	JUN		3.69600	FE/MA		15.82400
PJAN	MY/JN		3.69600	MY/JL1		3.69600
PJAN	MY/JL		3.69600	MY/AU1		3.69600
PJAN	MY/AU		3.69600	MY/SE1		3.69600
PJAN	MY/SE		3.69600	JN/JL1		3.69600
PJAN	JN/JL		3.69600	JN/AU1		3.69600
PJAN	JN/AU		3.69600	JN/SE1		3.69600
PJAN	JN/SE		3.69600	*YRLABOR		39.20200
PJAN	OJAN1	-	4.92800	OMAR1	-	3.69600
PJAN	OMAR2	-	2.52800	ODEC	-	6.75400
PJAN	OJAN	-	4.92800	OMAR	-	6.22400
PJAN	OJUN	-	3.69600	OFE/MA	-	6.22400
PJAN	OMY/JN	-	3.69600	*OYLABOR		21.60200
PJAN	TJAN1		4.40000	TMAR1		3.30000
PJAN	TMAR2		2.20000	TDEC		6.05000
PJAN	TJAN		4.40000	TMAR		5.50000
PJAN	TJUN		3.30000	TFE/MA		5.50000
PJAN	TMY/JN		3.30000	TMY/JL1		3.30000
PJAN	TMY/JL		3.30000	TMY/AU1		3.30000
PJAN	TMY/AU		3.30000	TMY/SE1		3.30000
PJAN	TMY/SE		3.30000	TJN/JL1		3.30000
PJAN	TJN/JL		3.30000	TJN/AU1		3.30000
PJAN	TJN/AU		3.30000	TJN/SE1		3.30000
PJAN	TJN/SE		3.30000	PDEC		3.30000
PJAN	PJUN		3.30000	PJN/JL1		3.30000
PJAN	PJN/JL		3.30000	PJN/AU1		3.30000

PJAN	PJN/AU		3.30000	HDEC	1.65000
PJAN	PPJAN1		4.40000	PPMAR1	1.10000
PJAN	CMAR1		2.20000	CMAR2	2.20000
PJAN	KMAR2		3.20000	*CAPITAL	1906.77700
PJAN	*PJAN	-	1.00000	*TRACTOR	19.25000
PJAN	*PLOW		6.60000	*HARROW	1.65000
PJAN	*PLANTER		5.50000	*CULTIV	4.40000
PJAN	*KINK		3.20000	INCOME	- 1906.77700
QSEP	JUL		3.69600	AUG	6.75400
QSEP	SEP		2.23200	DEC	48.00000
QSEP	JAN		49.23200	JN2/AU	10.45000
QSEP	JL2/AU		6.75400	MY/JL	3.69600
QSEP	MY/AU		10.45000	MY/SE1	10.45000
QSEP	MY/SE		12.68200	JN/JL	3.69600
QSEP	JN/AU		10.45000	JN/SE1	10.45000
QSEP	JN/SE		12.68200	JN2/JL	10.45000
QSEP	JN2/AU1		10.45000	JN2/SE1	12.68200
QSEP	JL/AU		10.45000	JL/SE1	10.45000
QSEP	JL/SE		12.68200	JL2/SE1	6.75400
QSEP	JL2/SE		8.98600	AU/SE1	6.75400
QSEP	AU/SE		8.98600	AU2/SE	2.23000
QSEP	*YRLABOR		109.91400	OJUL	- 3.69600
QSEP	OAUG	-	6.75400	OSEP	- 1.23200
QSEP	OJAN	-	1.23200	OJN2/AU	- 10.45000
QSEP	OJL2/AU	-	6.75400	*OYLABOR	12.91400
QSEP	TJUL		3.30000	TAUG	6.05000
QSEP	TSEP		1.10000	TJAN	1.10000
QSEP	TJL2/AU		6.05000	TMY/JL	3.30000
QSEP	TMY/AU1		3.30000	TMY/AU	9.35000
QSEP	TMY/SE1		9.35000	TMY/SE	10.45000
QSEP	TJN/JL		3.30000	TJN/AU1	3.30000
QSEP	TJN/AU		9.35000	TJN/SE1	9.35000
QSEP	TJN/SE		10.45000	TJN2/JL	3.30000
QSEP	TJN2/AU1		3.30000	TJN2/AU	9.35000
QSEP	TJN2/SE1		9.35000	TJN2/SE	10.45000
QSEP	TJL/AU1		3.30000	TJL/AU	9.35000
QSEP	TJL/SE1		9.35000	TJL/SE	10.45000
QSEP	TJL2/SE1		6.05000	TJL2/SE	7.15000
QSEP	TAU/SE1		6.05000	TAU/SE	7.15000
QSEP	TAU2/SE		1.10000	PJUL	3.30000
QSEP	PAUG		3.30000	PJN/JL	3.30000
QSEP	PJN/AU1		3.30000	PJN/AU	6.60000
QSEP	PJN2/JL		3.30000	PJN2/AU1	3.30000
QSEP	PJN2/AU		6.60000	PJL/AU1	3.30000
QSEP	PJL/AU		6.60000	PJL2/AU	3.30000
QSEP	HAUG		1.65000	HJL2/AU	1.65000
QSEP	GSEP		1.10000	GJAN	1.10000
QSEP	GJL2/SE		1.10000	GAU2/SE	1.10000
QSEP	*CAPITAL		195.42000	*QSEP	- 1.00000
QSEP	*TRACTOR		11.55000	*PLOW	6.60000
QSEP	*HARROW		1.65000	*DRILL	2.20000

QSEP	INCOME	-	195.42000			
QOCT	JAN1		48.00000	JAN2		49.23200
QOCT	JUL		3.69600	SEP		6.75400
QOCT	OCT		2.23200	JAN		97.23200
QOCT	JN2/AU		3.69600	MY/JL		3.69600
QOCT	MY/AU1		3.69600	MY/AU		3.69600
QOCT	MY/SE1		3.69600	MY/SE		10.45000
QOCT	JN/JL		3.69600	JN/AU1		3.69600
QOCT	JN/AU		3.69600	JN/SE1		3.69600
QOCT	JN/SE		10.45000	JN2/JL		3.69600
QOCT	JN2/AU1		3.69600	JN2/SE1		3.69600
QOCT	JN2/SE		10.45000	JL/AU1		3.69600
QOCT	JL/AU		3.69600	JL/SE1		3.69600
QOCT	JL/SE		10.45000	JL2/SE		6.75400
QOCT	AU/SE		6.75400	AU2/SE		6.75400
QOCT	*YRLABOR		109.91400	OJAN2	-	1.23200
QOCT	OJUL	-	3.69600	OSEP	-	6.75400
QOCT	OOCT	-	1.23200	OJAN	-	1.23200
QOCT	OJN2/AU	-	4.34900	*OYLABOR		12.91400
QOCT	TJAN2		1.10000	TJUL		3.30000
QOCT	TSEP		6.05000	TOCT		1.10000
QOCT	TJAN		1.10000	TMY/JL		3.30000
QOCT	TMY/AU1		3.30000	TMY/AU		3.30000
QOCT	TMY/SE1		3.30000	TMY/SE		9.35000
QOCT	TJN/JL		3.30000	TJN/AU1		3.30000
QOCT	TJN/AU		3.30000	TJN/SE1		3.30000
QOCT	TJN/SE		9.35000	TJN2/JL		3.30000
QOCT	TJN2/AU1		3.30000	TJN2/AU		3.30000
QOCT	TJN2/SE1		3.30000	TJN2/SE		9.35000
QOCT	TJL/AU1		3.30000	TJL/AU		3.30000
QOCT	TJL/SE1		3.30000	TJL/SE		9.35000
QOCT	TJL2/SE		6.05000	TAU/SE		6.05000
QOCT	TAU2/SE		6.05000	PJUL		3.30000
QOCT	PSEP		3.30000	PJN/AU1		3.30000
QOCT	PJN/AU		3.30000	PJN2/JL		3.30000
QOCT	PJN2/AU1		3.30000	PJN2/AU		3.30000
QOCT	PJL/AU1		3.30000	PJL/AU		3.30000
QOCT	HSEP		1.65000	GJAN2		1.10000
QOCT	GOCT		1.10000	GJAN		1.10000
QOCT	*CAPITAL		195.42000	*QOCT	-	1.00000
QOCT	*TRACTOR		11.55000	*PLOW		6.60000
QOCT	*HARROW		1.65000	*DRILL		2.20000
QOCT	INCOME	-	195.42000			
HJLAU	NOV		2.46400	DEC		9.66400
HJLAU	MAY		3.69600	MY/JN		3.69600
HJLAU	JN2/JL1		6.75400	JN2/AU		11.21800
HJLAU	JL2/AU		4.46400	MY/JL1		10.45000
HJLAU	MY/JL		10.45000	MY/AU1		10.45000
HJLAU	MY/AU		14.91400	MY/SE1		14.91400
HJLAU	MY/SE		14.91400	JN/JL1		6.75400
HJLAU	JN/JL		6.75400	JN/AU1		6.75400

HJLAU	JN/AU		6.75400	JN/SE1		6.75400
HJLAU	JN/SE		6.75400	JN2/JL		6.75400
HJLAU	JN2/AU1		6.75400	JN2/SE1		6.75400
HJLAU	JN2/SE		6.75400	JL/AU		4.46400
HJLAU	JL/SE1		4.46400	JL/SE		4.46400
HJLAU	JL2/SE1		4.46400	JL2/SE		4.46400
HJLAU	*YRLABOR		27.04200	ONOV	-	2.46400
HJLAU	ODEC	-	.06400	OMAY	-	3.69600
HJLAU	OMY/JN	-	3.69600	OJN2/JL1	-	6.75400
HJLAU	OJN2/AU	-	9.21800	OJL2/AU	-	2.46400
HJLAU	*OYLABOR		15.44200	TNOV		2.20000
HJLAU	TMAY		3.30000	TMY/JN		3.30000
HJLAU	TJN2/JL1		6.05000	TJL2/AU		2.20000
HJLAU	TMY/JL1		9.35000	TMY/JL		9.35000
HJLAU	TMY/AU1		9.35000	TMY/AU		11.55000
HJLAU	TMY/SE1		11.55000	TMY/SE		11.55000
HJLAU	TJN/JL1		6.05000	TJN/JL		6.05000
HJLAU	TJN/AU1		6.05000	TJN/AU		8.25000
HJLAU	TJN/SE1		8.25000	TJN/SE		8.25000
HJLAU	TJN2/JL		6.05000	TJN2/AU1		6.05000
HJLAU	TJN2/AU		8.25000	TJN2/SE1		8.25000
HJLAU	TJN2/SE		8.25000	TJL/AU		2.20000
HJLAU	TJL/SE1		2.20000	TJL/SE		2.20000
HJLAU	TJL2/SE1		2.20000	TJL2/SE		2.20000
HJLAU	PMAY		3.30000	PJN2/JL1		3.30000
HJLAU	PJN/JL1		3.30000	PJN/JL		3.30000
HJLAU	PJN/AU1		3.30000	PJN/AU		3.30000
HJLAU	PJN2/JL		3.30000	PJN2/AU1		3.30000
HJLAU	PJN2/AU		3.30000	HJN2/JL1		1.65000
HJLAU	GJL2/AU		2.20000	GJL2/SE1		2.20000
HJLAU	GJL2/SE		2.20000	CNOV		2.20000
HJLAU	KDEC		3.20000	*CAPITAL		530.51700
HJLAU	*HJLAU	-	1.00000	*TRACTOR		13.75000
HJLAU	*PLOW		6.60000	*HARROW		1.65000
HJLAU	*DRILL		2.20000	*CULTIV		2.20000
HJLAU	*KINK		3.20000	INCOME	-	530.51700
HAUSE	NOV		2.46400	DEC		9.66400
HAUSE	MAY		3.69600	MY/JN		3.69600
HAUSE	JN2/AU		6.75400	JL2/AU1		6.75400
HAUSE	JL2/AU		6.75400	AU2/SE1		4.46400
HAUSE	MY/JL1		3.69600	MY/JL		3.69600
HAUSE	MY/AU1		10.45000	MY/SE1		14.91400
HAUSE	MY/SE		14.91400	JN/AU1		6.75400
HAUSE	JN/AU		6.75400	JN/SE1		11.21800
HAUSE	JN/SE		11.21800	JN2/AU1		11.21800
HAUSE	JN2/SE1		11.21800	JN2/SE		11.21800
HAUSE	JL/AU1		6.75400	JL/AU		6.75400
HAUSE	JL/SE1		11.21800	JL/SE		11.21800
HAUSE	JL2/SE1		11.21800	JL2/SE		11.21800
HAUSE	AU/SE1		4.46400	AU/SE		4.46400
HAUSE	AU2/SE		4.46400	*YRLABOR		27.04200

HAUSE	ONOV	-	2.46400	ODEC	-	.06400
HAUSE	OMAY	-	3.69600	OMY/JN	-	3.69600
HAUSE	OJN2/AU	-	6.75400	OJL2/AU1	-	6.75400
HAUSE	OJL2/AU	-	6.75400	OAU2/SE1	-	2.46400
HAUSE	*OYLABOR		15.44200	TNOV		2.20000
HAUSE	TMAY		3.30000	TMY/JN		3.30000
HAUSE	TJL2/AU1		6.05000	TJL2/AU		6.05000
HAUSE	TAU2/SE1		2.20000	TMY/JL1		3.30000
HAUSE	TMY/JL		3.30000	TMY/AU1		9.35000
HAUSE	TMY/AU		9.35000	TMY/SE1		11.55000
HAUSE	TMY/SE		11.55000	TJN/AU1		6.05000
HAUSE	TJN/AU		6.05000	TJN/SE1		8.25000
HAUSE	TJN/SE		8.25000	TJN2/AU1		6.05000
HAUSE	TJN2/AU		6.05000	TJN2/SE1		8.25000
HAUSE	TJN2/SE		8.25000	TJL/AU1		6.05000
HAUSE	TJL/AU		6.05000	TJL/SE1		8.25000
HAUSE	TJL/SE		8.25000	TJL2/SE1		8.25000
HAUSE	TJL2/SE		8.25000	TAU/SE1		2.20000
HAUSE	TAU/SE		2.20000	TAU2/SE		2.20000
HAUSE	PMAY		3.30000	PJN/AU1		3.30000
HAUSE	PJN/AU		3.30000	PJN2/AU1		3.30000
HAUSE	PJN2/AU		3.30000	PJL/AU1		3.30000
HAUSE	PJL/AU		3.30000	PJL2/AU		3.30000
HAUSE	HJL2/AU1		1.65000	HJL2/AU		1.65000
HAUSE	GAU2/SE1		2.20000	GJL2/SE1		2.20000
HAUSE	GJL2/SE		2.20000	GAU2/SE		2.20000
HAUSE	CNOV		2.20000	KDEC		3.20000
HAUSE	*CAPITAL		530.51700	*HAUSE	-	1.00000
HAUSE	*TRACTOR		13.75000	*PLOW		6.60000
HAUSE	*HARROW		1.65000	*DRILL		2.20000
HAUSE	*CULTIV		2.20000	*KINK		3.20000
HAUSE	INCOME	-	530.51700			
BARL	NOV		6.75400	DEC		2.23200
BARL	JAN		2.23200	JUN		3.69600
BARL	MY/JN		3.69600	MY/JL1		3.69600
BARL	MY/JL		3.69600	MY/AU1		3.69600
BARL	MY/AU		3.69600	MY/SE1		3.69600
BARL	MY/SE		3.69600	JN/JL1		3.69600
BARL	JN/JL		3.69600	JN/AU1		3.69600
BARL	JN/AU		3.69600	JN/SE1		3.69600
BARL	JN/SE		3.69600	*YRLABOR		14.91400
BARL	ONOV	-	6.75400	ODEC	-	1.23200
BARL	OJAN	-	1.23200	OJUN	-	3.69600
BARL	OMY/JN	-	3.69600	*OYLABOR		12.91400
BARL	TNOV		6.05000	TDEC		1.10000
BARL	TJAN		1.10000	TJUN		3.30000
BARL	TMY/JN		3.30000	TMY/JL1		3.30000
BARL	TMY/JL		3.30000	TMY/AU1		3.30000
BARL	TMY/AU		3.30000	TMY/SE1		3.30000
BARL	TMY/SE		15.95000	TJN/JL1		3.30000
BARL	TJN/JL		3.30000	TJN/AU1		3.30000

BARL	TJN/AU		3.30000	TJN/SE1	3.30000
BARL	TJN/SE		15.95000	PNOV	3.30000
BARL	PJUN		3.30000	PJN/JL1	3.30000
BARL	PJN/JL		3.30000	PJN/AU1	3.30000
BARL	PJN/AU		3.30000	PJN2/JL	3.30000
BARL	PJN/SE1		3.30000	PJN/SE	3.30000
BARL	HNOV		1.65000	GDEC	1.10000
BARL	GJAN		1.10000	*CAPITAL	356.57000
BARL	*B	-	1.00000	*TRACTOR	11.55000
BARL	*PLOW		6.60000	*HARROW	1.65000
BARL	*DRILL		2.20000	INCOME	- 356.57000
ALFAL	SEP		80.67400	OCT	65.92900
ALFAL	NOV		75.24000	DEC	63.88000
ALFAL	JAN		20.82100	FEB	69.13800
ALFAL	JUN		3.69600	FE/MA	69.13800
ALFAL	MY/JN		3.69600	MY/JL1	3.69600
ALFAL	MY/JL		3.69600	MY/AU1	3.69600
ALFAL	MY/AU		3.69600	MY/SE1	3.69600
ALFAL	MY/SE		84.37000	JN/JL1	3.69600
ALFAL	JN/JL		3.69600	JN/AU1	3.69600
ALFAL	JN/AU		3.69600	JN/SE1	3.69600
ALFAL	JN/SE		84.37000	JN2/SE	80.67400
ALFAL	JL/SE		80.67400	JL2/SE	80.67400
ALFAL	AU/SE		80.67400	AU2/SE	80.67400
ALFAL	*YRLABOR		379.37800	OSEP	- 15.49000
ALFAL	OOCT	-	3.48900	ONOV	- 1.52000
ALFAL	ODEC	-	1.28600	OJAN	- .42100
ALFAL	OFEB	-	1.33800	OJUN	- 3.69600
ALFAL	OFE/MA	-	1.33800	OMY/JN	- 3.69600
ALFAL	*OYLABOR		27.24000	WATSEP	452.59700
ALFAL	WATOCT		607.91100	WATNOV	409.48300
ALFAL	WATDEC		346.39700	WATJAN	113.46000
ALFAL	WATFEB		376.74000	*YRWATER	2306.58800
ALFAL	TSEP		12.65000	TOCT	1.10000
ALFAL	TJUN		3.30000	TMY/JN	3.30000
ALFAL	TMY/JL1		3.30000	TMY/JL	3.30000
ALFAL	TMY/AU1		3.30000	TMY/AU	3.30000
ALFAL	TMY/SE1		3.30000	TMY/SE	15.95000
ALFAL	TJN/JL1		3.30000	TJN/JL	3.30000
ALFAL	TJN/AU1		3.30000	TJN/AU	3.30000
ALFAL	TJN/SE1		3.30000	TJN/SE	15.95000
ALFAL	TJN2/JL		3.30000	TJN2/AU1	3.30000
ALFAL	TJN2/AU		3.30000	TJN2/SE1	3.30000
ALFAL	TJN2/SE		15.95000	TJL/SE	12.65000
ALFAL	TJL2/SE		12.65000	TAU/SE	12.65000
ALFAL	TAU2/SE		12.65000	PSEP	3.30000
ALFAL	PJUN		3.30000	PJN/JL1	3.30000
ALFAL	PJN/JL		3.30000	PJN/AU1	3.30000
ALFAL	PJN/AU		3.30000	HSEP	1.65000
ALFAL	GOCT		1.10000	*CAPITAL	444.40000
ALFAL	*A	-	1.00000	*TRACTOR	17.05000

ALFAL	*PLOW		6.60000	*HARROW		1.65000
ALFAL	*DRILL		1.10000	INCOME	=	444.40000
WEEP	NOV		6.75400	DEC		2.23200
WEEP	JAN		4.92800	JUN		3.69600
WEEP	MY/JN		3.69600	MY/JL1		3.69600
WEEP	MY/JL		3.69600	*YALABOR		21.61000
WEEP	MY/AU1		3.69600	MY/AU		3.69600
WEEP	MY/SE1		3.69600	MY/SE		3.69600
WEEP	JN/JL1		3.69600	JN/JL		3.69600
WEEP	JN/AU1		3.69600	JN/AU		3.69600
WEEP	JN/SE1		3.69600	JN/SE		3.69600
WEEP	ONOV	=	6.75400	ODEC	=	1.23200
WEEP	OJAN	=	4.92800	OJUN	=	3.69600
WEEP	OMY/JN	=	3.69600	*OYLABOR		16.61000
WEEP	TNOV		6.05000	TDEC		1.10000
WEEP	TJAN		4.40000	TJUN		3.30000
WEEP	TMY/JN		3.30000	TMY/JL1		3.30000
WEEP	TMY/JL		3.30000	TMY/AU1		3.30000
WEEP	TMY/AU		3.30000	TMY/SE1		3.30000
WEEP	TMY/SE		3.30000	TJN/JL1		3.30000
WEEP	TJN/JL		3.30000	TJN/AU1		3.30000
WEEP	TJN/AU		3.30000	TJN/SE1		3.30000
WEEP	TJN/SE		3.30000	PNOV		3.30000
WEEP	PJUN		3.30000	PJN/JL1		3.30000
WEEP	PJN/JL		3.30000	PJN/AU1		3.30000
WEEP	PJN/AU		3.30000	HNOV		1.65000
WEEP	GDEC		1.10000	GJAN		4.40000
WEEP	*CAPITAL		931.24500	*WEEP	=	1.00000
WEEP	*TRACTOR		14.85000	*PLOW		6.60000
WEEP	*HARROW		1.65000	*DRILL		5.50000
WEEP	INCOME	=	931.24500			
POCT1	LAND1		1.00000	*POCT		1.00000
POCT1	*P1	=	1.00000	*PHARV	=	210.00000
POCT1	*LANDUSE		1.00000			
POCT2	LAND2		1.00000	*POCT		1.00000
POCT2	*P2	=	1.00000	*PHARV	=	173.00000
POCT2	*LANDUSE		1.00000			
POCT3	LAND3		1.00000	*POCT		1.00000
POCT3	*P3	=	1.00000	*PHARV	=	100.00000
POCT3	*LANDUSE		1.00000			
PNOV1	LAND1		1.00000	*PNOV		1.00000
PNOV1	*P1	=	1.00000	*PHARV	=	205.00000
PNOV1	*LANDUSE		1.00000			
PNOV2	LAND2		1.00000	*PNOV		1.00000
PNOV2	*P2	=	1.00000	*PHARV	=	169.00000
PNOV2	*LANDUSE		1.00000			
PNOV3	LAND3		1.00000	*PNOV		1.00000
PNOV3	*P3	=	1.00000	*PHARV	=	98.00000
PNOV3	*LANDUSE		1.00000			
PDEC1	LAND1		1.00000	*PDEC		1.00000
PDEC1	*P1	=	1.00000	*PHARV	=	200.00000

0.0.0.0.0.0 = 0.0.0.0.0.0					
0.0.0.0.0.0 = 0.0.0.0.0.0	=	0.0.0.0.0.0 = 0.0.0.0.0.0	0.0.0.0.0.0 = 0.0.0.0.0.0	=	0.0.0.0.0.0 = 0.0.0.0.0.0

0.00000	1,500,000	1,500,000	=	0.00000	1,500,000	1,500,000	=
0.00000	2.4	0.00000	=	0.00000	2.4	0.00000	=
0.00000	0.00000	0.00000		0.00000	0.00000	0.00000

P*JAN3	FED		30.14500	FE/MA		30.14500
P*JAN3	*HRL ABOR		30.14500	OFED	=	.60900
P*JAN3	*OWL ABOR		.60900	WATFED		820.33700
P*JAN3	*HRWATER		820.33700	*PJAN		1.00000
GSEP1	LAND1		1.00000	*GSEP		1.00000
GSEP1	*G1	=	1.00000	*GMARW	=	35.00000
GSEP1	*LANDUSE		1.00000			
GSEP2	LAND2		1.00000	*GSEP		1.00000
GSEP2	*G2	=	1.00000	*GMARW	=	30.00000
GSEP2	*LANDUSE		1.00000			
GSEP3	LAND3		1.00000	*GSEP		1.00000
GSEP3	*G3	=	1.00000	*GMARW	=	20.00000
GSEP3	*LANDUSE		1.00000			
GOCT1	LAND1		1.00000	*GOCT		1.00000
GOCT1	*G1	=	1.00000	*GMARW	=	35.00000
GOCT1	*LANDUSE		1.00000			
GOCT2	LAND2		1.00000	*GOCT		1.00000
GOCT2	*G2	=	1.00000	*GMARW	=	30.00000
GOCT2	*LANDUSE		1.00000			
GOCT3	LAND3		1.00000	*GOCT		1.00000
GOCT3	*G3	=	1.00000	*GMARW	=	20.00000
GOCT3	*LANDUSE		1.00000			
G*SEP1	LAND1		1.00000	*GSEP		1.00000
G*SEP1	*G*1	=	1.00000	*GMARW	=	45.00000
G*SEP1	*LANDUSE		1.00000	NOW		41.66600
G*SEP1	FED		7.25400	FE/MA		7.25400
G*SEP1	*HRL ABOR		48.92400	ONOW	=	.67600
G*SEP1	OFED	=	.11400	OFE/MA	=	.11400
G*SEP1	*OWL ABOR		.79400	WATNOW		910.82200
G*SEP1	WATFED		158.75200	*HRWATER		1069.57400
G*SEP1	2NOW		4.09900	2FED		.71400
G*SEP1	*2PRE INK		4.81300			
G*SEP2	LAND2		1.00000	*GSEP		1.00000
G*SEP2	*G*2	=	1.00000	*GMARW	=	38.00000
G*SEP2	*LANDUSE		1.00000	NOW		41.66600
G*SEP2	FED		7.25400	FE/MA		7.25400
G*SEP2	*HRL ABOR		48.92400	ONOW	=	.67600
G*SEP2	OFED	=	.11400	OFE/MA	=	.11400
G*SEP2	*OWL ABOR		.79400	WATNOW		910.82200
G*SEP2	WATFED		158.75200	*HRWATER		1069.57400
G*SEP2	2NOW		4.09900	2FED		.71400
G*SEP2	*2PRE INK		4.81300			
G*SEP3	LAND3		1.00000	*GSEP		1.00000
G*SEP3	*G*3	=	1.00000	*GMARW	=	25.00000
G*SEP3	*LANDUSE		1.00000	NOW		41.66600
G*SEP3	FED		7.25400	FE/MA		7.25400
G*SEP3	*HRL ABOR		48.92400	ONOW	=	.67600
G*SEP3	OFED	=	.11400	OFE/MA	=	.11400
G*SEP3	*OWL ABOR		.79400	WATNOW		910.82200
G*SEP3	WATFED		158.75200	*HRWATER		1069.57400
G*SEP3	2NOW		4.09900	2FED		.71400

Q*SEP3	*ZPRINK		4.81300			
Q*OCT1	LAND1		1.00000	*QOCT		1.00000
Q*OCT1	*Q*1	=	1.00000	*QHARV	=	45.00000
Q*OCT1	*LANDUSE		1.00000	NOV		41.66600
Q*OCT1	FEB		7.25800	FE/MA		7.25800
Q*OCT1	*YRL ABOR		48.92400	ONOV	=	.67600
Q*OCT1	OFEB	=	.11800	OFE/MA	=	.11800
Q*OCT1	*OYL ABOR		.79400	WATNOV		910.82200
Q*OCT1	WATFEB		158.75200	*YRWATER		1069.57400
Q*OCT1	ZNOV		4.09900	ZFEB		.71400
Q*OCT1	*ZPRINK		4.81300			
Q*OCT2	LAND2		1.00000	*QOCT		1.00000
Q*OCT2	*Q*2	=	1.00000	*QHARV	=	38.00000
Q*OCT2	*LANDUSE		1.00000	NOV		41.66600
Q*OCT2	FEB		7.25800	FE/MA		7.25800
Q*OCT2	*YRL ABOR		48.92400	ONOV	=	.67600
Q*OCT2	OFEB	=	.11800	OFE/MA	=	.11800
Q*OCT2	*OYL ABOR		.79400	WATNOV		910.82200
Q*OCT2	WATFEB		158.75200	*YRWATER		1069.57400
Q*OCT2	ZNOV		4.09900	ZFEB		.71400
Q*OCT2	*ZPRINK		4.81300			
Q*OCT3	LAND3		1.00000	*QOCT		1.00000
Q*OCT3	*Q*3	=	1.00000	*QHARV	=	25.00000
Q*OCT3	*LANDUSE		1.00000	NOV		41.66600
Q*OCT3	FEB		7.25800	FE/MA		7.25800
Q*OCT3	*YRL ABOR		48.92400	ONOV	=	.67600
Q*OCT3	OFEB	=	.11800	OFE/MA	=	.11800
Q*OCT3	*OYL ABOR		.79400	WATNOV		910.82200
Q*OCT3	WATFEB		158.75200	*YRWATER		1069.57400
Q*OCT3	ZNOV		4.09900	ZFEB		.71400
Q*OCT3	*ZPRINK		4.81300			
HJLAU1	LAND1		1.00000	*HJLAU		1.00000
HJLAU1	*H1	=	1.00000	*HJLAU1	=	1.00000
HJLAU1	*LANDUSE		1.00000			
HJLAU2	LAND2		1.00000	*HJLAU		1.00000
HJLAU2	*H2	=	1.00000	*HJLAU2	=	1.00000
HJLAU2	*LANDUSE		1.00000			
HJLAU3	LAND3		1.00000	*HJLAU		1.00000
HJLAU3	*H3	=	1.00000	*HJLAU3	=	1.00000
HJLAU3	*LANDUSE		1.00000			
HAUSE1	LAND1		1.00000	*HAUSE		1.00000
HAUSE1	*H1	=	1.00000	*HAUSE1	=	1.00000
HAUSE1	*LANDUSE		1.00000			
HAUSE2	LAND2		1.00000	*HAUSE		1.00000
HAUSE2	*H2	=	1.00000	*HAUSE2	=	1.00000
HAUSE2	*LANDUSE		1.00000			
HAUSE3	LAND3		1.00000	*HAUSE		1.00000
HAUSE3	*H3	=	1.00000	*HAUSE3	=	1.00000
HAUSE3	*LANDUSE		1.00000			
BAR1	LAND1		1.00000	*B		1.00000
BAR1	*B1	=	1.00000	*LANDUSE		1.00000

BAR2	LAND2		1.00000	*B		1.00000
BAR2	*B2	-	1.00000	*LANDUSE		1.00000
BAR3	LAND3		1.00000	*B		1.00000
BAR3	*B3	-	1.00000	*LANDUSE		1.00000
ALF1	LAND1		5.00000	*A		1.00000
ALF1	*A1	-	1.00000	*LANDUSE		5.00000
ALF2	LAND2		5.00000	*A		1.00000
ALF2	*A2	-	1.00000	*LANDUSE		5.00000
ALF3	LAND3		5.00000	*A		1.00000
ALF3	*A3	-	1.00000	*LANDUSE		5.00000
GHHJLAU1	*HJLAU1		1.00000	*HFORGH	-	160.00000
GHHJLAU2	*HJLAU2		1.00000	*HFORGH	-	133.00000
GHHJLAU3	*HJLAU3		1.00000	*HFORGH	-	80.00000
GHHAUSE1	*HAUSE1		1.00000	*HFORGH	-	155.00000
GHHAUSE2	*HAUSE2		1.00000	*HFORGH	-	129.00000
GHHAUSE3	*HAUSE3		1.00000	*HFORGH	-	77.00000
DHHJLAU1	*HJLAU1		1.00000	*HFORDH	-	45.00000
DHHJLAU2	*HJLAU2		1.00000	*HFORDH	-	37.00000
DHHJLAU3	*HJLAU3		1.00000	*HFORDH	-	22.00000
DHHAUSE1	*HAUSE1		1.00000	*HFORDH		43.00000
DHHAUSE2	*HAUSE2		1.00000	*HFORDH	-	36.00000
DHHAUSE3	*HAUSE3		1.00000	*HFORDH	-	21.00000
BSIL1	*BHARV1		1.00000	*BFORSIL		400.00000
BSIL2	*BHARV2		1.00000	*BFORSIL	-	330.00000
BSIL3	*BHARV3		1.00000	*BFORSIL		190.00000
BHAY1	*BHARV1		1.00000	*BFORHAY		210.00000
BHAY2	*BHARV2		1.00000	*BFORHAY	-	173.00000
BHAY3	*BHARV3		1.00000	*BFORHAY	-	100.00000
ASIL1	*AHARV1		1.00000	*AFORSIL	-	800.00000
ASIL2	*AHARV2		1.00000	*AFORSIL	-	667.00000
ASIL3	*AHARV3		1.00000	*AFORSIL	-	400.00000
AHAY1	*AHARV1		1.00000	*AFORHAY	-	430.00000
AHAY2	*AHARV2		1.00000	*AFORHAY	-	358.00000
AHAY3	*AHARV3		1.00000	*AFORHAY	-	215.00000
APAST1	*AHARV1		1.00000	*AFORMAT	-	9.34700
APAST2	*AHARV2		1.00000	*AFORMAT	-	7.94600
APAST3	*AHARV3		1.00000	*AFORMAT	-	6.07700
POTHARV	*PHARV		1.00000	*POTATO	-	1.00000
POTHARV	MAY		.27300	MY/JN		.27300
POTHARV	MY/JL1		.27300	MY/JL		.27300
POTHARV	MY/AU1		.27300	MY/AU		.27300
POTHARV	MY/SE1		.27300	MY/SE		.27300
POTHARV	*YRLABOR		.27300	OMAY	-	.01400
POTHARV	OJUN	-	.01400	*OYLABOR		.01400
POTHARV	TMAY		.01200	TMY/JN		.01200
POTHARV	TMY/JL1		.01200	TMY/JL		.01200
POTHARV	TMY/AU1		.01200	TMY/AU		.01200
POTHARV	TMY/SE1		.01200	TMY/SE		.01200
POTHARV	DMAY		.01200	*TRACTOR		.01200
POTHARV	*DIGGER		.01200			
QUINHARV	*QHARV		1.00000	*QUINUA	-	1.00000

QUIHARV	JUN		1.33300	JUL	1.84700
QUIHARV	MY/JN		1.33300	JN2/AU	1.84700
QUIHARV	MY/JL1		1.33300	MY/JL	3.18000
QUIHARV	MY/AU1		3.18000	MY/AU	3.18000
QUIHARV	MY/SE1		3.18000	MY/SE	3.18000
QUIHARV	JN/JL1		1.33300	JN/JL	3.18000
QUIHARV	JN/AU1		3.18000	JN/AU	3.18000
QUIHARV	JN/SE1		3.18000	JN/SE	3.18000
QUIHARV	JN2/JL		1.84700	JN2/AU1	1.84700
QUIHARV	JN2/SE1		1.84700	JN2/SE	1.84700
QUIHARV	JL/AU1		1.84700	JL/AU	1.84700
QUIHARV	JL/SE1		1.84700	JL/SE	1.84700
QUIHARV	*YRLABOR		3.18000	OJUL	- .01900
QUIHARV	OJN2/AU	-	.01900	*OYLABOR	.01900
QUIHARV	TJUL		.01700	TMY/JL	.01700
QUIHARV	TMY/AU1		.01700	TMY/AU	.01700
QUIHARV	TMY/SE1		.01700	TMY/SE	.01700
QUIHARV	TJN/JL		.01700	TJN/AU1	.01700
QUIHARV	TJN/AU		.01700	TJN/SE1	.01700
QUIHARV	TJN/SE		.01700	TJN2/JL	.01700
QUIHARV	TJN2/AU1		.01700	TJN2/AU	.01700
QUIHARV	TJN2/SE1		.01700	TJN2/SE	.01700
QUIHARV	TJL/AU1		.01700	TJL/AU	.01700
QUIHARV	TJL/SE1		.01700	TJL/SE	.01700
QUIHARV	WJUL		.01700	*TRACTOR	.01700
QUIHARV	*WAGON		.01700		
GHHARV	*HFORGH		1.00000	*GBEANS	- 1.00000
GHHARV	FE/MA		.20600	*YRLABOR	.20600
GHHARV	OFE/MA	-	.01900	*OYLABOR	- .01900
GHHARV	TFE/MA		.01700	WFE/MA	.01700
GHHARV	*TRACTOR		.01700	*WAGON	.01700
DHHARV	*HFORDH		1.00000	*DBEANS	- 1.00000
DHHARV	MAY		.91900	MY/JN	.91900
DHHARV	MY/JL1		.91900	MY/JL	.91900
DHHARV	MY/AU1		.91900	MY/AU	.91900
DHHARV	MY/SE1		.91900	MY/SE	.91900
DHHARV	*YRLABOR		.91900	OMAY	- .01900
DHHARV	OMY/JN	-	.01900	*OYLABOR	.10900
DHHARV	TMAY		.01700	TMY/JN	.01700
DHHARV	TMY/JL1		.01700	TMY/JL	.01700
DHHARV	TMY/AU1		.01700	TMY/AU	.01700
DHHARV	TMY/SE1		.01700	TMY/SE	.01700
DHHARV	WMAY		.01700	WMY/JN	.01700
DHHARV	*TRACTOR		.01700	*WAGON	.01700
BSILMAK	APR		.15000	*YRLABOR	.15000
BSILMAK	OAPR	-	.03100	*OYLABOR	.03100
BSILMAK	TAPR		.02800	FAPR	.01100
BSILMAK	WAPR		.01700	*BFORSIL	1.00000
BSILMAK	*CAPITAL		.09100	*BARSIL	- 1.00000
BSILMAK	*TRACTOR		.02800	*HARVEST	.01100
BSILMAK	*WAGON		.01700	INCOME	- .09100

BHAYMAK	MY/JN		.14600	MY/JL1		.14600
BHAYMAK	MY/JL		.14600	MY/AU1		.14600
BHAYMAK	MY/AU		.14600	MY/SE1		.14600
BHAYMAK	MY/SE		.14600	*YRLABOR		.14600
BHAYMAK	OMY/JN	-	.05900	*OYLABOR		.05900
BHAYMAK	TMY/JN		.05300	TMY/JL1		.05300
BHAYMAK	TMY/JL		.05300	TMY/AU1		.05300
BHAYMAK	TMY/AU		.05300	TMY/SE1		.05300
BHAYMAK	TMY/SE		.05300	RMY/JN		.01400
BHAYMAK	BMY/JN		.02200	WMY/JN		.01700
BHAYMAK	*BFORHAY		1.00000	*CAPITAL		.22700
BHAYMAK	*BARHAY	-	1.00000	*TRACTOR		.05300
BHAYMAK	*RAKE		.01400	*BALER		.02200
BHAYMAK	*WAGON		.01700	INCOME	-	.22700
ASILMAK	MAR		.07500	APR		.07500
ASILMAK	FE/MA		.07500	*YRLABOR		.15000
ASILMAK	OMAR	-	.01550	OAPR	-	.01550
ASILMAK	OFE/MA	-	.01550	*OYLABOR		.03100
ASILMAK	TMAR		.01400	TAPR		.01400
ASILMAK	TFE/MA		.01400	FMAR		.00550
ASILMAK	FAPR		.00550	WMAR		.00850
ASILMAK	WAPR		.00850	WFE/MA		.00850
ASILMAK	*AFORSIL		1.00000	*CAPITAL		.09100
ASILMAK	*ALFSIL	-	1.00000	*TRACTOR		.02800
ASILMAK	*HARVEST		.01100	*WAGON		.01700
ASILMAK	INCOME	-	.09100			
AHAYMAK	MAY		.06800	JUN		.07800
AHAYMAK	MY/JN		.14600	MY/JL1		.14600
AHAYMAK	MY/JL		.14600	MY/AU1		.14600
AHAYMAK	MY/AU		.14600	MY/SE1		.14600
AHAYMAK	MY/SE		.14600	JN/JL1		.07800
AHAYMAK	JN/JL		.07800	JN/AU1		.07800
AHAYMAK	JN/AU		.07800	JN/SE1		.07800
AHAYMAK	JN/SE		.07800	*YRLABOR		.14600
AHAYMAK	OMAY	-	.02400	OJUN	-	.03500
AHAYMAK	OMY/JN	-	.05900	*OYLABOR		.05900
AHAYMAK	TMAY		.21200	TJUN		.31800
AHAYMAK	TMY/JN		.53000	TMY/JL1		.53000
AHAYMAK	TMY/JL		.53000	TMY/AU1		.53000
AHAYMAK	TMY/AU		.53000	TMY/SE1		.53000
AHAYMAK	TMY/SE		.53000	TJN/JL1		.31800
AHAYMAK	TJN/JL		.31800	TJN/AU1		.31800
AHAYMAK	TJN/AU		.31800	TJN/SE1		.31800
AHAYMAK	TJN/SE		.31800	RMAY		.00600
AHAYMAK	RJUN		.00800	RMY/JN		.01400
AHAYMAK	BMAY		.00900	BJUN		.01300
AHAYMAK	BMY/JN		.02200	WMAY		.00700
AHAYMAK	WJUN		.01000	WMY/JN		.01700
AHAYMAK	*AFORHAY		1.00000	*CAPITAL		.22700
AHAYMAK	*ALFHAY	-	1.00000	*TRACTOR		.05300
AHAYMAK	*RAKE		.01400	*BALER		.02200

AHAYMAK	*WAGON		.01700	INCOME	-	.22700
CHUMAK	*POTATO		3.00000	*CHUNO1	-	.40000
CHUMAK	*CHUNO2	-	.57000	*CHUNO3	-	.03000
CHUMAK	AUG		.22910	JN2/AU		9.22910
CHUMAK	MY/AU		9.22910	MY/SE1		9.22910
CHUMAK	MY/SE		9.22910	JN/AU		9.22910
CHUMAK	JN/SE1		9.22910	JN/SE		9.22910
CHUMAK	JN2/SE1		9.22910	JN2/SE		9.22910
CHUMAK	JL/AU		.22910	JL/SE1		.22910
CHUMAK	AU/SE		.22910	*YRLABOR		9.22910
CHUMAK	OAUG	-	.01910	*OYLABOR		.01910
CHUMAK	TAUG		.01700	TMY/JN		.01700
CHUMAK	TMY/SE1		.01700	TMY/SE		.01700
CHUMAK	TJN/AU		.01700	TJN/SE1		.01700
CHUMAK	TJN/SE		.01700	TJN2/SE1		.01700
CHUMAK	TJN2/SE		.01700	TJL/SE1		.01700
CHUMAK	TJL/SE		.01700	TJL2/SE1		.01700
CHUMAK	TJL2/SE		.01700	TAU/SE1		.01700
CHUMAK	TAU/SE		.01700	TAU2/SE1		.01700
CHUMAK	TAU2/SE		.01700	SAUG		.02000
CHUMAK	WAUG		.01700	*TRACTOR		.01700
CHUMAK	*SORTER		.02000	*WAGON		.01700
SELCHU1	*CHUNO1		1.00000	AUG2		.20000
SELCHU1	AUG		.20000	MY/AU		.20000
SELCHU1	MY/SE1		.20000	MY/SE		.20000
SELCHU1	JN/AU		.20000	JN/SE1		.20000
SELCHU1	JN/SE		.20000	JN2/AU		.20000
SELCHU1	JN2/SE1		.20000	JN2/SE		.20000
SELCHU1	JL/AU		.20000	JL/SE1		.20000
SELCHU1	JL/SE		.20000	JL2/AU		.20000
SELCHU1	JL2/SE1		.20000	JL2/SE		.20000
SELCHU1	AU/SE1		.20000	AU/SE		.20000
SELCHU1	AU2/SE1		.20000	AU2/SE		.20000
SELCHU1	*YRLABOR		.20000	*SALEAGR		150.00000
SELCHU1	INCOME		150.00000			
SELCHU2	*CHUNO2		1.00000	AUG2		.20000
SELCHU2	AUG		.20000	MY/AU		.20000
SELCHU2	MY/SE1		.20000	MY/SE		.20000
SELCHU2	JN/AU		.20000	JN/SE1		.20000
SELCHU2	JN/SE		.20000	JN2/AU		.20000
SELCHU2	JN2/SE1		.20000	JN2/SE		.20000
SELCHU2	JL/AU		.20000	JL/SE1		.20000
SELCHU2	JL/SE		.20000	JL2/AU		.20000
SELCHU2	JL2/SE1		.20000	JL2/SE		.20000
SELCHU2	AU/SE1		.20000	AU/SE		.20000
SELCHU2	AU2/SE1		.20000	AU2/SE		.20000
SELCHU2	*YRLABOR		.20000	*SALEAGR		130.00000
SELCHU2	INCOME		130.00000			
SELCHU3	*CHUNO3		1.00000	AUG2		.20000
SELCHU3	AUG		.20000	MY/AU		.20000
SELCHU3	MY/SE1		.20000	MY/SE		.20000

SELCHU3	JN/AU	.20000	JN/SE1	.20000
SELCHU3	JN/SE	.20000	JN2/AU	.20000
SELCHU3	JN2/SE1	.20000	JN2/SE	.20000
SELCHU3	JL/AU	.20000	JL/SE1	.20000
SELCHU3	JL/SE	.20000	JL2/AU	.20000
SELCHU3	JL2/SE1	.20000	JL2/SE	.20000
SELCHU3	AU/SE1	.20000	AU/SE	.20000
SELCHU3	AU2/SE1	.20000	AU2/SE	.20000
SELCHU3	*YRLABOR	.20000	*SALEAGR	110.00000
SELCHU3	INCOME	110.00000		
SELQUIN	*QUINUA	1.00000	AUG	.20000
SELQUIN	MY/AU	.20000	MY/SE1	.20000
SELQUIN	MY/SE	.20000	JN/AU	.20000
SELQUIN	JN/SE1	.20000	JN/SE	.20000
SELQUIN	JN2/AU	.20000	JN2/SE1	.20000
SELQUIN	JN2/SE	.20000	JL/AU	.20000
SELQUIN	JL/SE1	.20000	JL/SE	.20000
SELQUIN	JL2/AU	.20000	JL2/SE1	.20000
SELQUIN	JL2/SE	.20000	AU/SE1	.20000
SELQUIN	AU/SE	.20000	*YRLABOR	.20000
SELQUIN	*SALEAGR	60.00000	INCOME	60.00000
SELGBEAN	*GBEANS	1.00000	MAR	.20000
SELGBEAN	FE/MA	.20000	*YRLABOR	.20000
SELGBEAN	*SALEAGR	25.00000	INCOME	25.00000
SELDBEAN	*DBEANS	1.00000	JUN	.20000
SELDBEAN	MY/JN	.20000	MY/AU	.20000
SELDBEAN	MY/SE1	.20000	MY/SE	.20000
SELDBEAN	JN/AU	.20000	JN/SE1	.20000
SELDBEAN	JN/SE	.20000	*YRLABOR	.20000
SELDBEAN	*SALEAGR	80.00000	INCOME	80.00000
SELBHAY	JN2/AU	.20000	*YRLABOR	.20000
SELBHAY	*BARHAY	1.00000	*SALEAGR	2.45000
SELBHAY	MY/AU	.20000	MY/SE1	.20000
SELBHAY	MY/SE	.20000	JN/AU	.20000
SELBHAY	JN/SE1	.20000	JN/SE	.20000
SELBHAY	JN2/SE1	.20000	JN2/SE	.20000
SELBHAY	INCOME	2.45000		
SELAHAY	JN2/AU	.20000	*YRLABOR	.20000
SELAHAY	*ALFHAY	1.00000	*SALEAGR	4.41000
SELAHAY	MY/AU	.20000	MY/SE1	.20000
SELAHAY	MY/SE	.20000	JN/AU	.20000
SELAHAY	JN/SE1	.20000	JN/SE	.20000
SELAHAY	JN2/SE1	.20000	JN2/SE	.20000
SELAHAY	INCOME	4.41000		
SELLPELT	*LPELTS	1.00000	*SALELIV	9.50000
SELAPELT	*APELTS	1.00000	*SALELIV	14.25000
SELWOOL1	*WOOL1	1.00000	*SALELIV	9.02500
SELWOOL2	*WOOL2	1.00000	*SALELIV	8.55000
SELWOOL3	*WOOL3	1.00000	*SALELIV	7.60000
SELWOOL6	*WOOL6	1.00000	*SALELIV	2.75500
SELRAMS	*RAMS	1.00000	*SALELIV	334.00000

SELEWES	*EWES		1.00000	*SALELIV		221.50000
SELWETH	*WETHERS		1.00000	*SALELIV		188.30000
SELFLAMB	*FLAMBS		1.00000	*SALELIV		188.30000
TRACTOR	*TRACTOR	-	1.00000	*CAPITAL		14.75600
TRACTOR	INCOME	-	14.75600			
PLOW	*PLOW	-	1.00000	*CAPITAL		3.30600
PLOW	INCOME	-	3.30600			
HARROW	*HARROW	-	1.00000	*CAPITAL		.83200
HARROW	INCOME	-	.83200			
MOTORPUM	*MOTPUMP	-	1.00000	*CAPITAL		10.91600
MOTORPUM	INCOME	-	10.91600			
PPLANTER	*PLANTER	-	1.00000	*CAPITAL		3.03100
PPLANTER	INCOME	-	3.03100			
DRILL	*DRILL	-	1.00000	*CAPITAL		4.31200
DRILL	INCOME	-	4.31200			
CULTIVAT	*CULTIV	-	1.00000	*CAPITAL		1.77100
CULTIVAT	INCOME	-	1.77100			
SPRAYER	*KINK	-	1.00000	*CAPITAL		1.75100
SPRAYER	INCOME	-	1.75100			
HARVESTR	*HARVEST	-	1.00000	*CAPITAL		5.74100
HARVESTR	INCOME	-	5.74100			
RAKE	*RAKE	-	1.00000	*CAPITAL		4.54000
RAKE	INCOME	-	4.54000			
BALER	*BALER	-	1.00000	*CAPITAL		8.14600
BALER	INCOME	-	8.14600			
PDIGGER	*DIGGER	-	1.00000	*CAPITAL		3.19800
PDIGGER	INCOME	-	3.19800			
WAGON	*WAGON	-	1.00000	*CAPITAL		1.48700
WAGON	INCOME	-	1.48700			
SORTER	*SORTER	-	1.00000	*CAPITAL		.11300
SORTER	INCOME	-	.11300			
SPRINKLR	*ZPRINK	-	1.00000	*CAPITAL		.04500
SPRINKLR	INCOME	-	.04500			
*LANDTR	LAND		1.00000	LAND1	-	.09000
*LANDTR	LAND2	-	.05000	LAND3	-	.34000
*LANDTR	LAND4	-	.23000	LAND5	-	.04000
*LABORTR	PEOPLE		1.00000	JUL1	-	44.11420
*LABORTR	JUL2	-	47.50760	AUG1	-	40.72080
*LABORTR	AUG2	-	47.50760	SEP1	-	44.11420
*LABORTR	SEP2	-	44.11420	OCT1	-	44.11420
*LABORTR	OCT2	-	44.11420	NOV1	-	49.64700
*LABORTR	NOV2	-	49.64700	DEC1	-	49.64700
*LABORTR	DEC2	-	53.46600	JAN1	-	49.64700
*LABORTR	JAN2	-	49.64700	FEB1	-	40.72080
*LABORTR	FEB2	-	40.72080	MAR1	-	44.11420
*LABORTR	MAR2	-	47.50760	APR1	-	44.11420
*LABORTR	APR2	-	44.11420	MAY1	-	44.11420
*LABORTR	MAY2	-	44.11420	JUN1	-	44.11420
*LABORTR	JUN2	-	44.11420	JUL	-	91.62180
*LABORTR	AUG	-	88.22840	SEP	-	88.22840
*LABORTR	OCT	-	88.22840	NOV	-	99.29400

*LABORTR	DEC	-	103.11300	JAN	-	99.29400
*LABORTR	FEB	-	81.44160	MAR	-	91.62180
*LABORTR	APR	-	88.22840	MAY	-	88.22840
*LABORTR	JUN	-	88.22840	FE/MA	-	173.06340
*LABORTR	MY/JN	-	176.45680	JN2/JL1	-	88.22840
*LABORTR	JN2/AU	-	223.96440	JL2/AU1	-	88.22840
*LABORTR	JL2/AU	-	135.73600	AU2/SE1	-	91.62180
*LABORTR	*FIXCOST	-	16.30510	MY/JL1	-	132.34260
*LABORTR	MY/JL	-	179.85020	MY/AU1	-	220.57100
*LABORTR	MY/AU	-	268.07860	MY/SE1	-	312.19280
*LABORTR	MY/SE	-	356.30700	JN/JL1	-	132.34260
*LABORTR	JN/JL	-	179.85020	JN/AU1	-	220.57100
*LABORTR	JN/AU	-	268.07860	JN/SE1	-	312.19280
*LABORTR	JN/SE	-	356.30700	JN2/JL	-	135.73600
*LABORTR	JN2/AU1	-	176.45680	JN2/SE1	-	268.07860
*LABORTR	JN2/SE	-	312.19280	JL/AU1	-	132.34260
*LABORTR	JL/AU	-	179.85020	JL/SE1	-	223.96440
*LABORTR	JL/SE	-	268.07860	JL2/SE1	-	179.85020
*LABORTR	JL2/SE	-	223.96440	AU/SE1	-	132.34260
*LABORTR	AU/SE	-	176.45680	AU2/SE	-	135.73600
*BSILJUL	*DRYMJUL	-	.29400	*BARSIL		22.04600
*BSILAUG	*DRYMAUG	-	.28000	*BARSIL		22.04600
*BSILSEP	*DRYMSEP	-	.26600	*BARSIL		22.04600
*BSILOCT	*DRYMOCT	-	.25200	*BARSIL		22.04600
*BSILNOV	*DRYMNOV	-	.24000	*BARSIL		22.04600
*BSILDEC	*DRYMDEC	-	.28800	*BARSIL		22.04600
*BSILJAN	*DRYMJAN	-	.21600	*BARSIL		22.04600
*BSILFEB	*DRYMFEB	-	.20600	*BARSIL		22.04600
*BSILMAR	*DRYMMAR	-	.19500	*BARSIL		22.04600
*BSILAPR	*DRYMAPR	-	.18600	*BARSIL		22.04600
*BSILMAY	*DRYMMAY	-	.17600	*BARSIL		22.04600
*BSILJUN	*DRYMJUN	-	.31000	*BARSIL		22.04600
*ASILJUL	*DRYMJUL	-	.30600	*ALFSIL		22.04600
*ASILAUG	*DRYMAUG	-	.29100	*ALFSIL		22.04600
*ASILSEP	*DRYMSEP	-	.27600	*ALFSIL		22.04600
*ASILOCT	*DRYMOCT	-	.26200	*ALFSIL		22.04600
*ASILNOV	*DRYMNOV	-	.24900	*ALFSIL		22.04600
*ASILDEC	*DRYMDEC	-	.23700	*ALFSIL		22.04600
*ASILJAN	*DRYMJAN	-	.22500	*ALFSIL		22.04600
*ASILFEB	*DRYMFEB	-	.21400	*ALFSIL		22.04600
*ASILMAR	*DRYMMAR	-	.20300	*ALFSIL		22.04600
*ASILAPR	*DRYMAPR	-	.19300	*ALFSIL		22.04600
*ASILMAY	*DRYMMAY	-	.18300	*ALFSIL		22.04600
*ASILJUN	*DRYMJUN	-	.32200	*ALFSIL		22.04600
*BHAYJUL	*BARHAY		22.04600	*DRYMJUL	-	.87300
*BHAYAUG	*BARHAY		22.04600	*DRYMAUG	-	.85600
*BHAYSEP	*BARHAY		22.04600	*DRYMSEP	-	.83800
*BHAYOCT	*BARHAY		22.04600	*DRYMOCT	-	.82200
*BHAYNOV	*BARHAY		22.04600	*DRYMNOV	-	.80500
*BHAYDEC	*BARHAY		22.04600	*DRYMDEC	-	.78900
*BHAYJAN	*BARHAY		22.04600	*DRYMJAN	-	.73300

*BHAYFEB	*BARHAY		22.04600	*DRYMFEB	- .75800
*BHAYMAR	*BARHAY		22.04600	*DRYMMAR	- .74300
*BHAYAPR	*BARHAY		22.04600	*DRYMAPR	- .72800
*BHAYMAY	*BARHAY		22.04600	*DRYMMAY	- .71300
*BHAYJUN	*BARHAY		22.04600	*DRYMJUN	- .69900
*AHAYJUL	*ALFHAY		22.04600	*DRYMJUL	- .89200
*AHAYAUG	*ALFHAY		22.04600	*DRYMAUG	- .87400
*AHAYSEP	*ALFHAY		22.04600	*DRYMSEP	- .85700
*AHAYOCT	*ALFHAY		22.04600	*DRYMOCT	- .84000
*AHAYNOV	*ALFHAY		22.04600	*DRYMNOV	- .82300
*AHAYDEC	*ALFHAY		22.04600	*DRYMDEC	- .80600
*AHAYJAN	*ALFHAY		22.04600	*DRYMJAN	- .79000
*AHAYFEB	*ALFHAY		22.04600	*DRYMFEB	- .77400
*AHAYMAR	*ALFHAY		22.04600	*DRYMMAR	- .75900
*AHAYAPR	*ALFHAY		22.04600	*DRYMAPR	- .74400
*AHAYMAY	*ALFHAY		22.04600	*DRYMMAY	- .72900
*AHAYJUN	*ALFHAY		22.04600	*DRYMJUN	- .71400
*WETRJAN	*DRYMJAN	-	1.00000	*WEDMAT	1.00000
*WETRFEB	*DRYMFEB	-	1.00000	*WEDMAT	1.00000
*WETRMAR	*DRYMMAR	-	1.00000	*WEDMAT	1.00000
*WETRAPR	*DRYMAPR	-	1.00000	*WEDMAT	1.00000
*WETRMAY	*DRYMMAY	-	1.00000	*WEDMAT	1.00000
*ALTRMAR	*DRYMMAR	-	1.00000	*ALFDMAT	1.00000
*ALTRAPR	*DRYMAPR	-	1.00000	*ALFDMAT	1.00000
*ALTRMAY	*DRYMMAY	-	1.00000	*ALFDMAT	1.00000
*ALTRJUN	*DRYMJUN	-	1.00000	*ALFDMAT	1.00000

RHS

CHGCOL	LAND	1.00000		
F1	PEOPLE	125.00000	LAND	500.00000
F1	WATJUL	165391.2000	WATAUG	165391.2000
F1	WATSEP	160056.0000	WATOCT	165391.2000
F1	WATNOV	160056.0000	WATDEC	165391.2000
F1	WATJAN	165391.2000	WATFEB	149385.6000
F1	WATMAR	165391.2000	WATAPR	160056.0000
F1	WATMAY	165391.2000	WATJUN	160056.0000
F1	TJAN1	104.00000	TJAN2	104.00000
F1	TFEB1	96.00000	TFEB2	96.00000
F1	TMAR1	104.00000	TMAR2	112.00000
F1	TJUL	216.00000	TAUG	208.00000
F1	TSEP	208.00000	TOCT	208.00000
F1	TNOV	208.00000	TDEC	216.00000
F1	TJAN	208.00000	TMAR	216.00000
F1	TAPR	208.00000	TMAY	208.00000
F1	TJUN	208.00000	TFE/MA	408.00000
F1	TMY/JN	416.00000	TJN2/JL1	208.00000
F1	TJL2/AU1	208.00000	TJL2/AU	320.00000
F1	TAU2/SE1	216.00000	TMY/JL1	520.00000
F1	TMY/JL	632.00000	TMY/AU1	728.00000
F1	TMY/AU	840.00000	TMY/SE1	944.00000
F1	TMY/SE	1048.00000	TJN/JL1	312.00000
F1	TJN/JL	424.00000	TJN/AU1	520.00000

F1	TJN/AU	632.00000	TJN/SE1	736.00000
F1	TJN/SE	840.00000	TJN2/JL	320.00000
F1	TJN2/AU1	416.00000	TJN2/AU	528.00000
F1	TJN2/SE1	632.00000	TJN2/SE	736.00000
F1	TJL/AU1	312.00000	TJL/AU	424.00000
F1	TJL/SE1	528.00000	TJL/SE	632.00000
F1	TJL2/SE1	424.00000	TJL2/SE	528.00000
F1	TAU/SE1	312.00000	TAU/SE	416.00000
F1	TAU2/SE	320.00000	PJUL	216.00000
F1	PAUG	208.00000	PSEP	208.00000
F1	POCT	208.00000	PNOV	208.00000
F1	PDEC	216.00000	PMAY	208.00000
F1	PJUN	208.00000	PJN2/JL1	208.00000
F1	PJN/JL1	312.00000	PJN/JL	424.00000
F1	PJN/AU1	520.00000	PJN/AU	632.00000
F1	PJN/SE1	736.00000	PJN/SE	840.00000
F1	PJN2/JL	320.00000	PJN2/AU1	416.00000
F1	PJN2/AU	528.00000	PJL/AU1	312.00000
F1	PJL/AU	424.00000	PJL2/AU	320.00000
F1	HAUG	208.00000	HSEP	208.00000
F1	HOCT	208.00000	HNOV	208.00000
F1	HDEC	216.00000	HJN2/JL1	208.00000
F1	HJL2/AU1	208.00000	HJL2/AU	320.00000
F1	PPJAN1	104.00000	PPJAN2	104.00000
F1	PPFEB1	96.00000	PPMAR1	104.00000
F1	PPOCT	208.00000	PPNOV	208.00000
F1	PPDEC	216.00000	GJAN2	104.00000
F1	GSEP	208.00000	GOCT	208.00000
F1	GDEC	216.00000	GJAN	208.00000
F1	GJL2/AU	320.00000	GAU2/SE1	216.00000
F1	GJL2/SE1	424.00000	GJL2/SE	528.00000
F1	GAU2/SE	320.00000	CJAN1	104.00000
F1	CJAN2	104.00000	CFEB1	96.00000
F1	CFEB2	96.00000	CMAR1	104.00000
F1	CMAR2	112.00000	CNOV	208.00000
F1	KFEB2	96.00000	KMAR1	104.00000
F1	KMAR2	112.00000	KDEC	216.00000
F1	FMAR	216.00000	FAPR	208.00000
F1	RMAY	208.00000	RJUN	208.00000
F1	RMY/JN	416.00000	BMAY	208.00000
F1	BJUN	208.00000	BMY/JN	416.00000
F1	DMAY	208.00000	WJUL	216.00000
F1	WAUG	208.00000	WMAR	216.00000
F1	WAPR	208.00000	WMAY	208.00000
F1	WJUN	208.00000	WFE/MA	408.00000
F1	WMY/JN	416.00000	SAUG	208.00000
F1	ZNOV	208.00000	ZFEB	192.00000
F1	JAN1	.01000	OJAN2	.01000
F1	OFEB1	.01000	OFEB2	.01000
F1	OMAR1	.01000	OMAR2	.01000
F1	OJUL	.01000	OAUG	.01000

```
    F1          OSEP            .01000    OOCT            .01000
    F1          ONOV            .01000    ODEC            .01000
    F1          OJAN            .01000    OFEB            .01000
    F1          OMAR            .01000    OAPR            .01000
    F1          OMAY            .01000    OJUN            .01000
    F1          OFE/MA          .01000    OMY/JN          .01000
    F1          OJN2/JL         .01000    OJN2/AU         .01000
    F1          OJL2/AUL        .01000    OJL2/AU         .01000
    F1          OAU2/SEL        .01000    *FINCOST     50657.36700
ENDATA
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APPENDIX A. SHADOW PRICES OF LIMITING RESOURCES IN THE OPTIMAL SOLUTIONS

The complete version of this appendix consists of 20 tables covering all the solutions. To conserve space, only a sample of 6 tables is included here. Copies of the complete version are on file at:

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Ames, Iowa 50010 U.S.A.

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La Paz, Bolivia

Table 4.3. Shadow prices of binding resources in models 1-2 (in pence)

Farm size in ha/person	Land		Labour	Machinery	
	Land 1	Land 2	Mx/yr	Now	Mx/yr
4	2306.7/ha	1404.1-1.33		7.5-1.63	1.22-.331
4.5	2216.1-.37	1431.1-.565	1.4/7.5	1.14-7.31	1.12-.641
5	7.25-7.13			.41-.24	.283-.253
5.5	7.25-7.13			.41-.24	.283-.253
6	7.59-1.08		1-.592		.283-.241
6.5	7.59-1.08		1-.592		.283-.241
7	7.59-1.08		1-.592		.283-.241
7.5	7.59-1.08		1-.592		.283-.241
8			1-.1.53		1.79-.598

[illegible] 4.2. Shadow prices of limiting resources in scenarios F2-L25 (in pesos)

Farm size in ha/person	Land LAND1	Land LAND2	Labor WAGE	Flow FLOW	Superuse SUPERUS
1.	2053.430	1359.542	2.245	546.853	36.527
1.5	2003.276	1323.936	2.530	537.37	33.487
2.	1932.526	1277.303	2.936	478.757	32.067
2.5	1932.526	1277.303	2.936	478.757	32.067
3.	1930.94	1275.68	2.943	477.442	32.034
3.5	1921.43	743.852	3.230		12.235
4.	223.422		11.312		
4.5	223.422		11.312		
5.	223.422		11.312		
5.5	223.422		11.312		
6.	223.422		11.312		
6.5	223.422		11.312		
10.	210.623		11.328		
10.5	100.11		11.673		
11.	110.11		11.673		
11.5			11.673	71.502	

Table A-3. Shadow prices of limiting resources in solutions F3-L25 (in pesos)*

Farm size in ha/person	Land		Labor		Tractor	
	LAND1	LAND2	JAN2	MY/AU	TSEP	TJN/SE
4.	1216.986	807.184	0.075	7.636		9.734
4.5	1132.181	750.976		8.219	6.977	
5.	1132.181	750.976		8.219	6.977	
5.5	1132.181	750.976		8.219	6.977	
6.	1111.088	736.998		8.359		
6.5	1111.088	736.998		8.359		
7.	223.422			11.312		
7.5	223.422			11.312		
8.	223.422			11.312		
8.5	223.422			11.312		
9.	223.422			11.312		
9.5	223.422			11.312		
10.	223.422			11.312		
10.5	118.11			11.673		
11.	118.11			11.673		
11.5	118.11			11.673		
12.	118.11			11.673		
12.5	59.4			11.915		
13.	59.4			11.915		
13.5	59.4			11.915		
14.	59.4			11.915		
14.5	59.4			11.915		
15.	59.4			11.915		
15.5	59.4			11.915		
16.				11.905		6.36

*This table appears as Table A-4 in the complete version of Appendix A.

Table A-6. Shadow prices of limiting resources in solutions F1-125 (in pesos)[a]

Farm size in ha/person	Land		Tractor		
	LAND1	LAND2	TNOW	TM2/J4	TJ4/S2
4.	2389.176	1521.882	83.109	26.534	96.346
4.5	2266.598	1604.594	95.164	27.826	105.633
5.	769.818		93.514	30.618	225.089
5.5	769.818		93.514	30.618	225.089
6.	751.011		93.198	30.618	249.605
6.5	751.011		93.198	30.618	249.605
7.	751.011		93.198	30.618	249.605
7.5	369.004		93.01	30.618	264.216
8.			92.504	31.337	301.206

[a]This Table appears as Table A-47 in the complete version of Appendix A.

Table H-5. Shadow prices of binding resources in solutions F2-125 (in pesos)[a]

Farm size in ha/person	Land		Labor		Tractor	Plow		Sprayer
	LAND1	LAND2	MD/AU	MD2/AU	TRCK	PLOW	PLOW/HLD	SPRB2
4.	2429.713	4613.496				724.262	22.427	42.358
4.5	2439.713	4613.496				724.262	22.427	42.358
5.	2439.713	4613.496				724.262	22.427	42.358
5.5	2058.718	1363.013	2.363			513.149	11.831	34.849
6.	2058.718	1363.013	2.363			513.149	11.831	34.849
6.5	1737.031	1149.531		5.283		323.405	13.28	26.789
7.	1729.884	1142.385		5.283		323.405	13.28	23.723
7.5	246.702			13.668		30.308		
8.	246.702			13.668		30.308		
8.5	238.792			15.871	1.053	24.57		
9.	233.996			13.994	0.799	10.785		
9.5	233.693			13.994	0.999	10.535		
10.	229.623			14.054	0.844	4.939		
10.5	229.623			14.054	0.844	4.939		
11.	228.363			14.087		2.881		
11.5				14.087		141.404		

[a]This Table appears as Table H-48 in the complete version of Appendix H.

Table B-6. Shadow prices of limiting resources in solutions F3-125[a]

Farm size in ha/person	Land		Labor	Tractor			Planter
	LAND1	LAND2	JN2/AU	TSEP	TMOV	TJN/SE	PPJAN1
4.	1709.187	1133.419	5.283		36.641	48.308	9.537
4.5	1709.187	1133.419	5.283		36.641	48.307	9.537
5.	1213.34	802.294	9.621			7.388	
5.5	1153.211	762.418	10.139	6.602			
6.	1153.211	762.418	10.139	6.602			
6.5	1132.974	749.	10.307				
7.	1132.974	749.	10.307				
7.5	251.791	17.795	13.994		0.799		
8.	233.317	4.754	14.087				
8.5	233.317	4.754	14.087				
9.	227.909		14.107	0.52			
9.5	227.909		14.107	0.52			
10.	227.909		14.107	0.52			
10.5	227.909		14.107	0.52			
11.	227.909		14.107	0.52			
11.5	227.909		14.107	0.52			
12.	227.909		14.107	0.52			
12.5	227.909		14.107	0.52			
13.	226.132		14.113	0.69			
13.5	177.253		14.379				
14.	177.253		14.379				
14.5	177.253		14.379				
15.	177.253		14.379				
15.5			14.358		21.443	14.697	21.443

[a]This table appears as Table B-50 in the complete version of Appendix B.

APPENDIX I. UNUSED MACHINERY IN THE OPTIMAL SOLUTIONS

The complete version of this Appendix consists of 67 Tables covering all the solutions. To conserve space, only a sample of 6 Tables is reproduced here. Copies of the complete version are on file at:

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Casilla 3654
La Paz, Bolivia

Table I-1. Unused machinery in solutions P5[a]

Farm size in ha/person	P5-275			P5-425		P5-625	
	x	Silo	Annual fixed cost	Silo	Annual fixed cost	Silo	Annual fixed cost
2.		1	500.	1	500.	1	500.
2.5	1		809.210	1	500.	1	500.
3.				1	500.	1	500.
3.5				1	500.	1	500.
4.				1	500.	1	500.
4.5		1	500.			1	500.
5.	1	1	1309.210			1	500.
5.5	1	1	1309.210			1	500.
6.	1	1	1309.210			1	500.
6.5		1	500.				
7.	1	1	1309.210				
7.5	1	1	1309.210				
8.	1	1	1309.210				
8.5	1	1	1309.210				
9.	1	1	1309.210				
9.5		1	500.				
10.	1	1	1309.210				
10.5	1	1	1309.210				
11.	1	1	1309.210				
11.5	1	1	1309.210				
12.	1	1	1309.210				
12.5	1	1	1309.210				
13.	1	1	1309.210				
13.5	1	1	1309.210				
14.	1	1	1309.210				
14.5	1	1	1309.210				

[a]This table appears as Table I-4 in the complete version of Appendix I.

Table I-2. Unused machinery in solutions P6[a]

Farm size in ha/person	P6-425		P6-625	
	Silo	Annual fixed cost	Silo	Annual fixed cost
2.	1	500.	1	500.
2.5	1	500.	1	500.
3.	1	500.	1	500.
3.5			1	500.
4.			1	500.
4.5			1	500.
5.			1	500.
5.5			1	500.
6.			1	500.
6.5	1	500.	1	500.
7.	1	500.	1	500.
7.5	1	500.	1	500.
8.	1	500.	1	500.
8.5	1	500.		
9.	1	500.		
9.5	1	500.		
10.	1	500.		
10.5	1	500.		
11.	1	500.		
11.5				
12.				
12.5				
13.				
13.5				

[a]This Table appears as Table I-5 in the complete version of Appendix I.

Table I-3. Unused machinery in solutions P7[a]

Farm size in ha/person	P7-425				P7-625			P7-1000		
	K	Z	Silo	Annual fixed cost	K	Silo	Annual fixed cost	K	Silo	Annual fixed cost
2.			1	500.	1	1	1309.218			
2.5	1			809.218	1	1	1309.218			
3.	1			809.218	1	1	1309.218			
3.5	1			809.218	1	1	1309.218		1	500.
4.	1			809.218	1	1	1309.218			
4.5	1			809.218		1	500.			
5.	1		1	1309.218		1	500.	1		809.218
5.5	1		1	1309.218						
6.			1	500.						
6.5			1	500.						
7.	1	1	1	3045.218						
7.5	1	1	1	3045.218						
8.	1	1	1	3045.218						
8.5	1	1	1	3045.218						
9.	1	1	1	3045.218						
9.5		1	1	2236.218						
10.	1	1	1	3045.218						
10.5	1	1	1	3045.218						
11.	1	1	1	3045.218						
11.5	1		1	1309.218						
12.	1		1	1309.218						
12.5			1	500.						
13.			1	500.						
13.5			1	500.						
14.										
14.5										
15.										

[a]This Table appears as Table I-6 in the complete version of Appendix I.

Table I-4. Unused machinery in solutions F6[a]

Farm size in ha/person	F6-425						F6-625		
	PP	F	D	W	Silo	Annual fixed cost	PP	W	Annual fixed cost
2.	1	1	1	1	1	13491.734			
2.5	1	1	1	1	1	13491.734			
3.	1	1		1	1	12484.167			
3.5	1	1		1	1	12484.167			
4.	1			1		5391.334			
4.5	1			1		5391.334			
5.	1			1		5391.334			
5.5	1			1		5391.334	1	1	5391.334
6.	1			1		5391.334	1	1	5391.334
6.5	1			1		5391.334	1		4383.667
7.	1			1		5391.334	1		4383.667
7.5	1			1		5391.334			
8.	1			1		5391.334			
8.5	1			1		5391.334			
9.	1			1		5391.334			
9.5	1			1		5391.334			
10.	1			1		5391.334			

[a]This Table appears as Table I-38 in the complete version of Appendix I.

Table I-5. Unused machinery in solutions F7[a]

Farm size in ha/person	F7-425						F7-625	
	F	R	B	W	Silo	Annual fixed cost	W	Annual fixed cost
2.	1			1	1	8100.5		
2.5	1			1	1	8100.5	1	1007.667
3.	1			1	1	8100.5	1	1007.667
3.5				1		1007.667	1	1007.667
4.				1		1007.667	1	1007.667
4.5				1		1007.667		
5.				1		1007.667		
5.5	1	1	1	1	1	8100.5		
6.	1	1	1	1	1	8100.5		
6.5	1	1	1	1	1	15760.666		
7.	1	1	1	1	1	15760.666		
7.5	1	1	1	1	1	15760.666		
8.	1	1	1	1	1	15760.666		
8.5	1	1	1	1	1	15760.666		
9.	1	1	1	1	1	15760.666		
9.5	1	1	1	1	1	15760.666		
10.	1	1	1	1	1	15760.666		
10.5	1	1	1	1	1	15760.666		
11.	1	1	1	1	1	15760.666		
11.5	1	1	1	1	1	15760.666		
12.	1	1	1	1	1	15760.666		
12.5	1	1	1	1	1	15760.666		
13.	1	1	1	1	1	15760.666		
13.5	1	1	1	1	1	15760.666		

[a]This Table appears as Table I-39 in the complete version of Appendix I.

Table I-6. Unused machinery in solutions F8[a]

Farm size in ha/person	F8-625						F8-1000		
	PP	K	F	W	S	Annual fixed cost	PP	K	Annual fixed cost
2.		1	1	1	2	8925.718			
2.5	1		1	1	1	12500.167			
3.	1		1	1	1	12500.167			
3.5	1		1	1	1	12500.167	1		4383.667
4.	1		1	1	1	12500.167	1		4383.667
4.5	1		1			10976.5	1		4383.667
5.	1		1			10976.5	1		4383.667
5.5	1		1			10976.5	1		4383.667
6.	1		1			10976.5		1	809.218
6.5	1		1			10976.5			
7.									
7.5									
8.									
8.5									
9.			1			6592.833			
9.5			1			6592.833			
10.			1			6592.833			
10.5			1			6592.833			
11.			1			6592.833			

[a]This Table appears as Table I-40 in the complete version of Appendix I.

APPENDIX J. RESULTS FROM THE OPTIMAL SOLUTIONS

The complete version of this Appendix consists of 96 Tables covering all cooperative sizes. To conserve space, only the 12 Tables for cooperative size 125 are included here. Copies of the complete version are on file at:

Library
Department of Economics
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Ames, Iowa 50010 U.S.A.

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Casilla 5854
La Paz, Bolivia

Table J-4. Relative use of land in the solutions for cooperative size 125 (in percent of total land available)*

Farm size in ha/person	Degrees of partial mechanization			Degrees of full mechanization		
	#1	#2	#3	#1	#2	#3
4.	47.62	25.24	32.61	47.45	25.24	34.24
4.5	44.92	22.41	27.43	45.59	22.41	30.38
5.	43.56*	20.17	23.41	43.33*	20.17	25.47
5.5	42.3	18.34	20.12	42.07	18.34	22.91
6.	41.28	16.81	17.41	41.02	16.81	19.
6.5	40.43	15.13	15.13	40.13	15.52	16.[illegible]
7.	9.7	13.66*	13.66*	9.36	14.41	14.48
7.5	9.07	12.59	12.59	9.	13.45*	14.
8.	8.5	11.67	11.67	8.6	12.61	14.
8.5		10.85	10.85		11.86	14.
9.		10.13	10.13		11.21	13.27*
9.5		9.48	9.48		10.62	12.53
10.		9.	9.		10.08	11.82
10.5		9.	9.		9.6	11.2
11.		9.	9.		9.17	10.66
11.5		8.77	9.		8.77	10.12
12.			9.			9.65
12.5			9.			9.21
13.			9.			9.
13.5			9.			9.
14.			9.			9.
14.5			9.			9.
15.			9.			9.
15.5			8.73			8.8

*The starred figures in the body of the Table indicate the farm size at which land class 2 becomes non-limiting (although it is still partly used). This Table appears as Table J-3 in the complete version of Appendix J.

Table J-2. Relative use of labor in the solutions for cooperative size 125 (in percent of total labor available)*

Farm size in ha/person	Degrees of partial mechanization			Degrees of full mechanization		
	P1	P2	P3	P1	P2	P3
4.	43.6	43. *	47.66*	32.69	36.38	36.68*
4.5	43.38	50.59	46.67	34.41	37.65	33.5
5.	42.96	50.28	45.58	32.59	38.91	32.58
5.5	43.29	45.93	44.5	33.3	38.15*	32.14
6.	43.43*	42.33	43.45	33.95	35.4	28.73
6.5	43.46	42.42	42.41	34.6	34.74	31.33
7.	43.47	41.82	41.83	35.25	32.26	30.36
7.5	43.47	41.66	41.66	31.7	30.77	30.66
8.	43.48	41.5	41.5	29.22	30.72	31.14
8.5		41.33	41.33		30.67	31.43
9.		41.26	41.26		30.46	31.46
9.5		41.	41.		30.62	31.43
10.		40.92	40.92		30.41	31.4
10.5		41.42	41.42		30.6	31.36
11.		42.06	42.06		30.59	31.33
11.5		42.3	42.67		30.59	31.29
12.			43.29			31.25
12.5			44.			31.22
13.			44.78			31.31
13.5			45.56			31.66
14.			46.36			32.01
14.5			47.12			32.36
15.			47.9			32.71
15.5			48.68			32.81
16.			49.71			

*The starred figures in the body of the Table indicate the farm size at which labor becomes limiting (scarce) in one or more time periods. This Table appears as Table J-11 in the complete version of Appendix J.

Table J-2. Working capital borrowed per person in the solutions for cooperative size 125 (in pesos)*

Farm size in ha/person	Degrees of partial mechanization			Degrees of full mechanization		
	F1	F2	F3	F1	F2	F3
4.	1333.3	1686.1	1814.1	1249.	1645.4	1922.5
4.5	1321.5	1680.9	1812.9	1280.6	1668.5	1811.7
5.	1310.6	1657.2	1658.6	1258.3	1691.6	1697.2
5.5	1315.7	1552.7	1584.4	1271.2	1661.7	1622.4
6.	1317.4	1464.8	1512.7	1282.8	1582.	1551.2
6.5	1316.6	1441.8	1441.3	1294.1	1531.7	1481.1
7.	1315.8	1405.7	1405.7	1305.5	1418.6	1412.8
7.5	1314.9	1393.6	1393.6	1234.1	1403.2	1443.5
8.	1314.0	1381.5	1381.5	1183.7	1401.6	1514.2
8.5		1369.3	1369.3		1400.3	1585.9
9.		1357.2	1357.2		1399.3	1590.4
9.5		1345.1	1345.1		1398.6	1583.7
10.		1342.6	1342.6		1398.	1577.
10.5		1387.6	1387.6		1397.6	1570.2
11.		1435.9	1435.9		1397.2	1563.5
11.5		1435.7	1484.2		1397.1	1556.8
12.			1532.4			1550.1
12.5			1582.8			1543.3
13.			1635.2			1562.4
13.5			1687.5			1612.2
14.			1739.8			1662.
14.5			1792.1			1711.9
15.			1844.5			1761.8
15.5			1896.8			1776.8
16.			1898.4			

*This Table appears as Table J-19 in the complete version of Appendix J.

Table J-4. Relative use of water in the solutions for cooperative size 125 (in percent of total water available)*

Farm size in ha/person	Degrees of partial mechanization			Degrees of full mechanization		
	F1	F2	F3	F1	F2	F3
4.	2.96	3.71	4.78	2.79	3.71	4.58
4.5	2.84	3.71	4.53	2.82	3.71	4.57
5.	2.78	3.71	4.3	2.66	3.71	4.48
5.5	2.78	3.71	4.06	2.70	3.71	4.43
6.	2.76	3.70	3.84	2.74	3.71	4.19
6.5	2.73	3.61	3.61	2.76	3.71	3.93
7.	2.70	3.30	3.30	2.83	3.70	3.72
7.5	2.67	3.30	3.30	2.46	3.30	3.05
8.	2.66	3.29	3.29	2.23	3.24	2.67
8.5		3.29	3.29		3.12	2.37
9.		3.28	3.28		3.03	2.3
9.5		3.28	3.28		2.95	2.27
10.		3.14	3.14		2.88	2.25
10.5		2.67	2.67		2.83	2.22
11.		2.43	2.43		2.77	2.19
11.5		2.36	2.22		2.76	2.16
12.			2.			2.14
12.5			1.93			2.11
13.			2.01			2.01
13.5			2.09			2.09
14.			2.16			2.16
14.5			2.24			2.24
15.			2.32			2.32
15.5			2.39			2.34
16.			2.4			

*This Table appears as Table J-27 in the complete version of Appendix J.

Table J-5. Land productivity in the solutions for cooperative size 125 (in pesos/ha)*

Farm size in ha/person	Degrees of partial mechanization			Degrees of full mechanization		
	F1	F2	F3	F1	F2	F3
4.	4452.6	3796.8	3228.7	4356.9	3847.4	3270.9
4.5	4875.5	3907.7	3410.4	4566.3	4007.7	3286.9
5.	4975.3	4004.5	3398.1	4919.6	4168.	3511.6
5.5	5035.	4054.5	3807.5	5002.1	4278.2	3707.6
6.	5086.3	4114.5	4025.3	5082.7	4344.1	3917.8
6.5	5125.3	4289.1	4290.8	5183.7	4410.	4150.2
7.	5166.1	4430.	4430.	5243.3	4428.2	4406.1
7.5	5206.9	4479.5	4479.5	5076.8	4448.	4314.2
8.	5211.5	4530.3	4530.3	4947.9	4457.9	4119.9
8.5		4582.2	4582.2		4467.7	3968.5
9.		4635.3	4635.3		4477.6	3965.5
9.5		4689.7	4689.7		4487.5	3968.9
10.		4702.5	4702.5		4497.4	3992.5
10.5		4535.	4535.		4507.3	4016.4
11.		4377.	4377.		4517.2	4040.5
11.5		4217.4	4235.6		4521.2	4064.9
12.			4105.8			4089.6
12.5			3986.4			4114.5
13.			3876.2			4074.5
13.5			3774.2			3971.2
14.			3679.5			3875.2
14.5			3591.3			3783.9
15.			3509.			3702.6
16.			3430.			

*Average land productivity, that is, value of output sold divided by hectares of land used. This Table appears as Table J-35 in the complete version of Appendix J.

Table J-6. Labor productivity in the solutions for cooperative size 125 (in pesos/hour)*

Farm size in ha/person	Degrees of partial mechanization			Degrees of full mechanization		
	F1	F2	F3	F1	F2	F3
4.	6.571	6.989	8.032	8.491	9.734	11.077
4.5	6.846	7.109	8.233	8.112	9.798	12.242
5.	7.115	7.33	8.432	9.181	9.857	12.525
5.5	7.179	8.125	8.641	9.1	10.32	12.666
6.	7.228	8.346	8.835	9.013	11.293	12.867
6.5	7.296	9.078	9.079	8.363	11.686	13.011
7.	7.366	9.228	9.228	8.849	12.036	13.177
7.5	7.432	9.263	9.263	9.866	12.304	13.396
8.	7.44	9.297	9.297	10.621	12.237	13.524
8.5		9.332	9.332		12.406	13.633
9.		9.367	9.367		12.468	13.672
9.5		9.403	9.403		12.486	13.896
10.		9.438	9.438		12.523	13.724
10.5		9.436	9.436		12.557	13.764
11.		9.406	9.406		12.59	13.774
11.5		9.396	9.376		12.603	13.796
12.			9.348			13.824
12.5			9.302			13.846
13.			9.243			13.836
13.5			9.184			13.808
14.			9.13			13.922
14.5			9.077			13.936
15.			9.025			13.946
15.5			8.973			13.95
16.			8.973			

*Average labor productivity, that is, value of output sold divided by hours of labor used. This table appears as Table J-42 in the complete version of Appendix J.

Table 3-7. Capital productivity in the solutions to cooperative size 125 (in pesos/peso of working capital)*

Farm size in ha/person	Degrees of partial mechanization			Degrees of full mechanization		
	F1	F2	F3	F1	F2	F3
4.	2.354	2.271	2.322	2.435	2.358	2.326
4.5	2.477	2.344	2.322	2.504	2.427	2.481
5.	2.57	2.437	2.539	2.606	2.485	2.635
5.5	2.589	2.633	2.639	2.612	2.596	2.754
6.	2.612	2.833	2.787	2.619	2.769	2.86
6.5	2.639	2.926	2.927	2.626	2.904	3.016
7.	2.666	3.009	3.009	2.633	3.148	3.142
7.5	2.693	3.295	3.295	2.777	3.197	3.138
8.	2.636	3.06	3.06	2.875	3.208	3.047
8.5		3.087	3.087		3.218	2.963
9.		3.113	3.113		3.227	2.964
9.5		3.14	3.14		3.236	2.979
10.		3.152	3.152		3.244	2.995
10.5		3.086	3.086		3.252	3.008
11.		3.018	3.018		3.26	3.023
11.5		2.993	2.954		2.964	3.039
12.			2.894			3.054
12.5			2.833			3.07
13.			2.774			3.051
13.5			2.717			2.993
14.			2.663			2.938
14.5			2.615			2.886
15.			2.568			2.837
15.5			2.524			2.823
16.			2.523			

*Average capital productivity, that is, value of output sold divided by pesos of working capital used. This table appears as Table 3-51 in the complete version of Appendix 3.

Table J-8. Average variable cost in the solutions for cooperative size 125 (in pesos/100 pesos of output sold)[a]

Farm size in ha/person	Degrees of partial mechanization			Degrees of full mechanization		
	F1	F2	F3	F1	F2	F3
4.	42.476	44.036	43.071	41.061	42.408	42.952
4.5	40.37	42.654	41.16	39.983	41.283	40.311
5.	38.912	41.034	39.381	38.374	40.244	37.956
5.5	38.63	37.973	37.603	38.288	38.514	36.31
6.	38.286	35.301	35.878	38.183	36.112	34.73
6.5	37.9	34.171	34.161	38.078	34.44	33.161
7.	37.515	33.232	33.232	37.976	31.766	31.628
7.5	37.14	32.954	32.954	36.013	31.281	31.866
8.	37.098	32.667	32.667	34.781	31.176	32.816
8.5		32.399	32.399		31.078	33.753
9.		32.121	32.121		30.989	33.74
9.5		31.843	31.843		30.905	33.574
10.		31.723	31.723		30.823	33.407
10.5		32.4	32.4		30.746	33.241
11.		33.137	33.137		30.671	33.074
11.5		33.436	33.836		30.64	32.909
12.			34.539			32.743
12.5			35.294			32.578
13.			36.055			32.774
13.5			36.799			33.413
14.			37.527			34.039
14.5			38.229			34.65
15.			38.936			35.153
15.5			39.618			35.424
16.			39.639			35.424

[a]This table appears as Table J-59 in the complete version of Appendix J.

Table J-9. Average total cost in the solutions for cooperative size 125 (in pesos/100 pesos of output sold)[a]

Farm size in ha/person	Degrees of partial mechanization			Degrees of full mechanization		
	F1	F2	F3	F1	F2	F3
4.	49.776	51.651	50.672	54.921	53.839	53.117
4.5	47.371	50.052	48.917	53.144	52.256	50.435
5.	45.716	48.253	47.135	51.23[illegible]	50.795	46.795
5.5	45.358	45.104	45.355	50.9[illegible]	50.109	45.3
6.	44.946	42.424	43.624	50.732	47.531	43.719
6.5	44.493	41.176	41.902	50.482	44.412	42.155
7.	44.049	40.219	40.219	50.239	41.698	40.62
7.5	43.613*	39.943	39.943	48.315	39.818	40.59
8.	43.564	39.667	39.667	47.167*	39.694	41.38
8.5		39.392	39.392		39.577	42.164
9.		39.115	39.112		39.469	42.262
9.5		38.839	38.839		39.367	42.089
10.		38.706*	38.706*		39.266	41.917
10.5		39.301	39.301		39.171	41.744
11.		39.957	39.957		39.077	41.572
11.5		40.222	41.159		39.038*	41.4
12.			41.778			41.228
12.5			42.432			41.057*
13.			43.114			41.2
13.5			43.78			41.738
14.			44.432			42.133
14.5			45.07			42.649
15.			45.831			43.153
15.5			46.44			43.303
16.			46.459			

[a]The starred figures in the body of the Table are the lowest average cost in each column. This Table appears as Table J-67 in the complete version of Appendix J.

Table J-10. Wage bill as percent of income in solutions for cooperative size 125 (in percent)[a]

Farm size in ha/person	Degrees of partial mechanization			Degrees of full mechanization		
	P1	P2	P3	F1	F2	F3
4.	24.78	24.59	21.48	22.31	19.66	17.45
4.5	22.93	23.57	20.39	21.49	18.95	15.19
5.	21.64	22.28	19.38	19.5	18.34	13.9
5.5	21.46	19.43	18.42	19.55	17.39	13.37
6.	21.2	17.15	17.53	19.58	15.35	12.85
6.5	20.89	16.6	16.69	19.60	14.11	12.36
7.	20.59	16.13	16.13	19.63	12.23	11.91
7.5	20.29	16.	16.	17.41	11.66	11.74
8.	20.26	15.88	15.88	16.02	11.59	11.8
8.5		15.76	15.76		11.53	11.89
9.		15.65	15.65		11.48	11.88
9.5		15.53	15.53		11.43	11.82
10.		15.45	15.45		11.39	11.77
10.5		15.6	15.6		11.34	11.71
11.		15.81	15.81		11.3	11.66
11.5		15.89	16.06		11.29	11.61
12.			16.27			11.55
12.5			16.51			11.5
13.			16.79			11.5
13.5			17.07			11.6
14.			17.35			11.67
14.5			17.63			11.78
15.			17.95			11.88
15.5			18.23			11.91
16.			18.24			

[a]This Table appears as Table J-75 in the complete version of Appendix J.

Table J-11. Crop output as percent of total output sold in the solutions for cooperative size 125 (in percent)[a]

Farm size in ha/person	Degrees of partial mechanization			Degrees of full mechanization		
	P1	P2	P3	F1	F2	F3
4.	88.76	92.89	100.	89.08	91.89	96.77
4.5	90.44	94.04	100.	89.19	91.87	99.57
5.	90.93	95.46	100.	91.97	91.86	100.
5.5	90.93	97.93	100.	91.86	93.38	100.
6.	90.98	100.	100.	91.79	96.3	100.
6.5	91.08	100.	100.	91.74	96.79	100.
7.	91.17	100.	100.	91.69	99.7	100.
7.5	91.26	100.	100.	92.8	100.	100.
8.	91.27	100.	100.	93.61	100.	100.
8.5		100.	100.		100.	100.
9.		100.	100.		100.	100.
9.5		100.	100.		100.	100.
10.		100.	100.		100.	100.
10.5		100.	100.		100.	100.
11.		100.	100.		100.	100.
11.5		100.	100.		100.	100.
12.			100.			100.
12.5			100.			100.
13.			100.			100.
13.5			100.			100.
14.			100.			100.
14.5			100.			100.
15.			100.			100.
15.5			100.			100.
16.			100.			

[a]This Table appears as Table J-83 in the complete version of Appendix J.

Table J-12. Level of sheep raising activity in solutions for cooperative size 125 (in number of ewes)[a]

Farm size in ha/person	Degrees of partial mechanization			Degrees of full mechanization		
	P1	P2	P3	F1	F2	F3
4.	284	219	0	267	253	116
4.5	251	189	0	278	264	16
5.	246	147	0	212	275	0
5.5	248	68	0	217	230	0
6.	249	0	0	222	130	0
6.5	249	0	0	226	115	0
7.	249	0	0	230	11	0
7.5	249	0	0	198	0	0
8.	249	0	0	175	0	0
8.5		0	0		0	0
9.		0	0		0	0
9.5		0	0		0	0
10.		0	0		0	0
10.5		0	0		0	0
11.		0	0		0	0
11.5		0	0		0	0
12.			0			0
12.5			0			0
13.			0			0
13.5			0			0
14.			0			0
14.5			0			0
15.			0			0
15.5			0			0
16.			0			

[a]This Table appears as Table J-91 in the complete version of Appendix J.

APPENDIX K. MISCELLANEOUS TABLES

Table K-1. Water deficit per hectare, by crops and months, at 60% efficiency, at the Experimental Station of Patacamaya (sheet in mm/ha)[a,b]

	Potato	Quinua	Barley for forage	Broad beans	Alfalfa[c]	Permanent pastures
July					61.2	59.8
August		12.96			66.6	75.06
September		36.08		12.88	53.23	75.51
October		91.55		55.33	67.4	109.65
November	9.05	94.62		54.35	34.2	88.57
December	7.53	64.5	9.63	37.06	9.63	60.28
January	41.68	33.37	25.06	22.98	10.52	45.83
February	91.85	26.75	65.8	23.03	43.48	56.5
March	108.63	10.63	54.25	5.76	65.9	65.9
April	63.73		57.27		105.86	96.87
May					89.26	79.46
June					72.	66.23
Total	322.47	370.46	212.01	211.39	679.33	879.66

[a]Source: Sejas 1960.

[b]These figures were computed with the Blaney and Criddle method using weather information for the years 1965-1968. The research was part of the Vizachani project. A 20% loss of water from the dam to the field and another 20% loss on the field were assumed; hence the 60% efficiency figure. A sheet of one milimeter per hectare is equivalent to 10 m^3.

[c]An irrigation-fertilization experiment with alfalfa and fescue is being performed since 1968 at the Experimental Station (Allred 1969); the irrigation coefficients are not yet available.

Table K-2. Water deficit per hectare, by crops and months, at 60% efficiency, in Sicasica (sheet in mm/ha)[a,b]

	Potato	Quinua	Barley for forage	Broad beans	Alfalfa	Permanent pastures
July					57.05	55.66
August		11.05			55.8	63.82
September		37.27		14.48	53.87	73.78
October		89.51		56.45	68.11	107.01
November	19.3	141.16		74.4	54.52	106.21
December	33.73	89.93	37.9	62.88	37.9	85.76
Janaury	61.25	53.05	42.82	40.77	28.46	63.3
February	76.77	23.5	54.43	20.06	37.25	47.55
March	99.06	10.4	48.75	5.75	59.93	59.93
April	51.06		45.93		83.96	77.35
May					82.4	73.12
June					58.3	53.
Total	341.17	455.87	229.83	274.79	677.55	866.49

[a]Source: Sejas 1970.

[b]See note b in Table K-1.

Table K-3. Water deficit per hectare, by crops and months, at 60% efficiency, at the railroad station in Patacamaya (sheet in mm/ha)[a,b]

	Potato	Quinua	Barley for forage	Broad beans	Alfalfa	Permanent pastures
July					54.	52.61
August		11.1			58.05	66.2
September		31.75		11.42	51.31	76.2
October		104.47		64.71	77.26	125.38
November	17.5	128.55		80.7	54.6	119.85
December	66.21	186.05	73.71	126.13	73.71	174.82
January	41.65	32.55	21.18	16.65	0.73	46.2
February	104.83	31.25	75.	25.28	51.13	65.06
March	93.11		32.91		46.95	46.95
April	57.66		52.08		94.25	87.22
May					65.93	56.55
June					54.25	49.08
Total	380.96	525.72	254.88	324.89	682.17	966.12

[a]Source: Sejas 1970.

[b]See note b in Table K-1.

Table K-4. Chuño production in five cooperatives, by class, in the Development Area of Patacamaya, 1968-69[a,b]

	Production by cooperatives, in cwt						
	Achaya	Llojlla	Pujravi	San José	Santiago	Total	Percent
Bitter potato chuño							
class 1	82.78	30.09	11.	6.	7.	136.87	39.63
class 2	93.1	38.8	30.	17.	18.	196.9	57.02
class 3		10.58	1.			11.58	3.35
Total	175.88	79.47	42.	23.	25.	345.35	100.
Irish potato chuño							
class 1	25.49				93.	118.49	31.88
class 2	54.39				52.	106.39	28.63
class 3	69.79				77.	146.79	39.49
Total	149.67				222.	371.67	100.

[a]Source: Derived from records at the Central de Cooperativas.

[b]Information is available for only five cooperatives and for the agricultural year 1968-69 only. In the Area of Patacamaya it takes 3 kg of bitter potato, as an average, to make 1 kg of chuño; the time required is about 3 hours per cwt of potato.

Table K-5. Total purchase cost of Farmall-706 tractor, disk-plow and harrow for the Development Area of Patacamaya, 1968[a]

	In dollars		In pesos	
Price of tractor[b]	4939.		59268.	
Price of disk-plow[c]	470.		5640.	
Price of harrow[b]	537.		6444.	
Total factory price		5946.		71352.
Transportation to New York	140.		1680.	
Insurance	73.		876.	
Other expenses	150.		1800.	
Transportation to Arica, Chile (ship)	370.		4440.	
Total from factory to Arica		733.[d]		8796.
Dock expenses	135.		1620.	
Transportation to La Paz (railroad)	295.		3540.	
Customs clearing	210.		2520.	
Broker's commission and other	50.		600.	
Assembling	120.		1440.	
Handling	10.		120.	
Total from Arica to La Paz		820.[e]		9840.
Total cost in La Paz[f]		7499.		89988.
Transportation to Patacamaya (truck)			450.	
From Patacamaya to the cooperative			159.	
Total from La Paz to the cooperative				609.[g]
Total purchase cost				90597.[h]

[a]Sources: Derived from the contract between McDonald de La Paz and the cooperatives, and from records at the Central de Cooperativas.

[b]International Harvester. The tractor is a Farmall-706, diesel, Model D-310, 69.03 HP drawbar, 76.0 HP belt. The harrow is Model 130, 32 disks, 20". These prices are FOB prices at the factory in the United States.

[c]Athens, Model 24, 4 disks, 26". This price is FOB price at the factory in the United States.

[d]595 for tractor and harrow, 138 for the plow.

[e]No breakdown is given. Assuming the same preportions as in the previous note the cost would be 666 for tractor and harrow, 154 for plow.

[f]26.12% higher than FOB factory price.

[g]Transportation by truck to Patacamaya: 250 for the tractor, 200 for plow and harrow. Transportation of plow and harrow by truck to the cooperative: 100 pesos. Travel of tractor to the cooperative: average of 59 pesos (100 liters of diesel).

[h]26.97% higher than FOB factory price. The estimated breakdown is: tractor 71205 pesos, plow 9294 pesos, harrow 10098 pesos.

Table K-6. Least-cost combinations for NPK fertilizers, 1970[a]

NPK/ha	Crop	Combinations NPK Formula	Kg	Urea 46%[b] kg	Total kg	Price in[c] pesos/ha
80-80-0[d]	Potato	16-20-0	400.	34.78	434.78	920.60
		13-39-0	205.13	115.94	321.07	678.64
		18-46-0	173.91	105.86	279.77	617.11*
		20-20-0	400.		400.	838.
		11-48-0	166.67	134.06	300.73	686.57
45-0-0	Quinua			97.63	97.83	187.34*
13-39-0	Broad beans	13-39-0	100.		100.	227.60*
		11-48-0	81.25	8.83	90.08	226.45
40-40-0	Barley	16-20-0	200.	17.39	217.39	460.30
		13-39-0	102.56	57.97	160.53	339.31
		18-46-0	86.97	52.92	139.89	306.07*
		20-20-0	200.		200.	419.
		11-48-0	83.33	67.03	150.36	343.27
40-0-0	Weeping lovegrass			86.96	86.96	166.53*

[a]Source: Computed from Tables 5-8 and 6-4.

[b]No formulas are calculated using Urea 45%, because the price per kg of nitrogen is lower in Urea 46%.

[c]Price at which the fertilizers will be available at the Central de Cooperativas. They are obtained by using the lowest price for each formula in the last column of Table 6-4; however, Obrist supplied fertilizer is omitted for the reason given in note e there. Starred combinations are the least-cost ones.

[d]The recommended procedure for applying 80-80-0 is 50 kg of urea when cultivating, while the rest was applied at planting time. Therefore, only those combinations that contain 50 or more kg of urea will be acceptable.

Table K-7. Railroad freight rates from Patacamaya to La Paz and Oruro, 1970 (in pesos)[a,b]

Freight[c]	Volume[d]	Class[e]	Patacamaya - La Paz		Patacamaya - Oruro	
			pesos/ metric ton	pesos/cwt	pesos/ metric ton	pesos/cwt
Potatoes, chuño, quinua grain	MCE	6	31.91	0.145	29.28	0.133
	CE	6	31.91	0.145	29.28	0.133
Quinua flour	MCE	2	57.36	0.26	52.46	0.238
	CE	4	42.82	0.194	39.04	0.177
Fresh meat	MCE	3	50.49	0.229	46.36	0.21
	CE	5	35.95	0.163	32.94	0.149
Farm machinery	MCE	2	57.36	0.26	52.46	0.238
	CE	4	42.82	0.194	39.04	0.177
Chemical fertilizers	MCE	4	42.82	0.194	39.04	0.177
	CE	5	35.95	0.163	32.94	0.149
Other agricultural inputs	MCE	3	50.49	0.229	46.36	0.21
	CE	5	35.95	0.163	32.94	0.149

[a]Source: Information supplied by Empresa Nacional de Ferrocarriles, Departmento Comercial, La Paz, June, 1970.

[b]Presently all transportation for the Central de Cooperativas is done by truck, but the profitability of shipping by railroad should be studied, at least for machinery, fertilizer and non-perishable products. Although the distances from Patacamaya to La Paz and to Oruro are the same (122 km), the rates to La Paz are higher because the steep section between El Alto and La Paz proper is more expensive. Including stopovers and delays, the trip takes one day to Oruro and two days to La Paz. Loading and unloading is the customers' responsibility. Storage rates in La Paz are 1.1 dollars/ton/day under cover and 0.55 dollars/ton/day in the open.

[c]Only those products are listed here which are related to this study.

[d]MCE (= menos carro entero) means less than a full freight car; CE (= carro entero) means a full railroad car. A full car is defined as 12 metric tons or more for flour, and 6 metric tons or more for the other products listed in this Table.

[e]Rates are computed on the basis of six classes into which all products are divided.

Table K-8. Information available for the Communities Antipampa and Culli Culli Bajo in the DAP, 1968[a]

	Units	Antipampa[b]	Culli Culli Bajo[c]
Farm size	ha	2493.	2693.
Number of persons	No.	396.	243.
Aggregate income	pesos	301990.95	253267.95
From agriculture[d]	pesos	264857.95	231027.45
Other[e]	pesos	37133.	22240.5
Land under cultivation	ha	424.0631	.[f]
Investment in work animals and tools	pesos	153931.05	145577.3
Working capital[g]	pesos	56509.4	76536.
Total output	pesos	319087.1	321639.9
Sold	pesos	83413.9	67497.2
Bartered[h]	pesos	10008.	4229.
Consumed on the farm[h]	pesos	169364.25	166380.7
Used for seed[h]	pesos	20042.2	39002.
Change in livestock inventory[h,i]	pesos	36258.75	44531.

[a]Source: Farm size and land under cultivation for Antipampa are from the map drawn while performing the survey in Bolivia 1969a; farm size for Culli Culli Bajo and number of persons in both Communities are from Delucca 1969b; all other information is computed from Bolivia 1969a.

[b]The survey covered 17 property owners out of the 81 owners existing in the 70 families of the Community.

[c]The survey covered 10 property owners out of the 73 owners existing in the 49 families of the Community.

[d]Including both cash income and income in kind (from barter and on-the-farm consumption).

[e]Handicrafts and seasonal employment in the cities or in the subtropical regions.

[f]Not available.

[g]Market value of output used for seed or feed on the farm (barley) plus a few other miscellaneous expenses.

[h]At market value.

[i]The proportion of livestock which are work animals is unknown.

Table K-9. Statistical measures from the sample of 21 Communities in the DAP[a]

$n = 21$

$\bar{X} = 563.0952$

$s = 473.9837$

$V = \frac{s}{\bar{X}} = \frac{1}{1.188} = 0.8417$

$\hat{\sigma}_{\bar{X}} = \frac{s}{\sqrt{n}} = 103.4317$

$P(\bar{X} - 2.086\ \hat{\sigma}_{\bar{X}} < \mu < \bar{X} + 2.086\ \hat{\sigma}_{\bar{X}}) = 0.95$

$P(347.34 < \mu < 778.85) = 0.95$

[a]Source: Computed from Table 2-6.

APPENDIX L. THE SHEEP RAISING ACTIVITY

Sheep raising does not enter any of the six highest-income optimal solutions, as shown in Chapter VIII (Table 8-11). It does, enter, however many other solutions under both partial and full mechanizations.

Among extension and research personnel, sheep raising is believed to be an important part of the agricultural potential of the Altiplano. Therefore, it seems appropriate to include a few remarks on the behavior of the activity throughout all the optimal solutions.

Tables J-91 through J-98 show the level at which sheep raising enters the solutions. Tables J-91 through J-98 contain the percent of the total output value represented by crop output; the rest is output from sheep.

A few features are apparent in those tables: (i) At the lower degrees of mechanization, the level of the activity increases with the farm size, (ii) at the higher degrees of mechanization, the level of the activity increases as well at the beginning with the farm size, but then it starts decreasing until it is reduced to zero at the highest farm sizes, (iii) as a percent of the total output value sheep raising never goes above 15% and in most solutions it stays below 10%.

The reason for that behavior of the sheep raising activity is a result of its profitability and its high labor-intensity.

On the question of profitability, Tables 6-19 and 6-24 showed a revenue of 36,420 pesos against variable costs of 30,509 pesos; the resulting return over and above variable costs is lower than for any of the crops in this study. Moreover, those variable costs do not include

the cost of hay, silage and pasture; since barley or alfalfa must enter all rotations, their growing costs can be charged to the crop activities, leaving only the costs of making hay and silage to be charged to the sheep activity.

On the question of high labor-intensity of sheep raising. Table G-4 showed that the labor required in each month varies from 681 to 1569 hours, with a total of 10,732 hours for the entire year. A cursory confrontation of Tables J-91 through J-98 with the corresponding tables on shadow-prices in Appendix H, shows that the sharp decreases in the sheep raising activity is paralleled by steep increases in the shadow-price for labor during the May-August period. This means that, as labor becomes scarce, it is removed from the sheep activity and allocated to crop activities. In this situation of labor scarcity, it is more profitable to plow under the barley (required by the rotations) than to make it into hay or silage for feeding sheep; the opportunity cost of making hay or silage would be the potato and quinua that would not be grown because of the labor shortage at harvest time.

The only two ways in which sheep raising can become more profitable are: (i) by increasing its efficiency and (ii) through a higher output price.

Table 5-10 and Appendix E should be helpful in detecting what input-output relationships can be improved in order to increase efficiency. The shadow-price on the sheep raising activity would tell the percentage by which efficiency should be improved in order for the activity

to become competitive. However, no shadow-price was present in the solutions, because it was hidden in the shadow-prices for auxiliary activities, such as silage or hay making; the shadow-price for sheep can still be tracked and reconstructed, but it is a laborious task when so many transfer activities are involved.

As for higher output prices, the prospects do not seem favorable, since mutton is already overpriced relative to beef (Vanderslice 1970), partly as a result of Government subsidies for shipment of beef by plane from the Beni and Santa Cruz regions.

APPENDIX M. CHANGES IN THE MODEL

For further uses of the model, some changes are suggested, which will shorten the computer time required and will simplify the application of the variable-resource and parametric procedures.

1. As a result of the information on shadow-prices (Appendix H), a number of rows can be eliminated from the matrices, because they never become limiting constraints:

(i) The 68 labor rows can be reduced to two: JAN2 and MY/AU in the partial mechanization matrix, JN2/AU and MY/AU in the full mechanization matrix.

(ii) The 12 rows for water can be brought down to two: WATNOV and WATFEB in both matrices.

(iii) The only rows for machinery-time that are ever limiting are those shown in Table 8-16. However, for some pieces of machinery all the rows should be kept, because they are needed in checking for unused machinery (Appendix I). Thus, in the matrix for partial mechanization, the following rows are retained: TSEP, TNOV, TJN/SE, PJUN, PJN/JL1, PJN/AU, SAUG, ZNOV and all the rows for harrow, sprayer and wagon. In the matrix for full mechanization these rows are kept: TSEP, TNOV, TMY/JN, TMY/SE, TJN/SE, PJUN, PJN/JL1, PJN/AU, FAPR, RMY/JN, BMY/JN, DMAY, SAUG, ZNOV and all the rows for harrow, potato planter, grain drill, cultivator, sprayer and wagon.

Then the number of rows decreases from 316 to 168 in the partial mechanization matrix, and from 351 to 207 in the full mechanization matrix.

2. The machine-time rows can be organized in the same way as the land and labor rows, where one master row supplies the RHS values to the other rows by means of a transfer column (see note i in Table G-1). With this procedure, changing the RHS values, as required by the various degrees of mechanization, will be a simple matter of assigning to the master rows a RHS value equal to the number of machines entering the particular degree of mechanization; a transfer column will then supply to the other machine-time rows and to the *FIXCOST row the corresponding RHS values. Moreover, by merely looking at the vector of RHS values the composition of the degree of mechanization can be known (without having to check with Tables 7-3 and 7-4).

3. Through a set of transfer rows and columns, the purchase prices of the major inputs (fertilizer, concentrate, etc.) can be made to appear by themselves in the objective function (negative sign, or course), in the same manner as the rate of interest. By having these prices isolated, instead of built into the other activities, it will be possible to treat them parametrically in order to study the effects of changing input prices. In the case of fertilizer, even the selection of the least-cost combinations (Table K-6) can be handled by the model; then, the fertilizer prices appearing in the objective function will be the prices of the commercial fertilizers from which the least-cost combinations are obtained.

4. The same procedure just explained for inputs can be used for the price per kilo of meat in the sheep activity, instead of using the price per head. Then, the effects could be studied of changing the prices at

which the Central de Cooperativas buys from the cooperatives.

5. If the model is going to be used regularly for planning specific farms, a program can be attached that will output a printed report ready for use. It may be the IBM Mathematical Programming System Report Generator MPSRG (Winterboer 1971) or any other similar routine.