Table D-5-13 Estimated ECe of lower layers after leaching: Medium-textured soil

m^S/cm

Soil depth	Water depth / ECsw/ECe / Calculation method	20 cm		60 cm		60 cm		70 cm		90 cm	
		ECsw	ECe	ECsw	ECe	ECsw	ECe	ECsw	ECe	ECsw	ECe
0 - 15 cm C_1 = 20 m/m d_1 = 10 m/m	Initial ECe	10		30		50		70		90	
	Numerical method	3.6	1.8	3.9	4.0	5.8	4.9	6.8	5.4	6.8	5.4
	Proposed method	2.9[a]	4.0	3.9[a]	4.0	5.9[a]	4.0	6.9[a]	4.0	6.9[a]	4.0
15 - 30 cm C_2 = 30 m/m d_2 = 10 m/m	Initial ECe	1.0		3.0		5.0		7.0		9.0	
	Numerical method	3.5	1.8	4.1	2.1	6.1	3.1	7.2	3.6	7.2	3.6
	Proposed method	3.9	1.5	4.1	2.1	6.2	3.1	7.3	3.7	7.3	3.7
30 - 50 cm C_3 = 30 m/m	Initial ECe	1.0		1.5		2.5		3.5		4.5	
	Numerical method	3.1	1.6	4.0	2.0	6.0	3.0	7.2	3.6	7.3	3.7
	Proposed method	2.8	1.4	4.0	2.0	6.1	3.1	7.3	3.7	7.4	3.7
50 - 100 cm C_4 = 30 m/m	Initial ECe	1.0		1.5		2.5		3.5		4.5	
	Numerical method	2.8	1.4	4.0	2.0	6.0	3.0	7.2	3.6	7.4	3.7
	Proposed method	2.6	1.3	4.0	2.0	6.0	3.0	7.3	3.7	7.5	3.8
	Remarks	0-100cm: s=0		0-15cm: s=2.0 15-100cm: s=0		0-15cm: s=2.0 15-100cm: s=0		0-15cm: s=2.0 15-100cm: s=0		0-15cm: s=2.0 15-100cm: s=0	

a: Estimated EC of percolation water into the second layer (from Table A-3-30)
Proposed method: Proposed method for estimation of ECe of lower layers in 3.2.5 (2) 4).
ECe = ECsw x FC%/SP% + S (EC of slightly soluble salts): ECw = 1 m^S, FC%/SP% = 0.5
ECsw: EC of soil water at FC%, equal to EC of percolation water into a lower layer.
C_1 - C_4: Assumed initial moisture content (m/m) in each layer.
d_1 - d_3: Assumed moisture volume in m/m retained in each layer after leaching.

Table D-5-14 Estimated ECe of lower layers after leaching: Fine-textured soil

m^S/cm

Soil depth	Calculation method	Water depth / ECsw/ECe	20 cm		60 cm		60 cm		70 cm		90 cm	
			ECsw	ECe	ECsw	ECe	ECsw	ECe	ECsw	ECe	ECsw	ECe
0 - 15 cm C_1 = 25 m/m d_1 = 20 m/m	Initial ECe		10		30		50		70		90	
	Numerical method		6.7	3.8	7.2	5.6(3.6)	11.4	7.7(5.7)	13.5	8.8(6.8)	13.6	6.8
	Proposed method		6.3[a]	4.0	7.4[a]	4.0	11.9[a]	4.0	14.1[a]	4.0	14.1[a]	4.0
15 - 30 cm C_2 = 25 m/m d_2 = 20 m/m	Initial ECe		1.0		3.0		5.0		7.0		9.0	
	Numerical method		6.7	3.8	7.6	3.8	12.0	6.0	14.3	7.2	14.5	7.6
	Proposed method		6.2	3.1	7.7	3.9	12.5	6.3	14.9	7.5	15.0	7.5
30 - 50 cm C_3 = 35 m/m d_3 = 10 m/m	Initial ECe		1.0		1.5		2.5		3.5		4.5	
	Numerical method		6.2	3.1	7.5	3.8	11.8	5.9	14.2	7.1	14.6	7.3
	Proposed method		5.8	2.9	7.6	3.8	12.3	6.2	14.8	7.4	15.1	7.6
50 - 100 cm C_4 = 45 m/m	Initial ECe		1.0		1.5		2.5		3.5		4.5	
	Numerical method		5.4	2.7	7.3	3.7	11.5	5.8	13.9	7.0	14.5	7.3
	Proposed method		5.1	2.6	7.4	3.7	11.9	6.0	14.5	7.3	15.0	7.5
	Remarks		0-100cm: s=0		0-15cm: s=2.0 15-100cm: s=0		0-15cm: s=2.0 15-100cm: s=0		0-15cm: s=2.0 15-100cm: s=0		0-15cm: s=2.0 15-100cm: s=0	

a: Estimated EC of percolation water into the second layer (from Table A-3-30)
Proposed method: Proposed method for estimation of ECe of lower layers in 3.2.5 (2) 4).
ECe = ECsw x FC%/SP% + S (EC of slightly soluble salts): ECw = 1 m^S, FC%/SP% = 0.3
ECsw: EC of soil water at FC%, equal to EC of percolation water into a lower layer.
C_1 - C_4: Assumed initial moisture content (m/m) in each layer.
d_1 - d_3: Assumed moisture volume in m/m retained in each layer after leaching.
ECe in pharensis is if s=0 m^S

Table D-5-15 Estimated EC of percolation water from surface layer (0-15cm) to 2nd layer (15-30cm)

	Medium-textured soil					Fine-textured soil					Coarse-textured soil				
A. Total salt when leaching process is ongoing															
1 Initial ECe	10	30	50	70	90	10	30	50	70	90	10	30	50	70	90
2 SP in m/m	60	60	60	60	60	130	130	130	130	130	50	50	50	50	50
3 Salt content in m^S·m/m 1 x 2	600	1,800	3,000	4,200	5,400	1,300	3,900	6,500	9,100	11,700	500	1,500	2,500	3,500	4,500
4 ECw in m^S	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5 Depth in irrigation water in m/m	200	600	600	700	900	200	600	600	700	900	200	600	600	700	900
6 Salt content of water in m^S.m/m 4 x 5	200	600	600	700	900	200	600	600	700	900	200	600	600	700	900
7 Total salt at leaching in m^S·m/m 3 x 7	800	2,400	3,600	4,900	6,300	1,500	4,500	7,100	9,800	12,600	700	2,100	3,100	4,200	5,400
B. Total salt retained after leaching															
8 Water depth in m/m retained, = FC m/m	30	30	30	30	30	45	45	45	45	45	15	15	15	15	15
9 EC of soil water at FC ECe x 2; if b=0, (ECp-2) x 2; if b=2.0	8 b=0	4 b=2.0	4 b=2.0	4 b=2.0	4 b=2.0	8 b=0	4 b=2.0	4 b=2.0	4 b=2.0	4 b=2.0	8 b=0	4 b=2.0	4 b=2.0	4 b=2.0	4 b=2.0
10 Total salt retained 8 x 9 in m^S·m/m	240	120	120	120	120	360	180	180	180	180	120	60	60	60	60
C. Salt concentration of percolation water															
11 Total salt in percolation water 7 - 10 m^S.m/m	560	2,280	3,480	4,780	6,180	1,140	4,320	6.920	9,620	12,420	580	2,040	3,040	4,140	5,340
12 Depth of percolation water 5 - 8 + C_1* m/m	190	590	590	690	890	180	580	580	680	880	185	585	585	685	885
13 EC of percolation water (ECsw) 11/12 m^S	2.9	3.9	5.9	6.9	6.9	6.3	7.4	11.9	14.1	14.1	3.1	3.5	5.2	6.0	6.0

C_1* : Initial moisture content in m/m : medium-textured soil 20 m/m fine-textured soil 25 m/m

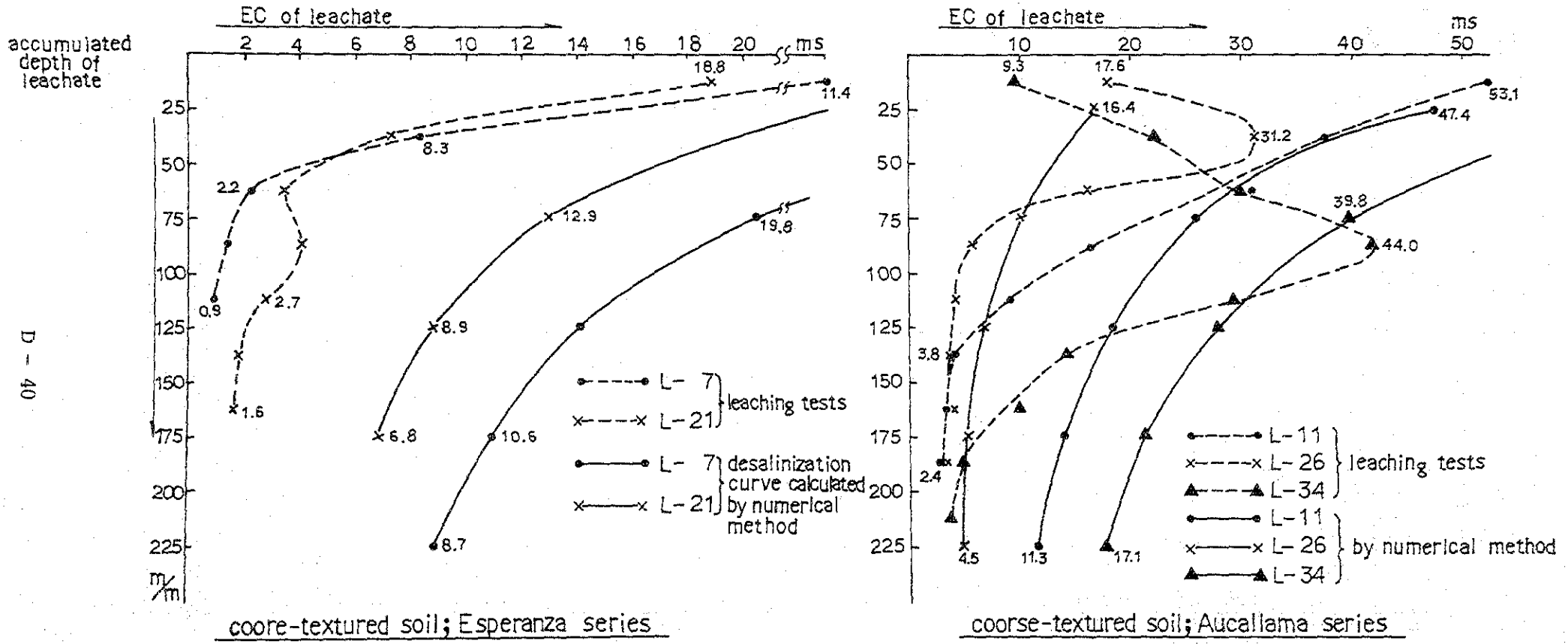
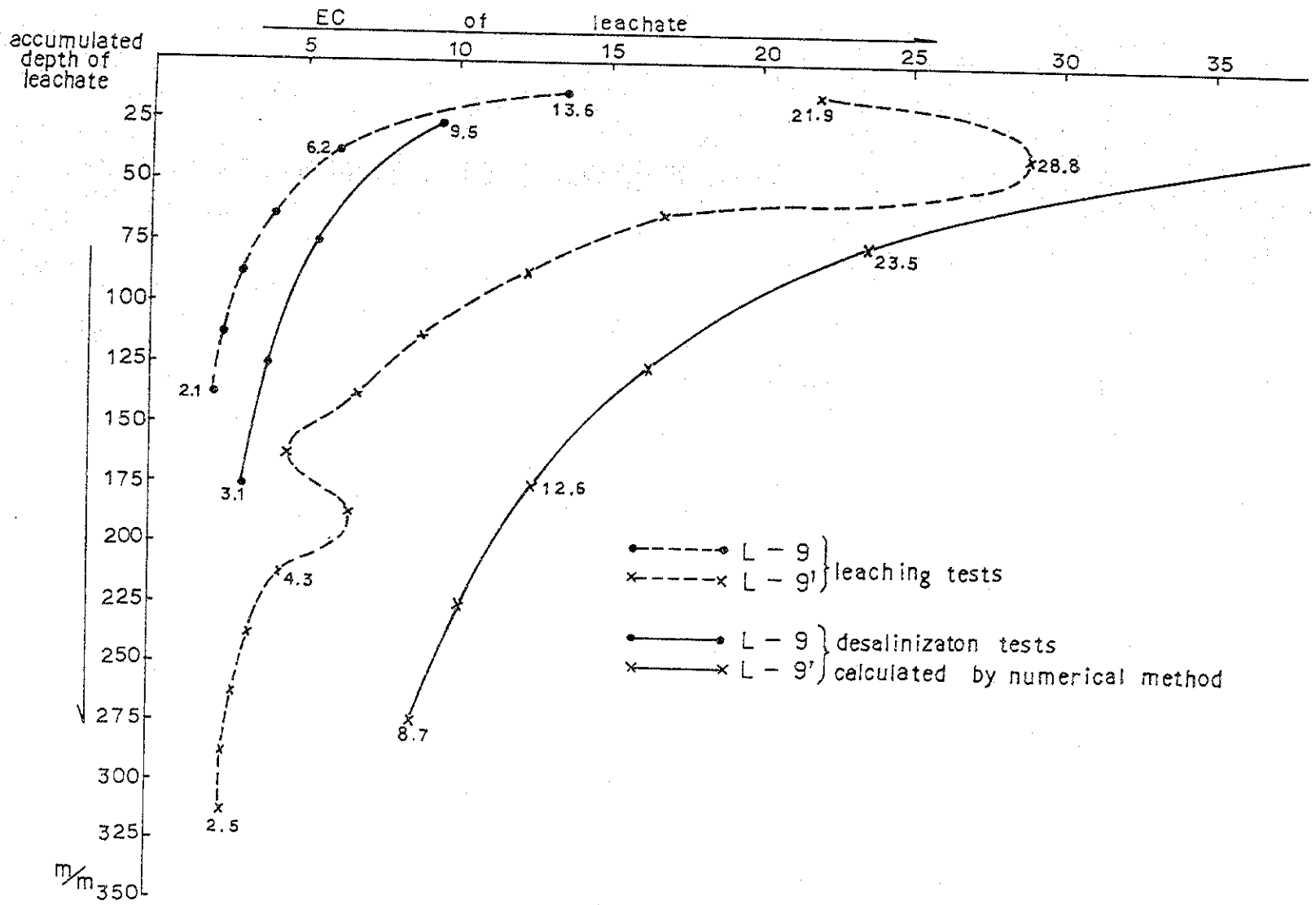
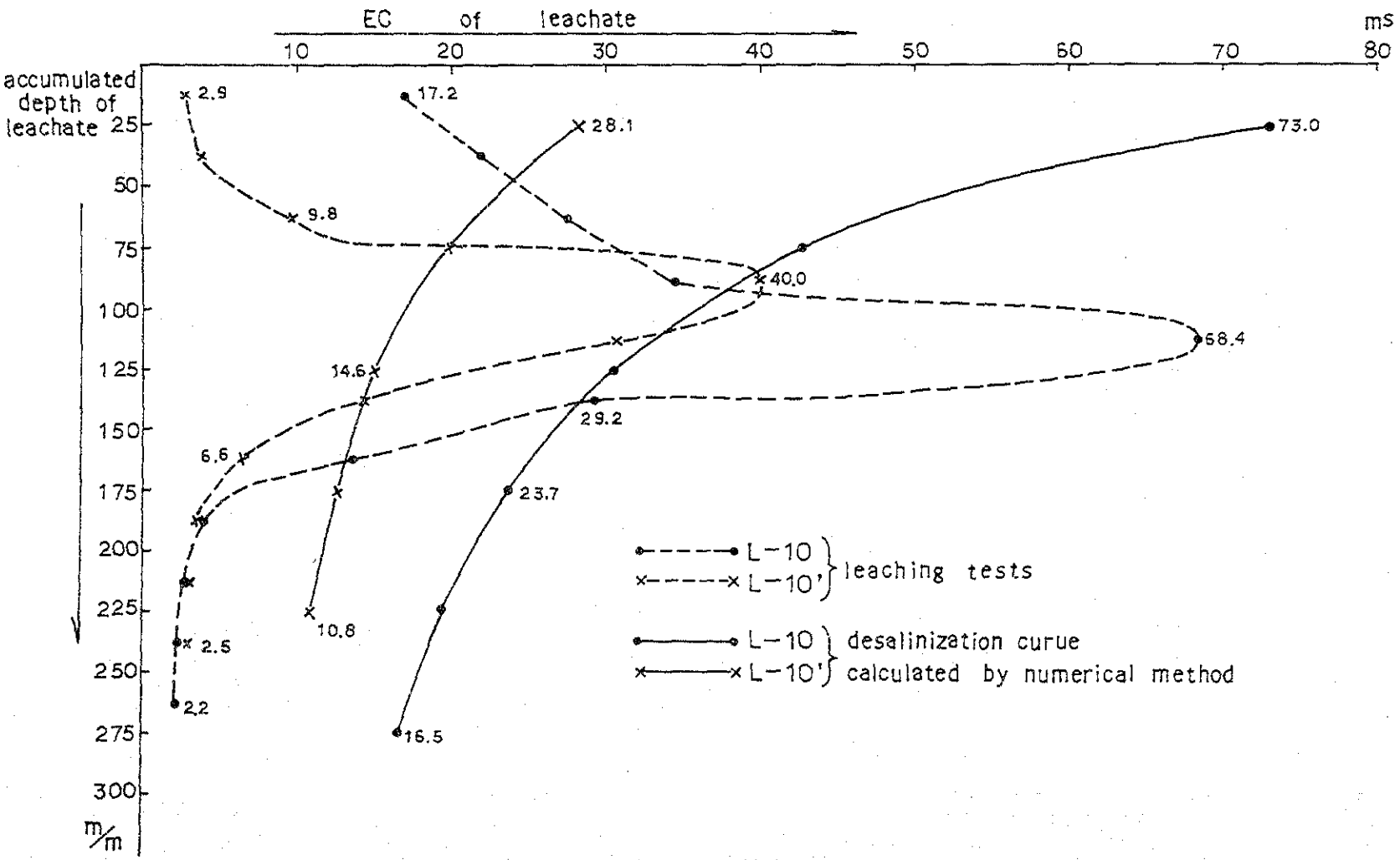


Fig. D-5-1 Results of leaching tests-indoor test ; Changes in EC of leachate



medium-textured soil; Mochumi series

Fig. D-5-2 Results of leaching tests-indoor test; Changes in EC of leachate



fine-textured soil ; Quepecaliche series

Fig. D-5-3 Results of leaching tests- indoor test ; Changes in EC of leachate

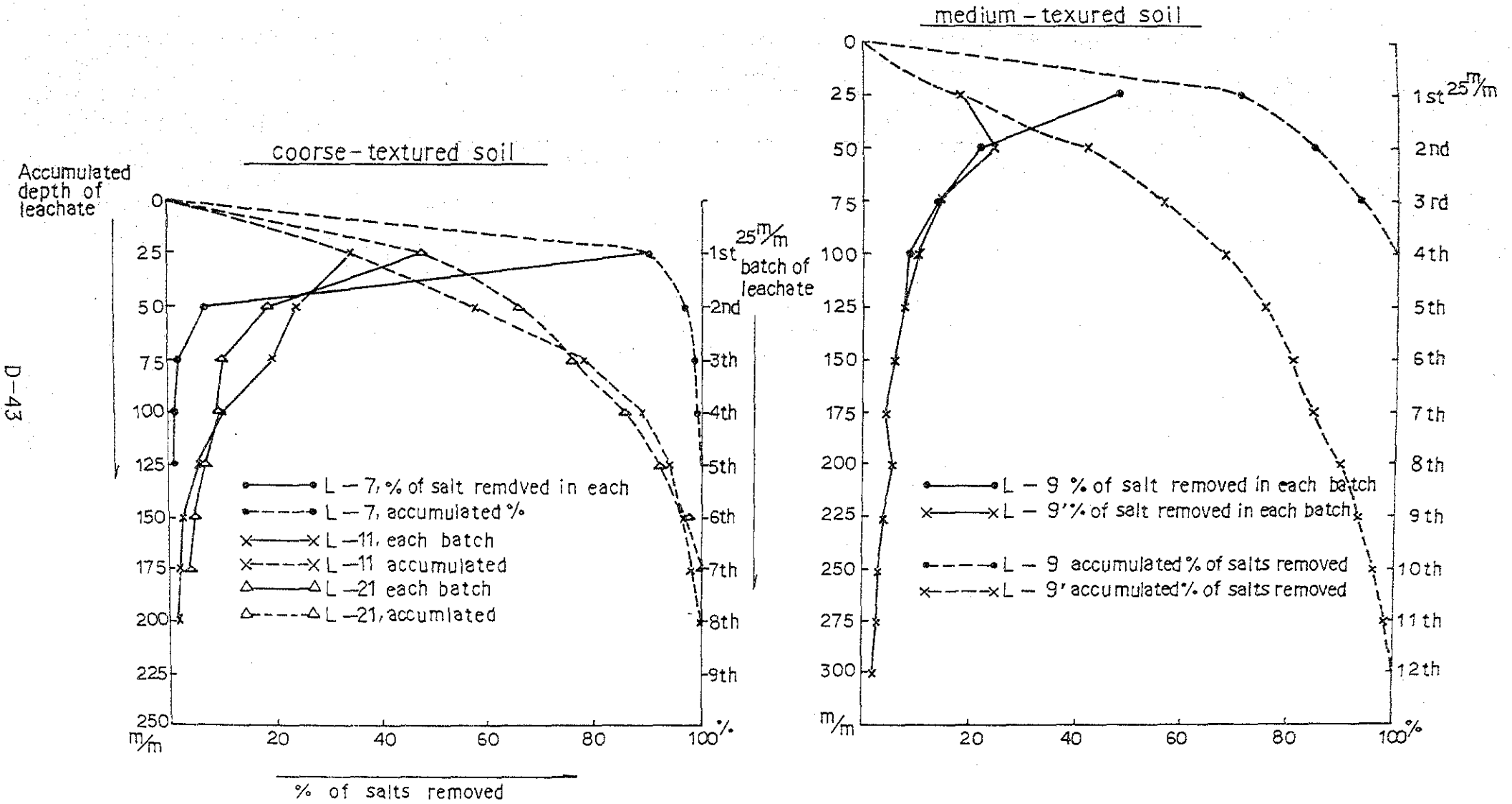


Fig. D-5-4 Desalinization processes of readiy soluble salts-indoor test

Fine-textured soil/Medium textured soil

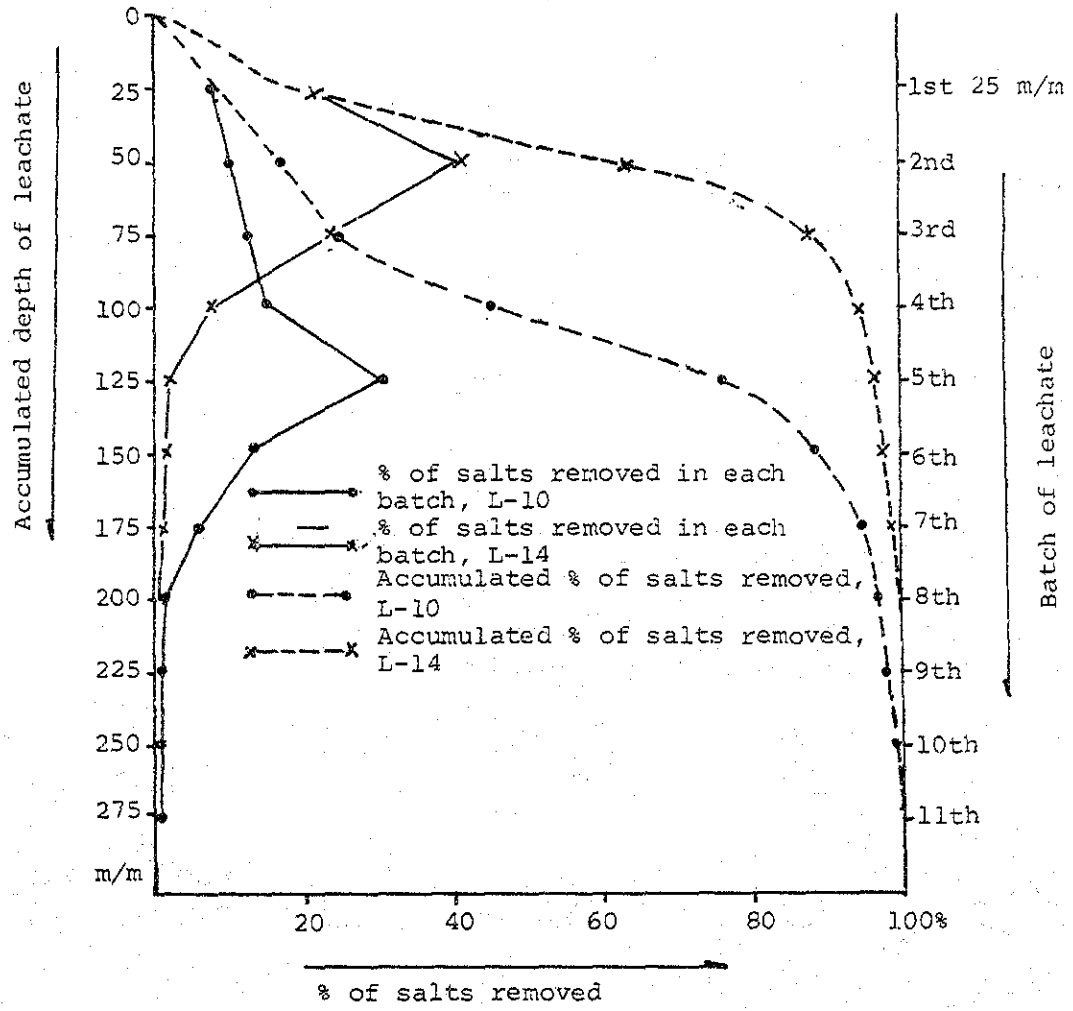


Fig. D-5-5 Desalinization Process of readily soluble salts - indoor test

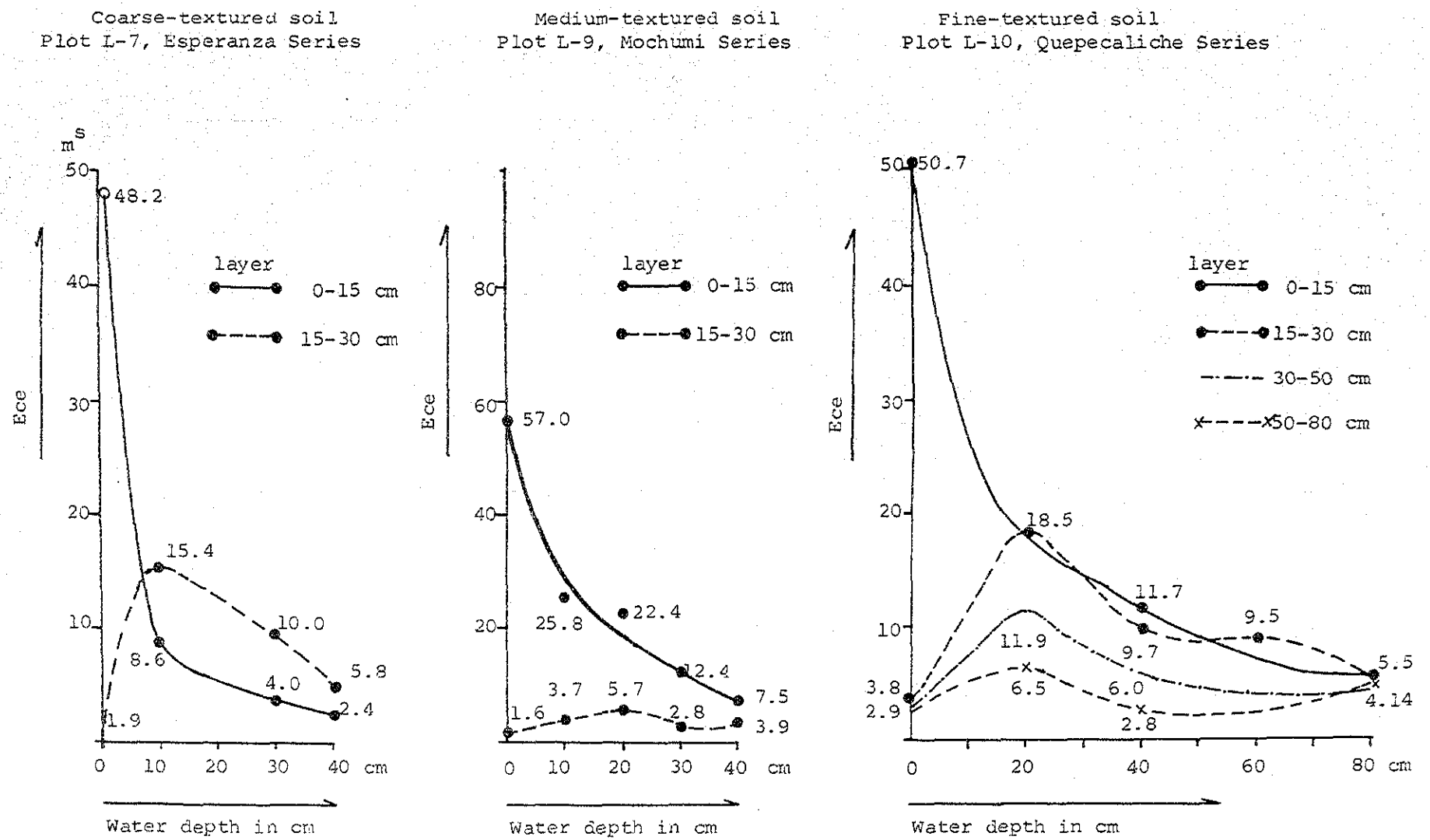
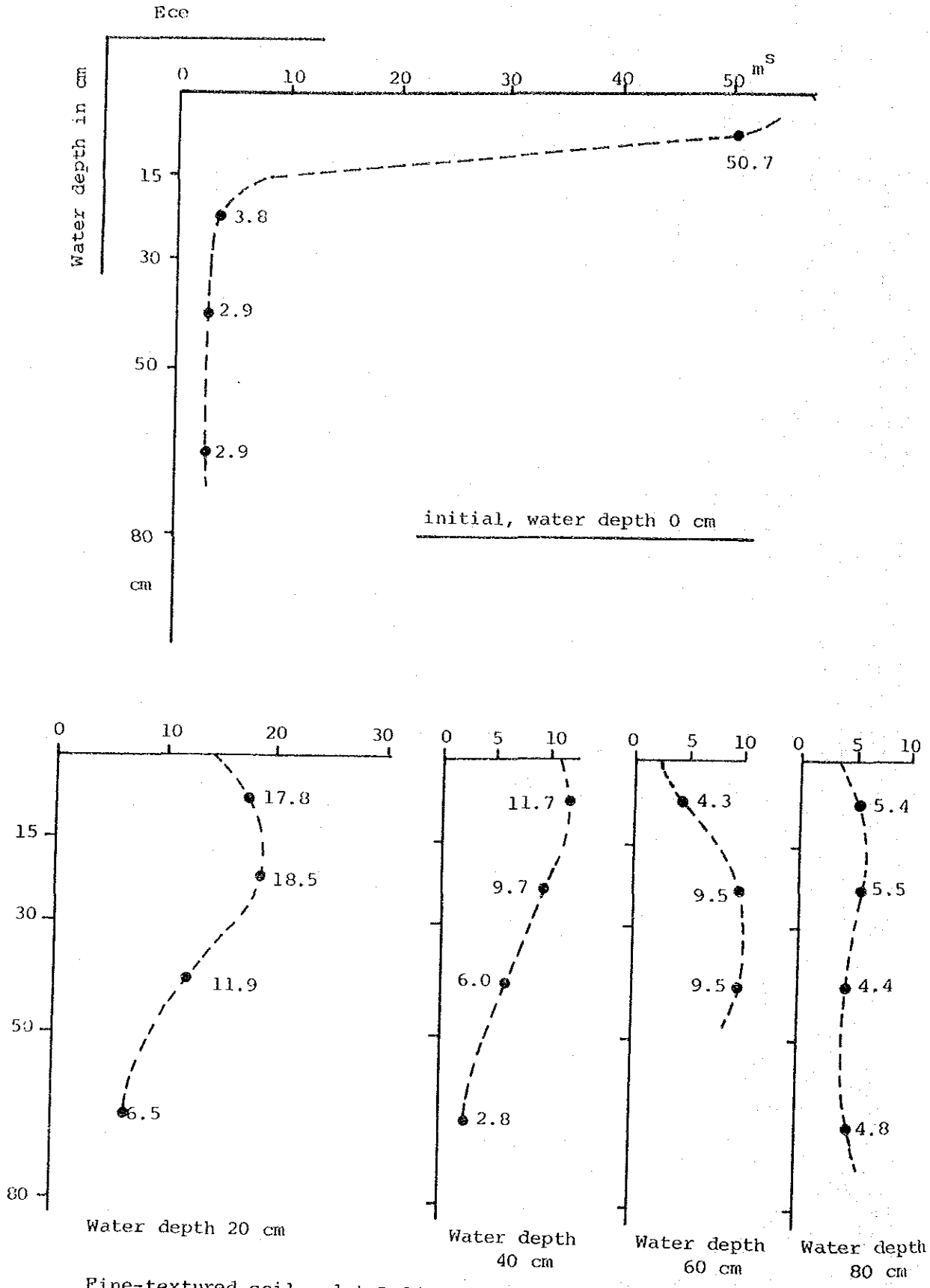


Fig. D-5-6 Desalinization Curves of Soils with Different Texture-Field Test



Fine-textured soil, plot L-10, Quepecaliche series, Grand water level & Quality: 1.1m, 1.0ms

Fig. D-5-7 Changes in Ece after leaching with different depth of water-field test

ANNEX E

AGRICULTURE

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ANNEX E AGRICULTURE

1 Present Agriculture in the Project Area

1-1 General

The Project area is situated in a subtropical arid zone in which a variety of crops have been cultivated for along time by the water resource of the Chancay River. The said area is one of the major agricultural production areas in Peru, holding an important position as the supply base of agricultural food products (mainly vegetables and fruit) to the Metropolitan area of Lima.

The total arable land of the Project area is 20,200ha, of which about 65 and 32% are utilized for annual crop production and fruit production, respectively. The major crops in the area are cotton, maize, vegetables and fruit. Cultivation of maize is rapidly expanding in recent years. Under the favored temperature conditions, year-round cultivation of a variety of crops is practised.

Farming scale of the area is relatively small and farm households with farming scale less than 3ha account for about 50% of the total. Cultivated crops vary in areas and crop production is carried out based on various farming patterns.

1-2 Present Land Use

(1) Land Use

Present land use in the Project area (23,100ha) is tabulated on the following page. Arable land is 20,200ha (87%) while nonarable land (1,750ha, 8%) consist of hilly area (890ha, 4%), stony land (70ha) and residential area and others (790ha, 3%). The remaining 1,150ha (5%) is right-of-way.

Table E-1-1 **PRESENT LAND USE**

Unit: ha

Land Use Categories	Land Utilization Patterns	Area (%)
Arable land 1/		20,200ha (87)
	Perennial crop production	6,530 (28)
	Annual crop production	13,050 (56)
	Grass land/fallow	620 (3)
Non-arable land 2/		1,750 (8)
	Hilly area, precipices and drains	890 (4)
	Stony land	70 (-)
	Residential area, yard and others	790 (3)
Right-of-way		1,150 (5)
Total		23,100 (100)

1/ Irrigable area

2/ River and river land not included

(2) Land Utilization Patterns

Land utilization patterns of arable land (20,200ha) include perennial crop production (fruit production) -- 6,530ha, 32% of arable land; annual crop production -- 13,050ha, 65%; and natural grassland and fallow -- 620ha, 3% . The land utilization patterns by irrigation block are as presented in Table E-1-2 and the general features of land utilization patterns are shown in Fig. E-1-1.

The land utilized for annual crop production is further subclassified into three subpatterns on the basis of crops planted as tabulated on the following page.

CROPS PLANTED

Sub Patterns	Discription
1	Cotton and maize (generally in rotation)
2	Vegetables
3	Miscellaneous crops in rotation (beans, vegetables, tuber crops, soiling corn)

The characteristics of land utilization in the Project area are summarized by irrigation subsector as in set below.

1) Irrigation block (left bank upper)

Irrigation subsector: Palpa - Caqui (mapping code:I)
Cultivation of cotton and maize is predominant while fruit cullivation is predominant on sloping land adjacent to Cerro Arana and Cerro San Cristobal.

2) Irrigation block (left bank lower)

a) Irrigation subsector: Miraflores - San Jose

Cotton, maize and vegetables are cultivated on flat to nearly flat land while fruit cultivation is exclusively carried out on sloping land adjacent to Cerro Arana.

b) Irrigation subsector: Boza-Aucallama

Cultivation of cotton and maize is most widely practiced while planting of miscellaneous crops in rotation is also common. Fruit cultivation is common on sloping land while cotton and maize are almost exclusively cultivated in the poorly drained areas.

c) Irrigation subsector: Pasamayo

Cotton and maize production accounts for the majority of land utiliation. However, in the coastal area where land holding is limited, cultivation of vegetables and miscellaneous crops in rotation is predominant.

3) Irrigation block (right bank upper)

a) Irrigation subsector: Esperanza/Huando

Fruit cultivation, mainly of citrus and apple, is carried out exclusively. Cultivation of annual crops is limited.

4) Irrigation block (right bank central)

a) Irrigation subsector: Retes-Naturales/Jes del Valle-Esquivel/Chancay Alto

Cultivation of cotton and maize is predominant, especially in poorly drained areas. Fruit, miscellaneous crops and vegetables occupy about 10% each of the irrigation block's surface area.

5) Irrigation block (right bank lower)

a) Irrigation subsector: Chancay Bajo

As a whole, cultivation of cotton and maize are predominant. However, in the coastal area, cultivation of vegetables and miscellaneous crops is generally practiced.

b) Irrigation subsector: Chancayllo

The majority of the subsector is utilized for production of miscellaneous crops in rotation. Both vegetables cultivation and cultivation of cotton/maize are carried out to a considerable extent while fruit cultivation, on the other hand, is insignificant.

c) Irrigation subsector: Salinas

Cotton and maize are predominant while cultivation of both vegetables and miscellaneous crops is common. Fruit cultivation is almost nil.

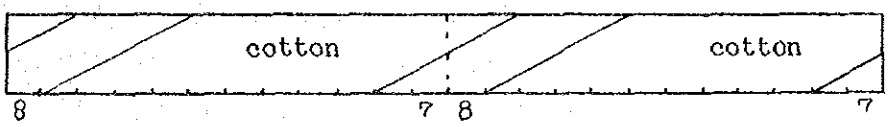
1-3 Cropping Patterns

In the Project area in which year-round cultivation is possible under the favored temperature conditions, planting periods

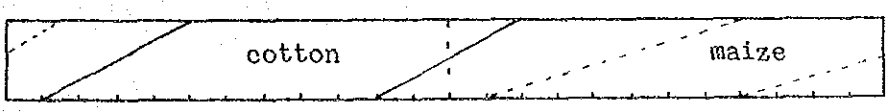
of crops are generally irregular and prolonged by various factors. A variety of crops, in particular vegetables, are cultivated throughout the year. However, plantings in September and October (in early summer) prevail and most cotton planting are carried out during this period. Plantings of maize and potato are mainly undertaken from April to August. In accordance with the irregularity of planting times, haversting times of most crops vary. The main harvesting season of cotton is May to August and that of fruit is March to July. The vegetable harvest peak occurs from October to January. The cropping season and the ratio of monthly planting area to the total cropped area of major crops in 1982 are shown in Fig. E-1-2 and Table E-1-3, respectvely. The prolonged planting times and the annual fluctuation of the same which are generally attributable to shortages of irrigation water supply and farming tractors tend to lower crop productivity of the area.

While cropping patterns adopted in the Project area are not fixed due to market price trends, in addition to annual fluctuation of planting times, prevailing cropping patterns are illustrated as below.

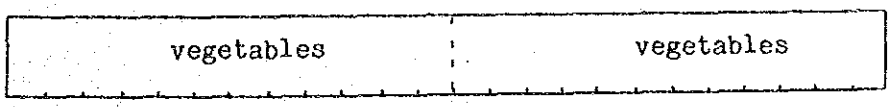
a. cotton (continuous cropping)



b. cotton - maize in rotation

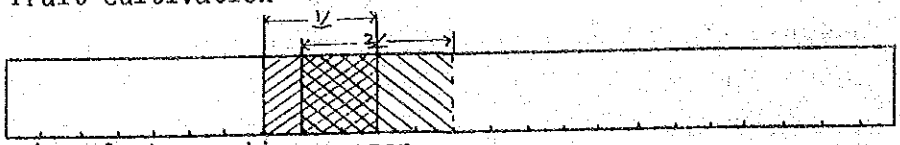


c. vegetables in rotation (or continuous cropping)



d. vegetables - potatoes in rotation

e. fruit cultivation



1/ apple harvesting season
2/ sitrus harvesting season

Other than the above, the cropping pattern in which the rotation system of cotton and crops with short growing periods such as beans and soiling corn is practiced to the limited extent. Cropping patterns of cotton-cotton-maize and maize-maize-cotton are also found, but limited. In the cropping patterns of vegetables-vegetables and potatoes-vegetables, rotation or continuous cropping of a variety of vegetables are carried out.

The cropping situations in the Project area fluctuates considerably from year to year. In addition, maize cultivation is encouraged by the government agricultural policy and in recent years is thus increasing. However, agricultural statistics of the District may not be reliable enough to grasp the actual cropping situations of the Project area. Therefore, the present cropping condition of the Project area is estimated through comprehensive examination of the following information:

a) agricultural statistics of major crops in Chancay and Huaral District (Table E-1-4);

b) production statistics of 1982 which cover harvested areas of all crops (Table E-1-5);

c) present land use map; and,

d) information on cropping situations obtained from producers assoications and related organizations in the Project area.

The present cropping conditions (the present cropped area) of the area based on the above are shown in Table E-1-6. From the table, the present cropping intensity is culculated at 116%.

1-4 Factors Adversely Affecting Crop Productivity

Crop productivity of the Project area are affected by a number of factors such as: i) weather conditions, ii) cultivation technique, iii) cropping season, iv) water shortage, and, v) poor drainage (salinity). The influences of these factors are usually interrelated mutually and complicatedly. Therefore, it is impossible to exactly define the degree of influence of each factor.

The set in items indicate the general adverse affects of each factor in the Project area. The average yield levels of major crops corresponding to each factor are shown collectively in Table E-1-7.

1) Weather conditions

While the Project area has temperature conditions in which year-round cultivation is possible, yield decreases caused by abnormally high temperature and low temperature have been reported. Effects of temperature differ depending on kind of crops and growth stages of crops, and, thereby, depending on the period when abnormally high and low temperature occurs. Many crops in the Project area suffered damages by abnormally high temperature in 1983. In particular, the average yield of cotton sharply decreased from 2.9t/ha in 1982 to 1.3t/ha in 1983.

2) Cultivation technique

The difference in cultivation technique between successful farmers and the others, especially small scale farmers, is pointed out as one of the major problems with agricultural production in the Project area. The differences in average yield levels between the successful farmers and others may considerably be attributable to the difference in cultivation technique.

3) Cropping season

Difference in yield due to the difference in cropping season is recognized in some crops in the Project area. The optimum planting period of cotton is from August to September in the area. It is reported that delay in planting may bring about yield decrease of about 30% due to low temperature injury at flowering stage and insect damages. Higher yield of maize is obtained in summer cropping in which vigorous growth of maize is expected.

4) Water shortage

According to the results of spot surveys, most farmers except those in poorly drained areas pointed out that water shortage is a problem with crop production. Therefore, water shortage is almost omnipresent in the Project area. In the area in which water shortage is severe (the water shortage area), yield decreases due to water deficit and dislocated cropping season are noticed. However, the extent of yield decrease differs annually depending on availability of irrigation water in each year and crop response to water shortage varies in accordance with growing stage. Cultivation of drought resistant cotton and maize is generally practiced in the water shortage area. Apple, grape and passion fruit are predominantly planted in orchards of the said area. Crop yields of the water shortage area will be easily increased by the improvement of water supply.

5) Poor drainage (poorly drained salt accumulated area)

Accumulated salts in soil raise osmotic pressure of soil solution and thus restrict crop growth through inhibiting water absorption by crop roots. Crop yields in salt accumulated area are influenced by the success or failure of germination, while salt moves with water and success or failure of germination greatly depend on crop tolerance in salinity. Therefore, crop yields in salt accumulated areas are largely affected by crop selection and irrigation water management.

In the poorly drained salt accumulated area, various countermeasures for salinity control such as "machaco" (leaching by flooding), leaching by furrow irrigation before planting and cultivation of salt tolerant crops are practiced. Crop yields rely on suitability of these measures and, generally speaking, little difference in crop yields is noticed between the salt accumulated are a and non salt accumulated area as far as salt tolerant crops are concerned, except for highly salt accumulated area (ECe of surface soil over 15m^S/cm). Even in highly salt accumulated areas, high yields of maize can be anticipated if good germination of the same is assured. In case of cotton, excessive water supply from subsurface water may cause excessive vegetative growth and delayed growth of cotton and results in yield decrease. In the poorly drained area, cultivation technique of farmers is high and thereby, crop yields will be improved by desalinization.

The relation between the said factors and average yield levels are summarized in Table E-1-7 presented on the next page.

Table E-1-7 **AVERAGE YIELD LEVELS OF MAJOR CROPS**

Factors or Land Conditions	Average Yield Levels t/ha					
	Cotton	Maize	Orange	Grape	Apple	Passion fruit
Weather 1983 1/	1.2	3.9	5.9	4.3	6.1	-
Conditions 1982 1/	2.9	4.6	12.2	4.9	10.2	-
Poor Drained Salt Accumulated area 2/	2.0-3.0	3.0-4.0	-	-	-	-
Water shortage area 3/	1.5-2.5	2.0-3.0	-	4.0-5.0	5.0-6.0	7.0-8.0
Ordinary area	2.5-3.5	4.0-5.0	18-22	7.0-8.0	9.5-10.5	9.5-10.5
Yield levels of successful farmers	5.5	8.0	30.0	12.0	16.0	-

1/ average yield in the Project area (Source: Banco Agrario Del Peru), abnormally high temperature in 1983, normal temperature in 1982.

2/ highly salt accumulated area (ECe of Surface soil over 15ms/cm).

3/ in area water shortage is severe.

1-5 **Crop Yields and Production**

Crop yields of the Project area are influenced by a number of factors. The average crop yields of the past in the Project area which show as a whole combined effects of these factors are shown in Table E-1-8 and E-1-9. From the tables, considerable fluctuations of yields are noticed in most crops and differences between the two tables which have been prepared based on different sources are also noticed. Therefore, the present crop yields are estimated based on the average crop yields during 1978-83 and information obtained from related organizations such as producers associations in the Project area (Table E-1-8).

Accordingly, present crop production is calculated based on the present cropped area and crop yields as shown in Table E-1-10.

1-6 Farm Management

(1) Farming Patterns

In the Project area, the number of small scale farmers has remarkably increased due mainly to disorganization of agricultural cooperatives. In estimation, farm households with farming scale less than 3ha account for about 50% of the total. In addition to the limited farm land, these farmers suffer from shortage of farming funds and are facing difficulty in farm management. Meanwhile, farming scale of fruit producers is relatively large. Farm management of the same is considerably stabilized.

In the Project area, crop production is carried out under various farming patterns. The major farming patterns are as follows:

Pattern A: fruit production
Pattern B: vegetable production
Pattern C: vegetable and potatoes production
Pattern D: cotton production
Pattern E: cotton and maize production

Pattern A is almost exclusively adopted in the right bank-upper irrigation block. The fruit production area in the same accounts for about 70% of the total in the Project area. In general, fruit producers possess a relatively large land area compared with farmers practicing other farming patterns. Main fruits are citrus and apple which represent about 60% of total fruit production area.

Pattern B and C are mainly found in the right bank-upper and left bank-lower irrigation block. Farming scale of the said patterns is not uniform. Most vegerables are grown throughout the year, however crops such as tomato, choclo (a type of maize, harvested unripen), watermelon, and sweet potato are mainly cultivated in summer season whereas cabbage, cauliflower, onion,

carrot and potato are mainly grown in the winter season. Double cropping is practiced in most areas, although some areas with superior agricultural conditions crop 2.5 to 3 times a year.

Pattern D, cotton production, is common on the right bank-central and left bank-upper irrigation block among farmers with a farming scale of about 5-10ha. The same is also comparatively common in areas suffering from insufficient water supply.

Pattern E, cotton and maize production, is common throughout the Project area, but is most prevailent in the right bank-central irrigation block. This pattern is also found mainly among farmers with a farm scale of 5-10ha in areas with relatively good water supply.

(2) Farming Practises

Cultivation techniques employed in the Project area are relatively high standard in comparison with those of other areas in Peru. Use of farm machinery has been fairly extended and tractors are generally used for land preparation. Those households which do not own tractors hire the same for the above purposes. Other farm operations, however, are generally preformed by manual labor excluding farmers' cooperatives and large scale farms. The present farming paractises in the Project area are set in below.

1) Cotton

Cotton cultivation has an important place in the economy of the Project area. The main variety is TANGI CN which composes about 90% of cotton cultivation. The remainder consists of TANGI ICA and TANGI LM. These varieties have high salt-tolerance and resistance to drought while at the same time, they provide high yields of good quality.

Farmers' cooperatives and large scale farms use seeding machines for sowing cotton while small-scale farmers rely solely on manual labor. About 50kg of seed is planted per hectare with seeding machines versus about 30kg/ha for manual seeding. Planting distance is genrally 1.2 x 0.2-0.3m with

3-4 seeds/hill. The planting period is from September to December. Most of plantings are completed by October. Thinning and supplementary planting is performed manually about two months after planting resulting in 1-2 plants/hill.

The amount and kind of fertilizer used varies greatly from farm to farm; however, in general, 250kg of urea, 150kg of ammounium phosphate, 100kg of potasium sulphate, and 5-6t of organic fertilier (guano) is applied per hectare. Weeding is usually undertaken 2-3 times per cropping by tractor or manually at the same time as earthening up. Some farmers' cooperatives and large scale farmers presently use herbicides. The predominant weeds in cotton cultivation are grama china, pega-pega, and rabo de zorro.

Plant protection is extremely important in cotton cultivation. The predominant threats to cotton production in the Project area consist of Anomis texana, Anthonomus vestitas (Picudo Peruano), Aphis gossyipii (Pulgon Del), Empoasca kraeneri (Lorito), Paratchan chus sp (Arañita Roja), Alternia tenuis, and Phezocfonia solani. Pectinophera gossyphiella, (Gusano Rosado de la India) which causes extensive damage to cotton crops, is not presently found in the Project area, however, an outbreak of the same occured at the begining of 1984 in Cañete.

Agro-chemicals used for spraying consist of Nimrod 25CE, Belmark, etc. These are applied by tractor in large scale farms and farmers cooperatives; the majority of farmers, however, use a knapsack-type sprayer. Harvesting is performed by manual labor with an average of abouut 40 laborers required per hectare. In general, harvesting begins around April and is split into three with 60% being harvested the first time, 30% the second time, and 10% the third time.

2) Maize

Maize cultivation has expanded greatly in recent years in the Project area. Cultivation of hybrid varieties is practiced. The main varieties consist of PM210, PM211, and

PM204. Cultivation is carried out year-round, although, according to 1982 statistics, most intense cultivation occurs from April to August.

Tractors are used for land preparation. Planting is conducted both by machine and manually. About 20-25kg/ha is sown with planting distance of 0.9-1 x 0.3 - 0.4m. Approximately 3-4 seeds are planted per hill. Thinning is undertaken by some farmers. Fertilizer is generally applied as follows: 200-400kg/ha, ammonium phosphate 60kg/ha, potasium sulphate, 80kg/ha, and, on some farms, about 1t/ha of organic fertilizer. Top dressing is usually undertaken at the same time as earthening up in two or three months after planting. Intertillage and weeding is performed both manually and by tractor. A small percentage of farmers also use draft animals.

Agro-chemicals are applied by power sprayer on large scale farms and farmers' cooperatives whereas the majority of small-scale farmers use knapsack type sprayers.

Crop damage due to insect infestation and disease is minimal in the Project area; however, there is some evidence of Agrotis sp (Gusano de Tierra), Diatraea saccharalis (Cañero), Rhopalosiphom maidis (Pulgon), and Spodopfera fruguperda (Cogollero). Agro-chemicals used mainly consists of Dipterex, Folidol, Ametrin, and Endirithion CE.

All harvesting is performed by manual labor and the harvest is dried in the open air.

3) Vegetables

The Project area is one of the main sources of vegetable supply for markets in Lima. Cultivation techniques are comparatively high; however, except for a few farmers, the majority of farmers depend on traditional methods and management practices are generally inadequate. Cultivation methods presently used in the Project area for major vegetables are described on the next page.

a) Tomato

Although tomato is grown year-round in the Project area, cultivation is generally greatest during the summer season. Varieties include Redondo, and Mazano. Sowing is predominately by the direct sowing method as transplanting requires more time and effort while at the same time resulting in greater damage to plants during planting. The seed rate is 0.5kg/ha with planting distance 1.5 x 0.5 x 0.8m.

Fertilizer use varies with each farm; however, ususally 300kg of ammonium nitrate, 350kg of super phosphate, 95kg of potasium chloride and about 5t of guano are applied per hectare. Weeding is performed both manually and by tractor.

The major insect pests affecting tomato in the Project area include Diabrotica sp (Escar Bajo de la Hoja), Depidopterus (Gusano de Tierra), and Lyriomya hundobrensis (Mosca Minadra), while main diseases include Phytophthora infestans (Hielo) and Rizoctionia solani (Chudadera). Agro-chemicals used to mitigate the effects of the same are Gusathion, Tamaron, Azodrin, Ripcord and Afalon.

Manual labor is used for harvesting, commencing in the third month after planting and being completed in one to two months.

b) Cabbage

Cabbage is usually cultivated in winter in the Project area. Varieties include Jade Cress and Long Island Improved and the seed rate is about 100g/ha. All cultivation is by the transplanting method. Planting distance is 1.0 x 0.6m in general and plant population is about 15,000 - 16,000 plants/ha.

Fertilizer is generally applied in the following amounts: urea 100kg/ha, ammonium phosphate 100kg/ha

and potasium sulphate 80kg/ha, with additional use of organic fertilizer in the form of guano.

Major diseases and insect pests which affect cabbage plants in the Project area include Lepidpteros (Gusano de Tierra), Spodoptera fluigiperda (Cogollero), Cercospora sp (Podrepumbre de la Hoja) and Perenospora parasitica (Mildiu). In general, agro-chemicals such as Tamaron, Sevin, Folimat and Benlate are applied by knapsack type sprayers to combat the above.

c) Maize Choclo

Vatieties in the Project area include Amilaceo, Tipo Cezco, Serrano, Chancayaho and Pardo. The cultiation period is 4 months and the seed rate is 20-25kg/ha. The majority of the crop is sown by hand although some of the larger farmers, use seeding machines. Planting distance is generally 1 x 0.8m with about 4 seeds per hill. Thinning occurs about one month after planting resulting in a plant population of about 3 plants/hill.

Fertilizer is almost the same as that used for maize although the amount is somewhat greater for maize choclo. Chemical spraying is carried out 3-4 times during cultivation period consisting mainly of Dipterex, Granulado and Dithane. The same are applied with a knapsack type sprayer.

d) Beans

Beans are cultivated on a year-round basis; however, most intensive cultivation occurs from April to July. Bean varieties include Canary, Castilla, and Panamito. Seeding machines are used by large scale farms while small scale farmers sow manually. Seed rate is 50kg/ha with planting distance of 0.8 x 0.15m. Fertilization is generally minimal with about 100kg/ha of urea and 70kg/ha of ammonium phosphate.

The main disease and insects affecting beans are agrotis sp (Gusano de Tierra), Epinotia aporana (Cogollero), Laspeyresia leguminis (Perforador de Vaina), and Uromyces sp (Royas). Decis, Dipterex and Benlate are usually sprayed by knapsack type sprayers.

Harvesting is performed by manual labor, requiring about 10 laborers/ha.

d) Potatoes

Varieties grown in the Project area include Revoluecion, Mariva; Tamasa, Conaemyta, Ticahuasi, Antaroui, Huancayo, and Miperu. Reboluencion, however, accounts for about 80%. All seed potatoes are produced in the mountainous region.

Planting season is fairly uniform occuring in the winter season (May - July) while the cultivation period is about 5 months. The seed rate is 1,200-1,500kg/ha. Some successful farmers and farmers cooperatives use potato planters, but the majority of planting is performed by manual labor. In general, planting distance is 1.0 x 0.3m with about 30,000 - 35,000 plants/ha. Earthening up is generally practiced by manual labor.

Fertilizer application varies from farm to farm; however, in general, about 5t of guano are used as a base fertilizer with 250kg of urea, 180kg of anmonium phosphate and 140kg of potasium sulphate per hectare.

Diseases and insect infestation of potato crop in the Project area are numerous, predominately consisting of Liriomyza huidobrensis (Mosca Minadora), Epitrix sp (Pulguilla Saltoma) Gnorimo chema sp (Gusano Minador de Hojos), Myzus pensicae (Pulgon de la Papa), Phytphora intesfans (Hielo

Orancha), Rhizoctonia solani (Chupadera) and Heterodera rostochinesis (Nematoda Dorado). Chemical spraying is therefore undertaken once every 8-10 days mainly by means of a knapsack type sprayer. Weeding and inter-tillage are also widely practised. Manual harvesting is predominant, while a potato digger is used in large scale cultivation.

4) Fruit

a) Citrus

The main citrus fruits in the Project area consist of orange which account for about 70% of citrus cultivation and mandarin orange which account for about 30%. Orange varieties include Criolla, Valencia and Washington, while mandarin orange include Wase unshu and ordinary unshu. Planting distance is usually about 5m x 3m.

The majority of fruit orchards are situated on sandy area and usually substantial quantities of fertilizer are used. Japanese-Peruvian farmers tend to use large amounts of organic fertilizer and in general, the amount of fertilizer applied per hectare is as follows: urea 500kg, triple superphosphote, 200kg, potasium sulphate 280kg, and about 5t of bird droppings, etc.

Pruning is usually carried out from July - August; however, thinning is rare resulting in broken branches from the excessive weitht of ripend fruits.

Spraying is performed with power sprayers. Disease and insects which most affect the citrus crop include Pennospis sp (Quereses), Alletofrichum sp (Antacnosis), and Tylenchulus semipenefrans (Nema todos).

Wase unshu is harvested from March to June, and ordinary unshu from May to June while orange is from around May to January with the largest amounts being harvested from May to August.

b) Apple

The planted area of apple in the Project area accounts for 26% of the fruit cultivation area. Generally, however, areas where apple is cultivated have less favorable agricultural conditions. The main varieties include San-Antonio, Pero and Delicias. Fruits are generally small and irregular in shape. Planting distance is about 3m x 3m with about 1,100 trees/ha.

Fertilization varies with each farm, however, in general 5-6t of guano, 800kg of ammonium nitrate, 280kg of superphosphate and 200kg of potasium sulphate are applied per hectare. Lack of adequate irrigation is particularly influential around October and November during howering and ripening stage of the friut.

Pruning is practised in most of the area but thinning is not, resulting damage to the branches and weakening of the trees from the excessive weight of ripend fruit. Some farms practise leaf thinning in August when leaves are particularly numerous. Salinan is used in this case to make the leaves fall.

Apple is harvested from April to May. In some areas, chemicals are used after the harvest to cause defoliation resulting in two harvests per year. (April - May and October - November). The latter practise however, weakens trees and shortens life span of the same.

c) Passion fruit

There are two methods of passionfruit propagation; seedage and cutting. The former is practised in the Project area. Plants are transplanted to the field 3 months after planting in the seedbed and are usually replanted every 4 or 5 years. Planting

distance is 2.5m x 2.0m with about 1,500-2,000 plant/ha.

A relatively small amount of fertilizer is applied, ususally consisting of 150kg ammonium nitrate, 75kg potasium sulphate, and 15kg urea per hectare. Some farmers also apply organic fertilizer. Chemical spraying is carried out once a month with a knapsack type sprayer.

Although fruits are harvested year-round, harvest is generally from January to August with maximum yields from about April to May. Pruning is conducted from mid-October to mid-November.

d) Grape

The majority of grapes in the Project area are produced for brewing purpose. The same are grown without adopting trellis training. Distance between plants is 1.5-2m x 1.0m with a plant population of about 3,000 plants/ha.

Fertilizer use varies with each farm; however, usually 260kg of potasium nitrate, 200kg of superphosphate, 100kg of potasium sulphate and 5-6t of organic fertilizer are applied per hectare.

Chemical spraying is successively carried out by means of a knapsack type sprayer.

(3) Labor Balance

The cropping intensity in the Project area is not high and there exists no labor shortages. The estimation of monthly labor requirement is impossible due to annual fluctuation of cropping pattern. While annual labor requirement is calculated based on the present cropping conditions as tabulated on the following page.

Table E-1-14 **ANNUAL LABOR REQUIREMENT**

Crops	Labor Requirement per ha (man·days)	Cropped Area (ha)	Total Labor Requirement (man·days)
Cotton	106	5,300	561,800
Maize	58	3,850	223,300
Potatoes 1/	50	900	45,000
Vegetables 2/	124	4,800	372,000
Soiling corn	44	1,200	52,800
Beans 3/	39	900	35,100
Fruit	146	6,530	953,380
Total			2,243,380

1/ calculated with potato
2/ calculated with tomato
3/ calculated with frijol seco

The annual available labor force is estimated as follows:

Annual available labor force
= number of farm households 1/
x potential working days per year 2/
x potential labor force per farm household 3/
x (1 - accident and sickness rate) 4/
= 4,413 x 300 x 3.5 x (1 - 0.05)
= 4,401,968 man·days; about 4,402,000

1/ Table E-1-11
2/ 25 days/month x 12 months
3/ Table E-1-12
4/ estimate accident and sickness rate at 5%

The annual labor balance is:

Annual available labor force - annual labor requirement
= 4,402,000 - 2,243,000
= 2,159,000

Therefore, an annual surplus of labor force is estimated at about 2,160,000 man·days or about 50% of available labor force.

The number of farm households in rural areas was only taken for calculation, however, there are considerable numbers of farm households in urban areas as well. In addition, many migrant laborers from mountain areas are employed for cotton harvest. It may accordingly be assumed that the surplus labor force is greater than the above.

(4) Farm Machinery Balance

The peak of tractor use in the Project area occurs during a harvesting period of cotton (September to November). Tractor ownership in the Project area is shown in Table E-1-13. Tractors owned by cooperatives amount to 91 units while privately owned tractors equal 154 units, resulting in a total of 245 units. Judging from the number of tractors, shortage of tractor is not anticipated in the Project area. In reality, however, delay in farming operation due to shortage of the same always occurs in the Project area. Major reasons for the above are:

a) about 30% of the tractors in the Project area are inoperative due to inadequate O & M; and,

b) most of the tractors owned by fruit producers are not used for hiring service.

Although, there are some repair shops in the Project area, spare parts are difficult to obtain and consequently, tractors remain unrepaired. Countermeasures such as establishement of tractor hiring service centers and well-equipped repair shops are essential.

1-7 Livestock Industry

Livestock raising in the Project area is practiced by a few farmers or farmer's groups, generally more or less in an entrepreneur manner. Conditions of the livestock industry in Chancay/Huaral District are presented in Table E-1-14 and E-1-15. As can be seen from the same, the majority of livestock production is derived from poultry. No significant variation occured in population during 1981-83, although there was a slight decrease in cattle, goats and broilers in 1983.

Table E-1-14 **LIVESTOCK POPULATION IN CHANCAY/HUARAL/AUCALLAMA DISTRICT, 1981-83**

Unit: 1,000 heads

Item	1981	1982	1983
Dairy/beef cattle	3.5	3.0	2.8
Pig	22	27	18
Goat	20	16	15
Horse	0.5	0.5	0.6
Broiler	20,000	28,000	27,600
Hen	5,000	6,000	6,000

Source: Distriro Agropecuario Huaral

2 Agricultural Development Plan

2-1 Agricultural Constraints and Development Potential

The agricultural production in the Project area is carried out under the irrigation farming system cultivated through agricultural activities for several decades. Both the agricultural productivity and farming technology are comparably higher than other areas of Peru. However, the deterioration of irrigation facilities and the lack of adequate drainage facilities which restrict both land utilization and improvement of agricultural productivity are decisive constraints on agriculture and farm management in the Project area. Technical and institutional constraints on agricultural production also exist in the area. Due to the above, farm management in the area is generally unstable. In particular, small scale farmers, the majority of farmers in the Project area, suffer from difficulties in farm management. Hereunder are several constraints which hinder the improvement of agricultural productivity and farm management.

(1) Deterioration of Irrigation Facilities and Lack of Adequate Drainage Facilities

The Project area is under the unstable supply of irrigation water due mainly to the deterioration of irrigation facilities, the lack of adequate irrigation facilities and the destruction of intake facilities by flooding. The condition of water supply has a detrimental effect on agriculture in the arid region and irrigation water shortages adversely affect land utilization and agricultural production of the Project area directly and indirectly.

1) Direct effects of irrigation water shortages

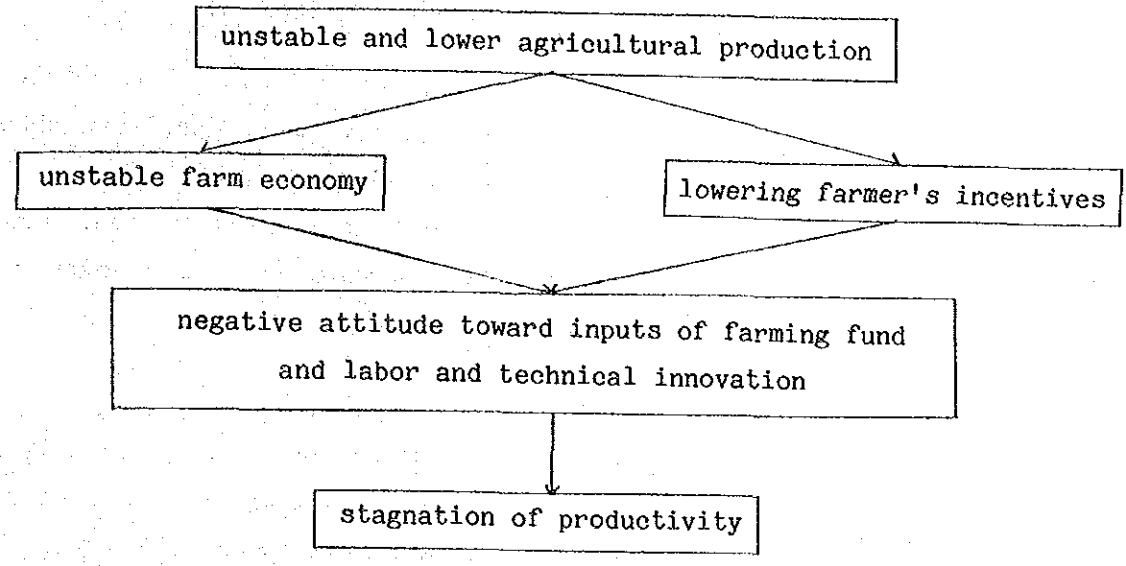
The direct effects of irrigation water shortages are:

a) limitations on cropping intensity and crops planted;
b) poor growth and yields; and
c) restrictions on observing optimum planting times and scheduled planting.

The effects result in unstable and lower agricultural production contrary to farmers expectation.

2) Indirect effects of irrigation water shortages

The unstable and lower agricultural production caused by the direct effects of irrigation water shortages indirectly affect agricultural production as illustrated below.



The relation between the condition of irrigation water supply and agricultural production and farm management is shown in Fig. E-2-1.

In the poorly drained salt accumulated areas, agricultural production is maintained by farmers' efforts in adopting various countermeasures for salinity control. However, problems such as limitation of cultivable crops and stagnation of productivity are common in these areas. The improvement of agricultural productivity is not expected without drastic countermeasures for salinity control such as drainage improvement and desalinization.

(2) Technical Constraints

1) Difference in farming technology among farmers

A limited number of successful farmers in the Project area carry on considerably profitable farm management based on advanced farming technology. Farming technology of small scale farmers, however, remain at a less advanced level.

2) Unscheduled cropping

Availability of irrigation water, market prices of products and amount of farming fund greatly influence cultivation in the Project area. Therefore, scheduled croppings and crop rotations are not always practiced which result in unstable farm management.

3) Shortage of farm machinery

The delay in cropping due to shortage of tractors is one of the major problems with farming practices, even though a number of tractors in the Project area exceeds the estimated requirement. The lack of adequate maintenance system and rational utilization system of farm machinery is apprarently the problem.

(3) Institutional Constraints

The followings are major problems with the agricultural supporting systems in the Project area, which should be seriously examined in order to improve agricultural production and farm management of the area:

a) lack of adequate extension service and research organizations;

b) inadequate agricultural financing system ---- shortage of farming fund; and

c) lack of proper marketing system.

The constraints which hinder the improvement of agricultural production and farm management are manifold. Agricultural production of the Project area, however, is primarily governed by the condition of irrigation water supply and little improvement of agricultural productivity is expected without solving shortages of irrigation water supply as shown in Fig. E-2-1. In the poorly drained salt accumulated area, the situation is similar and the improvement of agricultural productivity will be realized only after the improvement of drainage facilities and desalinization. The potential for improvement of agricultural productivity can be made through the rehabilitation and improvement of irrigation and

drainage facilities. Agricultural productivity will be improved by promoting the renovation of farming technology and strengthening agricultural supporting systems to materialize the potential of the area.

The Project area which accounts for about 2% of the total irrigated land in Peru and plays an important role as the base of food supply for the Metoropolitan area of Lima holds an important position in the national agriculture and economy as well. The high agricultural potential of the area is clear by the agricultural productivity of some farmers.

Improvement in irrigation and drainage facilities and improvement of technical and institutional drawbacks will result in an increase in agricultural productivity and improvement of farm management. The same will contribute to the national agriculture output and economy.

2-2 Basic Conceptions

(1) The Project-Area

The role of the Project area in the agricultural development strategies in Peru is not clearly defined. On the basis of the discussion held with OSPA (Oficina Sectorial del Planificacion Agraria), the organization responsible for agricultural planning, the following was spelled out:

a) In Peru, agricultural production has not expanded to meet demand. In particular, import of cereals has greatly increased. The import of maize has almost trebled since 1979-81. As a result, the promotion of agriculture and the improvement of self-sufficiency in agricultural products are the foundation of the agricultural policies of Peru. The expansion of agricultural production, especially cereals, is expected under the present Project.

b) Cotton, the principal crop in the Project area, is the most important export crop next to coffee. The production of cotton in the Project area is

significant in terms of export promotion which is the central theme of the Peruvian economic policies.

c) The project area is playing an important role as the suppling base of agricultural food products, mainly vegetables and fruit, for the Metropolitan area of Lima. The importance of this role will become greater in the future as the migration to the same continues to increase.

d) The Peruvian government has targeted the production of beans, one of the staple foods of the nation, to increase. Accordingly, production of beans in the Project area is encouraged.

The goals of the Project area are consistent with the recent tendency of crop production therein which generally represents the farmers' intentions.

(2) Basic Conceptions

The Project aims at an increase in crop yields, and stability and increase of agricultural production, thereby improvement of the farmer's living standard in the Project area by removing existing constaints in agriculture and farm management. The Project is also designed to contribute to the national economy. To this end, the basic conceptions for agricultural development plan of the Project are:

land utilization plan

a) To intensify land utilization to correspond with the improvement of irrigation and drainage facilities.

b) To increase land productivity through the introduction of appropriate rotation systems.

crop production plan

a) To increase crop yields.

b) To establish rotation systems and scheduled cropping and increase cropping intensity.

c) To increase maize production in order to contribute to the improvement of self-supply of agricultural products.

d) To plan production increases of cotton.

e) To plan production of vegetables and other food crops in order to help meet the demands of the Lima Metoropolitan area.

f) To restrict the area of fruit to the present area so as to place emphasis on production increase of other food crops.

g) To plan production increase of beans to correspond with the government policy.

farm management plan

a) To aim at the stability and improvement of production and farm management based on adequate crop rotation systems.

b) To plan the intensification of farming in terms of farm scales, and ensure sufficient returns from farming even in the small scale farmers.

c) To plan for stability and increases in crop yields by the improvement of farming practices.

2-3 Land Utilization Plan

The present land utilization patterns have been established based both on the experience and knowledge accumulated by farmers through agricultural activities. It is recognized that the present land utilization patterns are consistent with the natural and socioeconomic conditions of the Project area. Therefore, present patterns for perennial crop productions and annual crop productions in the Project area will be maintained under the land utilization plan. However, small patches of swampy grass and fallow lands will be utilized for annual crop production parallel to the progress of the present rehabilitation project.

The proposed land utilization patterns at full development are shown in Table E-2-1; the same by irrigation block are as presented in Table E-2-1.

Table E-2-1 **PROPOSED LAND UTILIZATION PATTERNS OF ARABLE LAND**

Land Utilization Patterns	Area (ha)	Changes in Area (ha)
Perennial crop production	6,530 (32.3%)	0
Annual crop production	13,670 (67.7%)	+ 620 (+4.8%)
Total	20,200 (100%)	

* Increase in area from the present level.

For annual crop production increase several area are emphasized. In short such areas are intensive land utilization and improvement of land productivity, both based on the rotation system which include i) cotton/maize rotation, ii) vegetable rotation, and iii) potato/vegetable rotation. The proposed land utilization subpatterns based on the above rotation systems have been formulated through the comprehensive study on: i) present land utilization subpatterns, ii) basic principles for cropping plan, iii) proposed rotation systems, and iv) intensions of producers associations and related organizations as shown in Table E-2-2.

The utilization of the salt accumulated poorly drained area is examined in the proposed cropping plan.

2-4 Crop Production Plan

(1) Selection of Crops

The annual crops to be produced in the Project has been determined taking into account; i) the basic conception, ii) present cropping conditions, iii) intention of farmers, iv) cultivation technique of farmers, v) importance of crops, and vi) profitability.

The present major crops in the Project area, namely, cotton, maize and vegetables have been selected as the principal crops in the cropping plan. The cultivation of beans is envisioned to be incorporated in the crop rotation system with the principal crops.

In the Project area, many kinds of vegetables are presently cultivated. In the present plan, however, only the cultivation of major vegetables such as choclo, tomato, kidney bean, cabbage and carrot, which hold on important positions in the Lima market and have relatively stabilized market prices are planned.

The introduction of leguminuous green manure crops into the rotation system with the principal crops is also planned in order to maintain and improve land productivity.

Finally, cultivation of soiling corn is less profitable while the same can be replaced by foliages of maize and choclo. Therefore, cultivation of soiling corn is not included in the present plan.

(2) Basic Principles for Cropping Plan

The cropping plan is formulated according to the following basic principles:

a) The intensification of land utilization and the resultant increase in cropping intensity should be in accordance with the improvement of irrigation and drainage facilities.

b) The Project will be designed to formulate cropping patterns in which the cultivation of economically important principal crops is the nucleus of the whole scheme. All crops except fruit would be cultivated under the rotation systems.

c) Taking into consideration the views of the Cotton Producers Cooperative Association of the Project area, the cropped area of cotton should be maintained at the present level. A production increase in proportion to yield increase is aimed at the same.

d) In order to increase maize production, the strengthening of maize cultivation is planned by allocating additional cropped area, anticipated by the improvement of the cropping pattern and

intensity due mainly to the incremental supply of irrigation water.

e) The present cropping conditions of fruit are maintained. A production increase and improvement of qualities are aimed at through the betterment of irrigation water supply.

f) The occasional over production due to unscheduled cropping and inadequate marketing system is the problem of vegetable cultivation in the Project area. The expansion of vegetable cropped area is not recommended. The importance of scheduled cropping and an adequate marketing system is recognized by farmers. Therefore, in the present plan the annual cropped area of vegetable is planned to be kept at the present level and year-round cultivation is projected. Scheduled cropping and improvement of the marketing system are prerequiste for successful handling of increased production anticipated by the implementation of the Project.

g) The cropped area of potato is maintained at the present level. A production increase in proportion to yield increase is expected.

h) The introducion of beans into the rotation system of principal crops is proposed with a view to increase production of staple foods promoted by the government and to improve soil conditions.

i) In the poorly drained salt accumulated area, the rotation system of cotton-green, manure crop-maize is adopted. The first crop after the commencement of desalinization should be cotton and salt torelant varieties of maize should be planted.

(3) Proposed Cropping Patterns

1) Proposed rotation systems

Cultivation of annual crops should be practiced under the rotation systems. The introduction of the following rotation systems is proposed:

- cotton-beans-maize ..... 3 crops in 2 years
- cotton-green manure crop-maize ..... 3 crops in 2 years
- potato-vegetables-vegetables-vegetables .... 4 crops in 2 years

  (Cultivation of potato should be once in 2 years in order to avoid injury by continuous cropping. In this system, choclo and kidney bean are mainly cropped.)
- vegetables-vegetables ..... 5 crops in 2 years

  (Kind of vegetables is proposed to be changed at every cropping.)

2) Proposed cropping pattern

Although year-round cultivation of crops is possible in the Project area, the optimum cropping seasons of major crops are defined as follows:

- cotton ... planting: August-September harvest: May-June
- maize .... planting: January-February harvest: June-July
- potato ... planting: June-August harvest: November-January

The planting time of cotton is restricted to the period of August 1 to October 15 by regulation, to prevent damage by Pectinopphera Gossypiella Sound. The growth characteristics of crops are summarized in Table E-2-3.

Based on the land utilization plan, the basic principles and other factors such as optimum cropping seasons, availability of irrigation water and balance between available and required labor force, the cropping pattern has been formulated as shown in Fig. E-2-2, Table E-2-4. The following table outlines the proposed cropping pattern.

PROPOSED CROPPING PATTERN

cropping pattern/rotation system	area (ha)	%
cotton - beans - maize	5,660	28
cotton - green, manure crop - maize	5,660	28
potato - vegetables - vegetables - vegetables	900	5
vegetables - vegetables	1,450	7
fruit	6,530	32
Total	20,200	100

(4) Proposed Cropping Plan

The proposed annual cropping plan corresponding to the proposed cropping pattern is as follows while also being tabulated as Table E-2-5;

cotton ... to slightly increase the cropped area to 5,660ha, under the rotation system with maize

maize ... to cultivate 5,660ha or 147% of the present cropped area by allocating additional cropped area, anticipated by the improvement of cropping pattern and irrigation water supply to maize cultivation

potato ... to cultivate 450ha under the two-years rotation system with vegetables

beans ... to incorporate within the rotation system of cotton-maize on 2,830ha

green manure crop ... to be included in the rotation system of cotton-maize on 2,830ha

vegetables ... to cultivate 1,350ha under the rotation system with potato, 3,625ha under the rotation system of vegetables and in total annual cropped area of 4,975ha as tabulated on the following page

VEGETABLES

Kind of Vegetables	Area (ha)	%
tomato	625	13
cabbage	500	10
choclo	900	18
kidney bean	700	14
cauliflower	300	6
other vegetables	1,950	39
Total	4,975	100

Fruit ... to maintain the present cropped area of 5630ha as tabulated below

FRUIT

Kind of Fruit	Area (ha)	%
apple	1,680	26
orange	1,550	24
mandarin orange	570	9
passion fruit	550	8
grape and others	2,180	33
Total	6,530	100

(5) Cropping Intensity

Substantial increase in cropped area is projected from the present 23,480ha to the future 28,935ha or an increase of 5,455ha (about 23% of the present cropped area). The cropping intensity will increase from the present 116% to 143% under the Project. The increase in cropping intensity and cropped area is mainly attributable to the intensification of land utilization.

(6) Target Yields

The present crop yields in the Project area are relatively high as compared with those in other areas of Peru. Crop yields considerably fluctuate year by year, however, due to irrigation water supply condition. With the completion of the rehabilitation Project, crop yields will be increased and stabilized through

improvement of irrigation and drainage facilities, renovation of farming practices and strengthening of agricultural supporting systems. The projected target yields at full development are assumed based on yield level of the successful farmers in the Project area and the yield level of the existing similar project Canete Project as shown in Table E-2-6.

In order to attain the projected target yields at a possible earlier stage, it is essential to improve the present farming practices and agricultural supporting systems. However, the farmers in the Project area have; i) adequate experience in irrigation farming, and ii) chances to observe the farming practices of successful farmers. Therefore, it would not take long for the farmers to improve farming practices. The target yields are then assumed to be attained in 5 years. The crop yields during the build-up period are assumed as shown in Table E-2-7.

(7) Anticipated Crop Production

The crop production in the Project area will increase year by year with the increase in crop yields. Based on the projected increase of crop yields in 5 years assumed in Table E-2-7, the anticipated annual crop production is estimated in Table E-2-8. The annual crop production at the full development are estimated at about; i) cotton 22,600 tons, ii) maize 39,600 tons, iii) fruit 108,700 tons, iv) vegetables 76,900 tons, v) beans 3,700 tons, and vi) potato 9,900 tons.

2-5 Farm Management Plan

(1) Proposed Farming Practices

To realize increased agricultural potential by the improvement of irrigation and drainage facilities, the improvement of farming practices should be achieved through the strengthening of agricultural supporting systems. The proposed farming practices have been formulated on the basis of the present farming practices as well as the farming practices of successful farmers in the Project area. Said practices are proposed hereunder.

1) Cotton

Cotton farmers in the Project area are experienced and capable, practising relatively reliable cultivation methods under the instruction of such agencies as CIPA and the Cotton Producers Cooperative Association. Conditions for cotton cultivation in the Project area are thus considered highly favorable. With implementation of water and fertilizer management after Project implementation, attainment of target yield is feasible.

Varieties

Cultivation of improved varieties presently popular in the Project area is recommended. The adequate guidance of related organizations is required for the introduction of new varieties.

Sowing

Sowing during August and September is preferable, and should be completed at the latest by mid-October, as delayed sowing presently results in a yield reduction of approximately 30%. Recommended seed rate is 70kg/ha to be sown by tractor, with 4-5 seeds per hill. Thinning should be undertaken about 1 month after sowing with a resultant plant population of 1-2 plants/hill. Upon completion of thinning, application of irrigation water is essential.

Fertilization

The following fertilizations are recommended:

- basic fertilizer	-organic fertilizer	8-10t/ha
	-urea	100kg/ha
	-ammonium phosphate	220kg/ha
	-potasium sulphate	160kg/ha
- top dressing	-urea	160kg/ha

Plant protection

Early detection is the most important factor in prevention of disease or insect infestation. Appropriate chemical spraying should be implemented

under the instruction of related agencies. Seeds should be disinfected prior to sowing and chemical spraying should be practiced at least 2-3 times from 1 month after sowing.

Harvesting

Harvesting by hand picking is proposed as presently practiced.

2) Maize

Varieties

Varieties presently used in the area such as, PM210, PM211, PM204 are recommended under the Project as well. The adequate guidance of related agencies is required for the introduction of the new varieties.

Sowing

The optimum cultivation period is from January to July and sowing should be completed from January to February with a seed rate of 25kg/ha. Proposed planting distance is 1.0x0.4m. Residues of preceding crop or green manure crops should be plowed in as far as possible at the time of land preparation.

Fertilization

The total fertilizer requirement for sustaining target yield would be 300kg/ha of urea, 230kg/ha of ammonium phosphate and 120kg/ha of potasium sulphate. The above should be applied, divided into two, basic fertilizer application as top dressing.

Plant protection

Chemical spraying should be conducted at least 2-3 times per cropping to prevent disease and insect infestation. The time of application and kinds of chemicals depend on the possibility and degree of infestation.

3) Vegetables

a) Tomato

Varieties

Proposed varieties include Floradel, Ace 55VF, Rearson, Tropic, Vista, Early Pok. New varieties will be introduced under the instruction of related organizations.

Sowing

Proposed seed rate is 0.5kg/ha with a planting distance of 1.2x0.5m and a plant population of about 17,000/ha.

Fertilization

The following fertilizations are recommended:

- basic fertilizer	-organic fertilizer	8t/ha
- top dressing	-ammonium ritrate	450kg/ha
	-superphosphate	800kg/ha
	-potasium chloride	130kg/ha

The above should be split into three applications.

b) Cabbage

Sowing and transplanting

Preparation of seedlings should be commenced in February and transplanting should be practiced from the end of March to the end of June. Proposed seed bed rate is 50g/ha and transplanting at 5-6 leves stage of seedlings is recommended. Proposed planting distance is 0.8x0.5m.

Fertilization

Application of organic fertilizer as a basic fertilizer is preferable at a rate of 8t/ha. Supplemental chemical fertilizer required to obtain higher yield would be 140kg/ha of urea, 130kg/ha of ammonium phosphate and 110kg/ha of potasium sulphate. The above should be divided into 3 applications.

Plant protection

Chemical spraying to prevent infestations of Lepidopteros (Gusano de Tierra), Brericorine brassi Cae (Afldos) and other insects is required using Dosis, Tamaron and Folimat. Benlate should be applied to prevent desease caused by Perenon Pora Parasitica.

c) Choclo

Varieties

Present varieties such as Amilaceo and Chancayaho are recommended for the time being. These varieties, however, are extremely long stemmed requiring substantial time for harvesting. Development of improved, short-stemmed varieties are desirable.

Sowing

Recommended seed rat is 25kg/ha with a planting distance of 1.0x0.5m and 3-4 seeds per hill. Thinning about 1 month after sowing is required to reduce plant population to 2-3 plants/hill.

Fertilization and plant protection of maize are applicable to choclo.

4) Bean (Frijol)

Variety and sowing

Canary is the recommended variety in the Project area. A seed rate of 60-70kg/ha is recommended with a planting distance of 70x15cm.

Fertilization

Proposed fertilization is 140kg/ha of urea and 90kg/ha of ammonium phosphate.

5) Potato

Planting

Optimum cropping season of potato is from June to January and planting should be conducted from June to August. Seed potatoes should be large in size and cut

for planting. This practice has advantages such as economizing seed potato and accelarating sprouting. Proposed planting distance is 1.2x0.3m, while seed potato requirement is about 2,000kg/ha. Seed potatoes should be soaked in 1:100 formalin solution for about 90 minutes for disinfection.

Fertilization

The recommended fertilization consists of organic fertilizer at a rate of 8t/ha, urea at 340kg/ha, ammonium phosphate at 260kg/ha and potasium sulphate at 200kg/ha. Application of urea should be split into a basic application and a top dressing at the latest by the flower-bud-appearing stage.

Plant protection

Chemical spraying should be practiced as needed for about 3 months from 1 month after planting. Nematicida should be applied before planting when infestation of nematodes is noticed.

6) Fruit

At present, fruit producers in the Project area place great importance on yield rather than on quality of products. Increased efforts to improve quality of products are necessary to raise the commercial value of fruit. Accordingly, adoption of appropriate water management, fertilizer application, pruning and fruit thinning practices are essential.

a) Citrus fruit

About 10t/ha of organic fertilizer is recommended for a matured orchard along with 740kg/ha of urea, 300kg/ha of superphosphate and 400kg/ha of potasium sulphate, split into 3 applications.

Pruning should be promoted in those areas where it is not yet practised and appropriate pruning methods should be determined under the guidance of experts from

related agencies or successful farmers. Fruit thinning should also be practised as the same has the following advantages; i) flourishing tree vigor, ii) preventing biennial bearing, and iii) improving fruit size, color and thereby quality.

b) Apple

The condition of irrigation water supply in the apple growing area is generally poor and water shortages are particularly evident from flowering stage to fruit thickening stage (October to November), which greatly affects yield.

About 8~10t/ha of organic fertilizer is recommended for a matured orchard along with 1200kg/ha of ammonium nitrate, 400kg/ha of superphosphate and 300kg/ha of potasium sulphate, to be divided into 3 applications. About 60% of the above should be applied as a basic application.

Fruit thinning is recommended for increasing tree vigor and preventing biennial bearing. The same should be practiced 2-3 weeks after falling of flowers in order to preserve 50-70 leaves per fruit. Pruning should be carried out as presently practiced. Chemical spraying for plant protection should be practiced under the guidance of related organizations or successful farmers.

c) Passion fruit

The continuation of the present cultivation method is proposed under the Project.

About 8t/ha of organic fertilizer is recommended to be applied as a basic fertilizer. In addition, 200kg/ha of ammonium nitrate, 100kg/ha of potasium sulphate and 50kg/ha of urea should be applied in 3 fertilizations.

d) Grape

Varieties and cultivation methods presently adopted are proposed to be maintained. However, increased application of fertilizer is required because grapes are generally planted in sandy to gravelly soils. In particular, organic fertilizer of about 8t/ha is recommended for basic application. Requirement of chemical fertilizers would be 370kg/ha of potasium nitrate, 300kg/ha of superphosphate and 200kg/ha of potasium, which should be applied in 3 doses.

(2) Proposed Farming Operation Systems

The proposed farming operation systems correspondent to the proposed cropping pattern and farming practices are shown in Fig. E-2-3 and E-2-4. In the formulation of the farming operation systems, the following conditions of the Project area have been taken into consideration and drastic changes in the farming operation systems are avoided:

a) There exist surplus labor in the urban areas;

b) Sufficient migrant laborers are employed every year during the harvesting period of cotton; and,

c) Rapid farming mechanization is difficult judging from availability of funds by farmers.

In the systems, planting mechanization of cotton, maize, maize choclo and beans are proposed to be exetended even in small scale farms.

(3) Future Farm Labor Balance

Study on the balance between available labor and labor requirement for the proposed cropping pattern and farming operation systems are shown in Table E-2-9 and Fig. E-2-5. Available labor are estimated based on the number of farm households in rural areas. The number of farm households in urban areas are excluded from the calculation because the actual figures are unknwon. As

the result of the study, labor deficits are indicated in the said table in May and June during the harvesting season of cotton and maize. For the following reasons, however, the proposed cropping pattern is possible in terms of the future labor balance:

a) Farm households in urban areas are not considered in the study of the labor balance;

b) Considerable proportion of cotton harvesting are presently carried out by migrant laborers from the mountain areas. The employment of these laborers will be possible in the future; and,

c) Considerable surplus labor exists in the urban areas where the phenomenon of population inflow is remarkable.

With the intensification of land utilization and agriculture under the Project, the annual labor requirement will increase from the present 2,243,380 man/days to 2,437,800 man/days in the future. The increase in labor opportunities of 194,420 man/days per year is expected under the Project.

(4) Future Farm Machinery Balance

The number of farm tractors required in each month under the proposed cropping pattern and farming operation systems are presented in Table E-2-10. According to the calculations therein, the peak period of tractor use occurs from July to August. On the basis of the above, the monthly tractor balance is examined in the following two cases as shown in Table E-2-11.

- Case 1 ... assuming that all the tractors in the Project area are available for hiring services
- Case 2 ... assuming that most tractors possessed by fruit producers are not used for hiring services

Table E-2-11 **TRACTOR BALANCE - CASE 1**

unit: number of tractors/day

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Tractor Requirements 1/	141	74	72	80	140	189	237	237	201	188	132	184
Tractors in Operation 2/	245	245	245	245	245	245	245	245	245	245	245	245
Balance 3/	+104	+171	+173	+165	+48	+48	+8	+8	+44	+57	+113	+61

1/ number of tractors required per day in each month
- monthly operating hours are assumed; Jan. to June and Sep. to Dec.: 8hrs/dayx25days/month=200hrs/month
July and August: 9hrs/dayx27days/month=243hrs/month

2/ number of tractors in operation in each month
- estimated that 245 tractors (equal to the number of tractors possessed in the Project area at present) are in operation, by assuming that maintenance system of tractors will be improved under the Project and the number of tractors possessed in the Project area will increase in the future.

3/ monthly tractor balance = 2/ - 1/

Table E-2-12 **TRACTOR BALANCE - CASE 2**

unit: number of tractors/day

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Tractor Requirements 1/	109	42	40	48	108	157	205	205	169	156	100	152
Tractors in Operation 2/	185	185	185	185	185	185	185	185	185	185	185	185
Balance 3/	+76	+143	+145	+137	+77	+28	-20	-20	+16	+29	+85	+33

1/ number of tractors required per day in each month
= total number of tractors required (Table E-2-10) - number of tractors used for fruit cultivation (32)
= number of tractors required for annual crop cultivation
Monthly operating hours are assumed as shown in Table E-2-11.

2/ total number of tractors in operation in each month (Table E-2-11) - number of tractors possessed by fruit producers in Esperanza, 60 (assuming equal to the present)

3/ monthly tractor balance = 2/ - 1/

As the result of the studies, the following countermeasures are proposed in order to make the proposed cropping pattern practicable:

a) Maintenance systems of farm tractors should be strengthened so as to improve the rate of operation. In concrete terms, maintenance and repair of tractors should be done during the period of low demand for tractor use, especially February to April, and the rate of operation should be increased to around 100% during the peak period of tractor use;

b) The system of tractor use should be formulated in order to ensure the intensified tractor use during the peak period;

c) The tractor hiring service systems in which most of the tractors possessed in the Project area is involved should be formulated; and,

d) If tractors possessed by fruit producers are not used for services, a deficit of tractors will occur as indicated in Table E-2-12.

In the latter case, the establishment of financial supporting services for the procurement of tractors by farmers' groups and/or the establishment of tractor hiring service center are proposed.

(5) Proposed Farming Pattern

Based on the basic conceptions of farm management plan, the proposed cropping pattern and farming operation systems, the farming patterns corresponding to farming scales are proposed as set in below.

1) Farming scale less than 1.5ha

In vegetable production, intensive cultural practices and quality control are required on the one hand. On the other hand, high profitability and intensified land utilization are possible. Therefore, the following farming patterns in which vegetables production is the mainstay are proposed for the farming scale of less than 1.5ha.

- proposed farming patterns ..... vegetables in rotation
  potato - vegetables
  rotation system

2) Farming scale 1.5 to 3.0ha

For farm households with farming scale between 1.5 to 3.0ha, the farming patterns which combine equally both labor intensive rotation system, vegetables or potato-vegetables, and less labor intensive rotation system except for harvesting season, cotton-beans-maize or cotton-green manure crop-maize, are proposed as set in below.

- proposed farming patterns
  cotton-beans or green manure crop-maize rotation system + vegetables in rotation

  cotton-beans or green manure crop-maize rotation system + potato-vegetables rotation system

3) Farming scale 3.0 to 6.0ha

The farming patterns which primarily consist of 2 rotation systems; i) cotton-beans-maize, and ii) cotton-green manure crop-maize, are proposed for farming scale of between 3.0 to 6.0ha. Depending on farming scale and labor condition, the combination of labor intensive rotation system is possible.

- proposed farming patterns
  cotton-beans-maize rotation system + cotton-green manure crop-maize rotation system

  cotton-beans or green manure crop-maize rotation system + vegetables or potato-vegetables rotation system

4) Farming scale over 6.0ha

Farm households with farming scale over 6.0ha enjoy relatively stable farm management at present. The farming patterns which combine 2 rotation systems; i) cotton-beans-maize; and ii) cotton-green, manure crop-maize, are proposed for farming scale over 6.0ha. The price of cotton is relatively stable and comparatively high returns are expected in cotton cultivation. Therefore, stable farm management is possible under cotton production of one crop per year if

farming scale is large enough. However, the rotation system with maize should be adopted in order to avoid risks of monoculture such as the sharp decline of market prices and outbreak of diseases and insects. The introduction of green manure crops is also recommended to improve soil conditons.

5) Fruit producers

The farming scale of fruit producers in the Project area is generally large and stable farm management is the norm. Therefore, the continuation of the present farming pattern is proposed. Increased production and improvement of quality of products will be achieved with the improvement of irrigation water supply and farming practices, and the establishment of stabilized profitable farm management is expected.

Summary of the proposed patterns are illustrated in Fig. E-2-6.

2-6 Anticipated Production Increase

(1) Crop Production under Without-Project Conditions

In the Project area, considerably matured agricultural production, established on the basis of a long history of irrigation farming, is carried out. Crop production in the area is primalily governed by the condition of irrigation water supply and accordingly the increase of crop productivity will not be expected without the improvement of irrigation and drainage facilities. While the water management system and the O&M systems of irrigation facilities in the area are relatively well organized, further strengthening of the management systems of both irrigation water and facilities is required to ensure the present condition of irrigation water supply. In the poorly drained area, continued efforts in farm management is also imperative. It is projected that further countermeasures including O&M aspects will be adopted even if the present Project is not implemented and that the crop production of the present level will be maintained.

(2) Anticipated Production Increase

The anticipated production increase under the Project are presented in Table E-2-13 and E-2-14. At the full development stage, the production increases of; i) cotton 8,330t, 58%, ii) maize 22,295t, 129%, iii) fruit 28,627t, 35%, iv) vegetables 25,175t, 49%, and, v) beans 2,779t, 309%, are expected.

2-7 Livestock Industry

Various constraints to the introduction of livestock raising for ordinary farmers in the Project area are as follows:

a) lack of supporting systems for livestock raising such as veterinary services and extension services;

b) shortage of funds; and,

c) limited land area available.

Accordingly, introduction of livestock raising for ordinary farmers is not included within the present Project. Livestock raising in the Project area is presently carried out under the feeding system depending on purchased feed. Therefore, the direct increase of benefit with the Project will not be expected.

3 Recommendation

Strengthening of Supporting System for the Utilization of Farm Machinery

In the implementation of the proposed cropping pattern, shortage of tractors is apprehended. Joint ownership and tractor hiring system are presently common in the Project area, however, strengthening of supporting systems are recommended. To this end, the following activities should be considered:

a) establishment of a tractor hiring service center with repairing function of farm machinery; and,

b) financial supporting service for procurement of farm machinery by individual and farmers' groups.

TABLE AND FIGURE

Table E-1-2 Present Land Utilization Patterns and Subpatterns by Irrigation-Block 1/

Land utilization patterns/subpatterns	Left Bank		Right Bank			Project Area
	upper	lower	upper	central	lower	Total
	ha (%)	ha (%)	ha (%)	ha (%)	ha (%)	ha (%)
Fruit production	640 (28)	590 (17)	4,360 (90)	630 (11)	310 (8)	6,530 (32)
Annual crop production	1,650 (71)	2,640 (78)	430 (9)	5,070 (88)	3,260 (85)	13,050 (65)
Grassland/fallow	30 (1)	170 (5)	70 (1)	90 (2)	260 (7)	620 (3)
Total	2,320 (100)	3,400 (100)	4,860 (100)	5,790 (100)	3,830 (100)	20,200 (100)

1/ prepared on the basis of the land use map and agricultural statistics of District Agropecuario Huaral

Table E-1-3 Monthly Planting Ratio (%) of Main Crops in 1982/1

Crops	Growth period (days)	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	Total
Maize	120 - 150	2	5	3	21	10	9	14	3	12	5	10	6	100
Maize Choclo	90 - 120		10	5	18	12	9	5	3	30	1	7		100
Soiling Corn/2	90 - 120	10	11	11	4	9	11	12	11	2	19			100
Beans	120 - 150	3	5	6	13	7	21	16	11	2		9	7	100
Tomato	120 - 150	4	5	5	13	8	3	7	2	19	16	18		100
Sweet Potato	120 - 150	8	23	7	5	2	3	6	3	9	10	15	9	100
Carrot	120				3	31	11	10	10	27	8			100
Onion	120								12	88				100
Pumpkin	120 - 150	16	13			3	5			50	13		8	100
Watermelon	120									41	15	18	26	100
Cassava	210 - 270									50	2	46		100
Potato	140 - 160			2	8	17	21	21	18	13				100
Cotton	250 - 270									40	52	10	8	100

/1 Percentage of planted area, each month to total planted area
/2 Maize Chala

Source: Oficina Sectorial de Estadistica, Ministerio de Agricultura

Table E-1-4 Crop Production During 1978 - 1983 in Chancar/Huaral

Crops	Year	1978	1979	1980	1981	1982	1983
Cotton	Yield (kg/ha)	2,767	2,700	2,740	2,403	2,921	1,237
	Production (M.T.)	8,154	11,476	13,827	14,250	14,604	6,036
	Harvested Area (ha)	2,947	4,250	5,047	5,930	5,000	4,878
Maize	Yield (kg/ha)	4,113	3,570	4,000	4,229	4,614	3,871
	Product (M.T.)	8,177	4,949	10,572	8,005	17,408	14,837
	Harvested Area (ha)	1,988	1,388	2,644	1,893	3,773	3,833
Maize Choclo	Yield (kg/ha)	8,960	9,347	-	9,596	9,362	7,329
	Product (M.T.)	3,109	2,552	-	6,775	6,123	4,939
	Harvested Area (ha)	347	273	-	706	654	674
Potato	Yield (kg/ha)	11,837	11,754	18,386	16,445	14,472	12,450
	Product (M.T.)	15,472	7,840	7,704	9,996	8,779	3,498
	Harvested Area (ha)	1,303	667	419	606	608	281
Beans (Seco)	Yield (kg/ha)	987	1,095	1,043	977	1,403	897
	Product (M.T.)	551	355	120	219	263	237
	Harvested Area (ha)	558	324	115	224	252	264
Beans (Verde)	Yield (kg/ha)	4,441	3,949	3,549	3,914	4,358	3,830
	Product (M.T.)	1,621	1,007	1,583	1,143	1,216	1,276
	Harvested Area (ha)	365	255	446	292	279	333
Tomato	Yield (kg/ha)	15,876	17,647	17,024	16,610	17,294	17,060
	Product (M.T.)	9,764	4,359	4,630	8,305	7,523	12,761
	Harvested Area (ha)	615	247	271	500	435	748
Sweet Potato	Yield (kg/ha)	15,959	10,495	16,570	21,228	18,027	11,794
	Product (M.T.)	11,235	4,450	5,286	10,486	5,336	10,544
	Harvested Area (ha)	704	424	319	494	296	894
Orange	Yield (kg/ha)	9,015	11,552	8,093	9,568	12,179	5,928
	Product (M.T.)	14,135	17,478	12,560	14,850	18,900	9,200
	Harvested Area (ha)	1,568	1,513	1,552	1,552	1,552	1,552
Apple	Yield (kg/ha)	6,909	4,344	6,978	5,374	10,155	6,107
	Product (M.T.)	14,883	12,842	23,878	18,390	34,750	20,900
	Harvested Area (ha)	2,155	2,956	3,422	3,422	3,422	3,442
Grape	Yield (kg/ha)	1,845	2,830	6,145	4,942	4,913	4,277
	Product (M.T.)	310	968	2,126	1,710	1,700	1,480
	Harvested Area (ha)	168	342	346	346	346	346

Source: Banco Agrario Del Peru

Table E-1-5 Cropped Area in Chancay/Huaral in 1982

Crops			Area (ha)	Proportional Extent
Annual Crop	Fruit	Apple	1,680	
		Orange	1,550	
		Mandarin Orange	570	
		Passion Fruit	550	
		Grape	346	
		Others	1,834	
		Sub-total	6,530	27
	Vegetables	Kindney bean (Vanita)	1,150	
		Tomato	435	
		Cabbage	530	
		Choclo	654	
		Cauliflower	390	
		Others	1,629	
		Sub-total	4,788	20
	Beans	Beans (Frijol seco)	726	
		Others	199	
		Sub-total	925	4
	Grain Crop	Maize	3,830	16
	Tuber Crop	Potato	608	
		Sweet Potato	296	
		Others	29	
		Sub-total	933	4
	Forage	Soiling Corn /1	1,240	5
	Industrial Crop	Cotton	5,631	24
Grand Total			23,877	100

/1 Maize Chala

Source: Distrito Agropecuario Huaral
Ministerio de Agricultura

Table E-1-6 Present Planted Area

Crops	Planted Area (ha)	(%)	(%)
Cotton	5,300	(23)	
Maize	3,850	(16)	
Potato 1/	900	(4)	
Beans	900	(4)	
Tomato	500		(10)
Cabbage	600		(13)
Choclo	500		(10)
Kidney bean	700		(15)
Cauliflower	400		(8)
Other 2/	2,100		(44)
Vegetable Total	4,800	(20)	(100)
Apple	1,680		(26)
Orange	1,550		(24)
Mandarin	570		(9)
Pasion Fruit	550		(9)
Grape, Other 3/	2,180		(33)
Fruit total	6,530	(28)	(100)
Soiling Corn 4/	1,200	(5)	
Total Cropped Area	23,480	(100)	
Grass land	150		
Fallow land	470		
Grand Total	24,100		
Cultivatable Area	20,200		
Cropping Intensity	116%		

1/ Potato, Sweet potato, etc.
2/ Radish, Onion, Carrot, etc.
3/ Peach, Pear, Avocado, etc.
4/ Maize chala

Table E-1-8 Crop Yields in the Project Area

Crops	1978 /1	1979 /1	1980 /1	1981 /1	1982 /1	1983 /1	Estimated present yield
Cotton	2,767	2,700	2,740	2,403	2,921	1,237	2,700 /2
Maize	4,113	3,570	4,000	4,229	4,614	3,871	4,500 /4
Potato	11,837	11,754	18,386	16,445	14,472	12,450	15,000 /2
Beans (Frijol seco)	987	11,095	1,043	977	1,403	897	1,000 /3
Kidney bean (Vanita)	4,441	3,949	3,549	3,914	4,358	3,830	4,000 /3
Maize choclo	8,960	9,347	-	9,596	9,362	7,329	9,000 /3
Tomato	15,876	17,647	17,024	16,610	17,294	17,060	17,000 /3
Sweet potato	15,959	10,495	16,570	21,228	18,027	11,794	16,500 /2
Orange	9,015	11,552	8,093	9,568	12,179	5,928	18,000 /4
Apple	6,909	4,344	6,978	5,374	10,155	6,107	10,500 /4
Grape	1,845	2,830	6,145	4,942	4,913	4,277	6,000 /4
Mandarin Orange	-	-	-	-	-	-	22,000 /4
Passionfruit	-	-	-	-	-	-	10,000 /4
Cabbage	-	-	-	-	-	-	17,000 /4
Cauli flower	-	-	-	-	-	-	17,000 /4
Soiling corn /5	-	-	-	-	-	-	35,000 /4

/1 Source: Banco Agrario Del Peru
/2 Present yields estimated --- based on average yield in 5 years from 1978-1982
/3 " --- based on average yield in 6 years from 1978-1983
/4 " --- based on information obtained from related organizations and producers associations

/5 Maize chala

Table E-1-9 Crop Yields in the Project Area

Crops \ Year	1965	1966	1967	1968	1977	1982
Cotton	2,300	1,800	1,840	1,866	2,200	2,650
Maize	-	-	-	4,500	4,500	4,610
Maize choclo	15,000	15,000	15,000	9,000	11,000	8,330
Soiling corn /1	40,000	40,000	40,000	40,000	27,000	27,650
Potato	15,000	18,000	18,000	16,000	13,000	14,470
Pallar	2,400	3,500	3,500	-	-	-
Kidney bean (Frijol)	900	950	950	900	1,000	1,000
Pea (Arverja)	1,100	3,500	3,500	-	-	-
Tomato	12,000	8,000	8,000	12,000	12,000	17,294
Cabbage	20,000	20,000	15,000	-	-	-
Chili	10,000	10,000	10,000	-	-	-
Carrot	-	-	-	-	-	14,209
Squash	12,000	20,000	20,000	12,000	-	19,140
Onion	-	-	-	-	-	13,870
Water melon	-	-	-	-	-	18,177
Cauli flower	12,000	15,000	15,000	-	-	-
Sweet potate	12,000	15,000	15,000	14,000	7,000	18,090
Apple	9,000	8,000	8,500	12,000	12,000	10,530
Orange	-	-	-	22,000	13,000	13,570
Grape	6,500	12,000	12,000	8,000	-	4,910
Avocado	9,000	10,000	10,000	-	-	7,800
Cassava	18,000	15,000	15,000	14,000	-	13,790

/1 Maize chala

Source: Ministerio de Agricultura

Table E-1-10 Present Crop Production in the Project Area

	Crops	Present Yield kg/ha	Area (ha)	Production M.T.
	Cotton	2,700	5,300	14,310
	Maize	4,500	3,850	17,325
	Potatoes /1	15,000	900	13,500
	Beans (Frijol seco)	1,000	900	900
Vegetables	Tomato	17,000	500	8,500
	Cabbage	17,000	600	10,200
	Maize Choclo	9,000	500	4,500
	Cauli flower	17,000	400	6,800
	Kindney bean (Vanita)	4,000	700	2,800
	Others /2	9,000	2,100	18,900
	Sub-total		4,800	51,700
Fruit	Apple	10,500	1,680	17,640
	Orange	18,000	1,550	27,900
	Mandarin orange	20,000	570	11,400
	Passion fruit	10,000	550	5,500
	Grape	6,000	350	2,100
	Others /3	8,500	1,830	15,555
	Sub-total		6,530	80,095
	Soiling Corn /4	35,000	1,200	42,000
	Grand Total	-	23,480	-

/1 Calculated with potato
/2 Caigua, Carrot, Onion, etc. Calculated with caigua
/3 Avocado, Peach, Pear, etc. Calculated with avocado
/4 Maize Chala

Table E-1-11 Household Population and Age Group

District	Total Households	Farm Households	Total Population	Farm Household Population	Age Group/Farm Household			
					0 - 5	6 - 14	15 - 64	65 & over
Huaral	9,135	2,136	45,981	10,280	1,858	2,335	5,715	372
Chancay	4,877	1,395	25,249	6,812	448	1,664	4,448	252
Aucallama	1,587	882	8,154	4,355	730	1,024	2,422	179
Total	15,599	4,413	79,384	21,447	3,036	5,023	12,585	803

Table E-1-12 Labor Available in One Farm Household in 1981

Age Group	Family Member	Labor Force Rate %	Labor Force
0 - 5	0.69	0	0
6 - 14	1.14	50	0.57
15 - 64	2.85	100	2.85
65 & over	0.18	50	0.09
	4.86		3.5

Source: Sensos Nationales VIII de Poblacion III de Vivienda 12 de Julio de 1981

Table E-1-13 Tractor Ownership in the Project Area

Zone	Ownership	Number	Type	Manufacture
Porvenir	CAP Individual	3 5	Wheel	John Deex (J.D.) Massey Ferguson (M.F.)
Retes	CAP	4	Wheel (3) Caterpillar(1)	J.D. Caterpillar D-4
Esperanza	CAP CAS * Individual *	4 5 60	Wheel " "	Ford, M.F., J.D., M.F. Fiat, International
Jecuar	CAP Individual	6 2	Wheel "	J.D., M.F., Chivaguer Ford, Oliver
Chankayllo	CAP Individual	2 28	Wheel "	M.F., J.D., Ford Chivaguer
Lavreles Sta. Rosa	CAP FDO Individual	11 4 7	Wheel " "	J.D., M.F., Ford International
Tilos	CAP	4	Wheel	M.F., J.D.
Torre Blanca	CAP	7	Wheel	J.D.
Pasamayo	CAP Individual	2 6	Wheel "	M.F., J.D., Fiat Ford
Boza	CAP Individual	3 1	Wheel "	M.F., J.D.
San Jose Milaflores	CAP Individual	8 8	Wheel "	M.F., J.D., Fiat
Palpa	CAP Individual	7 6	Wheel (6) Caterpillar(1)	M.F., J.D. Caterpillar D-6
Esquivel	CAP Individual*	2 20	Wheel "	
Del Valle	CAP	14	Wheel (13) Caterpillar(1)	M.F., J.D., Interna- tional caterpillar D-6
Candelaria	CAP* Individual*	4 4	Wheel "	
Huaxan	CAP*	4	Wheel	
Cuyo	CAP*	4	Wheel	
CAP, CAS, FDO		91		
Individual		154		
Total		254		

* Data obtained by field survey. Source: INAF
CAP, CAS, FDO = Corporatives

Table E-1-15 Livestock and Poultry-Population in Chancay/Huaral/Aucallama District

District	Dairy Cattle		Beef Cattle		Pig		Goat		Horse		Donkey		Hen		Broiler (10^3)	
	No. of House-holds	No. of Live-stock	No. of House-holds	No. of Live-stock	No. of House-holds	No. of Live-stock	No. of House-holds	No. of Live-stock	No. of House-holds	No. of Live-stock	No. of House-holds	No. of Live-stock	No. of House-holds	No. of Poultry	No. of House-holds	No. of Poultry
Huaral	6	300	4	843	7	8,700	-	-	-	-	-	-	11	30,000	43	18,000
Chancay	4	1,300	1	42	3	7,600	-	-	-	-	-	-	5	250,000	21	8,400
Aucallama	4	270	1	50	5	1,900	-	-	-	-	-	-	3	50,000	4	1,200
Total	14	1,870	6	935	15	18,200	-	15,000	-	600	-	100	19	600,000	68	27,600

Source: Distrito Agropecuario Huaral

Table E-2-2 Proposed Land Utilization Patterns and Subpatterns by Irrigation-Block

Land Utilization patterns/subpatterns	Left Bank		Right Bank			Project Area
	upper ha (%)	lower ha (%)	upper ha (%)	central ha (%)	lower ha (%)	Total ha (%)
Fruit production	640 (28)	590 (17)	4,360 (90)	630 (11)	310 (8)	6,530 (32)
Annual crop production cotton/maize in rotation	1,380 (59)	2,260 (66)	500 (10)	4,560 (79)	2,620 (68)	11,320 (56)
vegetables in rotation	150 (6)	400 (12)	-	300 (5)	600 (16)	1,450 (7)
Potato/vegetables in rotation	150 (6)	150 (4)	-	300 (5)	300 (8)	900 (4)
subtotal	1,680 (72)	2,810 (83)	500 (10)	5,160 (89)	3,520 (92)	13,670 (68)
Total	2,320 (100)	3,400 (100)	4,860 (100)	5,790 (100)	3,830 (100)	20,200 (100)

Table E-2-3 Growth Characteristics of Crops

Crop	Growth Period	Maximum /1 Potential Yield kg/ha	Varieties
Cotton	250 - 270 days	7,200	Solt tolerant, drought tolerant TANGI CN, ICA, LN
Maize	120 - 150 "	12,000	Solt tolerant, PM210, 211 204
Potato	140 - 160 "	45,000	Variety Revolvecion etc.
Beans (Frijol seco)	120 - 150	2,500	Variety Canary etc.
Tomato	120 - 150	40,000	Redondo, Mazano
Cabbage	120 - 150	35,000	Long island improved, etc.
Maize Choclo	90 - 120	20,000	Amilaceo, Chancayho, etc.
Kindney bean (Vanita)	90 - 120	8,000	-
Apple	20 - 25 years	20,000	Delicias, Pero, San-Antonio
Orange	35 - 40 "	36,000	Washington, Valencia
Mandarin orange	35 - 45 "	40,000	Early Unshu, Ordinary Unshu
Passion fruit	4 - 5 "	-	-
Grape	15 - 20 "	15,000	-

/1 Actual maximum yeild obtained in the Project area.

Table E-2-4 Proposed Cropping Pation by Irrigation Block

	Left Bank		Right Bank			Total	
	Upper (ha)	Lower (ha)	Upper (ha)	Central (ha)	Lower (ha)	Area (ha)	%
Cotton - Beans - Maize	460	1,360	250	2,280	1,310	5,660	28
Cotton - Green Manure - Maize	920	900	250	2,280	1,310	5,660	28
Potato - Vegetables	150	150	-	300	300	900	4
Vegetables	150	400	-	300	600	1,450	7
Fruit	640	590	4,360	630	310	6,530	32
Total	2,320	3,400	4,860	5,790	3,830	20,200	100

Table E-2-5 Proposed Cropping Plan by Irrigation Block

Crops	Left Bank (Upper)		Left Bank (Lower)		Right Bank (Upper)		Right Bank (Central)		Right Bank (Lower)		Total	
	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
Cotton	690	(20)	1,130	(20)	250	(5)	2,280	(26)	1,310	(21)	5,660	(19.5)
Maize	690	(20)	1,130	(21)	250	(5)	2,280	(26)	1,310	(21)	5,660	(19.5)
Potato	175	(2)	175	(2)	-		150	(2)	150	(2)	450	(1.5)
Beans (Frijol seco)	460	(14)	450	(9)	125	(2.5)	1,140	(13)	655	(10)	2,830	(10.0)
Vegetables	600	(18)	1,225	(23)	-		1,200	(14)	1,950	(31)	4,975	(17.0)
Fruit	640	(19	590	(11)	4,360	(85)	630	(7)	310	(5)	6,530	(22.5)
Green Manure	230	(7)	680	(13)	125	(2.5)	1,140	(13)	655	(10)	2,830	(10.0)
Total (ha)	3,385	(100)	5,280	(100)	5,110	(100)	8,820	(100)	6,340	(100)	28,935	(100)
Cultivable Area (ha)	2,320		3,400		4,860		5,790		3,830		20,200	
Cropping Intensity	146 %		155 %		105 %		152 %		167 %		143 %	

Table E-2-6 Target Yields of Crops

Crops	With Project 1/ (kg/ha)	Present/Without (kg/ha)	Rate of Increase (%)	Successful Farmer 2/ (Huaral) (kg/ha)	Cañete 3/ (kg/ha)
Cotton	4,000	2,700	148	5,500	3,680
Maize	7,000	4,500	156	8,000	5,000
Potato	22,000	15,000	147	30,000	20,000
Beans (Frijol Seco)	1,300	1,000	140	1,300	1,200
Tomato	25,000	17,000	147	33,000	25,000
Cabbage	25,000	17,000	147	30,000	-
Maize Choclo	13,000	9,000	144	15,000	10,000
Kidney bean (Vanita)	6,000	4,000	150	8,000	5,000
Cavliflower	25,000	17,000	147	28,000	-
Apple	14,000	10,500	133	16,000	-
Orange	23,000	18,000	128	30,000	15,000
Mandarin Orange	26,000	20,000	130	35,000	-
Passion Fruit	15,000	10,000	150	-	-
Grape	9,000	6,000	150	12,000	8,000

1/ target yield at full development

2/ average yield level obtained by successful farmers in the Project area

3/ average yield in Cañete Project

Table E-2-7 Crop Yields during the Build-Up Period

(Unit: kg/ha)

Crops	Present/Without	With Project				
		1st Year	2nd Year	3rd Year	4th Year	5th Year
Cotton	2,700	2,900	3,200	3,400	3,700	4,000
Maize	4,500	4,900	5,400	5,900	6,500	7,000
Potato	15,000	16,200	17,500	18,900	20,400	22,000
Beans (Frijol Seco)	1,000	1,050	1,100	1,200	1,250	1,300
Tomato	17,000	18,000	20,000	21,500	23,000	25,000
Cabbage	17,000	18,000	20,000	21,500	23,000	25,000
Maite Choclo	9,000	9,700	10,400	11,200	12,000	13,000
Kidnex bean (Vanita)	4,000	4,300	4,700	5,100	5,500	6,000
Cavliflower	17,000	18,000	20,000	21,500	23,000	25,000
Apple	10,500	11,100	11,800	12,500	13,200	14,000
Orange	18,000	18,900	19,800	21,000	22,000	23,000
Mandarin Orange	20,000	21,100	22,200	23,400	24,700	26,000
Passion fruit	10,000	10,800	11,800	12,800	13,800	15,000
Grape	6,000	6,500	7,100	7,700	8,300	9,000

Table E-2-8 Anticipated Crop Production

(Unit: M.T)

Crops	Present	With Project				
		1st Year	2nd Year	3rd Year	4th Year	5th Year
Cotton	14,310	16,414	18,112	19,244	20,942	22,640
Maize	17,325	27,734	30,564	33,394	36,790	39,620
Potato	13,500 3/	7,290	7,875	8,505	9,180	9,900
Beans (Frijol Seco)	900	2,972	3,113	3,396	3,538	3,679
Tomato	8,500	11,250	12,500	13,438	14,375	15,625
Cabbage	10,200	9,000	10,000	10,750	11,500	12,500
Maize Choclo	4,500	8,730	9,360	10,080	10,800	11,700
Kidney bean (Vanita)	2,800	3,010	3,290	3,570	3,850	4,200
Cavliflower	6,800	5,400	6,000	6,450	6,900	7,500
Other Vegetables 1/	18,900	18,915	20,280	21,840	23,400	25,350
Vegetables Total	51,700	56,305	61,430	66,128	70,825	76,875
Apple	17,640	18,648	19,824	21,000	22,176	23,520
Orange	27,900	29,295	30,690	32,550	34,100	35,650
Mandarin Orange	11,400	11,970	12,650	13,340	14,100	14,820
Passionfruit	5,500	5,940	6,490	7,040	7,590	8,250
Grape	2,100	2,275	2,485	2,695	2,905	3,150
Other 2/	15,550	17,751	19,032	20,496	21,960	23,332
Fruit Total	80,095	85,879	91,171	97,121	102,831	108,722

1/ Calculated with caigua

2/ Calculated with avocado

3/ Production of Tuber Crops

Table E-2-9 Future Farm Labor Balance

(Unit: Man-Day)

TERMS	AREA	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
1. Labor Requirement	per ha (Unit: Man-days)													
Cotton	1	4.8	2.8	2.8	2.8	28.8	28.8	1.8	3.0	6.0	9.8	8.8	5.8	106
Maize	1	5.5	12.75	9.75	3.25	3.25	7.5	7.5				3.0	5.5	58
Beans (Frijol Seco)	1							6.0	5.0	7.5	7.5	1.0	12.0	39
1/ Potato + Vegetables	1	9.95	9.4	10.5	7.5	7.25	11.9	17.4	10.5	5.4	4.8	8.0	7.6	107
2/ Vegetables	1	16.15	10.8	23.84	31.68	34.51	16.1	11.57	26.38	30.73	36.35	10.51	20.18	268.8
3/ Fruit	1	6.35	6.35	23.85	23.85	23.85	23.85	6.35	6.35	6.35	6.35	6.35	6.35	146
Green Manure	1						1.0	1.0	1.0	1.0	1.0			5
2. Total Labor Requirement	per ha (unit: 1000 man-days)													
Cotton	5,560	26.7	15.6	15.6	15.6	160.1	160.1	10.0	16.7	33.4	54.5	49.0	32.2	589.5
Maize	5,560	30.6	70.9	54.2	18.1	18.1	41.7	41.7				16.7	30.6	322.6
Beans	2,780							16.7	13.9	20.9	20.9	2.7	66.7	141.8
Potato + Vegetables	900	8.9	8.5	9.5	6.8	6.5	10.7	15.7	9.5	4.9	4.3	7.2	6.8	99.3
Vegetables	1,450	23.4	15.7	4.1	2.4	50.0	23.3	16.8	38.3	44.6	52.7	15.2	29.3	315.8
Fruit	6,530	41.5	41.5	155.7	155.7	155.7	155.7	41.5	41.5	41.5	41.5	41.5	41.5	954.8
Green Manure	2,780						2.8	2.8	2.8	2.8	2.8			14.0
Total Labor Requirement		131.1	152.2	239.1	198.6	390.4	394.3	145.2	122.7	148.1	176.7	132.3	207.1	2,437.8
3. Available Labor		366.8	366.8	366.8	366.8	366.8	366.8	366.8	366.8	366.8	366.8	366.8	366.8	4,401.6
4. Balance (3-2)		235.7	214.6	127.7	168.2	-23.6	-27.5	221.6	244.1	218.7	190.1	234.5	159.7	1,963.8
5. Surplus Ratio (%)		64	59	35	46	-6	-7	60	67	60	52	64	44	45

Available Labor : 4,413 (Farm Household) x 3.5 (Average Available Labor Per Farm Household) x 25 days x 0.95 (estimated accident and sickness rate at 5%) _ 366,831 man-days (per month)

1/ : Calculated with Potato and Vegetables (Choclo), 2.0 croppings per year

2/ : Calculated with Tomato and Cabbage, 2.5 croppings per year

Table E-2-10 Farm Tractors Required Under the Project

Crops	(2)	(3) Number of Tractors Required Per Day In Each Month											
		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Cotton	8 hrs x 25 days							127	168	127	127	56	14
	9 hrs x 27 days							105	139	105	105	46	12
Maize	8 hrs x 25 days	84	21	28	7								84
	9 hrs x 27 days	69	17	23	6								69
Beans	8 hrs x 25 days						49	49	42				
	9 hrs x 27 days						40	40	35				
Potato	8 hrs x 25 days	7				18	18	36	18	15		9	7
	9 hrs x 27 days	6				15	15	30	15	12		8	6
Vegetables 1/	8 hrs x 25 dyas	18	21	12	41	41	41	14	27	27	29	35	47
	9 hrs x 27 days	15	17	10	34	34	34	12	22	22	24	29	39
Fruit 2/	8 hrs x 25 days	32	32	32	32	32	32	32	32	32	32	32	32
	9 hrs x 27 days	26	26	26	26	26	26	26	26	26	26	26	26
Green Manure	8 hrs x 25 days					49	49	29					
	9 hrs x 27 days					40	40	24					
Total	8 hrs x 25 days	141	74	72	80	140	189	287	287	201	188	132	184
	9 hrs x 27 days	116	60	59	66	115	155	237	237	165	155	109	152

1/ Calculated with Tomato and Cabbage, 2.5 croppings per year

2/ Calculated with Orange

Basis for Calculation:

1) Iractor operation hours per ha (hrs/ha) x monthly operation area (Cropped area, ha) = monthly operation hours required (hrs/month)
2) Monthly operation hours/tractor (hrs/month-tractors) = Monthly working days (day/month) x Working hours per day (hrs/day)
3) Number of tractors required per day (units/day) = (1) ÷ (2)

Table E-2-13 Anticipated Production Increase-1

		Without Project			With Project			Rate of Increase	
		Area ha	Yield kg/ha	Production M.T	Area ha	Yield kg/ha	Production M.T	Area %	Production %
	Cotton	5,300	2,700	14,310	5,660	4,000	22,640	107	158
	Maize	3,850	4,500	17,325	5,660	7,000	39,620	147	229
	Potato	900	15,000	13,500 3/	450	22,000	9,900	-150	-136
	Beans (Frijol Seco)	900	1,000	900	2,830	1,300	3,679	314	409
Vegetables	Tomato	500	17,000	8,500	625	25,000	15,625	125	184
	Cabbage	600	17,000	10,200	500	25,000	12,500	-120	123
	Maize Choclo	500	9,000	4,500	900	13,000	11,700	180	260
	Cavliflower	400	17,000	6,800	300	25,000	7,500	-133	110
	Kidney bean (vanita)	700	4,000	2,800	700	6,000	4,200	0	150
	Others 1/	2,100	9,000	18,900	1,950	13,000	25,350	-108	134
	Sub-total	4,800	-	51,700	4,975		76,875	(104)	(149)
Fruit	Apple	1,680	10,500	17,640	1,680	14,000	23,520	-	133
	Orange	1,550	18,000	27,900	1,550	23,000	35,650	0	128
	Mandarin Orange	570	20,000	11,400	570	26,000	14,820	-	130
	Passion fruit	550	10,000	5,500	550	15,000	8,250	0	150
	Grape	350	6,000	2,100	350	9,000	3,150	0	150
	Others 2/	1,830	8,500	15,555	1,830	12,750	23,332	0	150
	Sub-total	6,530	-	80,095	6,530	-	108,722	0	136
	Forage (Maize Chala)	1,200	35,000	42,000	-	-	-	-	-
	Green Manure	-	-	-	2,830	-	-	-	-
	Grand Total	2,480	-	-	28,935	-	-	123	-

1/ Calculated with Caigua 2/ Calculated with Avocado 3/ Production of tuber crops

Table E-2-14 Anticipated Production Increase-2

Crops	Without Project	With Project													
		1st Year			2nd Year			3rd Year			4th Year			5th Year		
	Production M.T	Production M.T	Increase[1/] M.T	(%)	Production M.T	Increase[1/] M.T	(%)	Production M.T	Increase[1/] M.T	(%)	Production M.T	Increase[1/] M.T	(%)	Production M.T	Increase[1/] M.T	(%)
Cotton	14,310	16,414	2,104	(15)	18,112	3,802	(27)	19,244	4,934	(34)	20,942	6,632	(46)	22,640	8,330	(58)
Maize	17,325	27,734	10,409	(60)	30,564	13,239	(76)	33,394	16,069	(93)	36,790	19,465	(112)	39,620	22,295	(129)
Potato	13,500	7,290	-6,210	(-46)	7,875	-5,625	(-42)	8,505	-4,995	(-37)	9,180	-4,320	(-32)	9,900	-3,600	(-27)
Beans (Frijol Seco)	900	2,972	2,072	(230)	3,113	2,213	(246)	3,396	2,496	(277)	3,538	2,638	(293)	3,679	2,779	(309)
Tomato	8,500	11,250	2,750	(32)	12,500	4,000	(47)	13,438	4,938	(58)	14,375	5,875	(69)	15,625	7,125	(84)
Cabbage	10,200	9,000	-1,200	(-12)	10,000	-200	(-2)	10,750	550	(5)	11,500	1,300	(13)	12,500	2,300	(23)
Maize Choclo	4,500	8,730	4,230	(94)	9,360	4,860	(108)	10,080	5,580	(124)	10,800	6,300	(140)	11,700	7,200	(160)
Kidney bean (Vanita)	2,800	3,010	210	(7.5)	3,290	490	(18)	3,750	950	(34)	3,850	1,050	(38)	4,200	1,400	(50)
Cavliflower	6,800	5,400	-1,400	(-21)	6,000	-800	(-12)	6,450	-350	(-5)	6,900	100	(1.5)	7,500	700	(10)
Other Vegetables	18,900	18,915	15	(0.8)	20,280	1,380	(7)	21,840	2,940	(16)	23,400	4,500	(24)	25,350	6,450	(34)
Vegetables Total	51,700	56,305	4,605	(83)	61,430	9,730	(19)	66,128	14,428	(28)	70,825	19,125	(37)	76,875	25,175	(49)
Apple	17,640	18,648	1,008	(5.7)	19,824	2,184	(12)	21,000	3,360	(19)	22,176	4,536	(26)	23,520	5,880	(33)
Orange	27,900	29,295	1,395	(5)	30,690	2,790	(10)	32,550	4,650	(17)	34,100	6,200	(22)	35,650	7,750	(28)
Mandarin Orange	11,400	11,970	570	(5)	12,650	1,250	(10)	13,340	1,940	(7)	14,100	2,700	(24)	14,820	3,420	(30)
Passion fruit	5,500	5,940	440	(8)	6,490	990	(18)	7,040	1,540	(28)	7,590	2,090	(38)	8,250	2,750	(50)
Grape	2,100	2,275	175	(8)	2,485	385	(18)	2,695	595	(28)	2,905	805	(38)	3,150	1,050	(50)
Others	15,555	17,751	2,196	(14)	19,032	3,477	(22)	20,496	4,941	(32)	21,960	6,405	(41)	23,332	7,777	(50)
Fruit Total	80,095	85,879	5,784	(7)	91,171	11,076	(14)	97,121	17,026	(21)	102,831	22,736	(28)	108,722	28,627	(36)

1/ increase in production compared with that of without project conditions

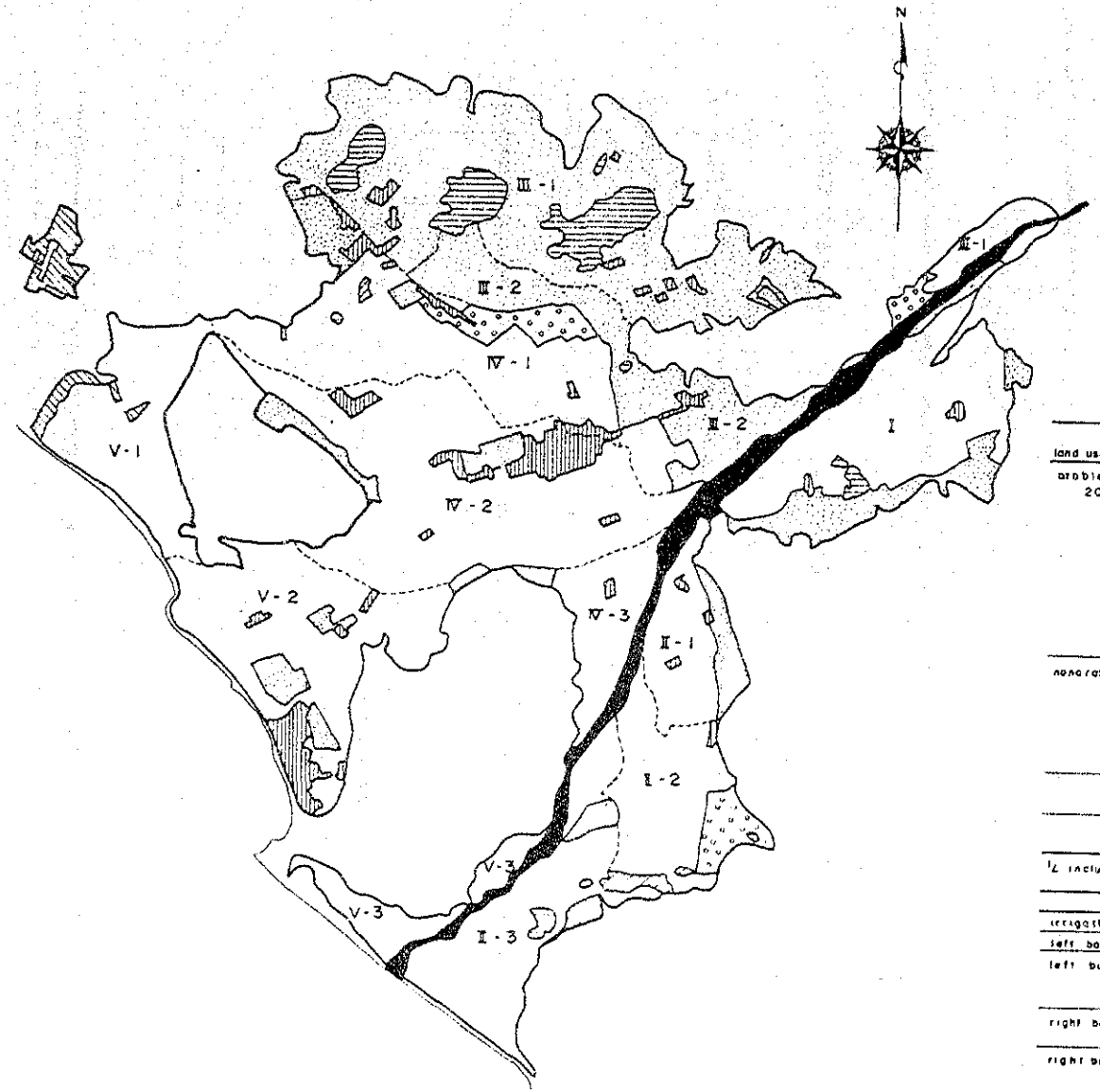


Fig. E-1-1 Present Land Utilization Patterns
S: 1/100,000

Legend

land use categories	present land utilization patterns	symbol	area (ha)
arable land 20,200 ha	land almost exclusively to exclusively utilized for fruits production		
	land predominantly utilized for fruits production		19580
	land almost exclusively utilized for annual crop production		
	natural grass land (poorly drained)		150
	fallow		470
nonarable land	hilly area		1/ 960
	residential area & yards		790
	river & river land		—
	project area		23100 2/
	boundaries of irrigation blocks & sub-sector of irrigation blocks		—

1/ including precipices, drains, stony land; 2/ including righ-of-way (1150 ha)

irrigation block	sub-sector of irrigation block	symbol
left bank upper	Palpa - Coqui	I
left bank lower	Miraflores - San Jose	II - 1
	Baza - Aucallama	II - 2
	Pasamayo	II - 3
right bank upper	La Esperanza	III - 1
	Huando	III - 2
right bank central	Retes - Naturales	IV - 1
	Jesus del Valle - Esquivel	IV - 2
	Chancay Alto	IV - 3
right bank lower	Chancaylle - El Hatillo	V - 1
	Chancay Bajo	V - 2
	Salinas	V - 3

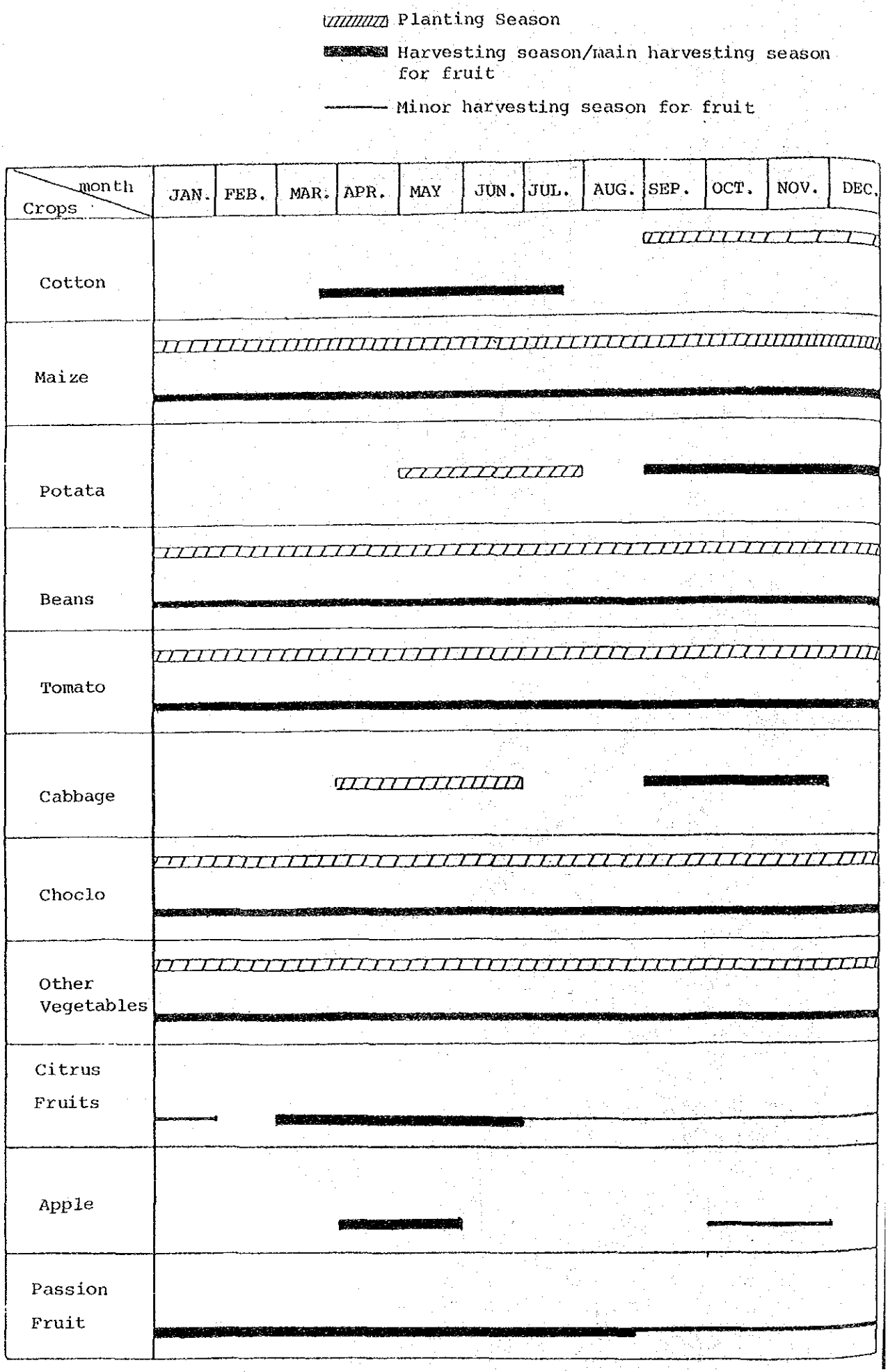


Fig. E-1-2 Cropping Calendar of Main Crops In 1982

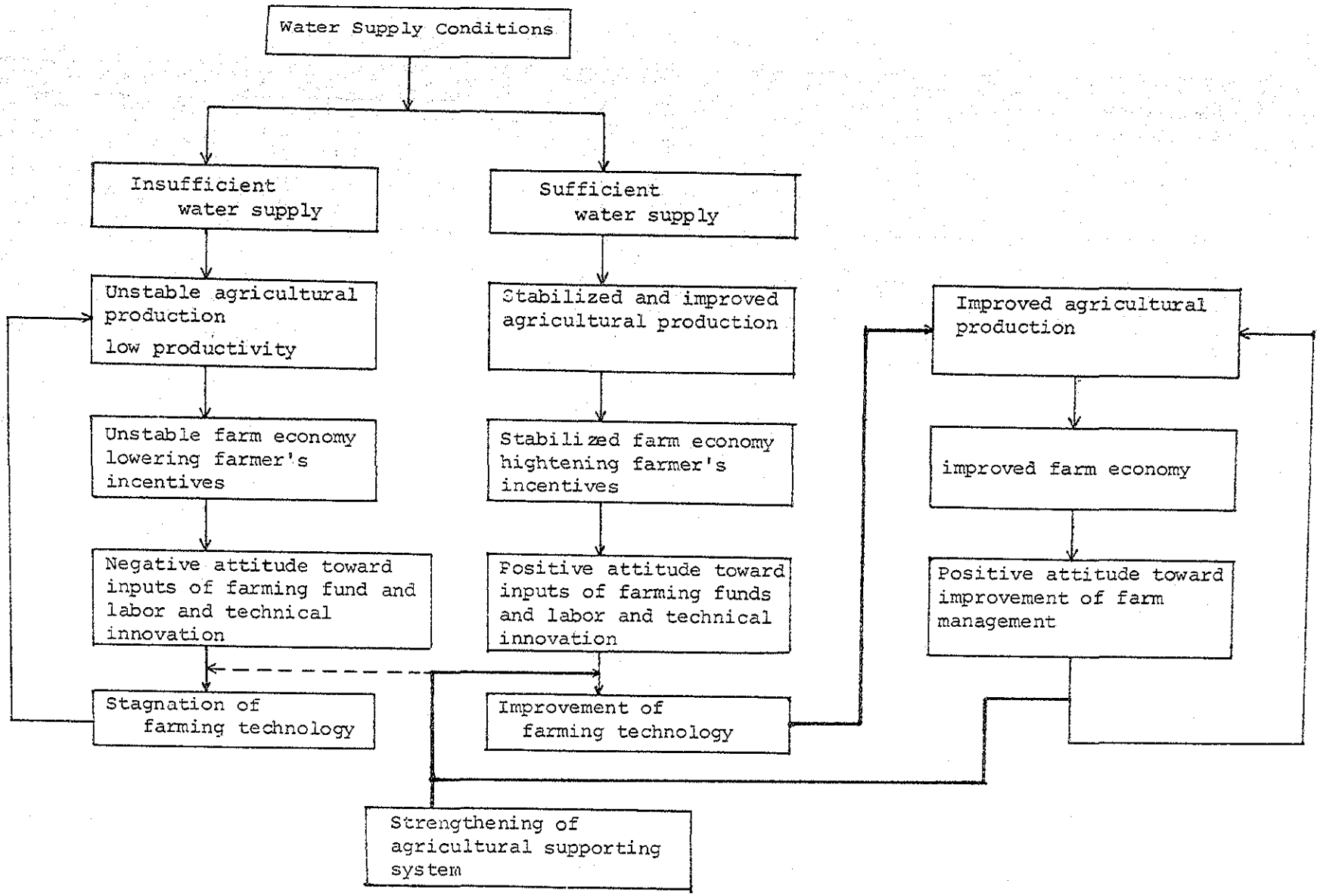


Fig. E-2-1 Relation between Water Supply Condition and Agricultural Production

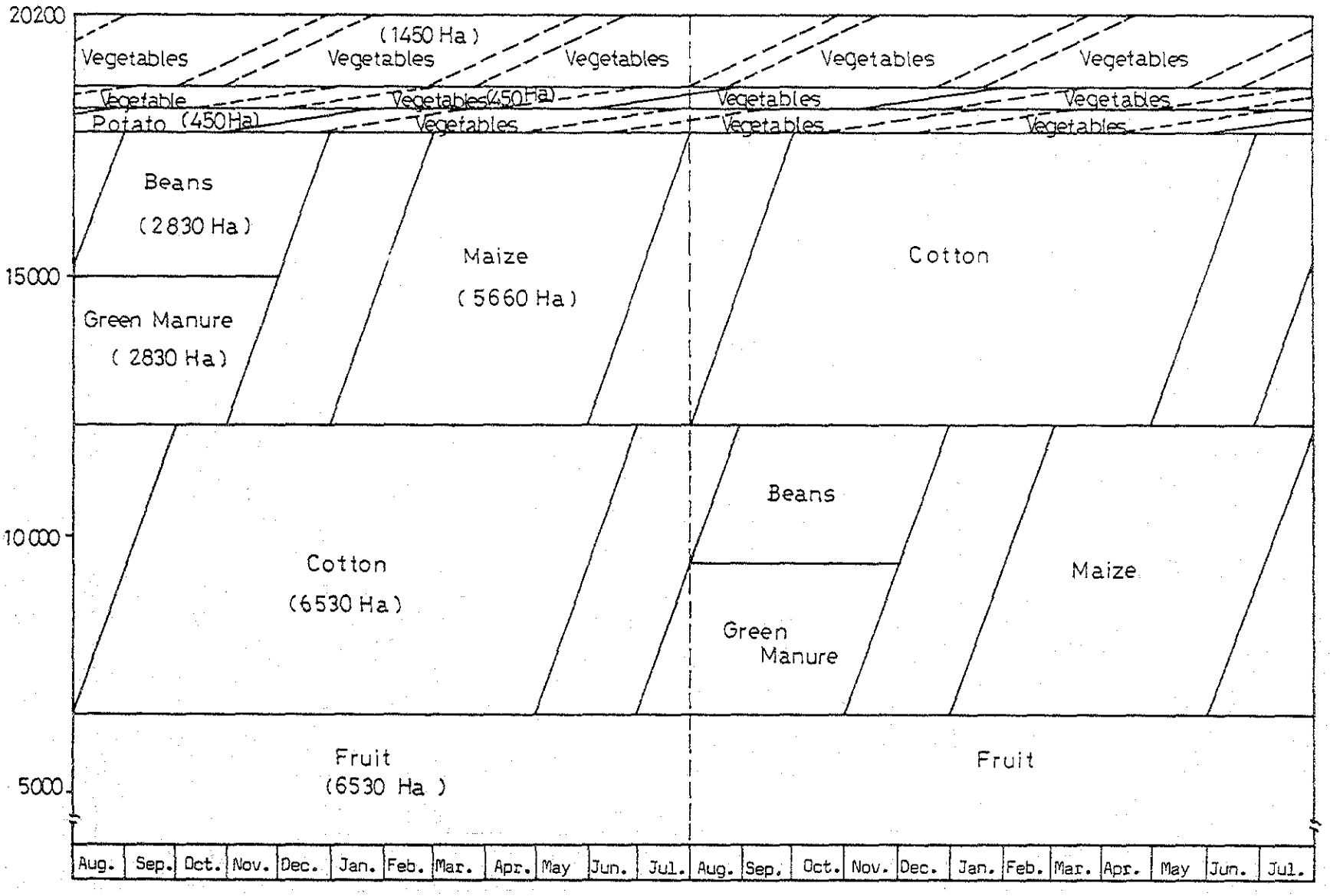


Fig. E-2-2 (1) Proposed cropping Pattern (Whole Project Area)

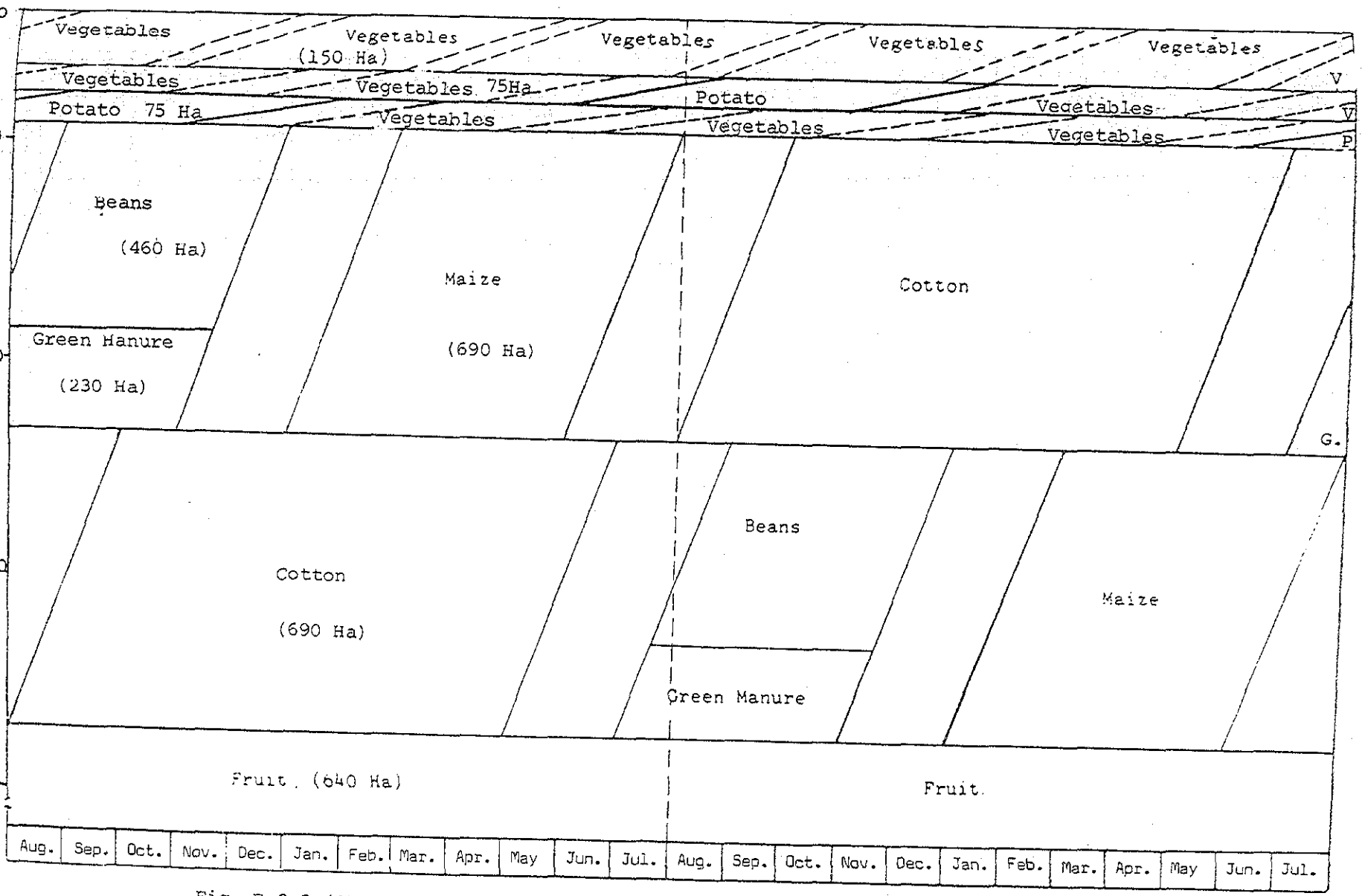


Fig. E-2-2 (2) PROPOSED CROPPING PATTERN (LEFT BANK UPPER)

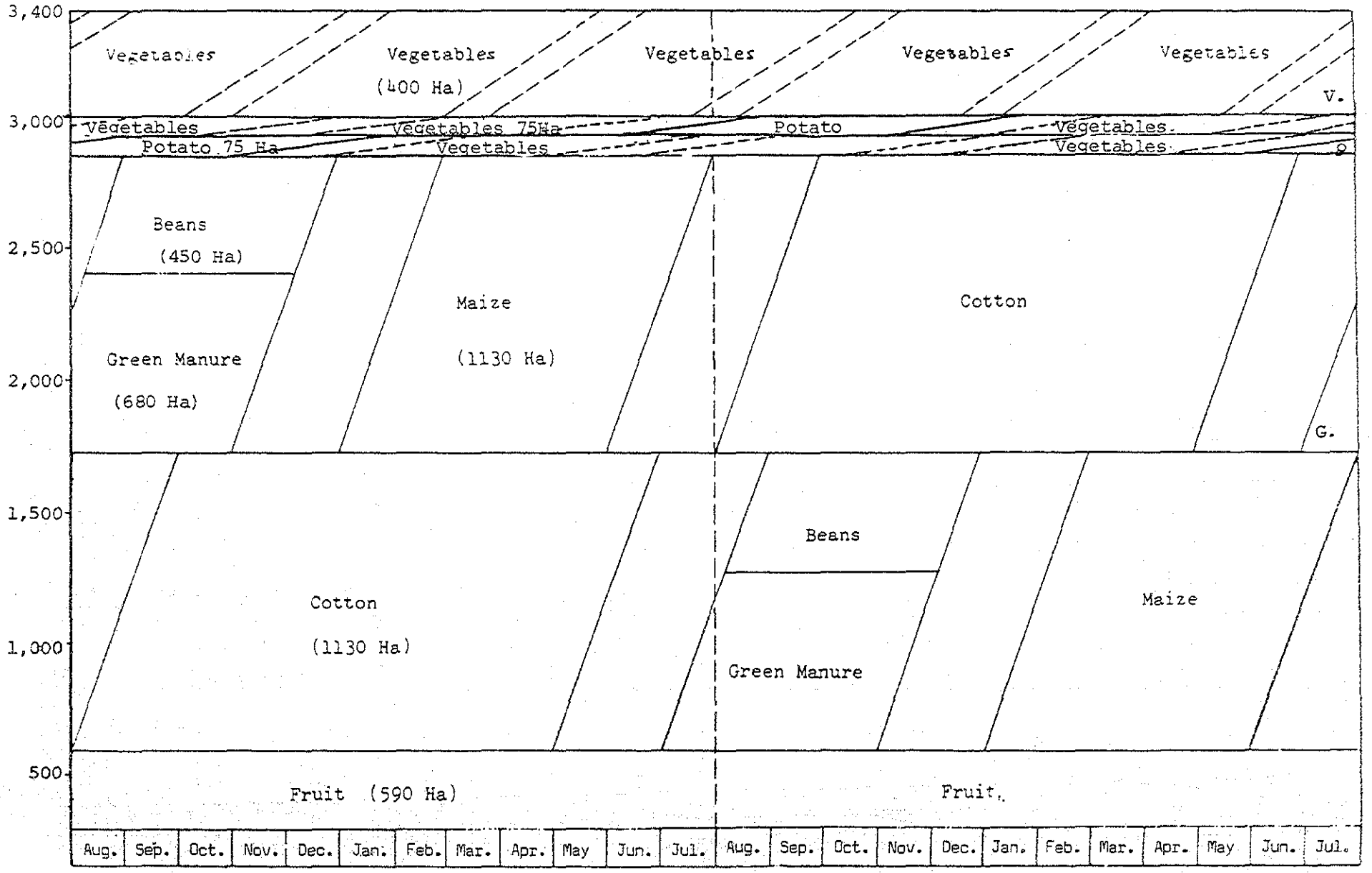


Fig. E-2-2 (3) PROPOSED CROPPING PATTERN (LEFT BANK LOWER)

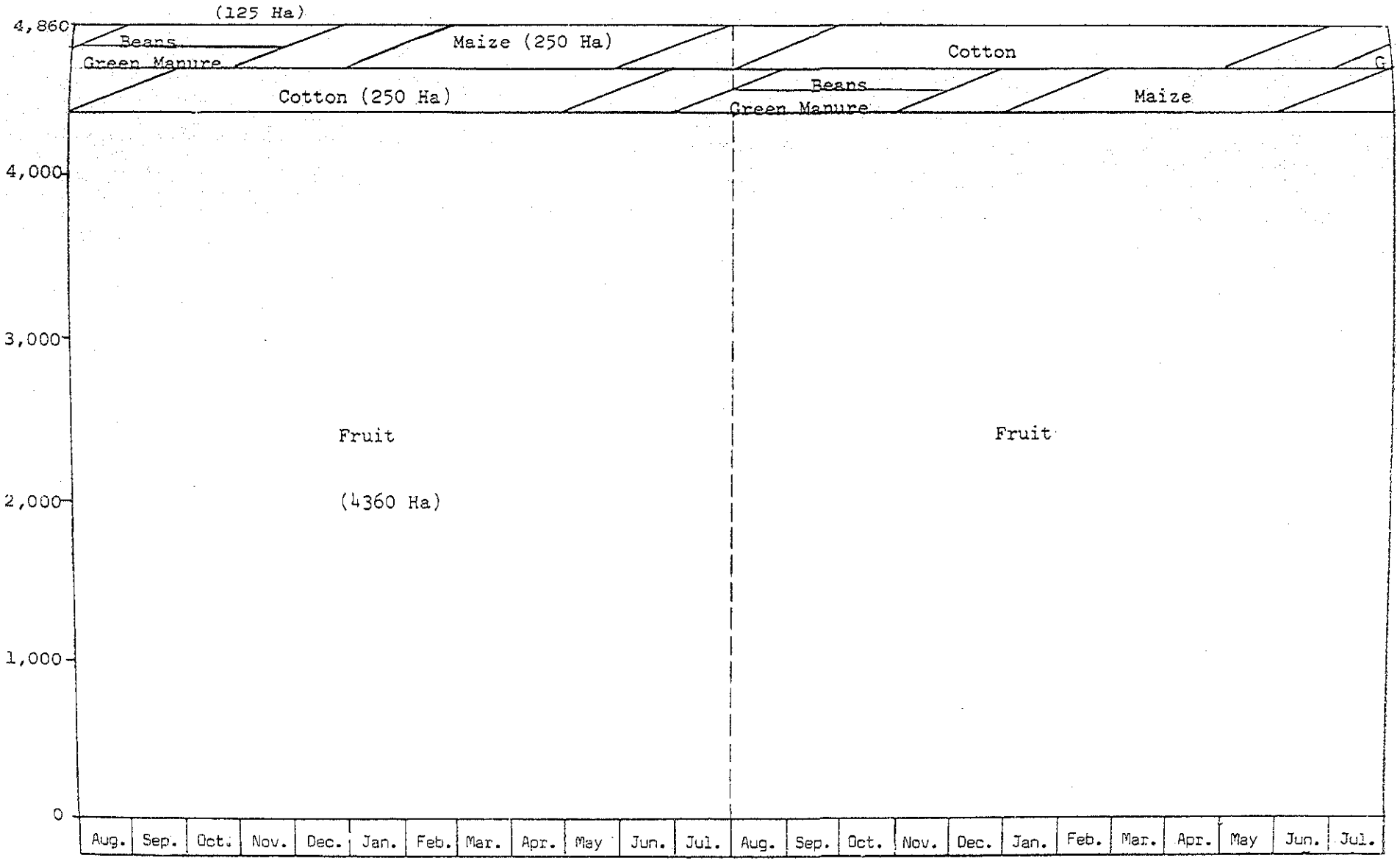


Fig. E-2-2 (4) PROPOSED CROPPING PATTERN (RIGHT BANK UPPER)

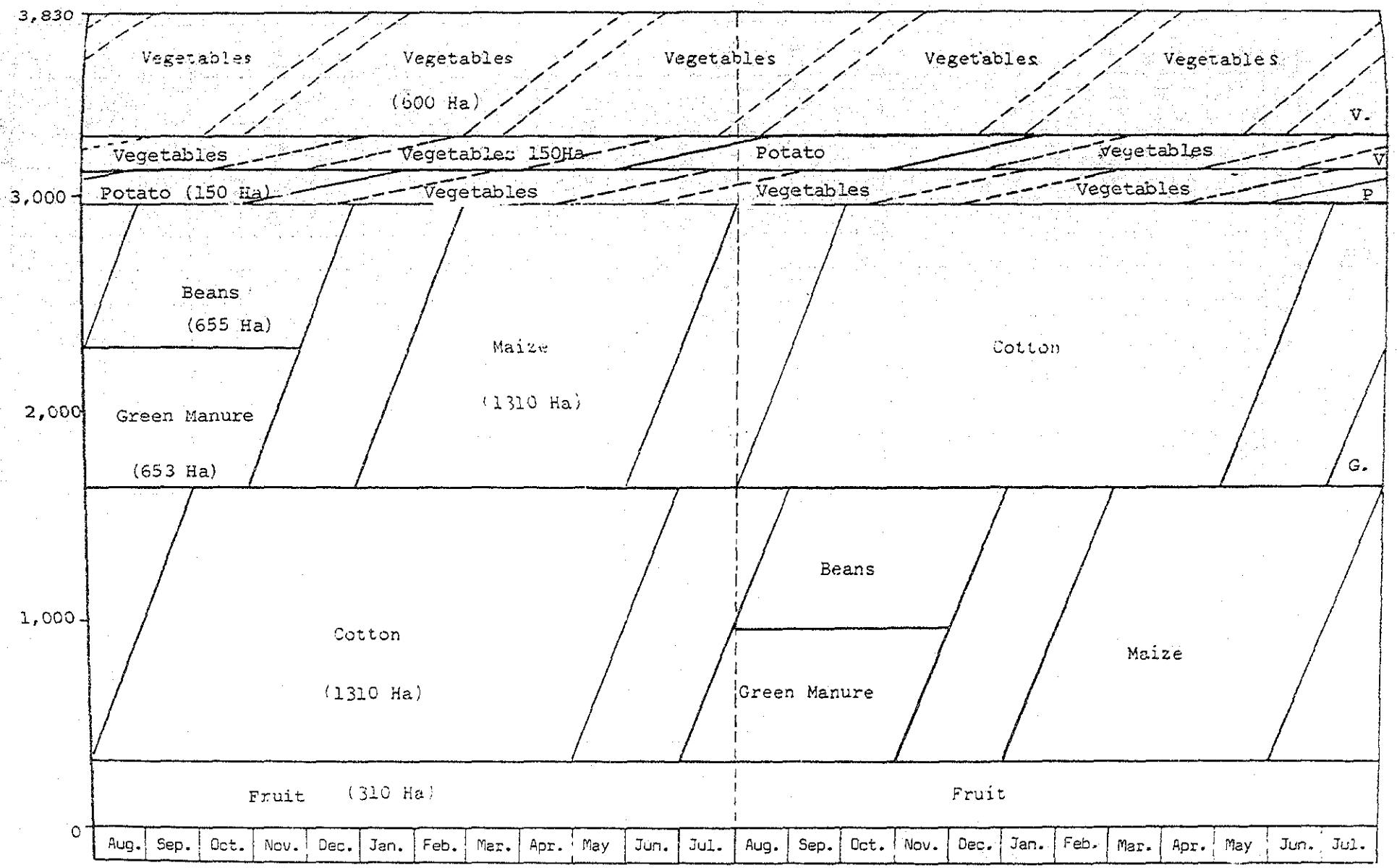


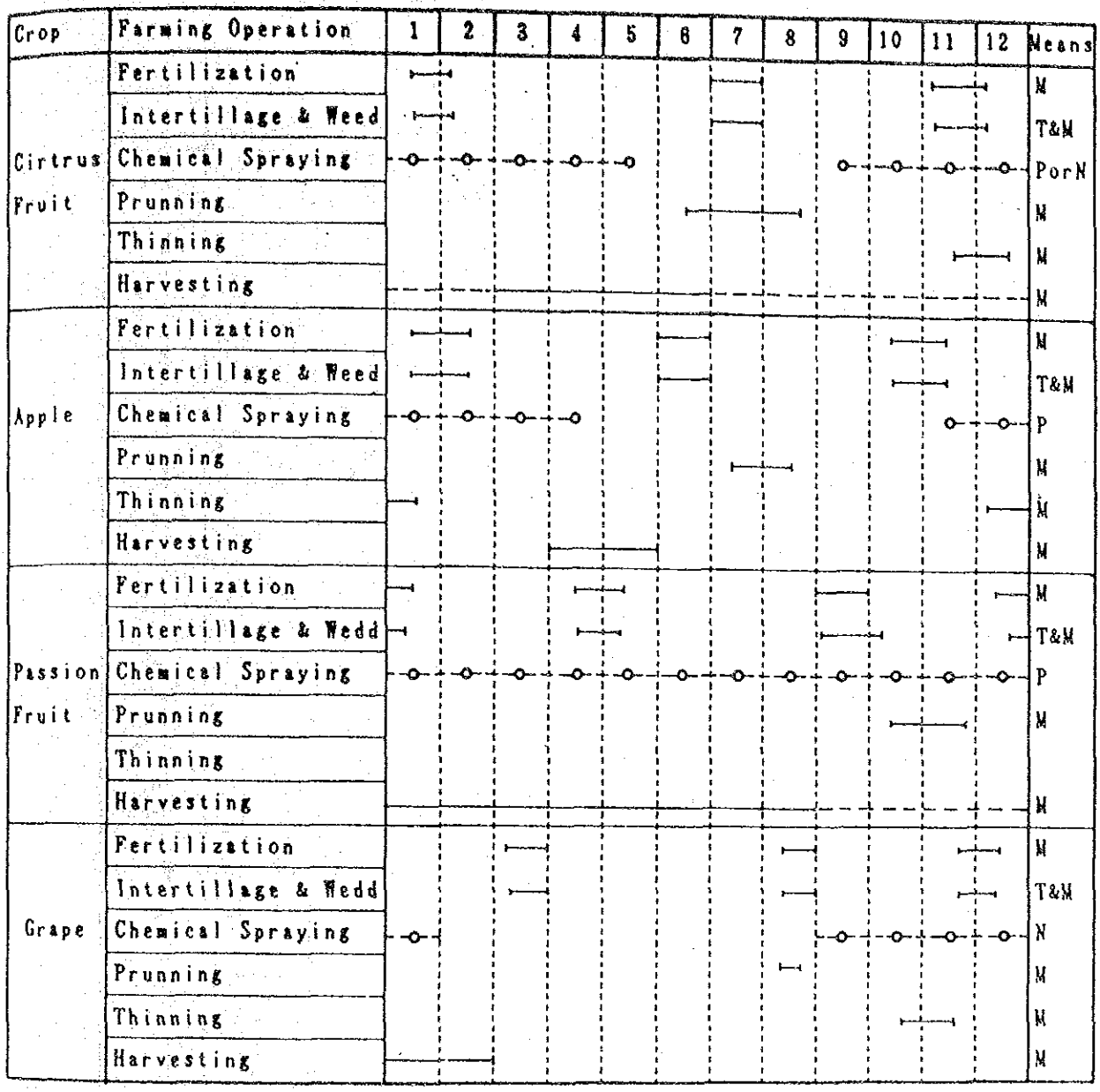
Fig. E-2-2 (6) PROPOSED CROPPING PATTERN (RIGHT BANK LOWER)

Fig. E-2-3 Proposed Farming Operation System

Crop	Farming Operations	-1 0 1 2 3 4 5 6 7 8 9 10	Mean
All Crops	Land Preparation		T
Cotton	Sowing		T
	Fertilization		T&M
	Intertillage & Wedding		T&M
	Thinning		M
	Harvesting		M
Maize	Sowing		T&M
	Fertilization		T&M
	Intertillage & Wedding		T&M
	Thinning		M
	Harvesting		M
Maize Choclo	Sowing		T
	Fertilization		M
	Intertillage & Wedding		T&M
	Thinning		M
	Harvesting		M
Beans (Frijor Seco)	Sowing		T
	Fertilization		M
	Intertillage & Wedding		T&M
	Thinning		-
	Harvesting		M
Potato	Sowing		M
	Fertilization		M
	Intertillage & Wedding		T&M
	Thinning		-
	Harvesting		M&P
Tomato	Sowing		M
	Fertilization		M
	Intertillage & Wedding		T&M
	Thinning		M
	Harvesting		M
Cabbage	Sowing		M
	Fertilization		M
	Intertillage & Wedding		T&M
	Thinning		-
	Harvesting		M

T : Tractor M : Manual Labour P : Potato Digger

Fig. E-2-4 Proposed Farming Operation System



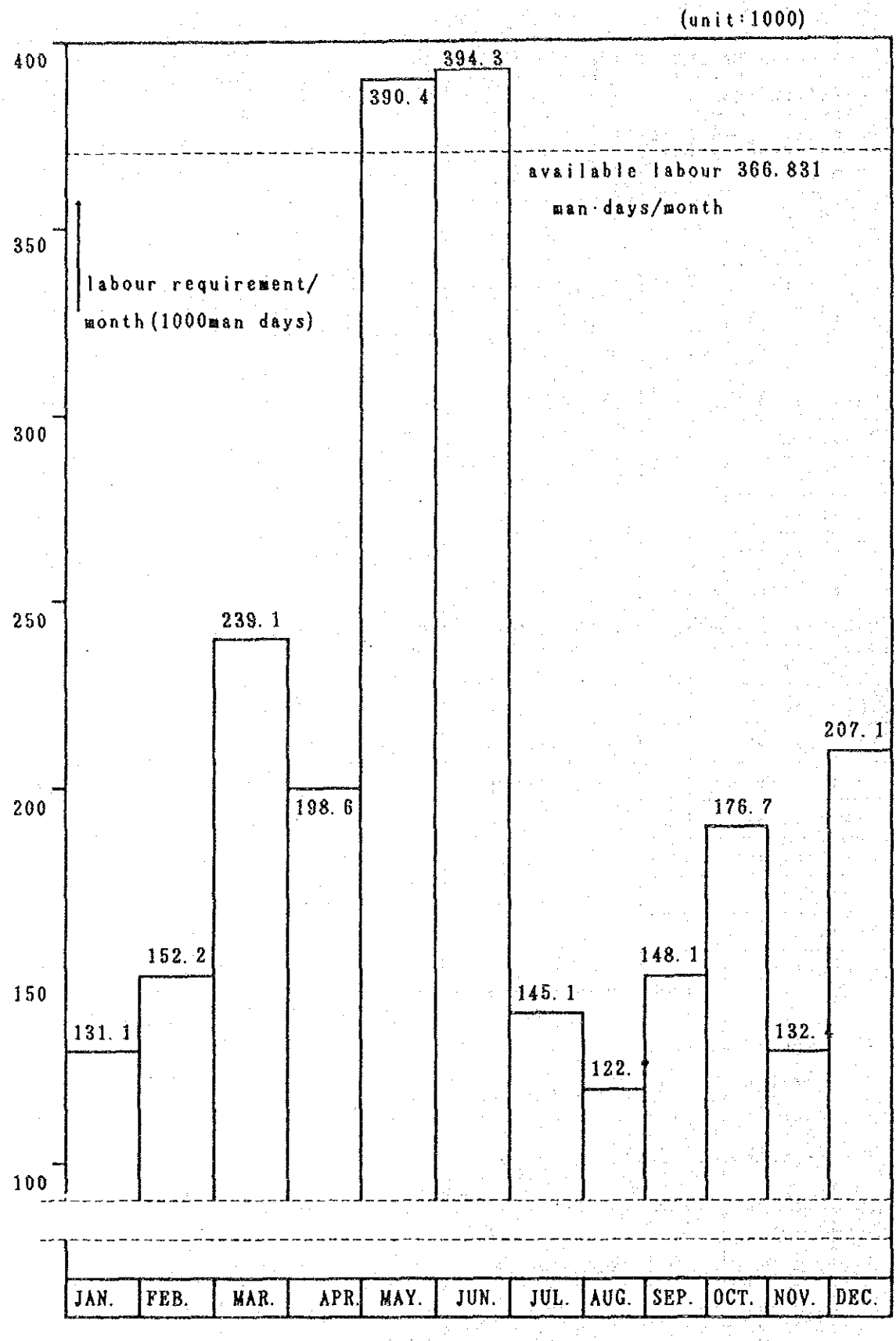
M : Manual Labour

T : Tractor

P : Power Splayer

N : Napsack Type Splayer

Fig. E-2-5 Future Farm Labour Balance



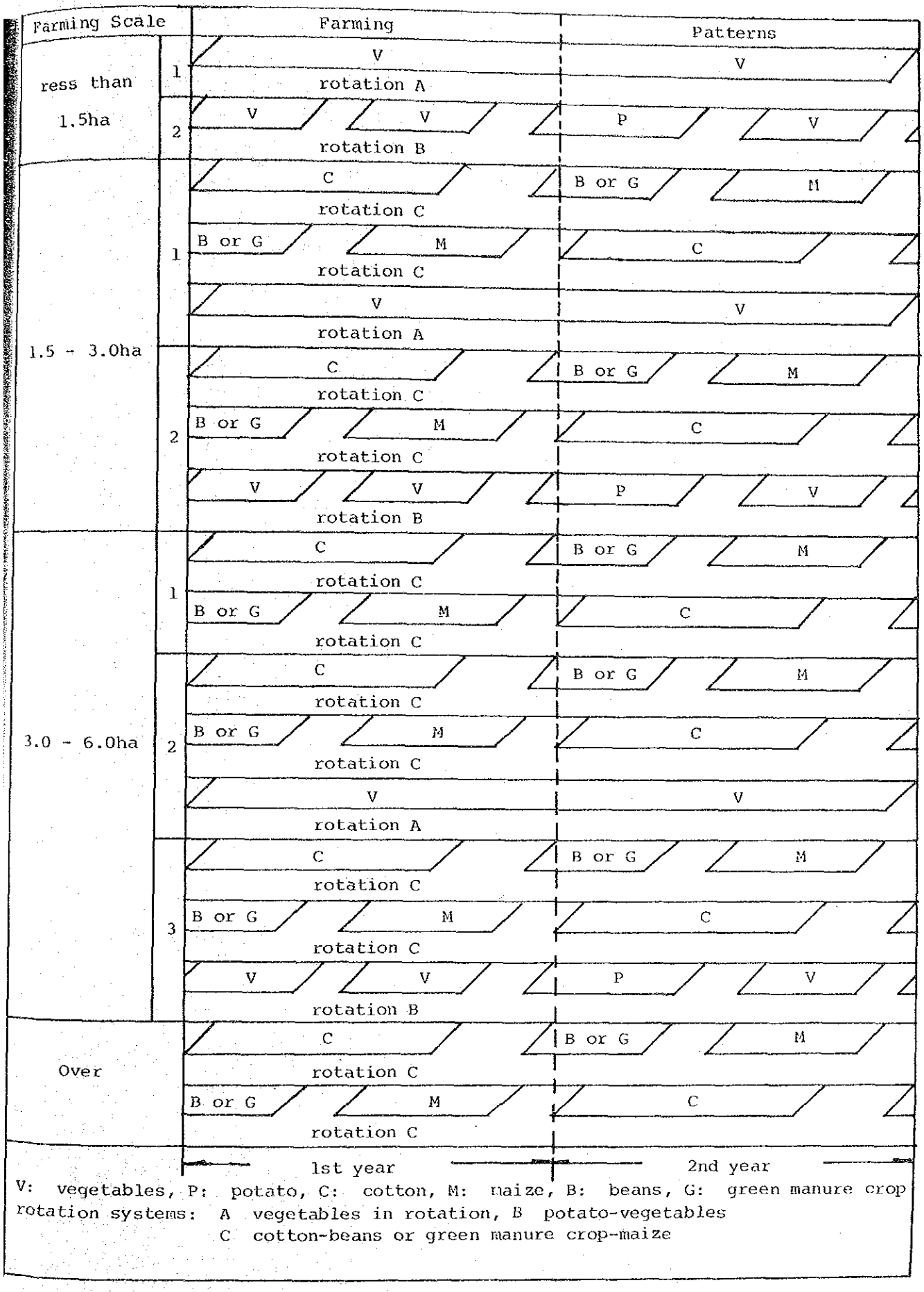


Fig. E-2-6 Illustration of Proposed Farming Patterns

ANNEX F

AGRICULTURAL ECONOMY

C O N T E N T S

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F. AGRICULTURE ECONOMY

1. General

The agricultural sector of Peru is important industry to perform the second place in the Gross Domestic Production, and accounts for 13.5% of 1983's GDP as shown in Table F-1-1. There are various agricultural products in the project area and its productivity is higher than national average. Cotton is the most important products for exportation, and maize is also necessary products for poultry farm. Moreover, production of vegetables in this area meets the consumption of fresh foods in the metroplitan area. Therefore, it can be said that this project area is performed an important role in terms of the food supply due to the favorable locality as close to Metropolitan Lima.

1-1 Agricultural Policy

The agricultural policy of Peru has dealing with one of the most important state measures. The laws and ordinances concerning the agricultural sector are determined on the Agrarian Law (D.L.No.17716) basis. These laws are divided into the following subjects.

1. Relevant laws on the agricultural sector
2. Relevant laws on the urban expansion
3. Relevant laws on the agricultural cooperatives
4. Relevant laws on the Agrarian Reform
5. Relevant laws on the compylsory expropriation
6. Relevant laws on the Agrarian Bank of Peru
7. Relevant laws on the Agrarian organization

Also, the general law on the water (D.L.17752) concerning water utilization is registlated.

The administration of the agricultural sector is enforced by the Ministry of agriculture and its organization is shown in Fig.F-1-1.

The authorities concerned in the project area is Huachs Agrarian Office of Regional Agrarian Bureau in Lima, Ministry of Agriculture. (See Fig.F-1-2 and F-1-3) There is established a district administration office for agriculture and livestock and water management in Huaral.

A technical administrator of Chancay-Huaral irrigation district has responsibility to carry out water management and O / M of irrigation facilities in the project area.

Public institutions concerned are as follows;

1) INAF - Instituto Nacional de Ampliacion de Frontera Agricola

INAF is an organization of planning and implementation for the projects as farmland and irrigation facilities rehabilitation, and its organization is shown in Fig.F-1-4. The DEPE-REHAHIC which is one of the bureaus in INAF, and carrying out the construction of its first stage project (6 valleys in the southern part from Lima) and the preliminary study of its third stage project (6 valleys in the northern part from Lima). Fig. F-1-5, shows its organization. The finance of these projects is provided by the loan from World Bank (BIRF) and Interamerican Development Bank (BID).

2) INIPA - Instituto Nacional de Investigacion y Promocion Agropecuaria

INIPA is an institution in charge of the agricultural investigation, extension and promotion of commercialization concerning to the agricultural products, and the organization of INIPA is shown in Fig.F-1-6 and F-1-7. In the project area, an experimental station exists at Donoso which is operated by CIPA (Fig.F-1-8) and produce seeds for farmers in the Chancay-Huaral Valley. But, they are not working as activities on the farm technical assistance and an extension due to lack of fund.

3) BAP - Banco Agrario del Peru

Banco Agrario del Peru is a financing organization for farmers and agricultural sector, dealing with 95% of the credit for the agricultural sector and is supporting by farm credit and technical assistance for

farmers. There are 19 branches and its 72 agents throughout the country.

Huaral agent office of Huacho Branch is existed in the project area, and an amount of its credit is shown in Table F-1-2 -- 4. In Huacho branch, 36% of total credit amount is accounted for cooperatives and 33.7% for individual farmers. Table F-1-5 -- 7, is a credit condition in the Chancay-Huaral Valley. Long term credit is available for farmers to procure irrigation pump, tractor, farm land improvement materials etc (Refer to Fig. F-1-9).

4) Other public institutes concerned

There are some institutes; INFOR for forestal service, INDDA for agroindustry and ENCI for commercialization on the production material as fertilizer, lime, etc. and dealings of cotton.

On the other hand, the budget in fiscal years of 1983 of Ministry of Agriculture is shown in Table F-1-8, and budget of INAF accounts for 54.82% in the capital investment part as shown in Table F-1-9 -- 10. Therefore, it seems that the government has put emphasis on the agricultural development.

Except the above mentioned, there is a water user's organization (Junta de Usuarios de Distrito Valle Chancay-Huaral) in Chancay-Huaral Valley, which is organized based on the general law of water (D.L.No.17752) and regulation of water user's organization (D.S.No.005-79-AA). This organization is formed by representative of 15 irrigation commissions in the Chancay-Huaral Valley. The irrigation commission is shown in Table F-1-11.

There are 27 cooperatives in the project area as shown in Table F-1-12. These cooperatives have two shapes with 5 CAT (common land ownership cooperatives) and 22 CAU (ordinary service cooperatives), and they are established Central de Cooperativas Chancay-Huaral-Aucallama Ltd. and their activities are carried out through this central cooperatives. Dealing amounts of the Central Cooperatives are shown in Table F-1-13.

In addition to this cooperative, the Comite de productores de