# ANNEX E : SOIL

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# ANNEX E: SOIL

## 1. Soil Survey

### 1.1 General

The soil of the study area was already surveyed by Direccion general del catastro nacional subprograma del catastro rural (PIDAGRO). The survey report was published in 1975 with the map of soil series scaled at 1:10,000. As aforementioned, the present survey has attempted to check the soil map. In phase I and II, the soil and land classification survey was carried out for farming plan, irrigation and drainage plan and land utilization plan.

The studies carried out are as follows:

- Confirmation of the previous results of the study.
- Soil classification by pit excavation method.
- Soil analysis

The criteria of soil and land classification is based on the United States Department of Agriculture (USDA) standard. Within the limited survey period, soil profile observation has been focused upon the development of feasible areas for land suitability classification.

### 1.2 Soil Profile Observation

Pit sites were selected on every typical land group topographically identified.

Soil profiles were observed in 10 points through the Phase I and Phase II study, resulting in a reconnaissance survey. The sites of soil profile observation are shown in Fig. 1.2.1-1.

Outlines of the survey method are described below:

### 1.2.1 Pit

The pits were excavated to a depth of 100cm from the surface with a width of 100cm. Observation of further boring was tried using a common posthole type auger.

### 1.2.2 Soil Hardness Test

Field test was conducted to determine soil hardness. A tester that is a kind of cone penetrometer to measure soil compactness, was used since it is handy and portable for the field survey. Compactness of the soil layer is much important to determine workability of a land for potentiality classification as well as to distinguish genetic differences in the soil classification process.

The results of the soil hardness test are shown in Table 1.2.2-1.

Table 1.2.2-1 Criteria of Soil Hardness Evaluation

| Hardness Category | Tester Index* (mm) | Resistance (kg/cm) | Easiness in Tillage Work |
|---|---|---|---|
| Soft | 8 | 0.98 | Very easy |
| Slightly Hard | 8 - 12 | 0.98 - 1.93 | Easy |
| Hard | 12 - 17 | 1.93 - 4.04 | Slightly difficult |
| Very Hard | 17 - 23 | 4.04 -10.0 | Difficult |
| Extremely Hard | 23 | 10.0 | Very difficult |

* Yamanaka's Soil Hardness Tester. Index (mm) is a reading of the cone when it penetrates into the solum.

## 1.3 Sampling and Analysis

Soil horizons of the typical profile were sampled and air-dried. Fine soil samples were prepared through a 2mm sieve.

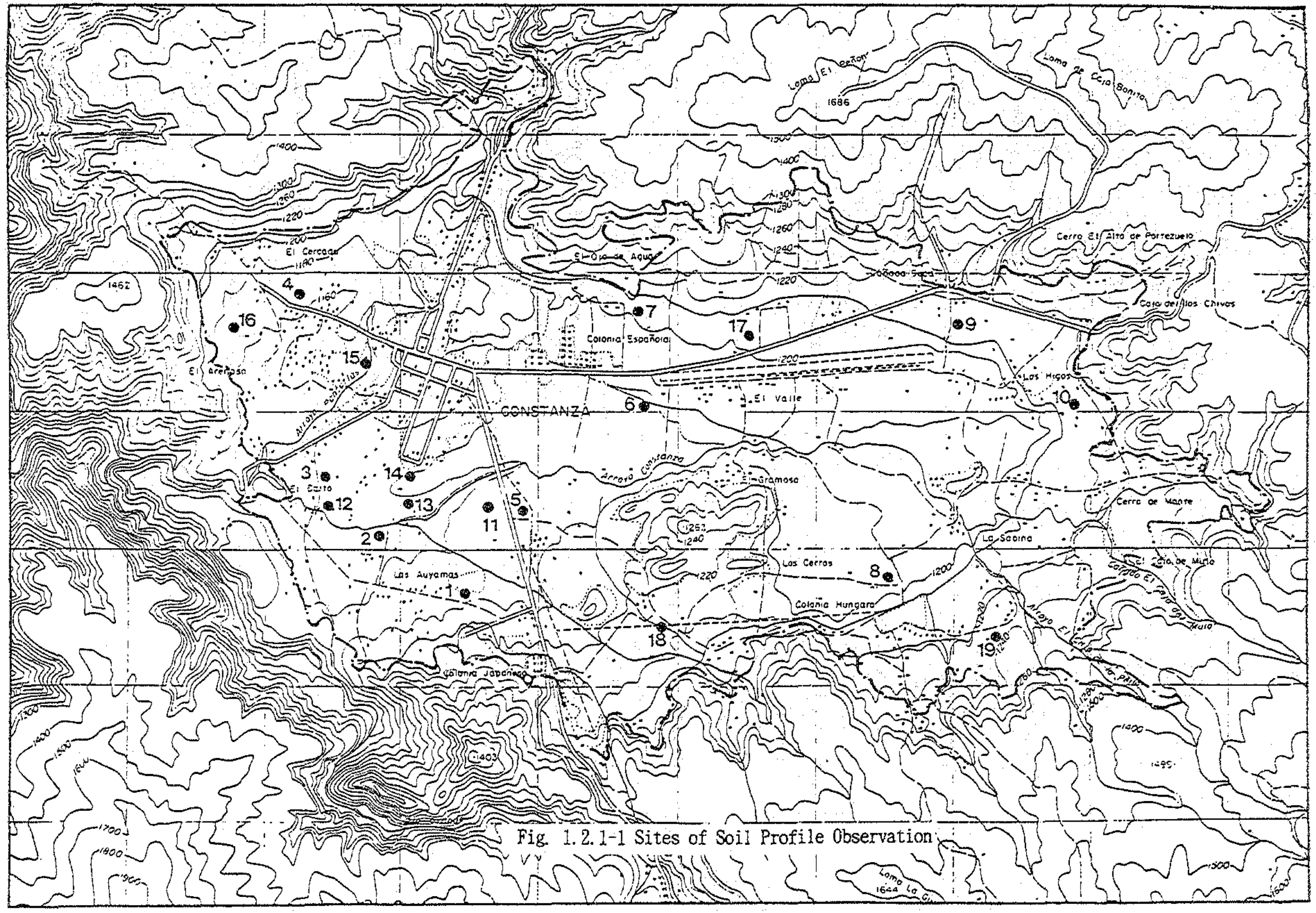



Fig. 1.2.1-1 Sites of Soil Profile Observation

## 2. Soil Profile

### 2.1 Soil Profile Observation

Description of representative soil profiles and soil profile observations are as follows:

(1) Information

| | | |
|---|---|---|
| Sample No. | : | P1 |
| Soil name | : | Inceptisol/Tropept |
| Date of examination, climate | : | Oct. 2, 89, Fine |
| Present land use | : | Upland crops |
| Drainage | : | Good |
| Depth of groundwater | : | Deep |
| Land form | : | 0-1%, Flat |

Profile description

| Depth in cm | Description |
|---|---|
| $A_p$0 - 40 | Clay Loam (CL), Dark brown (7.5 YR3/4)<br>Soil hardness: 29, Gravel: Very high (30%)<br>Angular, very fine/fine, pH5.1 |
| $A_3$ 40 - 60 | Light Clay (LiC), Brownish black (10YR2/3)<br>Soil hardness, 27, Gravel: High (15%)<br>Angular, very fine/fine, pH5.0 |
| $B_2$ 60 - 100 | Light Clay (LiC), Bright brown (7.5YR5/8)<br>Soil hardness: 23, Gravel: Less (3%)<br>Sub-angular, very fine, pH5.0 |

(2) Information

| | | |
|---|---|---|
| Sample No. | : | P2 |
| Soil name | : | Mollisol/Aquoll |
| Date of examination, climate | : | Sep. 20, 89, Fine |
| Present land use | : | Upland crops |
| Drainage | : | Imperfect |
| Depth of groundwater | : | 100cm |
| Land form | : | 0-1%, Flat |

Profile description

| Depth in cm | Description |
|---|---|
| $A_p$ 0 - 20 | Light Clay (LiC), Brownish black (10YR2/2)<br>Soil hardness: 27, Gravel: Less (1%)<br>Sub-angular, very fine, pH6.4 |
| $A_3$ 20-75 | Light Clay (LiC), Black (10YR2/1)<br>Soil hardness: 20, Gravel: Less (1%)<br>Sub-angular, very fine, pH6.7 |
| $B_t$ 75-100 | Heavy Clay (HC), Gray (5Y4/1)<br>Soil hardness: 14, Gravel: No, pH6.7 |

(3) Information

| | |
|---|---|
| Sample No. | : P3 |
| Soil name | : Mollisol/Aquoll |
| Date of examination, climate | : Sep. 25, 89, Cloudy |
| Present land use | : Upland crops |
| Drainage | : Imperfect |
| Depth of groundwater | : 80cm |
| Land form | : 0-1%, Flat |

Profile description

| Depth in cm | Description |
|---|---|
| $A_p$ 0 - 25 | Light Clay (LiC), Black (10YR2/1)<br>Soil hardness: 21, Gravel: No, pH6.9 |
| $B_2$ 25 - 45 | Clay Loam (CL), Brown (10YR4/6)<br>Soil hardness: 20, Gravel: Less (1%)<br>Sub-angular, very fine, pH6.9 |
| $B_{t1}$ 45 - 65 | Light Clay (LiC), Black (10YR1.7/1)<br>Soil hardness: 17, Gravel: No, pH6.7 |
| $B_{t2}$ 65 - 80 | Light Clay (LiC), Brown (10YR4/4)<br>Soil hardness: 18, Gravel: No, pH6.3 |

(4) Information

| | | |
|---|---|---|
| Sample No. | : | P4 |
| Soil name | : | Inceptisol/Tropept |
| Date of examination, climate | : | Sep. 21, 89, Cloudy |
| Present land use | : | Upland crops |
| Drainage | : | Good |
| Depth of groundwater | : | Deep |
| Land form | : | 0-1%, Flat |

Profile description

| Depth in cm | Description |
|---|---|
| $A_p$ 0-15 | Sandy Clay Loam (SCL), Dull yellowish brown (10YR4/3)<br>Soil hardness: 10, Gravel: Moderate (5%)<br>Angular, fine, pH6.4 |
| $A_3$ 15 - 30 | Sandy Clay Loam (SCL), Dark brown (10YR3/3)<br>Soil hardness: 21, Gravel: High (10%)<br>Angular, fine/medium/coarse, pH6.5 |
| $B_1$ 30 - 50 | Loamy Sand (LS), Dark brown (10YR3/3)<br>Soil hardness: 15, Gravel: Very high (20%)<br>Angular, fine/medium/coarse, pH65 |
| $B_3$ 50 - 100 | Sandy Clay Loam (SCL), Dark brown (10YR3/3)<br>Soil hardness: 17, Gravel: No, pH6.5 |

(5) Information

| | | |
|---|---|---|
| Sample No. | : | P5 |
| Soil name | : | Mollisol/Aquoll |
| Date of examination, climate | : | Sep. 20, 89, Fine |
| Present land use | : | Upland crops |
| Drainage | : | Imperfect |
| Depth of groundwater | : | 60cm |
| Land form | : | 0-1%, Flat |

Profile description

| Depth in cm | Description |
|---|---|
| $A_p$ 0 - 15 | Heavy Clay (HC), Black (10YR2/1)<br>Soil hardness: 20, Gravel: No, pH6.6 |
| $B_t$ 15 - 60 | Heavy Clay (HC), Yellowish brown (10YR5/8)<br>Soil hardness: 19, Gravel: No, pH6.7 |

(6) Information

| | | |
|---|---|---|
| Sample No. | : | P6 |
| Soil name | : | Mollisol/Udoll |
| Date of examination, climate | : | Sep. 21, 89, Fine |
| Present land use | : | Upland crops |
| Drainage | : | Moderate |
| Depth of groundwater | : | Deep |
| Land form | : | 0-1%, Flat |

Profile description

| Depth in cm | Description |
|---|---|
| $A_p$ 0 - 25 | Heavy Clay (HC), Black (10YR2/1)<br>Soil hardness: 21, Gravel: No, pH7.0 |
| $B_2$ 25 - 80 | Heavy Clay (HC), Brown (10YR4/6)<br>Soil hardness: 20, Gravel: No, pH7.4 |
| $C_{ca}$ 80 - 100 | Light Clay (LiC), Yellowish brown (10YR5/6)<br>Soil hardness: 23, Gravel: Moderate (7%)<br>Rounded, fine, pH7.4 |

(7) Information

| | | |
|---|---|---|
| Sample No. | : | P7 |
| Soil name | : | Mollisol/Udoll |
| Date of examination, climate | : | Sep. 26, 89, Fine |
| Present land use | : | Upland crops |
| Drainage | : | Moderate |
| Depth of groundwater | : | Deep |
| Land form | : | 1-3%, Gently sloping |

Profile description

| Depth in cm | Description |
|---|---|
| Ap 0 - 30 | Light Clay (LiC), Brownish Black (10YR3/2)<br>Soil hardness: 29, Gravel: Less (1%)<br>Angular, very fine, pH6.4 |
| $B_1$ 30 - 45 | Light Clay (LiC), Brownish Black (10YR2/2)<br>Soil hardness: 23, Gravel: Less (3%)<br>Angular, very fine, pH6.4 |
| $B_t$ 45 - 75 | Heavy Clay (HC), Black (10YR1.7/1)<br>Soil hardness: 20, Gravel: No, pH6.6 |
| C 75 - 100 | Light Clay (LiC), Brown (10YR4/4)<br>Soil hardness: 24, Gravel: No, pH6.6 |

(8) Information

| | |
|---|---|
| Sample No. | : P8 |
| Soil name | : Mollisol/Udoll |
| Date of examination, climate | : Sep. 26, 89, Cloudy |
| Present land use | : Upland crops |
| Drainage | : Good |
| Depth of groundwater | : Deep |
| Land form | : 1-3%, Gently sloping |

Profile description

| Depth in cm | Description |
|---|---|
| $A_p$ 0 - 30 | Clay Loam (CL), Dark brown (7.5YR3/3)<br>Soil hardness: 28, Gravel: Moderate (7%)<br>Angular, very fine/fine/medium/coarse, pH6.4 |
| $B_t$ 30 - 70 | Light Clay (LiC), Brown (7.5YR4/6)<br>Soil hardness: 30, Gravel: Moderate (5%)<br>Angular, very fine/fine/medium/coarse, pH6.3 |
| $B_3$ 70 - 100 | Light Clay (LiC), Bright brown (7.5YR5/8)<br>Soil hardness: 22, Gravel: Less (3%)<br>Angular, very fine/fine, pH6.2 |

(9) Information

| | | |
|---|---|---|
| Sample No. | : | P9 |
| Soil name | : | Mollisol/Udoll |
| Date of examination, climate | : | Oct. 2, 89, Fine |
| Present land use | : | Upland crops |
| Drainage | : | Moderate |
| Depth of groundwater | : | Deep |
| Land form | : | 1-3%, Gently sloping |

Profile description

| Depth in cm | Description |
|---|---|
| Ap 0 - 20 | Clay Loam (CL), Brownish black (10YR3/2)<br>Soil hardness: 18, Gravel: Less (3%)<br>Sub-angular, very fine/fine, pH6.0 |
| $A_3$ 20 - 45 | Light Clay (LiC), Brownish black (10YR2/2)<br>Soil hardness: 25, Gravel: Less (2%)<br>Sub-angular, very fine/fine, pH6.5 |
| AC 45 - 60 | Light Clay (LiC), Dark brown (10YR3/3)<br>Soil hardness: 29, Gravel: No, pH6.4 |
| C 60 - 100 | Light Clay (LiC), Brown (7.5YR4/6)<br>Soil hardness: 26, Gravel: No, pH6.4 |

(10) Information

| | | |
|---|---|---|
| Sample No. | : | P10 |
| Soil name | : | Mollisol/Udoll |
| Date of examination, climate | : | Sep. 25, 89, Fine |
| Present land use | : | Upland crops |
| Drainage | : | Moderate |
| Depth of groundwater | : | Deep |
| Land form | : | 0-1%, Flat |

Profile description

| Depth in cm | Description |
|---|---|
| $A_p$ 0 - 30 | Light Clay (LiC), Brownish black (10YR2/2)<br>Soil hardness: 26, Gravel: Less (1%)<br>Sub-angular, very fine, pH6.8 |
| $B_1$ 30 - 50 | Light Clay (LiC), Brownish (10YR4/4)<br>Soil hardness: 25, Gravel: Less (2%)<br>Sub-angular, very fine, pH6.4 |
| $B_2$ 50 - 90 | Light Clay (LiC), Black (7.5YR2/1)<br>Soil hardness: 24, Gravel: Less (1%)<br>Sub-angular, very fine, pH6.4 |
| $B_t$ 90 - 100 | Heavy Clay (HC), Brown (10YR4/4)<br>Soil hardness: 21, Gravel: No, pH6.3 |

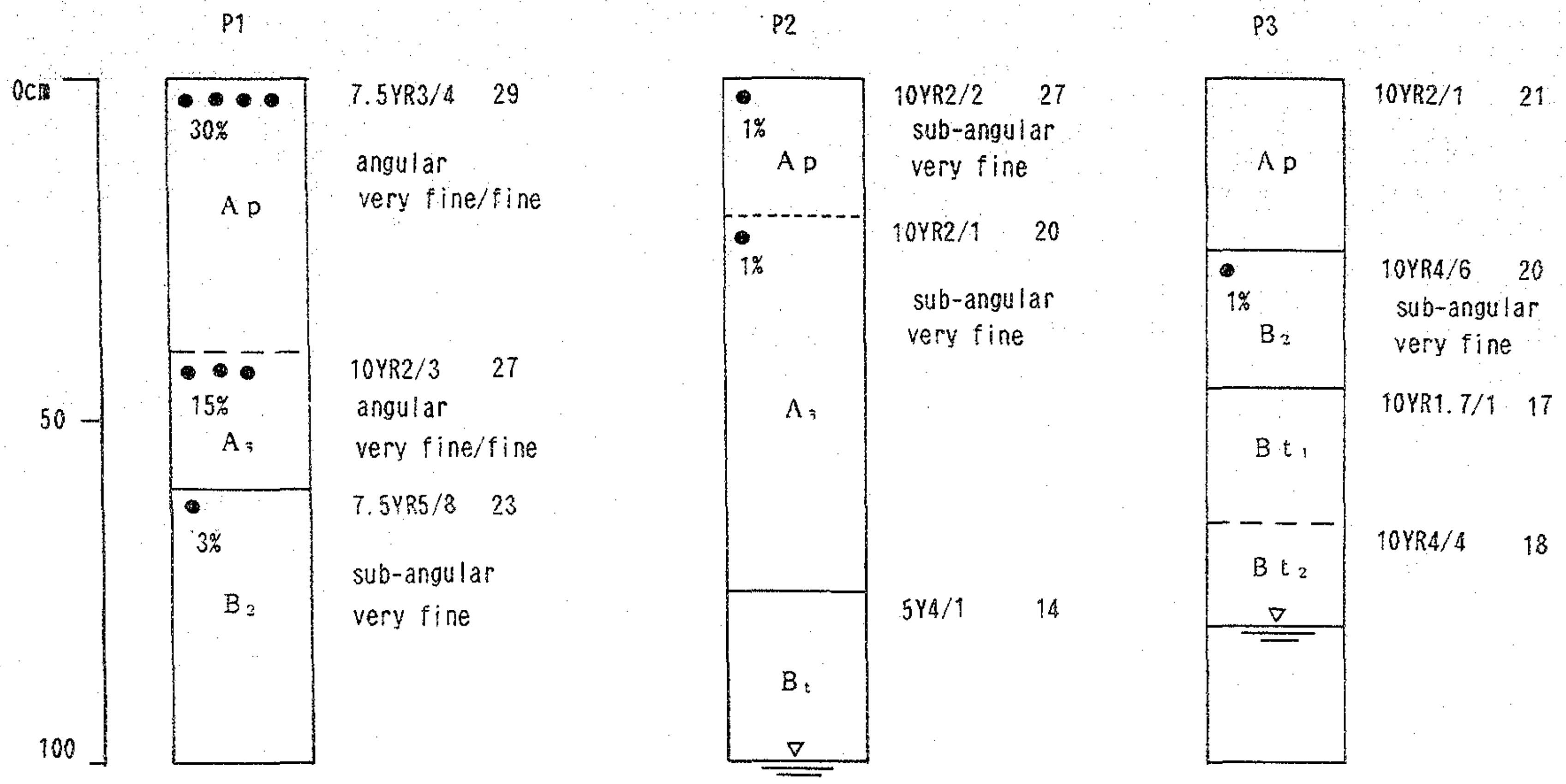



Fig.2.1.1-1 Soil Profile Observation(1)

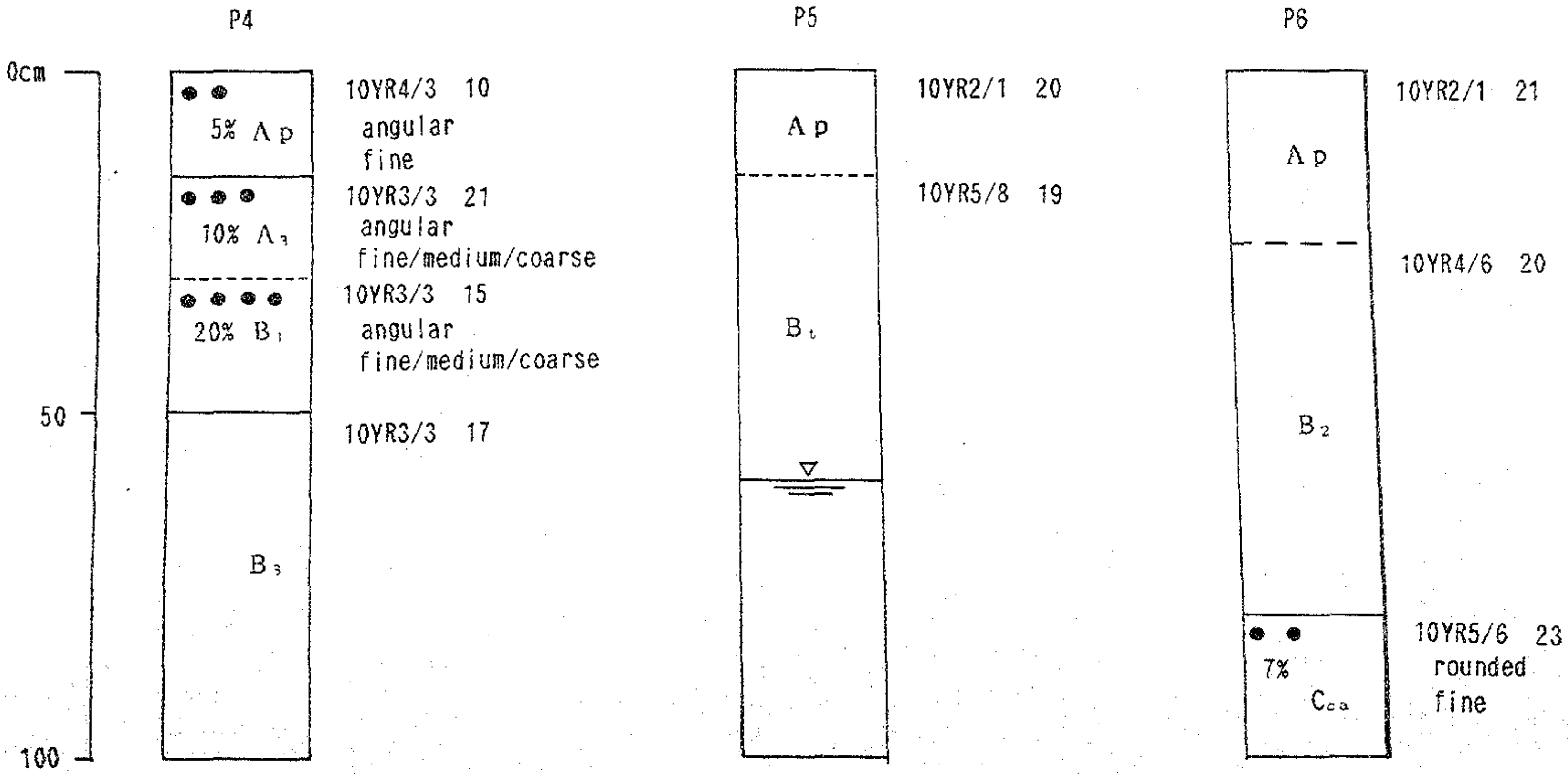



Fig. 2. 1. 1-1 Soil Profile Observation(2)

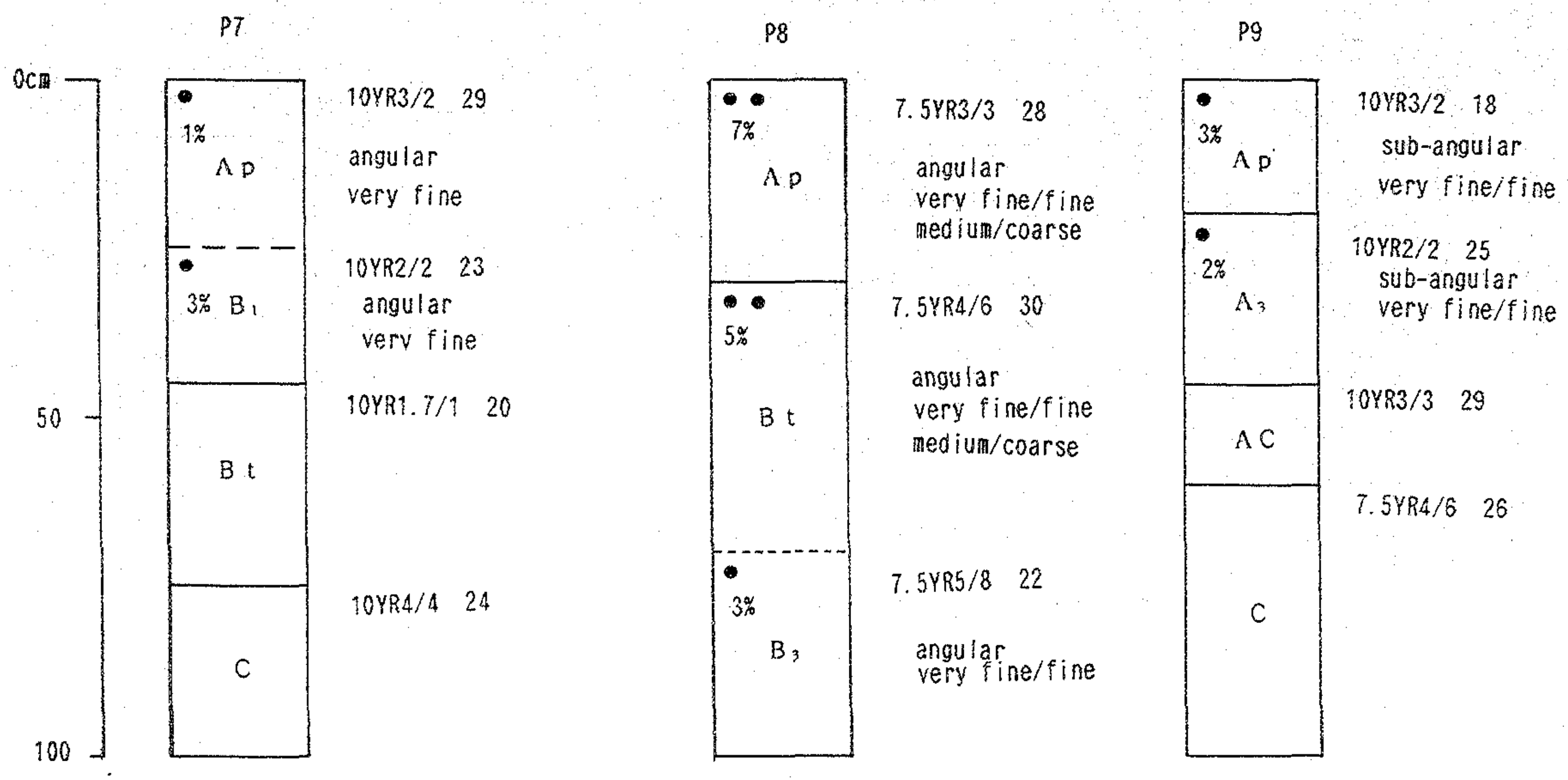
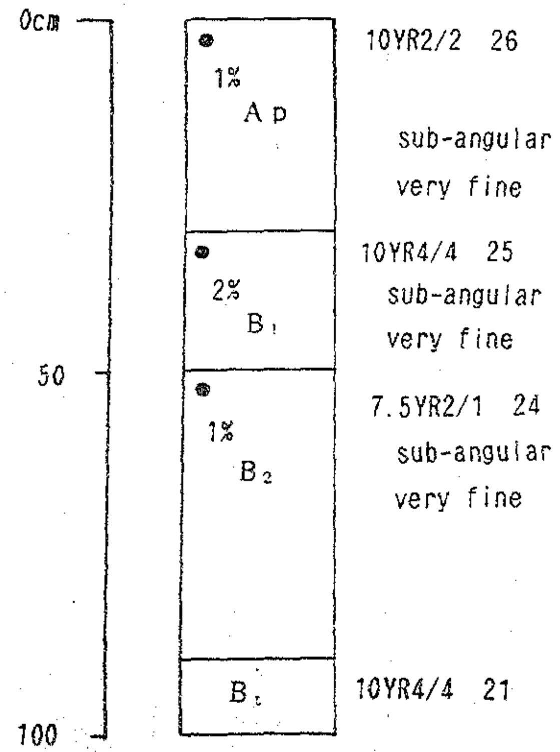



Fig. 2.1.1-1 Soil Profile Observation(3)

P10




Remarks:

Soil Color Soil Hardness

Gravel Content:

Rate:

| | |
|---|---|
| <5% | ● |
| 5〜10% | ● ● |
| 10 〜20% | ● ● ● |
| 20 〜50% | ● ● ● ● |

Grade:

| | |
|---|---|
| Very Fine | 0.2-1cm |
| Fine | 1-5cm |
| Medium | 5-10cm |
| Coarse | 10 〜20cm |

Horizon Boundary:

| | |
|---|---|
| adrupt | ——— |
| clear | - - - - |
| gradual | ...... |

Groundwater Level: ▽

Fig. 2.1.1-1 Soil Profile Observation(4)

# 3. Soil Analysis

## 3.1 Results of Soil Analysis

Soil samples were picked up from the typical horizon of 10 sites as shown in Fig. 1.2.1-1 and further physical and chemical analysis was carried out. Soil analysis was performed with regard to the following items.

pH, Saturation, Particle Size Distribution, Texture, Organic Carbon, Organic Matter, Bulk Density, Field Capacity, Wilting point, Exchangeable Cations, Cation Exchange Capacity (CEC), and Base Saturation.

The results of soil analysis are shown in Table 3.1.1-1.

## 3.2 Results of Soil Analysis in 1975

The survey report of Direction general del catastro nacional subprograma del catastro rural (PIDAGRO) in 1975 reporting the sites and results of soil profile observation are shown in Fig. 1.2.1-1 and Table 3.2.1-1.

Table 3.1.1-1 Results of Laboratory Analysis of Soil Samples (1)

| Sample No. | Depth cm | pH (1:2) | Saturation % | Particle Size Distribution Clay % | Silt % | Sand % | Texture |
|---|---|---|---|---|---|---|---|
| P1-1 | 0-40 | 5.1 | 45 | 30 | 29 | 47 | CL |
| 2 | 40-60 | 5.0 | 46 | 34 | 29 | 37 | LiC |
| 3 | 60-100 | 5.0 | 42 | 26 | 35 | 39 | LiC |
| P2-1 | 0-20 | 6.4 | 47 | 32 | 29 | 39 | LiC |
| 2 | 20-75 | 6.7 | 55 | 36 | 31 | 33 | LiC |
| 3 | 75-100 | 6.7 | 92 | 56 | 17 | 27 | HC |
| P3-1 | 0-25 | 6.9 | 57 | 30 | 31 | 39 | LiC |
| 2 | 25-45 | 6.9 | 46 | 18 | 43 | 39 | CL |
| 3 | 45-65 | 6.7 | 76 | 44 | 33 | 23 | LiC |
| 4 | 65-80 | 6.3 | 55 | 40 | 29 | 31 | LiC |
| P4-1 | 0-15 | 6.4 | 32 | 16 | 17 | 67 | SCL |
| 2 | 15-30 | 6.5 | 28 | 18 | 17 | 65 | SCL |
| 3 | 30-50 | 6.5 | 30 | 8 | 7 | 85 | LS |
| 4 | 50-100 | 6.5 | 33 | 16 | 15 | 69 | SCl |
| P5-1 | 0-15 | 6.6 | 75 | 50 | 31 | 19 | HC |
| 2 | 15-60 | 6.7 | 85 | 60 | 25 | 15 | HC |
| P6-1 | 0-25 | 7.0 | 73 | 58 | 17 | 25 | HC |
| 2 | 25-80 | 7.4 | 75 | 62 | 19 | 19 | HC |
| 3 | 80-100 | 7.4 | 54 | 40 | 39 | 21 | LiC |
| P7-1 | 0-30 | 6.4 | 43 | 32 | 21 | 47 | LiC |
| 2 | 30-45 | 6.4 | 40 | 30 | 21 | 49 | LiC |
| 3 | 45-75 | 6.6 | 90 | 46 | 21 | 33 | HC |
| 4 | 75-100 | 6.6 | 57 | 44 | 25 | 31 | LiC |
| P8-1 | 0-30 | 6.4 | 36 | 24 | 21 | 55 | CL |
| 2 | 30-70 | 6.3 | 55 | 40 | 21 | 39 | LiC |
| 3 | 70-100 | 6.2 | 37 | 26 | 25 | 49 | LiC |
| P9-1 | 0-20 | 6.0 | 37 | 24 | 23 | 53 | CL |
| 2 | 20-45 | 6.5 | 42 | 26 | 25 | 49 | LiC |
| 3 | 45-60 | 6.4 | 44 | 30 | 39 | 31 | LiC |
| 4 | 60-100 | 6.4 | 50 | 42 | 37 | 21 | LiC |
| P10-1 | 0-30 | 6.8 | 53 | 30 | 43 | 27 | LiC |
| 2 | 30-50 | 6.4 | 45 | 30 | 31 | 39 | LiC |
| 3 | 50-90 | 6.4 | 50 | 30 | 22 | 41 | LiC |
| 4 | 90-100 | 6.3 | 76 | 46 | 23 | 31 | HC |

Note : LS-Loamy Sand, SCL-Sandy Clay Loam, CL-Clay Loam, LiC-Light Clay, HC-Heavy Clay

Table 3.1.1-1 Results of Laboratory Analysis of Soil Samples (2)

| Sample No. | Depth cm | Organic Carbon(%) | Organic Matter(%) | Bulk density*1 | Field capacity(%) | Wilting point(%) | $CaCO_3$ % |
|---|---|---|---|---|---|---|---|
| P1-1 | 0-40 | 1.75 | 3.33 | 0.94 | 29.40 | 16.84 | t*2 |
| 2 | 40-60 | 1.36 | 2.59 | 1.03 | 29.83 | 17.11 | t |
| 3 | 60-100 | 1.17 | 2.22 | 0.88 | 27.09 | 15.39 | t |
| P2-1 | 0-20 | 2.10 | 4.00 | 1.17 | 28.40 | 16.21 | t |
| 2 | 20-75 | 1.95 | 3.70 | 0.90 | 29.56 | 16.94 | t |
| 3 | 75-100 | 1.95 | 3.70 | 1.04 | 29.81 | 17.10 | t |
| P3-1 | 0-25 | 5.85 | 11.11 | 1.13 | 30.80 | 17.72 | t |
| 2 | 25-45 | 2.73 | 5.18 | 1.21 | 28.00 | 15.96 | t |
| 3 | 45-65 | 2.73 | 5.18 | 1.22 | 34.51 | 20.05 | t |
| 4 | 65-80 | 2.73 | 5.18 | 0.96 | 31.91 | 18.42 | t |
| P4-1 | 0-15 | 1.56 | 2.96 | 1.29 | 18.40 | 9.92 | t |
| 2 | 15-30 | 1.48 | 2.81 | 0.95 | 18.15 | 9.77 | t |
| 3 | 30-50 | 1.17 | 2.22 | 1.39 | 19.24 | 10.45 | t |
| 4 | 50-100 | 1.01 | 1.92 | 0.92 | 19.43 | 10.51 | t |
| P5-1 | 0-15 | 1.95 | 3.70 | 1.13 | 34.01 | 19.74 | t |
| 2 | 15-60 | 1.01 | 1.92 | 0.97 | 35.61 | 20.75 | t |
| P6-1 | 0-25 | 3.90 | 7.40 | 1.16 | 38.16 | 22.35 | t |
| 2 | 25-80 | 1.17 | 2.22 | 1.06 | 34.20 | 19.87 | t |
| 3 | 80-100 | 0.58 | 1.11 | 1.02 | 34.67 | 20.16 | t |
| P7-1 | 0-30 | 5.07 | 9.63 | 1.13 | 27.49 | 15.64 | t |
| 2 | 30-45 | 3.51 | 6.70 | 1.03 | 27.16 | 15.43 | t |
| 3 | 45-75 | 3.51 | 6.70 | 0.94 | 35.97 | 20.97 | t |
| 4 | 75-100 | 2.92 | 5.55 | 1.23 | 31.09 | 17.90 | t |
| P8-1 | 0-30 | 2.53 | 4.81 | 1.17 | 26.63 | 15.10 | t |
| 2 | 30-70 | 1.95 | 3.70 | 1.05 | 31.49 | 18.16 | t |
| 3 | 70-100 | 1.75 | 3.33 | 1.03 | 25.30 | 14.26 | t |
| P9-1 | 0-20 | 3.90 | 7.41 | 1.13 | 25.41 | 14.33 | t |
| 2 | 20-45 | 3.90 | 7.41 | 0.84 | 26.19 | 14.82 | t |
| 3 | 45-60 | 3.12 | 5.92 | 0.76 | 30.12 | 17.29 | t |
| 4 | 60-100 | 2.53 | 4.81 | 0.83 | 32.67 | 18.90 | t |
| P10-1 | 0-30 | 5.07 | 9.63 | 0.91 | 31.47 | 18.14 | t |
| 2 | 30-50 | 4.29 | 8.15 | 1.28 | 30.19 | 17.34 | t |
| 3 | 50-90 | 3.12 | 5.92 | 1.26 | 31.26 | 18.01 | t |
| 4 | 90-100 | 2.34 | 4.44 | 0.78 | 34.71 | 20.18 | t |

Note : *1 Bulk density($g/cm^3$) *2 t-trace

Table 3.1.1-1 Results of Laboratory Analysis of Soil Samples (3)

| Sample No. | Depth cm | Exchangeable Cations(me/100g) Na | K | Ca | Mg | Total | CEC (me/100g) | Base Saturation ) |
|---|---|---|---|---|---|---|---|---|
| P1-1 | 0-40 | 0.49 | 0.08 | 24.0 | 1.6 | 26.17 | 30 | 87.23 |
| 2 | 40-60 | 0.47 | 0.08 | 21.6 | 2.4 | 24.55 | 30 | 81.83 |
| 3 | 60-100 | 0.42 | 0.09 | 24.0 | 4.0 | 28.51 | 29.8 | 95.67 |
| P2-1 | 0-20 | 0.66 | 0.10 | 31.2 | 3.2 | 35.16 | 36 | 97.67 |
| 2 | 20-75 | 0.73 | 0.10 | 32.0 | 4.0 | 36.83 | 37 | 99.54 |
| 3 | 75-100 | 0.80 | 0.08 | 32.8 | 4.8 | 38.48 | 40 | 96.20 |
| P3-1 | 0-25 | 0.47 | 0.11 | 32.8 | 5.6 | 38.98 | 41 | 95.07 |
| 2 | 25-45 | 0.52 | 0.13 | 35.2 | 4.8 | 40.65 | 42 | 96.79 |
| 3 | 45-65 | 0.49 | 0.13 | 36.8 | 4.8 | 42.22 | 42 | 91.78 |
| 4 | 65-80 | 0.54 | 0.14 | 43.2 | 5.8 | 49.68 | 51 | 97.41 |
| P4-1 | 0-15 | 0.57 | 0.11 | 40.0 | 1.6 | 42.28 | 44 | 96.09 |
| 2 | 15-30 | 0.76 | 0.10 | 32.0 | 5.6 | 38.46 | 40 | 96.15 |
| 3 | 30-50 | 0.86 | 0.09 | 31.2 | 4.8 | 36.95 | 40 | 92.38 |
| 4 | 50-100 | 0.86 | 0.09 | 32.0 | 0.8 | 33.75 | 39 | 86.54 |
| P5-1 | 0-15 | 0.52 | 0.17 | 28.8 | 10.9 | 40.39 | 48 | 84.15 |
| 2 | 15-60 | 0.54 | 0.16 | 32.8 | 7.2 | 40.70 | 49 | 83.06 |
| P6-1 | 0-25 | 0.86 | 0.10 | 41.6 | 6.4 | 48.96 | 52 | 94.15 |
| 2 | 25-80 | 0.47 | 0.11 | 40.0 | 4.0 | 44.58 | 48 | 92.88 |
| 3 | 80-100 | 0.54 | 0.11 | 40.8 | 2.4 | 43.85 | 47 | 93.30 |
| P7-1 | 0-30 | 0.54 | 0.10 | 43.2 | 5.6 | 49.44 | 50 | 98.88 |
| 2 | 30-45 | 0.60 | 0.10 | 41.6 | 6.4 | 48.70 | 52 | 93.65 |
| 3 | 45-75 | 0.60 | 0.11 | 33.6 | 3.2 | 37.51 | 40 | 93.78 |
| 4 | 75-100 | 0.66 | 0.11 | 34.4 | 5.2 | 40.37 | 40 | 100.93 |
| P8-1 | 0-30 | 0.49 | 0.09 | 30.4 | 4.0 | 34.98 | 37 | 94.54 |
| 2 | 30-70 | 0.44 | 0.09 | 32.0 | 4.0 | 36.53 | 38 | 96.13 |
| 3 | 70-100 | 0.39 | 0.08 | 25.6 | 6.4 | 32.47 | 36 | 90.19 |
| P9-1 | 0-20 | 0.54 | 0.11 | 32.0 | 2.4 | 35.05 | 36 | 97.36 |
| 2 | 20-45 | 0.49 | 0.10 | 28.8 | 3.2 | 32.59 | 33.6 | 96.99 |
| 3 | 45-60 | 0.60 | 0.10 | 28.0 | 4.8 | 33.50 | 34 | 98.53 |
| 4 | 60-100 | 0.66 | 0.09 | 28.8 | 3.2 | 32.75 | 33.6 | 97.47 |
| P10-1 | 0-30 | 0.63 | 0.10 | 41.6 | 6.4 | 48.73 | 50 | 97.46 |
| 2 | 30-50 | 0.63 | 0.10 | 41.6 | 5.6 | 47.93 | 48 | 99.85 |
| 3 | 50-90 | 0.54 | 0.13 | 43.2 | 4.8 | 48.67 | 50 | 97.34 |
| 4 | 90-100 | 0.66 | 0.13 | 44.8 | 4.8 | 50.39 | 52 | 96.90 |

Table 3.2.1-1 Results of Laboratory Analysis of Soil Samples -1975- (1)

| Sample No. | Depth cm | pH (1:1) | Organic Carbon(%) | Particle Size Distribution Clay % | Silt % | Sand % | Texture |
|---|---|---|---|---|---|---|---|
| P11-1 | 0-35 | 7.2 | 5.61 | 36.3 | 39.3 | 24.4 | LiC |
| 2 | 35-75 | 7.1 | 0.92 | 56.3 | 25.3 | 18.4 | HC |
| 3 | 75-110 | 7.1 | 0.30 | 40.3 | 35.3 | 24.4 | LiC |
| 4 | 110-150 | 7.3 | 0.20 | 20.3 | 27.3 | 52.4 | CL |
| P12-1 | 0-40 | 7.1 | 3.24 | 34.3 | 35.3 | 30.4 | LiC |
| 2 | 40-80 | 6.8 | 1.66 | 22.2 | 19.4 | 58.4 | SCL |
| 3 | 80-120 | 8.2 | 0.51 | 34.3 | 27.3 | 38.4 | LiC |
| 4 | 120-150 | 8.6 | 0.23 | 12.3 | 25.3 | 62.4 | L |
| P13-1 | 0-20 | 6.8 | 1.16 | 24.4 | 39.3 | 36.4 | CL |
| 2 | 20-35 | 6.5 | 1.07 | 18.3 | 53.3 | 28.4 | SiCL |
| 3 | 35-55 | 6.5 | 0.59 | 20.4 | 57.2 | 22.4 | SiCL |
| 4 | 55-150 | 7.0 | - | 13.3 | 18.3 | 68.4 | SL |
| P14-1 | 0-30 | 7.0 | 11.40 | - | - | - | - |
| 2 | 30-60 | 6.8 | 0.45 | 4.2 | 11.4 | 84.4 | SL |
| 3 | 60-150 | 6.0 | 24.06 | - | - | - | - |
| P15-1 | 0-35 | 7.0 | 2.59 | 8.3 | 19.3 | 72.4 | SL |
| 2 | 35-90 | 7.1 | 0.51 | 12.3 | 21.3 | 66.4 | SL |
| 3 | 90-150 | 6.8 | 0.31 | 4.3 | 7.3 | 88.4 | LS |
| P16-1 | 0-20 | 7.4 | 1.71 | 42.3 | 27.3 | 30.4 | LiC |
| 2 | 20-50 | 7.0 | 1.23 | 32.3 | 39.3 | 28.4 | LiC |
| 3 | 50-80 | 6.9 | 0.74 | 34.3 | 27.3 | 38.4 | LiC |
| 4 | 80-110 | 7.4 | - | 16.3 | 17.3 | 66.4 | SCL |
| 5 | 110-150 | 7.4 | - | 20.4 | 25.2 | 54.4 | CL |
| P17-1 | 0-30 | 6.8 | 3.03 | 28.4 | 37.2 | 34.4 | LiC |
| 2 | 30-45 | 7.0 | 2.75 | 20.3 | 15.3 | 64.4 | SCL |
| 3 | 45-70 | 7.1 | 0.50 | 14.6 | 15.8 | 70.2 | SL |
| 4 | 70-95 | 6.9 | 0.50 | 14.3 | 11.3 | 74.4 | SL |
| 5 | 95-150 | 7.5 | 0.30 | 14.4 | 15.2 | 70.4 | SL |
| P18-1 | 0-30 | 7.3 | 4.62 | 22.4 | 39.2 | 38.4 | CL |
| 2 | 30-70 | 6.4 | 3.84 | 4.3 | 19.3 | 76.4 | SL |
| 3 | 70-80 | 7.2 | 0.59 | 4.4 | 13.2 | 82.4 | SL |
| 4 | 80-100 | 7.2 | 1.67 | 16.3 | 21.3 | 62.4 | CL |
| 5 | 100-120 | 6.5 | 0.86 | 24.3 | 39.3 | 36.4 | CL |
| P19-1 | 0-25 | 6.5 | 3.74 | 16.4 | 21.2 | 62.4 | CL |
| 2 | 25-150 | 6.4 | 1.29 | 14.3 | 25.3 | 60.4 | L |

Note : LS-Loamy Sand, SL-Sandy Loam, L-Loam, SCL-Sandy Clay Loam,
Cl-Clay Loam, SiCL-Silty Clay Loam, LiC-Light Clay, HC-Heavy Clay

Table 3.2.1-1 Results of Laboratory Analysis of Soil Samples -1975- (2)

| Sample No. | Depth cm | Exchangeable Cations(me/100g) Na | K | Ca | Mg | Total | CEC (me/100g) | Base Saturation(%) |
|---|---|---|---|---|---|---|---|---|
| P11-1 | 0--35 | 0.40 | 0.11 | 30.0 | 23.3 | 53.81 | 53.3 | 100.96 |
| 2 | 35-75 | 0.43 | 0.11 | 40.1 | 9.9 | 50.54 | 52.4 | 96.45 |
| 3 | 75-110 | 0.62 | 0.30 | 26.0 | 14.0 | 40.92 | 41.3 | 99.08 |
| 4 | 110-150 | 0.58 | 0.15 | 24.0 | 16.0 | 40.73 | 40.8 | 99.83 |
| P12-1 | 0-40 | 0.32 | 2.22 | 28.4 | 19.6 | 50.54 | 53.6 | 94.29 |
| 2 | 40-80 | 0.29 | 0.11 | 34.0 | 14.8 | 49.20 | 45.9 | 107.19 |
| 3 | 80-120 | 0.81 | 0.43 | 36.0 | 16.2 | 53.44 | 48.7 | 109.73 |
| 4 | 120-150 | 1.40 | 0.76 | 34.7 | 17.7 | 54.56 | 50.1 | 108.90 |
| P13-1 | 0-20 | 0.70 | 0.48 | 26.7 | 10.2 | 38.08 | 55.4 | 68.74 |
| 2 | 20-35 | 0.54 | 0.24 | 27.5 | 11.5 | 39.78 | 58.0 | 68.59 |
| 3 | 35-55 | 0.27 | 0.10 | 22.7 | 5.4 | 28.47 | 30.1 | 94.58 |
| 4 | 55-150 | 0.70 | 0.10 | 31.5 | 19.5 | 51.80 | 53.0 | 97.74 |
| P14-1 | 0-30 | 0.70 | 0.31 | 54.0 | 12.6 | 67.61 | 67.3 | 100.46 |
| 2 | 30-60 | 0.48 | 0.24 | 8.0 | 3.0 | 11.72 | 12.6 | 93.02 |
| 3 | 60-150 | 1.40 | 0.22 | 40.0 | 20.0 | 61.62 | 83.2 | 74.06 |
| P15-1 | 0-35 | 0.64 | 0.18 | 11.5 | 3.8 | 16.12 | 27.0 | 59.70 |
| 2 | 35-90 | 0.70 | 0.15 | 12.7 | 4.1 | 17.65 | 22.5 | 78.44 |
| 3 | 90-150 | 0.54 | 0.15 | 5.6 | 3.0 | 9.29 | 10.3 | 90.19 |
| P16-1 | 0-20 | 0.29 | 0.14 | 40.0 | 16.0 | 56.43 | 59.0 | 95.64 |
| 2 | 20-50 | 0.80 | 0.82 | 35.0 | 9.0 | 45.62 | 51.0 | 89.45 |
| 3 | 50-80 | 0.43 | 0.11 | 41.4 | 10.1 | 52.04 | 55.1 | 94.45 |
| 4 | 80-110 | 0.20 | 0.60 | 29.5 | 11.3 | 41.60 | 55.4 | 75.09 |
| 5 | 110-150 | 0.27 | 0.60 | 32.6 | 12.2 | 45.67 | 47.4 | 96.35 |
| P17-1 | 0-30 | 0.48 | 1.34 | 23.0 | 15.0 | 39.82 | 48.9 | 81.43 |
| 2 | 30-45 | 0.40 | 0.30 | 28.0 | 17.0 | 45.70 | 46.6 | 98.07 |
| 3 | 45-70 | 0.70 | 0.12 | 24.5 | 14.5 | 39.82 | 35.8 | 111.23 |
| 4 | 70-95 | 0.70 | 0.15 | 27.0 | 16.5 | 44.35 | 35.8 | 123.88 |
| 5 | 95-150 | 0.42 | 0.42 | 24.0 | 13.0 | 37.84 | 32.9 | 115.02 |
| P18-1 | 0-30 | 0.28 | 0.10 | 17.5 | 11.7 | 29.58 | 29.2 | 101.03 |
| 2 | 30-70 | 1.52 | 0.36 | 8.4 | 9.8 | 20.08 | 19.2 | 104.58 |
| 3 | 70-80 | 1.08 | 0.10 | 11.5 | 1.2 | 13.88 | 14.3 | 97.06 |
| 4 | 80-100 | 0.32 | 0.26 | 22.0 | 14.5 | 37.08 | 35.5 | 104.45 |
| 5 | 100-120 | 0.42 | 0.15 | 12.4 | 11.3 | 24.27 | 33.6 | 72.23 |
| P19-1 | 0-25 | 0.80 | 1.08 | 8.0 | 5.5 | 15.38 | 39.1 | 39.34 |
| 2 | 25-150 | 0.76 | 0.76 | 4.5 | 6.7 | 12.72 | 24.6 | 51.71 |

# 4. Soil Characteristics

## 4.1 Characteristics of Soil

It is necessary to classify the soil in the study area in detail at lower categories. The characteristics of the soil based on the analysis of the collected data during phase I are summarized below.

### 4.1.1 Mollisols

Mollisols, which is rich in organic matter with high cation supply is the representative soil in the study area and is very suitable for crop cultivation.

Mollisols in the study area are mainly classified into two sub-orders called Udolls and Aquolls. Udolls cover an area of 1,121ha and occupy about 88% of Mollisols. This type of soil shows light clay with black to brownish black color. Udolls are widely distributed in the north, south east, northwest and southwest of the Valley. Soil fertility and moisture content of soil are rich.

Aquolls are distributed over an area of 159ha in both sides of the middle and downstream of the Arroyo Constanza and in the southeast of the Valley. Soil shows heavy clay with poor drainage and high groundwater level.

### 4.1.2 Inceptisols

Inceptisols are widely distributed second to Mollisols in the study area and cover an area of 400ha (23.8%). This soil is distributed in La Sabina area in the southeast, the west of the Valley, the part of the upstream and the alluvion along the Arroyo Pantuflas. The texture of the soil is slightly rough with the existance of gravel. These soil with high fertility and good drainage condition is suitable for crop cultivation.

The characteristics of the soil and the results of soil analysis are shown in Table 4.1.1-1.

* The upstream of the Arroyo Pantuflas

In this study, the soil of the above mentioned area is classified to Inceptisols/Tropepts for the following reasons.

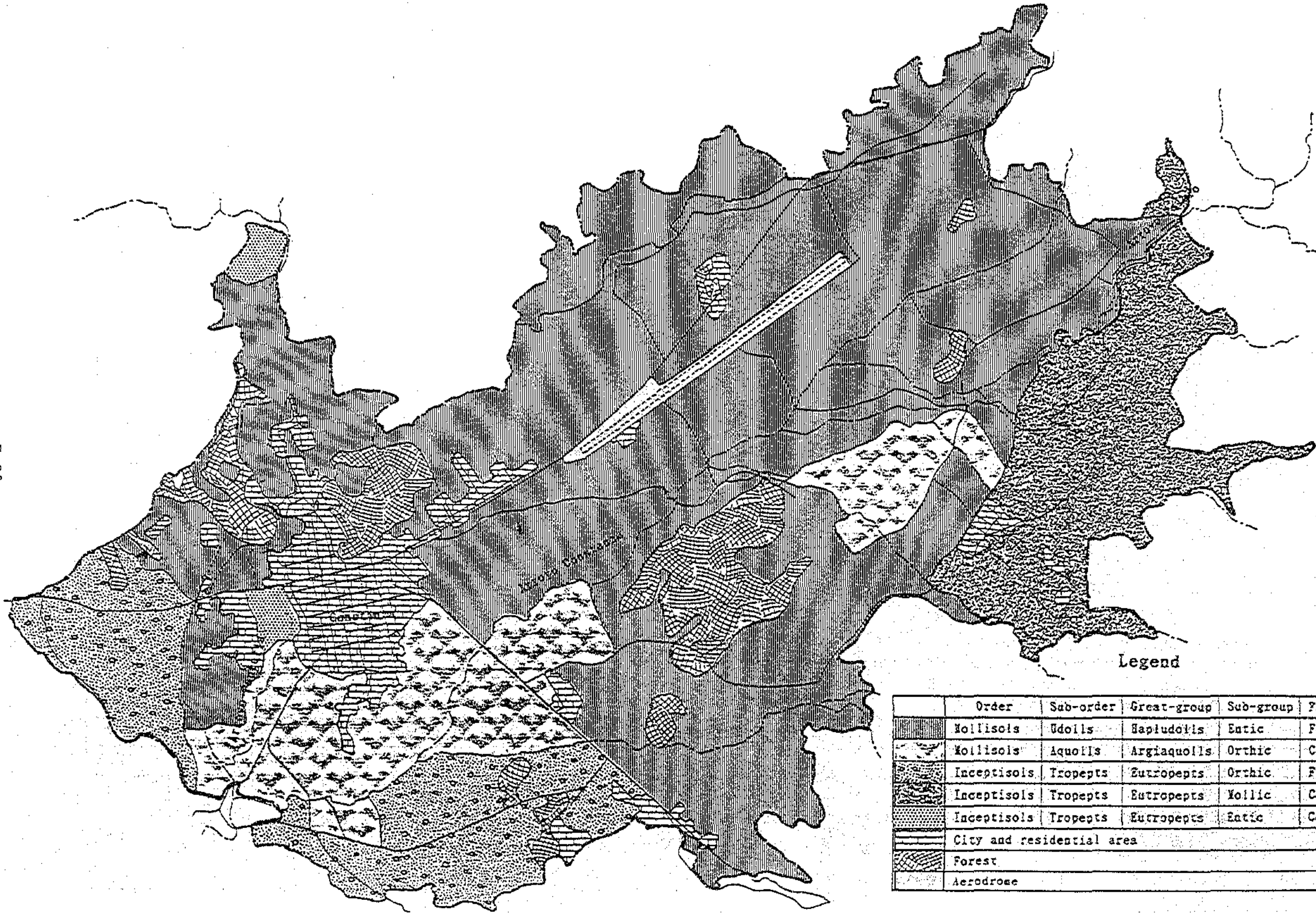
1. The Entisols is very similar to the Inceptisols. The Entisols is created newly with poor developed layers. On the other hand, the Inceptisols shows the little developed layers.

2. A little developed layers are observed in the area.

3. The characteristics of the soil in the area is similar to the Inceptisols in the other area of the Constanza Valley.

Therefore, it is concluded that the soil of the area is classified to the Inceptisols. Specially it is classified to the Entic which is one of the sub-group of the Inceptisols and very similar to the Entisols.

| Soil name | MOLLISOLS/ Udolls | MOLLISOLS/ Aquolls | INCEPTISOLS/ Tropepts |
|---|---|---|---|
| Distribution | • North and south of the Valley<br>• East of the central Valley<br>• North of the Valley in the west from Constanza city area | • On both sides of the Arroyo Constanza in the central Valley<br>• Southeast of the Valley | • Alluvion along the Arroyo Pantuflas<br>• On both sides of the Arroyo El Cajo<br>• West of the Valley |
| Area | 1,121ha 66.7% | 159ha 9.5% | 400ha 23.8% |
| Land use | Vegetable and flower cultivation | Vegetable cultivation | Vegetable and main crop cultivation |
| Soil color | • Surface soil : brownish black<br>• Subsoil : brown | Black, brownish black | Dark brown, yellowish brown |
| Soil structure | Part of subsoil : firm with single-grain structure | Heavy clay | • Gravels are included in the surface soil<br>• Subsoil : gravel layer, sandy layer |
| Water permeability | Slightly permiable | Slightly permiable | High to very high |
| Groundwater level | Deep | Shallow | Deep |
| Effective depth | 90-150cm | 60-100cm | 50-100cm |
| Erosion | Little to medium | Little | Little to medium |
| Gradient | 1-3% or 3-7% | 0-1% | 0-1% |
| Natural drainage | Good to moderate | Imperfect | Good |
| Soil fertility | High | High | High |
| pH | 6.3-6.9 | 6.4-6.9 | 5.0-6.5 |
| CEC | High | Very high | High |
| Exchangeable cations (Total) | High | High | High |
| Base saturation | High | High | High |
| Evaluation and suggestions | • Introduction of continuous cropping including pulse crop for the conservation of soil fertility<br>• Introduction of sprinkler irrigation for the conservation of erosion in the area of steep slope with the gradient of 3-7%<br>• Introduction of contour cropping for the control of surface soil erosion | | • Introduction of sprinkler irrigation to maintain of soil fertility and water permeability<br>• Suspension of gravel for the effective agricultural work<br>• Introduction of continuous cropping including pulse crop for the conservation of soil fertility |



Legend

| | Order | Sub-order | Great-group | Sub-group | Family |
|---|---|---|---|---|---|
| | Mollisols | Udolls | Hapludolls | Entic | Fine-loamy |
| | Mollisols | Aquolls | Argiaquolls | Orthic | Clay |
| | Inceptisols | Tropepts | Eutropepts | Orthic | Fine-loamy |
| | Inceptisols | Tropepts | Eutropepts | Mollic | Coarse-loamy |
| | Inceptisols | Tropepts | Eutropepts | Entic | Coarse-loamy |
| | City and residential area | | | | |
| | Forest | | | | |
| | Aerodrome | | | | |

Fig. 4.1.1.1 Soil Map

## 5. Land Classification

### 5.1 USDA Capability Classification

The USDA Soil Conservation Service developed the USDA Capability Classification as a means of grouping arable soils according to potentials and limitations for the sustained production of common cultivated crops. (Sustained production means that the soil can be used for agriculture without excessive soil erosion.) Nonarable soils are grouped according to potentials and limitations and risks of soil damage. This system was developed to give conservationists and farm planners a tool for evaluating agricultural potential of soils. It has eight classes, four subclasses, and ten units.

Classes: Soils with similar broad limitations are grouped in each class. Class I Soils have few permanent limitations for cultivated agriculture. They are greater than 100cm deep, and well drained and have medium surface textures (loams and sandy loams), good water-holding capacity, no alkali or toxicity limitations, and no moderate or severe salinity. To be in Class I, soils must be on level parts of the landscape and in a climate where the rain is sufficient and the frost-free season is long enough for common cultivated crops to be grown. Class I soils require ordinary good management such as fertilizer, lime to reduce acidity, animal manures, or rotations to maintain productivity.

Class II, III, and IV soils have progressively more limitations for sustained crop grown. Class II soils have some limitations and require careful management and some special management to maintain productivity. For example, Class II soils may require erosion control practices such as contour cultivation or nontillage.

Class III soils have severe limitations that restrict crops and require special practices to maintain productivity. Soils in this classification may require erosion control practices such as contour cultivation, nontillage, strip cropping, or terrace construction. Water management is also important to soils in Class III, as they may require artificial drainage.

Class IV soils have very severe limitations that require very careful management and restrict the choice of crops. Limitations such as shallowness to bedrock, steep slopes that increase the risk of soil erosion, low water-holding capacity, and wetness during the growing season increase from Class II to IV. Class IV soils are the lowest-capability arable soils.

Class V soils are nonarable soils. They have fewer slope and soil thickness limitations than Class IV soils, but are excluded from cultivation because of limitations such as climate or wetness. Soils in Classes VI and VII are range soils with increasing limitations. Management practices may be successfully applied to Class VI soils, but Class VII are so severely restricted that no management is possible. Class VIII soils are unsuitable for cultivated agriculture and severely limited for range and pasture but are often important for scenic, recreational, and watershed resources that require careful management.

Subclasses: Within Classes II through VIII are the subclasses e (erosion), s (soil morphology), w (wetness), and c (climate), which specify a kind of limitation or hazard. The subclass is not usually used for Class I soils, but sometimes the e subclass is used to indicate that there may be a potential erosion problem. An example of a IVe classification is a deep (over 1m), well-drainaed soil with slow permeability on slopes of over 15 percent. Because of slow permeability and slope, erosion is the dominant management problem.

The s subclass indicates that there is a morphologic problem such as shallow rooting depth, very sandy or clayey textures, undesirable pH, or salinity or alkali problems in the root zone. Examples of IIIs classifications are (1) a soil with sandy textures throughout the pedon with low waterholding capacity or (2) a soil on a zero to 2 percent slope that has a small rooting depth because it is shallow to bedrock.

Wetness is designated with a w, which usually means that soil cultivation is limited by a high water table during the growing season. These may be somewhat poorly to poorly drained soils that are unlikely to erode and that have no root-limiting layers within the pedon.

When climatic limitations reduce the number of crops that can be grown or the success of growing crops, the c subclass is used. Soils in northern latitudes or in mountainous areas may have desirable physical and chemical properties, but the growing season may be too short for most crops. Such soils are placed in the c subclass.

## 5.2 USDA Standard of Classification

Main specifications for soil and land conditions under irrigation system of upland crops are cited in Table 5.2.1-1.

In this method, lands suitability of upland crops are divided into three classes from 1 to 3; those suitable for rice and pasture are dealt with as 4A and 4P, respectively; and lands ranked at below 4S are not recommended for arable use.

Class 5 to 8 indicates problem lands which cannot be used at present but need to be further investigated.

Table 5.2.1-1 Land Classification Specification for Irrigation of Upland Crops (1)

| Characteristics of Soil or Land | Class 1 | Class 2 | Class 3 | Class 4A | Class 4P | Class 4S | Class 5 |
|---|---|---|---|---|---|---|---|
| Land suitability | Arable land with no limitation | Arable land with some limitations | Arable land with serious limitations | Land suitable to lowland rice | Land suitable to pasture only | Land of organic soil for special cultivation | Land to be further investigated |
| Soil texture, 0-30cm | SL - SiC | LS - permeable C | LS - C | SiL, SiCL - C | Gravelly L - C | (Organic) | (Organic or mineral) |
| Subsoil | SL - permeable C | LS - C | LS - C | SiL, SiCL - C | * | (Organic or mineral) | (Organic or mineral) |
| Available soil (until sand or gravel) | >100 cm | 60 - 100 cm | 40 - 60 cm | >75 cm | >25 cm | >30 cm | * |
| Soil acidity or alkalinity: pH of saturated paste | 5.5 - 8.2 | 5.0 - 8.5 | 4.5 - 8.5 | 5.0 - 8.5 | 4.5 - 8.5 | 4.5 - 8.2 | Strongly acidic until clayey layer |
| exchangeable sodium (PSI, %) | <5% throughout the profile | <15% throughout the profile | <15% over the upper 30 cm soil | <15% throughout the profile | <15% over the upper 20 cm soil | <15% throughout the profile | — |
| Soil salinity: electrical conductivity of saturation extract (mmhos/cm, 25°C) | <4ms throughout the profile | <4ms when permeable, <8 ms when less permeable | <8ms when drainable but less permeable, <16ms when drainable and permeable | <4-8ms with first class irrigation water, <8-16ms with second or third class water | <8ms with good water periodically, <16ms with poor quality water | <4ms throughout the profile. | — |
| Base saturation (%) | >50% throughout the profile | - | - | >35% throughout the profile. | ** | ** | ** |
| Cation exchange capacity (upper 30 cm) | >10 me per 100 g soil | >5me per 100 g soil | >3me per 100 g soil | >5-20ms per 100 g soil | >3me per 100 g soil | ** | ** |

Table 5.2.1-1 Land Classification Specification for Irrigation of Upland Crops (2)

| Characteristics of Soil or Land | Class 1 | Class 2 | Class 3 | Class 4A | Class 4P | Class 4S | Class 5 |
|---|---|---|---|---|---|---|---|
| Natural drainage of the land: | | | | | | | |
| Uncontrolled inundation | Not present | Not present | Exceptionally present | Not present | From time to time | Moderately frequent | Frequent |
| Depth of groundwater level | >200 cm | >150 cm | >100 cm | <100 - 150 cm | >50 cm | >20 cm | - |
| Class of natural drainage | Moderately well - well | Imperfect - somewhat excessive | Between poor and somewhat excessive | Very poor - moderately well | Very poor - excessive | Very poor - imperfect | Very poor excessive |
| Requirement for artificial drainage | No, <50 m of surface drainage per ha | Somewhat, <200m of surface drainage per ha | Required, <500m of sub-surface drainage per ha | No, but required when the area is irrigated | More or less required to remedy inundation | Significantly required including the area | Very significantly required including the area |
| Slope and relief: | | | | | | | |
| Slope | <2% | <5% | <5 - 8% | <2 - 5% | 0 - 20% | - | - |
| Relief and micro-relief | Flat - almost flat | Almost flat - slightly undulating | Undulating | Flat - slightly undulating | Flat - undulating or concave | Flat - concave | Flat - concave |
| Productive capacity: | | | | | | | |
| Cultivation adaptability | Suitable for annual cropping | Some limitations for annual cropping | Slightly serious limitations for annual | Only for rice or some selected crops | Only for grasses | Special crops only for organic soil | Depending on improvement of facilities |
| Production anticipated under good management | High with fertilization and protection | High - moderately high with best techniques | Moderate - moderately high. | High - moderate with fertilization and techniques | High - moderate with best techniques | Moderately high with recommended techniques | Depending on effect of improvement. |

NOTE: Cited from the report "De Suelos del Bajo Rio Yuna (1976)".
* --- No need to describe. ** --- Not applicable - Any values are included.

## 5.3 Land Classification

The distribution and outline for each class in the study area are shown as follows:

### (1) Class-I

The land of class I is very good for cultivation with no limitation and a high production is expected by effective soil management practices. This class is widely distributed in the south between Constanza city area and La Sabina, and in the north and east of the skirts of the mountain. Area of this class in the study area is 533ha (31.7%).

### (2) Class -IIs

This class has little limitations from soil conditions as compared with class I. The distribution of this class is in the south area of the central Valley and covers an area of 323ha (19.3%).

### (3) Class-IIe,s

This class is distributed in the surrounding Las Auyamas and both sides of the Arroyo Pantuflas and covers an area of 195ha (11.6%) . This class has some troubles of erosion and soil fertility and includes a little amount of gravel.

### (4) Class-IIIe

This class is distributed in the south of Loma El Penon and covers an area of 111ha (6.6%). This class is distributed at approximately 1,240m above the sea level. Soil erosion is possible in this class.

(5) Class-IIIs,w

This class is distributed in the south east of the Valley and in front of Colonia Hungaro and covers an area of 227ha (13.2%). Groundwater level is high. Soil is heavy clay. Drainage is necessary.

(6) Class-IIIe,s

The distribution of this class is at El Cercado and El Arenoso, west of the Valley and on the slope of mountain surrounding La Sabina area. High gravel content is found especially in these areas. Soil fertility is low. There are rooms for improvement of land and labor productivity. Area of this class in the study area is 297ha(17.7%).

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# ANNEX F: AGRICULTURE


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# ANNEX F: AGRICULTURE

## 1. Land Use and Land Tenure

Land use was analyzed using the topographical map of 1989 after the reconnaissance, and land tenure was grasped using the existing data for understanding the present land use and its tenure.

### 1.1 Land Use

The arable land occupies about 79% of the study area. Horticulture under structure includes growing of ornamental plants and flowers like chrysanthemum, rose, carnation, etc. Fruit trees such as apple and grapes are grown in some orchards. The breeding stock farm raises about 52,000 chicks. The present land use is shown in the following table.

Table 1.1.1-1 Present Land Use

| Land utilization | Area (ha) | Ratio (%) |
|---|---|---|
| Arable land | 1,680 | 78.6 |
| Uplands crops | (1,625) | (96.7) |
| Horticulture under structure | (30) | (1.8) |
| Orchard | (5) | (0.3) |
| Breeding stock farm | (20) | (1.2) |
| Sub-total | 1,680 | 100.0 |
| Forest | 140 | 6.5 |
| City and residential area | 150 | 7.0 |
| Aerodrome | 20 | 0.9 |
| Others including roads, rivers, etc. | 150 | 7.0 |
| Total | 2,140 | 100.0 |

### 1.2 Land Tenure

The number of farmers with the land holding size of less than 1ha is about 60% of the total farmers and medium and small scale farmers below 5ha is the exceeding majority occupying 90% of the total farmers in the study area.

The number of farmers of each type in the study area is shown in Table 1.2.1-1.

Table 1.2.1-1 Area of Each Type of Farming

| Land holding size (ha) | No. of farmers | Ratio (%) |
|---|---|---|
| less than 1 | 1,197 | 60.18 |
| 1-5 | 586 | 29.46 |
| 5-10 | 131 | 6.59 |
| 10-20 | 38 | 1.91 |
| more than 320 | 37 | 1.86 |
| Total | 1,989 | 100.0 |

Source: Estudíos Integrados de Recursos Naturales de la Cuenca del Río Grande o del Medio, SEA, Sep. 1988.

On the other hand, the number of farmers of each type was investigated by SEA Constanza as shown in Table 1.2.1-2. The tendency of land holding size of farmers is similar to the one by the study team.

Table 1.2.1-2 Number of Farmers According to Land Holding Size

| Land holding size (ha) | No. of farmers | Ratio (%) |
|---|---|---|
| less than 1.25 | 428 | 64.36 |
| 1.25-2.50 | 118 | 17.74 |
| 2.50-3.75 | 47 | 7.07 |
| 3.75-5.00 | 26 | 3.91 |
| 5.00-6.25 | 17 | 2.56 |
| 6.25-12.50 | 23 | 3.46 |
| more than 12.50 | 6 | 0.90 |
| Total | 665 | 100.0 |

Total number of farm lands: 1,077ha

Source: Investigation by SEA, 1986/87

Type of land ownership is shown below:

Table 1.2.1-3 Type of Land Ownership

| Type | No. of agricultural lands | Ratio (%) |
|---|---|---|
| Property with title | 703 | 23.82 |
| Inherited property | 621 | 21.04 |
| Other forms of property | 926 | 31.38 |
| Leased land with cash | 192 | 6.51 |
| Leased land with products | 152 | 5.15 |
| Leased land in other forms | 57 | 1.93 |
| Others | 300 | 10.17 |
| Total | 2,951 | 100.00 |

Note: Estudios Integrados de Recursos Naturales de la Cuenca del Río Grande o del Medio, SEA, Sep. 1988.

## 2. General Description of Agriculture

In Constanza, the climate is warm with medium rainfall, and mainly vegetable farming is practised utilizing natural precipitation or irrigation water. The following crops were observed in the Valley during the study.

Vegetables:

Garlic, Potato, Onion, Kidney bean,
Lettuce, Carrot, Beat, Celery, Cabbage,
Cauliflower, Broccoli,
Radish, Capsicum, Tomato, Parsely,
Garden pea, Zuquini, Pigeon pea,
Squash, coriander, Zayote, Egg plant,
Asparagus

Food Crops:

Cassava, Maize, Sweet potato, Yautía, Rábano

Fruits:

Apple, Grape, Banana, Orange, Avocado,
Guava, Loguat, Plum, Strawberry, Zapote,
Pecan, Persimon

Flowers:

Chrysanthemum, Rose, Carnation, Statis,
Strelichea, Margalet

Beans are used here as fully riped seeds instead of young bean with the pod. Most of the crops are grown for commercial purpose, and Garlic occupies the major part of cropping in winter season. With the garlic at the center of cropping, potato, onion, carrot, lettuce and/or beet are combined in a crop rotation throughout the year. A farm land is not usually fallowed without a particular reason.

Apart from vegetable growing, 7 farms are growing flowers in a big scale. They grow mainly chrysanthemum, rose and carnation almost totally under vinyl houses.

At present fruit production is small comparing with vegetable and flower growing, and some people have just started to grow apple and grape as trial cultivation.

By the hearing survey of farmers by the study team, it has been revealed that they are more interested in growing garlic, potato, onion and/or lettuce than introducing new crops.

Harvested vegetables are marketed largely to the capital, Santo Domingo and the second largest city, Santiago through the middle men. Garlic and onion are sold to middle men when the prices hike after stored dry in warehouses, but potato, carrot and lettuce are sold as green crops in some cases.

Animal raising in the Valley is also small. Farmers keep chickens and a few pigs around their houses. A few farmers in the Valley keep cattle and horses on the slope of mountains. Farmers keeping animals in the Valley are only 42%, which was revealed from the above mentioned hearing survey. There is an exception of a private firm behind Colonia Húngaro which runs a breeding farm of chickens raising 52,000 chicks and distributing them throughout the country. Edible eggs are not at all produced by the firm. Poultry manure of the farm contributes a lot to supply organic fertilizer to the Valley.

As mentioned above, farming in the Valley is intensive with conventional root crops (garlic, potato, onion, beet, etc.) mixed with pulses (kidney bean, pigeon pea, etc.), employing many casual workers and using chemical fertilizers and pesticides.

## 3. Agricultural Productivity

Irrigation is done predominantly by sprinklers, followed by surface irrigation. Flower growers use dripping and mist for growing seedlings. Water is particularly required in the dry season from January to March, and July when potato needs water at most.

In the Valley pests and diseases cause heavy damages on crops. It is possible that the yield of crops will be reduced drastically if proper countermeasures are not taken. Farmers usually spray pesticides once a week, and whenever it rains, they apply a pesticide after the rain. The conditions such as warm temperature through out the year, repetition of same cropping patterns, and cropping in succession of the same family crop, have proliferating pests and diseases more and more. And continuous application of pesticides reduces the immunization effect of pesticides on pests and diseases, and thus the situation becomes still worse.

Snow pea pods which earned the most once in the past in the Valley, were banned by U.S.A. because of pesticide residues, and snow pea growing has almost been adandoned. Exposed pesticides were methamidophos, profenos and monocrotophos.

There are pests and diseases parasiting on various crops and causing heavy damages, such as soil borne diseases, nematoda, mites, mosca blanca and thrips palmi. On the other hand, there are pests and diseases parasiting on the particular crop and giving serious damages, such as moho blanco on garlic and onion, and minador on potato.

In the above situation, irrigation water and the proper countermeasures against pests and diseases are thought to be the keys to increase the crop production in the Valley.

## 3.1 Crops and Crop Production

Principal crops in the Valley are garlic, potato, kidney bean, and onion. In 1987, garlic was grown by 51.4% of farmers, potato by 31.0%, kidney bean by 37.6%, onion by 15.5%, lettuce by 25.4% and carrot by 19.4% (Table 3.1.1-1). As of the planting area of those crops in 1986/87 21.5% of gross total area was with potato, 20.3% with garlic, 16.6% with kidney bean and 13.4% with onion (Table 3.1.1-2). The output of important crops in 1988 was recorded as 101,200qq. (4,655t) of garlic, 525,517qq. (24,174t) of potato, 14,221qq. (654t) of kidney bean, 151,515qq. (6,970t) of onion and 64,464qq. (2,965t) of lettuce (Table 3.1.1-3).

The trend of the principal crop production in the past 10 years is that kidney bean remains on the same level, garlic and onion show gradual increase, and potato and lettuce mark rapid increase (Fig. 3.1.1-1). Though snow pea pod was one of the main crops, its production got down suddenly because of banning of its import by U.S.A. due to pesticide residue problems.

Comparison of the unit yield of the principal crops with that of Japan is shown below, and in the future their yield may be improved, marking onion at the most.

| Crops | Constanza | Japan | Ratio (Constanza/Japan) |
|---|---|---|---|
| Garlic | 5.888 t/ha | 10.366 t/ha | 0.57 |
| Potato | 18.400 | 31.020 | 0.59 |
| Kidney bean | 1.104 | 1.740 | 0.63 |
| Onion | 11.040 | 44.456 | 0.25 |

Other than the principal crops, cabbage, cauliflower, broccoli, capsicum, tomato, and coriander are grown in the Valley for commercial purpose, and parsely, asparagus, zuquini, celery, raddish etc. are also planted for particular customers, and their growing is successful although the output is only a small quantity.

Most of the flowers are grown under vinyl houses in total area of about 434 tareas (27ha) run by 7 farmers. Chrysanthemum, rose and carnation are dominantly grown throughout a year, though their target dates of marketing are Dia de los muertos, Christmas, Valentine Day, Easter and Mother's Day. Chrysanthemum is grown under electric lights. Most of the outputs are sold to domestic markets with an exception of Dominican-Israelis joint firm growing rose soley aiming at the U.S.A. market. The firm is constructing a 1.6ha of vinyl house. Regarding fruit growing, apple and grapes are under trials in the Valley, and their production is small.

Table 3.1.1-1 Important Crops Grown by Farmers in 1987

| Crops | Gross Famers | Rate (%) | Rate of producers (%) | As a principal crop | Rate (%) |
|---|---|---|---|---|---|
| Garlic | 1,002 | 23.8 | 51.4 | 795 | 40.8 |
| Potato | 605 | 14.4 | 31.0 | 244 | 12.5 |
| Kidney Bean | 733 | 17.4 | 37.6 | 205 | 10.5 |
| Carrot | 378 | 9.0 | 19.4 | 171 | 8.8 |
| Onion | 303 | 7.2 | 15.5 | 151 | 7.8 |
| Lettuce | 494 | 11.8 | 25.4 | 132 | 6.8 |
| Celery | 249 | 5.9 | 12.8 | 116 | 6.0 |
| Beet | 285 | 6.8 | 14.6 | 75 | 3.9 |
| Snow Pea | 156 | 3.7 | 8.0 | 60 | 3.1 |
| Total | 4,205 | 100.0 | 215.7 | 1,949 | 100.0 |

Source: Estudios Integrados de Recursos Naturales de la cuenca del Rio Grande o del Medio, SEA, Sep. 1988

Table 3.1.1-2 Planted Area with Principal Crops in Constanza

| Crops | Area (ha) | Percent (%) |
|---|---|---|
| Potato | 438 | 21.5 |
| Garlic | 414 | 20.3 |
| Kidney bean | 338 | 16.6 |
| Onion | 273 | 13.4 |
| Maize | 112 | 5.5 |
| Garden pea | 111 | 5.4 |
| Beet | 85 | 4.2 |
| Other Vegetables | 119 | 3.3 |
| Carrot | 60 | 2.9 |
| Lettuce | 43 | 2.1 |
| Cabbage | 36 | 1.8 |
| Tomato | 16 | 0.8 |
| Sweet potato | 16 | 0.8 |
| Cassava | 14 | 0.7 |
| Capsicum | 6 | 0.3 |
| Others | 9 | 0.4 |
| Total | 2,090 | 100.0 |

Note : Farmers investigated were 665

Source : Investigation by SEA, 1986/87

Table 3.1.1-3 Annual Production of Principal Crops in Constanza for the Past 10 Years

Unit : ton

| Crops | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | *1989 | Total | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Garlic | 3.242 | 3.295 | 2.878 | 3.331 | 6.128 | 4.707 | 4.530 | 8.402 | 4.655 | 4.758 | 45.926 | 4.593 |
| Potato | 5.157 | 5.769 | 4.651 | 16.922 | 7.367 | 8.242 | 6.847 | 15.935 | 24.174 | 38.413 | 133.277 | 13.328 |
| Onion | 3.542 | 4.424 | 3.718 | 743 | 5.060 | 6.320 | 5.312 | 1.061 | 6.970 | 4.544 | 41.694 | 4.169 |
| Kidney bean | 619 | 232 | 430 | 306 | 384 | 332 | 614 | 437 | 854 | 767 | 5.275 | 528 |
| Lettuce | 1.227 | 1.363 | 966 | 845 | 1.753 | 1.947 | 1.380 | 1.207 | 2.965 | 3.476 | 17.129 | 1.713 |
| Total | 13.787 | 15.083 | 12.843 | 22.147 | 21.192 | 21.548 | 18.483 | 27.042 | 39.418 | 51.958 | 243.301 | 24.330 |

Note:*Up to the end of September

Source:URPE, Constanza, SEA, Oct.

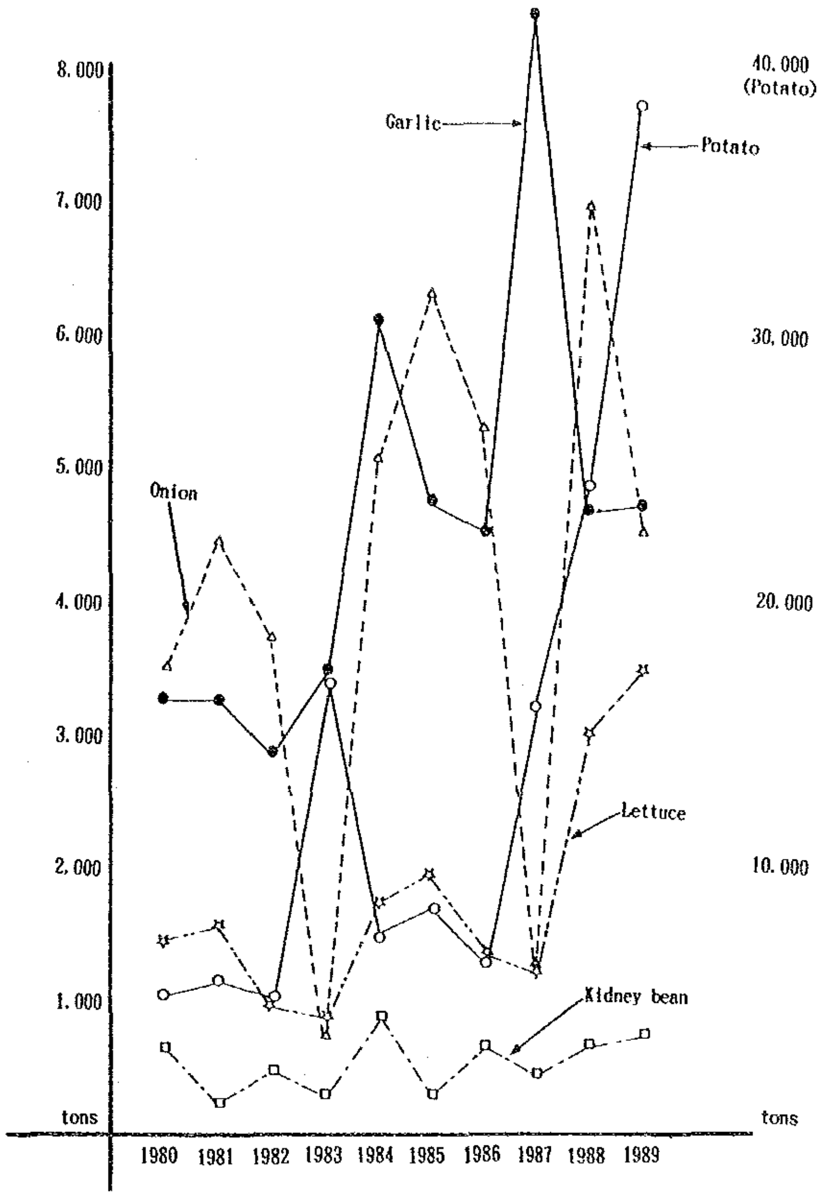



Fig. 3.1.1-1 Changes of Principal Crop Production

Note:The scale at the right side is just for potato production
Source:URPE, Constanza, SEA, Oct. 1989

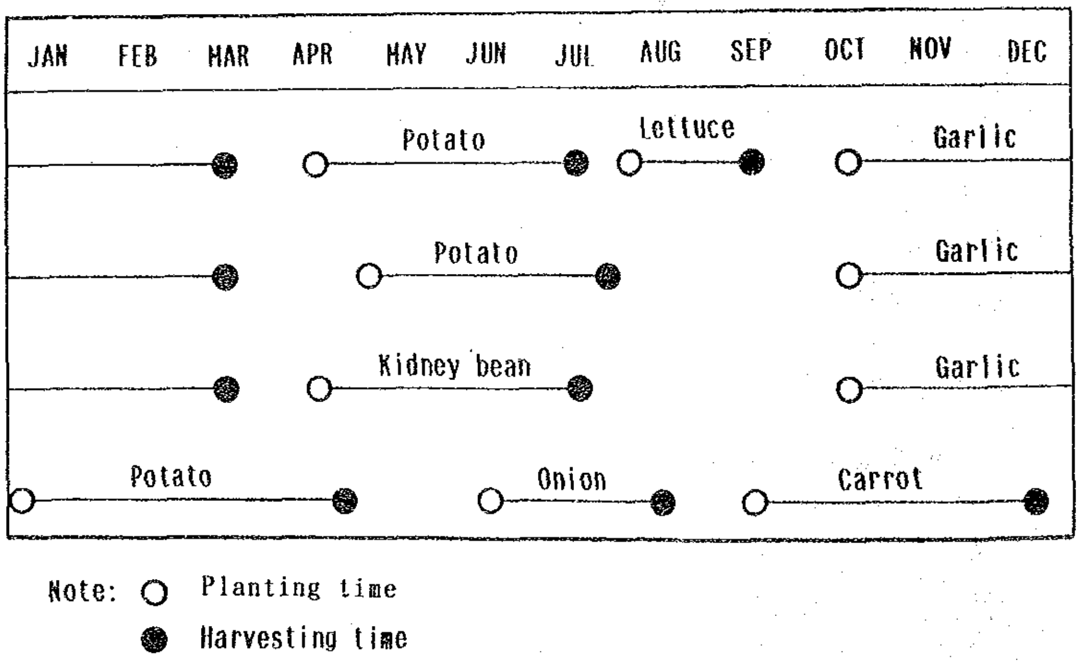
## 3.2 Cropping Pattern

A cropping pattern utilizing low temperatures at the elevation of 1,200m is established centralizing garlic in winter season (Fig. 3.2.1-1). Some typical cropping patterns in the Valley are shown below.

1. Garlic - Potato - Lettuce
2. Garlic - Potato
3. Garlic - Kidney bean
4. Potato - Onion - Carrot

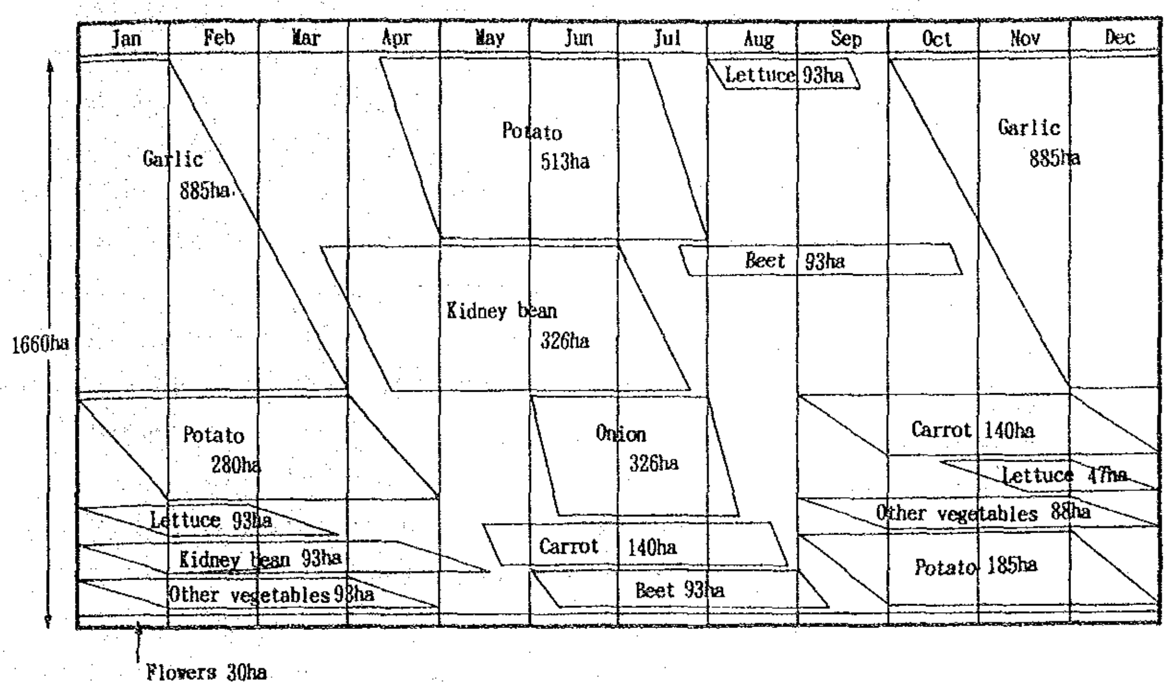
The cropping patterns have been completed with the reason that important crops except garlic may be grown at anytime in a year. The crops other than garlic, viz. carrot, lettuce, potato etc. are grown for the Christmas season. The data collected in Constanza (Table 3.1.1-1 and 2) show that garlic was grown by 51.4% of farmers and in 20.3% of the area to gross acreage of crop. (The figure can be 43.4%, considering 2 to 4 crops on the same farm in a year). Garlic growing may be increased tremendously if there are no problems in acquiring seeds, credit, water, etc.

The cropping patterns including areas are shown in Fig. 3.2.1-2. As for the frequency of cropping per annum by an individual, single cropping was followed by 27.4%, double cropping by 36.3%, tripple cropping by 31.5% and more than quadruple cropping by 4.7% (Table 3.2.1-1). Cropping rate of a farm was about 214%.




From: Investigation by Study Team, Oct. 1989

Fig. 3.2.1-1 Present Cropping Patterns




Source:Prepared by Study Team, Nov. 1989

Fig. 3.2.1-2 Cropping Patterns with Areas

Table 3.2.1-1 Number of Crops per Annum

| No. of Crops/year | Farmers | Percent (%) |
|---|---|---|
| 1 Crop | 545 | 27.4 |
| 2 Crops | 722 | 36.3 |
| 3 Crops | 626 | 31.5 |
| More than 4 crops | 94 | 4.7 |
| Total | 1,987 | 100.0 |

Source : Estudios Integrados de Recursos Naturales de la Cuenca del Rio Grande o del Medio, SEA, Sep. 1988

## 3.3 Cultivation Techniques

### 3.3.1 Garlic

Varieties of garlic are TAIWAN, BLANCO PEGUERO, CACATA, and POYO in Constanza, and the former two varieties are important. There is also a variety called TAIWAN which is not a single variety but a name given to varieties imported from Taiwan, including varieties of FEVA-SANG, SWE-CHA, etc. The variety imported in 1988, however, might be a variety which requires lower temperatures than the nature of the Valley, and caused a heavy damage to garlic growers that some of them did not produce the crop at all or the bulb did not segregate into bulbils, which had no commercial values. Two representatives from an association was delegated to Taiwan in this year, but it seemed that they could not solve the problem. Seeds of TAIWAN are purchased by growers every year. BLANCO PEGUERO takes 6 months to harvest, and is a popular variety in market, because it is a conventional one known to the people. Large scale farmers prefer this variety, and the seeds are produced on their own farms.

The farm is plowed and harrowed by a big tractor and prepared into high ridges. The seeds are planted in 3 lines on a ridge.

Pesticides are applied approximately in the intervals of a week for protection of the crop. Garlic is planted in October and November and harvested in February to April.

Main diseases and pests are Moho Blanco (Sclerotium cepivoram), Mancha púrpura (Alternaria porri), Botritis (Botrytis cinerea), Nematode (Ditylenchus dipsaci), Acaros (Aceria sp., Ryzoglyphus sp.), etc. (Table 3.3.1-1).

Crop protection is done only by pesticides. Control method against Moho Blanco has not been established yet. Pesticides such as Daconil and Antracol are used against Mancha purpura, Botran and copper fungicides against Botrytis, granular Nemacur, Miral or Mocad against nematoda, and Morestan, Hostathion and Methamidophos against mites.

Average output of garlic is 7 to 8qq/ta (5,150-5,900kg/ha), and the harvested garlic is kept drying in warehouses until the price hikes, and then is sold to middle men after packing it in red net sacks.

Table 3.3.1-1 Diseases and Pests on Garlic and Onion

| Diseases (Scientific name shows pathogen) | |
|---|---|
| Scientific name | Vernacular name |
| Sclerotium cepivorum | Moho Blanco |
| Alternania porri | Mancha Purpura |
| Botrytis cinerea | Botritis |
| Botrytis alli | |
| Peronospora destructer | Mildiu del Rayado |
| Virus | Virus del rayado |
| Pests | |
| Thrips tabaci | Tripido de la Cebolla |
| Thrips palmi | Tripido |
| Liriomyza sp. | Minador del Hoja |
| Rhizoglyphus sp. | Acaro del Ajo |
| Aceria sp. | Eriofido del Ajo |
| Ditylenchus dipsaci | Nematode |
| Spodoptera exigua | Gusano Constanzero |

### 3.3.2 Potato

Varieties of potato are GRANOLA, RED PONTIAC, QUEBEC, REO LA SODA, etc. Major variety in the Valley is GRANOLA which is yellow in colour. The variety was imported from Germany, propagated in the original seed farm, and the third generation seeds are sold to growers from SEA. Though the best growing season for potato is from January to April, it is grown more in other seasons since it may be grown in any of the seasons of the year. Its growing period is about 3 months. The land is prepared into high ridges. Major diseases and pests are Tizon tardio (Phythophtora infestans), Tizon templano (Alternaria solani), Pata Prieta (Erwinia carotovora), Minador (Phthorimaea opereulells), Gusano de hoja (Spodoptera sp.), etc. (Table 3.3.2-1). Among them, Minador causes the heaviest damage.

As control methods, Antracol, Daconil, Dithane M-45 and copper fungicides are used to prevent Tizon tardio and Tizon templano, a resistant variety against Pata Prieta, Tornade and Tivisect against Minador, and Lannate, Dipel or Loraban against Gusano de la hoja.

Output is about 25qq/ta (18,400kg/ha), and the produce is sold directly to a middle man at the farm, packing them in white sacks.

## Table 3.3.2-1 Diseases and Pests on Potato

1. Diseases (Scientific name shows pathogen)

| Scientific name | Vernacular name |
|---|---|
| Phytophthora infestans | Tizon Tardio |
| Alternaria solani | Tizon Temprano |
| Erwinia carotovora | Pata Prieta |
| Rhizoctonia solani | Podredumbre del Cuello |
| Streptomyces scabies | Roña |
| Fusarium solani | Marchitamiento |
| Sclerotium rolfsii | Podrdumbre del Cuello |
| Nigrospora sp. | Mancha foliar |
| Macrophomina sp. | Mancha foliar |
| Virus | Virosis |

2. Pests

| | |
|---|---|
| Phthorimae opereulells | Minador |
| Spodoptera exigua | Gusano de la Hoja |
| Eliotys sp. | Gusano de la Hoja |
| Agrotis subterranes | Gusano Cortdor |
| Trialeurodes vaporarorium | Mosca Blanca |
| Trichoplusia ni | Gusano Medidor |
| Prodenia sp. | Gusano Mantequilla |
| Aeolus sp. | Gusano alambre |
| Macrosiphum euphorbiae | Afido de papa |
| Myzus persicae | Melaito del Tabaco |
| Rhopalosiphum rufiabdominalis | Afido de la raiz |
| Empoasca fabae | - |
| Liriomyza sp. | Minador de la Hoja |

### 3.3.3 Kidney bean

Varieties of kidney bean are CONSTANZA I, CONSTANZA II, POMPA-DOUR CHECA, GIRA, BRASILENA and JOSE BETA, and the preceding 4 varieties are dominant in the Valley. CONSTANZA strains produce white long seeds and POMPADOUR CHECA the short ones. People here utilize only matured seeds instead of green pod beans. Kidney bean may be grown in any season throughout a year, and farmers grow it mainly from June to September.

Main diseases and pests are Roya (Uromyces sp), Moho (Sclerotium rolfsii), Marchitez (Fusarium oxysporum), Mosca Blanca (Trialeurodes vaporarorium), Trips (Thrips palmi), Cortadores (Agrotis sp), and Mosca Blanca causes the biggest damage among them (Table 3.3.3-1).

As control measures, Mancozeb, Dithane M-45 and copper fungicides are sprayed against Moho and Fusarium and Lannate, Selecron and Patrol against insects.

The kidney bean can be harvested 3 months after seeding. It is harvested with a hush and separated by hitting in the farm or near warehouse. The output is about 1,100kg/ha.

### 3.3.4 Onion

The variety of onion grown in the Valley is only RED CREOLE of red bulb. There are two types of growing. One is sowing seeds in November to December, and harvesting in May. The other type is transplanting seedling with small bulbs purchased from Baní lying at the lower altitude in June to July and harvesting in August to September. Pests and diseases, and their countermeasures are same as the garlic (Table 3.3.1-1). Yield is about 15qq/ta (1,100kg/ha). The harvest is either sold directly to a middle man or kept drying on the wooden shelves in a warehouse, and sold to a middle man when the price hikes. Bulbs are generally small.

Table 3.3.3-1 Diseases and Pests on Kidney bean

1. Diseases (Scientific name shows pathogen)

| Scientific name | Vernacular name |
|---|---|
| Uromyces phaseoli | Roya |
| Fusarium oxysporum | Marchitez |
| Sclerotium rolfsii | Moho |
| Colletotrichum lindemuthianum | Antracnosis |
| Isariopsis griseola | Mancha Angular |
| Cercospora canescens | Mancha Foliar |
| Phyllosticta phaseolina | Mancha Foliar |
| Erysiphe poligony | Mildiu Polvoriento |
| Xanthomonas phaseoli | Tizon Bacteriano |
| Pseudomonas phaseolicola | Tizon Bacteriano |
| Phoma sp. | Phomasis |

2. Pests

| | |
|---|---|
| Trialeurodes vaporarorium | Mosca Blanca |
| Thrips palmi | Tripido |
| Agrotis sp. | Gusano Cortador |
| Trichopulsia ni | Gusano medidor |
| Autopulsia egenea | - |
| Hedylecta indicata | - |
| Elasmopalpus lignosellus | - |
| Systena basalis | - |
| Diabrotica balteata | - |
| Liorimyza sp. | Minador de la Hoja |
| Myzus persicae | Melaito del Tabaco |
| Empoasca fabae | - |
| Thrips tabaci | Tripido |

## 4. Agricultural Management

### 4.1 General

The report of SEA in 1986/87 describes that small scale farmers with the land holding size of less than 20 tareas (1.25ha) occupy 64.4%, and the "Estudios Integrados de Recursos Naturales de la Cuenca del Río Grade o del Medio" from SEA 1988 reports that the number of small scale farmers with less than 16 tareas (1ha) are 60.18% of the total farmers. According to the investigation by the study team, the average number of members and those engaged in farming in a farmer's family are 6.64 persons and 2.22 persons respectively. 71.6% of farmers employ laborers in some way or other (Table 4.1.1-1), and all the farmers with the land holding of larger than medium scale size run their farms with employed labors. Only 3.7% of farmers, however, employ permanent labors. Casual laborers receive RD$20 to 40 per day according to the type of work. 75.2% of the farmers use a tractor and 73.4% of them utilize an animal-drawn plow (Table 4.1.1-2). Though farmers do not possess a tractor, they borrow it from an agricultural association or hire it. It is made clear that the Valley is spread seriously with pests and diseases by the fact that 92.7% of the farmers use sprayers. And farmers in the Valley use various pesticides as shown in Table 4.1.1-3, 4, 5 and 6. In 1989, it was recorded that 190 ton of fungicides and 230,000 l of insecticides were consumed in Constanza, and among this 150 ton of fungicides was Dithane and 150,000 l of insecticides was methamidophos. It was said that pesticide consumption increased by 15-20% every year. And the pesticide cost per tarea shows an increase of 2.1 to 3.33 times in 1989 compared to that of 1987 (Table 4.1.1-7). In the other inputs, it is striking that users of chemical fertilizers are 91.7% against 15.6% of organic matters (Table 4.1.1-2). Organic fertilizers utilized in the Valley are rotten baggages, poultry manure, etc.

The prices of agricultural inputs are shown in Table 4.1.1-8. Farmers purchase most of the agricultural implements and inputs such as agricultural machines, sprayers, fertilizers, pesticides, seeds, etc. from retail shops. Exceptionally they buy seeds of garlic, TAIWAN variety and potato from SEA. Agricultural production materials are not at all dealt by the farmers' associations. Vinyl sheets and steel frames for the facility of flower growing are imported from Israel.

Production cost of principal crops in 1989 investigated by Banco Agricola is shown below and the details are shown in Tables 4.1.1-9, 10, 11, 12 and 13. The details reveal that seed and labor costs are high for each crop.

Production Cost of Principal Crops

| Crop | Cost per ta | Cost per ha |
|---|---|---|
| Garlic | 2,759.72 | 44,156 |
| Potato | 1,073.06 | 17,169 |
| Kidney bean | 269.75 | 4,316 |
| Onion | 1,390.52 | 22,248 |

Average net incomes of principal crops, and lettuce, carrot and beet which are grown largely are calculated below. Average gross incomes are calculated by multiplying the average yield per ta (SEA, Constanza) and prices at farm at the time of study (Table 4.1.1-14). Average net incomes are produced deducting the above costs from the gross incomes.

| Crops | Average yield<br>A<br>qq/ta | Price<br>B<br>pesos/qq | Gross income<br>C=AXB<br>pesos/qq | Cost<br>D<br>Pesos/ta | Net income<br>E=C-D<br>pesos/ta |
|---|---|---|---|---|---|
| Garlic | 8 | 850 | 6,800 | 2,759.72 | 4,040.28 |
| Potato | 25 | 70 | 1,750 | 1,073.06 | 676.94 |
| Kidney bean | 1.5 | 400 | 600 | 269.75 | 330.25 |
| Onion | 15 | 100 | 1,500 | 1,390.52 | 109.48 |
| Lettuce | 27 | 25 | 675 | 633.54 | 41.46 |
| Carrot | 22.5 | 80 | 1,800 | 725.77 | 1,074.23 |
| Beet | 35 | 35 | 1,225 | 581.18 | 643.82 |

A conclusion on incomes can not be made simply because the prices fluctuate, yields are not constant and the growing periods are not the same, however profit of garlic per tarea is very prominent.

As per the farmer's investigation, 10 out of 50 farmers declared deficit of farming because of no yield of garlic, potato and onion. Particulary last year, it is thought that improper garlic seeds caused the deficit for 20% of the farmers. Non-agricultural income was recorded just by a farmer.

The investigation was carried out dividing the Valley into 10 sections. Comparing the output of principal crops per tarea, particularly the output of garlic which is the most affected by lacking of water from January to March is about 60% in the sections, El Cercado, Arenoso, Colonia Kennedy, Colonia Española and Arroyo Arriba where irrigation water is not enough (Table 4.1.1-15). Average income of a farmer in each section is written below. It reveals that the farmers at Arenoso where there are many small scale farmers and water is not enough and the neighboring sections, Las Auyamas and El Cercado earn less than the farmers of the other sections except Palero.

Average Individual Income per Annum in Each Section

| Section | Average Income (RD$) | Order |
|---|---|---|
| El Cercado | 180,801 | 7 |
| Arenoso | 99,944 | 10 |
| Las Auyamas | 101,863 | 9 |
| El Valle | 334,985 | 4 |
| Sabina | 349,293 | 3 |
| Palero | 152,284 | 8 |
| Cañada Seca | 440,117 | 2 |
| Col. Kennedy | 550,893 | 1 |
| Col. Espanola | 215,890 | 6 |
| Arroyo Arriba | 309,036 | 5 |

Source: Investigation by JICA Study Team, Oct. 1989.

Table 4.1.1-1 Characteristics of Agricultural Labor Force

| Characteristics | Rate (%) |
|---|---|
| With employed labour | 71.6 |
| Combined with family and employed labour | 47.7 |
| Predominantly with family labour | 13.8 |
| Predominantly with employed labour | 33.9 |
| Only with employed labour | 23.9 |
| Only with family labour | 28.4 |
| With permanent labour | 3.7 |
| Permanent family labour | 63.3 |
| With temporary employed labour | 69.7 |
| With temporary family member | 19.3 |

Source: Estudios Integrados de Recursos Naturales de la Cuenca del Rio Grande o del Medio, SEA, Sep 1988

Table 4.1.1-2 Utilization of Machines, Implements and Agricultural Inputs

| Indication | Percent(%) |
|---|---|
| Use of Machines and Implements | |
| Tractor | 75.2 |
| Animal-drawn plow | 73.4 |
| Sprayer | 92.9 |
| Speed sprayer | 61.5 |
| Water pump | 33.0 |
| Cultivator | 11.9 |
| Duster | 11.0 |
| Seeder | 1.8 |
| Grass mower | 3.7 |
| Smasher | 0.8 |
| Agricultural Inputs | |
| Improved Seeds | 57.8 |
| Chemical fertilizers | 91.7 |
| Organic fertilizers | 15.6 |
| Herbicides | 81.7 |
| Pesticides | 89.0 |

Source: Estudios Integrados de Recursos Naturales de la Cuenca del Rio Grande o del Medio, SEA, Sep. 1988

Table 4.1.1-3 List of Fungicides Used in the Valley

| No. | Commercial Name | Common Name | Manufacturer |
|---|---|---|---|
| 01 | AFUGAN | pyrazophos | HOECHST |
| 02 | AKZO MANOZEB | mancozeb | |
| 03 | ANTRACOL | propineb | BAYER |
| 04 | ANTROLOROTA | | |
| 05 | BAYFIDAN | triadimenol | BAYER |
| 06 | BAYLETON | triadimefon | BAYER |
| 07 | BEAUDORX | copper | |
| 08 | BENCARB | bencimidazoles | OSA |
| 09 | BENLATE | benomyl | DUPONT |
| 10 | BONDOLE | | |
| 11 | BOTRAN | | |
| 12 | BRESTAN | fentin acetate | HOECHST |
| 13 | CAPTAFOL | | |
| 14 | CAPTAN | captan | CALIFORNIA CHEM |
| 15 | COMOLO | | |
| 16 | CUPRAVIT | basic copper chloride | BAYER |
| 17 | CUPROSAN | copper | |
| 18 | DACONIL | TPN chlorothalonil | DIAMOND SHAMROCK |
| 19 | DEROSAL | | HOECHST |
| 20 | DETHANE | zineb | |
| 21 | DITHANE | zineb | |
| 22 | DITHANE M-45 | maneb | LOAM & HEARTH |
| 23 | DYRENE | anilazine | |
| 24 | FLONEX | mancozeb | AGRO FARM |
| 25 | FUNGITANE | mancozeb | SHELL |
| 26 | KARATHANE | DPC dinocup | LOAM & HEARTH |
| 27 | KOCIDE | copper hydroxide | |
| 28 | KUMULUS | | |
| 29 | MANEX | maneb | GRIFFIN |
| 30 | MANSICOR | | |
| 31 | MANZATE | | |
| 32 | MANZICARB | maneb | |
| 33 | NEMISPOR | mancozeb | MONTEDISON |
| 34 | ORETAN | | |
| 35 | PENTACLOR | PCNB quintozene | AGRO FARM |
| 36 | POLIRAM COMBI | | |
| 37 | RHODAX | fosetil+mancozeb | PHONE-POUENC |
| 38 | RIDOMIL | metalaxyl | |
| 39 | RONILAN | vinclozolin | BASF |
| 40 | RONISTAN | | |
| 41 | SANDOFAN | mancozeb+oxadixyl | SANDOZ |
| 42 | TITANE | | |
| 43 | VENCEDOR | azufure | QUIMICA |
| 44 | VITIGRAN | | HOECHST |
| 45 | VONDOZEB | mancozeb | |

## Table 4.1.1-4 List of Insecticides Used in the Valley

| No. | Commercial Name | Common Name | Manufacturer |
|---|---|---|---|
| 01 | ACRICID | binapcryl | HOECHST |
| 02 | AMBUS | | |
| 03 | AZOMARK | | SHELL |
| 04 | BAYTROID | cyflutrin | BAYER |
| 05 | CITROLANE | | |
| 06 | CYMBUSH | | ICI |
| 07 | DECIS | | HOECHST |
| 08 | DIAZINON | diazinon | CIBA-GEIGY |
| 09 | DICROMARK | phosphoric | SHELL |
| 10 | DIMECRON | phosphoric | CIBA-GEIGY |
| 11 | DIPEL | BT Bacillus thuringiensis | IMC |
| 12 | DIPTEREX | DEP trichlorphon | BAYER |
| 13 | EVICE | | |
| 14 | FAS-TAC | | |
| 15 | FOLIDOL | parathion | |
| 16 | HOSTHATHION | triazophos | HOECHST |
| 17 | JUPITOR | | |
| 18 | KENOPHOS | | |
| 19 | KEVOPLOX | | |
| 20 | KILVAL | vamidathion | RHONE POULENC |
| 21 | KINOBAN | | |
| 22 | LANNATE | methomyl | DUPONT |
| 23 | LORSBAN | | |
| 24 | LORVA | | |
| 25 | MALATHION | malathion | AMERICAN CYANAMID |
| 26 | MAVRIK | fluvalinate | ZOECON INT'L |
| 27 | METAMIDOFAN | | |
| 28 | MITAC | amitraz | SCHERING |
| 29 | MOGAP | | HOECHST |
| 30 | MONITOR | methamidophos | |
| 31 | MORESTAN | quinomethionate | |
| 32 | MTD | methamidophos | |
| 33 | NEMACUR | organo phosphoric | BAYER |
| 34 | NODAH | | |
| 35 | NUDRIN | methomyl | SHELL |
| 36 | NUVACRON | | CIBA-GEIGY |
| 37 | OCTATHION | | |
| 38 | OTTALION | | |
| 39 | PATROL | methamidophos | OSA |
| 40 | PAY-OFF | | CYANAMID |
| 41 | PENCAP | | |
| 42 | POUNCE | | |
| 43 | SELECTRON | | CIBA-GEIGY |
| 44 | SHERPA | | |
| 45 | SISTEMIN | | HOECHST |
| 46 | SOLVIREX | | SANDOZ |
| 47 | SUMITHION | MEP fenitrothion | |
| 48 | TAMARON | methamidophos | BAYER |
| 49 | TAMBO | | CIBA-GEIGY |
| 50 | THIODAN | benzoepin(endosulfan) | HOECHST |
| 51 | THURRECIDE | | |
| 52 | TORNADE | | |
| 53 | TRIGAR | | |
| 54 | TRIMILTOX | | |
| 55 | VOLATON | | BAYER |
| 56 | ZOLONE | benzoxazoline | PHONE POULENC |
| | | acephate | |
| | | permethrine | |

Table 4.1.1-5 List of Herbicides Used in The Valley

| No. | Commercial Name | Common Name | Manufacturer |
|---|---|---|---|
| 01 | AFALON | | |
| 02 | BASAGRAN | bentazon | BASF |
| 03 | DUAL | | |
| 04 | FUSILADE | | ICI |
| 05 | GOAL | | |
| 06 | GRAMOXONE | paraquat | |
| 07 | HERBADOX | | |
| 08 | LOROX | | |
| 09 | NUDOLIN | alaclor & linuron | OSA |
| 10 | PARADON | | |
| 11 | PARAQUAT | paraquat | |
| 12 | ROUNDUP | glyphosate | MONSANTO |
| 13 | RONSTAR | oxadiazon | PHONE POULENC |
| 14 | SENCOR | | |

Table 4.1.1-6 List of Soil Application Pesticides Used in the Valley

| No. | Commercial Name | Common Name | Manufacturer |
|---|---|---|---|
| 01 | DETIA GAS EX-T | fumigant | |
| 02 | MIRAL | | |
| 03 | MOCAP | | |
| 04 | NEMACUR | organo phosphoric | BAYER |
| 05 | RACUMIN POLVO | for rat | |
| 06 | SOLVIREX | | |
| 07 | TEMIK | | |
| 08 | THIODAN | benzoepin | HOECHST |

Table 4.1.1-7 Yearly Changes of Pesticide Cost (including labor)

Unit: RD$/ta

| Crop | 1985 | 1986 | 1987 (Index) | 1988 (Index) | 1989 (Index) |
|---|---|---|---|---|---|
| Garlic | - | - | 89.15 (100) | 167.30 (188) | 239.56 (269) |
| Potato | 70.05 | 80.60 | 80.60 (100) | 149.20 (185) | 268.58 (333) |
| Kidney beam | - | 11.25 | 11.10 (100) | 18.43 (166) | 34.35 (309) |
| Onion | 83.65 | 73.85 | 72.50 (100) | 91.22 (126) | 152.60 (210) |

Source: Costo de Produccion de una tarea, Banco Agricola

Table 4.1.1-8 Prices of Production Materialsat Constanza

| Fertilizers | Unit pesos/quintal |
|---|---|
| Complex 15-15-15 | 72 |
| Complex 15-15 | 69 |
| Complex 8-10-14 | 55 |
| Complex 12-24-12 | 75 |
| Complex 6-6 | 42 |
| Urea | 87 |
| Ammonium Sulfate | 45 |
| Slaked lime | 15 |
| **Foliar Fertilizers** | |
| Complesal Fluid (9-9-7) | RD$ 20／ℓ |
| Maricol (N.P.K.Mg.Mn.Bo.Zn.Cu.Co) | 25／kg |
| Mortal ( -do- ) | 25／kg |
| Microzit (Fe.Mg.Mn.Bo.Zn.Cu.Mo.Ni.Co) | 12／50g |
| **Pesticides** | |
| Antracol 70wp | RD$ 36／kg |
| Nemispor 80wp | 25／kg |
| Brestan 10 | 190／kg |
| fungitane | 34／kg |
| Dithane M-45 | 29／kg |
| vondozeb | 23／kg |
| Tamaron 600SL | 70／ℓ |
| Folidol M480EC | 47／ℓ |
| Hostathion 40EC | 138／ℓ |
| Nudrin | 30／1/4 lb |
| Selecron 500EC | 130／ℓ |
| Patrol | 70／ℓ |
| Fusilade | 185／ℓ |
| Nudolin | 100／ℓ |
| Round up | 125／ℓ |
| Ronstar | 135／ℓ |
| Mocap 10G | 390／25kg |
| **Fuel** | |
| Gasoline | 6.03／gallon |
| Gasoil | 2.93／gallon |
| Electricity | 0.75／kw |
| **Irrigation water** | 896／ha／year |

Source:Information from Retail Shops in Constanza, Study Team, Oct. 1989

Table 4.1.1-9 Production Cost of Garlic, 1989

| Activities | Unit | Quantity | Unit Price | Cost/ta RD$ | Cost/ha RD$ |
|---|---|---|---|---|---|
| I stage | | | | | |
| Purchase of bulbils | qq | 1 | 1,410.00 | 1,410.00 | 22,560 |
| Land preparation | ta | 1 | 36.00 | 36.00 | 576 |
| Nematicides | lb | 4 | 10.00 | 40.00 | 640 |
| Application of insecticides | ta | 1 | 2.00 | 2.00 | 32 |
| Ridging | ta | 1 | 5.80 | 5.80 | 93 |
| Fertilizer (N-P-K) | qq | 2 | 72.70 | 144.20 | 2,307 |
| Application of fertilizers | ta | 1 | 6.00 | 6.00 | 96 |
| Preparation, selection and disinfection of bulbils | ta | 1 | 27.40 | 27.40 | 438 |
| Planting | ta | 1 | 130.00 | 130.00 | 2,080 |
| Herbicides | l | 0.15 | 89.00 | 13.35 | 214 |
| Application of herbicides | ta | 1 | 5.66 | 5.66 | 90 |
| II stage | | | | | |
| Irrigation water | ta | 1 | 3.50 | 3.50 | 56 |
| Irrigation | ta | 1 | 114.04 | 114.04 | 1,825 |
| Intertillage and weeding | ta | 1 | 131.50 | 131.50 | 2,104 |
| Systemic insecticides | l | 0.30 | 122.00 | 36.60 | 586 |
| Contact insecticides | l | 0.60 | 74.00 | 44.40 | 710 |
| Fungicides | lb | 3.50 | 14.90 | 52.15 | 834 |
| Application of pesticides | ta | 1 | 47.10 | 47.10 | 754 |
| III stage | | | | | |
| Harvesting, preparation and storing | qq | 8 | 20.20 | 161.60 | 2,586 |
| Sub-total | | | | 2,411.30 | 38,581 |
| Miscellaneous (5%) | | | | 120.50 | 1,929 |
| Financial charges (18% annual) | | | | 227.86 | 3,646 |
| TOTAL | | | | 2,759.72 | 44,156 |
| Summary of Input | | | | | |
| 1. Fertilizers | qq | 2 | | 144.20 | 2,307 |
| 2. Herbicides | l | 0.10 | | 13.35 | 214 |
| 3. Nematicides | lb | 4 | | 40.00 | 640 |
| 4. Insecticides | l | 0.9 | | 81.00 | 1,296 |
| 5. Fungicides | lb | 3.5 | | 52.15 | 834 |
| 6. Labor | | | | 631.10 | 10,098 |
| 7. Lease plowing | | | | 36.00 | 576 |
| 8. Bulbils | | | | 1,410.00 | 22,560 |
| 9. Irrigation water | | | | 3.50 | 56 |
| 10. Miscellaneous (5%) | | | | 120.56 | 1,929 |
| 11. Financial (18% annual) charges | | | | 227.86 | 3,646 |
| TOTAL | | | | 2,759.72 | 44,156 |

Source : Banco Agricola, 1989

## Table 4.1.1-10 Production Cost of Potato, 1989

| Activities | Unit | Quantity | Unit Price | Cost/ta RD$ | Cost/ha RD$ |
|---|---|---|---|---|---|
| I stage | | | | | |
| Purchase of seed potato | qq | 2 | 174.00 | 348.00 | 5,568 |
| Land preparation | ta | 1 | 28.60 | 28.60 | 458 |
| Fertilizers (N-P-K) | qq | 1.5 | 74.80 | 112.20 | 1,795 |
| Application of fertilizers | ta | 1 | 3.50 | 3.50 | 56 |
| Cutting & disinfection of seed potato | ta | 1 | 6.00 | 6.00 | 96 |
| Ridging | ta | 1 | 5.00 | 5.00 | 80 |
| Planting | ta | 1 | 22.50 | 22.50 | 360 |
| II stage | | | | | |
| Irrigation water | ta | 1 | 3.61 | 3.61 | 58 |
| Irrigation | ta | 1 | 41.73 | 41.73 | 668 |
| Intertillage and weeding | ta | 1 | 38.25 | 38.25 | 612 |
| Systemic insecticides | l | 0.50 | 160.00 | 80.00 | 1,280 |
| Contact insecticides | l | 0.50 | 181.25 | 90.12 | 1,442 |
| Fungicides | lb | 4 | 14.90 | 59.60 | 954 |
| Sticker | l | 0.20 | 30.80 | 6.16 | 98 |
| Application of pesticides | ta | 1 | 32.70 | 32.70 | 523 |
| III stage | | | | | |
| Harvesting, transportation | qq | 20 | 5.00 | 100.00 | 1,600 |
| Sub-total | | | | 977.97 | 15,648 |
| Miscellaneous (5%) | | | | 48.89 | 782 |
| Financial charges (18% annual) | | | | 46.20 | 739 |
| TOTAL | | | | 1,073.06 | 17,169 |
| Summary of Input | | | | | |
| 1. Fertilizers | qq | 1.5 | | 112.20 | 1,795 |
| 2. Irrigation water | | | | 3.61 | 58 |
| 3. Insecticides | lb | 1.2 | | 176.28 | 2,820 |
| 4. Fungicides | l | 4 | | 59.60 | 954 |
| 5. Labor | | | | 249.68 | 3,995 |
| 6. Lease plowing | | | | 28.60 | 458 |
| 7. Seed potato | qq | 2 | | 348.00 | 5,568 |
| 8. Miscellaneous (5%) | | | | 48.89 | 782 |
| 9. Financial charges (18% annual) | | | | 46.20 | 739 |
| TOTAL | | | | 1,073.06 | 17,169 |

Source : Banco Agricola, 1989

## Table 4.1.1-11 Production Cost of Kidney bean, 1989

| Activities | Unit | Quantity | Unit Price | Cost/ta RD$ | Cost/ha RD$ |
|---|---|---|---|---|---|
| I stage | | | | | |
| Purchase of seed | qq | 0.12 | 254.50 | 30.54 | 489 |
| Land preparation | ta | 1 | 34.00 | 34.00 | 544 |
| Fertilizers (N-P-K) | qq | 0.50 | 72.55 | 36.27 | 580 |
| Application of fertilizers | ta | 1 | 2.40 | 2.40 | 38 |
| Ridging | ta | 1 | 5.25 | 5.25 | 84 |
| Sowing | ta | 1 | 10.70 | 10.70 | 171 |
| II stage | | | | | |
| Irrigation water | ta | 1 | 3.50 | 3.50 | 56 |
| Irrigation | ta | 1 | 28.84 | 28.84 | 462 |
| Intertillage | ta | 1 | 30.00 | 30.00 | 480 |
| Insecticides | l | 0.15 | 81.00 | 12.15 | 194 |
| Fungicides | lb | 1 | 17.20 | 17.20 | 275 |
| Application of pesticides | ta | 1 | 5.00 | 5.00 | 80 |
| III stage | | | | | |
| Harvesting, threshing, winnowing & transportation | ta | 1 | 30.00 | 30.00 | 480 |
| Sub-total | | | | 245.85 | 3,933 |
| Miscellaneous (5%) | | | | 12.29 | 197 |
| Financial charges (18% annual) | | | | 11.61 | 186 |
| TOTAL | | | | 269.75 | 4,316 |
| Summary of Input | | | | | |
| 1. Fertilizers | qq | 0.50 | | 36.27 | 580 |
| 2. Irrigation water | | | | 3.50 | 56 |
| 3. Insecticides | l | 0.15 | | 12.15 | 194 |
| 4. Fungicides | lb | 1 | | 17.20 | 275 |
| 5. Labor | | | | 112.19 | 1,795 |
| 6. Lease plowing | | | | 34.00 | 544 |
| 7. Seed | qq | 0.12 | | 30.54 | 489 |
| 8. Miscellaneous (5%) | | | | 12.29 | 197 |
| 9. Financial charges (18% annual) | | | | 11.61 | 186 |
| TOTAL | | | | 269.75 | 4,316 |

Source : Banco Agricola, 1989

## Table 4.1.1-12 Production Cost of Onion, 1989

| Activities | Unit | Quantity | Unit Price | Cost/ta RD$ | Cost/ha RD$ |
|---|---|---|---|---|---|
| I stage | | | | | |
| Purchase of bulbils | qq | 6 | 101.00 | 606.00 | 9,696 |
| Land preparation | ta | 1 | 44.80 | 44.80 | 717 |
| Fertilizers (N-P-K) | qq | 1.5 | 74.40 | 111.60 | 1,786 |
| Application of fertilizers | ta | 1 | 3.85 | 3.85 | 61 |
| Ridging | ta | 1 | 5.00 | 5.00 | 80 |
| Selection & desinfection of bulbils | ta | 1 | 5.00 | 5.00 | 80 |
| Planting | ta | 1 | 70.00 | 70.00 | 1,120 |
| Herbicides | l | 0.10 | 110.00 | 11.00 | 176 |
| Application of herbicades | ta | 1 | 4.40 | 4.40 | 70 |
| II stage | | | | | |
| Irrigation water | ta | 1 | 3.00 | 3.00 | 48 |
| Irrigation | ta | 1 | 40.00 | 40.00 | 640 |
| Intertillage & weeding | ta | 1 | 65.00 | 65.00 | 1,040 |
| Systemic insecticides | l | 0.25 | 124.00 | 31.00 | 496 |
| Contact insecticides | l | 0.30 | 60.00 | 18.00 | 288 |
| Fungicides | lb | 3 | 15.00 | 45.00 | 720 |
| Sticker | l | 0.20 | 16.00 | 3.20 | 51 |
| Application of pesticides | ta | 1 | 40.00 | 40.00 | 640 |
| III stage | | | | | |
| Harvesting, cutting & drying | qq | 15 | 9.50 | 142.50 | 2,280 |
| Sub-total | | | | 1,249.35 | 19,989 |
| Miscellaneous (5%) | | | | 62.47 | 1,000 |
| Financial charges (18% annual) | | | | 78.70 | 1,259 |
| TOTAL | | | | 1,390.52 | 22,248 |
| Summary of Input | | | | | |
| 1. Fertilizers | qq | 1.5 | | 111.60 | 1,786 |
| 2. Herbicides | l | 0.10 | | 11.00 | 176 |
| 3. Insecticides | l | 0.75 | | 52.20 | 835 |
| 4. Fungicides | lb | 3 | | 45.00 | 720 |
| 5. Labor | | | | 375.75 | 6,011 |
| 6. Lease plowing | | | | 44.80 | 717 |
| 7. Bulbils | | | | 606.00 | 9,696 |
| 8. Irrigation water | | | | 3.00 | 48 |
| 9. Miscellaneous (5%) | | | | 62.47 | 1,000 |
| 10. Financial charges (18% annual) | | | | 78.70 | 1,259 |
| TOTAL | | | | 1,390.52 | 22,248 |

Source : Banco Agricola, 1989

Table 4.1.1-13 Production Cost of Principal Crops per Unit Area

Cost: RD$

| Input | Unit | Garlic | | Potato | | Kidney bean | | Onion | |
|---|---|---|---|---|---|---|---|---|---|
| | | Q'ty | Cost | Q'ty | Cost | Q'ty | Cost | Q'ty | Cost |
| 1. Seed | kg | 726 | 22,560 | 1,452 | 5,568 | 87 | 489 | 4,355 | 9,696 |
| 2. Lease plowing | ha | 1 | 576 | 1 | 458 | 1 | 544 | 1 | 717 |
| 3. Fertilizers | kg | 1,089 | 2,307 | 1,089 | 1,795 | 363 | 580 | 1,089 | 1,786 |
| 4. Herbicides | l | 1.6 | 214 | - | - | - | - | 1.6 | 176 |
| 5. Nematicides | kg | 29 | 640 | - | - | - | - | - | - |
| 6. Insecticides | l | 14.4 | 1,296 | 19.2 | 2,820 | 2.4 | 194 | 12.0 | 835 |
| 7. Fungicides | kg | 25.4 | 834 | 29.0 | 954 | 7.3 | 275 | 21.8 | 720 |
| 8. Irrigation water | ha | 1 | 56 | 1 | 58 | 1 | 56 | 1 | 48 |
| 9. Labor | ha | 1 | 10,098 | 1 | 3,995 | 1 | 1,795 | 1 | 6,011 |
| 10. Miscellaneous | - | 5% | 1,929 | 5% | 782 | 5% | 197 | 5% | 1,000 |
| 11. Financial charge (18% annual) | Month | 6 | 3,646 | 3 | 739 | 3 | 186 | 4 | 1,259 |
| Total | | | 44,156 | | 17,169 | | 4,316 | | 22,248 |

Table 4.1.1-14 Prices of Crops in Constanza

| Crops | Prices pesos/quintal |
|---|---|
| Garlic | 850 |
| Patato | 70 |
| Kidney bean | 400 |
| Onion | 100 |
| Carrot | 80 |
| Lettuce | 25 |
| Beet | 35 |
| Celery | 45 |
| Capcicum | 30 |
| Strawberry | 350 |
| Cabbage | 1,200/millar |
| Banana | 5/bunch |

Note: millar=1,000 pieces

From: Weekly Report, SEA, Constanza, Oct. 1989

Table 4.1.1-15 Unit Yield of Principal Crops by Sections

| Sector | Garlic | Potato | Kidney bean | Onion |
|---|---|---|---|---|
| El Cercado | 4.4 | 18.1 | 1.1 | 10.9 |
| Arenoso | 4.4 | 18.1 | 0.8 | 10.9 |
| Las Auyamas* | 7.3 | 21.8 | 1.1 | 10.9 |
| El Valle | 7.3 | 21.8 | 1.1 | 10.9 |
| Sabina | 5.8 | 18.1 | 1.1 | 10.9 |
| Palero | 5.8 | 18.1 | 1.1 | 10.9 |
| Cañada Seca | 7.3 | 18.1 | 1.1 | 10.9 |
| Colonia Kennedy | 4.4 | 18.1 | 1.1 | 10.9 |
| Colonia Española | 4.4 | 18.1 | 1.1 | 10.9 |
| Arroyo Arriba | 4.4 | 18.1 | 1.1 | 10.9 |
| Mean Yield | 5.8 | 18.1 | 1.1 | 10.9 |

Note: These are data collected at the part in Las Auyamas where irrigation water is sufficient.

Source: URPE, SEA, Constanza, Jan. 1990

## 4.2 Control Methods

Control methods of pests, diseases and weeds heavily depend on chemical method as shown in the following table.

Table 4.2.1-1 Control Methods of Pests, Diseases and Weeds

Unit:Per cent(%)

| Methods | Pests | | Diseases | | Weeds | |
|---|---|---|---|---|---|---|
| | El Convento | El Valle | El Convento | El Valle | El Convento | El Valle |
| Biological | — | — | | | — | — |
| Chemical | 100.0 | 100.0 | 96.3 | 76.9 | 83.3 | 59.6 |
| Cultural | — | — | | 23.1 | 8.3 | 36.2 |
| Physical & Mechanical | — | — | 3.7 | | — | — |
| Integrated | — | — | | | — | — |
| Other | — | — | | | 8.3 | 4.2 |

Source: Levantamiento de informaciones basicas para el diseno de un programa de manejo integrado de plagas en la zona de Constanza, Fundacion de Desarrollo Agropecuario

As mentioned above, farmers in Constanza spray pesticides frequently as shown below. Insecticides and fungicides are applied on an average of once in every days.

Table 4.2.1-2 Frequency of Pesticide Application

Unit : Percent (%)

| Frequency of Pesticide Application (days) | Insectides | | Fungicides | | Herbicides | | Nematicides | |
|---|---|---|---|---|---|---|---|---|
| | El Convento | El Valle | El Convento | El Valle | El Convento | El Valle | El Convento | El Valle |
| 1 | 7.5 | 5.3 | 16.0 | | 72.1 | 52.2 | 29.6 | 16.0 |
| 2 | - | | | | | | | |
| 3 | - | 5.3 | | | 2.3 | | | |
| 4 | 5.7 | 2.6 | | | | | | |
| 5 | 15.1 | 5.3 | 16.0 | 3.4 | 2.3 | | 3.7 | |
| 6 | 7.5 | 5.3 | 8.8 | 13.8 | 2.3 | | 3.7 | |
| 7 | 3.8 | 13.2 | | | | | 3.7 | |
| 8 | 15.1 | 36.8 | 44.0 | 13.8 | 2.3 | | | |
| 9 | 32.1 | | | | | | | |
| 10 | 1.9 | 5.3 | 4.0 | | | | | |
| 11 | 5.7 | | | | | | | |
| 12 | - | 2.6 | | 6.9 | | | | |
| 13 | - | | | | | | | |
| 14 | - | 2.6 | | | | | | |
| 15 | 1.9 | 15.8 | 4.0 | | | | | |
| 18 | - | | | | | 13.0 | 3.7 | |
| 20 | 1.9 | | | | 2.3 | | | |
| 25 | - | | | | | 8.7 | | |
| 30 | - | | | | | | | |
| 45 | 1.9 | | 4.0 | 44.8 | 2.3 | 13.0 | | 4.0 |
| 90 | - | | | | 7.0 | | | |
| 100 | | | | | | | | |
| 180 | | | 4.0 | 13.8 | 4.6 | 13.0 | 3.7 | |
| 240 | | | | | 2.3 | | | |
| 365 | | | | | | | | |
| No specific | | | | | | | 51.9 | 80.0 |

Source : Levantamiento de informaciones basicas para el diseno de un programa de manejo integrado de plagas en la zona de Constanza, Fundacion De Desarrollo Agropecuario

Farmers usually apply pesticide combining insecticide with fungicide, and sometimes with foliarfeed. And they keep on applying it till harvest which may cause pesticide residue in the products. In the worst case, the study team heard that even harvested products were applied with pesticide. However, each pesticide usually reveals its safety use on the lavel of a pack that the application should be stopped some days before harvest. And it is warned to stop using already prohibited chemicals like parathion in other countries. Here, taking onion for example, the safety use level of pesticides in Japan is shown for comparison in the following table, and the level is kept strictly by farmers in Japan. The pesticides listed here are frequently applied chemicals or similar ones.

Table 4.2.1-3 Comparison of Pesticides Application on Onion

| Diseases & Pests | Constanza | | Japan | | |
|---|---|---|---|---|---|
| | | | Softy use level | | |
| | Pesticides | Time of application | Pesticides | Max. time of application | Days before harvest |
| Botrytis<br>Leaf rust<br>Downy mildew | Manzeb | 11 times | Maneb | 5 times | 7 days |
| Aphidos<br>Thrips | Methamidophos | 11 | Sumithion<br>Malathion<br>Diazinon<br>DDVP | 2<br>6<br>2<br>- | 21<br>7<br>21<br>3 |

5. Marketing and Processing of Agricultural Products

Most of the agricultural products are marketed through middle men. Though a few farmers sell the products directly to Santo Domingo and Santiago, they claim that it is better to sell the products through middle men because of the difficulty of marketing and collection of money. There exists farmers' associations in the Valley, but they do not function at all for marketing of agricultural products. Some associations have been requesting credits for pick-ups to transport agricultural products to the markets. The credits, however, have not been financed yet by Banco Agricola. Santo Domingo and Santiago are the two biggest markets for the Valley products.

Snow pea had been exported to USA by a Chinese firm in the past. But the export was banned because of pesticide residues. The firm gave it up to purchase snow peas for export, and went out of the Valley. At present snow pea is grown by a few farmers for domestic markets.

Marketing of agricultural products relies on the connection with markets in the two big cities, capitals to manage and timely arrangements of transportation. It is, therefore, difficult for individual farmers to sell their products by themselves, unless other countermeasures are taken.

Collected agricultural produce by middle men are transported on about one ton pick-ups to a huge whole sale market in Santo Domingo, sold to old whole sellers, then sold to retailers, and finally sold to consumers. Prices are decided between a seller and a buyer from the amount of the produces, and auction is not practised. The whole sale prices on the day of investigation in October, 1989 are shown below with the margin.

unit: RD$

| Crops | Buying | Selling | Rate |
|---|---|---|---|
| Garlic | 15/lb | 18/lb | 1.20 |
| Potato | 1.80/kg | 2.20/kg | 1.22 |
| Onion | 2.30/lb | 3.00/lb | 1.30 |
| Cabbage | 1.0/lb | 2.0/lb | 2.00 |
| Beet | 65/saco | 90/saco | 1.38 |
| Lettuce | 18/caja | 20/caja | 1.11 |

Processing of agricultural products is not practised in the Valley since the main products are vegetables. Garlic and onion are stored dry for some time in warehouses which were built according to the size of farms, and they are marketed when the prices are high. The other vegetables are marketed through middle men in a quantity required, in all the quantity at once or as green crops in the farms harvested by labor forces from middle men. Some progressive farmers among Japanese immigrants clean and pack special vegetables such as parsely, asparagus, broccoli, etc., and market them directly to super-markets and hotels.

# 6. Agricultural Supporting Services

## 6.1 Secretaría de Estado de Agricultura: SEA.

SEA Constanza office belongs to SEA in La Vega Province under Norcentral Región shown at the bottom of the organization chart of the headquarters SEA (Fig. 6.1.1-1). The Constanza office is composed of 5 programs and extension work (Fig. 6.1.1-2). Each program has an officer in charge. URPE works for economic planning and statistics, and the others are programs of rural organization, vegetable protection, coffee and natural resources.

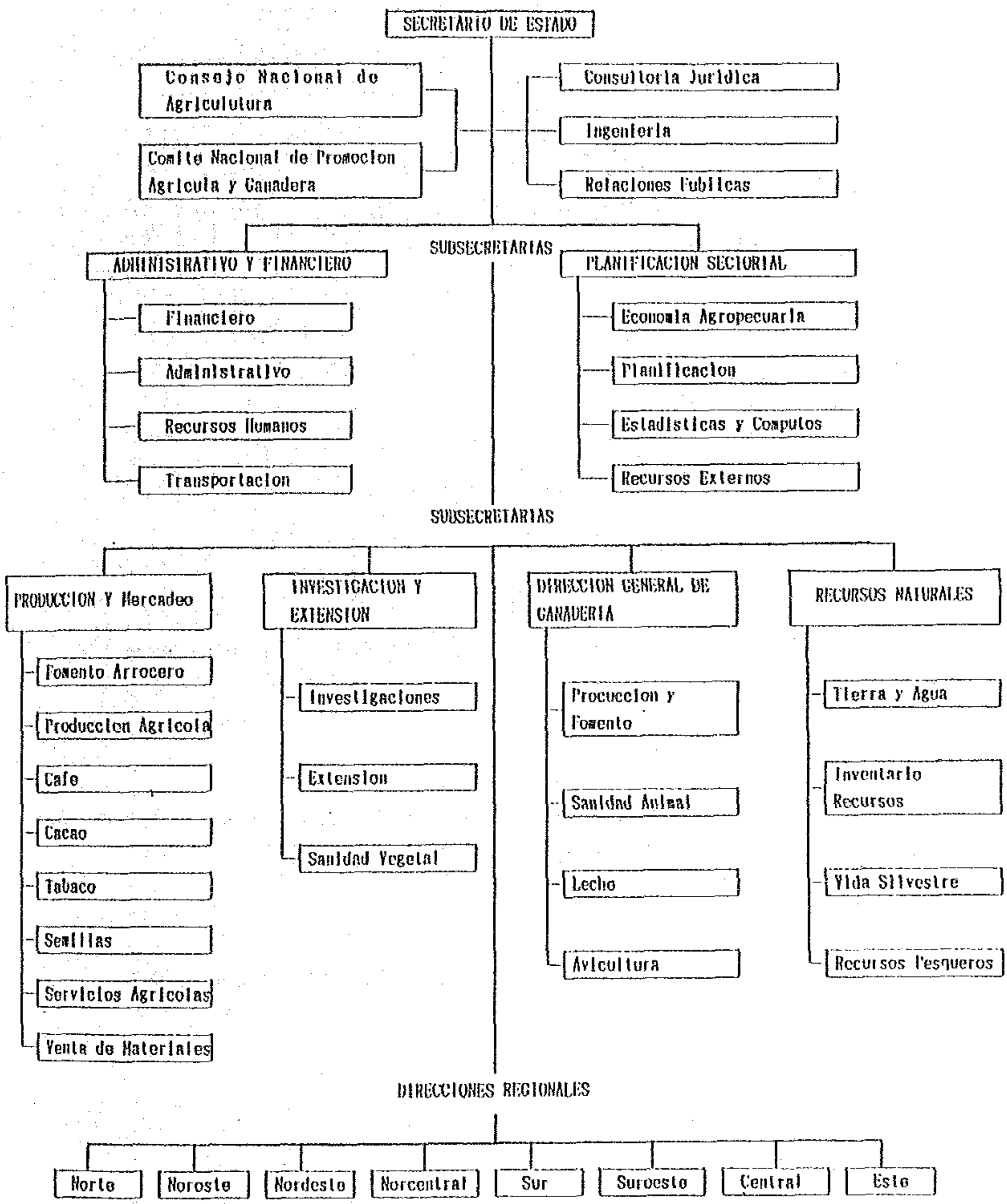
## 6.2 Agricultural Extension Work

Extension work in Constanza is divided into two sub-zones, Sub-zona Constanza and Sub-zona El Rio. Sub-zona Constanza is divided into 6 areas and sub-zona El Río into 3 areas (Fig. 6.1.1-2). An extension worker takes care of an area. The study area lies under the whole El Valle and a part of El Convento. Methods of extension are visiting farmers, interviews with farmers, demonstrate, crop growing in a demonstration farm, conduct short-term training, etc. Each extension worker is provided with a motor cycle for his activities.

## 6.3 Agricultural Research Station

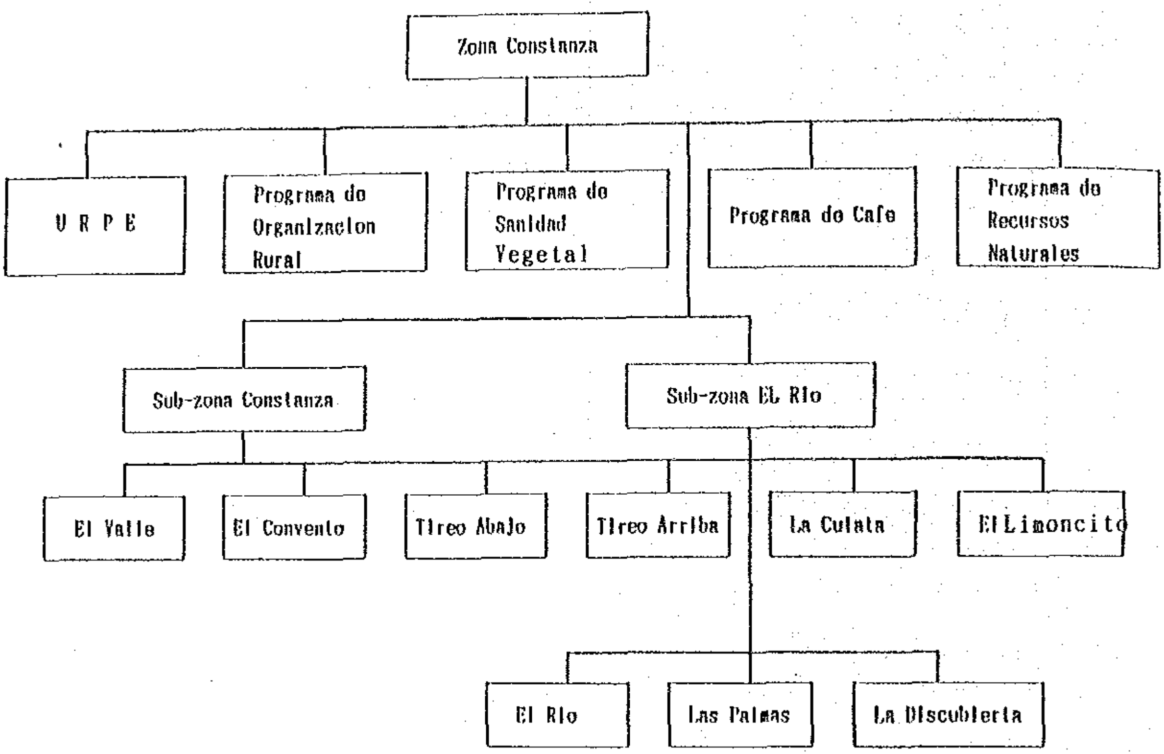
Research stations belong to Departamento de Investigaciones Agropecuarias: DIA under Subsecretaría de Investigación, Extension y Capacitación Agropecuaria (Fig. 6.1.1-1). There are six Research Centers as follows;

1. Centro Sur de Desarrollo Agropecuario: CESDA
2. Centro Norte de Desarrollo Agropecuario: CENDA
3. Centro de Investigaciones Arroceras: CEDIA
4. Centro de Investigaciones para Zonas Aridas: CIAZA
5. Centro de Investigaciones Pecuarias: CENIP
6. Centro de Investigación para la Recuperación de Suelos Salino-Sódico: CIRESS




From: SEA, 1986. Plan Operativo 1987.

Fig. 6.1.1-1 Organization Chart of the Headquaters SEA




Note:URPE is abbreviated from United Regional de Planificación y Economía.
From:Investigation by Study Team, Oct. 1989

Fig.6.1.1-2 Organization Chart of SEA,Zona Constanza

The headquaters of CENDA is located in Santiago, and has a branch in Constanza, Estación Experimental Horticola, Constanza, which deals with experiments on vegetables. The branch holds the director, two technicians, an Israelis expert, a Japanese volunteer and several farm workers. The area of experimental farm is 100 tareas (6.3ha). Themes for the experimental tests are picked up from the order by the headquarters, requests from extension workers, requests from farmers, ideas from researchers, etc., and submitted to the headquarters in Santiago. When an experiment is admitted by the headquarters and budgeted, it is put into practice. The experiments under practices in 1989 are shown below.

1. Varietal test on potato
2. Chemical control of weeds in carrot
3. Chemical control of mosca blanca (Trialeurodes vaporarorium)
4. International program of kidney bean varieties

Experimental programs in the past 5 years are classified as follows:

| | | |
|---|---|---|
| Crop Protection | 38 | 50.0% |
| Varietal test | 20 | 26.3% |
| Production of seeds | 6 | 7.9% |
| Application of fertilizers | 5 | 6.6% |
| Mixed cropping | 4 | 5.3% |
| Miscellaneous | 3 | 3.9% |
| Total | 76 | 100.0 |

Source: Investigation by the Study Team, Oct., 1989

Experiments on crop protection occupies 50.0% and prominent, and 35 out 38 programs were on chemical control of pests and diseases. It also reveals how big the damages from pests and diseases are.

## 6.4 Instituto Agrario Dominicano: IAD

IAD is an official institute to manage the national land. The right to cultivate the national land is admitted, and it can be inherited to the child of the holder, though sale of the right is not permitted. There exists 398 hectares of the national land in the Valley. The land rent is collected at the rate of RD$0.70/crop/tarea through Banco Agricola when the farmer gets credit. IAD has a branch office in Constanza.

## 6.5 Banco Agricola

Banco Agricola, Constanza was opened in 1987. Banco Agricola finances credits up to 70% of the output of a crop through agricultural association. The financing period is 4 to 8 months according to crops. In case the financed crop yields nothing with some reasons, the term of repayment may be prolonged. Its financial charges are 14% and handing fee is 4%, and they are calculated by days. Number of beneficiaries was 386 farmers, number of loans was 257 and total amount was RD$7,305,209.00 in 1988 (Table 6.5.1-1). Percentage of its utilization was 27.8% (Table 6.5.1-2). Farmers cultivating the national land and tenant farm may also be financed with the credit.

## 6.6 Universities and High Schools Offering Agricultural Education

Universities:

1. Universidad Nacional Pedro Henríquez Ureña: UNPHU
2. Universidad Autónoma de Santo Domingo: UASD
3. Universidad Católica Madre y Maestra: UCAMAIMA
4. Universidad Central del Este: UCE
5. Universidad Tecnológica del Cibao: UTECI
6. Universidad Mundial: UM

Table 6.5.1-1 Credits of Banco Agricola

| | 1987 | 1988 | 1989 * |
|---|---|---|---|
| No. Beneficiaries | 138 | 386 | 192 |
| No. Credits | 97 | 257 | 128 |
| Amount (RDS) | 2,146,199 | 7,305,209 | 3,507,839 |
| Financial Charges | 14% | 14% | 14% |
| Handling Fee | 4% | 4% | 4% |
| Periods | 4 to 8 months | 4 to 8 months | 4 to 8 months |

Note : * Up to September
From : Banco Agricola, Constanza, Oct. 1989

Table 6.5.1-2 Distribution of Agricultural Credits

| Characteristics | Rate (%) |
|---|---|
| Users of Credits | 41.3 |
| Source of Credits | |
| Banco Agricola | 27.8 |
| Commercial Banks | 4.6 |
| Private | 5.6 |

From: Estudios Integrados de Recursos Naturales de la Cuenca del Rio Grande o del Medio. SEA. Sep. 1988

High Schools:

1. Escuela Agricola Salesiana (La Vega)
2. Ivatituto Politécnico Loyola (San Cristobal)
3. Instituto Superior de Agricultura (Santiago)
4. Colegio San Ignacio de Loyola (Dajabón)

Other 2 to 3 high schools offer agricultural education.

6.7 Instituto Nacional de Recursos Hidráulicos: INDRHI

INDRHI is responsible for planning and management of irrigation to the farms, having a branch in Constanza. This study is carried out under INDRHI.

7. Farmers' Organization

Farmers' organizations in the Valley are listed below

1. Cooperativa Agropecuaria Productoras del Valle
2. Asociación de Productores Horticolas del Valle
   95 members
3. Asociación Las Mercedes (Los Cerros)
4. Asociación Amado Peguero (Palero)
   30 members
5. Asociación Juan Pablo Duarte (Las Auyamas)
6. Asociación Corpus Cristi (Las Auyamas)
7. Asociación Unión y Trabajo (Colonia Espanola)
   26 members
8. Asociación Las Mercedes (El Cercado)
9. Asociación Dulce María (El Cercado)
   25 members
10. Asociación La Altagracia (El Cercado)
    25 members
11. Asociación de Pequeños y Medianos Agricultores (El Valle)

Each organization has its own activities. Their activities are commonly facilitation of agricultural credit, common purchase of seeds (especially garlic), lease of agricultural machines bought by an association, improvement of schools, roads, public facilities, etc., and mutual help when a member is sick. At present, there is no associations which collect, transport and sell agricultural products.

# ANNEX G : EXISTING FACILITIES

## ANNEX G: EXISTING FACILITIES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# ANNEX G: EXISTING FACILITIES

## 1. Existing Irrigation and Drainage System

### 1.1 Head Works in the Rio Grande

The head works is located at the upper reach of the Rio Grande and outside of the Constanza Valley. The head works was constructed in 1947. Water collected at the facility is conducted to the Valley through the head race for a distance of approximately 3.9km and is distributed for irrigation by the Canal Constanza, the Lateral Constanza and their laterals. Its weir is 6m in height, its movable weir is 4.6m in width and its fixed weir is 37m in width.

The fixed weir of 15m length was added partially afterwards. Upper reach of the head works is completely varied by mud flow for many years. Hence the river bed of the upper reach is higher than the lower reach. In order to secure taking water, the upper reach of movable weir is excavated and maintained by the INDRHI. There are vegetation on both sides of dry river bed in 300m length at the upper reach of the head works. The width of the river is narrowed by 10 to 20m at the upper reach and bluff naked rocks are found on both sides of the river.

### 1.2 Head Race Between the Head Works and the Division Works

Water taken from the head works is conveyed to the division works at the mountain pass through the head race of 3.0km length. It is a part of the Canal Constanza. Its height is EL 1,288.16 at the head works and EL 1,283.83 at the division works. The difference of the height is 4.33m and its average longitudial slope is approximately 1/700. The head race is made of box culvert since it passes a steep slope of mountains for 300 meters after the head works. Manholes are installed in every 80 meters in this section. It is made of canal with wet masonry lining and unlined canal in the middle section as it passes calm slope of mountains. It is composed of box culvert for 300 meters before the division works on account of passing steep slope again. Its inside dimensions are 1.25 meter x 0.75 meter and its design flow rate is computated as 1.33$m^3$/sec.

## 1.3 Irrigation Network by Canals

Summary on the canals and irrigation network in the Valley are shown in Table 1.3.1-1 and Fig. 1.3.1-1 respectively.

The Canal Constanza flows through the eastern area of the Valley and reaches the Arroyo Pantuflas. Irrigation water is taken at the head works in the Río Grande and distributed to the Valley through the canal. Ten sub-canals are installed for irrigation in the Valley.

In accordance with the enlargement of farm lands, the Lateral Constanza which reaches the Arroyo Pantuflas was planned and constructed outside the Canal Constanza twenty years after the initial construction.

However, the Lateral Constanza after El Gajo de la Paila was buried with mud and irrigation water does not flow to the hind place at present.

As the other resources, irrigation water is taken at the head works in the Arroyo Pantuflas and distributed to the northern area of the Valley by the Canal Pantuflas.

The Canal Palero gets irrigation water at the head works in the Arroyo Palero and distribute to the eastern part of the Valley. On the other hand, the Canal Abud takes water from the Arroyo Constanza and supply it to the middle of the Valley for the purpose of supplementing irrigation water.

The irrigated area is divided into six sectors according to the present irrigation network . Among the six sectors, the present irrigation system supplies water for 5 days to the sector Las Auyamas, 2 days to the sector Upper Sabina, 5 days to Lower Sabina and 8 days to the sector Espanola respectively in each interval whose resource is from the Río Grande. And the sector Cercado Parte Arriba and the sector Cercado Parte Abajo where irrigation water comes from the Arroyo Pantuflas are supplied with water for 8 days in the same system (Fig. 1.3.1-2). Distribution of irrigation water and operation and maintenance for canals are controlled by the INDRHI.

## 1.4 Pump Station

Pump station was Constructed to make up for shortage of irrigation water in dry season. Water is pumped up from the Río Grande and conducted to the Canal Constanza.

The details of the pump station are as follows:

| | | |
|---|---|---|
| Location | : | Lower reach of the confluence of Río Grande and Arroyo Pinar Bonito |
| No. of pump | : | 1 unit |
| Lift | : | Approx. 70m |
| Pumped capacity | : | 800 gallon/min |

## 1.5 Irrigation System by Groundwater

Fifty wells are sunk and operated by farmers individually with their own funds for the purpose of getting groundwater for irrigation.

Typical dimensions of the existing wells are as follows;

Diameter: 8 inches

Depth : 30 meters

Total irrigated area by groundwater is 175ha.

## 1.6 Small Irrigation System with Stream Flow in the Project Area

Some farmers individually pump up the stream flow and put into practice for field irrigation on a small scale. This system has a good point that special facilities are unneccesary when a stream flow is near by the area.

## 1.7 Present Condition of Irrigation

The present condition of irrigation in the Constanza Valley is shown in Fig. 1.7.1-1. The southern area of the Arroyo Constanza is well irrigated, however water shortage occurs in winter when water supply decreases. In the western area of Las Auyamas which is at the downstream of Lateral 1, irrigation water is not supplied by canals and is irrigated by rainfall and/or pumping up from small rivers. The eastern area of the Valley is divided into two areas. The former is irrigated by the Canal Constanza, the Lateral Constanza and the Canal Palero, and the latter relies irrigation water on rainfall and small rivers. The northern area of the Valley is irrigated by Lateral 8, Lateral 9 and Canal Abud in the south of Carretera Constanza-Jarabacoa. It relies on pumped water from the Arroyo Constanza in the western area of the Valley. Irrigation water is not conveyed by the Canal Constanza or the Lateral Constanza in the north of Carretera Constanza-Jarabacoa. Groundwater pumped up from wells is used for irrigating that area. Cultivated area of high elevation was developed recently. Irrigation by groundwater from wells is not practiced. There it only relies on water by rainfall. Irrigation water is supplied from the Canal Pantuflas in the northern area of Constanza City and the western area of the Arroyo Pantuflas. However, the water is not conveyed to the end of the Canal Pantuflas. It relies on irrigation water by pumping up from the Arroyo Pantuflas in close area to the Arroyo Pantuflas. Water by rainfall is only supplied to the area of high elevation.

## 1.8 Drainage System

Drainage system is quite different in northern and southern areas which is divided by the Arroyo Constanza. Drainage canals in the northern area is shown in Table 1.8.1-1 and Fig. 1.8.1-1. In the northern area, drainage canal run along the slope, and flow into the Arroyo Constanza. In the southern area, small rivers flowing into the Arroyo Constanza also take part of drainage canals.

Operation and maintenance for main drainage canals are executed by the INDRHI once a year.

Groundwater level was obtained by well investigation and soil profile observation. The points where its groundwater level is within 1 meter from ground level are concentrated in the middle and downstream of the Arroyo Constanza. It is expected that the groundwater level is high in that area. According to the results of soil analysis, soil of aquoll/mollisol is distributed in that area and it includes high humidity. It is expected that the productivity of the area will be improved by introducing effective drainage.

2. Existing Farm Condition

There are about 1,660ha of farm land in the Valley. Most of its area is of upland cropping area. The features are as follows;

1. Block reformation is put into practice comparatively well and rectangular blocks are almost established along the land slope
2. Slope of farm land is almost within 0 to 2%
3. Ridges in the field are formed in the same direction with the land slope.

3. Existing Farm Road

Network of existing roads in the Project area is shown in Fig. 3.1.1-1. Two main roads run in the Valley and connect with the outside regions. Carretera Constanza - Jarabacoa runs from east to west, and Carretera Constanza - San José de Ocoa runs from south to north.

The roads are paved with asphalt and the width is 7 to 11m. Operation and maintenance of the main roads is executed by Ministry of Public Works.

On the other hand, farm roads run throughout the farm land. These farm roads are not paved and their widths are 2.5 to 7.5m. The operation and maintenance of these roads is executed by the INDRHI.

Table 1.3.1-1 Summary of Canals in Constanza Valley

| Name | Water Source | Start Point | End Point | Linear Meter | Etab-lished Year | Section | Design Capacity | Designed Irrigation Area | Facility |
|---|---|---|---|---|---|---|---|---|---|
| Canal Constanza | Rio Grande | Head works in Rio Grande | Arroyo Pantuflas | 13.8km | 1951 | -Con'c box culvert<br>-Unlinedcanal<br>-Canal w/encache | 1.5 m3/s | 797 ha | -2 division works<br>-mini hydropo<br>-chute/drop<br>-10 laterals |
| Lateral Constanza | Rio Grande | Division work in Canal Constanza | Arroyo Pantuflas | 14.7km | 1967 | -Canal w/encache | 0.5 m3/s | 207 ha | ―― |
| Canal Pantuflas | Arroyo Pantuflas | Head works in Arroyo Pantuflas | ―― | 3.7km | 1972 | -Canal w/encache | 0.5 m3/s | 166 ha | ―― |
| Canal Palero | Arroyo Palero | Head works in Arroyo Palero | Lateral Constanza | 0.5km | 1959 | -Canal w/encache | 0.2 m3/s | 71 ha | ―― |
| Canal Abud | Arroyo Constanza | Arroyo Constanza | Lateral 8 of Canal Constanza | 1.4km | 1969 | -Unlined canal | 0.25 m3/ | 93 ha | ―― |

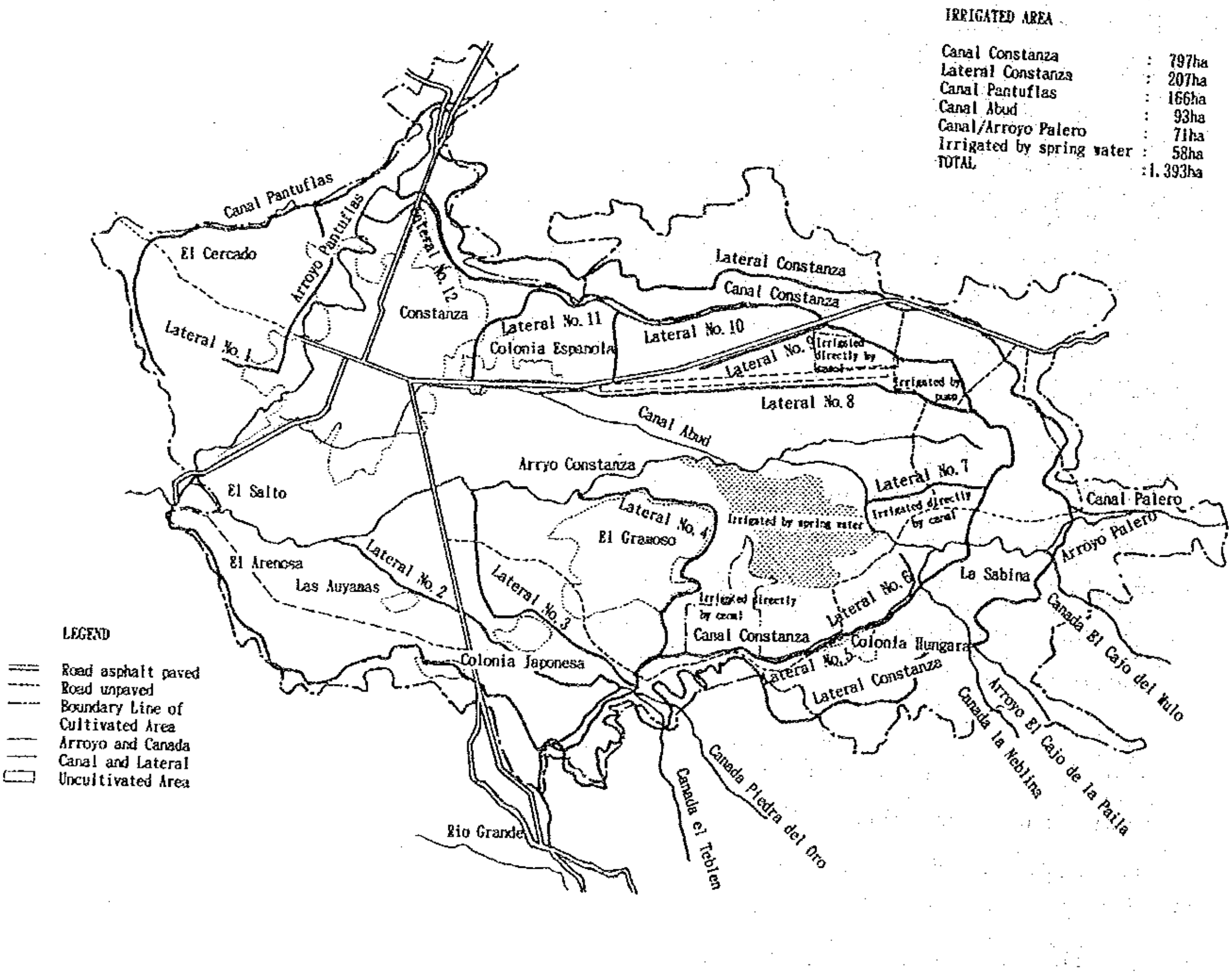


Fig. 1.3.1-1 Network of Irrigation Canals in Constanza Valley

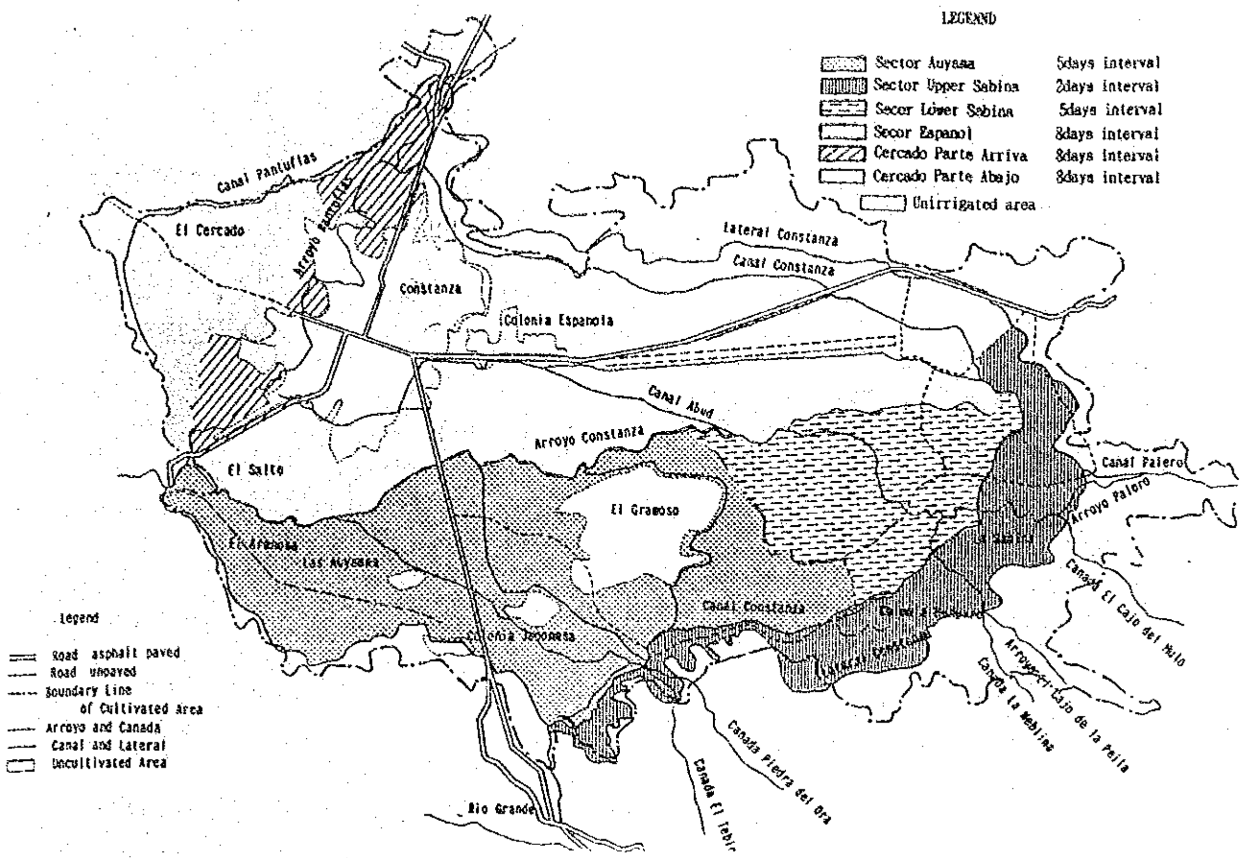


Fig. 1.3.1-2 Rotation Block and System for Irrigation in Constanza Valley

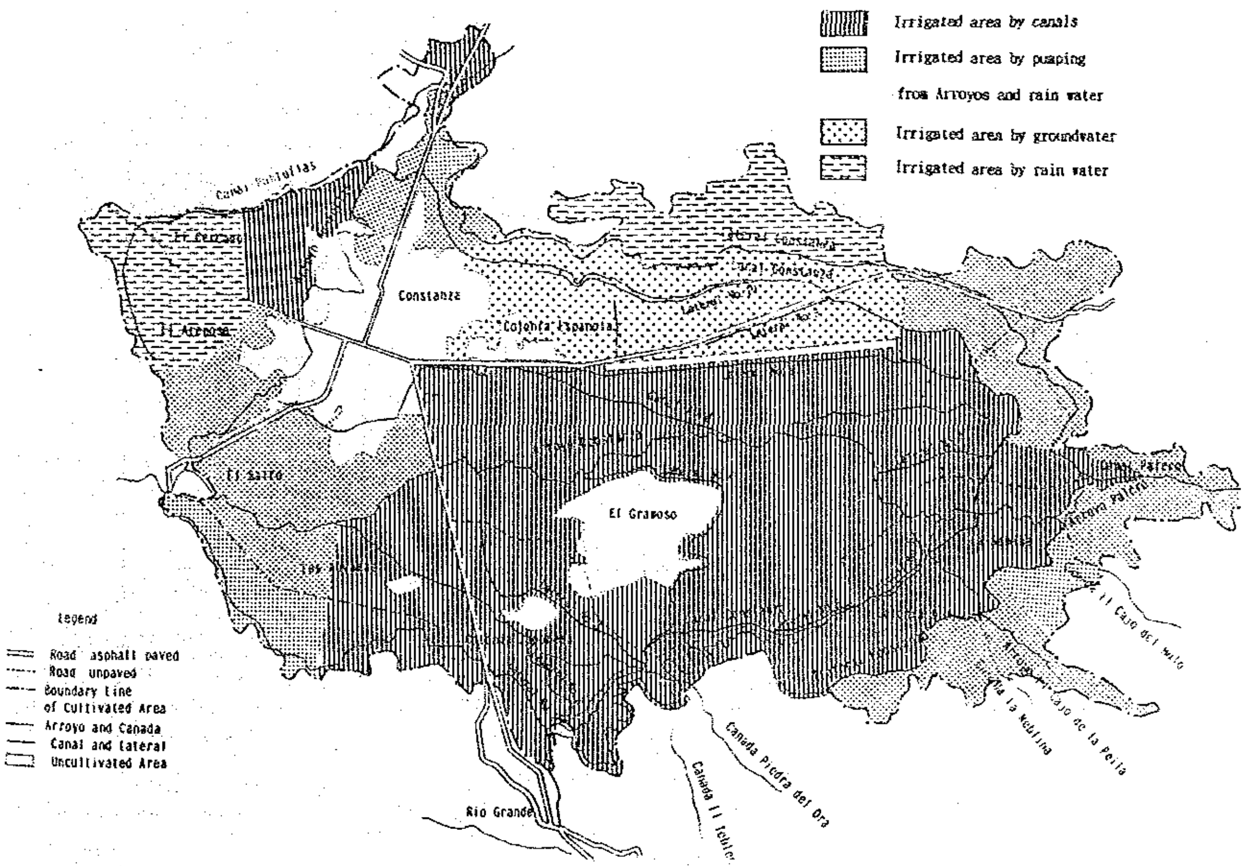


Fig. 1.7.1-1 Present Condition of Irrigation in Constanza Valley

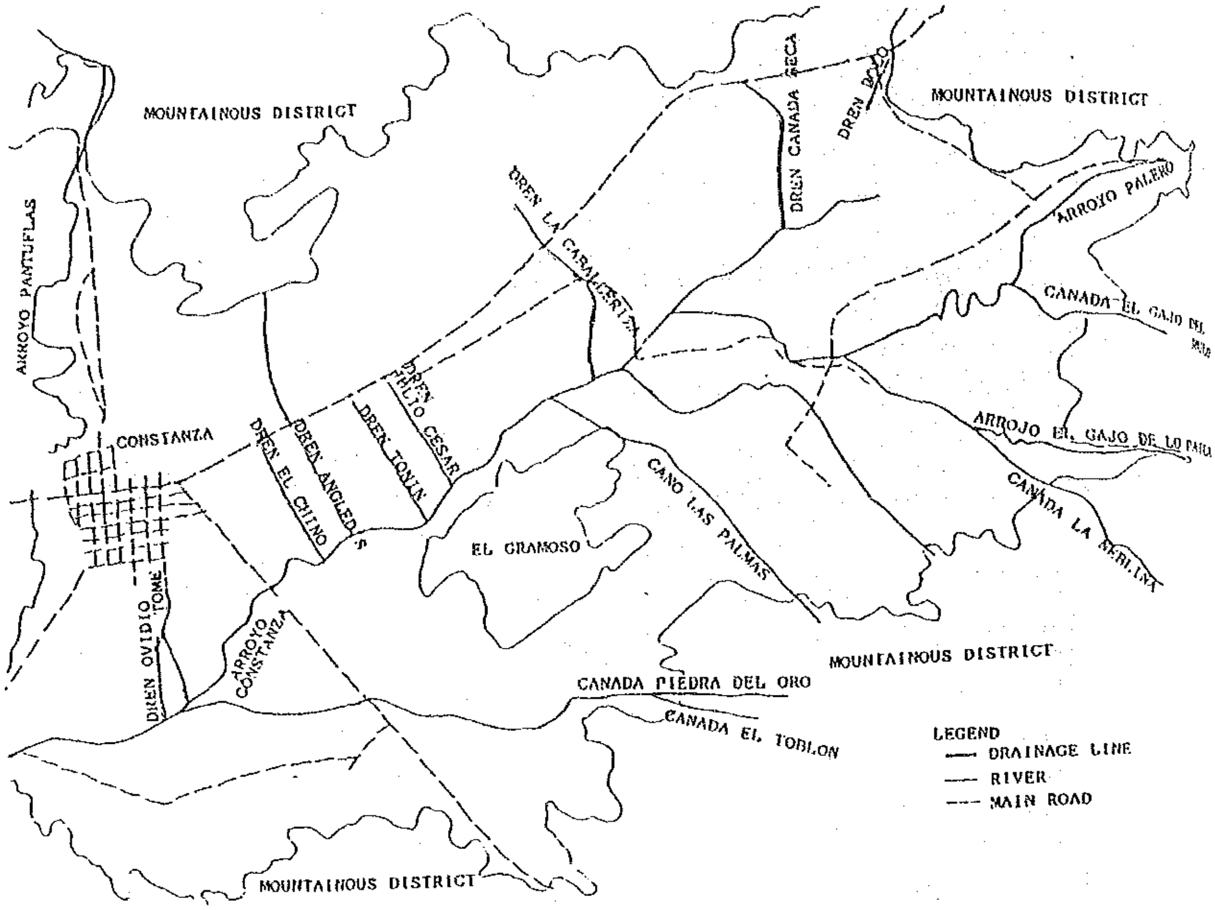


Fig. 1. 8. 1-1 Drainage Network in Constanza Valley

Table 1. 8. 1-1 Drainage Line

| Name | Location | Capacity (m3/sec) | Length (km) | Situation | Influenced Area(ha) |
|---|---|---|---|---|---|
| Dren Canada Seca | Sector spanol | 0.5 | 0.92 | 100% segement and vegetation | 411 |
| Dren la Caballerizo | -ditto- | 1.0 | 1.11 | 80% segement and vegetation | 748 |
| Dren la Aviation | -ditto- | 0.2 | 0.70 | 100% segement and vegetation | 354 |
| Dren Julio Cesar | -ditto- | 0.2 | 0.67 | 0 % | 348 |
| Dren Tonin | -ditto- | 0.2 | 0.60 | 0 % | 375 |
| Dren Angledis | -ditto- | 0.3 | 0.68 | 100% segement and vegetation | 200 |
| Dren el Chino | -ditto- | 0.3 | 0.72 | 100% segement and vegetation | 335 |

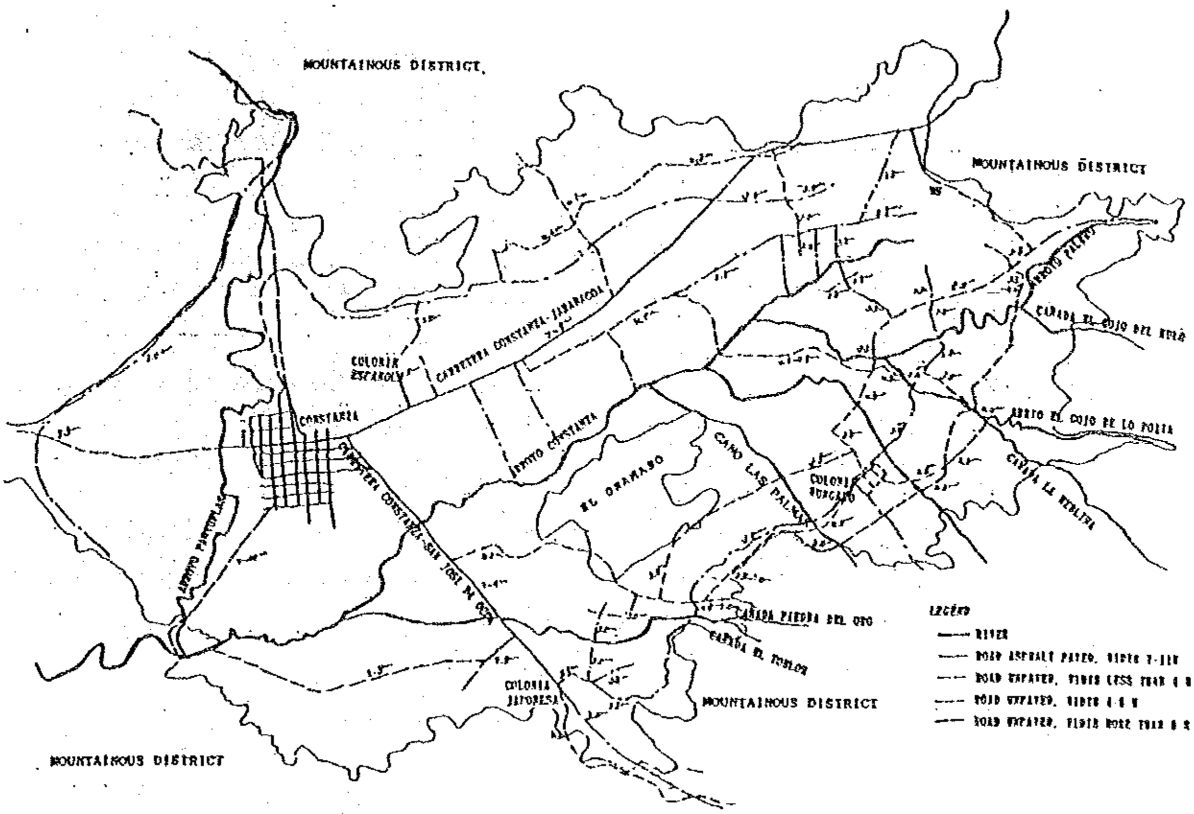


Fig. 3. 1. 1-1 Road Network in Constanza Valley

## 4. Related Project

### 4.1 El Salto Mini-hydropower Station

The mini-hydropower station is under construction at El Salto which is at the lowest reach of the stream in the Valley. The outline of the project is as follows.

Table 4.1.1-1 Outline of El Salto Mini-hydropower Station

| | | |
|---|---|---|
| Weir Type | : | Movable weir |
| Height | : | 8.0m |
| Width | : | 35.0m |
| Head race | : | Flume (1.25m x 1.0m) L=1,560m |
| | | Pipeline (Dia. 823mm) L=170m |
| Generator | : | Maximum generating power 700KVA |
| Transformer | : | 800KVA |

The project can be summarized as follows:

1. To construct a weir with the height of 8.0m at El Salto
2. To store water of 11,000$m^3$
3. To get water of 1.00$m^3$/sec.
4. To introduce water through the flume head race and drop it through the pipeline
5. To generate electric power by utilizing the potential energy of water drop with capacity of 3.00 GWH in a year.

In this project, the discharge of the Arroyo Constanza is estimated as shown below and the generation planning was formulated based on the estimated discharge.

Table 4.1.1-2 Discharge Frequency

| Discharge ($m^3/s$) | Frequency (%) |
|---|---|
| 1.22 | 10 |
| 1.00 | 20 |
| 0.88 | 30 |
| 0.70 | 50 |
| 0.48 | 90 |

## 4.2 Existing Small Water Power Plant

Water divided at the existing division works goes down through steel pipe to the existing small power plant at the side of end point of drop structure, and is supplied for electric generation.

Capacity of the power plant on the plan is as follows.

| | |
|---|---|
| Day time: | water power 120Kw |
| | steam power 450Kw |
| Night time: | water power 120Kw |
| | steam power 1,100Kw |

The power plant is out of operation at present.

The facilities and machines are not well maintained because of a long standstill. The following points of poor maintenance were found during the field survey.

- Rust of the machine parts
- Loss of parts and power transmission lines

In order to operate the power plant again, overhaul of facilities and machines are indispensable, but the overhaul is very costly. Moreover, regaining of operation can not be fully expected though they are overhauled.

# ANNEX H : ACTUAL USE OF THE WATER RESOURCES

# ANNEX H: ACTUAL USE OF THE WATER RESOURCES


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## ANNEX H : ACTUAL USE OF THE WATER RESOURCES

### 1. General

The utilization of the water resources is classified into 3 types; the potable water use for the Constanza City, the agricultural water use for the 1,660ha of the upland and the future water use for the mini-hydropower station project.

The potable water utilize the water resources of the Arroyo Pinar Bonito. The major parts of the discharge is utilized for the potable water by the head works, and distributed to the Constanza City.

The resources of the irrigation water are classified into 3 types; the utilization of the Rio Grande's water by the head works, the utilization of the small rivers in the study area and the utilization of the groundwater by well.

In addition to these, discharge of the Arroyo Constanza will also be used by the mini-hydropower station which is under construction (Sep. 1989).

The use of the water resources is shown in the Table 1.1.1-1.

Table 1.1.1-1 Use of the Water Resources in the Valley

| Use of the water | Water resources | Canal | Intake work |
|---|---|---|---|
| - Potable water | Arroyo Pinar Bonito | Aqueduct | Head works |
| - Irrigation water | Rio Grande | Canal Constanza | Head works |
| | Arroyo Pantuflas | Canal Pantuflas | Head works |
| | Arroyo Palero | Canal Palero | Head works |
| | Arroyo Constanza | Canal Abud | Head works |
| | Groundwater | | Pumping |
| - Hydropower station | Arroyo Constanza | | Weir |

The water resources usable for the project are the following 3 types:

1. Utilization of the Rio Grande water resources
2. Utilization of the small rivers in the study area
3. Utilization of the groundwater

The irrigated area of each water resource is shown in Table 1.1.1-2.

Table 1.1.1-2 Irrigated Area of Each Water Resource

| Water resources | Canal | Area (ha) |
|---|---|---|
| Rio Grande | Canal Constanza<br>Canal Lateral Constanza | 1,063 |
| Arroyo Constanza | Canal Abud | 93 |
| Arroyo Pantuflas | Canal Pantuflas | 166 |
| Arroyo Palero | Canal Palero | 71 |
| Rainfall or Groundwater | | 267 |
| Total | | 1,660 |

## 2. Surface Water

### 2.1 Actual Situation of the Utilization

The major part of the water resources of the study area depends on the water resource of the Rio Grande which flow at the southern parts outside the Valley. In addition to it, some parts of the arable area depend on the Arroyo Pantuflas, the Arroyo Constanza and the Arroyo Palero for supplementary use.

Up to the irrigation system map of the INDRHI, the irrigated area by each canal is shown as follows;

Table 2.1.1-1 Irrigated area

| | | |
|---|---|---|
| Canal Constanza (Rio Grande's Water) | 856 ha | 76.3% |
| Canal Lateral Constanza (Rio Grande's Water) | 207 ha | |
| Canal Abud (Arroyo Constanza's Water) | 93 ha | 6.7% |
| Canal Pantuflas (Arroyo Pantuflas's Water) | 166 ha | 11.9% |
| Canal Palero (Arroyo Palero's Water) | 71 ha | 5.1% |
| Total | 1,393 ha | 100.0% |

As shown above, three quarter (3/4) parts of the irrigated area (A=1,063ha) depends on the water resources of the Rio Grande, the dependence to small streams in the study area is relatively small.

In the study area, there are 32.4km$^2$ of mountainous region and 24.8km$^2$ of plain area (cultivated area and residential area). Actually, only the Pantuflas catchment areas (A=9.2km$^2$) and the Palero catchment area (A=4.8km$^2$) are utilized as the water resources, and the other mountainous parts (A=18.4km$^2$) are not developed as the water resources in the study area.

But, the development of the upstream area is very difficult owing to the alluvial topographic factor. The catchment area and irrigated area are shown in Table 2.1.1-2.

Table 2.1.1-2 Catchment Area and Irrigated Area

| Water resource | Catchment Area A | Irrigated Area B | B/A |
|---|---|---|---|
| Rio Grande | 42 km$^2$ | 1,063 ha | 25.3 ha/km$^2$ |
| Arroyo Pantuflas | 10 km$^2$ | 166 ha | 16.6 ha/km$^2$ |
| Arroyo Palero | 4.8 km$^2$ | 71 ha | 14.8 ha/km$^2$ |
| Arroyo Pinar Bonito | 13 km$^2$ | Potable water | - |
| Other mountainous region | 17.6 km$^2$ | - | - |

Judging from the Table 2.1.1-2, the water resources of the Rio Grande irrigates 25.3ha per $1km^2$ of mountainous region. On the other hand, the mountainous region utilized as the water resources for the irrigated land is a little and irrigates only 330ha of upland area. Based on this data, $1km^2$ of the mountainous region of the study area irrigate 10.2ha of upland and $1km^2$ of the mountaineous region of the Rio Grande irrigate 25.3ha of upland area.

Considering these points, it can be judged that the development of water resources of the Rio Grande is maximum, and on the other hand, the development of water resources of the study area is not sufficient.

The discharge data at the intake site is described below in Table 2.1.1-3.

Table 2.1.1-3 Estimated Discharge at Each Catchment Area

| Water resources | Catchment area | Mean discharge |
|---|---|---|
| Rio Grande | 42 $km^2$ | 0.56 $m^3/S$ |
| Arroyo Pinar Bonito | 15 $km^2$ | 0.25 $m^3/S$ |
| Arroyo Pantuflas | 8 $km^2$ | 0.08 $m^3/S$ |
| Arroyo Palero | 4.8 $km^2$ | - |
| Arroyo Constanza | 60.0 $km^2$ | 0.75 $m^3/S$ |

The mean monthly discharge at 5 year return period is shown in the Table 2.1.1-4.

Table 2.1.1-4 Estimated Mean Monthly Discharge at 5 year Return Period

| Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rio Grande | 0.33 | 0.38 | 0.38 | 0.51 | 0.96 | 0.66 | 0.53 | 0.84 | 0.77 | 0.67 | 0.51 | 0.41 |
| Arroyo Pinar Bonito | 0.13 | 0.15 | 0.15 | 0.19 | 0.33 | 0.23 | 0.20 | 0.29 | 0.27 | 0.29 | 0.19 | 0.17 |
| Arroyo Pantuflas | 0.06 | 0.07 | 0.07 | 0.10 | 0.21 | 0.14 | 0.11 | 0.18 | 0.17 | 0.14 | 0.10 | 0.09 |
| Arroyo Palero | 0.03 | 0.03 | 0.03 | 0.05 | 0.10 | 0.07 | 0.05 | 0.09 | 0.08 | 0.07 | 0.05 | 0.04 |

Based on this data, the annual runoff at 5 year return period is calculated as follows:

Table 2.1.1-5 Annual Runoff at 5 year Return Period

| Water resources | Annual runoff |
|---|---|
| Rio Grande | 1,829 x $10^4$ $m^3$/year |
| Arroyo Pinar Bonito | 662 x $10^4$ $m^3$/year |
| Arroyo Pantuflas | 378 x $10^4$ $m^3$/year |
| Arroyo Palero | 189 x $10^4$ $m^3$/year |

The total runoff of all basins, except the Pinar Bonito Basin, will be estimated as $V=2,396x10^4m^3$/year, totaling 1,700mm/year of irrigation capacity for the 1,393ha of irrigated area. It is evident that the insufficiency of the irrigation water was caused by the undevelopment of the water resources in the Valley.

Hence, it is possible to solve the problem of the water insufficiency in the study area by effective utilization of the resources.

3. Groundwater

The utilization of groundwater resources in the Valley is concentrated out of the Canal Constanza and upland places. Especially groundwater is used in the northern part of the Valley, i.e. Colonia Espanola. On the other hand, only a few cases of groundwater utilization are observed in the center of the Valley.

# ANNEX I : EVALUATION OF PRESENT STATUS OF THE STUDY AREA

## ANNEX I: EVALUATION OF PRESENT STATUS OF THE STUDY AREA


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# ANNEX I: EVALUATION OF PRESENT STATUS OF THE STUDY AREA

## 1. General

In the study area, the intensive agriculture aiming at commercial production is carried out in 1,660ha of upland. However, the agricultural economy is not in a favorable condition, owing to the continuous cropping for many years, especially the pests and diseases on the crops in the Valley. And the study area faces the shortage of the irrigation water, owing to the deterioration of the existing facilities constructed 42 years ago. It is more serious for small scale farmers who can not drill wells than large scale farmers.

The problems of the study area can be described as follows:

Existing Facilities
- Deterioration of the facilities
- Inefficient utilization of irrigation water

Problems of farming
- Decline of soil fertility and intensive cropping
- Continuous simple cropping pattern and the occurrence of pests and diseases
- Lacking of healthy seeds and seedlings
- Lacking of marketing system
- Shortage of irrigation water

Problems of agricultural management
- Lacking of credit
- Lacking of agricultural supporting services

Social problem
- Conflict by the water shortage problem