noticed. In highly salt accumulated soils, a high content of $CaCO_3$ is evident.

3) Phases

The soils are mainly distributed in poorly drained areas and the majority are salt accumualted soils. The same are classified into following phases:

a) Moderately deep phase (code QC); the soil has considerably high potential for agriculture and no major limitations. However, countermeasures to improve physical conditions of compacted subsurface soil and to prevent wet injury due to excessive water supply are recommended. The soil occupies 158ha or about 0.8% of arable land.

b) Poorly-drained salt accumulated, moderately deep phase (QCSII); the degree of salt accumulation varies from slight to high. Moderate to high salt accumulation is found in areas with a high subsurface water table. Agricultural productivity is considerably dependent on farming management practices and drainage improvement and desalinigation are prerequstites for diversified crop production. The soil occupies 437ha or about 2.2% of arable land.

Descriptions of the typical soil profiles of the soil series and the results of chemical and physical soil analysis are shown in Table C-3-2 and C-3-3.

## 4. Distribution of Problem Soils

### (1) Salt Accumulated Soils

Salt accumulated soils in the Project area are grouped into two types according to the formation processes of salt accumulation. The first type (1st type, poorly-drained salt accumulated phase) is found in poorly drained areas with high groundwater tables. Salt accumulation was brought about by the upward movement of groundwater. The distribution of the second type (2nd type, well-drained salt accumulated phase) is generally found in slightly sloping areas with good drainage conditions which are located adjacent to deserts or hills outside of the Project area. The sources of accumulated salts are considered to be the residues of salts accumulated in the process of land formation and salts disolved in irrigation water. In both types, the characteristic of salt accumulation is maximum concentration in the surface layer (10-15cm depth or less). The proposed countermeasures to improve these soils are alluded to in 3-2.

The classification and surface coverages of salt accumulated soils in the Project area are shown in Table C-4-1 while distribution is shown in Fig. C-4-1, C-4-2, C-4-3 and in the soil map (presented in Annex L). Salt accumulated soils occupy about 4,370ha or 22% of the total arable land in the Project area. The results of soil analysis on salt accumulated soils are presented in Table C-4-2.

Table C-4-1 **DISTRIBUTION OF SALT ACCUMULATED SOILS** 1/

| Type | Salinity and Alkalinity Classes 2/ | | | | Total |
|---|---|---|---|---|---|
| | S1 | S2 | S3 | S3N1 | |
| 1st Type (ha) | 1,243 | 562 | 80 | 675 | 2,560 |
| % of Total | 48.6 | 22.0 | 3.1 | 26.4 | 100.0 |
| 2nd Type (ha) | 482 | 1,020 | 304 | - | 1,806 |
| % of Total | 26.7 | 56.5 | 16.8 | - | 100.0 |
| 1st & 2nd (ha) | 1,725 | 1,582 | 384 | 675 | 4,366 |
| % of Total | 39.5 | 36.2 | 8.8 | 15.5 | 100.0 |

1/ Percentage of total arable land (20,200ha)
1st type: 12.7%, 2nd type 8.9%, 1st & 2nd type 21.6%

2/ Classifications are based on the following criteria:

Salinity: ECe of surface layer (0-15cm)
S1: ECe 4-8ms/cm at 25°C
S2: " 8-15 " " "
S3: " >15 " " "

Alkalinity: Exchageable sodium content or exchangeable sodium percentage (ESP) of surface layer (0-15cm)

| | coarse-textured soil | medium-textured soil | fine-textured soil |
|---|---|---|---|
| | exchangeable sodium content in meq/100g soil | ESP | ESP |
| N1: | 2-3 meq | 15-30% | 8-15% |
| N2: | >3 | >30 | >15 |

(2) Gravelly Surface Soils

Gravelly surface soils cover about 2,690ha or 13% of total arable land area as shown in Table C-4-3. In the Esquivel-Trujillo series, gravelly surface soils occupy about 40% (about 2,100ha) of the surface soils of the series.

Table C-4-3 **DISTRIBUTION OF GRAVELLY SURFACE SOILS**

| Gravelly Surface Classes | C2 | C3 | C4 | Total |
|---|---|---|---|---|
| Area (ha) | 1,776<br>(66.0) | 690<br>(25.6) | 225<br>(8.4) | 2,691<br>(100.0) |

Note: -( ) % of total gravelly surface soils
-classifications are based on the following criteria:

| | C2 | C3 | C4 |
|---|---|---|---|
| coarse fragment content (%) in surface layer (0-30cm) | 5-15 | 15-30 | 30 |

-coarse fragment defined are less than 10cm in size

A coarse fragment content of 5-15% is not considered to present significant limitations to crop productivity or to restrict workability to a significant extent. Soils of the gravelly surface class C3 present moderate limitations, to annual crop production both in crop growth and workability and occasional extraction of stones as presently practiced is recommended. However, the limitations of class C3 are comparatively less for fruit cultivation. Soils of class C4 have severe limitations and are generally not suitable for annual crop cultivation. The latter soils are utilized for fruit cultivation is the Project area.

(3) Shallow Soils (effective soil depth)

Effective soil depth of soils in the Project area is generally deep and distribution of soils with shallow effective soil depth is restricted to the Esperanza series and Esquivel-Trujillo series. The effective soil depth of the Esperanza series is considered to be restricted by coarse sandy gravelly subsoil and is generally about 30cm. In the Esquivel-Trujillo series, soils with gravelly (cobbly) layers found within 30 to 40cm depth from the ground surface occupy about 53% of the surface coverages of the series. These soils have significant limitations for crop production in root penetration, and in moisture and nutrient holding capacities. Accordingly, improved farming practices such as irrigation water supply based on soil moisture conditions of root zones and fertilizer application methods to reduce leaching losses of applied nutrients are recommended.

(4) Soils with Compacted Subsurface Layer

Soils in the Project area generally have a compacted subsurface layer restricting downward root distribution. The layer is usually found at 15 to 20cm depth from the ground surface and varies in thickness. The layer not only limits root penetration but also restricts available moisture holding capacity. Subsoiling once every one or two years, a rotation system using crops with different rooting habits, and dressing of organic materials should be practiced to improve physical conditions of subsurface soils.

## 5. Land Classification

(1) Procedures for Land Classification

1) Land classification system

For land classification, land qualities and characteristics selected in compliance with the conditions of the Project area has been taken into consideration and land irrigability has been subsequently classified into the following classes and subclasses based on the U.S.B.R system.

- Class I arable: high suitability for irrigation farming
- Class II arable: moderate suitability for irrigation farming (s, t, d, st, sd, td, std)
- Class III arable: low suitability or marginally suitable for irrigation farming (s, t, d, st, sd, td, std)
- Class IV limited arable or special use: limited arable for irrigation farming, or arable for special use (s, t, d, Fs, Rs, Is, Pd, etc.)
- Class VI nonarable for the use defined
- Sub-class
  - s: deficiency or limitation in soil factor which determines irrigabiltiy class
  - t: deficiency or limitation in topography factor which determines irrigabiltiy class
  - d: deficiency or limitation in drainage factor which determines irrigabiltiy class
  - F: special use for fruit
  - R: special use for salt tolerant crops
  - I: limited arability under intensive irrigation methods
  - P: limited arability due to possibility of flooding

Present nonarable land such as hilly, stony land and residential area are excluded from the above classification. In the present study, present and potential land irrigability classes for both annual crop production (upland crops) and fruit production are examined on the assumption that present surface irrigation will be continued and the proposed rehabilitation project will/be implemented. It is also presumed that desalinigation of salt accumated soils outside of the drainage improvement study areas (predominantly salt accumulated soils 2nd type), would be undertaken by irrigation practices.

2) <u>Factors, land qualities and land characteristics</u>

The factors, land qualities and characteristics for the assessment of land irrigability has been selected and are tabulated on the following page.

## FACTORS, LAND QUALITIES AND LAND CHARACTERISTICS

| Factors | Land Qualities (code) | Land Characteristics |
|---|---|---|
| Soil (s) | effective soil depth (p) | depth of penetrable layer |
| | workability (k) | stoniness of surface coverages |
| | | coarse fragments in the surface layer |
| | | texture of surface layer |
| | moisture availability (m) | potential moisture holding capacity |
| | soil fertility (n) | cation exchange capacity |
| | salinity (e) | ECe of surface soil |
| | Alkalinity (a) | exchageable sodium percentage (ESP) |
| | | exchageable sodium content |
| | permeability (b) | permeability |
| Topography (t) | slope & microrelief (g) | slope, microrelief |
| Drainage (d) | drainability (w) | soil drainability |
| | | depth to impermeable layer/ subsurface water table |
| | flood hazard (f) | flooding problem |

3) Criteria for rating of land qualities

The criteria for the rating of land qualities and land characteristics are in set below.

a) Soil factor (s)

effective soil depth (code: P)

| rating | depth of penetrable layer (cm)* |
|---|---|
| P1 | > 120 |
| P2 | 80 ~ 120 |
| P3 | 30 ~ 80 |
| P4 | < 30 |

* soil depth to gravel, strongly compacted layer or other root restricting materials

moisture availability (code: m)

| rating | potential moisture holding capacity in cm surface soil (0-30cm) | subsoil (30-120cm)* |
|---|---|---|
| m1 | > 4 | > 12 |
| m2 | 3 – 4 | 8 – 12 |
| m3 | 2 – 3 | 6 – 8 |
| m4 | < 2 | < 6 |

* from 30cm to 120cm or to impermeable layer

workability (code: k)

| rating | stoniness of surface coverages (%) | coarse fragments* in the surface layer (0-30cm) | texture of surface layer (0-30cm) |
|---|---|---|---|
| K1 | < 0.01 | < 5 (C1) | coarse to medium (S-L) |
| K2 | 0.01 – 0.1 | 5 – 15 (C2) | fine (CL-C) |
| K3 | 0.1 – 3 | 15 – 30 (C3) | very fine (HC) |
| K4 | 3 – 15 | >30 (C4) | - |

Note: stone herein defined are more than 10cm in size
Note: coarse fragments are less than 10cm in size
* ratings of this characteristic correspond to surface gravelly classes C2-C4 of Table C-4-3

soil fertility (code: n)

| rating | cation exchange capacity of surface layer (0-30cm) meq/100g soil |
|---|---|
| $n^1$ | > 20 |
| $n^2$ | 10 – 20 |
| $n^3$ | 5 – 10 |
| $n^4$ | < 5 |

Note: available nutrient contents are not considered because considerable amount of fertilization is common and nutrient contents seems to be affected by fertilization history

Salinity (code: e)

| rating | ECe* of surface soil (0-15cm) |
|---|---|
| $e^1$ | < 4 |
| $e^2$ | 4 – 8 |
| $e^3$ | 8 – 15 |
| $e^4$ | > 15 |

* electrical conductivity of saturated soil extract at 25°C

- $e^2$, $e^3$, $e^4$ correspond to $S^1$, $S^2$, $S^3$ of Table C-4-1

alkalinity (code: a)

| rating | coorse-textured soil exchangeable sodium content in meq/100g soil | medium-textured soil ESP | fine-textured soil ESP |
|---|---|---|---|
| $a^1$ | < 2 | < 15 | < 8 |
| $a^2$ | 2 - 3 | 15 - 30 | 8 - 15 |
| $a^3$ | > 3 | > 30 | > 15 |

* $a^2$, $a^3$ correspond to $N^1$, $N^2$ of Table C-4-1

permeadility (code: b)

| rating | permeability |
|---|---|
| $b^1$ | moderate |
| $b^2$ | moderately rapid, moderately slow |
| $b^3$ | rapid, slow |
| $b^4$ | very rapid, very slow |

b) Topography factor (t)

slope and microrelief (code: g)

| rating | slope (%) | landform |
|---|---|---|
| $g^1$ | 0 - 2 | flat |
| $g^2$ | 2 - 5 | slightly undulating |
| $g^3$ | 5 - 10 | undulating |
| $g^4$ | > 10 | rolling/hilly |

c) Drainage factor (d)

drainability (code: w)

| rating | soil drainability | depth to impermeable layer |
|---|---|---|
| $w^1$ | good to excessive | > 200cm |
| $w^2$ | moderate | 150 - 200 |
| $w^3$ | imperfect | 100 - 150 |
| $w^4$ | poor | < 100 |

flood hazard (code: f)

| rating | flood problem |
|---|---|
| $f^1$ | no flood occured in 1984 |
| $f^2$ | flood occured in 1984 |

Note: lands which are subject to flooding are classified as IV Pd

The ratings of land qualities and characteristic specific to soil series or phase are shown in Table C-5-1.

(2) Soil Units

In land classification, soil phases are further subclassified into soil mapping units for land classification (soil units) and land irrigability classes are assessed based on present land qualities and characteristics specific to each soil unit. Land qualities and land characteristics having practical importance to irrigation farming listed bewlow and are assessed in accordance with the criteria in the previous section (1) and soil phases are classified into soil units (Table C-3-1).

Land Qualities/Characteristics

Salinity (e), alkalinity (a), coarse fragments content in surface layer (correspond to gravelly surface classes, code c), drainability (d), slope and microrelief (g), flood hazard (f).

Soil units are expressed by soil phase code suffixed with rated code of land quality and characteristic, individually or collectively, as diagramed below.

drainability rating-3

EPSII $e^2$, $a^2$, $w^3$

salinity rating-2

alkalinity rating-2

soil phase code (Esperanza series, poorly-drained salt accumulated phase)

Land qualities or characteristic rated 1 are omitted from suffixing.

(3) Land Irrigability Classes

Irrigability classes are determined on the basis of land quality ratings and the maximum land irrigability class. The maximum land irrigability class corresponding to ratings of each land quality is shown in Table C-5-2. Maximum land irrigability class herein defined is the land class with the highest permissible level into which a specified rating of land quality may possibly be classified. Therefore, land can not be classified into a class higher than the maximum permissible irrigability class corresponding to the ratings of land qualities of the same. The maximum land irrigability class has been set on the basis of the following:

a) fertilization can compensate for deficiency in soil fertility to a significant extent;

b) irrigation can mitigate limitation in moisture availability; and,

c) workability is less significant for fruit production.

Irrigability of land in the Project area is graded into five classes. The classes, especially potential irrigability classes, are generally determined by land qualities related to or restricting availability of moisture and/or nutrients for crops which can be controlled by irrigation and farming practices to a significant degree. Therefore, agricultural potential of the land in the Project area is largely depend on both irrigation water availability and farm management level.

The agricultural potential of each irrigability class of land in the Project area is set in below.

Class I High productivily is expected in general for defined use. There are no major limitations that will adversely affect crop yields.

Class II Moderately high productivity is expected in general for defined use. There are moderate limitations which are likely to reduce crop yields and can generally be compensated by farming practices of a moderately high level.

Class III Low to moderate productively is generally expected. There are strong limitations for crop growth which can only be compensated by high level farming practices.

Class IV The land is limited arable or arable for a defined special use. The land would be expected to be highly to moderately productive dependent on specific conditions of farm management.

Class VI Nonarable. The land is not arable for defined special use.

In the study, present and potential land irrigabilities for both annual crop production and fruit production were first assessed separately. Based on the potential irrigabilities for both uses, the land of the Project area has been comprehensively evaluated and the land irrigability class for irrigation farming determined.

The results of land classification are shown in Table C-5-3, C-5-5, Fig. C-5-1 and summarized in Table C-5-4.

TABLE C-2-1 GROUPING OF SOIL SERIES

| Texture classes | Parent materials | Soil series | Soil Classification | |
|---|---|---|---|---|
| | | | Soil Taxonomy | FAO/UNESCO |
| Fine-textured | alluvial deposit | Quepecaliche | Ustifluvents | Fluvisol |
| Medium-textured | alluvial deposits | Tucume, Clemencia, Mochumi, Ocuaje Lambayeque, Huaral, Esquivel-Trujillo | Ustifluvents | Fluvisol |
| Coarse-Textured | alluvial & colluvial deposits | Esperanza | Ustipsaments | Arenosol |
| | alluvial & eolian deposits | Aucallama | Ustipsaments | Arenosol |

Based on soil classification system of Soil Taxonomy and FAO/UNESCO

Table C-3-1(1) Soil Classification And Soil Units For Land Classification

| Soil series | Soil Phases(code) | Soil units | Area(ha) | Percentage |
|---|---|---|---|---|
| Aucallama | | | 2,542 | 12.6 |
| | 1. deep (AU) | | 1,832 | 9.1 |
| | | AU | 436 | |
| | | " $-g^2$ | 776 | |
| | | " $-g^3$ | 620 | |
| | 2. well-drained salt accumulated, deep(AUSI) | | 212 | 1.0 |
| | | AUSI $-e^2g^3$ | 52 | |
| | | " $-e^4$ | 160 | |
| | 3. well-drained salt accumulated, gravelly surface, deep (AUSIC) | AUSIC$-e^4c^4g^3$ | 97 | 0.5 |
| | 4. poorly-drained salt accumulated, deep (AUSII) | | 401 | 2.0 |
| | | AUS II$-e^2w^2$ | 30 | |
| | | " $-e^2w^3$ | 46 | |
| | | " $-e^3w^3$ | 33 | |
| | | " $-e^4w^3$ | 61 | |
| | | " $-e^2g^2w^2$ | 35 | |
| | | " $-e^2g^2w^3$ | 46 | |
| | | " $-e^4a^2w^4$ | 48 | |
| | | " $-e^4a^2g^2w^4$ | 102 | |
| Esperanza | | | 4,020 | 19.9 |
| | 1. Shallow (EP) | | 2,422 | 12.0 |
| | | EP | 872 | |
| | | " $-g^2$ | 1,184 | |
| | | " $-g^3$ | 366 | |
| | 2. gravelly surface, shallow (EPC) | EPC$-c^2g^3$ | 198 | 1.0 |

% of total arable land 20,200 ha

Table C-3-1(2) Soil Classification and soil units for land classification

| Soil series | Soil Phases (code) | Soil unit | Area (ha) | Percentage / |
|---|---|---|---|---|
| Esperanza | | | | |
| | 3. well-drained salt accumulated, shallow(EPSI) | | 1,138 | 5.6 |
| | | EPSI - $e^{3}$ | 301 | |
| | | " - $e^{2}g^{2}$ | 213 | |
| | | " - $e^{3}g^{2}$ | 259 | |
| | | " - $e^{3}g^{3}$ | 344 | |
| | | " - $e^{4}g^{3}$ | 21 | |
| | 4. well-drained salt accumulated, gravelly surface, shallow(EPSIC) | | 174 | 0.9 |
| | | EPSIC -$e^{2}c^{2}g^{2}$ | 32 | |
| | | " -$e^{3}c^{2}g^{2}$ | 116 | |
| | | " -$e^{4}c^{2}g^{3}$ | 26 | |
| | 5. poorly-drained salt accumulated, shallow (EPSII) | | 88 | 0.4 |
| | | EPSII -$e^{2}w^{3}$ | 19 | |
| | | " -$e^{3}w^{4}$ | 21 | |
| | | " -$e^{4}a^{2}w^{4}$ | 48 | |
| Tucume | | | 1,962 | 9.7 |
| | 1. shallow (TCI) | | 877 | 4.3 |
| | | TCI | 589 | |
| | | " - $g^{2}$ | 210 | |
| | | " - $g^{2}w^{2}$ | 78 | |
| | 2. poorly-drained salt accumulated, shallow (TCISII) | | 147 | 0.7 |
| | | TCISII -$e^{2}w^{3}$ | 58 | |
| | | " -$e^{3}w^{3}$ | 14 | |
| | | " -$e^{3}w^{4}$ | 33 | |
| | | " -$e^{4}s^{2}w^{4}$ | 42 | |

/ % of total arable land

Table C-3-1 (3) Soil calssification and soil units for land classification

| Soil series | Soil Phase (code) | Soil units | Area (ha) | | Percentage / | |
|---|---|---|---|---|---|---|
| Tucume | | | | | | |
| | 3. moderately deep (TCII) | | 845 | | | 4.2 |
| | | TCII | | 520 | | |
| | | " $-g^2$ | | 283 | | |
| | | " $-w^2$ | | 42 | | |
| | 4. poorly-drained salt accumulated, moderately deep (TCIISII) | | 93 | | | 0.5 |
| | | TCIISII $-e^2w^3$ | | 57 | | |
| | | " $-e^3w^3$ | | 16 | | |
| | | " $-e^4a^2w^4$ | | 20 | | |
| Esquivel -Trujillo | | | 5,262 | | 26.0 | |
| | 1. shallow (ESI) | | 1,304 | | | 6.5 |
| | | ESI | | 688 | | |
| | | " $- g^2$ | | 422 | | |
| | | " $- g^3$ | | 82 | | |
| | | " $- w^3$ | | 29 | | |
| | | " $- f^2$ | | 20 | | |
| | | " $- g^2f^2$ | | 36 | | |
| | | " $- w^4f^2$ | | 27 | | |
| | 2. gravelly surface, shallow (ESIC) | | 1,176 | | | 5.8 |
| | | ESIC $- c^2$ | | 483 | | |
| | | " $- c^2g^2$ | | 101 | | |
| | | " $- c^3$ | | 234 | | |
| | | " $- c^3g^2$ | | 341 | | |
| | | " $- c^3w^3f^2$ | | 17 | | |
| | 3. well-drained salt accumulated, gravelly surface, shallow(ESISIC) | | 153 | | | 0.8 |
| | | ESISIC$-e^2c^2g^3$ | | 25 | | |
| | | " $-e^2c^4g^3$ | | 128 | | |

/ % of total arable land 20,200 ha

Table C-3-1(4) Soil classification and soil units for land classification

| Soil series | Soil | Phases (code) Soil units | Area (ha) | Percentage / |
|---|---|---|---|---|
| Esquivel -Trujillo | 4. poorly drained salt accumulated, shallow (ESI SII) | | 47 | 0.2 |
| | | ESISII-$e^2w^2$ | 33 | |
| | | " -$e^4a^2w^4$ | 14 | |
| | 5. poorly-drained salt accumulated, gravelly surface, shallow (ESISIIC) | | 109 | 0.5 |
| | | ESISIIC-$e^2c^2w^3$ | 35 | |
| | | " -$e^3c^2w^4$ | 26 | |
| | | " -$e^2c^2g^2w^2$ | 24 | |
| | | " -$e^2c^3g^2w^2$ | 24 | |
| | 6. moderately deep (ESII) | | 1,677 | 8.3 |
| | | ESII | 1,182 | |
| | | ESII - $g^2$ | 416 | |
| | | " - $w^2$ | 44 | |
| | | " - $w^3$ | 35 | |
| | 7. gravelly surface, moderately deep(ESIIC) | | 634 | 3.1 |
| | | ESIIC - $c^2$ | 526 | |
| | | " - $c^2g^2w^3f^2$ | 34 | |
| | | " - $c^3$ | 25 | |
| | | " - $c^3g^2$ | 49 | |
| | 8. well-drained salt accumulated, gravelly surface, moderately deep (ESIISIC) | ESIISIC-$e^2c^2g^2$ | 32 | 0.2 |
| | 9. poorly-drained salt accumulated (ESIISII) | | 130 | 0.6 |
| | | ESIISII -$e^2w^2$ | 22 | |
| | | " -$e^3w^3$ | 50 | |
| | | " -$e^3w^4$ | 30 | |
| | | " -$e^4a^2w^4$ | 28 | |

/ % of total arable land

Table C-3-1(5) Soil classification and soil units for land classification

| Soil series | Soil Phases (code) | Soil units | Area (ha) | | Percentage/ | |
|---|---|---|---|---|---|---|
| Clemencia | | | 695 | | 3.4 | |
| | 1. deep (CL) | | | 603 | | 3.0 |
| | | CL | | 475 | | |
| | | " - $g^2$ | | 44 | | |
| | | " - $w^3f^2$ | | 53 | | |
| | | " - $w^4f^2$ | | 31 | | |
| | 2. gravelly surface, deep (CLC) | CLC - $c^2$ | | 24 | | 0.1 |
| | 3. poorly-drained salt accumulated, deep (CLSII) | | | 68 | | 0.3 |
| | | CLSII - $e^3w^3$ | | 50 | | |
| | | " -$e^4a^2w^4$ | | 18 | | |
| Huaral | | | 309 | | 1.5 | |
| | 1. moderately deep (HU) | HU - $w^2$ | | 90 | | 0.4 |
| | 2. gravelly surface, moderately deep (HUC) | HUC - $c^2w^2$ | | 54 | | 0.3 |
| | 3. poorly-drained salt accumulated, moderately deep (HUSII) | | | 165 | | 0.8 |
| | | HUSII - $e^2w^3$ | | 144 | | |
| | | " -$e^3g^2w^4$ | | 21 | | |
| Mochumi | | | 3,850 | | 19.1 | |
| | 1. deep (MCH) | | | 3,158 | | 15.6 |
| | | MCH - $w^2$ | | 1,817 | | |
| | | " - $w^3$ | | 47 | | |
| | | " - $g^2w^2$ | | 1,218 | | |
| | | " - $w^2f^2$ | | 19 | | |
| | | " - $g^2w^2f^2$ | | 32 | | |
| | | " - $g^2w^3f^2$ | | 25 | | |

/ % of total arable land 20,200 ha

Table C-3-1 (6) SOIL CLASSIFICATION AND SOIL UNITS FOR LAND CLASSIFICATION

| soil series | soil phases (code) | soil units | area (ha) | percentage 1/ |
|---|---|---|---|---|
| Mochumi | | | | |
| | 2. poorly-drained salt accumulated, deep (MCHSII) | | 652 | 3.2 |
| | | MCHSII-$e^2w^2$ | 145 | |
| | | " -$e^2w^3$ | 160 | |
| | | " -$e^2w^4$ | 42 | |
| | | " -$e^2g^2w^3$ | 21 | |
| | | " -$e^3w^3$ | 66 | |
| | | " -$e^3w^3f^2$ | 30 | |
| | | " -$e^3g^2w^3$ | 47 | |
| | | " -$e^4a^2w^4$ | 141 | |
| | 3. gravelly surface, deep (MCHC) | MCHC-$c^2w^2$ | 40 | 0.2 |
| Ocuaje | | | 360 | 1.8 |
| | 1. deep (OC) | | 306 | 1.5 |
| | | OC - $w^2$ | 87 | |
| | | " - $g^2w^2$ | 219 | |
| | 2. poorly-drained salt accumulated, deep (OCSII) | OCSII-$e^2w^3$ | 54 | 0.3 |
| Lambayeque | | | 605 | 3.0 |
| | 1. deep (LB) | | 416 | 2.1 |
| | | LB - $w^2$ | 190 | |
| | | " - $w^3$ | 44 | |
| | | " - $w^3f^2$ | 22 | |
| | | " - $g^2w^2$ | 136 | |
| | | " - $g^3w^2$ | 24 | |
| | 2. poorly-drained salt accumulated, deep (LBSII) | | 189 | 0.9 |
| | | LBSII-$e^2w^2$ | 25 | |
| | | " -$e^2w^3$ | 104 | |
| | | " -$e^3w^3$ | 26 | |
| | | " -$e^4a^2w^4$ | 15 | |
| | | " -$e^4g^2w^4$ | 19 | |

1/ % of tatal arable land

Table C-3-1 (7) SOIL CLASSIFICATION AND SOIL UNITS FOR LAND CLASSIFICATION

| soil series | soil phases (code) | soil units | area (ha) | percentage 1/ |
|---|---|---|---|---|
| Quepecaliche | | | 595 | 2.9 |
| | 1. moderatly deep (QC) | QC - $w^3$ | 158 | 0.8 |
| | 2. poorly-drained salt accumulated, moderately deep (QCSII) | | 437 | 2.2 |
| | | QCSII-$e^2w^3$ | 114 | |
| | | " -$e^2w^4$ | 25 | |
| | | " -$e^3w^4$ | 99 | |
| | | " -$e^4a^2w^4$ | 199 | |
| | total | | 20,200 ha | 100.0 |

1/ % of total arable land

Table C-3-2 (1) SOIL PROFILE DESCRIPTION

1. Profile No. : R-6
2. Date of Examination : 9 March, 1984
3. Soil Classification : Aucallama series, Deep phase
4. Location : Chancayllo, plot No. R-6
5. Physiography : Slightly sloping land
6. Drainage : good to excessive, groundwater table > 1.5m
7. Parent Material : alluvial & eolian deposits
8. Land Utilization Pattern : annual crop production (kidney bean)

| Horizon | Depth (cm) | Discription |
|---|---|---|
| $A_P$ | 0 - 15 | Dull yellowish brown (10YR 5/4) moist, fine sand to loamy fine sand, weak platy, non-sticky and non-plastic, common fine roots, clear smooth boundary, soil hardness < 15, pH 8.3 - 8.8 EC 0.3 - 0.5 $m^S$ (soil : water = 1:2) |
| AC | 15 - 25 | Dull yellowish brown (10YR 5/4) moist, finesand, single grain, few fine roots, non-sticky and non-plastic diffuse wavy boundary, soil hardness 25 - 30, pH 8.8, EC 0.3 $m^S$ |
| C1 | 25 - 65 | Dull yellowish brown (10YR 5/4) moist, fine sand, single grain, non-sticky and non-plastic, diffuse wavy boundary, soil hardness < 20, pH 8.9, EC 0.2 $m^S$ |
| C2 | 65 - 150 | Dull yellowish brown (10YR 5/4) moist, fine sand, single grain, non-sticky and non-plastic, soil hardness < 15, pH 9.0, EC 0.1 $m^S$ |

Table C-3-2 (2) SOIL PROFILE DESCRIPTION

1. Profile No. : R-2
2. Date of Examination : 2 March, 1984
3. Soil Classification : Esperanza series, Shallow phase
4. Location : Esperanza Granada, plot No. R-2
5. Physiography : nearly flat land
6. Drainage : excessive, groundwater table > 1.5 m
7. Parent Material : alluvial & colluvial deposits
8. Land Utilization Pattern : fruit production (apple and peach)

| Horizon | Depth (cm) | Discription |
|---|---|---|
| A | 0 - 30 | Brown (7.5YR 4/3) moist, loamy sand, content of subangular gravel (0.5 - 1 cm) 3%, weak subangular blocky, mon-sticky and non-plastic, common modium roots, abrupt wavy boundary, pH 8.7, EC 0.2 $m^S$ (soil : water = 1 : 2) |
| C1 | 30 - 65 | Orange (7.5YR 6/6) moist, gravelly coarse sand, single grain, content of sub-angular gravel (0.5 - 2 cm) 10%, clear wavy boundary, pH 8.0, EC 0.1 $m^S$ |
| C2 | 65 - 150 | Bright reddish brown (5YR 5/6) moist, coarse sand, content of subangular gravel (0.5 - 2 cm) 5%, EC 0.1 $m^S$ |

Table C-3-2 (3) SOIL PROFILE DESCRIPTION

1. Profile No. : R-8
2. Date of Examination : 7 March, 1984
3. Soil Classification : Tucume series, Moderately deep phase
4. Location : Retes, plot No. R-8
5. Physiography : flat land
6. Drainage : good, groundwater table > 2 m
7. Parent Material : alluvial deposits
8. Land Utilization Pattern : annual crop production (red pepper)

| Horizon | Depth (cm) | Discription |
|---|---|---|
| $A_p$ | 0 - 15 | Brown (7.5YR 4/3) moist, sandy loam, weak subangular blocky, slightly sticky to slightly plastic, common fine roots, clear smooth boundary, soil hardness 20, pH 7.8 EC 0.8 $m^s$ (soil : water = 1 : 2) |
| AC | 15 - 35 | Brown (7.5YR 4/3) moist, sandy loam, weak subangular blocky, slightly sticky to slightly plastic, few fine roots, diffuse smooth boundary, soil hardness 25, pH 8.2, EC 0.2 $m^2$ |
| C1 | 35 - 95 | Dull reddish brown (5YR 4/3), sandy loam, massive, slightly sticky and slightly plastic, abrupt smooth boundary, soil hardness 20 - 28, pH 7.8, EC 0.2 $m^s$ |
| C2 | 95 - 145 | Dull yellow orange (10YR 6/3), fine to medium sand, single grain, non-sticky and non-plastic, soil hardness 15, pH 7.3, EC 0.2 $m^s$ |

Table C-3-2 (4) SOIL PROFILE DESCRIPTION

1. Profile No. : R-20
2. Date of Examination : 7 March, 1984
3. Soil Classification : Esquivel-Trujillo series, Moderately deep phase
4. Location : Huand, plot No. R-20
5. Physiography : flat land
6. Drainage : good, groundwater table > 2 m
7. Parent Material : alluvial deposits
8. Land Utilization Pattern : fruit production (mandarin)

| Horizon | Depth (cm) | Discription |
|---|---|---|
| Ap | 0 - 15 | Brownish black (7.5YR 3/2) moist, loam, moderate granular, sticky and plastic, few medium roots, clear wavy boundary, soil hardness < 15 (wet), pH 5.9, EC 0.3 $m^S$ (soil : water = 1 : 2) |
| AC | 15 - 30 | Dark brown (7.5 YR 3/3) moist, loam, weak subangular blocky, sticky and plastic, few medium roots, diffuse wavy boundary, soil hardness 28 - 30, pH 6.1, EC 0.3 $m^S$ |
| C1 | 30 - 70 | Dark brown (7.5YR 3/3) moist, loam, weak blocky, sticky and plastic, few to common medium roots, abrupt wavy boundary, soil hardness 24, pH 6.4, EC 0.4 $m^S$ |
| C2 | 70 - 85 | Brown (7.5YR 4/4) moist, fine sand, many coarse prominent mottles (5YR 5/8), single grain, non-sticky and non-plastic, few to common medium roots, abrupt wavy boundary, pH 6.7, EC 0.1 $m^S$ |
| C3 | 85 - 105 | Bright brown (7.5YR 5/8) moist, gravelly sand, many coarse prominent mottles, pH 7.0, EC 0.1 $m^S$ |

Table C-3-2 (5)   SOIL PROFILE DESCRIPTION

1. Profile No. : R-29
2. Date of Examination : 29 June, 1984
3. Soil Classification : Clemencia series, Deep phase
4. Location : Torre Blanca, plot No. R-29
5. Physiography : nearly flat land
6. Drainage : good, groundwater table > 2 m
7. Parent Material : alluvial deposit
8. Land Utilization Pattern : annual crop production (maize)

| Horizon | Depth (cm) | Discription |
|---|---|---|
| $A_p$ | 0 - 20 | Dark brown (10YR 3/3) moist, sandy loam, weak subangular blocky, slightly sticky and slightly plastic, common fine roots, diffuse wavy boundary, soil hardness 15, EC 0.3 $m^s$ |
| AC | 20 - 40 | Dark brown (10YR 3/3) moist, sandy loam, massive, slightly sticky and slightly plastic, few fine roots, diffuse wavy boundary, soil hardness 25, EC 0.3 $m^s$ |
| C1 | 40 - 90 | Dark brown (10YR 3/4) moist, fine sand to loamy sand, single grain non-sticky and non-plastic, very few fine roots, clear wavy boundary, soil hardness 20, EC 0.2 $m^s$ |
| C2 | 90 - 125 | Dark brown (10YR 3/3) moist, sandy loam, content of subangular gravel (1 - 2 cm) 3%, massive, slightly sticky and slightly plastic, clear smooth boundary, soil hardness 21, EC 0.3 $m^s$ |
| C3 | 125 - 150 | Grayish yellow brown (10YR 5/2) moist, loam, massive, sticky and plastic, soil hardness 21 |

Table C-3-2 (6) SOIL PROFILE DESCRIPTION

1. Profile No. : R-35
2. Date of Examination : 2 July, 1984
3. Soil Classification : Huaral series, Moderately deep phase
4. Location : Naturares, plot No. R-35
5. Physiography : flat land
6. Drainage : moderate, groundwater table $>$1.5 m
7. Parent Material : alluvial deposits
8. Land Utilization Pattern : annual crop production (maize)

| Horizon | Depth (cm) | Discription |
|---|---|---|
| A | 0 - 30 | Dark brown (7.5YR 3/3) moist, loam, content of subangular gravel (0.5 - 1 cm) 2%, moderate subangular blocky, sticky and plastic, frequent fine roots, diffuse wavy boundary, soil hardness 17, pH 7.4, ECe 0.8 $m^S$ |
| C1 | 30 - 55 | Dark brown (7.5YR 3/4) moist, clay loam, content of subangular gravel (0.5 - 1 cm) 5%, weak blocky, sticky and plastic, few to common fine roots, diffuse wavy boundary, soil hardness 23, pH 7.2, ECe 0.6 $m^S$ |
| C2 | 55 - 65 | Dark brown (7.5YR 3/4) moist, sandy loam, content of subangular gravel (1 - 2 cm) 10%, moderate subangular blocky, slightly sticky and slightly plastic, few fine roots, abrupt smooth boundary, soil hardness 20, pH 7.2, ECe 0.5 $m^S$ |
| C3 | 65 - 100 | Brown (10YR 4/4) moist, gravelly coarse sand, content of platy and angular gravel (0.2 - 5 cm) 30 - 40%, single grain, non-sticky and non-plastic, few fine roots |

Table C-3-2 (7) SOIL PROFILE DESCRIPTION

1. Profile No. : R-21
2. Date of Examination : 8 March, 1984
3. Soil Classification : Mochumi series, Deep phase
4. Location : Baza Alto, plot No. R-21
5. Physiography : flat land
6. Drainage : good, groundwater table >1.5m
7. Parent Material : alluvial deposits
8. Land Utilization Pattern : annual crop production

| Horizon | Depth (cm) | Discription |
|---|---|---|
| $A_P$ | 0 - 15 | Dark brown (10YR 3/3) moist, sandy loam, moderate subangular blocky, slightly sticky and slightly plastic, very frequent fine roots, clear smooth boundary, soil hardness <10, pH 8.3, EC 0.3 $m^S$ (soil : water = 1 : 2) |
| C1 | 15 - 80 | Dark brown (10YR 3/3) moist, sandy loam, weak blocky, slightly sticky and slightly plastic, very few fineroots, clear wavy boundary, soil hardness 30 (semi-dry), pH 8.3, EC 0.3 $m^S$ |
| C2 | 80 - 100 | Dull yellowish brown (10YR 5/4) moist, sandy loam, common medium distinct mottles massive slightly sticky and slightly plastic, clear smooth boundary, soil hardness 28 (semi-dry), pH 8.0, EC 0.2 $m^S$ |
| C3 | 100 - 150 | Bull brown (7.5YR 5/3) moist, sandy clay loam, common medium distinct mottles, sticky and plastic, soil hardness 24 |

Table C-3-2 (8) SOIL PROFILE DESCRIPTION

1. Profile No. : R-32
2. Date of Examination : 30 June, 1984
3. Soil Classification : Ocuaje series, Deep phase
4. Location : Palpa, plot No. R-32
5. Physiography : slightly undulating land
6. Drainage : moderate, groundwater table > 1.5 m
7. Parent Material : alluvial deposit
8. Land Utilization Pattern : annual crop production (cotton)

| Horizon | Depth (cm) | Discription |
|---|---|---|
| A | 0 - 30 | Brown (7.5YR 4/3) moist, loam, moderate subangular blocky, sticky and plastic, common fine roots, diffuse wavy boundary, soil hardness 15, Ph 7.3, ECe 0.6 $m^{s}$ |
| BC | 30 - 50 | Brown (7.5YR 4/3) moist, clay loam, content of subangular gravel (0.5 cm) 1%, weak blocky, sticky and plastic, few fine roots, gradual wavy boundary, soil hardness 19, pH 7.4, ECe 0.8 $m^{s}$ |
| C1 | 50 - 75 | Brown (10YR 4/4) moist, sandy loam, content of subangular gravel (0.5 - 1 cm) 2%, massive, slightly sticky and slightly plastic, very few fine roots, gradual wavy boundary, soil hardness 24 (semi-dry) pH 7.1, ECe 1.0 $m^{s}$ |
| C2 | 75 - 150 | Dull yellowish brown (10YR 5/4) moist, sandy loam content of subangular gravel (0.5 - 1 cm) 10%, massive slightly sticky and slightly plastic, soil hardness 24 (semi-dry) |

Table C-3-2 (9) SOIL PROFILE DESCRIPTION

1. Profile No. : R-17
2. Date of Examination : 5 March, 1984
3. Soil Classification : Lambayeque series, Deep phase
4. Location : San Francisco, plot No. R-17
5. Physiography : flat land
6. Drainage : imperfect, groundwater table >1.5 m
7. Parent Material : alluvial deposits
8. Land Utilization Pattern : annual crop production

| Horizon | Depth (cm) | Discription |
|---|---|---|
| $A_p$ | 0 - 15 | Brownish black (2.5Y 3/2) moist, loam, weak subangular blocky, sticky and plastic, common fine roots, clear smooth boundary, soil hardness 18, pH 7.9, EC 0.4 $m^s$ (soil : water = 1 : 2) |
| A2 | 15 - 30 | Brownish black (2.5Y 3/2) moist, loam, weak subangular blocky, sticky and plastic, common fine roots, clear smooth boundary, soil hardness 22, pH 7.8, EC 0.3 $m^s$ |
| B1 | 30 - 55 | Dark grayish yellow (2.5Y 4/2), loam, common fine distinct mottles (bright reddish brown), weak blocky, sticky and plastic, few fine roots, diffuse wavy boundary, soil hardness 22, pH 7.7, EC 0.7 $m^s$ |
| B2 | 55 - 75 | Yellowish gray (2.5Y 4/1), clay, many fine prominent mottles (bright reddish brown), weak blocky, sticky to very sticky and plastic to very plastic, few fine roots, clear wavy boundary, soil hardness 22, pH 7.7, EC 0.6 $m^s$ |
| C1 | 75 - 100 | Grayish yellow (2.5Y 6/2), clay, many fine prominent mottles (bright reddish brown), weak blocky, abandant small hard ca-concretions (caliche), pH 7.8, EC 0.6 $m^s$ |

Table C-3-2 (10) SOIL PROFILE DESCRIPTION

1. Profile No. : R-10
2. Date of Examination : 6 March, 1984
3. Soil Classification : Quepecaliche series, Moderately deep phase
4. Location : San Francisco Bajo, plot No. R-10
5. Physiography : flat land
6. Drainage : moderate to imperfect, groundwater take > 1.5 m
7. Parent Material : alluvial deposits
8. Land Utilization Pattern : annual crop production (cotton)

| Horizon | Depth (cm) | Discription |
|---|---|---|
| A | 0 - 35 | Brownish black (10YP 3/2) moist, clay loam, moderate granular, sticky and plastic, frequent fine roots, diffuse wavy boundary, soil hardness 25 - 30 (dry) pH 7.9, EC 0.2 $m^S$ (soil : water = 1 : 2) |
| C1 | 35 - 75 | Grayish yellow brown (10YR 4/2) moist, clay, many medium prominent mettles, moderate subangular blocky, very sticky and very plastic, very frequent small to large hard ca-concretions, very few fine roots, clear irregular boundary, soil hardness 25, pH 8.2, EC 0.3 $m^S$ |
| C2 | 75 - 110 | Dully yellow orange (10YR 6/3) moist, clay, many medium to coarse prominent mottles, moderate subangular blocky, abandant small to large hard ca-concretions, clear wavy boundary, pH 7.9, EC 0.3 $m^S$ |
| Cm | 110 - 125 | Dull yellow orange (10YR 6/3) moist, light gray (10YR 8/1) dry, continuous vesicular ca-pans (caliche) |

Table C-3-3(1) Result of Soil Analysis Chemical Characteristics of Soil Profiles

| Series | Plat No. | Horizon | | PH | S.P % | O.M % | CaCO3 % | CaSO4 % | EC ms/cm | Soluble Cations(meg/ℓ) Na | K | Ca | Mg | Soluble Anions(meg/ℓ) Cl | SO4 | CO3 | HCO3 | Cation Exchange CEC meg/100g | Ex-Na meg/100g | % | AV. Nutrient ✓ P PPM | K PPM | Texture Clay | Silt | Sabd | Class | Remarks | Sample No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aucallama (Au) | R-6 | I | 0-15 | 8.1 | 26.7 | 0.74 | 9.64 | 0.045 | 1.18 | 0.63 | 0.16 | 3.28 | 1.72 | 0.6 | 5.28 | 0 | 3.2 | 5.2 | 0.62 | 12 | 19.7 | 135 | 5.2 | 8.0 | 86.8 | LS | | C-7 |
| | | II | 15-25 | 8.3 | 22.7 | 0.33 | 7.69 | 0.034 | 0.50 | 0.61 | 0.13 | 1.04 | 1.64 | 1.1 | 0.36 | 0 | 3.0 | 4.0 | 0.36 | 9 | 13.0 | 166 | 2.2 | 9.0 | 88.8 | S | | C-8 |
| | | III, IV | 25-100 | 8.4 | 25.3 | 0.17 | 6.82 | 0.031 | 0.43 | 0.50 | 0.08 | 0.92 | 1.24 | 1.0 | 0.66 | 0 | 2.0 | 2.8 | 0.20 | 7 | 7.5 | 137 | 1.2 | 2.0 | 96.8 | A | | C-9 |
| Esperanza (Ep) | R-2 | I | 0-15 | 7.8 | 25.0 | 0.74 | 0.85 | tr. | 0.83 | 0.84 | 0.14 | 2.52 | 0.43 | 2.0 | 0.56 | 0 | 4.0 | 5.6 | 0.10 | 2 | 6.1 | 102 | 7.2 | 16.0 | 76.8 | LB-SL | | C-1 |
| | | II | 15-30 | 8.1 | 23.3 | 0.43 | 1.00 | tr. | 0.65 | 0.70 | 0.10 | 2.20 | 2.32 | 1.2 | 2.92 | 0 | 3.4 | 5.6 | 0.16 | 3 | 3.2 | 66 | 7.0 | 12.6 | 80.4 | LS | | C-2 |
| Tucume (Tc) | R-8 | I | 0-15 | 7.7 | 24.7 | 1.00 | 0.49 | tr. | 2.41 | 0.64 | 0.48 | 10.0 | 7.10 | 2.4 | 23.32 | 0 | 2.5 | 8.8 | 0.11 | 3 | 18.2 | 141 | 9.2 | 18.0 | 71.8 | SL | | C-13 |
| | | II | 15-35 | 7.9 | 23.7 | 0.74 | 0.37 | tr. | 1.11 | 0.35 | 0.20 | 3.68 | 1.52 | 2.2 | 4.23 | 0 | 3.0 | 9.0 | 0.14 | 2 | 12.7 | 104 | 9.0 | 15.2 | 75.8 | SL | | C-14 |
| | | III | 35-95 | 7.5 | 24.7 | 0.43 | 0.00 | tr. | 1.08 | 0.42 | 0.11 | 5.40 | 2.52 | 1.8 | 10.05 | 0 | 2.0 | 14.0 | 0.10 | 1 | 4.0 | 96 | 13.2 | 19.0 | 67.8 | SL | | C-15 |
| " (Es) | R-20 | I | 0-15 | 7.6 | 36.8 | 1.98 | 0.06 | 0.103 | 3.80 | 14.4 | 2.55 | 20.5 | 16.5 | 2.5 | 58.45 | 0 | 2.0 | 19.2 | 0.10 | 1 | 54.3 | 364 | 21.2 | 30.0 | 48.8 | L | | C-47 |
| | | II | 15-30 | 6.6 | 34.8 | 1.00 | 0.03 | 0.069 | 1.32 | 1.60 | 0.84 | 6.60 | 2.42 | 1.6 | 8.16 | 0 | 2.0 | 21.2 | 0.08 | - | 32.7 | 252 | 22.2 | 29.0 | 38.8 | L | | C-48 |
| | | III | 30-70 | 7.0 | 32.1 | 0.37 | 0.00 | 0.076 | 0.91 | 1.35 | 0.57 | 3.60 | 2.92 | 1.3 | 5.14 | 0 | 2.0 | 15.4 | 0.06 | 1 | 19.1 | 223 | 17.2 | 30.0 | 52.8 | SL | | C-49 |
| Huaral (Hu) | R-35 | I | 0-30 | 7.4 | 32.4 | 1.31 | 0.20 | | 0.75 | | | | | | | | | 11.8 | 0.08 | 1 | | | 22.0 | 28.0 | 50.0 | L | | T-6 |
| | | II | 30-55 | 7.2 | 30.2 | 0.90 | 1.19 | | 0.55 | | | | | | | | | 11.6 | 0.08 | 1 | | | 23.0 | 21.0 | 56.0 | SCL | | T-7 |
| | | III | 55-65 | 7.2 | 25.0 | 0.37 | 0.10 | | 0.53 | | | | | | | | | 10.0 | 0.06 | 1 | | | 19.0 | 17.0 | 64.0 | SL | | T-8 |
| " (Mch) | R-21 | I | 0-15 | 7.9 | 24.0 | 1.14 | 1.28 | 0.052 | 0.83 | 2.40 | 0.29 | 3.76 | 1.68 | 1.0 | 5.73 | 0 | 2.4 | 8.8 | 0.10 | 1 | 11.6 | 240 | 8.2 | 15.0 | 76.8 | SL | | C-50 |
| | | II | 15-80 | 7.9 | 23.9 | 0.54 | 2.34 | 0.065 | 0.58 | 1.86 | 0.24 | 2.20 | 1.52 | 1.4 | 2.42 | 0 | 2.0 | 7.8 | 0.16 | 2 | 5.8 | 166 | 9.0 | 12.2 | 78.8 | SL | | C-51 |
| Ocuaje (Oc) | R-32 | I | 0-30 | 7.3 | 38.2 | 1.57 | 0.46 | | 0.58 | | | | | | | | | 18.8 | 0.18 | 1 | | | 28.0 | 38.4 | 33.6 | CL | | T-3 |
| | | II | 30-50 | 7.4 | 37.6 | 1.41 | 0.46 | | 0.79 | | | | | | | | | 16.8 | 0.10 | 1 | | | 26.0 | 38.0 | 36.0 | L | | T-4 |
| | | III | 50-75 | 7.1 | 35.4 | 0.80 | 0.03 | | 0.96 | | | | | | | | | 10.2 | 0.08 | 1 | | | 12.4 | 32.6 | 55.0 | SL | | T-5 |
| Lambayeque(LB) | R-17 | I | 0-15 | 7.6 | 49.0 | 3.85 | 34.25 | 0.038 | 1.49 | 2.05 | 0.64 | 6.40 | 4.92 | 2.6 | 9.21 | 0 | 2.2 | 14.2 | 0.12 | 1 | 23.4 | 270 | 23.0 | 34.5 | 42.5 | L | | C-38 |
| | | II | 15-30 | 7.7 | 47.5 | 3.82 | 33.39 | 0.048 | 1.42 | 2.85 | 0.37 | 6.40 | 4.36 | 2.6 | 9.38 | 0 | 2.0 | 17.6 | 0.36 | 2 | 13.0 | 199 | 23.0 | 30.0 | 47.0 | L | | C-39 |
| | | III | 30-55 | 7.9 | 46.2 | 1.00 | 20.62 | 0.038 | 1.49 | 2.25 | 0.12 | 8.00 | 4.00 | 3.2 | 9.17 | 0 | 2.0 | 21.8 | 0.32 | 2 | 2.9 | 96 | 22.0 | 30.0 | 48.0 | L | | C-40 |
| | | IV | 55-75 | 7.8 | 62.5 | 1.81 | 38.51 | 0.038 | 1.49 | 2.25 | 0.08 | 7.60 | 3.76 | 4.0 | 7.39 | 0 | 2.0 | 25.2 | 0.40 | 2 | 3.5 | 78 | 53.2 | 39.8 | 7.0 | C-SiC | | C-41 |
| | | V | 75-100 | 7.8 | 72.9 | 1.44 | 80.94 | tr. | 1.82 | 2.65 | 0.11 | 9.52 | 6.04 | 8.0 | 8.12 | 0 | 2.2 | 17.4 | 0.20 | 1 | 6.6 | 74 | | | | | | C-31 |
| Quepecaliche (QC) | R-10 | I | 0-10 | 8.1 | 38.0 | 2.48 | 22.07 | 0.065 | 0.56 | 0.37 | 0.18 | 2.80 | 1.52 | 1.2 | 3.7 | 0 | 3.3 | 23.4 | 0.28 | 1 | 18.0 | 194 | 22.0 | 26.0 | 52.0 | SCL | | C-19 |
| | | II | 10-35 | 8.1 | 41.7 | 2.51 | 22.75 | 0.048 | 0.43 | 0.19 | 0.16 | 2.64 | 1.16 | 1.1 | 2.09 | 0 | 3.6 | 23.4 | 0.14 | 1 | 13.0 | 164 | 25.3 | 21.7 | 52.0 | SCL | | C-20 |
| | | III | 35-55 | 8.0 | 48.2 | 1.74 | 44.89 | 0.076 | 0.65 | 0.40 | 0.17 | 3.00 | 1.88 | 1.0 | 4.45 | 0 | 3.0 | 32.4 | 0.28 | 1 | 6.4 | 166 | 58.0 | 35.0 | 7.0 | C | | C-21 |
| | | IV | 55-75 | 8.0 | 47.7 | 1.67 | 38.01 | 0.069 | 0.55 | 0.37 | 0.12 | 2.48 | 1.68 | 1.0 | 3.53 | 0 | 2.6 | 21.8 | 0.18 | 1 | 4.3 | 141 | 43.0 | 45.0 | 12.0 | Sic | | C-22 |
| | | VI | 80-110 | 8.1 | 41.5 | 0.30 | 20.11 | 0.031 | 0.66 | 3.60 | 1.10 | 3.60 | 1.20 | 2.0 | 5.30 | 0 | 2.2 | 13.4 | 0.24 | 2 | 3.2 | 221 | 15.3 | 32.7 | 52.0 | L | | C-61 |

S.P --- Saturalion %, O.M --- Organic matter %, EC --- E.C. of Saturation extract, ms/cm of 25°C, AV. nutient --- available nutrient

Outside --- Outside of Project area

Table C-3-3 (2) Results of soil analysis: Three Phases of soil and available moisture percentage

| Soil Series | Plot No. | Soil Depth | | Av | Mr | Sr | P | Do | d | FC | P.W.P 1/ | P.W.P 2/ | A.M 3/ | A.M 4/ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | cm | % | % | % | % | $g/cm^3$ | $g/cm^3$ | % | % | % | % | % |
| Aucallama | R-40 | I | 0-20 | 37.1 | 12.8 | 50.2 | 49.9 | 1.34 | 2.66 | 10.0 | 3.0 | 4.9 | 9 | 7 |
| | | II | 20-35 | 24.6 | 14.9 | 60.5 | 39.5 | 1.61 | 2.66 | 10.2 | 3.1 | 5.0 | 11 | 8 |
| | | III | 35-60 | 28.3 | 9.8 | 62.0 | 38.1 | 1.63 | 2.63 | 7.3 | 2.1 | 3.2 | 8 | 7 |
| Esperanza | R-38 | I | 0-10 | 39.2 | 8.8 | 52.0 | 48.0 | 1.44 | 2.77 | 4.3 | 1.2 | 1.3 | 4 | 4 |
| | | II | 10-40 | 30.4 | 13.4 | 56.3 | 43.8 | 1.56 | 2.77 | 4.8 | 1.3 | 1.6 | 6 | 5 |
| | | III | 40-70 | 38.0 | 4.1 | 57.9 | 42.1 | 1.57 | 2.71 | 2.2 | 0.6 | - | 3 | 3 |
| Tucume | R-30 | I | 0-15 | 25.8 | 14.7 | 59.6 | 40.4 | 1.55 | 2.60 | 8.5 | 2.5 | 3.9 | 9 | 7 |
| | | II | 15-30 | 7.3 | 20.9 | 71.8 | 28.2 | 1.87 | 2.60 | 8.7 | 2.6 | 4.1 | 11 | 9 |
| | | III | 30-70 | 27.3 | 13.6 | 59.1 | 40.9 | 1.59 | 2.69 | 4.0 | 1.1 | 1.1 | 5 | 5 |
| Esquivel-Trujillo | R-28 | I | 0-15 | 28.7 | 17.4 | 54.0 | 46.1 | 1.45 | 2.69 | 11.8 | 3.6 | 6.0 | 12 | 8 |
| | | II | 15-30 | 18.3 | 25.4 | 56.3 | 43.7 | 1.52 | 2.69 | 9.8 | | | | |
| | | III | 30-50 | 19.5 | 21.9 | 58.7 | 41.4 | 1.58 | 2.69 | 8.7 | 2.6 | 4.1 | 10 | 7 |
| | | IV | 50-80 | 28.9 | 15.1 | 56.0 | 44.0 | 1.47 | 2.63 | 6.4 | 1.8 | 2.6 | 7 | 6 |
| Esquivel-Trujillo | R-37 | I | 0-30 | 29.0 | 21.8 | 49.3 | 50.8 | 1.33 | 2.69 | 14.5 | 4.5 | 7.7 | 13 | 9 |
| | | II | 30-60 | 23.4 | 12.1 | 64.5 | 35.5 | 1.59 | 2.46 | 12.2 | 3.7 | 6.3 | 14 | 9 |
| | | III | 60-100 | 29.0 | 12.1 | 59.0 | 41.1 | 1.52 | 2.58 | 9.0 | 2.7 | 4.2 | 10 | 7 |

Av: gass phase Mr: liquid phase Sr: solid phase P: porosity do: bulk density
d: real density FC: field capacity P.W.P: permanent wilting point AM: available moisture (volume percentage)

$P.W.P^{1/} = 0.238 \times FC^{1.102}$ (empirical formula obtained in Japan)

$P.W.P^{2/} = (FC/0.862-2.62)/1.84$ (from soil study report by Direccion General de Agua)

$A.M^{3/} = (FC\% - P.W.P^{1/}) \times do$

$A.M^{4/} = (FC\% - P.W.P^{2}/) \times do$

Table C-3-3 (3) Results of soil analysis: Three Phases of soil and available moisture percentage

| Soil Series | Plot No. | Soil Depth | Av | Mr | Sr | P | Do | d | FC | P.W.P 1/ | P.W.P 2/ | A.M 3/ | A.M 4/ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | cm | % | % | % | % | $g/cm^3$ | $g/CM^3$ | % | % | % | % | % |
| Clemencia | R-29 | I 0-20 | 22.8 | 19.6 | 57.6 | 42.4 | 1.45 | 2.52 | 12.0 | 3.7 | 6.1 | 12 | 9 |
| | | II 20-40 | 17.5 | 18.5 | 64.1 | 36.0 | 1.61 | 2.52 | 10.3 | 3.1 | 5.1 | 12 | 8 |
| | | III 40-90 | 30.3 | 10.1 | 59.7 | 40.3 | 1.51 | 2.53 | 7.6 | 2.2 | 3.4 | 8 | 6 |
| Mochumi | R-31 | I 0-50 | 14.9 | 18.3 | 66.8 | 33.2 | 1.62 | 2.41 | 14.3 | 4.5 | 7.6 | 16 | 11 |
| | | II 15-30 | 12.2 | 16.9 | 70.9 | 29.1 | 1.71 | 2.41 | 12.0 | 3.7 | 6.1 | 14 | 11 |
| | | III 30-60 | 26.1 | 5.2 | 68.7 | 31.3 | 1.77 | 2.57 | 10.2 | 3.1 | 5.0 | 13 | 9 |
| Mochumi | R-41 | I 0-20 | 19.9 | 22.2 | 58.0 | 42.1 | 1.43 | 2.46 | 16.6 | 5.3 | 9.0 | 16 | 11 |
| | | II 20-45 | 13.9 | 18.5 | 67.7 | 32.3 | 1.67 | 2.46 | 13.9 | 4.3 | 7.3 | 16 | 11 |
| | | III 45-85 | 17.8 | 20.2 | 62.0 | 38.0 | 1.59 | 2.57 | 13.6 | 4.3 | 7.3 | 15 | 10 |
| | | IV 85-150 | 12.0 | 22.6 | 65.4 | 34.6 | 1.68 | 2.57 | 13.1 | 4.1 | 6.8 | 15 | 11 |
| Ocucaje | R-32 | I, II 0-30 | 22.8 | 15.0 | 62.2 | 37.8 | 1.54 | 2.47 | 14.9 | 4.7 | 8.0 | 16 | 11 |
| | | III 30-50 | 19.3 | 18.6 | 62.2 | 37.9 | 1.49 | 2.40 | 14.4 | 4.5 | 7.6 | 15 | 10 |
| | | IV 50- | 31.9 | 9.7 | 58.4 | 41.6 | 1.48 | 2.53 | 11.5 | 3.5 | 5.8 | 13 | 8 |
| Quepacalich | R-39 | I 0-15 | 38.1 | 16.9 | 45.1 | 55.0 | 1.07 | 2.36 | 21.9 | 7.1 | 12.4 | 16 | 10 |
| | | II 15-25 | 22.5 | 26.0 | 51.6 | 48.4 | 1.22 | 2.36 | 22.3 | 7.3 | 12.7 | 18 | 12 |
| | | III 25-75 | 21.5 | 19.0 | 59.6 | 40.5 | 1.38 | 2.31 | 19.6 | 6.3 | 10.9 | 18 | 12 |

Av: gass phase  Mr: liquid phase  Sr: solid phase  P: porosity  do: bulk density  d: real density
FC: field capacity  P.W.P: permanent wilting point  AM: available moisture (volume percentage)

P.W.P 1/ $= 0.238 \times FC^{1.102}$ (empirical formula obtained in Japan)

P.W.P 2/ = (FC/0.862-2.62)/1.84 (from soil study report by Direccion general de Agua)

A.M 3/ = (FC% - P.W.P 1/) x do

A.M 4/ = (FC% - P.W.P 2/) x do

Table C-4-2 (1) Results of soil analysis - Characteristics of accumulated salts - 1st phase survey

| Plot No. (soil series code) | Horizon/depth cm | pH | ECe ms/cm | CaCo3 % | CaSo4 % | Soluble cations (meg/ℓ) Na | K | Ca | M8 | Soluble anions (meg/ℓ) Cl | SO4 | CO3 | HCO3 | Remark | Sample No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R-4 (EP) | I 0-15 | 7.0 | 10.0 | 0.06 | 0.03 | 19.0 | 6.4 | 54.6 | 33.6 | 25.0 | 85.4 | 0 | 3.2 | 2nd type A | E - 1 |
| | II 15-30 | 7.7 | 0.8 | 0.60 | tr. | 2.4 | 0.8 | 3.2 | 2.4 | 2.0 | 4.3 | 0 | 2.5 | | E - 2 |
| | III 35-75 | 7.8 | 0.5 | 0.60 | tr. | 1.2 | 0.3 | 1.9 | 1.8 | 1.0 | 2.6 | 0 | 1.6 | | E - 3 |
| R-5 (EP) | I 0-3 | 7.3 | 128 | 1.19 | 0.17 | 1,260 | 54.0 | 276 | 228 | 1,800 | 16.4 | 0 | 1.6 | 2nd typa A | E - 4 |
| | II 3-6 | 7.2 | 94.6 | 0.74 | 1.24 | 510 | 42.5 | 520 | 200 | 1,220 | 50.5 | 0 | 2.0 | Outside | E - 5 |
| | III 6-10 | 7.6 | 41.5 | 1.02 | 0.65 | 243 | 18.4 | 220 | 86.0 | 500 | 65.8 | 0 | 1.6 | | E - 6 |
| | IV 10-30 | 7.5 | 59.8 | 0.38 | 378 | 18.0 | 193 | 60.0 | 600 | 52.4 | 0 | 0 | 1.6 | | E - 7 |
| | V 30-50 | 7.0 | 199 | 1.02 | 0.72 | 1,450 | 13.0 | 320 | 240 | 1,980 | 40.2 | 0 | 2.8 | | E - 8 |
| | VI 50-65 | 7.9 | 29.9 | 0.33 | 1.38 | 130 | 10.9 | 102 | 87.2 | 300 | 29.1 | 0 | 1.0 | | E - 9 |
| R-25 (AU) | I 0-15 | 7.8 | 48.1 | 5.03 | 0.18 | 320 | 11.8 | 124 | 50.0 | 500 | 0.8 | 0 | 5.0 | 2nd type B | E - 10 |
| | II 15-30 | 7.9 | 26.6 | 2.44 | 0.18 | 168 | 5.1 | 78.8 | 26.8 | 230 | 45.2 | 0 | 3.0 | Hattillo | E - 11 |
| | IV 32-57 | 7.7 | 20.8 | 5.42 | 0.07 | 130 | 3.0 | 63.6 | 26.4 | 180 | 41.8 | 0 | 1.2 | | E - 12 |
| | V 57-77 | 7.9 | 14.4 | 7.53 | 0.05 | 60.0 | 2.6 | 45.6 | 20.9 | 100 | 27.9 | 0 | 1.2 | | E - 13 |
| | VI 77-83 | 7.8 | 22.2 | 7.75 | 0.10 | 97.5 | 4.2 | 84.0 | 45.2 | 204 | 25.4 | 0 | 1.5 | | E - 14 |
| S-2 (EP) | I 0-15 | 7.3 | 149 | 1.18 | 0.96 | 1,280 | 53.2 | 288 | 244 | 1,850 | 12.7 | 0 | 2.5 | 2nd type A | E - 15 |
| | II 15-25 | 7.7 | 49.8 | 0.37 | 0.41 | 385 | 12.2 | 130 | 80.0 | 600 | 4.7 | 0 | 2.5 | | E - 16 |
| | III 25-50 | 7.8 | 33.2 | 0.23 | 0.58 | 230 | 5.3 | 44.0 | 58.6 | 340 | 46.1 | 0 | 1.8 | | E - 17 |

Outside: outisde of the Project area    pH, ECe: pH & EC of Saturation extract

1st type, 2nd type A, 2nd type B: types of salt accumulated soils (see 3.2.1)

Table C-4-2 (2) Results of soil analysis - Characteristics of accumulated salts - 1st phase survey

| Plot No. (soil series code) | | Horizon/depth cm | | PH | ECe ms/cm | CaCo3 % | CaSo4 % | Soluble cations (meg/ℓ) Na | K | Ca | Mg | Soluble anions (meg/ℓ) Cl | SO4 | CO3 | HCO3 | Remark | Sample No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S-28 | (TC) | I | 0-10 | 8.5 | 3.2 | 1.87 | 0.05 | 25.2 | 0.7 | 8.5 | 3.5 | 15.0 | 19.4 | 0.2 | 3.3 | | E - 18 |
| | | II | 10-25 | 8.2 | 1.3 | 1.73 | 0.03 | 8.2 | 0.3 | 4.0 | 1.8 | 5.2 | 7.2 | 0 | 1.8 | | E - 19 |
| | | III | 25-40 | 8.4 | 1.2 | 0.62 | tr. | 3.1 | 0.1 | 3.6 | 1.7 | 4.0 | 2.5 | 0 | 2.0 | | E - 20 |
| S-29 | (AU) | I | 0-15 | 7.9 | 7.6 | 7.44 | 0.04 | 45.0 | 1.7 | 30.0 | 4.3 | 30.0 | 48.5 | 0 | 2.5 | 2nd type A | E - 21 |
| | | II | 15-45 | 8.6 | 2.0 | 4.74 | 0.03 | 2.0 | 0.6 | 4.2 | 2.6 | 60 | 1.2 | 0.2 | 2.0 | | E - 22 |
| S-30 | (QC) | I | 0-20 | 8.0 | 3.8 | 37.3 | 0.96 | 8.2 | 0.6 | 36.3 | 10.5 | 3.0 | 49.8 | 0 | 2.8 | | E - 23 |
| | | II | 20-50 | 7.9 | 3.3 | 36.5 | 0.45 | 2.2 | 0.5 | 30.0 | 11.0 | 4.0 | 37.1 | 0 | 2.5 | | E - 24 |
| | | III | 50-70 | 7.9 | 3.0 | 22.3 | 1.82 | 11.5 | 0.4 | 30.0 | 9.4 | 2.5 | 46.6 | 0 | 2.2 | | E - 25 |
| S-31 | (QC) | I | 0-15 | 8.0 | 4.3 | 24.1 | 0.26 | 18.0 | 0.50 | 29.7 | 12.6 | 10.5 | 47.8 | 0 | 2.5 | 1st type | E - 26 |
| | | II | 15-30 | 8.1 | 2.3 | 25.3 | 0.07 | 5.7 | 0.40 | 14.1 | 5.5 | 5.8 | 17.4 | 0 | 2.6 | | E - 27 |
| | | III | 30-55 | 8.0 | 1.8 | 20.0 | 0.03 | 7.4 | 0.4 | 7.9 | 5.1 | 4.0 | 14.3 | 0 | 2.4 | | E - 28 |
| S-32 | (LB) | I | 0-15 | 8.6 | 5.1 | 4.6 | 0.06 | 37.2 | 1.1 | 16.3 | 8.5 | 12.5 | 47.1 | 0.2 | 9.6 | 1st type | E - 29 |
| | | II | 15-25 | 8.4 | 3.8 | 8.7 | 0.05 | 24.0 | 0.6 | 6.6 | 4.5 | 12.5 | 20.2 | 0 | 3.0 | | E - 30 |
| | | III | 25-50 | 7.9 | 5.0 | 10.0 | 0.03 | 33.5 | 0.9 | 10.5 | 3.4 | 21.5 | 24.0 | 0 | 2.8 | | E - 31 |
| S-34 | (MCH) | I | 0-20 | 7.7 | 6.3 | 40.1 | 0.20 | 9.5 | 1.6 | 43.5 | 20.4 | 10.0 | 62.6 | 0 | 2.4 | 1st type | E - 34 |
| | | II | 20-45 | 7.9 | 3.2 | 34.6 | 0.18 | 6.0 | 0.7 | 24.8 | 12.7 | 5.0 | 37.0 | 0 | 2.2 | | E - 35 |

Outside: outside of the Project area  pH, ECe: pH & EC of saturation extract

1st type, 2nd type A, 2nd type B: types of salt accumulated soils (see 3.2.1)

Table C-4-2 (3) Results of soil analysis - Characteristics of accumulated salts - 2nd phase survey

| Plot No. (soil series code) | | Horizon/depth cm | | pH | ECe $m^3/cm$ | CaCo3 % | CaSo4 % | Soluble cations(meq/ℓ) Na | K | Ca | M8 | Soluble anions(meq/ℓ) Cl | SO4 | CO3 | HCO | Remark | Sample No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L-3 | (MCH) | I | 0-30 | 7.4 | 37.6 | | | 270 | 1.8 | 82.4 | 57.2 | 410 | 30.3 | 0 | 2.8 | 1st type | C - 1 |
| | | II | 30-50 | 7.3 | 14.6 | | | 97.5 | 0.5 | 38.1 | 22.3 | 118 | 38.2 | 0 | 2.2 | | C - 2 |
| L-7 | (EP) | I | 0-15 | 8.0 | 13.9 | | | 185 | 2.2 | 27.2 | 12.8 | 52 | 171 | 0 | 4.3 | 1st type | A - 1 |
| | | II | 15-25 | 8.4 | 1.9 | | | 12.0 | 0.3 | 3.6 | 2.8 | 8.0 | 5.7 | 0 | 5.0 | | A - 2 |
| | | III | 25-40 | 7.7 | 0.8 | | | 4.8 | 0.3 | 3.2 | 10.4 | 2.0 | 4.1 | 0 | 3.2 | | A - 3 |
| | | IV | 40-60 | 8.0 | 1.2 | | | 10.6 | 0.3 | 3.0 | 1.8 | 5.0 | 149 | 0 | 3.6 | | A - 4 |
| L-9' | (MCH) | I | 0-15 | 7.7 | 30.2 | | | 210 | 3.5 | 45.6 | 53.2 | 200 | 107 | 0 | 5.0 | 1st type | A - 5 |
| | | II | 15-30 | 7.6 | 1.6 | | | 10.8 | 0.2 | 10.9 | 5.0 | 10.0 | 14.9 | 0 | 2.0 | | A - 6 |
| L-10 | (QC) | I | 0-15 | 7.4 | 37.0 | | | 270 | 2.5 | 50.8 | 20.0 | 242 | 103 | 0 | 4.0 | 1st type | A - 7 |
| | | II | 15-25 | 7.6 | 3.8 | | | 16.8 | 0.1 | 20.9 | 4.9 | 5.0 | 35.1 | 0 | 2.6 | | A - 8 |
| | | | 30-75 | 7.5 | 2.9 | | | 13.0 | 0.1 | 11.3 | 6.8 | 5.5 | 23.2 | 0 | 2.5 | | A - 9 |
| | | | 75-100 | 7.7 | 1.9 | | | 5.7 | 0.1 | 14.1 | 5.3 | 5.5 | 17.7 | 0 | 2.0 | | A - 10 |
| L-11 | (AU) | I | 0-15 | 7.9 | 24.8 | | | 110 | 4.4 | 26.0 | 140 | 158 | 117 | 0 | 5.2 | 1st type | A - 11 |
| | | II | 15-30 | 7.5 | 2.0 | | | 5.0 | 0.2 | 11.0 | 5.5 | 5.0 | 13.6 | 0 | 3.0 | | A - 12 |
| | | III | 30-45 | 7.7 | 24. | | | 16.0 | 0.9 | 17.9 | 6.4 | 12.5 | 25.9 | 0 | 2.8 | | A - 13 |
| L-14 | (LB) | I | 0-15 | 7.6 | 43.2 | | | 460 | 19.8 | 47.0 | 49.0 | 400 | 171 | 0 | 5.0 | 1st type | A - 14 |
| | | II | 15-45 | 7.8 | 1.7 | | | 7.7 | 0.1 | 10.2 | 2.3 | 5.0 | 12.8 | 0 | 2.5 | | A - 15 |
| | | III | 45-100 | 7.5 | 3.8 | | | 17.0 | 0.5 | 16.9 | 10.5 | 5.0 | 36.9 | 0 | 3.0 | | A - 16 |
| L-25 | (AU) | I | 0-15 | 7.8 | 39.8 | | | 250 | 13.1 | 36.0 | 128 | 400 | 4.1 | 0 | 3.0 | 1st type | A - 22 |
| | | II | 15-30 | 7.4 | 9.6 | | | 58.4 | 0.3 | 13.6 | 15.8 | 75.0 | 10.6 | 0 | 2.6 | | J - 1 |

Table C-4-2 (4) Results of soil analysis - Charactoristics of accumulated salts - 2nd phase survey

| (soil series code) | | Horizon/depth | cm | pH | ECe $m^3/cm$ | CaCO3 % | CaSO4 % | Soluble cation (meg/ℓ) Na | K | Ca | Mg | Soluble anions (meg/ℓ) Cl | SO4 | CO3 | HCO3 | Remark | Sample No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L-28 | (HCH) | I | 0-15 | 7.4 | 32.0 | | | 178 | 1.6 | 59.0 | 75.8 | 298 | 13.1 | 0 | 2.8 | 1st type | C - 19 |
| | | II | 15-30 | 7.5 | 4.9 | | | 19.5 | 0.2 | 27.7 | 17.9 | 12.5 | 50.2 | 0 | 2.5 | | C - 20 |
| L-31 | (MCM) | I | 0-15 | 7.3 | 75.2 | | | 500 | 5.3 | 92.0 | 362 | 700 | 251 | 0 | 8.0 | 1st type | A - 19 |
| | | II | 15-45 | 7.4 | 5.8 | | | 24.0 | 0.2 | 33.7 | 10.6 | 25.0 | 40.7 | 0 | 2.8 | | A - 20 |
| | | III | 45-80 | 7.4 | 4.7 | | | 13.8 | 0.2 | 35.5 | 9.3 | 18.0 | 37.3 | 0 | 3.5 | | A - 21 |
| L-32 | (LES) | I | 0-15 | 7.3 | 27.3 | | | 154 | 1.2 | 56.0 | 44.0 | 140 | 110 | 0 | 2.0 | 1st type | P - 1 |
| | | II | 15-30 | 7.5 | 3.8 | | | 8.4 | 0.2 | 19.3 | 10.2 | 20.0 | 14.3 | 0 | 1.8 | | P - 2 |

Outside: Outside of the Project area pH, ECe: pH & EC of saturation extract

1st type, 2nd type A, 2nd type B: Types of salt accumulated soils (see 3.2.1)

Table C-5-1 Ratings of land qualities / characteristic specific to soil series or phases

| Soil series/phases | Effective soil depth | Moisture availability 1/ potential moisture holding capacity (0-30cm) | (30-150cm) | rating | Soil ferlitily 1/ CEC | rating | Permeability | | Soil drainability |
|---|---|---|---|---|---|---|---|---|---|
| Aucallama | P1 | 2.4 cm | 6.3 cm | m3 | 6.5 | n3 | rapid | b3 | good-excessive |
| Esperanza | P3 | 1.5 | 2.7 | m4 | 5.0 | n3 | rapid-very rapid | b4 | excessive |
| Tucume (TC I) | P1 | 3.3 | 5.4 | m3 | 10.0 | n2 | moderately rapid | b2 | good |
| " (TC II) | P1 | 3.3 | 8.1 | m2 | 10.0 | n2 | " | b2 | good |
| Esquivel-Trujillo (ES I) | P3 | 3.3 | 5.4 | m3 | 11.0 | n2 | moderately rapid | b2 | good |
| " (ES II) | P2 | 3.3 | 8.1 | m2 | 11.0 | n2 | " | b2 | good |
| Clemencia | P1 | 3.3 | 8.1 | m2 | 10.0 | n2 | moderately rapid | b2 | good |
| Huaral | P2 | 4.2 | 12.6 | m1 | 16.0 | n2 | mo-erate-moderately rapid | b2 | moderate |
| Mochumi | P1 | 3.6 | 10.8 | m2 | 17.0 | n2 | moderate | b1 | moderate |
| Ocuaje | P1 | 4.2 | 12.6 | m1 | 20.0 | n1 | moderate-moderately rapid | b2 | moderate |
| lambayeque | P1 | 4.2 | 12.6 | m1 | 15.0 | n2 | moderate-moderately slow | b2 | moderate |
| Quepecaliche | P1 | 4.2 | 14.4 | m1 | 20.0 | n1 | moderately slow | b2 | imperfect too poor |

1/ ..... Estimated on the basis of laboratory analysis and existing data shown in "Estudio Agrologico Detallado Y Zonificacion Climatica De Cultivos Del Valle Chancay-Huaral".

TC I, ES I ....... Shallow phase of the series

TC II, ES II ..... Moderately deep phase of the series

Table C-5-2 The Maximum Land Irrigability Class

| factor | land qualities | Class 1 annual crop | Class 1 fruit | Class 2 annual crop | Class 2 fruit | Class 3 annual crop | Class 3 fruit | Class 4 annual crop | Class 4 fruit | Class 6 |
|---|---|---|---|---|---|---|---|---|---|---|
| soil(s) | effective soil depth(P) | P1 | P1 | p2 | P2 | P3 | P3 | P4 | P4 | P4 |
| | moisture availability(m) | m1,2 | m1,2 | (m2) | (m2) | m3 | m3 | m4 | m4 | m4 |
| | workability(k) | k1 | k1,2 | k2 | k3 | k3 | k4 | k4 | (k4) | k4 |
| | soil fertility(n) | n1,2 | n1,2 | n3 | n3 | n4 | n4 | (n4) | (n4) | n4 |
| | salinity(e) | e1 | e1 | e2 | e2,3 | e3 | e4 | e4 | (e4) | e4 |
| | alkalinity(a) | a1 | a1 | a2 | a2 | a3 | a3 | (a3) | (a3) | a3 |
| | permability(b) | b1,2 | b1,2 | b3 | b3 | b4 | b4 | (b4) | (b4) | b4 |
| topography(t) | slope & microrelief(g) | g1 | g1 | g2 | g2 | g3 | g3 | g4 | g4 | g4 |
| drainage (d) | drainability(w) | w1,2 | w1,2 | w3 | w3 | w4 | (w3) | (w4) | w4 | w4 |
| | flooding hazard(f) | f1 | f1 | (f1) | (f1) | (f1) | (f1) | f2 | f2 | f2 |

** annual crop --- land class for annual crop production, fruit --- land class for fruit production.

Table C-5-3 (1) Potential land classification -- land irrigability class for irrigation forming

| Soil Series | | Class I | Class II: II | Class II Subclass: s | d | t | sd | st | dt | sdt | Class III: III | Class III Subclass: s | d | t | sd | st | dt | sdt | Class IV: IV | Class IV Subclass: IVFs | IVTs | IVRLs | IVR | IVRs | IVPd | Class VI | Total area |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aucallama (AU) | ha | - | - | | | | | | | | 2445 | 1773 | | | | 672 | | | 97 | 97 | | | | | | - | 2542 |
| | (%) | | | | | | | | | | (96) | | | | | | | | (4) | | | | | | | | (100) |
| Esperanza (EP) | ha | - | - | | | | | | | | 88 | 88 | | | | | | | 3932 | 3932 | | | | | | - | 4020 |
| | (%) | | | | | | | | | | (2) | | | | | | | | (98) | | | | | | | | (100) |
| Tucume (TC) | ha | - | 938 | 655 | | | | 283 | | | 1024 | 1024 | | | | | | | - | | | | | | | - | 1962 |
| | (%) | | (48) | | | | | | | | (52) | | | | | | | | | | | | | | | | (100) |
| Esquivel-Trujillo(Es) | ha | - | 2399 | 1882 | | | 35 | 448 | | 34 | 2709 | 2602 | | | | 107 | | | 154 | 128 | | | | 26 | | - | 5262 |
| | % | | (46) | | | | | | | | (51) | | | | | | | | (3) | | | | | | | | (100) |
| Clemencia (CL) | ha | - | 695 | 651 | | | | 44 | | | - | | | | | | | | - | | | | | | | - | 695 |
| | % | | (100) | | | | | | | | | | | | | | | | | | | | | | | | (100) |
| Huaral (HU) | ha | - | 309 | 309 | | | | | | | - | | | | | | | | - | | | | | | | - | 309 |
| | % | | (100) | | | | | | | | | | | | | | | | | | | | | | | | (100) |
| Mochumi (MCH) | ha | 2420 | 1430 | 40 | 47 | 1318 | | | 25 | | - | | | | | | | | - | | | | | | | - | 3850 |
| | % | (63) | (37) | | | | | | | | | | | | | | | | | | | | | | | | (100) |
| Ocuaje (OC) | ha | 141 | 219 | | | 219 | | | | | - | | | | | | | | - | | | | | | | - | 360 |
| | % | (39) | (61) | | | | | | | | | | | | | | | | | | | | | | | | (100) |
| Lambayeque (LB) | ha | 426 | 136 | | | 136 | | | | | 24 | | | 24 | | | | | 19 | | | | | 19 | | - | 605 |
| | % | (70) | (22) | | | | | | | | (4) | | | | | | | | (3) | | | | | | | | (100) |
| Quepecaliche(QC) | ha | - | 595 | | | | 595 | | | | - | | | | | | | | - | | | | | | | - | 595 |
| | % | | (100) | | | | | | | | | | | | | | | | | | | | | | | | (100) |
| Total | ha | 2987 | 6721 | 3537 | 47 | 1673 | 630 | 775 | 25 | 34 | 6290 | 5487 | | 24 | | 779 | | | 4202 | 4157 | | | | 45 | | - | 20200 |
| | % | (15) | (33) | (18) | (-) | (8) | (3) | (4) | (-) | (-) | (31) | (27) | | (-) | | (4) | | | (21) | (21) | | | | (-) | | | (100) |

Subclass: s ..... deficiency or limitation in soil factor which determine irrigability class in the level
t ..... deficiency or limitation in topography factor which determine irrigability class in the level
d ..... deficiency or limitation in drainade factor which determine irrigability class in the level
IVF ..... special use for fruit cultivation
IVR ..... special use for salt tolerant crops

Table C-5-3 (2) Potential land classification -- land irrigability class for irrigation forming

| Soil Series | | Land Irrigability Class: Class I | Class II | | | | | | | | Class III | | | | | | | | Class IV | | | | | | | Class VI | Total area |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | II | Subclass | | | | | | | III | Subclass | | | | | | | IV | Subclass | | | | | | | |
| | | | | s | d | t | sd | st | dt | sdt | | s | d | t | sd | st | dt | sdt | | IVs | IVIs | IVRLs | IVR | IVRs | IVPd | | |
| Aucallama (AU) | ha | - | - | | | | | | | | 2445 | 1773 | | | | 672 | | | - | | | | | | | 97 | 2542 |
| | (%) | | | | | | | | | | (96) | | | | | | | | | | | | | | | (4) | (100) |
| Esperanza (EP) | ha | - | - | | | | | | | | 38 | 88 | | | | | | | 3932 | | 3932 | | | | | - | 4020 |
| | (%) | | | | | | | | | | (2) | | | | | | | | (98) | | | | | | | | (100) |
| Tucume (TC) | ha | - | 938 | 655 | | | | 233 | | | 1024 | 1024 | | | | | | | - | | | | | | | - | 1962 |
| | (%) | | (48) | | | | | | | | (52) | | | | | | | | | | | | | | | | (100) |
| Esquivel-Trujillo(Es) | ha | - | 2399 | 1882 | | | 35 | 448 | | 34 | 2709 | 2602 | | | | 107 | | | 26 | | | | | 26 | | 128 | 5262 |
| | % | | (46) | | | | | | | | (51) | | | | | | | | (-) | | | | | | | (2) | (100) |
| Clemencia (CL) | ha | - | 695 | 651 | | | | 44 | | | - | | | | | | | | - | | | | | | | - | 695 |
| | % | | (100) | | | | | | | | | | | | | | | | | | | | | | | | (100) |
| Huaral (HU) | ha | - | 309 | 309 | | | | | | | - | | | | | | | | - | | | | | | | - | 309 |
| | % | | (100) | | | | | | | | | | | | | | | | | | | | | | | | (100) |
| Mochumi (MCH) | ha | 2420 | 1430 | 40 | 47 | 1318 | | | 25 | | - | | | | | | | | - | | | | | | | - | 3850 |
| | % | (63) | (37) | | | | | | | | | | | | | | | | | | | | | | | | (100) |
| Ocuaje (OC) | ha | 141 | 219 | | | 219 | | | | | - | | | | | | | | - | | | | | | | - | 360 |
| | % | (39) | (61) | | | | | | | | | | | | | | | | | | | | | | | | (100) |
| Lambayeque (LB) | ha | 426 | 136 | | | 136 | | | | | 24 | | | 24 | | | | | 19 | | | | | 19 | | - | 605 |
| | % | (70) | (22) | | | | | | | | (4) | | | | | | | | (3) | | | | | | | | (100) |
| Quepecaliche(QC) | ha | - | 595 | | | | 595 | | | | - | | | | | | | | - | | | | | | | - | 595 |
| | % | | (100) | | | | | | | | | | | | | | | | | | | | | | | | (100) |
| Total | ha | 2987 | 6721 | 3537 | 47 | 1673 | 630 | 775 | 25 | 34 | 6290 | 5487 | | 24 | | 779 | | | 3977 | | 3932 | | | 45 | | 225 | 20200 |
| | % | (15) | (33) | (18) | (-) | (8) | (3) | (4) | (-) | (-) | (31) | (27) | | (-) | | (4) | | | (20) | | (20) | | | (-) | | (1) | (100) |

Subclass:
- s ..... deficiency or limitation in soil factor which determine irrigability class in the level
- t ..... deficiency or limitation in topography factor which determine irrigability class in the level
- d ..... deficiency of limitation in drainade factor which determine irrigability class in the level
- IVI ..... limited arable under intensive irrigation methods
- IVR ..... special use for salt tolerant crops
- IVRI ..... special use for salt tolerant crops under intensive irrigation methods
- IVP ..... limited arable due to flooding possibility

Table C-5-3 (3) Potential land classification -- land irrigability class for irrigation forming

| Soil Series | | Land Irrigability Class: Class I | Class II | Class II Subclass s | d | t | sd | st | dt | sdt | Class III | Class III Subclass s | d | t | sd | st | dt | sdt | Class IV | Class IV Subclass IVs | IVIs | IVRLs | IVR | IVRs | IVPd | Class VI | Total area |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aucallama (AU) | ha | - | - | | | | | | | | 2445 | 1745 | | | 28 | 672 | | | 97 | 97 | | | | | | - | 2542 |
| | (%) | | | | | | | | | | (96) | | | | | | | | (4) | | | | | | | | (100) |
| Esperanza (EP) | ha | - | - | | | | | | | | - | | | | | | | | 4020 | 4020 | | | | | | - | 4020 |
| | (%) | | | | | | | | | | | | | | | | | | (100) | | | | | | | | (100) |
| Tucume (TC) | ha | - | 938 | 520 | | | 135 | 283 | | | 1024 | 1024 | | | | | | | - | | | | | | | - | 1962 |
| | (%) | | (48) | | | | | | | | (52) | | | | | | | | | | | | | | | | (100) |
| Esquivel-Trujillo(Es) | ha | - | 2404 | 1733 | | | 174 | 497 | | | 2704 | 2449 | 69 | | 79 | 107 | | | 128 | 128 | | | | | | 26 | 5262 |
| | % | | (46) | | | | | | | | (51) | | | | | | | | (2) | | | | | | | (-) | (100) |
| Clemencia (CL) | ha | - | 695 | 499 | | | 152 | 44 | | | - | | | | | | | | - | | | | | | | - | 695 |
| | % | | (100) | | | | | | | | | | | | | | | | | | | | | | | | (100) |
| Huaral (HU) | ha | - | 309 | 144 | | | 165 | | | | - | | | | | | | | - | | | | | | | - | 309 |
| | % | | (100) | | | | | | | | | | | | | | | | | | | | | | | | (100) |
| Mochumi (MCH) | ha | 1876 | 1902 | | 584 | 1250 | | | 68 | | 72 | | 72 | | | | | | - | | | | | | | - | 3850 |
| | % | (49) | (49) | | | | | | | | (2) | | | | | | | | | | | | | | | | (100) |
| Ocuaje (OC) | ha | 87 | 273 | | 54 | 219 | | | | | - | | | | | | | | - | | | | | | | - | 360 |
| | % | (24) | (76) | | | | | | | | | | | | | | | | | | | | | | | | (100) |
| Lambayeque (LB) | ha | 190 | 372 | | 236 | 136 | | | | | 24 | | | 24 | | | | | - | | | | | | | 19 | 605 |
| | % | (31) | (61) | | | | | | | | (4) | | | | | | | | | | | | | | | (3) | (100) |
| Quepecaliche(QC) | ha | - | 595 | | 595 | | | | | | - | | | | | | | | - | | | | | | | - | 595 |
| | % | | (100) | | | | | | | | | | | | | | | | | | | | | | | | (100) |
| Total | ha | 2153 | 7488 | 2896 | 1469 | 1605 | 626 | 824 | 68 | | 6269 | 5218 | 141 | 24 | 107 | 779 | | | 4245 | 4245 | | | | | | 45 | 20200 |
| | % | (11) | (37) | (14) | (7) | (8) | (3) | (4) | (-) | | (31) | (26) | (1) | (-) | (1) | (4) | | | (21) | | | | | | | (-) | (100) |

Subclass:
- s ..... deficiency or limitation in soil factor which determine irrigability class in the level
- t ..... defieiency or limitation in topography factor which determine irrigability class in the level
- d ..... deficiency or limitation in drainade factor which determine irrigability class in the level
- IVI ..... limited arable under intensive irrigation methods
- IVR ..... special use for salt tolerant crops
- IVRI ..... special use for salt tolerant crops under intensive irrigation methods
- IVP ..... limited arable due to flooding possibility

Table C-S-3 (4) Potential land classification -- land irrigability class for irrigation forming

| Soil Series | | Land Irrigability Class | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Class I | Class II | | | | | | | | Class III | | | | | | | | Class IV | | | | | | | Class VI | Total area |
| | | | II | Subclass | | | | | | | III | Subclass | | | | | | | IV | Subclass | | | | | | | |
| | | | | s | d | t | sd | st | dt | sdt | | s | d | t | sd | st | dt | sdt | | IVs | IVIs | IVRLs | IVR | IVRs | IVPd | | |
| Aucallama (AU) | ha | - | - | | | | | | | | 2041 | 1369 | | | | 672 | | | 244 | | | | | 244 | | 257 | 2542 |
| | (%) | | | | | | | | | | (80) | | | | | | | | (10) | | | | | | | (10) | (100) |
| Esperanza (EP) | ha | - | - | | | | | | | | 19 | 19 | | | | | | | 3975 | | 2865 | 1041 | | 69 | | 26 | 4020 |
| | (%) | | | | | | | | | | (-) | | | | | | | | (99) | | | | | | | (1) | (100) |
| Tucume (TC) | ha | - | 902 | 562 | | | 57 | 283 | | | 935 | 935 | | | | | | | 125 | | | | 63 | 62 | | - | 1962 |
| | (%) | | (46) | | | | | | | | (48) | | | | | | | | (6) | | | | | | | | (100) |
| Esquivel-Trujillo(Es) | ha | - | 2225 | 1774 | | | 35 | 416 | | | 2627 | 2520 | | | | 107 | | | 282 | | | | 80 | 68 | 134 | 128 | 5262 |
| | % | | (42) | | | | | | | | (50) | | | | | | | | (5) | | | | | | | (2) | (100) |
| Clemencia (CL) | ha | - | 543 | 499 | | | | 44 | | | - | | | | | | | | 152 | | | | 50 | 18 | 84 | - | 695 |
| | % | | (78) | | | | | | | | | | | | | | | | (22) | | | | | | | | (100) |
| Huaral (HU) | ha | - | 288 | 144 | | | 144 | | | | - | | | | | | | | 21 | | | | 21 | | | - | 309 |
| | % | | (93) | | | | | | | | | | | | | | | | (7) | | | | | | | | (100) |
| Mochumi (MCH) | ha | 1817 | 1631 | 185 | 47 | 1218 | 160 | | | 21 | 42 | | 42 | | | | | | 360 | | | | 113 | 141 | 106 | - | 3850 |
| | % | (47) | (42) | | | | | | | | (1) | | | | | | | | (9) | | | | | | | | (100) |
| Ocuaje (OC) | ha | 87 | 273 | | | 219 | 54 | | | | - | | | | | | | | - | | | | | | | - | 360 |
| | % | (24) | (76) | | | | | | | | | | | | | | | | | | | | | | | | (100) |
| Lambayeque (LB) | ha | 190 | 309 | 25 | 44 | 136 | 104 | | | | 24 | | | 24 | | | | | 82 | | | | 26 | 34 | 22 | - | 605 |
| | % | (31) | (51) | | | | | | | | (4) | | | | | | | | (14) | | | | | | | | (100) |
| Quepecaliche(QC) | ha | - | 272 | | | | 272 | | | | 25 | | 25 | | | | | | 298 | | | | 99 | 199 | | - | 595 |
| | % | | (46) | | | | | | | | (4) | | | | | | | | (50) | | | | | | | | (100) |
| Total | ha | 2094 | 6443 | 3189 | 91 | 1573 | 826 | 743 | | 21 | 5713 | 4843 | 67 | 24 | | 779 | | | 5539 | | 2865 | 1041 | 452 | 835 | 346 | 411 | 20200 |
| | % | (10) | (32) | (16) | (-) | (8) | (4) | (4) | | (-) | (28) | (24) | (-) | (-) | | (4) | | | (27) | | (14) | (5) | (2) | (4) | (2) | (2) | (100) |

Subclass:
- s ..... deficiency or limitation in soil factor which determine irrigability class in the level
- t ..... deficiency or limitation in topography factor which determine irrigability class in the level
- d ..... deficiency or limitation in drainade factor which determine irrigability class in the level
- IVI ..... limited arable under intensive irrigation methods
- IVR ..... special use for salt tolerant crops
- IVRI ..... special use for salt tolerant crops under intensive irrigation methods

Table C-5-4(1) Land irrigability class of soil units for land classification-1

| Soil series | Soil phases (code) | Soil units | area | Conditions of classification | Land irrigability classes: Irrigability classes for annualcrop production | Irrigability classes for fruit production | Potential irrigability classes for irrigation forming | mapping code 1/ | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| Aucallama | AU | AU | 436 | 1. Present land classification(Pr) | IIIs | IIIs | | | |
| | | | | 2. Potential land classification(Po) | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | | AU-g$^2$ | 776 | 1. Pr | IIIs | IIIs | | | |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | | AU-g$^2$ | 620 | 1. Pr | IIIst | IIIst | | | |
| | | | | 2. Po | IIIst | IIIst | IIIst | IIIst(IIIst-IIIst) | |
| | AUSI | AUSI-e$^2$g$^3$ | 52 | 1. Pr | IIIst | IIIst | | | |
| | | | | 2. Po | IIIst | IIIst | IIIst | IIIst(IIIst-IIIst) | |
| | | AUSI-e$^4$ | 160 | 1. Pr | VI | VI | | | |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | AUSIC | AUSIC-e$^4$c$^4$g$^3$ | 97 | 1. Pr | VI | IVs | | | |
| | | | | 2. Po | VI | IVs | IVFs | IVFs(VI-IVs) | |
| | AUSII | AUSII-e$^2$w$^2$ | 30 | 1. Pr | IIIs | IIIs | | | D.P. |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | | AUSII-e$^2$w$^3$ | 28 | 1. Pr | IIIs | IIIsd | | | |
| | | | | 2. Po | IIIs | IIIsd | IIIs | IIIs(IIIs-IIIsd) | |
| | | AUSII-e$^2$w$^3$ | 18 | 1. Pr | IIIs | IIIsd | | | D.P. |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | | AUSII-e$^3$w$^3$ | 33 | 1. Pr | IVRs | IIIsd | | | D.P. |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | | AUSII-e$^4$w$^3$ | 61 | 1. Pr | IVRs | IIIsd | | | D.P. |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | | AUSII-e$^2$g$^2$w$^2$ | 35 | 1. Pr | IIIs | IIIs | | | D.P. |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | | AUSII-e$^2$g$^2$w$^3$ | 46 | 1. Pr | IIIs | IIIsd | | | D.P. |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | | AUSII-e$^4$a$^2$w$^4$ | 48 | 1. Pr | IVRs | VI | | | D.P. |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |

IVF --- special use for fruit cultivation
IVR --- special use for salt tolerant crop cultivation
IVRI -- special use for salt tolerant crop cultivation under intensive irrigation methods
IVI --- limited arable under intensive irrigation methods
IVP --- limited arable due to flooding possibility
Phases ----- I: shallow phase, II: moderately deep phase, SI: well-drained salt accumulated phase
SII: poorly-drained salt accumulated phase, C: gravelly surface phase
Subclases --- s: deficiency or limitation in soil factor which determine irrigability class in the level
t: " " in topography factor " "
d: " " in drainage factor " "
D.P. --- drainage improvement study area
1/ soil mapping code of land classification

Table C-5-4(2) Land irrigability class of soil units for land classification-2

| Soil series | Soil phases (code) | Soil units | area | Conditions of classification | Land irrigability classes: Irrigability classes for annualcrop production | Irrigability classes for fruit production | Potential irrigability classes for irrigation forming | mapping code 1/ | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| Aucallama | AUSII | AUSII-$e^4a^2g^2w^4$ | 102 | 1. Present land classification(Pr) | IVRs | VI | | | D.P. |
| | | | | 2. Potential land classification(Po) | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | | Total area | 2,542 | | | | | | |
| Esperanza | EP | EP | 872 | 1. Pr | IVIs | IVs | | | |
| | | | | 2. Po | IVIs | IVs | IVFs | IVFs(IVIs-IVs) | |
| | | EP-$g^2$ | 1,184 | 1. Pr | IVIs | IVs | | | |
| | | | | 2. Po | IVIs | IVs | IVFs | IVFs(IVIs-IVs) | |
| | | EP-$g^3$ | 366 | 1. Pr | IVIs | IVs | | | |
| | | | | 2. Po | IVIs | IVs | IVFs | IVFs(IVIs-IVs) | |
| | EPC | EPC-$c^2g^3$ | 198 | 1. Pr | IVIs | IVs | | | |
| | | | | 2. Po | IVIs | IVs | IVFs | IVFs(IVIs-IVs) | |
| | EPSI | EPSI-$e^3$ | 301 | 1. Pr | IVRIs | IVs | | | |
| | | | | 2. Po | IVIs | IVs | IVFs | IVFs(IVIs-IVs) | |
| | | EPSI-$e^2g^2$ | 213 | 1. Pr | IVIs | IVs | | | |
| | | | | 2. Po | IVIs | IVs | IVFs | IVFs(IVIs-IVs) | |
| | | EPSI-$e^3g^2$ | 259 | 1. Pr | IVRIs | IVs | | | |
| | | | | 2. Po | IVIs | IVs | IVFs | IVFs(IVIs-IVs) | |
| | | EPSI-$e^3g^3$ | 344 | 1. Pr | IVRIs | IVs | | | |
| | | | | 2. Po | IVIs | IVs | IVFs | IVFs(IVIs-IVs) | |
| | | EPSI-$e^4g^3$ | 21 | 1. Pr | IVRIs | IVs | | | |
| | | | | 2. Po | IVIs | IVs | IVFs | IVFs(IVIs-IVs) | |
| | EPSIC | EPSIC-$e^2c^2g^2$ | 32 | 1. Pr | IVIs | IVs | | | |
| | | | | 2. Po | IVIs | IVs | IVFs | IVFs(IVIs-IVs) | |
| | | EPSIC-$e^3c^2g^2$ | 116 | 1. Pr | IVRIs | IVs | | | |
| | | | | 2. Po | IVIs | IVs | IVFs | IVFs(IVIs-IVs) | |
| | | EPSIC-$e^4c^2g^3$ | 26 | 1. Pr | VI | IVs | | | |
| | | | | 2. Po | IVIs | IVs | IVFs | IVFs(IVIs-IVs) | |
| | EPSII | ESPII-$e^2w^3$ | 19 | 1. Pr | IIIs | IVs | | | D.P. |
| | | | | 2. Po | IIIs | IVs | IIIs | IIIs(IIIs-IVs) | |

IVF --- special use for fruit cultivation
IVR --- special use for salt tolerant crop cultivation
IVRI -- special use for salt tolerant crop cultivation under intensive irrigation methods
IVI --- limited arable under intensive irrigation methods
IVP --- limited arable due to flooding possibility
Phases ----- I: shallow phase, II: moderately deep phase, SI: well-drained salt accumulated phase
SII: poorly-drained salt accumulated phase, C: gravelly surface phase
Subclases --- s: deficiency or limitation in soil factor which determine irrigability class in the level
t: " " in topography factor " "
d: " " in drainage factor " "
D.P. --- drainage improvement study area
1/ soil mapping code of land classification

Table C-5-4(3) Land irrigability class of soil units for land classification-3

| Soil series | Soil phases (code) | Soil units | area | Conditions of classification | Land irrigability classes: Irrigability classes for annualcrop production | Irrigability classes for fruit production | Potential irrigability classes for irrigation forming | mapping code 1/ | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| Esperanza | EPSII | EPSII-$e^3w^4$ | 21 | 1. Present land classification(Pr) | IVRs | VI | | | D.P. |
| | | | | 2. Potential land classification(Po) | IIIs | IVs | IIIs | IIIs(IIIs-IVs) | |
| | | ESPII-$e^4a^2w^4$ | 48 | 1. Pr | IVRs | VI | | | D.P. |
| | | | | 2. Po | IIIs | IVs | IIIs | IIIs(IIIs-IVs) | |
| | | Total area | 4,020 | | | | | | |
| Tucume | TCI | TCI | 589 | 1. Pr | IIIs | IIIs | | | |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | | TCI-$g^2$ | 210 | 1. Pr | IIIs | IIIs | | | |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | | TCI-$g^2w^2$ | 78 | 1. Pr | IIIs | IIIs | | | |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | TCSII | TCISII-$e^2w^3$ | 58 | 1. Pr | IIIs | IIIsd | | | D.P. |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | | TCISII-$e^3w^3$ | 14 | 1. Pr | IVR | IIIsd | | | D.P. |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | | TCISII-$e^3w^4$ | 33 | 1. Pr | IVR | VI | | | D.P. |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | | TCISII-$e^4a^2w^4$ | 42 | 1. Pr | IVRs | VI | | | D.P. |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | TCII | TCII | 520 | 1. Pr | IIs | IIs | | | |
| | | | | 2. Po | IIs | IIs | IIs | IIs(IIs-IIs) | |
| | | TCII-$g^2$ | 283 | 1. Pr | IIst | IIst | | | |
| | | | | 2. Po | IIst | IIst | IIst | IIst(IIst-IIst) | |
| | | TCII-$w^2$ | 42 | 1. Pr | IIs | IIsd | | | |
| | | | | 2. Po | IIs | IIsd | IIs | IIs(IIs-IIsd) | |
| | TCIISII | TCIIsII-$e^2w^3$ | 57 | 1. Pr | IIsd | IIId | | | D.P. |
| | | | | 2. Po | IIs | IIsd | IIs | IIs(IIs-IIsd) | |
| | | TCIISII-$e^3w^3$ | 16 | 1. Pr | IVR | IIIsd | | | D.P. |
| | | | | 2. Po | IIs | IIsd | IIs | IIs(IIs-IIsd) | |

IVF --- special use for fruit cultivation
IVR --- special use for salt tolerant crop cultivation
IVRI -- special use for salt tolerant crop cultivation under intensive irrigation methods
IVI --- limited arable under intensive irrigation methods
IVP --- limited arable due to flooding possibility
Phases ----- I: shallow phase, II: moderately deep phase, SI: well-drained salt accumulated phase
SII: poorly-drained salt accumulated phase, C: gravelly surface phase
Subclases --- s: deficiency or limitation in soil factor which determine irrigability class in the level
t: " " in topography factor " "
d: " " in drainage factor " "
D.P. --- drainage improvement study area
1/ soil mapping code of land classification

Table C-5-4(4) Land irrigability class of soil units for land classification-4

| Soil series | Soil phases (code) | Soil units | area | Conditions of classification | Land irrigability classes: Irrigability classes for annualcrop production | Land irrigability classes: Irrigability classes for fruit production | Land irrigability classes: Potential irrigability classes for irrigation forming | mapping code 1/ | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| Tucume | TCIISII | TCIISII-$e^4a^2w^4$ | 30 | 1. Present land classification(Pr) | IVRs | VI | | | D.P. |
| | | | | 2. Potential land classification(Po) | IIs | IIsd | IIs | IIs(IIs-IIsd) | |
| | | Total area | 1,962 | | | | | | |
| Esquirel -Trujillo | ESI | ESI | 688 | 1. Pr | IIIs | IIIs | | | |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | | ESI-$g^2$ | 422 | 1. Pr | IIIs | IIIs | | | |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | | ESI-$g^3$ | 82 | 1. Pr | IIIst | IIIst | | | |
| | | | | 2. Po | IIIst | IIIst | IIIst | IIIst(IIIst-IIIst) | |
| | | ESI-$w^3$ | 29 | 1. Pr | IIIs | IIIsd | | | |
| | | | | 2. Po | IIIs | IIIsd | IIIs | IIIs(IIIs-IIIsd) | |
| | | ESI-$f^2$ | 20 | 1. Pr | IVPd | IVPd | | | D.P. |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | | ESI-$g^2f^2$ | 36 | 1. Pr | IVPd | IVPd | | | D.P. |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | | ESI-$w^4f^2$ | 27 | 1. Pr | IVPd | VI | | | |
| | | | | 2. Po | IIIs | IIIsd | IIIs | IIIs(IIIs-IIIsd) | |
| | ESIC | ESIC-$c^2$ | 483 | 1. Pr | IIIs | IIIs | | | |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | | ESIC-$c^2g^2$ | 101 | 1. Pr | IIIs | IIIs | | | |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | | ESIC-$c^3$ | 234 | 1. Pr | IIIs | IIIs | | | |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | | ESIC-$c^3g^2$ | 341 | 1. Pr | IIIs | IIIs | | | |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | | ESIC-$c^3w^3f^2$ | 17 | 1. Pr | IVPd | IVPd | | | |
| | | | | 2. Po | IIIs | IIIsd | IIIs | IIIs(IIIs-IIIsd) | |
| | ESISIC | ESISIC-$e^2c^2g^3$ | 25 | 1. Pr | IIIst | IIIst | | | |
| | | | | 2. Po | IIIst | IIIst | IIIst | IIIst(IIIst-IIIst) | |

IVF --- special use for fruit cultivation
IVR --- special use for salt tolerant crop cultivation
IVRI -- special use for salt tolerant crop cultivation under intensive irrigation methods
IVI --- limited arable under intensive irrigation methods
IVP --- limited arable due to flooding possibility
Phases ----- I: shallow phase, II: moderately deep phase, SI: well-drained salt accumulated phase
SII: poorly-drained salt accumulated phase, C: gravelly surface phase
Subclases --- s: deficiency or limitation in soil factor which determine irrigability class in the level
t: " " in topography factor " "
d: " " in drainage factor " "
D.P. --- drainage improvement study area
1/ soil mapping code of land classification

Table C-5-4(5) Land irrigability class of soil units for land classification-5

| Soil series | Soil phases (code) | Soil units | area | Conditions of classification | Land irrigability classes: Irrigability classes for annualcrop production | Land irrigability classes: Irrigability classes for fruit production | Land irrigability classes: Potential irrigability classes for irrigation forming | 1/ mapping code | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| Esquivel -Trujillo | ESISIC | ESISIC-$e^2c^4g^3$ | 128 | 1. Present land classification(Pr) | VI | IVs | | | |
| | | | | 2. Potential land | VI | IVs | IVFs | IVFs(VI-IVs) | |
| | ESISII | ESISII-$e^2w^2$ | 33 | 1. Pr | IIIs | IIIs | | | D.P. |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | | ESISII-$e^4a^2w^4$ | 14 | 1. Pr | IVRs | VI | | | D.P. |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | ESISIIC | ESISIIC-$e^2c^2w^3$ | 35 | 1. Pr | IIIs | IIIsd | | | |
| | | | | 2. Po | IIIs | IIIsd | IIIs | IIIs(IIIs-IIIsd) | |
| | | ESISIIC-$e^3c^2w^4$ | 26 | 1. Pr | IVRs | VI | | | |
| | | | | 2. Po | IVRs | VI | IVRs | IVRs(IVRs-VI) | |
| | | ESISIIC-$e^2c^2g^2w^2$ | 24 | 1. Pr | IIIs | IIIs | | | D.P. |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | | ESISIIC-$e^2c^3g^2w^2$ | 24 | 1. Pr | IIIs | IIIs | | | D.P. |
| | | | | 2. Po | IIIs | IIIs | IIIs | IIIs(IIIs-IIIs) | |
| | ESII | ESII | 1,182 | 1. Pr | IIs | IIs | | | |
| | | | | 2. Po | IIs | IIs | IIs | IIs(IIs-IIs) | |
| | | ESII-$g^2$ | 416 | 1. Pr | IIst | IIst | | | |
| | | | | 2. Po | IIst | IIst | IIst | IIst(IIst-IIst) | |
| | | ESII-$w^2$ | 44 | 1. Pr | IIs | IIsd | | | |
| | | | | 2. Po | IIs | IIsd | IIs | IIs(IIs-IIsd) | |
| | | ESII-$w^3$ | 35 | 1. Pr | IIsd | IIId | | | |
| | | | | 2. Po | IIsd | IIId | IIsd | IIsd(IIsd-IIId) | |
| | ESIIC | ESIIC-$c^2$ | 526 | 1. Pr | IIs | IIs | | | |
| | | | | 2. Po | IIs | IIs | IIs | IIs(IIs-IIs) | |
| | | ESII-$c^2g^2w^3f^2$ | 34 | 1. Pr | IVPd | IVPd | | | |
| | | | | 2. Po | IIsdt | IIId | IIsdt | IIsdt(IIsdt-IIId) | |
| | | ESIIC-$c^3$ | 25 | 1. Pr | IIIs | IIs | | | |
| | | | | 2. Po | IIIs | IIs | IIIs | IIIs(IIIs-IIs) | |
| | | ESIIC-$c^3g^2$ | 49 | 1. Pr | IIIs | IIst | | | |
| | | | | 2. Po | IIIs | IIst | IIIs | IIIs(IIIs-IIst) | |

IVF --- special use for fruit cultivation
IVR --- special use for salt tolerant crop cultivation
IVRI -- special use for salt tolerant crop cultivation under intensive irrigation methods
IVI --- limited arable under intensive irrigation methods
IVP --- limited arable due to flooding possibility
Phases ----- I: shallow phase, II: moderately deep phase, SI: well-drained salt accumulated phase
SII: poorly-drained salt accumulated phase, C: gravelly surface phase
Subclases --- s: deficiency or limitation in soil factor which determine irrigability class in the level
t: " " in topography factor " "
d: " " in drainage factor " "
D.P. --- drainage improvement study area
1/ soil mapping code of land classification

Table C-5-4(6) Land irrigability class of soil units for land classification-6

| Soil series | Soil phases (code) | Soil units | area | Conditions of classification | Land irrigability classes: Irrigability classes for annualcrop production | Irrigability classes for fruit production | Potential irrigability classes for irrigation forming | 1/ mapping code | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| Esquivel -Trujillo | ESIISIC | ESIISIC-$e^2c^2g^2$ | 32 | 1. Present land classification(Pr) | IIIs | IIst | | | |
| | | | | 2. Potential land | IIst | IIst | IIst | IIst(IIst-IIst) | |
| | ESIISII | ESIISII-$e^2w^2$ | 22 | 1. Pr | IIs | IIsd | | | D.P. |
| | | | | 2. Po | IIs | IIsd | IIs | IIs(IIs-IIsd) | |
| | | ESIISII-$e^3w^3$ | 50 | 1. Pr | IVR | IIId | | | D.P. |
| | | | | 2. Po | IIs | IIsd | IIs | IIs(IIs-IIsd) | |
| | | ESIISII-$e^3w^4$ | 30 | 1. Pr | IVR | VI | | | D.P. |
| | | | | 2. Po | IIs | IIsd | IIs | IIs(IIs-IIsd) | |
| | | ESIISII-$e^4a^2w^4$ | 28 | 1. Pr | IVRs | VI | | | D.P. |
| | | | | 2. Po | IIs | IIsd | IIs | IIs(IIs-IIsd) | |
| | | Total area | 5,262 | | | | | | |
| Clemencia | CL | CL | 475 | 1. Pr | IIs | IIs | | | |
| | | | | 2. Po | IIs | IIs | IIs | IIs(IIs-IIs) | |
| | | CL-$g^2$ | 44 | 1. Pr | IIst | IIst | | | |
| | | | | 2. Po | IIst | IIst | IIst | IIst(IIst-IIst) | |
| | | CL-$w^3f^2$ | 55 | 1. Pr | IVPd | IVPd | | | D.P. |
| | | | | 2. Po | IIs | IIsd | IIs | IIs(IIs-IIsd) | |
| | | CL-$w^4f^2$ | 31 | 1. Pr | IVPd | VI | | | D.P. |
| | | | | 2. Po | IIs | IIsd | IIs | IIs(IIs-IIsd) | |
| | CLC | CLC-$c^2$ | 24 | 1. Pr | IIs | IIs | | | |
| | | | | 2. Po | IIs | IIs | IIs | IIs(IIs-IIs) | |
| | CLSII | CLSII-$e^3w^3$ | 50 | 1. Pr | IVR | IIId | | | D.P. |
| | | | | 2. Po | IIs | IIsd | IIs | IIs(IIs-IIsd) | |
| | | CLSII-$e^4a^2w^4$ | 18 | 1. Pr | IVRs | VI | | | D.P. |
| | | | | 2. Po | IIs | IIsd | IIs | IIs(IIs-IIsd) | |
| | | Total area | 695 | | | | | | |

IVF --- special use for fruit cultivation
IVR --- special use for salt tolerant crop cultivation
IVRI -- special use for salt tolerant crop cultivation under intensive irrigation methods
IVI --- limited arable under intensive irrigation methods
IVP --- limited arable due to flooding possibility
Phases ----- I: shallow phase, II: moderately deep phase, SI: well-drained salt accumulated phase
SII: poorly-drained salt accumulated phase, C: gravelly surface phase
Subclases --- s: deficiency or limitation in soil factor which determine irrigability class in the level
t: " " in topography factor " "
d: " " in drainage factor " "
D.P. --- drainage improvement study area
1/ soil mapping code of land classification

Table C-5-4(7) Land irrigability class of soil units for land classification-7

| Soil series | Soil phases (code) | Soil units | area | Conditions of classification | Land irrigability classes: Irrigability classes for annualcrop production | Land irrigability classes: Irrigability classes for fruit production | Land irrigability classes: Potential irrigability classes for irrigation forming | 1/ mapping code | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| Huaral | HU | HU-$w^2$ | 90 | 1. Present land classification(Pr) | IIs | IIs | | | |
| | | | | 2. Potential land classification(Po) | IIs | IIs | IIs | IIs(IIs-IIs) | |
| | HUC | HUC-$c^2w^2$ | 54 | 1. Pr | IIs | IIs | | | |
| | | | | 2. Po | IIs | IIs | IIs | IIs(IIs-IIs) | |
| | HUSII | HUSII-$e^2w^3$ | 144 | 1. Pr | IIsd | IIId | | | D.P. |
| | | | | 2. Po | IIs | IIsd | IIs | IIs(IIs-IIsd) | |
| | | HUSII-$e^3g^2w^4$ | 21 | 1. Pr | IVR | VI | | | D.P. |
| | | | | 2. Po | IIs | IIsd | IIs | IIs(IIs-IIsd) | |
| | | Total area | 309 | | | | | | |
| Mochumi | MCH | MCH-$w^2$ | 1,817 | 1. Pr | I | I | | | |
| | | | | 2. Po | I | I | I | I(I-I) | |
| | | MCH-$w^3$ | 47 | 1. Pr | IId | IIId | | | |
| | | | | 2. Po | IId | IIId | IId | IId(IId-IIId) | |
| | | MCH-$g^2w^2$ | 1,218 | 1. Pr | IIt | IIt | | | |
| | | | | 2. Po | IIt | IIt | IIt | IIt(IIt-IIt) | |
| | | MCH-$w^2f^2$ | 19 | 1. Pr | IVPa | IVPd | | | D.P. |
| | | | | 2. Po | I | I | I | I(I-I) | |
| | | MCH-$g^2w^2f^2$ | 32 | 1. Pr | IVPd | IVPd | | | D.P. |
| | | | | 2. Po | IIt | IIt | IIt | IIt(IIt-IIt) | |
| | | MCH-$g^2w^3f^2$ | 25 | 1. Pr | IVPd | IVPd | | | D.P. |
| | | | | 2. Po | IIdt | IIId | IIdt | IIdt(IIdt-IIId) | |
| | MCHSII | MCHSII-$e^2w^2$ | 34 | 1. Pr | IIs | IIsd | | | |
| | | | | 2. Po | I | IId | I | I(I-IId) | |
| | | MCHSII-$e^2w^2$ | 111 | 1. Pr | IIs | IIsd | | | D.P. |
| | | | | 2. Po | I | IId | I | I(I-IId) | |
| | | MCHSII-$e^2w^3$ | 160 | 1. Pr | IIsd | IIId | | | D.P. |
| | | | | 2. Po | I | IId | I | I(I-IId) | |
| | | MCHSII-$e^2w^4$ | 42 | 1. Pr | IIId | VI | | | D.P. |
| | | | | 2. Po | I | IId | I | I(I-IId) | |

IVF --- special use for fruit cultivation
IVR --- special use for salt tolerant crop cultivation
IVRI -- special use for salt tolerant crop cultivation under intensive irrigation methods
IVI --- limited arable under intensive irrigation methods
IVP --- limited arable due to flooding possibility
Phases ----- I: shallow phase, II: moderately deep phase, SI: well-drained salt accumulated phase
SII: poorly-drained salt accumulated phase, C: gravelly surface phase
Subclases --- s: deficiency or limitation in soil factor which determine irrigability class in the level
t: " " in topography factor " "
d: " " in drainage factor " "
D.P. --- drainage improvement study area
1/ soil mapping code of land classification

Table C-5-4(8) Land irrigability class of soil units for land classification-8

| Soil series | Soil phases (code) | Soil units | area | Conditions of classification | Land irrigability classes: Irrigability classes for annualcrop production | Irrigability classes for fruit production | Potential irrigability classes for irrigation forming | 1/ mapping code | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| Mochumi | MCHSII | MCHSII-$e^2g^2w^3$ | 21 | 1. Present land classification(Pr) | IIsdt | IIId | | | D.P. |
| | | | | 2. Potential land classification(Po) | IIst | IIdt | IIt | IIt(IIt-IIdt) | |
| | | MCHSII-$e^3w^3$ | 66 | 1. Pr | IVR | IIId | | | D.P. |
| | | | | 2. Po | I | IId | I | I(I-IId) | |
| | | MCHSII-$e^3w^3f^2$ | 30 | 1. Pr | IVPd | IVPd | | | D.P. |
| | | | | 2. Po | I | IId | I | I(I-IId) | |
| | | MCHSII-$e^3g^2w^3$ | 47 | 1. Pr | IVR | IIId | | | D.P. |
| | | | | 2. Po | IIt | IIdt | IIt | IIt(IIt-IIdt) | |
| | | MCHSII-$e^4a^2w^4$ | 141 | 1. Pr | IVRs | VI | | | D.P. |
| | | | | 2. Po | I | IId | I | I(I-IId) | |
| | MCHC | MCHC-$c^2w^2$ | 40 | 1. Pr | IIs | I | | | |
| | | | | 2. Po | IIs | I | IIs | IIs(IIs-I) | |
| | | Total area | 3,850 | | | | | | |
| Ocuaje | OC | OC-$w^2$ | 87 | 1. Pr | I | I | | | |
| | | | | 2. Po | I | I | I | I(I-I) | |
| | | OC-$g^2w^2$ | 219 | 1. Pr | IIt | IIt | | | |
| | | | | 2. Po | IIt | IIt | IIt | IIt(IIt-IIt) | |
| | OCSII | OCSII-$e^2w^3$ | 54 | 1. Pr | IIsd | IIId | | | D.P. |
| | | | | 2. Po | I | IId | I | I(I-IId) | |
| | | Total area | 360 | | | | | | |
| Lambayeque | LB | LB-$w^2$ | 190 | 1. Pr | I | I | | | |
| | | | | 2. Po | I | I | I | I(I-I) | |
| | | LB-$w^3$ | 44 | 1. Pr | IId | IIId | | | D.P. |
| | | | | 2. Po | I | IId | I | I(I-IId) | |
| | | LB-$w^3f^2$ | 22 | 1. Pr | IVPd | IVPd | | | D.P. |
| | | | | 2. Po | I | IId | I | I(I-IId) | |

IVF --- special use for fruit cultivation
IVR --- special use for salt tolerant crop cultivation
IVRI -- special use for salt tolerant crop cultivation under intensive irrigation methods
IVI --- limited arable under intensive irrigation methods
IVP --- limited arable due to flooding possibility
Phases ----- I: shallow phase, II: moderately deep phase, SI: well-drained salt accumulated phase
SII: poorly-drained salt accumulated phase, C: gravelly surface phase
Subclases --- s: deficiency or limitation in soil factor which determine irrigability class in the level
t: " " in topography factor " "
d: " " in drainage factor " "
D.P. --- drainage improvement study area
1/ soil mapping code of land classification

Table C-5-4(9) Land irrigability class of soil units for land classification-9

| Soil series | Soil phases (code) | Soil units | area | Conditions of classification | Land irrigability classes: Irrigability classes for annualcrop production | Irrigability classes for fruit production | Potential irrigability classes for irrigation forming | mapping code 1/ | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| Lambayeque | LB | LB-$g^2w^2$ | 136 | 1. Present land classification(Pr) | IIt | IIt | | | |
| | | | | 2. Potential land classification(Po) | IIt | IIt | IIt | IIt(IIt-IIt) | |
| | | LB-$g^3w^2$ | 24 | 1. Pr | IIIt | IIIt | | | |
| | | | | 2. Po | IIIt | IIIt | IIIt | IIIt(IIIt-IIIt) | |
| | LBSII | LBSII-$e^2w^2$ | 25 | 1. Pr | IIs | IIsd | | | D.P. |
| | | | | 2. Po | I | IId | I | I(I-IId) | |
| | | LBSII-$e^2w^3$ | 104 | 1. Pr | IIsd | IIId | | | D.P. |
| | | | | 2. Po | I | IId | I | I(I-IId) | |
| | | LBSII-$e^3w^3$ | 26 | 1. Pr | IVR | IIId | | | D.P. |
| | | | | 2. Po | I | IId | I | I(I-IId) | |
| | | LBSII-$e^4a^2w^4$ | 15 | 1. Pr | IVRs | VI | | | D.P. |
| | | | | 2. Po | I | IId | I | I(I-IId) | |
| | | LBSII-$e^4g^2w^4$ | 19 | 1. Pr | IVRs | VI | | | |
| | | | | 2. Po | IVRs | VI | IVRS | IVRs(IVRs-VI) | |
| | | Total area | 605 | | | | | | |
| Quepecaliche | QC | QC-$w^3$ | 158 | 1. Pr | IIsd | IIsd | | | |
| | | | | 2. Po | IIsd | IIsd | IIsd | IIsd(IIsd-IIsd) | |
| | QCSII | QCSII-$e^2w^3$ | 114 | 1. Pr | IIsd | IIId | | | D.P. |
| | | | | 2. Po | IIsd | IIsd | IIsd | IIsd(IIsd-IIsd) | |
| | | QCSII-$e^2w^4$ | 25 | 1. Pr | IIId | VI | | | D.P. |
| | | | | 2. Po | IIsd | IIsd | IIsd | IIsd(IIsd-IIsd) | |
| | | QCSII-$e^3w^4$ | 99 | 1. Pr | IVR | VI | | | D.P. |
| | | | | 2. Po | IIsd | IIsd | IIsd | IIsd(IIsd-IIsd) | |
| | | QCSII-$e^4a^2w^4$ | 199 | 1. Pr | IVRs | VI | | | D.P. |
| | | | | 2. Po | IIsd | IIsd | IIsd | IIsd(IIsd-IIsd) | |
| | | Total area | 595 | | | | | | |

IVF --- special use for fruit cultivation
IVR --- special use for salt tolerant crop cultivation
IVRI -- special use for salt tolerant crop cultivation under intensive irrigation methods
IVI --- limited arable under intensive irrigation methods
IVP --- limited arable due to flooding possibility
Phases ----- I: shallow phase, II: moderately deep phase, SI: well-drained salt accumulated phase
SII: poorly-drained salt accumulated phase, C: gravelly surface phase
Subclases --- s: deficiency or limitation in soil factor which determine irrigability class in the level
t: " " in topography factor " "
d: " " in drainage factor " "
D.P. --- drainage improvement study area
1/ soil mapping code of land classification

Table C-5-5(1) Summary of land classification ——— potential land irrigability class for irrigation farming

| Soil series | | Land irrigability Class | | | | | | | Total area |
|---|---|---|---|---|---|---|---|---|---|
| | | Class I | Class II | Class III | Class IV | | | Class VI | |
| | | | | | TV | IV Fs | IV Rs | | |
| Aucallama | ha | - | - | 2,445 | 97 | 97 | - | - | 2,542 |
| | (%) | | | (96) | (4) | | | | (100) |
| Esperanza | ha | - | - | 88 | 3,932 | 3,932 | - | - | 4,020 |
| | (%) | | | | | | | | (100) |
| Tucume | ha | - | 938 | 1,024 | - | - | - | - | 1,962 |
| | (%) | | (48) | (52) | | | | | (100) |
| Esquivel -Trujillo | ha | - | 2,399 | 2,709 | 154 | 128 | 26 | - | 5,262 |
| | (%) | | | | | | | | (100) |
| Clemencia | ha | - | 695 | - | - | - | - | - | 695 |
| | (%) | | | | | | | | (100) |
| Huaral | ha | - | 309 | - | - | - | - | - | 309 |
| | (%) | | (100) | | | | | | (100) |
| Mochuml | ha | 2,420 | 1,430 | - | - | - | - | - | 3,850 |
| | (%) | (63) | (37) | | | | | | (100) |
| Ocuaje | ha | 141 | 219 | - | - | - | - | - | 360 |
| | (%) | | | | | | | | (100) |
| Lamba yegue | ha | 426 | 136 | 24 | 19 | - | 19 | - | 605 |
| | (%) | (70) | (22) | (4) | (3) | | | | (100) |
| Quepecaliche | ha | - | 595 | - | - | - | - | - | 595 |
| | (%) | | (100) | | | | | | (100) |
| Total | ha | 2,987 | 6,721 | 6,290 | 4,202 | 4,157 | 45 | - | 20,200 |
| | (%) | (15) | (33) | (31) | (21) | | | | (100) |

IVF -- special use for fruit cultivation
IVR -- special use for salt tolerant crop cultivation
IVRI-- special use for salt tolerant crop cultivation under intensive irrigation methods
IVI -- limited arable under intensive irrigation methods
IVP -- limited arable due to flooding possibility

Table C-5-5(2) Summary of land classification —— potential land irrigability class for annual crop production

| Soil series | | Land irrigability Class | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Class I | Class II | Class III | Class IV | | | Class VI | Total area |
| | | | | | TV | IV Fs | IV Rs | | |
| Aucallama | ha | - | - | 2,445 | - | - | - | 97 | 2,542 |
| | (%) | | | (96) | | | | (4) | (100) |
| Esperanza | ha | - | - | 88 | 3,932 | 3,932 | - | - | 4,020 |
| | (%) | | | (2) | (98) | | | | (100) |
| Tucume | ha | - | 938 | 1,024 | - | - | - | - | 1,962 |
| | (%) | | (48) | (52) | | | | | (100) |
| Esquivel -Trujillo | ha | - | 2,399 | 2,709 | 26 | - | 26 | 128 | 5,262 |
| | (%) | | (46) | (51) | (-) | | | (2) | (100) |
| Clemencia | ha | - | 695 | - | - | - | - | - | 695 |
| | (%) | | (100) | | | | | | (100) |
| Huaral | ha | - | 309 | - | - | - | - | - | 309 |
| | (%) | | (100) | | | | | | (100) |
| Mochuml | ha | 2,420 | 1,430 | - | - | - | - | - | 3,850 |
| | (%) | (63) | (37) | | | | | | (100) |
| Ocuaje | ha | 141 | 219 | - | - | - | - | - | 360 |
| | (%) | (39) | (61) | | | | | | (100) |
| Lamba yegue | ha | 426 | 136 | 24 | 19 | - | 19 | - | 605 |
| | (%) | (70) | (22) | (4) | (3) | | | | (100) |
| Quepecaliche | ha | - | 595 | - | - | - | - | - | 595 |
| | (%) | | (100) | | | | | | (100) |
| Total | ha | 2,987 | 6,721 | 6,290 | 3,977 | 3,932 | 45 | 225 | 20,200 |
| | (%) | (15) | (33) | (31) | (20) | | | (1) | (100) |

IVF -- special use for fruit cultivation  IVI -- limited arable under intensive irrigation methods
IVR -- special use for salt tolerant crop cultivation  IVP -- limited arable due to flooding possibility
IVRI-- special use for salt tolerant crop cultivation under intensive irrigation methods

Table C-5-5(3) Summary of land classification —— potential land irrigability class for fruit production

| Soil series | | Land irrigability Class | | | | | | | Total area |
|---|---|---|---|---|---|---|---|---|---|
| | | Class I | Class II | Class III | Class IV | | | Class VI | |
| | | | | | TV | IV Fs | IV Rs | | |
| Aucallama | ha | - | - | 2,445 | 97 | 97 | | - | 2,542 |
| | (%) | | | (96) | (4) | | | | (100) |
| Esperanza | ha | - | - | - | 4,020 | 4,020 | | - | 4,020 |
| | (%) | | | | (100) | | | | (100) |
| Tucume | ha | - | 938 | 1,024 | - | - | | - | 1,962 |
| | (%) | | (48) | (52) | | | | | (100) |
| Esquivel -Trujillo | ha | - | 2,404 | 2,704 | 128 | 128 | | 26 | 5,262 |
| | (%) | | (46) | (51) | (2) | | | (-) | (100) |
| Clemencia | ha | - | 695 | - | - | - | | - | 695 |
| | (%) | | (100) | | | | | | (100) |
| Huaral | ha | - | 309 | - | - | - | | - | 309 |
| | (%) | | (100) | | | | | | (100) |
| Mochuml | ha | 1,876 | 1,902 | 72 | - | - | | - | 3,850 |
| | (%) | (49) | (49) | (2) | | | | | (100) |
| Ocuaje | ha | 87 | 273 | - | - | - | | - | 360 |
| | (%) | (24) | (76) | | | | | | (100) |
| Lamba yegue | ha | 190 | 372 | 24 | - | - | | 19 | 605 |
| | (%) | (31) | (61) | (4) | | | | (3) | (100) |
| Quepecaliche | ha | - | 595 | - | - | - | | - | 595 |
| | (%) | | (100) | | | | | | (100) |
| Total | ha | 2,153 | 7,488 | 6,269 | 4,245 | 4,245 | | 45 | 20,200 |
| | (%) | (11) | (37) | (31) | (21) | | | (-) | (100) |

IVF -- special use for fruit cultivation
IVR -- special use for salt tolerant crop cultivation
IVRI-- special use for salt tolerant crop cultivation under intensive irrigation methods
IVI -- limited arable under intensive irrigation methods
IVP -- limited arable due to flooding possibility

Table C-5-5(4) Summary of land classification —— present land irrigability class for annual crop production

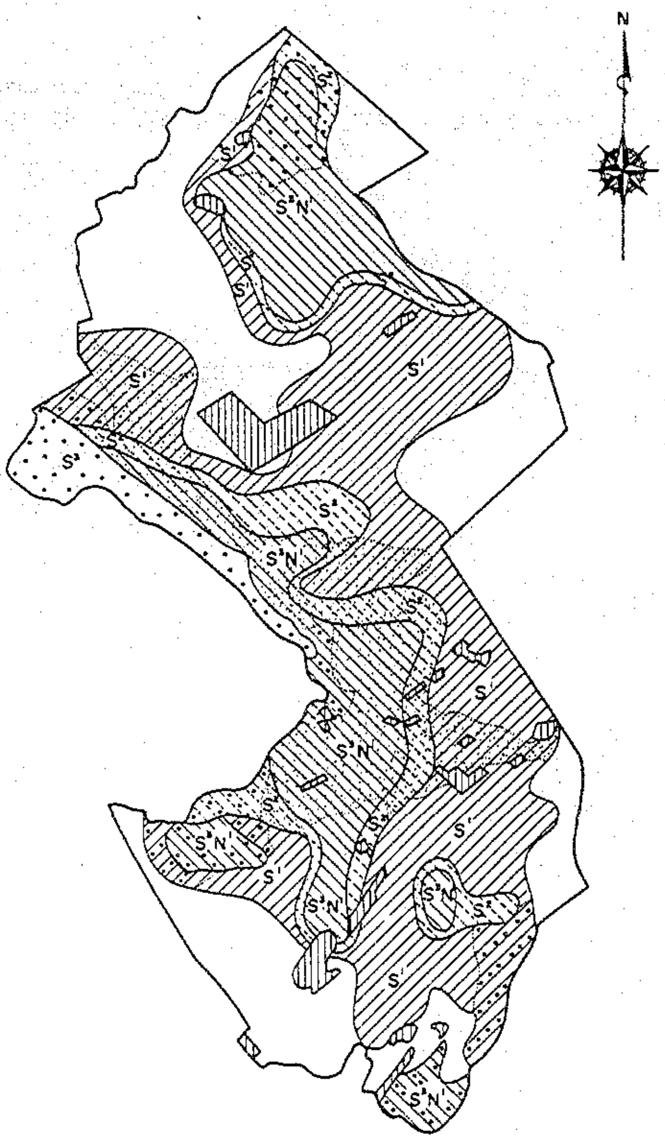
| Soil series | | Land irrigability Class | | | | | | | | | | Total area |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Class I | Class II | Class III | Class IV | | | | | | Class VI | |
| | | | | | TV | IV Fs | IV Rs | IVR | IVRs | IVPd | | |
| Aucallama | ha | - | - | 2,041 | 244 | - | - | - | 244 | - | 257 | 2,542 |
| | (%) | | | (80) | (10) | | | | | | (10) | (100) |
| Esperanza | ha | - | - | 19 | 3,975 | 2,865 | 1,041 | - | 69 | - | 26 | 4,020 |
| | (%) | | | (-) | (99) | | | | | | (1) | (100) |
| Tucume | ha | - | 902 | 935 | 125 | - | - | 63 | 62 | - | - | 1,962 |
| | (%) | | (46) | (48) | (6) | | | | | | | (100) |
| Esquivel -Trujillo | ha | - | 2,225 | 2,627 | 282 | - | - | 80 | 68 | 134 | 128 | 5,262 |
| | (%) | | (42) | (50) | (5) | | | | | | (2) | (100) |
| Clemencia | ha | - | 543 | - | 152 | - | - | 50 | 18 | 84 | - | 695 |
| | (%) | | (78) | | (22) | | | | | | | (100) |
| Huaral | ha | - | 288 | - | 21 | - | - | 21 | - | - | - | 309 |
| | (%) | | (93) | | (7) | | | | | | | (100) |
| Mochuml | ha | 1,817 | 1,631 | 42 | 360 | - | - | 113 | 141 | 106 | - | 3,850 |
| | (%) | (47) | (42) | (1) | (9) | | | | | | | (100) |
| Ocuaje | ha | 87 | 273 | - | - | - | - | - | - | - | - | 360 |
| | (%) | (24) | (76) | | | | | | | | | (100) |
| Lamba yegue | ha | 190 | 309 | 24 | 82 | - | - | 26 | 34 | 22 | - | 605 |
| | (%) | (31) | (51) | (4) | (14) | | | | | | | (100) |
| Quepecaliche | ha | - | 272 | 25 | 298 | - | - | 99 | 199 | - | - | 595 |
| | (%) | | (46) | (4) | (50) | | | | | | | (100) |
| Total | ha | 2,094 | 6,443 | 5,713 | 5,539 | 2,865 | 1,041 | 452 | 835 | 346 | 411 | 20,200 |
| | (%) | (10) | (32) | (28) | (27) | | | | | | (2) | (100) |

IVF -- special use for fruit cultivation
IVR -- special use for salt tolerant crop cultivation
IVRI-- special use for salt tolerant crop cultivation under intensive irrigation methods
IVI -- limited arable under intensive irrigation methods
IVP -- limited arable due to flooding possibility

Table C-5-5(5) Summary of land classification —— present land irrigability class for fruit production

| Soil series | | Land irrigability Class | | | | | | | Total area |
|---|---|---|---|---|---|---|---|---|---|
| | | Class I | Class II | Class III | Class IV | | | Class VI | |
| | | | | | TV | IV Fs | IV Rs | | |
| Aucallama | ha | - | - | 2,135 | 97 | 97 | - | 310 | 2,542 |
| | (%) | | | (84) | (4) | | | (12) | (100) |
| Esperanza | ha | - | - | - | 3,951 | 3,951 | - | 69 | 4,020 |
| | (%) | | | | (98) | | | (2) | (100) |
| Tucume | ha | - | 845 | 1,022 | - | - | - | 95 | 1,962 |
| | (%) | | (43) | (52) | | | | (5) | (100) |
| Esquivel -Trujillo | ha | - | 2,296 | 2,606 | 235 | 128 | 107 | 125 | 5,262 |
| | (%) | | (44) | (50) | (4) | | | (2) | (100) |
| Clemencia | ha | - | 543 | 50 | 53 | - | 53 | 49 | 695 |
| | (%) | | (78) | (7) | (8) | | | (7) | (100) |
| Huaral | ha | - | 144 | 144 | - | - | - | 21 | 309 |
| | (%) | | (47) | (47) | | | | (7) | (100) |
| Mochuml | ha | 1,857 | 1,363 | 341 | 106 | - | 106 | 183 | 3,850 |
| | (%) | (48) | (35) | (9) | (3) | | | (5) | (100) |
| Ocuaje | ha | 87 | 219 | 54 | - | - | - | - | 360 |
| | (%) | (24) | (61) | (15) | | | | | (100) |
| Lamba yegue | ha | 190 | 161 | 198 | 22 | - | 22 | 34 | 605 |
| | (%) | (31) | (27) | (33) | (4) | | | (6) | (100) |
| Quepecaliche | ha | - | 158 | 114 | - | - | - | 323 | 595 |
| | (%) | | (27) | (19) | | | | (54) | (100) |
| Total | ha | 2,134 | 5,729 | 6,664 | 4,464 | 4.176 | 288 | 1,209 | 20,200 |
| | (%) | (11) | (28) | (33) | (22) | | | (6) | (100) |

IVF -- special use for fruit cultivation
IVR -- special use for salt tolerant crop cultivation
IVRI-- special use for salt tolerant crop cultivation under intensive irrigation methods
IVI -- limited arable under intensive irrigation methods
IVP -- limited arable due to flooding possibility



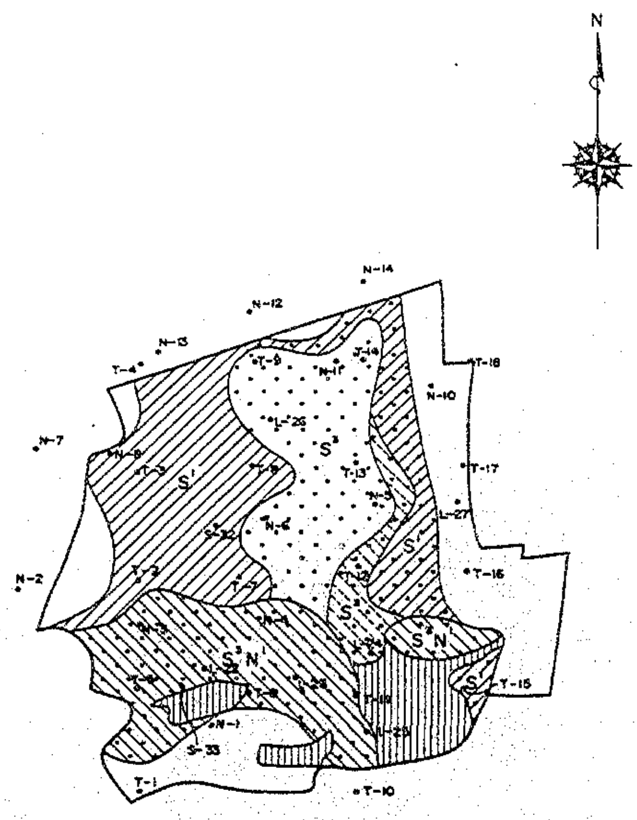

Legend

| symbol | salinity & alkalinity classes | net area (ha) | % of total salt accumulated soils |
|---|---|---|---|
| | $S^3N^1$ | 129 | 7.0 |
| | $S^3K^1$ | 196 | 10.6 |
| | $S^3N^1$ | 199 | 10.8 |
| — | $S^3N^1$ total | 524 | 28.3 |
| | $S^2$ | 39 | 2.1 |
| | $S^2$ | 135 | 7.3 |
| | $S^2$ | 99 | 5.4 |
| — | $S^2$ total | 273 | 14.8 |
| | $S^1$ | 102 | 5.5 |
| | $S^1$ | 139 | 7.5 |
| | $S^1$ | 715 | 38.6 |
| — | $S^1$ total | 956 | 51.7 |
| — | sub-total | 1753 | 94.8 |
| | $S^{2x}$ | 97 | 5.2 |
| — | salt accumulated soils total | 1850 | 100.0 |
| | $S^0$ | — | — |
| | | | |
| | drainage improvement study area boundary | | |

| symbol | soil texture classes |
|---|---|
| | coarse - textured soil |
| | medium - textured soil |
| | fine - textured soil |
| | nonarable land (hilly area, township, yard) |

X: salt accumulated soils 2nd type, on sloping land

Fig. C-4-1 Distribution of Salt Accumulated Soils in The Drainage Improvement Study Area - Quincho/Donoso




Legend

| symbol | soil texture/salinity & alkalinity classes | | netarea (ha) | % of total salt accumulated soils |
|---|---|---|---|---|
| | coarse-textured | $S^3N^1$ | 69 | 28.0 |
| | coarse-textured | $S^3$ | 61 | 24.8 |
| | coarse-textured | $S^2$ | 15 | 6.1 |
| | coarse-textured | $S^1$ | 31 | 12.6 |
| | medium-textured | $S^1$ | 70 | 28.5 |
| — | $S^1$ total | | 101 | 41.1 |
| — | salt accumulated soils total | | 246 | 100.0 |
| | $S^0$ | | — | — |
| | | | | |
| | drainage improvement study area boundary | | | |
| | nonarable land (hilly area, Township, yard) | | | |

N– , L– , S– , T– : plot location for soil profile observations and samplings

Fig. C-4-2 Distribution of Salt Accumulated Soils in The Drainage Improvement Study Area–Boza

Legnd

| symbol | salinity & alkalinity classes | net area (ha) | % of total salt accumulated soils |
|---|---|---|---|
| | San Luis | | |
| | $S^3N^1$ | 82 | |
| | $S^2$ | 168 | 57.7 |
| | $S^1$ | 41 | 14.1 |
| — | salt accumulated soils total | 291 | 100.0 |
| | $S^0$ | | — |
| — | total | | — |
| | study area, 494ha | | |
| | Lunavilca | | |
| | $S^2$ | 50 | 100.0 |
| — | salt accumulated soils total | 50 | 100.0 |
| | $S^0$ | | — |
| — | | | |
| | drainage improvement study area boundary | | |
| | nonarable land (gravelly land) | | |
| | river & river land | | |

L- ,V- ,M- ,O- :plot location for soil profile observations and samplings

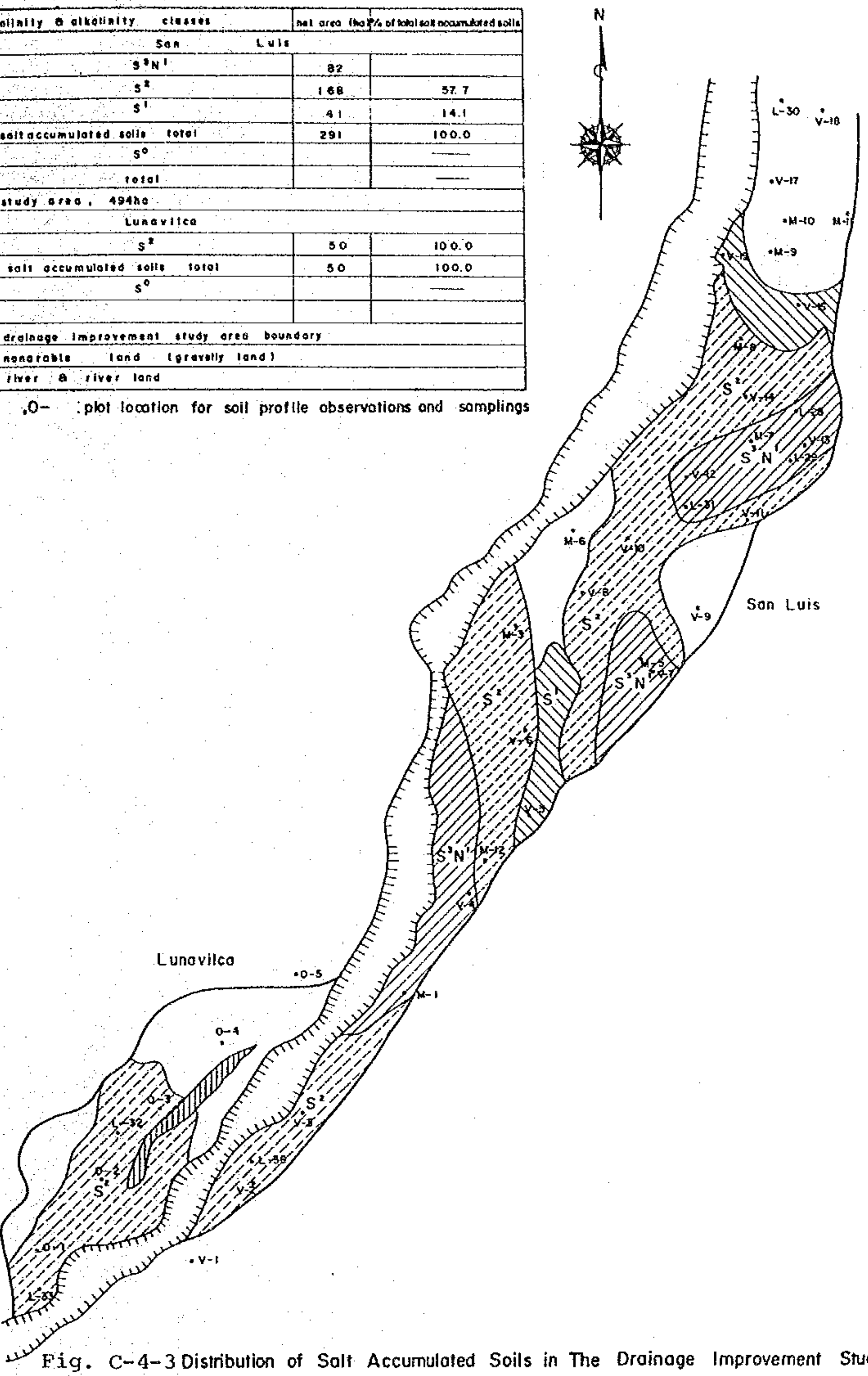
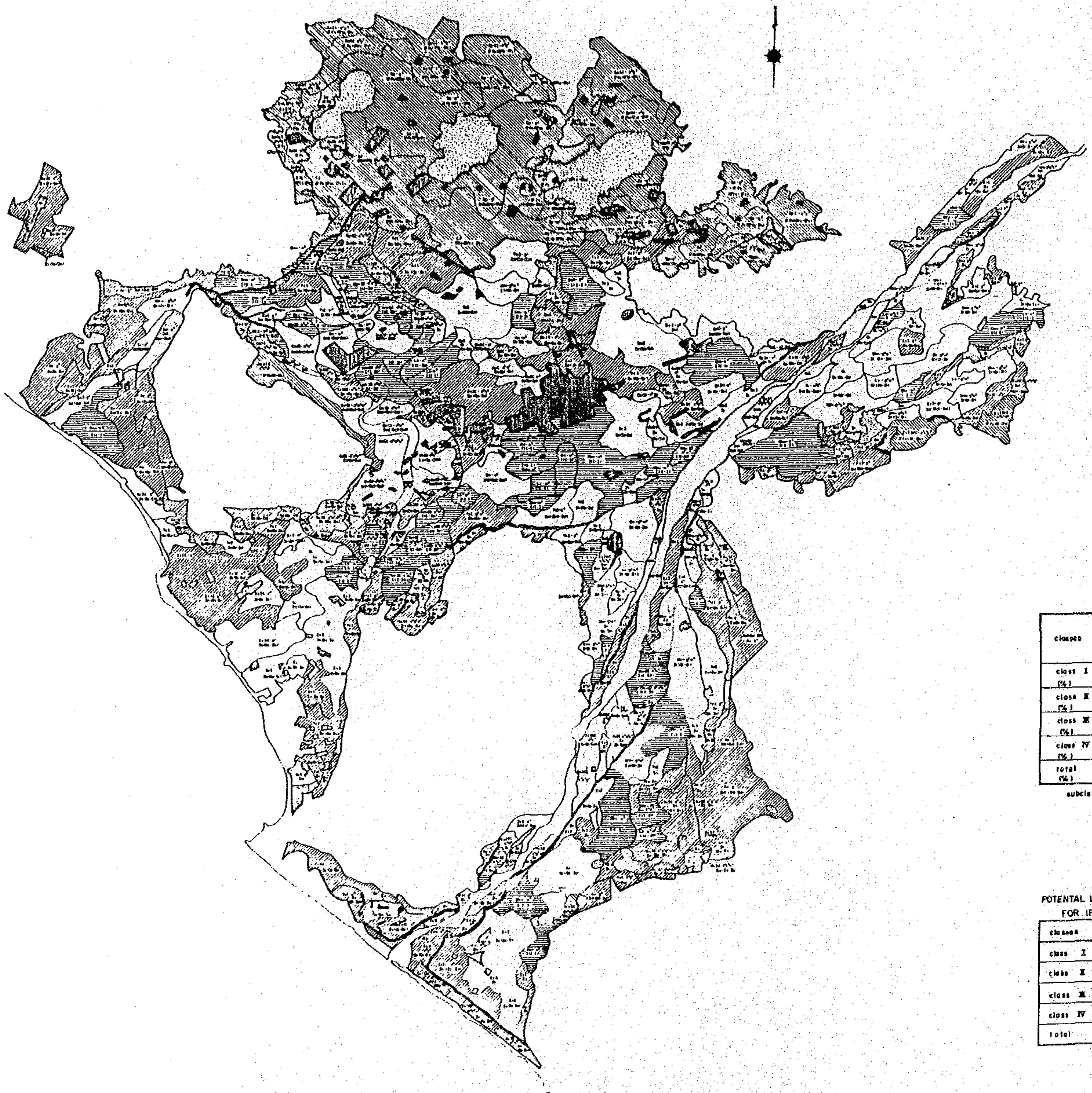



Fig. C-4-3 Distribution of Salt Accumulated Soils in The Drainage Improvement Study Area - San Luis / Lunavilca



LEGEND

| land use categories | area (% 1/) | symbol |
|---|---|---|
| arable land | ha 20,200 % (87) | Sp2tC |
| nonarable land | | |
| hilly area | 810 (4) | |
| streams, drains, ponds | 85 (-) | |
| stony land | 70 (-) | NA |
| residential area, ponds, others | 780 (3) | |
| right-of-way | 1160 (5) | — |
| project area | 23,100 (100) | — |
| river and river land | | |
| soil series/phase boundary | | |
| soil unit boundary | | |
| project area boundary | | |

(soil phase, soil unit code)

TcSSC — $s^4 a^2 c^2 g^2 w^3$

soil unit code

soil phase code

Tanamo series, poorly-drained salt accumulated, gravelly surface, moderately deep phase

(land classification code)

IIs (IIs — IIId)

potential land irrigability class for fruit production

potential land irrigability class for annual crop production

potential land irrigability class for irrigation farming

(soil unit code — $s^4 a^2 c^2 g^2 w^3 f^2$)

$s^4$ — salinity rating 4

$a^2$ — alkalinity rating 2

$c^2$ — coarse fragment content rating 2

$g^2$ — slope and microrelief rating 2

$w^3$ — drainability rating 3

$f^2$ — flooding hazard rating 2

land irrigability class

I — class I (arable) II — class II (arable), III — class III (arable) IV — class IV (limited arable or special use) VI — class VI (nonarable)

IVF --- special use for fruit cultivation

IVR --- special use for salt tolerant crop cultivation

IVI --- limited arable under intensive irrigation methods

subclass ---- s: deficiency or limitation in soil factor which determine irrigability class in the level

t: " " in topography factor " "

d: " " in drainage factor " "

phases ------ I. shallow phase, II: moderately deep phase, SI: well-drained salt accumulated phase

SII: poorly-drained salt accumulated phase, C: gravelly surface phase

1/ % of project area (23,100 ha)

POTENTIAL LAND CLASSIFICATION

| classes | land irrigability classes for irrigation farming: class total ha | subclass ha: s | d | t | sd | st | dt | sdt | IVFs | IVRs | for annual crop production: class total ha | subclass ha: s | d | t | sd | st | dt | sdt | IVFs | IVRs | for fruit production: class total ha | subclass ha: s | d | t | sd | st | dt | IVs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| class I (%) | 2987 (15) | | | | | | | | | | 2987 (15) | | | | | | | | | | 2153 (11) | | | | | | | |
| class II (%) | 6721 (33) | 3537 | 47 | 1673 | 630 | 775 | 23 | 34 | | | 6721 (33) | 3537 | 47 | 1673 | 630 | 775 | 25 | 34 | | | 7488 (37) | 2896 | 1459 | 1605 | 626 | 824 | 69 | |
| class III (%) | 6290 (31) | 5487 | | 24 | | 779 | | | | | 6290 (31) | 5487 | | 24 | | 779 | | | | | 6269 (31) | 5218 | 141 | 24 | 107 | 779 | | |
| class IV (%) | 4202 (21) | | | | | | | | 4157 | 45 | 3977 (20) | | | | | | | | 3932 | 45 | 4245 (21) | | | | | | | 4245 |
| total (%) | 20200 (100) | | | | | | | | | | 20200 (100) | | | | | | | | | | 20200 (100) | | | | | | | |

subclass s: deficiency or limitation in soil factor which determine irrigability class in the level

t: " in topography factor "

d: " in drainage factor "

IVF special use for fruit cultivation

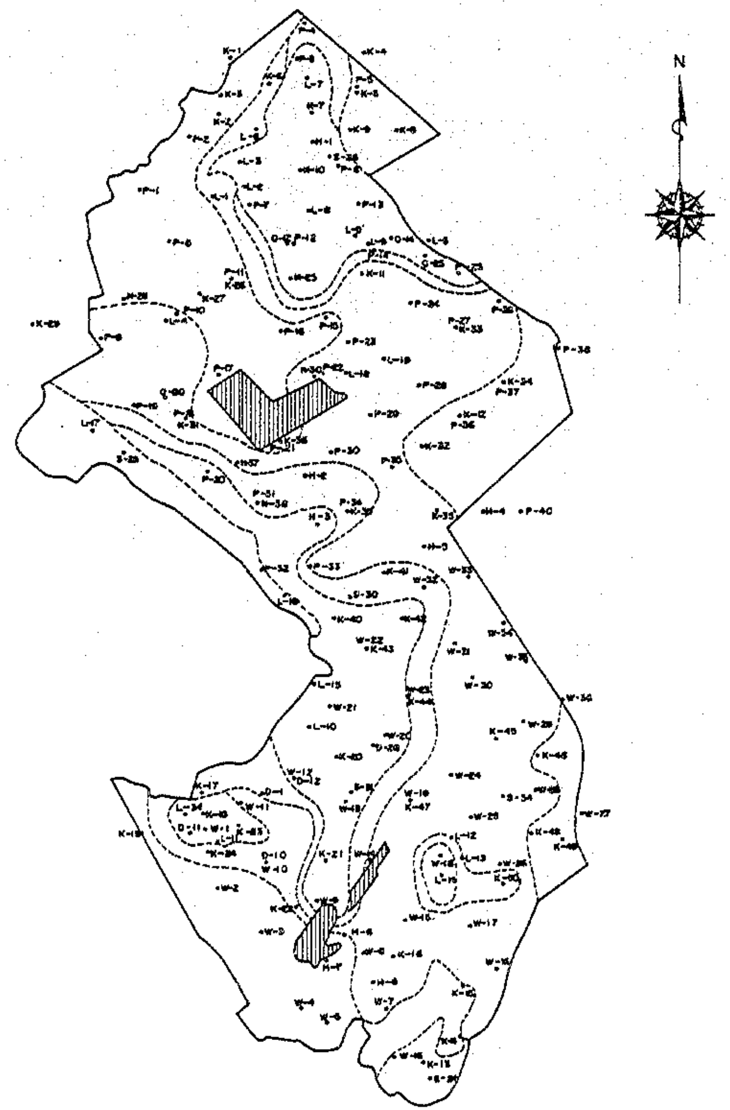
IVR special use for salt tolerant crop cultivation

IVI limited arable under intensive irrigation methods

POTENTIAL LAND IRRIGABILITY CLASSES FOR IRRIGATION FARMING

| classes | area (ha) | symbol |
|---|---|---|
| class I | 2987 | |
| class II | 6721 | |
| class III | 6290 | |
| class IV | 4202 | |
| total | 20200 | |

Fig. C-5-1 Land Classification Map



Plot Location for Soil Profile Observations and Samplings :
Drainage Improvement Study Area – Donoso / Quincha

# ANNEX D

# SALINITY CONTROL

# C O N T E N T S

## ANNEX D Salinity Control

ANNEX D

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# ANNEX D SALINITY CONTROL

## 1. Distribution and Characteristics of Salt Accumulated Soils

In the Project area, the following two types (1st and 2nd) of salt accumulated soils are distributed as previously described (ANNEX C 4(1)).

| | |
|---|---|
| 1st Type | salt accumulated soils in poorly drained areas (poorly-drained salt accumulated phase) |
| 2nd Type | salt accumulated soils in well-drained areas, generally found in slightly sloping areas (well-drained salt accumulated phase) |

The 2nd Type is futher subdivided into two subtypes:

| | |
|---|---|
| Type A | salt accumulated soils in slightly sloping areas; salt accumulation is only recongnized in the surface layer |
| Type B | salt accumualted soils in level area of isolated Project area, Hatillo; High salt concentration is found is an entire soil profile; distribution limited to 160ha |

The distribution of two types of salt accumulated soils are summarized in Table C-4-1. The following table shows the distribution and degree of salt accumulation in the drainage improvement study areas delineated by PLANREHATIC. The soil salinity maps of the areas are presented in FIG. C-4-1, C-4-2, C-4-3. The distribution and degrees of salinity are generally related to the depth of subsurface water.

Table D-1-1 DISTRIBUTION OF SALT ACCUMULATED SOILS IN THE DRAINAGE IMPROVEMENT STUDY AREAS

| Salinity Class<br>Study Area | S1<br>ha | (%)1/ | S2<br>ha | (%)1/ | S3<br>ha | (%)1/ | S3N1<br>ha | (%)1/ | Total<br>ha | (%)1 | Study Area2/<br>ha |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Quincha/ Donoso | 956 | (55) | 273 | (16) | - | | 524 | (30) | 1,753 | (100) | 2,714 |
| Boza | 101 | (41) | 15 | (6) | 61 | (25) | 69 | (28) | 246 | (100) | 390 |
| San Luis | 41 | (14) | 168 | (58) | - | | 82 | (28) | 291 | (100) | 494 |
| Lunavilca | - | | 50 | (100) | - | | - | | 50 | (100) | 103 |
| Palpa | - | | 30 | (100) | - | | - | | 30 | (100) | 498 |
| Total | 1,098 | (46) | 536 | (23) | 61 | (3) | 675 | (28) | 2,370 | (100) | 4,199 |

1/ % of Total
2/ drainage improvement study area
* in Quncha/Donoso, salt accumulated soils on sloping land (2nd type, 97ha) are not included.
** ECe of surface 0-15cm was adopted for the delineation of salt accumulated soils. Salinity class criteria are the same as shown in Table C-4-1.
*** average ECe of salinity class S3/S3N1: 30-40m$^{s}$/cm

The apparent characteristic of salt accumulated soils in the Project area is the fact that a high concentration of salt accumulation is generally recognized only in the surface layer (10-15cm depth or less) and concentration of salts in the lower layer is considerably low compared with the surface layer, usually less than 10-20% of the surface. In general, the tendency is more prominent during the fallow period and less prominent during cultivation. In the course of field survey, a higher concentration of salts up to about 50cm in depth has been detected at a few plots under cultivation. This fact shows higher possibility of salt accumulation in the subsoil if the leaching water depth is not enough to wash surface salts out of the root zones.

In the desalinization process, a rapid decrease of soil salinity (ECe) is generally recognized at an early stage of leaching. However, at a later stage, a slow decrease in ECe (sometimes nearly constant) is ussually a result after soil salinity reaches a certain level. These phenomena in the process of desalinization explain the existence of two types of salts in soil; readily soluble salts and slightly soluble salts.

The difficulty in achieving desalinization beyond a certain level could be due to the existance of slightly soluble salts like $CaCO_3$, and $CaSO_4 \cdot 2H_2O$, whose sulubilities correspond to EC of 0.8ms/cm and 3.3ms/cm respectiviely. This is the case with poorly drained highly salt accumulated soils in the Project area which may contain considerable amounts of $CaCO_3$ and $CaCO_4 \cdot 2H_2O$ and the corresponding EC value is estimated at about 2.0ms/cm (Table D-1-2). The contents of these kinds of salts in slightly to moderately salt accumulated soils in the Project area are estimated to be less than 1.0ms/cm.

## 2. Present Conditions of the Salt Accumulated Area

The highly salt accumulated areas in the poorly drained area was deserted grassland with high salt concentration until the land reclamation which was carried out about bitween 20 to 50 years ago. The reclamations required drain excavations and leaching with quantities of water demanding a great effort from the farmers. Since then, the land has produced considerable returns.

At present, salt accumulated areas in the poorly drained area are generally utilized for the cultivation of cotton and maize except for small patches of grassland (in total, estimated to be about 150ha including scattering grasslands). Crop yields are higher than expected from the ECe level in the fallow period and largely dependent on farming practices. Under good managment, higher yields than the average of the Project area are obtained. Countermeasures listed below may be successful to some extent in overcoming the adverse effects of accumulated salts. In addition, the water supply from subsurface water to root zones is considered to be mitigating and/or compensating the adverse effects of salts.

The following represent the main present countermeasures:

a) leaching of accumulated salts by flooding or furrow irrigation after harvest or before sowing;

b) presowing wetting of soils by furrow irrigation;

c) cultivation of salt-tolerant crops or salt resistance varieties; and,

d) cultural practices such as seed placement, utilization of salt-free subsoil as major root zones, planting without plowing so as not to mix salt accumulated surface soil with subsoil.

In the 2nd type salt accumulated area, fruit production is carried out. Therefore, it is presumed that accumulated salts in the surface layer above the root zones of existing fruits have no significant effect on production. The most detrimental factor for fruit production in the area is limited availability of irrigation water.

## 3. Future Conditions of the Poorly Drained Salt Accumulated Area

It is impractical to predict, by any theory, the future conditions of the salt accumulated area if the present Project is not implemented as the same would involve numerous assumptions of unknown factors which affect future conditions in the area. In this study, the following information was taken into consideration of future projections:

a) Flooding (machaco) or irrigation for leaching is a common practice.

b) Farmers are well aware of the salinity conditions of their fields and know how to solve the problem.

c) Not only planting of salt tolerant crops but also physical countermeasures like excavation of farm drains by each farmer or groups of farmers are practiced.

d) In the past 20 years, no significant expansion of deserted grass land has occured.

e) Results of groundwater study estimating the tendency of groundwater level to remain at present level or to decrease. As for the poorly drained areas in Quincha and Donoso, the results of present survey shows a considerable decrease in salt accumulated area (especially salinity class S3) compared with the results obtained by Direccion General De Aguas in 1977.

From the above, it may be safe to conclude that there will be no significant change in crop yields in the future, although yield increases are not anticipated.

## 4. General Salinity Control Measures

### (1) Management Practices for Salt Accumulated Soils

The major objective of management practices for salt accumulated soils is to improve soil moisture availability for crops. General management practices include:

a) increased irrigation frequency to maintain a more adequate soil moisture supply to crops;

b) routine use of extra water to satisfy leaching requirements;

c) selection of irrigation methods which provide better salt control;

d) cultivation of salt tolerant crops;

e) implementation of cultural practices such as pre-sowing irrigation and adequate seed placement to ensure good germination;

f) improvement of soil drainability;

g) reduceding concentration of accumulated salts by leaching;

h) improvement of drainage conditions; and,

i) application of chemical amendments.

Of the above, d) and e) are commonly practiced in the Project area. However, g), h) and i) are drastic practices to improve salt accumulated soils.

### (2) Countermeasures to Control Salt Accumulation

Salt accumulation is generally directly dependent on water management; irrigation, leaching and drainage as salts move with water. Therefore, primary measures to control future salt accumulation consist of the following irrigation and drainage practices:

a) satisfaction of leaching requirement;

b) irrigation before-sowing or after-harvesting to leach accumulated salts during cropping season;

c) improvement of drainage conditions; and

d) control of excess seepage loss by water management.

In the present fesibility study, these aspects are considered as part of the irrigation and drainage study.

## 5. Proposed Plan for Improvement of Salt Accumulated Soils

### (1) Basic Counter Measures

In the formulatin of the improvement plan, not only the types of salt accumulatin but also land utilization patterns should be taken into consideration. Basic countermeasures are proposed for the improvement of each type of salt accumulated soils as discassed below.

#### 1) 1st type: salt accumulated soils in poorly drained areas

The land utilization pattern is annual crop production mainly with cotton-maize rotation. Improvement measures to be taken include lowering of subsurfce water level by drainage improvement, desalinization by leaching, and application of chemical amendments, if necessary.

As the area is presently utilized for annual crop production any interruption of cropping for a considerable period should be avoided in desalinization.

Approaches to be taken in desalinization include leaching of the surface layer (0-15cm, seed bed and root zones of young seedlings) by the application of leaching water, presow wetting by furrow irrigation, and continuation of leaching by irrigation practices.

2) 2nd type A: salt accumulated soils in slightly sloping areas

Measures to be taken for improvement consist of desalinization by leaching.

As the subject area is utilized for fruit production at present, accumulatin of salts in the lower layer, where the main root zones of fruits occur, should be prevented. Complete desalinization in a short period should accordingly be planned.

Approaches to be taken in desalinization include leaching down accumulated salts from the surface layer to the lower layer, and application of fresh leaching water when water from the first leaching has drained out of the root zone.

3) 2nd type B: salt accumulated soils in Hattillo

Desalinization by leaching is the proposed countermeasure. The area is presently fallow because of high salt concentration in the entire soil profile. In the first leaching, the surface layer of soil should be leached to obtain a certain ECe which permits planting of salt tolerant crops.

Steps to be taken in desalinization include leaching surface layer by application of leaching water, presow wetting by furrow irrigation and continious leaching by irrigation practices.

(2) Results of Leaching Tests

Both indoor and field leaching tests were carried out with three texture classes of soils; i) coarse-textured soils, ii) medium-textured soils, and iii) fine-textured soils. In the field test, the method used for determination of cylinder intake ratio was adopted. In the indoor test, undisturbed core samples of 10cm in depth were collected for leaching operations and each 50ml of leachate was sampled for EC measurement.

The purpose of leaching test is primarily to study ponding water depth required for achieving ECe of around 4ms in the 0-15cm surface layer having varying initial ECe values. For this purpose, the following steps were taken:

a) clarifying water depth required for achieving ECe of around 4ms of surface 10cm core samples by indoor tests;

b) field tests to obtain water depth required for achieving ECe of around 4ms of surface 15cm in field test conditions;

c) comparison of results of both tests and calculated the conversion ratio for estimating water requirement in field test conditions from results obtained in indoor test conditions; and,

d) estimation of water requirement in depth in field conditions for achieving ECe of around 4ms of surface layer (0 -15cm) from results obtained by indoor tests.

The actual procedures are shown in Table D-5-11 while the results of leaching test are shown in Table D-5-1 - D-5-5 and Fig. D-5-1 - D-5-7 and summarized below.

1) Indoor tests: leaching of 10cm surface soil layer (Table D-5-1, D-5-2, Fig. D-5-1 - D-5-5)

Removal of the majority of salts is achieved in the early stages of leaching process as speed of desalinization is faster in the early rather than in the later stage. For the estimation of ECe value, the following equations were adopted respectively.

from EC of 1:2 soil-water suspension and from ECsw

ECe = (d - s) x 200%/sp% + s, when d ≦ s, ECe = d

d : EC of 1:2 soil-water suspension

s : estimated EC for slightly soluble salts in soil samples (from Table D-1-2)

ECe[1/] = a x Fc%/Sp%

a : EC of leachate
Fc : field capacity

1/ Not applicable to coarse-sandy Esperanza Series soils

The higher the concentration of salts, the faster desalinization occurs. Therefore, the quantity of water required for desalinization is not proportional to concentration of salts in soil. This is clearly expressed when the adjusted leaching rate is calculated by the following equation:

adjusted leaching rate ka $m^s/cm$

$$= \frac{\text{decrease in ECe (initial ECe} - 4m^s)}{\text{water depth in cm required to achieve ECe } 4m^s}$$

The rate express decrease in salt concentration of soil per unit depth of leaching water. In general, the same is dependent on the initial salt concentration of soil and is independent from soil texture classes. In the test, the following adjusted leaching rates corresponding to initial ECe of soil were obtained.

| | | | |
|---|---|---|---|
| Initial ECe | $30m^s/cm$ | adjusted leaching rate | $1\text{-}2m^s/cm$ |
| " | 30 – 70 " | " | 2-3 " |
| " | $>$ 70 " | " | $>$3 " |

For practical purposes, the water depth required for achieving ECe of $4m^s$ of surface 10cm soil under indoor test conditions is estimated based on the results of indoor tests on major soils in the poorly drained area as follows:

| initial ECe of soil | estimatd water depth required |
|---|---|
| $< 20m^s$ | 10 - 15cm |
| $20 - 60m^s$ | 15 - 20cm |

2) Field tests (Table D-5-3 - D-5-5. Fig D-5-6. D-5-7)

The same patterns of the desalinization process found in the indoor tests were observed. About 50% of readily soluble salts were washed out of the surface layer with 10cm of water in two plots, while in a fine textured soil 20cm of water were consumed. As a result of rapid desalinization of the surface layers, apparent salt accumulation in the 2nd layer was recognized in the initial stage of leaching. The phenomenon may explain crop failures in some fields after leaching operations. This also shows that the difficulty in desalinization exists in estimating how much water is required to prevent salt accumulation in lower layers.

With increase in water depth, ECe values of all layers are gradually approaching the ECe of the surface layer as theoretically predicted.

ECe values after leaching showed considerable differences between replicates. The differences tend to become less with increased water depth. This may show that uniform desalinization under field conditions requires more water than the quantity obtained in desalinization tests.

3) <u>Comparison of desalinization efficiency and convertion ratio</u>

The following table shows the differences in efficiency of the desalinization process between two tests carried out on the same plots.

Table D-5-6 **COMPARISON OF DESALINIZATION EFFICIENCY**

| Plot No. | Depth of Water to Achieve ECe of about 4ms | | | A/C | Conversion ratio 4/ |
|---|---|---|---|---|---|
| | Field test A | Indoor test B 5/ | Depth adjustment C 3/ | | |
| L - 17 coarse-textured soil | 30cm<br>soil depth= 15cm | 10cm<br>soil depth= 10cm | 15cm/10cm = 1.5<br>10cm x 1.5=15cm | 2 | 2 x 1.5 = 3 |
| L - 10 fine-textured soil | 60 - 80cm<br>soil depth= 15cm | 22.5cm<br>soil depth= 10cm | 15cm/10cm = 1.5<br>22.5cmx1.5= 34cm | 1.8 ~ 2.4 | 1.8-2.4x1.5 = 2.7 - 3.6 |
| L - 9' medium-textured soil | 40cm 1/ (ECe 5.1-7.5)<br>soil depth= 15cm | 15cm 6/<br>soil depth= 10cm | 15cm/10cm = 1.5<br>15cmx1.5 = 22.5cm | 1.8 | 1.8 x 1.5 = 2.7 |

con't

| Plot No. | Depth of Water to Achieve ECe of about 4m$^{s}$ | | | A/C | Conversion ratio 4/ |
|---|---|---|---|---|---|
| | Field test A | Indoor test B 5/ | Depth adjustment C 3/ | | |
| L - 9' | 80cm 2/ (ECe 4.4) soil depth= 15cm | 25-27.5cm soil depth= 10cm | 15cm/10cm = 1.5 25-27.5cmx1.5 = 37.5 - 41.3cm | 1.9 ~ 2.1 | 1.9-2.1x1.5 = 2.9 - 3.2 |

1/ actual figures obtained from field tests: with 40cm depth - ECe 5.1, 7.5 in replicates

2/ calculated ECe & water depth by numerical method

3/ estimated water depth required to desalinize surface 15cm/assume that salts up to 15cm distributed uniformly

4/ conversion ratio to estimate water depth required in field test conditions from water depth obtained in indoor tests; estimated water depth to achieve about 4m$^{s}$ in field test conditions = conversion ratio x water depth to achieve 4m$^{s}$ in indoor test

5/ results obtained by indoor tests carried out in triplicate

6/ water depth required to achieve ECe 6.5

From the table, it is estimated that under field test conditions about three times of water depth is required to achieve ECe of around 4m$^{s}$, of surface 15cm soil compared with water depth required to achieve the same level of ECe of surface 10cm soil in indoor test conditions.

4) Examination of numerical method

For the purpose of examining the applicability of numerical method expressed in the following equations, calculated ECe values and actual and estimated ECe values obtained with both tests were compared as shown in Table D-5-7 - D-5-10.

$$ECswI = \frac{a \cdot EC1 + b1\ ECe1}{a + C1}$$

$$ECswII = \frac{(a - d1) \cdot ECswI + b2 \cdot ECe2}{a - d1 + C2}$$

$$ECswIII = \frac{(a - d1 - d2) \cdot ECswII + b3\ ECe3}{a - d1 - d2 + C3}$$

$$ECswN = \frac{(a - d1 - d2 \cdots \quad dn-1) \cdot ECsw\ (N-1) + bn \cdot ECen}{(a - d1 - d2, \ldots\ldots dn-1) + Cn}$$

$$ECeI = ECswI \cdot \frac{Fc\%}{Sp\%} + S$$

ECswI - N : EC of percolation water in to the next layer

= ECsw of soil water at field capacity

where:

a : depth of water irrigated in cm

b1 - bn : saturation % in cm

C1 - Cn : initial moisture content in cm

d1 - dn-1 : moisture volume in cm retained in the upper layer after leaching

S : EC of slightly soluble salts

Under field tests conditions, the differences between actual and calculated ECe are more significant with shallow water depth. With increases in water depth, the differences tend to decrease.

Under indoor tests conditions, estimated ECe tended to show higher values than calculated ECe in the initial stage of leaching. On the contrary, estimated ECe are lower than calculated ECe in the later stage.

In the case of coarse-textured soils, L-11, L-26, L-34 (Aucallama Series), both values are fairly consistent with each other.

Except for coarse-textured Aucallama Series, the numerical method is not considered applicable becuase calculated leaching processes of surface layers, as shown in FIG. D-5-1, are different from actual patterns.

However, if salt concentration of percolation water from an upper layer is known, the numerical method is considered applicable at least for rough estimation of ECe of lower layers after leaching because salt content of a lower layer is less significant compared with salt concentration of percolation water which is the principal source of salts at the time of the leaching process in the lower layer. Under this condition, situations more or less similar to the basic assumption of the numerical method that all salts existing in a soil layer mix before commencement of percolation can be expected.

(3) Proposed Measures for Desalinization and Water Requirement

For the formulation of desalinization measures, the following issues should be taken into account.

a) Any interruption in cropping for a considerable period should not be involved in desalinization measures.

b) Irrigation practices such as pre-sowing wetting and application of more water than crop requirement should be practiced to supplement leaching operation and to ensure desalinization.

c) Surface layer (0-15cm) should be desalinized to a permissible level as soon as possible so as to make annual crop planting possible.

d) Major root zones should be desalinized to a permissible level by the time growing roots reach the same.

e) Target ECe should be achieved in three years in the case of 1st type and 2nd type B. As for 2nd type A, target ECe should be achieved in approximately one week.

Desalinization measures corresponding to types and degrees of salt accumulation and topographic conditions are proposed as set in below.

1) 1st type: salt accumulated soils in poorly drained areas

In the poorly drained area, the ponding method or furrow flooding method is proposed depending on topographical conditions. In the ponding method, achievement of an ECe around 4ms in the surface layer (0-15cm) is planned by the initial ponding in the first year. In the furrow flooding method, initial furrow flooding for three years is planned in order to ensure desalinization of the surface layer.

The Target ECe in the final year is:

soil depth 0 - 50cm $<$ 4ms/cm

" 50 - 100cm $<$ 8ms/cm

a) Desalinization measures

1st year - 1st step: initial ponding/initial furrow flooding

removal of accumulated salts in surface layer by ponding or furrow flooding

2nd step: pre-sow wetting

pre-sow furrow irrigation, to ensure good germination of crops

3rd step: irrigation

continuous leaching by irrigation water (applications loss fraction of irrigation water or more if possible)

2nd, 3rd year: initial furrow flooding (in case of furrow flooding method adopted)

pre-sow wetting

continous leaching by irrigation

* The 2nd and 3rd step should be performed by ordinary irrigation practices.

The above measures are applicable for soils of salinity class S2 and S3. As for soils of salinity class S1, the 2nd and 3rd step measures are considered adequate to wash out accumulated salts.

b) Ponding water depth requirements

Ponding water depth requirements to achieve an ECe of about 4ms of the surface layer (0-15cm) are estimated based on the results of leaching tests and are shown in Table D-5-11.

Table D-5-11 **PONDING WATER DEPTH REQUIRED IN CM TO ACHIEVE ECe ABOUT 4MS OF SURFACE LAYER (0-15CM)**

| Conditions | Initial ECe | | | | | |
|---|---|---|---|---|---|---|
| | 10m^s | 30m^s | 40m^s | 50m^s | 70m^s | 90m^s |
| A. Water depth1/ required in indoor test conditions: soil depth = 10cm | 10m^s/Ka = 10/1 = 10cm | 20cm | 20cm | 20cm | 70m^s/Ka = 70/3 = 23cm | 90m^s/Ka = 90/3 = 30cm |
| B. Conversion2/ ratio | 3 | 3 | 3 | 3 | 3 | 3 |
| C. Water depth required in field test conditions: soil depth = 15cm | A x B 30cm | A x B 60cm | A x B 60cm | A x B 60cm | A x B 70cm | A x B 90cm |
| D. Conversion3/ ratio | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| E. Water depth required in field conditions: soil depth = 15cm | C x D 30cm | C x D 60cm | C x D 60cm | C x D 60cm | C x D 70cm | C x D 90cm |

1/ from results of indoor test, Ka = ajusted leaching rate

2/ Conversion rate to obtain water depth required in field test conditions from water depth required in indoor test conditions (Table D-1-6).

3/ Conversion rate to obtain water depth required in field conditions from water depth required in field test conditions. Same leaching efficiency assumed in both conditions.

In the above estimation, leaching efficiencies for both field test conditions and field conditions are assumed to be equal. Lower leaching efficiency of surface layer in field conditions may occur depending on ground surface conditions. Therefore, supplemental leachings by pre-sow wetting and irrigation are also proposed. In the lower layers (15cm below the surface), on the other hand, a higher leaching efficiency is expected because the lateral percolation loss is less in field conditions.

From the table, average ponding water depth requirements for desalinization of salt accumulated soils in the poorly drained areas in the Project area are estimated as follows:

| Salinity Class | Average ECe 1/ | Ponding Water Requirement |
|---|---|---|
| $S^2$ | 10ms/cm | 30cm |
| $S^3$ | 30-40ms/cm | 60cm |

1/ Average ECe to each salinity class in the Project area.

c) Water requirement in furrow flooding method

The leaching efficiency of furrow flooding method is estimated to be 60 - 70% compared to that of the ponding method. Water requirement in a total of three years to achieve a final ECe level similar to that for the ponding method is estimated to be 1.5 times greater as follows:

| Salinity Class | Average ECe | Water Requirement |
|---|---|---|
| $S^2$ | 10ms/cm | 45cm |
| $S^3$ | 30-40ms/cm | 90cm |

d) Estimated ECe value of lower layers

ECe values of lower layers after leaching with ponding water depths shown in Table D-5-11 were estimated by the numerical method and are shown in Table D-5-12 - D-5-14. In the estimation, the EC of percolation water corresponding to initial Ece of surface layer were calculated (Table D-5-15) and adopted as proposed in 4). In the calculation, the following ECe values of lower layers were assumed:

15 - 30cm: 10% of surface layer
30 - 100cm: 10% of surface layer when ECe of surface is 10mS

5% of surface layer when ECe of surface is 30 - 90mS

2) 2nd type B: salt accumulated soils in Hattillo

The land is flat and the ponding method is applicable. The Target ECe in the final year is:

Soil depth 0 - 30cm $<$ 4mS/cm
" 30 - 100cm $<$ 8mS/cm

a) Desalinization measures (2nd and 3rd step should be performed by ordina irrigation practices)

1st year - 1st step : initial ponding
2nd step : pre-sow wetting
3rd step : irrigation

2nd, 3rd year - pre-sow wetting
irrigation

b) Ponding water requirement and estimated ECe

Ponding water depth required to achieve ECe 4ms of surface layer (0-30cm) and corresponding ECe of lower layers can be estimated by the numerical method as shown in Table D-5-16.

Table D-5-16 **ESTIMATED ECe AFTER LEACHING BY PONDING**

| | 0-30 cm | 30-50 cm | 50-100 cm | | |
|---|---|---|---|---|---|
| | | | | ECw = 1 | C1=0 |
| | | | | Sp = 30% | C2=0 |
| | | | | FC = 10% | C3=0 |
| Initial ECe (mS/cm)1/ | 30 | 20 | 20 | d1 = 30m/mS =2 | |
| | | | | d2 = 30m/m | |
| ECe after leaching | 3.9 | 4.7 | 6.7 | FC/Sp= 0.3 | |

Note: see following page

$$ECe\ 4.0ms = ECI \cdot FC/Sp + 2 \qquad ECI = 5.7$$

$$ECI = \frac{a \cdot ECI + b1 \cdot ECe1}{a + c} \qquad a = 500m/m$$

1/ ECe of typical soil profile

* Ponding water depth required is estimated to be 50cm.

3) 2nd type A: salt accumulated soils in slightly sloping area

The land is sloping and the wide-bottom furrow irrigation method for leaching is proposed.

The target ECe at the end of the 2nd step is:

soil dept 0 - 1.5m or deeper < 2ms/cm

a) Desalinization measures

1st step: furrow irrigation (wide-bottom furrows), for removal of surface salts

2nd step: furrow irrigation within a few days after 1st step
removal of salts in lower layers

b) Water requirement and estimated ECe

Water depth required to achieve the target ECe was estimated by the numerical method as shown in Table D-5-17.

Table D-5-17 **WATER REQUIREMENT AND ESTIMATED ECE**

| | 0-15 cm | 15-50 cm | 50-150 cm | | |
|---|---|---|---|---|---|
| Salinity class $S_1$ 1/ | | | | ECw=1 | $C_1$=0 |
| initial ECe (ms/cm) | 6 | 2 | 1 | SPv=35% | $C_2$=0 |
| ECe after leaching | | | | FCv=14% | $C_3$=0 |
| water depth 20cm | 1.0 | 1.4 | 2.4 | FC/SP=0.4 | S=0 |
| " 30cm | 0.8 | 1.1 | 1.6 | $d_1$=50m/m | |
| | | | | $d_2$=100m/m | |
| Salinity class $S_2$ 1/ | | | | | |
| initial ECe (ms/cm) | 10 | 2 | 1 | | |
| ECe after leaching | | | | | |
| water depth 20cm | 1.4 | 1.8 | 2.8 | | |
| " 30cm | 1.1 | 1.4 | 1.8 | | |

1/ ECe of typical soil profile

* Water depth required is estimated to be 20-30cm for both salinity classes.

(4) Chemical Amendment Requirement

Amounts of chemical amendment (gypsum, $CaSO_4 \cdot 2H_2O$) needed to reduce the exchangeable - sodium content or percentage of surface layer (0-15cm) of saline-alkali soils in the poorly drained area were estimated based on procedures by the U.S.D.A. (Diagnosis and Improvement of Saline and Alkali Soils).

1) Exchangeable-Na content to be reduced

| | coarse-textured soils | medium-textured soils | fine-textured soils |
|---|---|---|---|
| 1. alkalinity class | N1 | N1 | N1 |
| 2. average ESP/ exchangeable-Na content of surface 15cm | 2.5meq/100g soil | 23% | 12% |
| 3. to be lowered to | 1.5meq/100g soil | 15% | 8% |
| 4. CEC (meq/100g soil) | - | 15 | 20 |
| 5. exchangeable-Na content to be removed (meq/100g soil) | 1.0 | (2-3)x4<br>1.2 | (2-3)x4<br>0.8 |

* average exchangeable-Na content to be reduced
........... 1.0 meq/100g soil

2) Amount of gypsum required per ha

Amount of gypsum required per ha to replace 1.0 meq/100g soil of exchangeable-Na in the surface layer (0-15cm) is as follows:

2.25t/ha.15cm ÷ 0.8 (application efficiency) = 2.8t/ha·15cm

3) Total amount of gypsum required

2.8t/ha x 675ha (surface coverage of saline-alkali soils in the Project area) = 1890t

In conclusion, about 1,900t of gypsum are required to improve sodicity of surface layer (0-15cm) of saline-alkali soils in the Project area.

(5) Improvement Plans for Salt Acumulated Soils

Improvement plans were formulated on the basis of the study results of preceding sections. The furrow flooding method has been adopted as desalization measures for salt accumulated soils in the poorly drained area considering topographic conditions and water availability. The plans are proposed as follows:

1) 1st type: salt accumulated soils in poorly drained areas

a) Water requirement

The water requirement for furrow flooding was calculated according to the following conditions:

- initial leaching method:
  furrow flooding
- time of initial leaching:
  May - July
- intensity of furrows:
  width of ridge:
  width of furrow = 1:1 (50% of ground surface to be flooded)
- rate of water application:
  one third of total water requirement for furrow flooding to be applied in each year
- proposed cropping plan:
  cotton-green manure-maize in rotation (first crop ... cotton)

Water requirement in depth per ha for furrow flooding is tabulated on the following page.

| | Salinity | Class |
|---|---|---|
| | $S^2$ | $S^3$ |
| 1. Average ECe (ms/cm) of surface layer | 10 | 30-40 |
| 2. Total water requirement in depth for furrow flooding (cm) | 45 | 90 |
| 3. Rate of application in each year | 1/3 | 1/3 |
| 4. Water requirement in depth for furrow flooding/year (cm) | 2x3<br>15 | 2x3<br>30 |
| 5. Intensity of furrows (% of ground surface to be flooded)(%) | 50 | 50 |
| 6. Water depth in cm to be applied in furrows (cm) | 4+5<br>30 | 4+5<br>60 |

Water requirement in depth and in volume per ha for furrow flooding is tabulated below.

| | Salinity | Class |
|---|---|---|
| | $S^2$ | $S^3$ |
| depth/ha·year (cm) | 15 | 30 |
| volume/ha·year ($m^3$) | 1500 | 3000 |
| depth/ha·3 years (cm) | 45 | 90 |
| volume/ha·3 years ($m^3$) | 4500 | 9000 |

Water requirement for furrow flooding in the drainage improvement study area is tabulated on the following page.

| | Area for Furrow Flooding | | | Water Requirement in Volume for Furrow Flooding | | | |
|---|---|---|---|---|---|---|---|
| | | | | 1000m$^3$ | | | |
| | | | | Total | | | |
| Drainage Improvement Study Area | Salinity Class | Area ha | Per ha· year | 1st year | 2nd year | 3rd year | total |
| Donoso/Quincha | S2 | 273 | 1.5 | 410 | 410 | 410 | 1,230 |
| | S3N1 | 524 | 3 | 1,572 | 1,572 | 1,572 | 4,716 |
| Sub-total | | | | 1,982 | 1,982 | 1,982 | 5,946 |
| Boza | S2 | 15 | 1.5 | 23 | 23 | 23 | 69 |
| | S3 | 61 | 3 | 183 | 183 | 183 | 549 |
| | S3N1 | 69 | 3 | 207 | 207 | 207 | 621 |
| Sub-total | | | | 413 | 413 | 413 | 1239 |
| San Luis | S2 | 168 | 1.5 | 252 | 252 | 252 | 756 |
| | S3 | 82 | 3 | 246 | 246 | 246 | 738 |
| Sub-total | | | | 498 | 498 | 498 | 1,494 |
| Lunavilca | S2 | 50 | 1.5 | 75 | 75 | 75 | 225 |
| Palpa | S2 | 30 | 1.5 | 45 | 45 | 45 | 135 |
| Total | | 1,272 | | 3,013 | 3,013 | 3,013 | 9,039 |

Water requirement for furrow flooding in the entire drainage improvement study area:

about 3 million m$^3$/year

about 9 million m$^3$/3 years

b) Chemical amendment requirement (gypsum)

The amounts of gypsum required for improving sodicity of saline-alkali soils in poorly drained areas are estimated in the table presented on the following page.

| Drainage Improvement Study Area | Alkalinity Class | Affected Area ha | Gypsum Requirement(t) Per/ha | Total |
|---|---|---|---|---|
| Donoso/Quincha | $N_1$ | 524 | 2.8 | 1467 |
| Boza | $N_1$ | 69 | 2.8 | 193 |
| San Luis | $N_1$ | 82 | 2.8 | 230 |
| Total | | 675 | 2.8 | 1890 |

In total, about 1900t of gypsum are required.

2) <u>2nd type B: salt accumulated soils in Hattillo</u>

For the desalinization of this type of soil, the ponding method has been adopted.

a) Water requirement for initial ponding

i. conditions
initial leaching method ... ponding
time of initial laching ... May - July
proposed cropping plan .... cotton-green manure-maize in rotation (first crop...cotton)

ii. water requirement for initial ponding
initial ponding water requirement in depth ..... 50cm
initial ponding water requireemnt in volume/ha ... 5000m$^3$/ha
area to be desalinized ..... 160 ha
total water requirement for initial ponding ..... 800,000m$^3$

In total, 800,000m$^3$ of irrigation water are required for the desalinization of the area by initial ponding.

3) <u>2nd type A: salt accumulated soils in slightly sloping area</u>

The desalinization of sandy to gravelly salt accumulated soils on slightly sloping areas (2nd type A) is not included in the present improvement plan for the following reasons:

a) The adverse effects of salt accumulation above the root zone of fruit trees are not considered significant and therefore sufficient benefit can not be expected.

b) Low salt-tolerant crops of citrus and apple are prevailing in the area. A large quantity of irrigation water will be required in a short period to prevent salt accumulation in the lower root zone of these crops. However, availability of water is limited in the area.

It is recommended to promote desalinization gradually from one place to another by wide-bottom furrow irrigation.

## 6. Recommendations

The desalinization plan proposed in the present study has been formulated based on the results of a limited number leaching tests. As field leaching tests are fundamental to desalinization plans, it is recommended that leaching tests be performed in the field and that desalinization measures and water requirement be studied in detail, similar field tests are required for estimation of the gypsum requirement.

TABLE AND FIGURE

D-1-2 Results of Indoor Leaching Test

Relation between soil: water ratio and EC of suspension on various soils after leaching operation - indoor test

| Sample No. | Soil: water ratio 1:05 | 1:1 | 1:2 | 1:3 | 1:4 | Estimated 1/ EC of S.S.S. * |
|---|---|---|---|---|---|---|
| 1. Coarse textured soils | | $\frac{s}{m}$ | $\frac{s}{m}$ | $\frac{s}{m}$ | $\frac{s}{m}$ | |
| L-26, No.3 | | 1.9 | 2.1 | 1.9 | 1.8 | 2.0 |
| L-21, No.1 | | 1.4 | 1.0 | 660 MS | 520 MS | 0.5 |
| L-20, No.3 | | 2.2 | 1.7 | 1.2 | 1.1 | 1.0 |
| L-11, No.3 | | 1.9 | 1.5 | 1.4 | 1.2 | 1.5 |
| L-7, No.3 | 1.5 | 400 | 200 | 200 | - | 0.2 |
| L-34, No.1 | | 1.6 | 1.9 | 1.9 | - | 2.0 |
| No.2 | | 1.5 | 2.0 | 1.9 | - | 2.0 |
| No.3 | | 1.7 | 2.0 | 2.0 | - | 2.0 |
| 2. Medium textured soils | | | | | | |
| L-9', No.1 | 2.0 | 2.1 | 2.1 | 1.8 | 1.9 | 2.0 |
| L-9, No.1 | | 1.1 | 740 MS | 580 | 460 | 0.5 |
| L-9", No.1 | | 1.7 | 1.8 | 1.5 | - | 2.0 |
| " No.2 | | 1.8 | 1.8 | 1.6 | - | 2.0 |
| " No.3 | | 1.8 | 1.8 | 1.7 | - | 2.0 |
| 3. Fine textured soils | | | | | | |
| L-10", No.1 | | 1.4 | 1.6 | 1.8 | | 2.0 |
| " No.2 | | 1.4 | 1.7 | 1.9 | | 1.0 |
| " No.3 | | 1.4 | 1.7 | 1.9 | | 2.0 |

* Slightly soluble salts.

1/ It is assumed that EC of suspension when the same is nearly constant indepent from soil: water ratio is attributable to EC of slightly soluble salts in soil.

Table D-5-1 EC of leachate and corresponding ECe of soil ——— indoor test coarse textured soils

| Batch of leachate | accumulated depth of leachate in m/m | Esperanza series | | | | | | Aucallama series | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L - 7 | | L - 21 | | | | L - 11 | | L - 24 | | L - 34 | | | | | | | |
| | | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| 1st 50mℓ | 25 m/m | 114 | 45.6 | 18.8 | 7.5 | | | 52.1 | 17.4 | 17.6 | 7.3 | 9.3 | 4.8 | | | | | | |
| 2nd " | 50 " | 8.3 | 3.3 | 7.2 | 2.9 | | | 37.2 | 13.7 | 31.2 | 11.4 | 22.0 | 8.6 | | | | | | |
| 3rd " | 75 " | *2.2 | 0.9 1/ | *3.4 | 1.4 | | | 30.8 | 10.7 | 16.1 | 6.8 | 30.0 | 11.0 | | | | | | |
| 4th " | 100 " | 1.4 | 0.7 | 4.0 | 1.6 | | | 16.0 | 6.3 | *6.0 | 3.8 | 44.0 | 15.2 | | | | | | |
| 5th " | 125 " | 0.9 | 0.4 | 2.7 | 1.1 | | | *8.8 | 4.1 | 4.1 | 3.2 | 28.8 | 10.6 | | | | | | |
| 6th " | 150 " | | | 1.8 | 0.7 | | | 3.8 | 2.6 | 3.3 | 3.0 | 14.4 | 6.3 | | | | | | |
| 7th " | 175 " | | | 1.6 | 0.6 | | | 3.0 | 2.4 | 3.1 | 2.9 | 9.5 | 4.9 | | | | | | |
| 8th " | 200 " | | | | | | | 2.4 | 2.2 | 2.7 | 2.8 | *4.7 | 3.4 | | | | | | |
| 9th " | 225 " | | | | | | | | | | | 3.7 | 3.1 | | | | | | |
| 10th " | 350 " | | | | | | | | | | | 3.1 | 2.9 | | | | | | |
| 11th " | 275 " | | | | | | | | | | | 2.8 | 3.8 | | | | | | |
| 12th " | 300 " | | | | | | | | | | | 2.6 | 2.8 | | | | | | |
| 13th " | 325 " | | | | | | | | | | | 2.6 | 2.8 | | | | | | |
| 14th " | 350 " | | | | | | | | | | | | | | | | | | |
| 15th " | 375 " | | | | | | | | | | | | | | | | | | |
| Volume of last leachate in mℓ/EC | | | | 34 | 1.4 | | | | | 36 | 2.7 | 40 | 2.6 | | | | | | |
| ECw mS | S mS | 840 | 0 | 440 | 0 | | | 480 | 1.5 | 880 | 2.0 | 480 | 2.0 | | | | | | |
| 3 Total volume of water added in cm | | 15.0 | | 20.0 | | | | 22.5 | | 22.5 | | 35.0 | | | | | | | |
| 4 Total volume of leachate in cm | | 13.0 | | 16.0 | | | | 20.0 | | 22.0 | | 34.5 | | | | | | | |
| 5 Initial ECe of soil | | 58.3 | | 37.6 | | | | 56.4 | | 18.8 | | 86.5 | | | | | | | |
| 6 ECe of soil after leaching | | 2.3 | | 4.5 | | | | 1.5 | | 2.7 | | 2.0 | | | | | | | |
| 7 Decrease in EC volume ( 5 - 6 ) | | 56.0 | | 33.1 | | | | 54.9 | | 16.1 | | 84.5 | | | | | | | |
| 8 EC of 1:2 soil-water suspension after leaching | | 1.0(1:0.5)2/ | | 0.5 | | | | 1.5 | | 2.1 | | 1.9 | | | | | | | |
| 9 Leaching rate 7 ÷ 3 | mS/cm | 3.7 | | 1.7 | | | | 2.4 | | 0.7 | | 2.4 | | | | | | | |
| 10 Adjusted leaching rate | mS/cm | 5.5 | | 3.6 | | | | 3.5 | | 1.0 | | 3.7 | | | | | | | |
| 11 FC%/SP% | SP% | 0.4 | 22 | 0.4 | 22 | | | 0.3 | 20 | 0.3 | 30 | 0.3 | 30 | | | | | | |

1 : EC of leachate,

2 : ECe corresponding to EC of leachate in mS, calculated by ECe = a x FC%/SP% + S

6 : ECe of soil after leaching, calculate by:

$$ECe = S + (d-S) \times \frac{200}{SP\%} \ mS$$

a - 1 = EC of leachate in mS, S = EC of slightly soluble salts in soil, d = EC of 1:2 soil-water suspension

10 : Adjusted leaching rate: accumulated volume of water added by the time when drcrease in EC of successive leachate become low, marked * in the lable, was taken, in stead of 3 (corresponding ECe 2 is generally about 4 mS/cm)

1/: Estimated ECe from final ECe 2.3 mS - 3.4

2/: EC of 1:0.5 soil water suspension after leaching

Table D-5-2 EC of leachate and corresponding ECe of soil —— indoor test medium-textured soils/fine-textured soils

| Batch of leachate | accumulated depth of leachate in m/m | Mochumi series | | | | | | Quepecaliche series | | | | | | | | Lambayeque series | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L - 9 | | L - 9' | | L - 9" | | L - 10 | | L - 10' | | L - 10" | | L - 14 | | | | | |
| | | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| 1st 50mℓ | 25 m/m | 13.6 | 7.3 | 21.9 | 13.0 | 29.5 | 16.8 | 17.2 | 7.0 | 2.9 | 2.9 | 6.1 | 3.8 | 53.0 | 28.5 | | | | |
| 2nd " | 50 " | 6.2 | 3.6 | 28.8 | 16.4 | 31.6 | 17.8 | 22.0 | 3.4 | 3.9 | 3.2 | 24.4 | 9.3 | 98.0 | 51.0 | | | | |
| 3rd " | 75 " | *3.9 | 2.5 | 16.8 | 10.4 | 39.6 | 21.8 | 27.8 | 10.1 | 9.8 | 4.9 | 72.0 | 23.6 | 58.0 | 31.0 | | | | |
| 4th " | 100 " | 3.0 | 2.0 | 12.4 | 8.2 | 31.2 | 17.6 | 34.5 | 12.2 | 40.0 | 14.0 | 33.6 | 12.1 | 17.0 | 10.5 | | | | |
| 5th " | 125 " | 2.5 | 1.8 | 8.9 | 6.5 | 11.2 | 7.6 | 68.4 | 22.3 | 30.4 | 11.1 | 24.4 | 9.3 | 5.1 | 4.6 | | | | |
| 6th " | 150 " | 2.1 | 1.6 | 6.8 | 5.4 | 5.5 | 4.8 | 27.2 | 10.6 | 14.2 | 6.3 | *5.5 | 3.7 | *3.4 | 3.7 | | | | |
| 7th " | 175 " | | | 4.5 | 4.3 | *3.9 | 4.0 | 12.8 | 5.6 | *6.6 | 4.0 | 3.3 | 3.0 | 2.7 | 3.4 | | | | |
| 8th " | 200 " | | | 6.6 | 5.3 | 3.1 | 3.6 | *4.0 | 3.0 | 3.9 | 3.2 | 2.7 | 2.8 | 2.7 | 3.4 | | | | |
| 9th " | 225 " | | | *4.3 | 4.0 | 3.1 | 3.6 | 2.8 | 2.6 | 2.9 | 2.9 | 2.6 | 2.8 | | | | | | |
| 10th " | 250 " | | | 3.3 | 3.7 | 2.9 | 3.5 | 2.4 | 2.5 | 2.8 | 2.8 | 2.3 | 2.7 | | | | | | |
| 11th " | 275 " | | | 2.8 | 3.4 | | | 2.2 | 2.5 | | | 2.3 | 2.7 | | | | | | |
| 12th " | 300 " | | | 2.5 | 3.3 | | | | | | | 2.1 | 2.6 | | | | | | |
| 13th " | 325 " | | | 2.5 | 3.3 | | | | | | | 2.4 | 2.7 | | | | | | |
| 14th " | 350 " | | | | | | | | | | | | | | | | | | |
| 15th " | 375 " | | | | | | | | | | | | | | | | | | |
| Volume of last leachate in mℓ/EC | | | | 2.5 | 2.4 | | | | | | | 30 | 2.1 | | | | | | |
| ECw ms | S ms | 590 | 0.5 | 590 | 2.0 | 440 | 2.0 | 710 | 1.8 | 440 | 2.0 | 440 | 2.0 | 440 | 2.0 | | | | |
| 3 Total volume of water added in cm | | 17.5 | | 37.5 | | 27.5 | | 30.0 | | 27.5 | | 35.0 | | 22.5 | | | | | |
| 4 Total volume of water leachate in cm | | 15.0 | | 36.0 | | 25.0 | | 27.5 | | 25.0 | | 34.0 | | 20.0 | | | | | |
| 5 initial ECe of soil | | 13.5 | | 63.0 | | 65.8 | | 56.4 | | 37.0 | | 45.0 | | 101.8 | | | | | |
| 6 ECe of soil after leaching | | 3.1 | | 2.7 | | 1.8 | | 1.8 | | 1.7 | | 1.6 | | 3.2 | | | | | |
| 7 Decrease in EC value ( 5 - 6 ) | | 10.4 | | 60.3 | | 64.0 | | 54.6 | | 35.3 | | 43.4 | | 98.6 | | | | | |
| 8 EC of 1:2 soil-water suspension after leading | | 0.9 | | 2.1 | | 1.8 | | 1.8 | | 1.7 | | 1.6 | | 2.3 | | | | | |
| 9 Leaching rate 7 ÷ 3 ms/cm | | 0.6 | | 1.6 | | 2.3 | | 1.8 | | 1.3 | | 1.2 | | 4.4 | | | | | |
| 10 Adjusted leaching rate ms/cm | | 1.1 | | 2.4 | | 3.1 | | 2.4 | | 1.7 | | 2.4 | | 5.6 | | | | | |
| 11 FC%/SP% | SP% | 0.5 | 30 | 0.5 | 30 | 0.3 | 30 | 0.3 | 65 | 0.3 | 65 | 0.3 | 65 | 0.5 | 50 | | | | |

1 : EC of leachate, 2 : ECe corresponding to EC of leachate in $m^s$, calculated by ECe = a x FC%/SP% + S

6 : ECe of soil after leaching, calculated by:

$$ECe = S + (d - S) \times \frac{200}{SP\%} \; m^s$$

a = 1 = EC of leachate in $m^s$, S = EC of slightly soluble salts in soil, d = EC of 1:2 soil-water suspension

10 : Adjusted leaching rate: accumulated volume of water added by the time when decrease in EC of sucessive leachate become low, marked * in the lable, was taken in stead of 3 (corresponding ECe 2 is generally about 4 $m^s$/cm)

Table D-5-3 Charges in ECe after leaching —— field leaching test
Plot No. L-7, coarse-textured soil, Experanza series

| Depth of soil layer/initial ECe | | Item | | Leaching water depth in cm | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 10 | | 20 | | 30 | | 40 | |
| | | | | No.1 | No.2 | No.1 | No.2 | No.1 | No.2 | No.1 | No.2 |
| 0 - 15cm | 48.2 mS | ECe after leaching | mS | 8.6 | 8.1 | 2.6 | 3.7 | 4.0 | 7.3 | 2.4 | 2.4 |
| | | Charges in ECe | mS | -39.6 | -40.1 | -45.6 | -44.5 | -44.2 | -40.9 | -45.8 | -45.8 |
| | | | % | 82 | 83 | 95 | 92 | 92 | 85 | 95 | 95 |
| 15 - 30cm | 1.9 mS | ECE after leaching | mS | 15.4 | | 9.4 | | 10.0 | | 4.9 | 5.8 |
| | | Changes in ECe | mS | +13.5 | | +7.5 | | +8.1 | | +3.0 | +3.9 |
| | | | % | 711 | | 395 | | 426 | | 158 | 205 |
| 30 - 50cm | mS | ECe after leaching | mS | | | | | | | | |
| | | Changes in ECe | mS | | | | | | | | |
| | | | % | | | | | | | | |
| 50 - 80cm | mS | ECe after leaching | mS | | | | | | | | |
| | | Changes in ECe | mS | | | | | | | | |
| | | | % | | | | | | | | |

ECe : EC mS/cm at 25°C of saturation extract
Changes in ECe : Difference in ECe before and after leaching

ECw : 840 mS
Groundwater level : 65cm
" quality: 1.2 mS

* Water depth required to achieve ECe of about 4 mS/cm : 30cm

** Leaching rate to achieve ECe of about 4 mS/cm : 1.5 mS/cm water

Table D-5-4 Changes in ECe after leaching —— field leaching test
Plot No. L-9', medium-textured soil, Mochumi series

| Depth of soil layer | Initial ECe | Item | Unit | Leaching water depth in cm: 10 No.1 | 10 No.2 | 20 No.1 | 20 No.2 | 30 No.1 | 30 No.2 | 40 No.1 | 40 No.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 - 15cm | 57.0 mS | ECe after leaching | mS | 25.8 | 18.6 | 22.4 | 20.7 | 12.4 | 8.1 | 7.5 | 5.1 |
| | | | mS | -31.2 | -38.4 | -34.6 | -36.3 | -44.6 | -48.9 | -49.5 | -51.9 |
| | | | % | 55 | 67 | 61 | 64 | 78 | 86 | 87 | 91 |
| 15 - 30cm | 1.6 mS | ECe after leaching | mS | 3.7 | | 5.7 | | 2.8 | | 3.9 | |
| | | Changes in ECe | mS | +2.1 | | +4.1 | | +1.2 | | +2.3 | |
| | | | % | 131 | | 256 | | 75 | | 144 | |
| 30 - 50cm | mS | ECe after leaching | mS | | | | | | | | |
| | | Changes in ECe | mS | | | | | | | | |
| | | | % | | | | | | | | |
| 50 - 80cm | mS | ECe after leaching | mS | | | | | | | | |
| | | Changes in ECe | mS | | | | | | | | |
| | | | % | | | | | | | | |

ECe : EC mS/cm at 25°C of saturation extract
Changes in ECe : Difference in ECe before and after leaching

ECw : 59 mS
Groundwater level : 40cm
" quality: 3.4 mS

* by numerical method, ECe of surface 15cm is estimated at about 4 mS/cm with water depth 80cm

** leaching rate to achieve ECe of about 4 mS/cm : 0.7 mS/cm

Table D-5-5 Charges in ECe after leaching —— field leaching test
Plot No. L-10, fine-textured soil, Quepecallche series

| Depth of soil layer | Initial ECe | Item | Unit | 20 No.1 | 20 No.2 | 40 No.1 | 40 No.2 | 60 No.1 | 60 No.2 | 80 No.1 | 80 No.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Leaching water depth in cm | | | | | | | |
| 0 - 15cm | 50.7 $m^S$ | ECe after leaching | $m^S$ | 17.8 | | 11.7 | 4.3 | 5.3 | 4.3 | 5.4 | |
| | | Changes in ECe | $m^S$ | -32.9 | | -39.0 | -46.4 | -45.4 | -46.4 | -45.3 | |
| | | | % | 65 | | 77 | 92 | 90 | 92 | 89 | |
| 15 - 30cm | 3.8 $m^S$ | ECe after leaching | $m^S$ | 18.5 | | 9.7 | 16.1 | 10.4 | 9.5 | 5.5 | |
| | | Changes in ECe | $m^S$ | +14.7 | | +5.9 | +12.3 | +6.6 | +5.7 | +1.7 | |
| | | | % | 387 | | 155 | 324 | 174 | 150 | 45 | |
| 30 - 50cm | 2.9 $m^S$ | ECe after leaching | $m^S$ | 11.9 | | 6.0 | | | 9.5 | 4.4 | |
| | | Changes in ECe | $m^S$ | +9.0 | | +3.1 | | | +6.6 | +1.5 | |
| | | | % | 310 | | 107 | | | 228 | 52 | |
| 50 - 80cm | 2.9 $m^S$ | ECe after leaching | $m^S$ | 6.5 | | 2,8 | | | | 4.8 | |
| | | Changes ECe | $m^S$ | +3.6 | | -0.1 | | | | +1.9 | |
| | | | % | 124 | | 3 | | | | 66 | |

ECe : EC $m^S$/cm at 25°C of saturation extract
Changes in ECe : difference in ECe before and after leaching

ECw : 710 $m^S$
Groundwater level : 1.1m
" quality: 10 $m^S$

* water depth required to achieve ECe of about 4 $m^S$/cm : 60 - 80cm
** leaching rate to achieve ECe of about 4 $m^S$/cm : 0.6 - 0.8 $m^S$/cm water

Table D-5-7 Comparison of actual ECe and calculated ECe —— field tests
Coarse-textured soil, plot L-7

| Soil depth | Items | Leaching water depth | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 10 cm | | 20 cm | | 30 cm | | 40 cm | |
| | | ECsw | ECe | ECsw | ECe | ECsw | ECe | ECsw | ECe |
| | | $m^S$ | $m^S$ | $m^S$ | $m^S$ | $m^S$ | $m^S$ | $m^S$ | $m^S$ |
| 0 - 15 cm s=0 | A | | 8.6 8.1 | | 2.6 3.7 | | 4.0 | | 2.4 2.4 |
| | B | 22.6 | 9.0 | 12.2 | 4.9 | 8.5 | 3.4 | 6.7 | 2.7 |
| 15 - 30 cm s=0 | A | | 15.4 - | | 9.4 - | | 10.0 | | 4.9 5.8 |
| | B | 21.3 | 8.5 | 12.1 | 4.8 | 8.5 | 3.4 | 6.8 | 2.7 |
| 30 - 50 cm | A | | | | | | | | |
| | B | | | | | | | | |
| 50 - 80 cm | A | | | | | | | | |
| | B | | | | | | | | |

Initial ECe: 0-15 cm —— 48.2 $m^S$, 15-30 cm —— 1.9 $m^S$,
ECw: 0.8 $m^S$, SPV%: 35%, FCV%: 14%, FC%/SP% = 0.4

A : Actual ECe after leaching
B : Calculated ECe by numerical method
ECe = ECsw x FC%/SP% + S (EC of slightly soluble salts)

Table D-5-8 Comparison of actual ECe and calculated ECe ——— field tests
Mediam-textured soil, plot L-9'

| Soil depth | Items | Leaching water depth | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ECsw | ECe | | ECsw | ECe | | ECsw | ECe | | ECsw | ECe | |
| | | mS | | mS | mS | | mS | mS | | mS | mS | | mS |
| 0 - 15 cm s=2.0 | A | | 25.8 | 18.6 | | 22.4 | 20.7 | | 12.4 | 8.1 | | 7.5 | 5.1 |
| | B | 30.3 | 17.2 | | 16.5 | 10.3 | | 11.4 | 7.7 | | 8.8 | 6.4 | |
| 15 - 30 cm s=0 | A | | 3.7 | - | | 5.7 | - | | 2.8 | - | | 3.9 | - |
| | B | 26.7 | 13.4 | | 15.7 | 7.9 | | 11.2 | 5.6 | | 8.7 | 4.4 | |
| 30 - 50 cm | A | | | | | | | | | | | | |
| | B | | | | | | | | | | | | |
| 50 - 80 cm | A | | | | | | | | | | | | |
| | B | | | | | | | | | | | | |

Initial ECe: 0-15 cm ——— 57.0 mS, 15-30 cm ——— 1.6 mS,
ECw: 0.6 $m^3$, SPV%: 30%, FCV%: 14%, FC%/SP% = 0.5

A : Actual ECe after leaching
B : Calculated ECe by numerical method
ECe = ECsw x FC%/SP% + S (EC of slightly soluble salts)

Table D-5-9 Comparison of actual ECe and calculated ECe —— field tests
Fine-textured soil, plot L-10

| Soil depth | Items | Leaching water depth | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Ecsw | ECe | ECsw | Ece | ECsw | ECe | ECsw | ECe |
| | | $m^S$ | $m^S$ | $m^S$ | $m^S$ | $m^S$ | $m^S$ | $m^S$ | $m^S$ |
| 0 - 15 cm s=2.0 | A | | 17.8 | | 11.7 4.3 | | 5.3 4.3 | | 5.4 |
| | B | 29.3 | 10.8 | 16.0 | 6.8 | 11.1 | 5.3 | 8.6 | 4.6 |
| 15 - 30 cm s=0 | A | | 18.5 | | 9.7 16.1 | | 10.4 9.5 | | 5.5 |
| | B | 27.3 | 10.9 | 15.9 | 6.4 | 11.3 | 4.5 | 8.8 | 3.5 |
| 30 - 50 cm s=0 | A | | 11.9 | | 6.0 - | | - 9.5 | | 4.4 |
| | B | 22.9 | 9.2 | 14.9 | 6.0 | 10.9 | 4.4 | 8.7 | 3.5 |
| 50 - 80 cm s=0 | A | | 6.5 | | 2.8 - | | | | 4.8 |
| | B | 31.6 | 12.6 | 14.0 | 5.6 | 10.6 | 4.2 | 8.6 | 3.4 |

Initial ECe: 0-15 cm —— 50.7 $m^S$, 15-30 cm —— 3.8 $m^S$, 30-80 cm —— 2.9 $m^S$
ECw: 0.7 $m^S$, SPV%: 90%, FCV%: 30%, FC%/SP% = 0.3

A : Actual ECe after leaching
B : Calculated ECe by numerical method
ECe = ECsw x FC%/SP% + s (EC of slightly soluble salts)

Table D-5-10 Comparison of results of leaching tests and calculated ECe —— indoor tests

$m^3/cm$

| Plot/soil series | Water depth in m/m | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 50 | | 100 | | 150 | | 200 | | 250 | | 300 | |
| | A | B | A | B | A | B | A | B | A | B | A | B |
| Coarse-textured soils | | | | | | | | | | | | |
| L-11, Aucallama series | 17.4 | 15.7 | 10.7 | 9.3 | 4.1 | 6.9 | 2.4 | 5.7 | | | | |
| L-26, " | 7.3 | 6.9 | 6.8 | 4.8 | 3.2 | 4.0 | 2.9 | 3.6 | 2.7 | 3.4 | | |
| L-34, " | 4.8 | 23.8 | 11.0 | 13.9 | 10.6 | 10.3 | 4.9 | 8.3 | 3.1 | 7.1 | 2.8 | 6.3 |
| L-21, Esperanza series | 7.5 | 9.7 | 1.4 | 5.2 | 1.1 | 3.6 | 0.6 | 2.7 | | | | |
| Medium-textured soils | | | | | | | | | | | | |
| L-9, Mochumi series | 7.3 | 5.3 | 2.5 | 3.3 | 1.8 | 2.5 | | | | | | |
| L-9', " | 13.0 | 23.3 | 10.4 | 13.8 | 6.5 | 10.2 | 4.3 | 8.5 | 4.0 | 7.2 | 3.4 | 6.4 |
| L-9", " 65.8 | 16.8 | 29.6 | 21.8 | 17.2 | 7.6 | 12.5 | 4.0 | 10.0 | 3.6 | 8.5 | | |
| L-14, Lambayeque series | 28.5 | 49.7 | 31.0 | 30.7 | 4.6 | 22.6 | 3.4 | 18.0 | | 6.6 | | |
| Fine-textured soils | | | | | | | | | | | | |
| L-10, Quepecaliche series | 7.0 | - | 10.7 | 14.9 | 22.3 | 11.2 | 5.6 | 9.1 | 2.6 | 7.8 | 2.5 | 7.0 |
| L-10', " | 2.9 | - | 4.9 | 10.4 | 11.1 | 8.0 | 4.0 | 6.7 | 2.9 | 5.8 | | |
| L-10", " | 3.8 | - | 23.6 | 12.2 | 9.3 | 9.3 | 3.0 | 7.6 | 2.8 | 6.6 | 2.7 | 5.9 |

A : ECe estimated by the follwoing equation:
ECe = ECsw (EC of leachate) x FC%/SP% + S

B : Calculated ECe by numerical method
ECe = calculated ECsw x FC%/SP% + S

S : EC of slightly soluble salts
L-9', L-9", L-10, L-10', L-10", L-14, L-26, L-34 .....s = 2.0 ms/cm
L-11...s = 1.5 $m^s$, L-9...s = 0.5 $m^s$,
L-21...s = 0 $m^s$

Table D-5-12 Estimated ECe of lower layers after leaching: Coarse-textured soil

$m^S/cm$

| Soil depth | Water depth / ECsw/ECe / Calculation method | 20 cm | | 60 cm | | 60 cm | | 70 cm | | 90 cm | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ECsw | ECe | ECsw | ECe | ECsw | ECe | ECsw | ECe | ECsw | ECe |
| 0 - 15 cm<br>$C_1$ = 0 m/m<br>$d_1$ =15 m/m | Initial ECe | 10 | | 30 | | 50 | | 70 | | 90 | |
| | Numerical method | 3.5 | 1.8 | 3.5 | 3.8(1.8) | 5.2 | 4.6(2.6) | 6.0 | 5.0(3.0) | 6.0 | 5.0(3.0) |
| | Proposed method | 3.1[a] | 4.0 | 3.5[a] | 4.0 | 5.2[a] | 4.0 | 6.0[a] | 4.0 | 6.0[a] | 4.0 |
| 15 - 30 cm<br>$C_2$ = 5 m/m<br>$d_2$ =10 m/m | Initial ECe | 1.0 | | 3.0 | | 5.0 | | 7.0 | | 9.0 | |
| | Numerical method | 3.7 | 1.9 | 3.7 | 1.9 | 5.6 | 2.8 | 6.5 | 3.8 | 6.5 | 3.8 |
| | Proposed method | 3.3 | 1.7 | 3.7 | 1.9 | 5.6 | 2.8 | 6.5 | 3.8 | 6.5 | 3.8 |
| 30 - 50 cm<br>$C_3$ = 5 m/m<br>$d_3$ =10 m/m | Initial ECe | 1.0 | | 1.5 | | 2.5 | | 3.5 | | 4.5 | |
| | Numerical method | 3.9 | 2.0 | 3.8 | 1.9 | 5.8 | 2.9 | 6.7 | 3.9 | 6.7 | 3.9 |
| | Proposed method | 3.5 | 1.8 | 3.8 | 1.9 | 5.8 | 2.9 | 6.7 | 3.9 | 6.7 | 3.9 |
| 50 - 100 cm<br>$C_4$ =15 m/m | Initial ECe | 1.0 | | 1.5 | | 2.5 | | 3.5 | | 4.5 | |
| | Numerical method | 3.9 | 2.0 | 3.8 | 1.9 | 5.9 | 3.0 | 6.8 | 3.9 | 6.8 | 3.9 |
| | Proposed method | 3.5 | 1.8 | 3.8 | 1.9 | 5.9 | 3.0 | 6.8 | 3.9 | 6.8 | 3.9 |
| | Remarks | 0-100cm:<br>s=0 | | 0-15cm: s=2.0<br>15-100cm: 2=0 | | 0-15cm: s=2.0<br>15-100cm: s=0 | | 0-15cm: 2=2.0<br>15-100cm: s=0 | | 0-15cm: s=2.0<br>15-100cm: s=0 | |

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