

Soil Brief *Cuba 7*

CUBA

Organic matter-rich calcareous reference soil

R. Marín
C. Balmaseda
R. Villegas
J. Arcia



Instituto Nacional de Investigaciones de la Caña de Azúcar

International Soil Reference and Information Centre



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Soil Brief Cuba 7

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Organic matter-rich calcareous reference soil

ISRIC Soil Monolith:

| | | |
|---------------|-------------------|----------------------|
| <i>Number</i> | <i>FAO-Unesco</i> | <i>Soil Taxonomy</i> |
| CU 10 | Calcaric Phaeozem | Entic Haplustoll |

R. Marín
C. Balmaseda
R. Villegas
J. Arcia

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ISRIC
P.O. Box 353
6700 AJ Wageningen
The Netherlands

INICA
Ave. Van Troi # 17203
CP 19210, Boyeros
C. Habana, Cuba

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FOREWORD

The main objective of the Soil Brief is to present a short characterization of a reference soil, to discuss selected properties, and to provide a qualitative assessment of the soil, climate and management qualities.

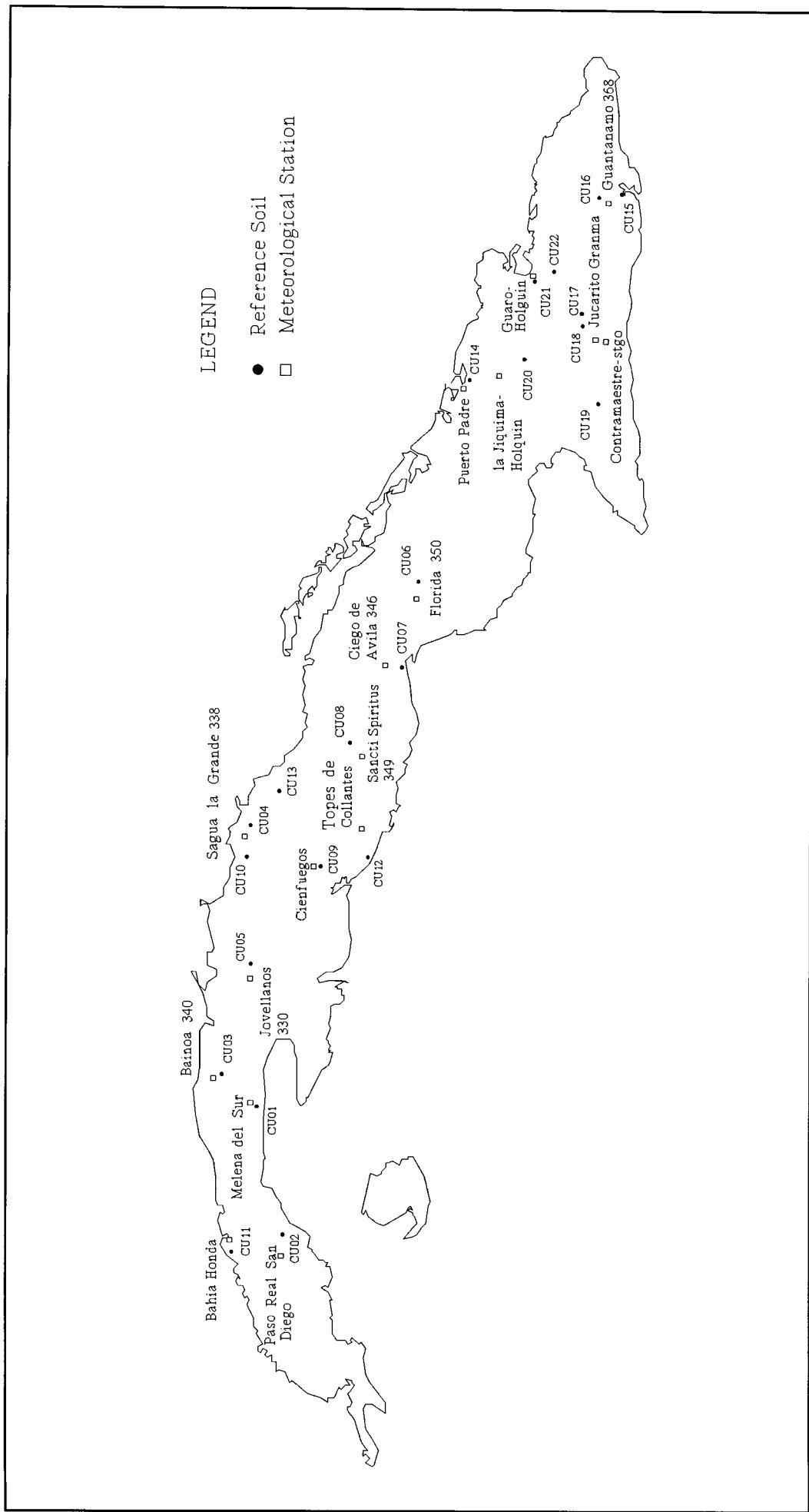
This Soil Brief presents a Calcaric Phaeozem. These soils are distributed throughout Cuba and cover an area of about 2200 km² (Ascanio, 1984), they are used for different crops, mainly sugarcane and pasture land.

It should be stressed that the origin of this soil allow its separation from the Brown calcareous soils, although they form part of the same soil class according to the FAO-Unesco soil classification system.

A joint cooperation project of INICA and ISRIC was initiated in 1990. The project operates in the framework of ISRIC's National Soil Reference Collection and

Database (NASREC) programme. The NASREC goals are to support the establishment of national soil expositions, databases and accompanying publications. In Cuba it aims to describe and sample a series of reference soils, representative for the sugarcane areas of Cuba. Duplicates of these soils were collected for the national soil collection of Cuba in Villa Clara and for the world soil collection of ISRIC in Wageningen, The Netherlands.

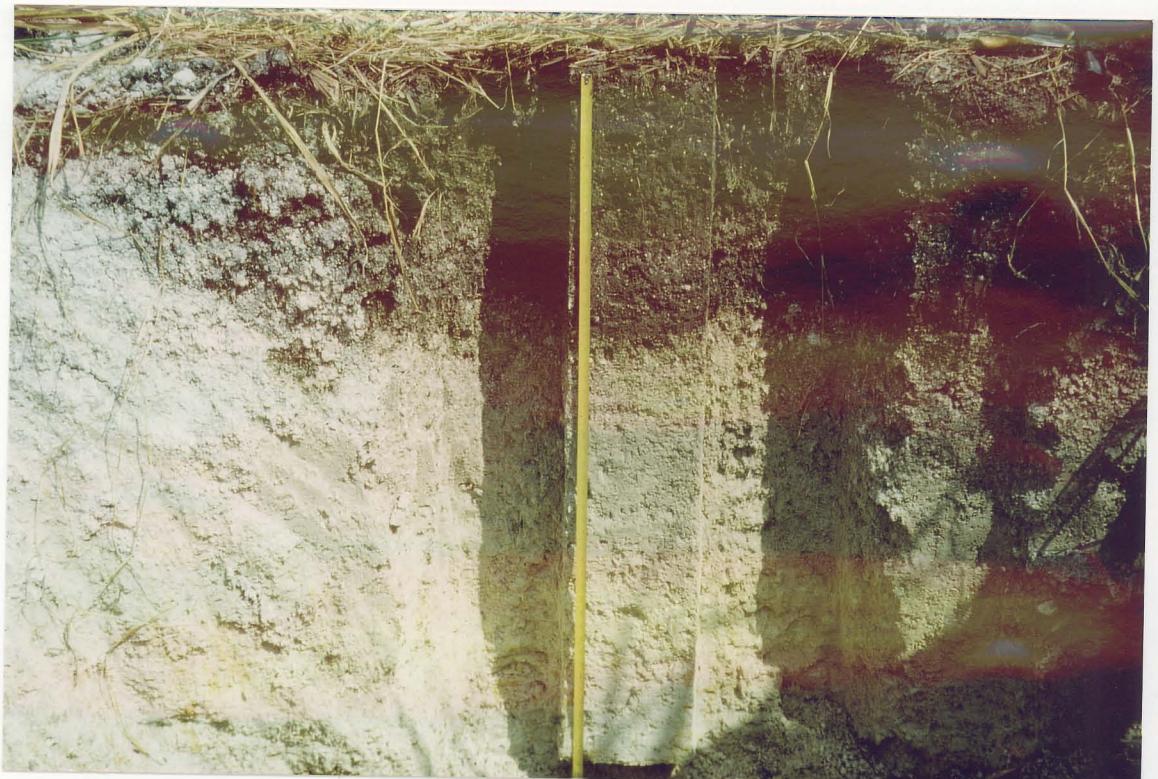
This Soil Brief was compiled in cooperation with ISRIC staff: M.-B.B.J. Clabaut (text processing), L.P. van Reeuwijk (laboratory), R.A. Smaal (diagrams), J.H. Kauffman, T. de Meester and A.E. Hartemink (editing). During fieldwork, I. Rodríguez, I. Fernández, E. Pineda, R. Díaz and M.E. Sánchez from Sugarcane Experiment Station of Villa Clara province made important contributions.





1

1. Well drained solum but also permeable limestone substratum
2. Profile CU 10



2

Soil Brief CU 7

1 LOCATION AND DISTRIBUTION

Reference Soil CU 10 is located in the North of the Central region of Cuba, in the Villa Clara province (Figure 1). The profile was selected in an area used for sugarcane cultivation at the "Panchito Gómez Toro" mill, municipality of Quemado de Güines, at $22^{\circ}49'$ and $80^{\circ}15'$. Altitude was 50 m.a.s.l.

These soils are distributed throughout the country occurring in different topographic conditions, from mountainous to plain zones. Topography influences the degree of carbonate leaching, soil depth and its association to other soil units.

1.1 Climate

The climate of the region where the Reference Soil is located is considered tropical with relatively humid summers (Aw). Such climate is prevailing in almost all the country (Díaz Cisneros, 1989).

Climatic data taken from the Sagua la Grande meteorological station are representative for the reference site. Figure 2 shows a marked dry period from November to April and also during the rainy season there are two relatively dry months. These moisture deficits reduce crop production. The dry winter, together with the lower temperatures (Figure 3) during that season favours crop ripening, especially for sugarcane.

The diagrams were made with Solgraph (Brunt and Kauffman, 1995).

1.2 Landscapes and Soils

Phaeozems (humus rich calcareous) soils occur in Cuba in different landscapes ranging from mountains to plains. With an undulating relief, slopes between 5 and 10%, these soils are generally associated with Cambisols (Brown calcareous soils). In mountainous regions with slopes up to 20% the soils are associated with ferralsols and Cambisols. In zones comparable to the reference site, with a (slightly undulating to almost plain) relief (slopes less than 5%), they are usually associated to Vertic Cambisols and Vertisols.

1.3 Geology and Geomorphology

Reference Soil CU 10 and comparable ones are formed in geological strata consisting of clay, loam, limestone and sandstone, mainly belonging to the Inferior-medium Miocene and Eocene.

The reference site CU 10 is located in an abrasive plain and hilly marine terrace (Cuban National Atlas, 1989).

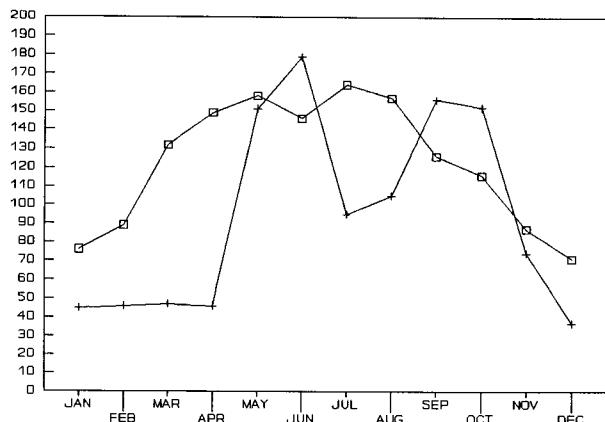


Figure 2 Precipitation (+) and evapotranspiration (□) in mm at the CU10 site.

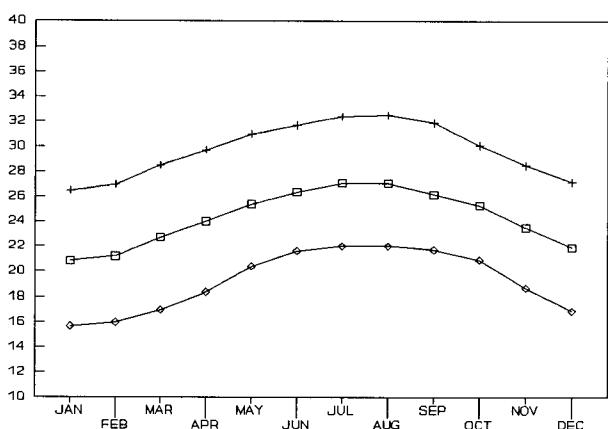


Figure 3 Maximum (+), average (□) and minimum (◊) temperature in °C at the CU10 site.

1.4 Vegetation and Land Use

The original vegetation of the area was a "latifolia" tropical forest, semi-deciduous. Some residual species are: Royal Palm (*Reystonea regia*), Cedar (*Cedrela mexicana*), Mahogany (*Swietenia mahogany*), and Baria (*Coedea gerascanthus*). As a result of deforestation at the beginning of the twentieth century, most of these areas are at present used for agricultural crops like grains, vegetables, sugarcane and pasture, the two latter with high input.

2 SOIL CHARACTERIZATION

2.1 Brief analytical characterization of the profile

CU 10 is a shallow, moderately well-drained, dark greyish brown clay soil. The soil has a subangular blocky structure and contains small calcareous nodules and gravels.

Soil samples were analyzed at the ISRIC soil laboratory according to the procedures described by van Reeuwijk (1992).

Texture: Clay strongly decreasing with depth

Organic Carbon: High (2.4%) in the first 34 cm

Acidity: Slightly alkaline in the upper 46 cm

Sum of Bases*: Very high (83 cmol (+)/kg soil)

Cation Exchange Capacity: Very high (49 cmol(+) /kg soil) in the upper 46 cm

Bulk density: Medium in the upper 46 cm

Air capacity: Low to very low (6-3%)

Available soil moisture: Medium

Clay mineralogy: Smectite dominant with medium kaolinite and mixed minerals

*) Although the sum of bases is always very high in these soils, it is overestimated here probably due to the extraction method utilized (a part of the calcium carbonate in the soil is measured as exchangeable Ca^{2+} cation).

Figure 4 shows the texture profile characterized by a clay A horizon with an abrupt change in texture towards the weathered limestone substratum (45-50 cm). The 2:1 clay type (montmorillonite group) is dominant, with an increase of mixed minerals and kaolinite in the weathered limestone rock (Annex 1).

Figure 5 shows the organic carbon, pH and the sum of bases versus depth.

Humus-rich horizons are the result of humus accumulation, being one of the dominant soil forming processes in these soils. This process is strengthened by a seasonal moisture regime, and a high calcium and clay content as a result of sialitization inherited from the carbonated rock (Ascanio, 1984).

In a comparative study of 30 Phaeozems a significative correlation between organic matter, total Nitrogen and Munsell Soil Value (color) was found (Table 1).

Soil reaction is slightly alkaline to alkaline with a close correlation between pH and calcium carbonate content. The sum of bases is high throughout the profile.

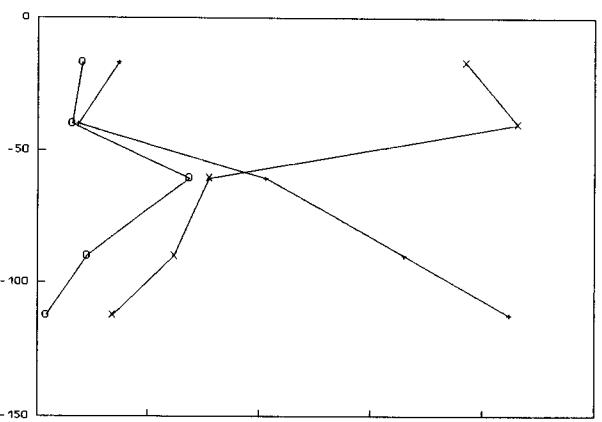


Figure 4 Percentages clay (X), silt (+) and sand (o) versus depth (cm) in profile CU 10.

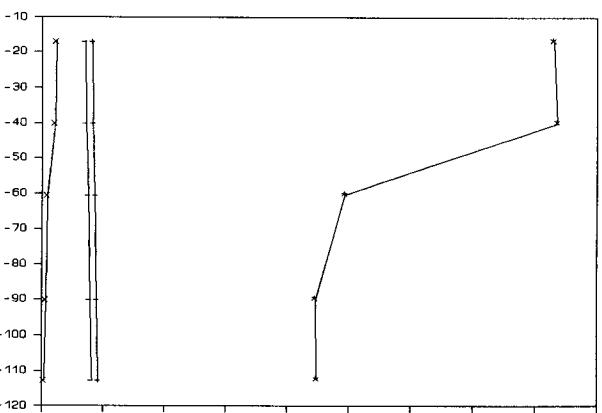


Figure 5 Sum of bases ($\text{cmol}_e \text{ kg}^{-1}$ soil) (*), $\text{pH-H}_2\text{O}$ (+), pH-KCl (-) and organic carbon (x) versus depth (cm) in profile CU 10.

Table 1 Correlation of Organic Matter, Total Nitrogen versus soil color (After Marín *et al.*, 1968).

| | Correlation Coefficient | | |
|---------|-------------------------|-------|--------|
| | Total-N | Value | Chroma |
| O.M | 0.52 | 0.35 | 0.23 |
| Total-N | - | 0.15 | 0.21 |
| Value | - | - | 0.07 |

2.2 Soil classification

FAO-UNESCO (1988)

The soil has a mollic A horizon. It is assumed that there is no calcic horizon. Therefore it classifies as Hyper-Calcaric Phaeozem. If a calcic horizon was present, the soil is classified as Chernozem.

USDA Soil Taxonomy (1990)

The soil classifies as a Entic Haplustoll because of the mollic horizon and the ustic moisture regime, and the assumed absence of a calcic horizon.

2nd Cuban Soils Genetic Classification

It classifies as "Humic Carbonated", due to the Organic Matter content, the type of humus, the presence of high active calcium carbonate content and the presence of a humified A horizon with more than 50% clay (Montmorillonite) and the subangular blocky structure.

3 SOIL MANAGEMENT

These soils have been submitted to an intensive agricultural exploitation for a very long time, because of their high natural fertility and appropriate physical conditions. There are some slight constraints reducing the productivity, such as effective depth, stoniness, medium moisture reserves and high active carbonate content. The latter could lead to a pH over 8, causing insolubility of some plant nutrients. A qualitative evaluation of the soil and the reference site according to FAO (1983) and ISRIC (1994) methodology is presented in Annex 2.

Experience has shown that with high input some of the limitations can be alleviated, resulting in good yields. In studies carried out by Roldós *et al.* (1993) in similar soils of the same region under long term sugarcane cultivation, yields varies between 70 and 80 t ha⁻¹.

It has been proved that in improved conditions these soils give yields up to 190 t ha⁻¹ in plant cane of 19 months age. Yields obtained in experimental areas on these soils are shown in Table 2.

Table 2 Sugarcane yields obtained in experimental areas on these soils.

| Crop cycle | Yields | |
|------------|-------------------------|------------------------|
| | Cane t ha ⁻¹ | Pol t ha ⁻¹ |
| Plant Cane | 171 | 26 |
| 1st Ratoon | 140 | 17 |
| 2nd Ratoon | 117 | 20 |

The management of these soils should be focused on:

- Shallow ploughing
- Complementary irrigation to satisfy the crop water requirements in view of the limited cm effective soil-depth.
- Fertilization

Annex 1 ISIS Data Sheet CU 10

Reference soil CU 10, CUBA

Print date: 3 July 1995

FAO/UNESCO (1988) : Calcaric Phaeozem
 (1974) : Rendzinas
 USDA/SCS SOIL TAXONOMY (1992) : Entic Haplustoll, clayey over fine-silty, montmorillonitic (calc.), isohyperthermic
 (1975) : -do-
 LOCAL CLASSIFICATION : Humico carbonatico

DIAGNOSTIC CRITERIA FAO (1988) : mollic A
 USDA/SCS (1992) : mollic epipedon
 Soil moisture regime : ustic
 Soil temperature regime : isohyperthermic

LOCATION : Cuba Prov. V. Clara Mun. Q.de Guines CAI P.G.Toro Bloque 37 Campo 19
 Latitude / Longitude : 22°49'0"N / 80°15'0"W Altitude : 50 m a.s.l.
 AUTHOR(S) : Marin/Regla/Balmas. Date : July 1991

GENERAL LANDFORM : valley Topography : undulating
 PHYSIOGRAPHIC UNIT : undulated
 SLOPE Gradient, Form : 2%, undulating, Position of site : middle slope
 MICRO RELIEF Kind : termite mounds
 SURFACE CHAR. Rock outcrop : nil Cracking : nil
 Stoniness, Size, Form : very few stones, 10 cm, angular irregular
 Slaking/crusting : capped
 SLOPE PROCESSES Soil erosion : no

PARENT MATERIAL 1 type, texture : marine sediments, clayey
 Remarks :

EFFECTIVE SOIL DEPTH : 100 cm
 WATER TABLE Kind, Depth : apparent, 140 cm
 DRAINAGE : well
 PERMEABILITY : No slowly permeable layer observed
 FLOODING Frequency : nil Run off : medium

MOISTURE CONDITIONS PROFILE : 0-120 cm moist

LAND USE : high level arable farming (sugar cane), no irrigation

CLIMATE Köppen : Aw
 MET. STATIONS Name, Location : SAGUA LA GRANDE 338, 22°49' / 80°5', 22 m a.s.l
 Distance to site (relevance) : SAGUA LA GRANDE 338 lays 29 km NE of the site (good)

| | No. years of record | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---------------------|------------------------|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|
| SAGUA LA GRANDE 338 | | | | | | | | | | | | | | |
| act. evapotransp. | mm | 21 | 130 | 137 | 191 | 215 | 208 | 180 | 210 | 200 | 162 | 145 | 120 | 118 |
| EP Penman | mm | 21 | 76 | 89 | 132 | 149 | 158 | 146 | 164 | 157 | 126 | 116 | 87 | 71 |
| relative humidity | % | 21 | 82 | 79 | 77 | 75 | 79 | 82 | 80 | 81 | 83 | 84 | 84 | 83 |
| precipitation | mm | 21 | 45 | 46 | 47 | 46 | 151 | 179 | 95 | 105 | 156 | 152 | 74 | 37 |
| tot.glob.rad. | MJ/m ² | 10 | 412.3 | 465.0 | 629.0 | 690.0 | 682.0 | 648.0 | 703.7 | 675.8 | 534.0 | 489.0 | 399.0 | 384.4 |
| T mean | °C | 21 | 20.8 | 21.2 | 22.7 | 24.0 | 25.4 | 26.4 | 27.1 | 27.1 | 26.2 | 25.3 | 23.5 | 21.9 |
| T max | °C | 21 | 26.5 | 27.0 | 28.5 | 29.7 | 31.0 | 31.7 | 32.4 | 32.5 | 31.9 | 30.1 | 28.5 | 27.2 |
| T min | °C | 21 | 15.7 | 16.0 | 17.0 | 18.4 | 20.4 | 21.6 | 22.0 | 22.0 | 21.7 | 20.9 | 18.7 | 16.9 |
| windspeed(at 2m) | m/s | 4 | 2.9 | 3.5 | 4.5 | 3.7 | 3.8 | 3.1 | 3.3 | 2.9 | 2.5 | 2.9 | 3.1 | 2.6 |
| bright sunshine | h/d | 10 | 6.6 | 7.4 | 8.3 | 9.3 | 8.6 | 7.9 | 8.9 | 8.7 | 7.4 | 7.8 | 7.1 | 6.7 |

PROFILE DESCRIPTION :

Ap 0 - 34 cm very dark gray (10YR 3.0/1.0, moist) clay; strong medium to coarse subangular blocky; slightly sticky, slightly plastic, friable; no mottles; no cutans; few fine pores; slightly porous; many medium roots throughout and many fine roots throughout; few medium spherical hard calcareous unspc. inclusions; no fragments; very frequent worm channels and channels; calcareous (10% HCL) throughout; diffuse smooth boundary to
 AC 34 - 46 cm dark grayish brown (10YR 4.0/2.0, moist) clay; strong medium to coarse subangular blocky; slightly sticky, slightly plastic, friable; no mottles; no cutans; few fine pores; slightly porous; many medium roots throughout and many fine roots throughout; few medium spherical hard calcareous inclusions; no fragments; very frequent worm channels and channels; calcareous (10% HCL) throughout; clear irregular boundary to

| | | |
|----|--------------|---|
| CA | 46 - 75 cm | very pale brown (10YR 8.0/3.0, moist) slightly gravelly silt; moderately coherent; non sticky, non plastic, firm; no mottles; no cutans; common fine pores; moderately porous; few fine roots throughout; few medium spherical hard calcareous inclusions; no fragments; few worm channels and channels; strongly calcareous (10% HCl) throughout; diffuse smooth boundary to |
| Ck | 75 - 105 cm | white (10YR 8.0/2.0, moist) slightly gravelly silt; structureless; non sticky, non plastic, firm; few medium distinct clear mottles (10YR 7.0/8.0); no cutans; common fine pores; moderately porous; few fine roots throughout; no inclusions; no fragments; few channels and worm channels; strongly calcareous (10% HCl) throughout; diffuse smooth boundary to |
| R | 105 - 120 cm | white (10YR 8.0/1.0, moist) structureless; non sticky, non plastic, firm; common coarse prominent clear mottles (10YR 7.0/8.0); no cutans; few fine pores; slightly porous; no roots; no inclusions; no fragments; strongly calcareous (10% HCl) throughout; |

ADDITIONAL REMARKS

Short field description:

Shallow, moderately well drained, dark greyish brown clay. The soil has a subangular blocky structure and contains small calcareous nodules and gravels.

Geology: Neogene Era, mid-lower Miocene. Arabos formation: clays, marls, sandstone, limestone and aleurolitas.

Geomorphology: abrasive, erosive, undulating marine plains.

ANALYTICAL DATA:

| Hor. | Top | Bot. | PARTICLE SIZE DISTRIBUTION (μm)----- | | | | | | | | | | | | WDIS | BULK | pF----- | | | | | | |
|--|-----------|------|---|------|------|--------|----------------------|-----|-----|------|-------|-------|------|------|--|-------|---------|-------|-------|-------|-------|------|-------|
| | | | >2 | 2000 | 1000 | 500 | 250 | 100 | TOT | 50 | 20 | TOT | <2 | CLAY | DENS | 0.0 | 1.0 | 1.5 | 2.0 | 2.3 | 2.7 | 3.4 | 4.2 |
| Ap | 0 - 34 | - | 1 | 1 | 1 | 2 | 3 | 8 | 7 | 8 | 15 | 77 | - | 1.27 | 56 | 54 | 54 | 50 | 49 | 47 | 44 | 37 | |
| AC | 34 - 46 | - | 0 | 1 | 2 | 1 | 2 | 6 | 7 | 0 | 7 | 86 | - | 1.14 | 60 | 60 | 60 | 57 | 56 | 55 | 54 | 47 | |
| CA | 46 - 75 | - | 11 | 8 | 4 | 3 | 2 | 28 | 5 | 36 | 41 | 31 | - | - | - | - | - | - | - | - | - | - | |
| Ck | 75 - 105 | - | 2 | 2 | 1 | 1 | 2 | 9 | 11 | 55 | 66 | 25 | - | - | - | - | - | - | - | - | - | - | |
| R | 105 - 120 | - | 0 | 0 | 0 | 0 | 1 | 2 | 4 | 81 | 85 | 14 | - | - | - | - | - | - | - | - | - | - | |
| | | | pH | pH | ORG. | MATTER | EXCHANGEABLE CATIONS | | | | EXCH. | ACID. | CEC | CEC | CEC | BASE | AL | | | | | | |
| Hor. | H2O | KCl | CaCO3 | | C | N | Ca | Mg | K | Na | sum | H+Al | Al | soil | clay | OrgC | ECEC | SAT | SAT | EC2.5 | ESP | | |
| Ap | 8.2 | 7.1 | 36.6 | - | 0.31 | 74.4 | 7.9 | 0.5 | 0.2 | 83.0 | - | - | 49.3 | 64 | - | 83.0 | * | - | 0.38 | | | | |
| AC | 8.3 | 7.2 | 32.6 | - | - | 74.0 | 8.7 | 0.6 | 0.3 | 83.6 | - | - | 49.0 | 57 | - | 83.6 | * | - | 0.38 | | | | |
| CA | 8.7 | 7.6 | 75.7 | - | - | 44.6 | 4.4 | 0.1 | 0.3 | 49.4 | - | - | 14.7 | 47 | - | 49.4 | * | - | 0.20 | | | | |
| Ck | 9.0 | 7.9 | 85.2 | - | - | 39.3 | 5.0 | 0.1 | 0.3 | 44.7 | - | - | 8.7 | 35 | - | 44.7 | * | - | 0.17 | | | | |
| R | 9.2 | 8.2 | 90.2 | - | - | 36.5 | 8.0 | 0.1 | 0.3 | 44.9 | - | - | 5.3 | 39 | - | 44.9 | * | - | 0.14 | | | | |
| CLAY MINERALOGY (1 = very weak .. 8 = very strong) | | | | | | | | | | | | | | | EXTRACTABLE Fe, Al, Si, Mn by amm. oxal.(o), Na dith(d) & pyroph.(p) | | | | | | | | |
| Hor. | MI | VE | CH | SM | KA | HA | ML | QU | FE | GI | GO | HE | | | Fe(o) | Al(o) | Si(o) | Fe(d) | Al(d) | Fe(p) | Al(p) | Pret | pHNaF |
| Ap | 0 | 0 | 0 | 8 | 3 | 0 | 2 | 3 | 2 | 0 | 0 | 0 | | | 0.2 | 0.4 | 0.1 | - | - | - | - | - | - |
| AC | 0 | 0 | 0 | 7 | 3 | 0 | 3 | 3 | 2 | 0 | 0 | 0 | | | 0.2 | 0.4 | 0.1 | - | - | - | - | - | - |
| CA | 0 | 0 | 0 | 6 | 3 | 0 | 4 | 1 | 1 | 0 | 0 | 0 | | | 0.0 | 0.1 | 0.1 | - | - | - | - | - | - |
| Ck | 0 | 0 | 0 | 6 | 3 | 0 | 5 | 0 | 1 | 0 | 0 | 0 | | | 0.0 | 0.0 | 0.1 | - | - | - | - | - | - |
| R | 0 | 0 | 0 | 6 | 4 | 0 | 6 | 0 | 1 | 0 | 0 | 0 | | | 0.1 | 0.0 | 0.0 | - | - | - | - | - | - |

Annex 3 Methods of Soil Analysis

| | |
|---|---|
| <i>Preparation</i> | Each sample is air-dried, cleaned, crushed (not ground), passed through 2 mm sieve, homogenized. Moisture content is determined at 105° C. |
| <i>pH H₂O</i> | (1:2.5): 20 g of soil is shaken with 50 ml of deionised water for 2 hours, electrode in upper part of suspension. |
| <i>pH-KCl</i> | likewise but shaken with 1 M KCl. |
| <i>EC</i> | (1:2.5): Conductivity of pH-H ₂ O suspension. |
| <i>Particle-size distribution</i> | Soil is treated with 15% hydrogen peroxide overnight in the cold, then on waterbath at about 80°C. Then boiled on hot plate for 1 hour. Washings until dispersion. Dispersing agent is added (20 ml solution of 4% Na-hexametaphosphate and 1% soda) and suspension shaken overnight. Suspension sieved through 50 µm sieve. Sand fraction remaining on sieve dried and weighed. Clay and silt determined by pipetting from sedimentation cylinder. |
| <i>Exchangeable bases and CEC</i> | Percolation with 1M ammonium acetate pH7 using automatic extractor. (If EC > 0.5mS pre-leaching with ethanol 80%). Cations are determined in the leachate by AAS. CEC: saturation with sodium acetate 1M pH7; washed with ethanol 80% and then leached with ammonium acetate 1M pH7. Na determined by FES. |
| <i>Exchangeable acidity and Aluminium</i> | The sample is extracted with 1 M KCl solution and the exchange acidity (H + Al) titrated with NaOH. Al is measured by AAS. |
| <i>Carbonate</i> | Piper's procedure. Sample is treated with dilute acid and the residual acid is titrated. |
| <i>Organic carbon</i> | Walkley-Black procedure. The sample is treated with a mixture of potassium dichromate and sulphuric acid at about 125°C. The residual dichromate is titrated with ferrous sulphate. The result expressed in % carbon (because of incomplete oxidation a correction factor of 1.3 is applied). |
| <i>Total nitrogen</i> | Micro-Kjeldahl. Digested in H ₂ SO ₄ with Se as catalyst. Then ammonia is distilled, trapped in boric acid and titrated with standard acid. |
| <i>Extractable Iron, Aluminium, Manganese and Silicon</i> | All determinations by AAS. <ol style="list-style-type: none">1 "Free" (Fe, Al, Mn): Holmgren Shaken with sodium citrate (17%) + sodium dithionite (1.7%) solution for 16 hours.2 "Active" (Fe, Al, Si): Shaken with acid ammonium acetate 0.2 M pH 3 for 4 hours in the dark.3 "Organically bound" (Fe, Al): Shaken with sodium pyrophosphate 0.1 M for 16 hours. |
| <i>Clay mineralogy</i> | Clay is separated as indicated for particle-size analysis. about 10-20 mg of clay is brought on porous ceramic tile by suction and analyzed using a Philips diffractometer. |
| <i>Soluble salts</i> | Measuring pH, EC, cations and anions in water extracts. <ol style="list-style-type: none">1 1:5 extract. Shaking 30 g of fine earth + 150 ml of water for 2 hours.2 saturation extract. Adding to 200-1000 g fine earth just enough water to saturate the sample. |
| <i>Gypsum</i> | Standing overnight. After filtration Ca, Mg, Na, K are measured by AAS. Cl with the Chlorocounter and SO ₄ turbidimetrically. |
| <i>Elemental composition</i> | To 10 g of fine earth 100 ml of water is added, shaken overnight and centrifuged. Precipitation by adding acetone. Precipitate redissolved in water and determination of Ca by AAS. |
| <i>Moisture retention</i> | The fine earth is dried, ignited and fused with lithium tetraborate. The formed bead is analyzed by X-ray fluorescence spectroscopy. |
| | Moisture determinations on undisturbed core samples in silt box (pF1.0;1.5;2.0) and kaolinite box (pF2.3;2.7) respectively and on disturbed samples in high pressure pan (pF3.4;4.2). Bulk density obtained from dry weight of core sample. |

Annex 4 Units, Glossary, Classes and Acronyms

UNITS

Chinese weights and measures

| | SI equivalent |
|----------|---------------------------|
| 1 mu | 0.067 ha |
| 1 jin | 0.5 kg |
| 1 jin/mu | 0.133 kg ha ⁻¹ |

Other units

| | |
|------------------------------------|--|
| cmol _c kg ⁻¹ | centimol charge per kilogram (formerly meq/100 g; 1 meq/100 g = 1 cmol _c kg ⁻¹) |
| µm | micro-metre: 1/1000 th of a millimetre. |
| mg kg ⁻¹ | milligram per kilogram (formerly parts per million (ppm)) |
| mS cm ⁻¹ | millSiemens per cm at 25°C (formerly mmho cm ⁻¹) |
| MJ | Megajoules (formerly kcal; 1 MJ = 4186.8 kcal) |

GLOSSARY

| | |
|-------------------------|--|
| Air capacity | Amount of pore space filled with air 2 or 3 days after soil has been wetted. It is calculated from the difference between amount of water under almost saturated conditions (pF 0.0) and moisture retained at "field capacity" (pF 2.0), and expressed as volume percentage. |
| Al saturation | Ratio of exchangeable aluminium to the CEC, expressed as percentage. |
| Available soil moisture | Amount of moisture retained between "field capacity" (pF 2.0) and "wilting point" (pF 4.2), expressed as volume percentage (also called "available water capacity"). It is indicative of the amount of moisture available for plant growth. |
| Base saturation | Ratio of the sum of bases to the CEC, expressed as percentage. |
| Bulk density | Weight of an undisturbed soil sample divided by its volume. |
| CEC | Cation exchange capacity, indicative of the potential nutrient retention capacity of the soil. |
| Clay mineralogy | Type of clay-sized (< 2µm) particles. |
| kaolinite | Clay mineral with a low nutrient retention capacity, common in soils from (sub)tropical regions. |
| smectite | Silica-rich clay mineral with a high nutrient retention capacity and the ability to absorb water, resulting in swelling of the clay particles. |
| illite | Potassium-rich clay mineral with a moderately high nutrient retention capacity, common in soils from temperate regions and in alluvial soils. |
| vermiculite | Clay mineral with a high nutrient retention capacity and strong potassium-fixation. |
| chlorite | Aluminium-rich clay mineral with a moderately high nutrient retention capacity, occurring in variable quantities in soils rich in aluminium. |
| halloysite | Clay mineral with a moderately high nutrient retention capacity, common in soils derived from volcanic ashes. |
| quartz | Residual silica, resistant to weathering. |
| feldspar | Residual primary mineral, unstable in soil environments and, if present, indicative of a slight to moderate degree of weathering. |
| hematite | Reddish coloured iron oxide, common in well drained soils of tropical regions. |
| goethite | Yellowish coloured hydrated iron oxide, common in soils of temperate regions. |
| gibbsite | Aluminium hydroxide, indicative of a high degree of weathering. |
| Consistence | Refers to the degree and kind of cohesion and adhesion of the soil material, or to the resistance to deformation or rupture. |
| ECEC | Effective cation exchange capacity. It is calculated by addition of the sum of bases and exchangeable acidity, and reflects the actual nutrient retention capacity of the soil. |
| ESP | Exchangeable sodium percentage, ratio of exchangeable sodium to the CEC, expressed as percentage. |
| Exchangeable acidity | Sum of exchangeable hydrogen and aluminium. |
| Fine earth fraction | Part of the soil material with a particle-size of 2 mm or less (nearly all analyses are carried out on this soil fraction). |
| Horizon | Layer of soil or soil material approximately parallel to the earth's surface. |
| Land characteristic | Measurable property of land (e.g. texture). |
| Land quality | Set of interacting land characteristics which has a distinct influence on land suitability for a specified use (e.g. erosion hazard, which is a.o. influenced by slope, rainfall intensity, soil cover, infiltration rate, soil surface characteristics, texture). |
| Leaching | Downward or lateral movement of soil materials in solution or suspension. |
| Mottle | Spot or blotch differing in colour from its surroundings, usually indicative of poor soil drainage. |
| Organic carbon | Content of organic carbon as determined in the laboratory (% org. C x 1.72 = % org. matter) |

| | |
|---------------------|--|
| Parent material | The unconsolidated mineral or organic material from which the soil is presumed to have been developed by pedogenetic processes. |
| pF value | Measure for soil moisture tension. |
| SAR | Sodium adsorption ratio of the soil solution, indicative of sodication hazard. |
| Soil reaction (pH) | Expression of the degree of acidity or alkalinity of the soil. |
| Soil structure | Aggregates of primary soil particles (sand, silt, clay) called peds, described according to grade, size and type. |
| Sum of bases | Total of exchangeable calcium (Ca^{++}), magnesium (Mg^{++}), potassium (K^{+}) and sodium (Na^{+}). |
| Texture | Refers to the particle-size distribution in a soil mass. The field description gives an estimate of the textural class (e.g. sandy loam, silty clay loam, clay); the analytical data represent the percentages sand, silt and clay measured in the laboratory. |
| Water soluble salts | Salts more soluble in water than gypsum. |

CLASSES OF SOME ANALYTICAL SOIL PROPERTIES

Organic Carbon - C (%)

| | |
|-----------|-----------|
| < 0.3 | very low |
| 0.3 - 1.0 | low |
| 1.0 - 2.0 | medium |
| 2.0 - 5.0 | high |
| > 5.0 | very high |

Base saturation - BS [CEC pH7] (%)

| | |
|---------|-----------|
| < 10 | very low |
| 10 - 20 | low |
| 20 - 50 | medium |
| 50 - 80 | high |
| > 80 | very high |

Acidity pH-H₂O

| | |
|-----------|-------------------|
| < 4.0 | extremely acid |
| 4.0 - 5.0 | strongly acid |
| 5.0 - 5.5 | acid |
| 5.5 - 6.0 | slightly acid |
| 6.0 - 7.5 | neutral |
| 7.5 - 8.0 | slightly alkaline |
| 8.0 - 9.0 | alkaline |
| > 9.0 | strongly alkaline |

Aluminium saturation (%)

| | |
|---------|-----------|
| < 5 | very low |
| 05 - 30 | low |
| 30 - 60 | moderate |
| 60 - 85 | high |
| > 85 | very high |

Available phosphorus (mg kg⁻¹)

| Olsen | Bray |
|--------|-------------------|
| low | < 5 < 15 |
| medium | 5 - 15 15 - 50 |
| high | > 15 > 50 |

Exchangeable sodium percentage - ESP (%)

| Soil structure | Crops |
|----------------|-------------------------|
| < 5 | very low < 2 |
| 05 - 10 | low 02 - 20 |
| 10 - 15 | medium 20 - 40 |
| 15 - 25 | high 40 - 60 |
| > 25 | very high > 60 |

CEC [pH7] (cmol_c kg⁻¹ soil)

| | |
|---------|-----------|
| < 4 | very low |
| 04 - 10 | low |
| 10 - 20 | medium |
| 20 - 40 | high |
| > 40 | very high |

Bulk density (kg dm⁻³)

| | |
|-----------|-----------|
| < 0.9 | very low |
| 0.9 - 1.1 | low |
| 1.1 - 1.5 | medium |
| 1.5 - 1.7 | high |
| > 1.7 | very high |

Sum of bases (cmol_c kg⁻¹ soil)

| | |
|---------|-----------|
| < 1 | very low |
| 1 - 4 | low |
| 4 - 8 | medium |
| 08 - 16 | high |
| > 16 | very high |

ACRONYMS

| | | | |
|-------|--|--------|--|
| FAO | Food and Agricultural Organization of the United Nations | ISRIC | International Soil Reference and Information Centre |
| ISIS | ISRIC Soil Information System | SCS | Soil Conservation Service |
| INICA | Instituto Nacional de Investigaciones de la Caña de Azúcar | UNESCO | United Nations Educational, Scientific and Cultural Organization |
| | | USDA | United States Department of Agriculture |

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Soil Briefs of Cuba
(ISSN: 1381-6950)

| No. | Title | No. of soils* |
|---------------|--|---------------|
| <i>Cuba 1</i> | Reference Soil of the Central Valley, derived from Alluvium | 1 |
| <i>Cuba 2</i> | Salt-Affected Reference Soil of the Guantánamo Valley | 1 |
| <i>Cuba 3</i> | Strongly weathered Reference Soils of the Central and Northeastern Regions | 4 |
| <i>Cuba 4</i> | Hydromorphic Reference Soils | 3 |
| <i>Cuba 5</i> | Brown Calcareous Reference Soils derived from Limestone | 4 |
| <i>Cuba 6</i> | Brown Reference Soils | 2 |
| <i>Cuba 7</i> | Organic matter-rich Calcareous Reference Soil | 1 |
| <i>Cuba 8</i> | Cracking Heavy Clay Reference Soils (Vertisols) | 3 |

Country Reports
(ISSN: 1381-5571)

| No. | Country | No. of soils* | No. | Country | No. of soils* |
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| 2 | P.R. of China | 51 | 16 | Ghana | in prep. |
| 3 | Turkey | 15 | 17 | Philippines | 6 |
| 4 | Côte d'Ivoire | 7 | 18 | Zimbabwe | 13 |
| 5 | Thailand | 13 | 19 | Spain | 20 |
| 6 | Colombia | 18 | 20 | Italy | 17 |
| 7 | Indonesia | 48 | 21 | Greece | in prep. |
| 8 | Ecuador | in prep. | 22 | India | in prep. |
| 9 | Brazil | 28 | 23 | Kenya | in prep. |
| 10 | Peru | 21 | 24 | Mali | in prep. |
| 11 | Nicaragua | 11 | 25 | Nigeria | in prep. |
| 12 | Costa Rica | 12 | 26 | Mozambique | in prep. |
| 13 | Zambia | 11 | 27 | Botswana | in prep. |
| 14 | Uruguay | 10 | | | |

* State of reference collections as of January 1995