Cultivos Tropicales, Vol. 46, No. 3, July-September 2025, e-ISSN: 1819-4087, p-ISSN: 0258-5936, https://ediciones.inca.edu.cu

Cu-ID: https://cu-id.com/2050/v46n3e01

Bibliographic review

Origin, development and current situation of the soil classification in Cuba

Origen, desarrollo y situación actual de la clasificación de suelos de Cuba

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ABSTRACT: Soil Classification is one of the main results in Agriculture Science in Cuba. Thanks to the support and systematic work during more than 50 years in this specialty, give the opportunity to develop a system of soil classification that is grateful as a most important classification for tropical soils. In 2006 was published a book "The History of Soil Classification of Cuba" that obtained the first Prize "Andres Aguilar Santelises In Memoriam" un the Latin-American Congress of Soil Science held in Leon Guanajuato, Mexico. Before almost 20 years of this publication, the objective of this paper is present in a short form an outline of this line work, that is very important for our country, because Cuba is one of the countries in American Latin that have an inner system of soil classification.

Key words: Soil taxonomy, types of soils, pedon.

RESUMEN: La Clasificación de Suelos es uno de los principales resultados en las Ciencias Agrícolas en Cuba. Gracias al trabajo sistemático y sostenido durante más de 50 años en esta línea de trabajo se ha desarrollado un sistema que ha sido planteado como una de las clasificaciones de suelos tropicales más importantes a nivel internacional. En el año 2006 se escribió el libro "La Historia de la Clasificación de Suelos de Cuba", trabajo que fue seleccionado como Primer Premio "Andrés Aguilar Santelises In Memoriam" en el Congreso Latinoamericano de la Ciencia del Suelo, celebrado en León Guanajuato, México. Como han pasado casi 20 años de esta publicación, el objetivo de este trabajo es presentar en forma resumida una recopilación actualizada de esta línea de trabajo que resulta muy importante para nuestro país, ya que es uno de los dos países que tiene un sistema propio de clasificación de suelos en América Latina.

Palabras Clave: Taxonomía de suelos, tipos de suelos, pedón.

INTRODUCTION

Classifying an object of nature, including its taxonomic units, bases and nomenclature, is one of the most arduous tasks in any natural science; a more difficult and delicate task when dealing with one of the most important natural resources for mankind: soil (1).

The soil, the upper membrane of the pedosphere, is dynamically interrelated with the biosphere, in which all the changes that have occurred during its formation are recorded, so it is considered as a "memory block", in which all the past changes in nature are manifested, through which future changes can be predicted (2). In addition, this natural and complex body is open, polyphasic and has been subject to transformations by man both in the production of food and raw materials and in mining.

This paper presents how soil classification arose in Cuba and its current situation, taking into account the stages of its development, from the first works in the colonial period through the period of capitalist development and, after the Revolution, in the socialist period, to the current situation (3).

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Received: 19/06/2024

Accepted: 06/09/2024

Conflict of interest: Authors declare that they have no conflict of interest.

Authors' contribution: Conceptualization: Alberto Hernández-Jiménez. **Research:** Alberto Hernández-Jiménez, Greter Carnero-Lazo. **Methodology:** Alberto Hernández-Jiménez, Greter Carnero-Lazo. **Supervision:** Alberto Hernández-Jiménez, Greter Carnero-Lazo, Initial draft writing, **Final writing and editing, and Data curation:** Alberto Hernández-Jiménez, Greter Carnero-Lazo.

In Cuba, the classification of soils arose in the colonial period with some sporadic works and the soil was denominated with the term earth. Later, the North American line of classification of soil series and families was applied and, from the 1960s on, the genetic classification was developed at the Soil Institute of the Cuban Academy of Sciences (ACC according its acronyms in Spanish), on which some versions have been made that have enriched this classification by systematically applying the modern conceptions of this subject that exist at international level.

In order to better understand and know the development achieved in this subject of soil classification in Cuba, the following is a review of the historical development of this line of work, according to the stages outlined in the book "The History of Soil Classification in Cuba" (3).

DEVELOPMENT

Different stages in the classification of soils in Cuba

1. Soil Classification during the Colonial Period in Cuba (up to 1902)

At this stage there was no soil classification system of its own and soils were named with the word "earth". This is well highlighted in reports made by Matínez Viera, 1968 and in the book "La Historia de la Clasificación de los Suelos de Cuba" (3).

The first report on the soils of Cuba dates back to 1797, by Antonio Morejón y Gato, made before the Real Sociedad Económica de Amigos del País, on "The good properties of the red soil for the cultivation of sugar cane, on its excellence with respect to the black soil". Later, in 1842 Mariano Carrillo explained before the same Society his "reflections on the nature of the soil of the Antilles" (3).

In 1850, in the Anales y Memorias de la Real Junta de Fomento appeared the report on "Memorias sobre caña de azúcar y los diversos terrenos adecuados a ella". Then in 1855 Ramón de la Sagra made 16 analyses of the Cuban soils and in 1864 Manuel Fernández de Castro presented what could be considered the first genetic study of the soils of Cuba, in the work "on the formation of the red soil, which constitutes a large part of the cultivated land of the Island of Cuba" (3)

From this moment on, soil studies were scarce due to the revolutionary gesture of the Wars of Independence of Cuba, although some works were made mainly in the period between the two Wars and mainly related to the fertility or the fertilizers in the soils (3).

Thus we have the work of Jules Lachaume (1872), who in his report "Physiology of the Island of Cuba", writes about fertilizers, advising their application to each vegetable variety and discussing problems of agricultural, political and industrial economy of the lands. Maximino Zandoya, in 1881, makes a study on bat guano in which he exposes its history, characters and chemical composition, demonstrating its superiority as a fertilizer for land restoration. In 1880, Edgard Carbonne published a work on the fertilizers produced in the Cuban sugar mills and their corresponding value.

As can be observed, most of the works deal with fertility problems and do not deal with the intrinsic problems of soil properties. But at this time, all over the world, a primordial importance was given to the studies of Plant Physiology and Agricultural Chemistry, which were predominant in relation to the works of genesis, classification and mapping of soils, which really begin to develop in the world with the studies of the Russian scientist V.V. Dokuchaev, at the end of the XIX century in Russia.

2. Soil Classification in Cuba during the period (1902-1958)

After the establishment of the so-called "Republic" in 1902, we know the study carried out by Mario Sánchez Roig in 1913, "Los Suelos de la Isla de Pinos", and that of Gastón Alonso Cuadrado in 1912, "sobre la tierra colorada y la tierra negra" (3). All these works presented regional criteria without taking into account the national territory. The first attempt to classify the soils of Cuba was made by Crawley in 1916, with his work "The Lands of Cuba" (4), where he proposes the classification of soils by their mechanical composition (clayey, sandy and loam soils) and by soil color (colored, brown, mulatto, black soils) and other characteristics (calcareous-stony soils and savannah soils).

As it is well known, at the end of the decade of the 20th century, Drs. Bennett and Allison came to Cuba and carried out a study of soils mainly related to the cultivation of sugar cane. These specialists established a soil classification based on the North American system of series and families. The results of their study culminated in the publication of the book "The Soils of Cuba" and a map at a scale of 1: 800 000 of the soils of Cuba (5). The series of soils described by Bennett and Allison were diagnosed following morphological indexes such as color, texture, concretion, compaction, etc. The soils were named according to the place where they were observed for the first time (for example: Matanzas, Camagüey, Havana, Oriente, Palma, San Cristóbal, etc.) and, in other cases, they inherited names of soil series already existing in the United States (for example: Norfolk, Orangeburg, Greenville, Ruston, etc.). The series were grouped into families, which in turn were determined mainly by the characteristics of the B horizon. In their work, these authors diagnosed 13 soil families with 81 soil series and, in addition, the Greda family with coco and marl and 7 groups of savanna soils.

In 1932 Dr. Bennett returned to Cuba and continued his soil studies publishing the book "Some New Cuban Soils", in which he described and classified new soil series. In this new trip Bennett diagnosed 17 new soil series, as well as new types and phases of several previously studied soil series (6).

The book "The Soils of Cuba" dominated the Cuban edaphological literature during all this stage, and constituted the basis for several specialists to begin to develop some works, mainly related to the problems of fertility, management, and soil classification.

In 1945 the V National Congress of Engineers was held, in which some works on soils were presented, among them "Soils and Scientific Agriculture", by P. Cabrer Mestre and "Classification of the productive capacity of soils" by R. García Vázquez (3).

In 1954 the Bank of Agricultural and Insdustrial support of Cuba (BANFAIC, according its acornyms in Spanish) hired again the services of Dr. Bennett, together with those of the expert in photointerpretation Charles B. Gay. They together with the participation of some Cuban specialists made the study of the soils of several municipalities of Havana and Pinar del Rio, at a scale of 1:40,000. These works were published in the form of independent booklets.

A total of 13 municipalities were studied; in Havana province: Güira de Melena, Alquízar, San Antonio de los Baños, La Salud and Quivicán (1954-1955); and in Pinar del Río province: Artemisa (1955), Candelaria (1956), San Cristóbal, Los Palacios, Guane and Mantua (1957) and Viñales and Consolación del Norte (1958).

In fact, the studies carried out by Bennett and Allison set the standard in this stage of soil classification in Cuba, being the central and basic work from which a weak development of Cuban Edaphology was obtained. Bennett and Allison's soil classification, as an exponent of the North American school of soil classification, had a strong roots and, practically, it can be said that it was the only soil classification system used until the 60's; when with the Triumph of the Revolution, new changes were opened in the development of Pedology and, specifically in the field of soil classification.

3. Soil classification after the Triumph of the Revolution (1959-2024)

It is necessary to emphasize that with the triumph of the Revolution in Cuba, on January 1, 1959, the first action taken to promote soil studies in Cuba at that time was to translate the works: “The Soils of Cuba” and “Some New Cuban Soils”, by Bennett and Allison, into Spanish, an initiative taken by the Cuban Commission at UNESCO, which culminated with the publication of both books in 1962. It is necessary to recognize that it took 34 years for Cuban specialists, producers, teachers and students to have both works in Spanish, despite the fact that they were the most important document for soil scientists and agronomists in the nation.

Since in Cuba the classification of soils in soil series and families, made by Drs. Bennett and Allison in 1928, was established, this classification line was initially followed. Thus, the Department of Soils between 1960 and 1964 was sometimes in the Ministry of Public Works (today Ministry of Construction) and other times in the Ministry of Agriculture, to later move to the National Institute of Hydraulic Resources (INRH). During this period, an attempt was made to make a basic soil map in soil series, and between 1960-1964 a soil map was made on a scale of 1:100 000 of the provinces of Pinar del Río, La Habana, Matanzas and part of the former province of Las Villas, under the direction of Engineer Gerardo Soto Hernández. At the end of this stage, about 217 soil series had already been described and only one third of the country was mapped only one third of the country, where the series were more easily identifiable, but the relatively dry flat regions of the former provinces of the eastern part and Camagüey, as well as the soils of the mountainous regions, had yet to be studied (3).

In 1964, the Directorate of Soils was created in INRA, under the direction of Engineer Pablo León Echandi, who began a soil mapping work in the province of Camagüey, with the Bennett and Allison soil classification. This line of work was continued years later with the creation of the Ministry of Agriculture and with the Direction of Soils and Fertilizers of the Ministry of Agriculture, under the direction of Eng. Cristóbal Colom, which culminated with a soil map 1:50 000 with the Bennett and Allison series classification, which was completed in the 1970s. This map did not study the mountain soils or the soils of the wetland regions (swamps) and only worked with the soil series established by Bennett and Allison, not with the 217 soil series established by INRH (3).

At the same time, books were published in the 1980s, for each province and for the Isle of Pines. In these books there is a report of the characteristics of the soil series studied and their relation with the cultivation possibilities. Undoubtedly, the wealth of information in these books is remarkable.

In 1965, the Soil Institute was founded in the ACC, under the direction of Eng. Germán Planas, with a main project, advised by specialists from the People's Republic of China, which was the elaboration of a Basic Soil Map of the soils of Cuba at a scale of 1:25 000. The map was completed and published in color in 1971 by the Instituto de Suelos in 1971 (7). In the collaboration with the People's Republic of China at the Soil Institute, several specialists from the Nanjing Soil Institute, among them: Zhao Ki Guo, Chu Chiao Lian, Liu Sin Wen, Chen Chia Fan, Tin Shien and, in addition, visits from Professor Li Chin Kwei, who was Vice President of the Chinese Academy of Sciences (SINICA).

In this 1:250 000 soil map, a new classification line was applied for the first time, based on the genesis of soils, which was widely used at that time in Europe, the former Soviet Union and the countries of the former socialist area.

The bases of the classification were their genesis, factors and processes of formation. The nomenclature on the basis of the processes, for example: Gleyzation, Gley soils; Latosolization (later recognized as Ferrallitization), Latosolic soils; Sialitization, Sialitic Brown soils. The classification Units were 4: Large Group of Soils according to the main soil formation process; Subgroup, within each Group, according to secondary processes; the third unit, the Genus, took into account the character of the parent rock and its influence on soil formation and, the Species according to the depth of the horizons (A+B).

The first approximation of this classification resulted from the diploma thesis as Agronomist Engineer, of the University of Havana by Alberto Hernández and was published in the journal Tecnología Agropecuaria (8). Another work applying this classification was the diploma thesis of Osvaldo Ascanio, also published in the aforementioned journal (9). Finally, the complete version of this classification was embodied in the

1:250 000 soil map, although it was presented at the First National Soil Meeting in 1968, presented by Hernández, Ascanio and Pérez Jiménez, and later published in the Agriculture journal of ACC (10).

This classification had the advantage of being applied in the whole territory of Cuba, both in plain, pre-mountain and mountain conditions; gathering very important geographical genetic aspects and phenomena in the diagnosis and classification of soils. At the same time, it is observed that it is based not only on the processes of soil formation, but also on the stages of soil evolution, from sialitic to latosolic (ferrallitic) characteristics.

The first version of the genetic classification of soils had a strong support with the publication of the book “Génesis y Clasificación de los Suelos de Cuba” (11) and “Estudio Edafológico de Isla de Pinos” (12), where the descriptions and analytical results of numerous soil profiles that supported the classification were shown.

The initial cartographic application of this classification for the entire territory of Cuba was in the 1:1.000 000 soil map presented for the First National Atlas of Cuba. This map had not yet elaborated the complete classification and its elaboration was in charge of O. Ascanio with the collaboration of Pérez Jiménez and Hernández (13).

This classification played an important role in Cuban edaphology, since for the first time in Cuba this type of classification was applied in a basic map on a medium scale, which served at that time to begin to evaluate the agro-productive potential of the land, for example in important crops such as citrus (14), forestry (15) and rice (10). It also served as the basis for the first agro-productive land grouping, which was applied to the evaluation of all soils for agriculture in general (16).

It is necessary to emphasize that in addition to the results obtained in the classification, mapping and distribution of soils in Cuba with the 1:250 000 soil map project, in collaboration with specialists from the People's Republic of China, this type of classification had partial contributions from Soviet and French specialists. Among them Igor Stepanov, at INRH, prepared a version of the Genetic classification of Cuban soils (17). Serguei V. Zonn, from the Institute of Geography of the ACC, in collaboration with Cuban soil scientists prepared a genetic classification of the soils of Cuba, which was a correlation with the Soil Series (18), for a soil map of the National Soil Atlas of Cuba. Also Lev L. Shishov, from the National Research Institute for Sugar Cane (INICA), elaborated a classification of Cuban soils for the areas cultivated with sugar cane on a genetic basis (19). In the 1970s, at the Pierre Segalen Soil Institute of ORSTOM, France carried out a project in collaboration with Cuban soil scientists Pérez Jiménez and Fernando Ortega on the application of the French soil classification in the classification of Cuban soils, which was also genetically based (20).

The second version of the genetic classification of Cuban soils

Taking into account the growing collaboration of Cuba with the former socialist countries, the need arises to increase agricultural yields of some crops such as sugar cane, citrus and other fruit trees for exchange with these countries, so the National Directorate of Soils and Fertilizers, creates the National Service of Soils and Agrochemistry and it becomes necessary to prepare a more accurate version of soil classification that can be applied in soil mapping in more detailed scale for effective soil management in agricultural production.

For this reason, the Soil Institute was asked to prepare this second version of soil classification. At that time, the Institute was carrying out a very important project on the main agricultural soils of the country. On the one hand, in collaboration with the Institute of Soils and Agrochemistry of Armenia, a project was being developed for the study of Pardos, Humic Carbonate and Vertisols soils, mainly in collaboration with the specialists: Grigor S. Tatevosian, Oleg A. Agafonov and Grigor Babaian, and on the other hand, in collaboration with ORSTOM, the Ferrallitic soils of Cuba were being studied in detail.

These results were useful for several specialists of the Soil Institute in Cuba to do their PhD thesis. They were, A. Hernández on the Brown soils of Cuba, in the former Soviet Union (21), Antonio Obregón on the Chemical Mineralogical Characteristics of the Main Soils of Cuba in 1979 (22), Juan M. Pérez Jiménez on the Brown Gray soils in Cuba (23), Osvaldo Ascanio on the Humic Carbonate soils, in Cuba (24). On the other hand, in France, in collaboration with ORSTOM, Eloy Camacho defends his doctoral thesis on the Red Ferrallitic compacted soils of Cuba (25).

With the results obtained up to that moment and with the incorporation of the Soviets Tatevosián, Agafonov and Shishov and Pierrre Segalen from France, the Second Version of the Soil Classification of Cuba was elaborated in 1975. This new version was published in 1975 (26). This document was presented as the Second Genetic Classification of Cuban Soils during the First Scientific Conference of the Soil Institute.

Profound changes were made in this classification, both in taxonomy and nomenclature. In it, the conception that soil classification should be based on the genesis of soils was reinforced. Units similar to the Soviet system, used in Cuba by S. V. Zonn (18) and Shishov (19), were adopted: Type, Subtype, Genus, Species and Variety. The unit of Soil Grouping was also adopted, which in part coincides with the Large Groups of the First Version of the Classification. It can then be stated that the Large Groups of soils sometimes include different genetic types of soils. The basis for establishing these soil units was the same as that followed in the Soviet classifications.

The nomenclature also changed, using names such as Ferritic, Vertisols, etc.; enriched with the names of new soils, for example: Fersialitic soils. In this new version, 10 groupings and 28 genetic types of soils were separated. The classification was presented in a more elaborated form, with lower units that take into consideration those properties of soils that are related to their use in agriculture.

The Second Version of the Genetic Classification of Cuban Soils was an achievement of Cuban science, especially because it was the system that was adopted at the national level and applied in all branches related to agriculture, whether research, teaching or production. This classification is recognized as one of the main achievements in Cuban agricultural science in the Theses and Resolutions of the First Congress of the Communist Party of Cuba (27).

From the elaboration of this version of soil classification in 1975, Cuban soil scientists achieved independence in this matter, so the versions that were prepared later (1980, 1988, 1995), were prepared by Cuban specialists.

This 1975 version was applied to the 1:25 000 soil map prepared by the National Directorate of Soils and Fertilizers of the Ministry of Agriculture, completed in 1990. The results of this work were presented at the International Soil Congress held in Cuba in 1990 (28). Based on this version and its corresponding map, it was possible to know with good precision the limiting factors for food production in Cuban soils. This version was awarded a prize at that congress.

The Third version of the genetic classification of Cuban Soils

It was published in 1980, with some new criteria achieved as a result of research and production experiences (29). The changes introduced in it were not very big; nevertheless, a new grouping appears in this version, that of swampy soils, and some adjustments of some names of the Plastc dark and little evolved soils respectively. In addition, some other changes were made at the levels of Types, Subtypes, Genera and Species, which clarified some deficiencies of the previous version.

Although this new version was an enrichment of the previous one, it did not have the same level of introduction, since it was not applied in soil mapping, therefore its application was mainly in the cognitive line, specifically in teaching.

Fourth version of Soil Classification of Cuba

In 1988, the International Conference on Soil Classification was held in Kazakhstan, former USSR. Some Cuban specialists were invited to attend this event, and for this purpose an updated version of the soil classification was prepared, headed by Hernández, Ascanio, Camacho and Pérez, which was presented by A. Hernández in 1988 and published in 1990 in the proceedings of the event (30). This classification was well appreciated, especially for the inclusion of new soil types, mainly within the Alitic Soil Grouping.

The most significant aspect of this event was to be able to grasp the direction that countries were taking in soil classification at that time. Countries with a tradition in the genetic classification of soils (such as the USSR, China, France, among others) and, in addition to the FAO List of Units, included the concepts of horizons and diagnostic characteristics, introduced by North American pedology in the Soil Taxonomy. These concepts reinforced and specified the genetic classification of soils.

1. The concepts were applied depending on the characteristics of the soils and were called differently (main horizons, reference horizons, etc.).
2. At the world level, the tension that existed in the world regarding soil classification had ended and there was a consensus to prepare a Pedological Reference Base that would serve all countries. This was finally presented at the XV World Congress of Soil Science, in Acapulco, Mexico, under the title World Reference Base for Soil Resources. Pedologists from different countries participated in the preparation of this material.

Already earlier, during a 3-month stay in 1982, at the V.V. Dokuchaev Soil Institute in Moscow, it was possible to notice the new direction in the genetic classification of soils in the Soviet Union, since Dr. Lev L. Shishov (Director of the Dokuchaev Soil Institute), provided a document prepared by V.M. Fridland (J'Dpt. of Genesis, Classification and Cartography of Soils of the V.V. Dokuchaev Institute), to prepare the new version of soil classification of the USSR (31). This trend was presented by Hernandez in a lecture given at the Institute of Soils, ACC, in the same year.

Fifth version of the Cuban Soil Classification

Based on the aforementioned aspects, in 1992 a Commission of Pedologists was created at the Soil Institute, in collaboration with specialists from other institutions, and work began on the preparation of a new version of genetic classification. The work lasted 2 years and was finished in 1994, being recognized as a scientific achievement of Cuban Science, by Resolution 63/90 of CITMA. This version was called “New Version of the Cuban Soil Classification”, was finished in 2004 and was selected as National Award of the ACC. Subsequently, in 1999, it was published by the Ministry of Agriculture of Cuba (32).

In this work, all the materials that served as basis for the versions of soil classification previously elaborated and the results achieved in the last 15 years in the characterization and classification of soils of different regions in Cuba were reviewed. The research was directed to the creation of horizons and diagnostic characteristics according to the characteristics of Cuban soils, related to the factors and processes of formation.

After 2 years of work, 2 types of diagnostic horizons were established; the main horizons, related to the genesis and evolution of the soils and which are mainly manifested in the B horizon and the normal horizons, which can be in the A horizon as well as in the B horizon, and also the diagnostic characteristics. In total, 12 main horizons, 14 normal horizons and 17 diagnostic characteristics were established.

In the classification, the higher taxonomic units (grouping, genetic type, subtype, genus and species) are maintained. In total, 14 groupings, 36 genetic types and 172 soil subtypes are separated. The use of horizons and diagnostic characteristics makes the classification simpler and more precise; and by maintaining the genetic line, the ecological value of the same is not lost.

On this new version of Cuban soil classification, several contributions were made, such as a Software and also a Key System to facilitate its application and its correlation with the international classifications Soil Tazonomy and World Reference Base. These tools were presented at the 2006 Soil Congress; while the Keys for their application were published by the Faculty of Agronomy of the University of Matanzas in 2008 (33).

This version of the Cuban Soil Classification was applied in Cuba in a little known 1:400 000 scale soil map, edited by Geocuba (34), which was presented at the International Conference on Soil Geography, held in Huatulco, Mexico, in 2009 (35).

It was also presented at international events such as the International University Congress of Soil Science held at UNAM, Mexico (36) and at the International Conference on Soil Classification in Karelia, Russia in 2004 (37).

Until 1994, when this New Version of Soil Classification of Cuba appeared, the period of updating and improvement of the same with its versions did not exceed ten years, so that one of the principles that should govern a classification was complied with, which is that of reproducibility, which establishes that the soil classification should not go more than 10 years without being revised and updated, as well established in the Russian Soil Classification of 2004 (38). This is demonstrated in Table 1, which shows the time that passed from one version to the other.

The updating of soil classifications arises with their application in cartography and soil research. Unfortunately, the soils service does not provide new criteria because it does not apply this version.

Sixth version of Soil Classification of Cuba

Taking into account the principle of reproducibility, which should govern in the Soil Classifications, and that since 2004 the Cuban Soil Classification had not been updated, and also that the world in the last 20 years numerous results were obtained on the influence of man in the change of soil properties, i.e. anthropogenic activity, in Cuba, a thesis was prepared resulting in an update version, in which the above aspects are taken into consideration. This work resulted in the Second Doctoral Thesis of Alberto Hernández (39) and it was the basis for preparing the 2015 version of the Cuban Soil Classification, among specialists from INCA and the Soil Institute (40).

This version was published in a book and presented in an activity organized by the Soil Institute at the Ministry of Agriculture and was disseminated both in Higher Education and in the Ministry of Agriculture. It presents the principles that should govern a soil classification which are:

1. **The genesis principle**, which establishes that soil classification should be elaborated taking into account properties in relation to the factors and processes of soil formation. It should be remembered that soil is a “Memory Block” whose properties constitute a record of the history of its formation.
2. **The principle of reproducibility**, which states that soil classifications should be revised and enriched in a period of time no longer than 5-10 years. In Cuba, this is complied with in the versions, except in the one elaborated in 1994, which has not been updated for more than 20 years.
3. **The principle of openness**, which in the 2015 version is applied since it opens a new grouping (Technosols). In addition, the influence of man in the change of soil properties is included in the classification, with the opening of new soil subtypes (with qualifiers, agrogenic and erogenic).
4. **The principle of structure and historical inheritance**, which is based on the fact that the new versions to be elaborated must include all the experience and structure of the previous versions. The same taxonomic units and their bases (Grouping, Genetic Type, Subtype, Genus, Species and Soil Variety) must be maintained.

The new 2015 version takes into consideration all taxonomic units up to the soil variety level. It has 15 Groupings, 39 Genetic Types and 197 Soil Subtypes. The previous version, from 1994, published in 1999, classified 14 Groupings, 36 Genetic Types and 172 Soil Subtypes. This difference shows the progress made in the 2015 version.

The 2015 version of the Cuban Soil Classification was presented at the International Conference on Soil Classification 2022, held in Querétaro, Mexico (41).

Table 1. Time elapsed between the 5 versions of the Cuban Soil Classification

Version and Year	Basis	Units of Classification	Nomenclature	Application
1rst. 1971	Genesis, SFF and SFP	Large Group, Subgroup, Genus and Species	International	Soils Map of Cuba 1:250 000 and regional maps in scale 1: 50 000
2nd. 1975 (4 years)	Genesis, SFF and SFP	Grouping, Type, Subtype, Genus, Species and Variety	International	Soils Map of Cuba 1:25 000
3rd. 1980 (5 years)	Genesis, SFF and SFP	Grouping, Type and Subtype	International	Teaching and Research
4th. 1988 (8 years)	Genesis, SFF and SFP	Grouping, Type and Subtype	International	International CS Conference in Alma Ata, USSR. Research in Cuba
5th. 1994 (6 years)	Genesis, SFF and SFP and and DH and DC	Grouping, Type and Subtype	International	Teaching and Research International Conference in Karelia, Russia in 2004. Soil Map 1:500 000, in 2009 Huatulco, Mexico

SFF: Soil Formation Factors, SFP: Soil Formation Processes, DH: Diagnostic Horizons and, DC: Diagnostic Characteristics.

It was highly valued since it was evidenced in that conference that the World Classifications: Soil Taxonomy and World Reference Base do not have attributes whose properties are transformed by anthropogenic action, while Cuba's has them, following results obtained in the Russian soil classification (38), the criteria of agrogenic and erogenic subtypes were included, with their diagnoses in each case, for soils under agricultural production.

Some international criteria on Cuban Soil Classification

Actually in Cuba, since the foundation of the Soil Institute, currently in the Ministry of Agriculture of Cuba, a sustained work has been carried out in the foundation of a very important classification that follows international principles. First with the collaboration of specialists from the People's Republic of China, later from the former Soviet Union and also from France. It has been a systematic work that has been enriched on the one hand by research results and on the other hand by exchanges at international meetings.

This classification was recognized in the Scientific Theses and Resolutions of the First Congress of the Communist Party of Cuba as one of the main scientific achievements in Agricultural Science (27). It is necessary to emphasize also, the international recognitions that it has received, among which we have the following:

"The genetic classification of Cuban soils was built under the influence of the Russian school of pedology. However, it is not a copy of the structure and errors of the initial Russian classifications. Since its first version, this classification presents a system of soil groups. The latest version of the Cuban soil classification also includes some productive ideas from Soil Taxonomy and international classifications, such as the concept of diagnostic horizons (New Version of Genetic Classification of Soils of Cuba, 1999). Because the territory of Cuba is dominated by intensively weathered tropical soils, these are classified in detail, which in fact constitutes the most successful attempt to classify tropical soils" (42).

"The soil classification of Cuba is influenced by four main schools of pedology Soviet (Russian), French, American and Chinese. The Soviet and Chinese schools paid attention to soil formation processes. The French school to the evolution of soils, based on geochemical and mineralogical properties. The American school was a source of foundation for diagnostic horizons. The Cuban system is not a simple compilation of these classifications of the above mentioned countries. The Cuban school has produced an original soil classification" (43).

"Cuba has a great advantage in the field of soil study; the Island has a long history regarding the development of agriculture, so many researchers have been engaged in the study of Cuban soils. Since the beginning of the 20th century, Cuba has been visited by soil scientists from the United States, France, the Soviet Union and China. Thanks to the exchange of ideas, Cuban specialists were able to integrate the concepts of various schools and develop their own school of soil sciences. Among other achievements, Cuban soil scientists developed a particular soil classification" (44).

From the results obtained, it is evident that Cuba is a country that has been able to develop its own soil classification system, which is very important for tropical countries. It is necessary to point out that there are only 32 countries in the world that have their own soil classification system and in Latin America, only Brazil and Cuba.

Unfortunately, although the Cuban Soil Classification has had contributions in the last 30 years, especially with the application of current issues such as the application of diagnostic characteristics and horizons and in the latest version the application of diagnosis to classify soils whose properties are affected by anthropogenic action; even in the National Directorate of Soils and Fertilizers the version of 1975, from 48 years ago, is still applied. Suffice it to recall that the classification of soils in series and families that was implemented in Cuba with the work of Bennett and Allison in 1928, was changed in 1971 by the classification based on the genesis and properties of soils (10). The 2015 version is applied in teaching and in thesis works and research projects, but not in the soil service.

CONCLUSIONS

1. Cuba has been able to systematically and continuously develop its own soil classification system.
2. It is a document that has been presented in national and international events with recognition in both cases, as one of the most important soil classifications for tropical regions.

RECOMMENDATIONS

1. The 2015 version should be used not only in teaching and research, but also in the soil service and in the most important agricultural plans of the country.
2. It is recommended to take into account that, from the last version of soil classification elaborated in 2015 to the current date, 9 years have already passed; and taking into account one of the principles that should govern our soil classification, a group of soil scientists should be prepared to update this version before 10 years have passed since the last version.

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