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Twenty Years of Agroecological Practices on a Family Farm in Pinar del Río, Cuba

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Abstract

The research is integrated with the DiveCropS project supported by DAAD, Germany, and shows that experience of more than twenty years of agroecological practices in a family farming, located in an area of slate heights in the Guaniguanico mountain, in the municipality of Los Palacios, province of Pinar del Río, Cuba. The studied is located in areas of fragile agricultural ecosystems with lithosol-type soil, which for many years have been subjected to poor management and intensive use, as a consequence they have been degraded by erosion and compaction, limiting their productive capacity. In the experience carried out, the effect of the system of agroecological practices implemented for the management of soils that allows them to improve, conserve and increase their productivity over time is evaluated. The study has a surface area of 5 hectares where they applied technologies for the improvement and conservation of soil, crop rotation, minimum tillage and agroforestry management. The results achieved show a reduction in erosion, by improving the chemical, physical and biological properties of the soil, increasing its fertility and the biodiversity of the agro-ecosystem, on the basis of reaching an increase in Organic Matter in the soil with values of 0.97 to 1.96 %, achieves a greater cation exchange capacity, with an increase in structural porosity and soil permeability, contributing to a 30 % increase in yields. These results allow a greater stability of the family, improve their quality of life and guarantee their permanence in the environment without the need to emigrate to other areas.

Keywords: Agroecology, agroforestry, biodiversity, family farming, soil

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Introduction

The research includes an experience in a family farming farm owned by the producer Juan Alonso, located in an area of slate heights in the Guaniguanico mountain range, in the municipality of Los Palacios, in the province of Pinar del Río, Cuba. During the year 2020, the results of this research are integrated into the Diversifying Cropping Systems Project (DiveCropS) supported by financing from the DAAD in Germany, to achieve through the project systematize the results of more than twenty years of research on the development of agroecological practices in a heavily degraded area.

Agricultural producers do not have a culture on the protection and conservation of the soil resource, and show a tendency to migrate to other areas, cutting down their forests for cultivation as a solution to their food needs, the intensity of deforestation problems accelerates it, soil erosion and loss of biodiversity in the area.

Erosion is a natural process by which soils are worn down by the action of wind, water, glaciers and other natural phenomena. Erosion, understood not as a process of landscape formation, but rather as a result of human intervention in a territory, with different purposes, has acquired such a magnitude over time that today it is considered one of the main global environmental problems, (Cordero *et al*, 2019).

An important argument to justify the problem is constituted by the criteria of the owner of the farm, Juan Alonso Hernández, when he stated that when his father arrived here in 1920, it rained regularly; When I was young, we cultivated 100,000 tobacco plants (*Nicotiana Tabacum*) no irrigation, on these hills and obtained high yields; now the droughts are so intense that they affect even the most resistant crops such as cassava (*Manihot sculenta*).

This situation determined the following problem to be investigated: how to stop the processes of deforestation, soil erosion and deterioration of biodiversity that cause serious problems for the development of productive processes in family farming systems in mountain areas of the province of Pinar del Río?

Objective: To implement a system of good agroecological practices that allow the development of agroforestry systems, the recovery and stability of the soils of slopes dedicated to family farming systems in mountain areas of the province of Pinar del Río.

Material and Methods

The research was carried out in an area with hilly relief, belonging to the slate heights of the Guanigüanico mountain range, specifically in the town of Ramón Gordo, at kilometer 8 of the highway to San Andrés, north of the Los Palacios municipality, the experience on the farm of the farmer Juan Alonso Hernández, known by Juanito, who is a member of the CCS F Alfredo Núñez, covering an area of 5 ha. The study area is located between 150 meters above sea level, between the following coordinates: North Latitude 24º 70 '05' 'and 24º 80' 00 " West Longitude 31º 20 '08' 'and 31º 30' 06 "

The climatic characteristics taken from the La Palma Meteorological Station show that we are in the presence of average annual temperature: Minimum = 17.4 ºC; Maximum = 32.8 ºC, Annual Total Precipitation: 1650.7 mm; Relative humidity: 76% Dry period: October - April, Wet period: May – September

After having carried out the study of the area, referring to the characterization of the soil (chemical and physical), topographic and climatic factors, as well as the determination of the main limiting factors of productive yields, we proceeded to carry out the design of a system of soil conservation and improvement measures, aimed at slowing down the accelerated degradation process of the same

An agroecological management system is built based on the following practices:

- ✓ Creation of an agroecological management design for the farm.
- ✓ They implement soil conservation technologies, with the design and layout of contour lines and the establishment of living barriers.
- ✓ Creation of agroforestry management areas
- ✓ Increase in the diversity of the farm's productions.
- ✓ Handling of organic fertilizers and green manures, with the use of compost using crop residues.
- ✓ Application of technologies for minimum tillage of soil with animal traction and contour lines
- ✓ Application of ecological pest management technologies.
- ✓ Philosophy of developing low-input technologies with a farm's natural resource management model

Results and Discussion

A relevant aspect is the improvement of the physical and chemical properties of soils. These results are shown in Table 1.

Properties	Initial diagnostic	Value with applied technologies 20 years later.
pH (KCl)	3,98	5.13
Organic material (%)	0,97	1.90
P_2O_5 (mg/100 grams)	5,02	6.91
K_2 O (mg/100 grams)	9,47	18.16
Ca^{++} (Cmol(+), Kg^{-1})	1,30	3.34
K^+ (Cmol (+). Kg^{-1})	0,14	0.35
Na^+ (Cmol (+). Kg^{-1})	0,02	0.4
Da (g/cm^3)	1,48	1.37
Dr (g/cm^3)	2,54	2.51
Porosity (%)	41,00	46.4

The organic matter content increased from 0.97% to 1.90% as a result of the applied technologies of conservation tillage, contour planting and the use of green manures, increased organic matter and improved structural porosity, infiltration of the water in the soil and the apparent density, coinciding with the results of (Chirino *et al,* 2020)

The cations and the percentage of saturation are determinants in soil fertility, and the results showed that there is a significant difference in the content of exchangeable cations between the fields at the beginning of the investigation and over the years, the values of Ca^{++} and K^+ in all cases where the technologies were introduced they reach a higher value.

It is observed that with the application of agroecological practices there is progress in the contents of organic matter, P_2O_5, K_2O, as well as the capacity to change bases and cation exchange, which express an increase in soil fertility due to management adequate of the same that decreased the degradation speed, as a result of the application of organic fertilizers, rotation and association of crops, use of green manures

Conservation technologies developed in the fields show changes in the physical characteristics of the soil, in the fields, once the agroecological agricultural practices have been developed, higher values are observed, as a result of the interaction of the increase in soil organic matter and the increase in its porosity that facilitates an improvement in the physical properties of the soil and the development of greater soil microbial activity.

With the practical application of integrated management with sustainable technologies, the nutrient balance of the soil was improved, erosion decreased and its fertility increased. A reduction in erosion of approximately 3 times was recorded with the use of agroecological practices and agroforestry technology systems under sloping conditions, evaluating erosion from erosive precipitations greater than 25 mm. The aggregation and stability of the soil structure increase with the content of organic matter, the infiltration rate and the capacity of available water in the soil increase, as well as the resistance against water and wind erosion, coinciding with works by Fernández- Betancourt et al, 2019.

The farm's production levels increase significantly when increasing from a production of only five (5), highlighting: cassava (Manihot esculenta), sweet potato (Ipomoea batatas), corn (Zea mayz), common beans (Phaseolus vulgaris) and rice (Oriza sativa), an increase of more than 25 agricultural productions is achieved together with the increase in yields due to the improvement of the properties of the soils, in addition to the introduction of fruit and forest trees in the agroforestry management of the farm, which allows a increase in the degree of conservation and biodiversity values, with the integral benefit for the agroecosystem, (Rivera *et al.,* 2020)

High biomass yields with vigorous initial crop growth promote rapid coverage thus protecting the soil from water erosion. Plants develop a more robust root system that keeps the soil in situ and allows rapid water absorption. Plants use the nutrients and water in the soil more efficiently and produce a greater amount of waste that further protects the soil against damage from wind and water erosion.

This entire process of implementing agroecological technologies based on soil conservation techniques, agroforestry management, crop rotation, ecological pest management and other applied technologies, allows a significant increase in biological diversity in the Agroecosystems.

Conclusions and Outlook

With the practical application of integrated management with sustainable technologies, the nutrient balance of the soil was improved, erosion decreased and its fertility increased. The results achieved show a reduction in erosion, by improving the chemical, physical and biological properties of the soil, increasing its fertility and the biodiversity of the agro-ecosystem, as well as a significant increase in agricultural production in the Family Farming Farm, thus allowing greater stability in the ecosystem and the family in their settlements without the need to migrate to other areas.

The integrated use and management of soil, water, crops and health, increased the yield and quality of the diversified and developed crops on the farm, achieving this result with a reduction of agrochemicals that minimize environmental contamination in the ecosystem under study.

The system of technologies of agro-ecological practices introduced increased profitability by 15.93% and reduced the cost per weight of production by 0.16%

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