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The Monoculture of Corn (Zea mayz) and its Impact on Fertility Soil

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Abstract---*The study determines the impact of corn monocultures on soil fertility, based on a rural corn farm located in the Jipijapa canton. The problem lies in the monocultures of corn as an agricultural activity in the San Bembe community, which causes a deterioration in the fertility of agricultural soils. An experimental field methodology was applied by taking several soil samples to determine macro and micronutrient content, pH, textural class of the soils, moisture content, etc. Low values were obtained in the content of organic matter of the soils, and nutrients such as phosphorus, particularly. It was possible to conclude that the levels of organic matter and phosphorus are very low, which constitutes an indicator of degradation of these soils, and low absorption of nitrogen in the corn leaves that affects the development of the grass.*
Keywords---*alkalinity, corn, fertility, monoculture, organic matter.*

Introduction

After wheat and rice, corn is the third most important crop in the world both in the area and in production. In developing countries, 82 million hectares are planted, with a production of 183 million tons. Corn provides 15% of the world's protein requirements and 19% of calories, being the staple food of hundreds of millions of people in Latin America, Asia, and Africa. By 2020, a change in global cereal demand is expected to occur. Demand for corn in developing countries will outpace the demand for rice and wheat. This change could be a 50% increase in global corn demand since 1995, with a level of 558 million tons to 837 million tons by 2020. And taking into account that acid soils cover a significant part of 48 developed countries and involve 1,660 million ha, it is necessary to search through genetic improvement of new cultivars that not only tolerate high aluminum saturation but are also efficient in the intake and use of P (Salazar, 2007).

Since the fields were intervened by the human being, either to carry outcrops, infrastructure works, or exploitation of resources in forest, mining and water areas; Soil loss became a constant and worrying problem, bringing with it important consequences, especially in agricultural land such as the loss of the thickness of the arable layer and the decrease in fertility, caused by a redistribution and loss soil, degradation of the structure and carry-over

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of organic matter and nutrients (Cajamarca & Macancela, 2008). The decrease in the productivity of agricultural soils is the most striking effect since in these soils the species that can be cultivated are limited to more than the farmer is forced to replace the deficient fertility of the soil with the use of chemical fertilizers to be able to maintain crop yields. To this can be added the expansion of the agricultural frontier, deforesting native forests especially in the highlands, where the cycle of erosion will continue in all aspects. All this to produce food to meet the needs of the home (Cajamarca & Macancela, 2008).

One of the negative effects on the soil is salinization that causes a decrease in biological activity. The reduction in the availability of nutrients, generating changes in the structure of the soil, which limits the development of crops (Avelino, 2018). The study of the soil is useful to determine production levels and predict possible shortage problems, this would help to establish suggestions for fertilization. The method to be used must be fast, effective, and low cost, in such a way that its nutrients can be widely reconstituted, and the agricultural activity is active and economically healthy. Soils with acidic characteristics are very scarce in phosphorus, calcium, magnesium, and potassium, which are essential for good vegetative nutrition and more so when the soils have high concentrations of organic matter, the available concentrations of phosphorus and nitrogen are also minimal. The drawbacks of demineralization, one of the ways to improve their quality and provide the scarce minerals in this type of soil with low pH, is the proper management using calcareous amendments, due to the neutralizing power they possess (Quispe, 2018).

Eggshell has always been considered a waste or waste. Which has generated the increase of these, in this research we will reuse these residues to improve the quality of soil due to its neutralizing effect; As well as agricultural lime is one of the ways to reestablish acidic soils, where it neutralizes the toxicity of soluble aluminum, disinfects the soil and at the same time is nourished with calcium (Quispe, 2018). The milpas (cornfields) have played a very important role in enriching our agricultural biodiversity. The corn-bean-squash association is found in the cornfields of almost all ecological zones, although the populations, varieties, races, and even species of these plants change, according to the environmental characteristics, customs, and culinary tastes of each human group. Just as there are many breeds of corn, there are five species of beans, four of squash, and countless varieties of these two plants that are planted in different arrangements within the milpa, to meet the needs of daily food, rituals, and special festivities. Up to 50 different species can be found, whether cultivated, sponsored, or tolerated (Aguilar et al., 2003).

In the milpa, each plant fulfills an ecological function. The corn-bean association is complementary, since the bean is a nitrogen-fixing plant that provides this nutrient to the corn, and the corn stalk provides support to the bean that is entangled in it to support and grow (Carrera et al., 2012). They are also complimentary due to the nutrients they provide, particularly in terms of amino acids, which when combined in the traditional diet provide a balanced diet. Pumpkin sown in the plot between corn and beans limits the development of weeds; with the shade of their large leaves glued to the ground, they help to keep moisture. The consumption of the seeds, guides, flowers, and tender or ripe fruits of the pumpkin provides carbohydrates, proteins, fat, vitamins, and fiber. The chili, which is often planted in the cornfield, allows better use of the space between plants, repels certain insects, and provides many vitamins (Aguilar et al., 2003).

Corn cultivation is one of the most important agricultural activities for peasant families in rural areas, for several reasons, among which the obtaining of food such as the traditional balanced one stands out for raising of birds, both fattening and creole (Oramas & Vivas, 2007), it is also used as one of the most widely used forages for feeding ruminants since it has a high yield potential per sown area, its use, Mainly as silage, it includes the whole plant, being of excellent fermentative aptitude. Due to the high digestibility of the dry matter, high content of non-structural carbohydrates, and low fiber, it has the highest energy level among the preserved forages, placing Manabí in third place as the Province that is dedicated to the cultivation of corn (León et al., 2018). The problem that arises in the San Bembe enclosure, La América parish of the Jipijapa canton, is the low yield of corn per hectare, which has been decreasing, if the causes have been determined for which this decrease in production occurs, it is believed that This situation arises from observing the erosion of the soils, where it is most likely that the fertility of the soils is being lost because, in the San Bembe enclosure, farmers have been dedicating themselves exclusively to the monoculture of corn for decades. As such, the objective of the study is to determine the impact of corn monoculture on soil fertility (Widarma & Setiawina, 2019; Sari & Sjah, 2016).

Materials and methods

The research was carried out in the farm owned by the Lesscal Sancán family, located in the San Bembe community, La América parish, Jipijapa canton, Manabí province, geographically located at coordinates 1 ° 25´53´´S; 80 ° 34´5´´W, with an elevation of 316 meters above sea level; the terrain is slightly flat topography, the soil texture is

silty (Piotto, 2008; Dam et al., 2005; Strom et al., 2020). Environmentally, it is located in the semi-humid tropical mega-thermal and tropical mega-thermal dry climatic floor, it has precipitation that ranges from 1,000 to 1,300 millimeters per year. The average annual temperature is 22 ° C between July, August, and September, and 25 ° C in February, March, April, and May. Evapotranspiration is 1,300 to 1,450 mm, which leads to a water deficit between 500 to 625 mm per year (PDOT-PARROQUIAL, 2015).

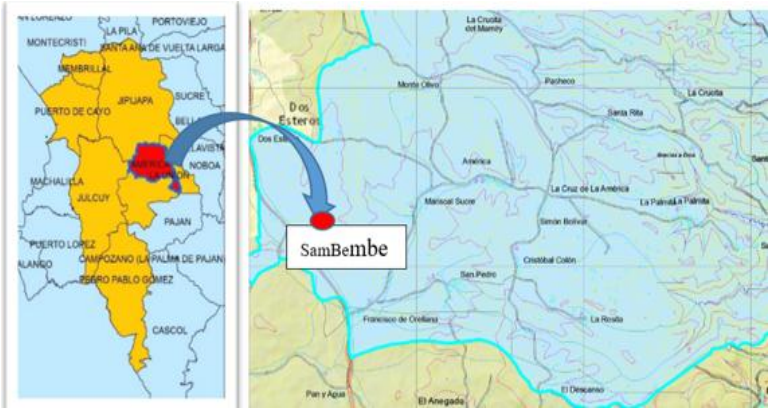

Figure 1. Geographic location of the La América parish and experimental location, San Bembe community
Source: (PDOT_Jipijapa, 2015)

Regarding the materials used in the research, they are described in table 1.

Table 1
Materials used to obtain the soil sample

Description	Quantity
Machete	2
Hole	1
Shovel	1
Bar	1
Sheaths	6

openerSource: Alcívar et al. (2021)

The machete is a short, edged tool used in agriculture for various uses. It was used to clean around the edges of the hole to get subsamples out of the ground. The manual hole opener was used for a depth of 30 cm wide by 30 cm deep and to obtain the soil sample, the shovel is an instrument composed of a cylindrical, long wooden support, a metal plate, it was used to collect and mix subsamples. The bar is a large, prismatic, cylindrical, thick, and heavy metal instrument used as an aid to open the holes and deteriorate the clods. The sleeves were used to locate the subsample and soil sample. The labels were used as an identification card to locate all the data referring to where the sample came from. A bibliographic review related to the subject was carried out, which allowed us to know antecedents of how monoculture has affected and the growing agricultural frontier of the environment, evidencing itself as problematic affectations in the ecosystem, flora, and fauna (Avelino, 2018; Ali et al., 1996).

Experimental field research was used to take soil samples, under the Zigzag method to take to the laboratory and determine the different nutrients, both primary, secondary, organic matter and pH and soil texture, following ordered and sequential steps such as cleaning of the land where the sample was taken, removal of the soil with the support of a bar, opening holes with the use of the hole opener, 30 wide by 30 deep, taking the sample by introducing the machete through the walls of the hole, Taking 1Kg subsamples, placing them in a plastic sleeve, mixing the 5 subsamples with the support of the Shovel, weighing (1 Kg), placing the identification label and sending them to the laboratory (Gardner et al., 1981; Coşkun et al., 2006). The application of the analytical method facilitated the interpretation of the results obtained in the laboratory.

Analysis and discussion of results

According to the results obtained from the soil analysis taken from the research area, organic matter (OM) is found with a percentage of 2.1%, about calcium (Ca), expressed in 5.8 mg, in the same way, it is found potassium (K) at 4.31 mg; The humidity is 15.8%, as for the texture it is classified as silty loam, this is due to the silt being found in 66% is the value with the highest representation, followed by sand with 18% and clay with 16% ., shown in table 2.

Table 2
Content of organic matter (OM), humidity, and a textural class of the soil

% MO	Ca Mg	Mg K	Ca + Mg k	Humidity (%)	Texture (%) Sand	Silt	Clay	Textural class
2, 1	5.8	4.31	29.31	15.8	18	66	16	Silty Mud

Source: Alcívar et al. (2021)

According to the results, the pH of 7.6 indicates that the soil is slightly alkaline, finding the presence of ammonia at 23ppm (parts per million) which is considered medium level (Behnke et al., 2020; Altieri & Nicholls, 2003). Regarding the essential nutrients of the soil, it contains 10 ppm of phosphorus, considered of medium level; potassium (K) in a high concentration of 0.72 meq / 100ml (milliequivalents per 100 milliliters); 18 meq of calcium (Ca) which is a high concentration; 3.1 meq of magnesium (mg) which is high too; an average concentration of 15 ppm of sulfur (S); an average concentration of 5.5 ppm of zinc (Z); a high concentration of 4.9 ppm of copper (Cu); iron (Fe) at a high concentration of 135 ppm; manganese (Mn) at a high concentration of 17.9 ppm, and boron (B) at an average concentration of 0.69 ppm, which can be shown in detail in table 3.

Table 3
Determination of soil and nutrients

pHpH	Ppm NH4	P	meq / 100ml K	Ca	Mg	Ppm S	Zn	Cu	Fe	Mn	B
7.6	23	10	0.72	18	3.1	15	5.5	4.9	135	17.9	0.69

Source: Alcívar et al. (2021)

In the study by (Arriechel & Mora, 2005) they found organic matter deficiency up to 1.15% in acid soils and 1.27% in alkaline soils planted with corn monoculture, which is very low. In the present study, the soil analyzes reflected an organic matter content of 2.1% in soils cultivated with cornfields, which is particularly low. A close relationship can be evidenced in both studies, which means that corn monocultures mainly affect soils, reducing the content of organic matter. In the research of (Contreras et al., 2005), a decrease in organic matter was obtained up to 0.78% average in cornfields, which were also affected by the loss of phosphorus up to a value of 4 considered as low. In the present investigation, the levels of phosphorus in soils cultivated with corn decreased to a value of 10 considered as a medium. It is not possible to show a close relationship with the indicated results, since the values of organic matter and phosphorus content differ significantly, due to the edaphoclimatic conditions, in both cases.

Conclusions

Corn monocultures lead to soil degradation, evidenced by the decrease in organic matter content, which consequently causes a decrease in other nutrients (Fiorini et al., 2020; Mann et al., 2002). The problem of the reduction of organic matter in slightly alkaline soils can cause substantial loss of micro and macronutrients. The decrease in organic matter in corn crops causes a deterioration in the absorption of nitrogen in the leaves of the cornfields, in the decrease in phosphorus, and therefore affects the reduction of the productivity of the crop.

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References

Aguilar, J., Illsley, C., & Marielle, C. (2003). Maize agricultural systems and their technical processes. *Without corn, there is no pea* , 83-122.

Ali, Y., Hanna, M. A., & Chinnaswamy, R. (1996). Expansion characteristics of extruded corn grits. *LWT-Food Science and Technology*, *29*(8), 702-707. https://doi.org/10.1006/fstl.1996.0109

Altieri, M. A., & Nicholls, C. I. (2003). Soil fertility management and insect pests: harmonizing soil and plant health in agroecosystems. *Soil and Tillage Research*, *72*(2), 203-211. https://doi.org/10.1016/S0167-1987(03)00089-8

Avelino Carhuaricra, CG (2018). Application of biofertilizers for the recovery of soils degraded by. salinity in the district of Huachipa-Lima.

Behnke, G. D., Zabaloy, M. C., Riggins, C. W., Rodriguez-Zas, S., Huang, L., & Villamil, M. B. (2020). Acidification in corn monocultures favor fungi, ammonia oxidizing bacteria, and nirK-denitrifier groups. *Science of the Total Environment*, *720*, 137514. https://doi.org/10.1016/j.scitotenv.2020.137514

Cajamarca, J., & Macancela, W. (2008). Evaluation of the dynamics of soil particles by means of micro-topographic profiles. Cuenca: University of Cuenca.

Carrera-Garcia, S., Navarro-Garza, H., Perez-Olvera, MA, & Mata-Garcia, B. (2012). Mazatec agricultural calendar, milpa and peasant dietary strategy in the territory of Huautepec, Oaxaca. *Agriculture, Society and Development* , *9* (4), 455-475.

Castillo-Nazareno, U. H., Matute-Petroche, J. S., & Alcívar-Avilés, M. T. (2021). Extended Quality Processes in Internationalized Agro-Industrial. Rural Collaborative Economy: Capital Accumulation and the Association of Small Farmers. In *Quality Management for Competitive Advantage in Global Markets* (pp. 81-94). IGI Global.Arrieche, L., & Mora, O. (2005). Effect of applications of organic residues on maize performance in two soils of Yaracuy State, Venezuela. *BIOAGRO* .

Contreras-Hinojosa, J., Volke-Haller, V., Oropeza-Mota, J., Rodríguez-Franco, C., Martínez-Saldaña, T., & Martínez-Garza, Á. (2005). Reduction of corn yield due to soil erosion in Yanhuitlán, Oaxaca, Mexico. *Terra Latinoamericana , 23* (3), 399-408.

Coşkun, M. B., Yalçın, İ., & Özarslan, C. (2006). Physical properties of sweet corn seed (Zea mays saccharata Sturt.). *Journal of food engineering*, *74*(4), 523-528. https://doi.org/10.1016/j.jfoodeng.2005.03.039

Dam, R. F., Mehdi, B. B., Burgess, M. S. E., Madramootoo, C. A., Mehuys, G. R., & Callum, I. R. (2005). Soil bulk density and crop yield under eleven consecutive years of corn with different tillage and residue practices in a sandy loam soil in central Canada. *Soil and Tillage Research*, *84*(1), 41-53. https://doi.org/10.1016/j.still.2004.08.006

Fiorini, A., Boselli, R., Maris, S. C., Santelli, S., Ardenti, F., Capra, F., & Tabaglio, V. (2020). May conservation tillage enhance soil C and N accumulation without decreasing yield in intensive irrigated croplands? Results from an eight-year maize monoculture. *Agriculture, Ecosystems & Environment*, *296*, 106926. https://doi.org/10.1016/j.agee.2020.106926

Gardner, B. R., Blad, B. L., & Watts, D. G. (1981). Plant and air temperatures in differentially-irrigated corn. *Agricultural Meteorology*, *25*, 207-217. https://doi.org/10.1016/0002-1571(81)90073-X

León, R., Bonifaz, N., & Gutiérrez, F. (2018). *Pastures and forages of Ecuador Sowing and production of pastures* .

Mann, L., Tolbert, V., & Cushman, J. (2002). Potential environmental effects of corn (Zea mays L.) stover removal with emphasis on soil organic matter and erosion. *Agriculture, ecosystems & environment*, *89*(3), 149-166. https://doi.org/10.1016/S0167-8809(01)00166-9

Oramas-Wenholz, C., & Vivas-Quila, N. J. (2007). Evaluation of two hybrids and one variety of corn (Zea mays) in intensive crop and association with pean (Phaseolus vulgaris), for silage. *Revista de la Facultad de Ciencias Agropecuarias*, *5*(1), 28-35.

PDOT_Jipijapa, S. (2015). Development Plan and Territorial Organization. Document, SENPLEDES - GAD CANTONAL JIPIJAPA, Jipijapa.

Piotto, D. (2008). A meta-analysis comparing tree growth in monocultures and mixed plantations. *Forest Ecology and management*, *255*(3-4), 781-786. https://doi.org/10.1016/j.foreco.2007.09.065

Quispe Abad, YE (2018). Eggshell application in an acid soil of Atalaya to increase production Zea mays, 2018.

Salazar, A. (2007). Inheritance of tolerance to low phosphorus in inbreeding lines of cimmyt maize tolerant to acid soils. Palmira: National University of Colombia.

Sari, M., & Sjah, T. (2016). Implementation of Special Program of Pajale (Rice, Corn and Soybean) in Terara District, East Lombok Regency. *International Research Journal of Management, IT and Social Sciences*, *3*(9), 49-60.

Strom, N., Hu, W., Haarith, D., Chen, S., & Bushley, K. (2020). Interactions between soil properties, fungal communities, the soybean cyst nematode, and crop yield under continuous corn and soybean monoculture. *Applied Soil Ecology*, *147*, 103388. https://doi.org/10.1016/j.apsoil.2019.103388

Widarma, G., & Setiawina, N. D. (2019). Factors of influencing household production and welfare of corn farmers. *International Research Journal of Management, IT and Social Sciences*, *6*(1), 103-112.