Local Farmers' Perception of Soil Health for Long-Term Sustainability in the Madre de Dios Region of Peru

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Abstract

In the Peruvian Amazon Rainforest, soil is an indispensable resource. Local farmers' knowledge of the soil is crucial for the long-term sustainability of the rainforest because they directly impact soil health and depend on this resource economically. Knowledge and information about how soil is treated can be correlated to how soil is used as a resource leading to a more comprehensive view of agriculture in the region. This study focuses on local farmers' perception of soil health in relation to the long-term sustainability of the forest and agriculture in Madre de Dios, Peru. Through firsthand interviews with farmers, inferences about sustainability were drawn, and a more qualitative and quantitative understanding of soil was gained. Most farmers did not directly state that soil health was an important factor in farming, but their actions directly correlated to proactive behavior in relation to protecting their soil. Soil perception in the region shows that soil is viewed as valuable and that the land must be preserved for following generations, yet scientific knowledge of soil is lacking.

Introduction

Soil is the upper layer of earth, which is composed of organic matter, clay, and rock particles. Soil is very important for plants and humans alike because it provides ecosystem services for humans, anchors plants by holding their roots and provides plants with critical nutrients for growth. Soil helps control flooding by regulating excess rainwater, safeguards, and filters against pollutants by protecting water quality, and helps mitigate greenhouse gas emissions through carbon sequestration. Farmers depend on ecosystem service provisions from soil such as water and nutrient cycling for the productivity of their crops (Marquardt et al., 2012). Yet, humans have an incredible capacity to disrupt ecosystems, thereby interfering with normal biochemical cycling, soil biota, and its composition (Barrios, 2007). When soil contains naturally occurring micro and macro-organisms, we call that healthy soil. In recent decades, land-use changes have had significant impacts on bacterial communities within the soil; changing the composition of organic matter, altering carbon and nitrogen and pH levels, and effecting microbial populations which all impact soil productivity (Mendes et al., 2015) and therefore soil health.

Only 4% of land is composed of productive/ fertile soil in Peru. The Amazon, contrary to what would be expected, has the smallest proportion of this fertile land despite occupying more than 60% of the territory (Pokorny et al., 2021). The most common soil order, a classification of soil condition, in the Amazon basin is Ultisols (Sanchez et al.,

1982). Ultisols are highly weathered soils with high acidity and low base saturation levels (Benítes, 1981). Since soil in the Amazon is classified as acidic, highly weathered, and generally low in available nutrients, much of the nutrients in the ecosystem are found in its biomass (Marquardt et al., 2012).

Anthropogenic pressures on soil due to clearing for livestock, agricultural fields, and gold mining are among the most common land-use changes in forest areas. Specifically, in agriculture, unfertile soils are being further degraded due to high demands in farming (Farella et al., 2006). For example, when farmers do not allow enough time for soil to fallow, nutrients cannot be replenished therefore putting the farmers in a position of working on infertile soil or cutting down more forest for usable soil (Marquardt et al., 2012). With an increase in food demand, agriculture in the Amazon is necessary, however, it requires control and technical support to prevent deforestation on a greater scale.

Farming is also relativity new in the Amazon. Farmers learn predominantly through experience, but their experience is limited; in this study the oldest farm was only sixty years old. The real implication of farming this land is probably not evident yet. There is also an absence of resources from the government to help farmers learn the basics leaving many without proper guidance.

This project explores local farmers' knowledge of soil health to assess sustainable agriculture in one of the most biodiverse areas on earth. The need to understand local people's perception of soil is critical when looking at the long-term sustainability of the rainforest. By understanding local knowledge of soil degradation, a foundation of information can be established that is specific to this region. It will hopefully provide understanding of the gaps in local knowledge so future management plans and implementation of a sustainable development system can be developed.

Methods

Study site

The study was carried out in Southeastern Peru, in the Madre de Dios region. The dry season occurs from May to October, with the driest months being August and September, while the wet season is November to April. Small-scale and large-scale farming are both present in the region; some farmers grow crops for their family while others grow crops for markets locally and for the closest and biggest city, Puerto Maldonado. Interviews were carried out in three small towns in the region: Planchon, Primero de Mayo, and Monterey. One interview was also conducted at the Alliance for a Sustainable Amazon (ASA) field site at Fincas Las Piedras. Interviews took place at properties where agriculture plots were located, a farmer's market, or farmers' houses in town. An additional interview was conducted with a local expert in the region, Juliet Danielle Aranibal Luna, who has been implementing agroforestry systems throughout the area as part of the NGO Caritas in Madre de Dios for two and a half years. Interviewees agreed to provide their information for research purposes through a consent form.

Interview questions

Interview questions for both farmers and the expert were created alongside Johana Reyes, the Director of ASA Peru and community social-psychologist, and Consuelo Alarcón, the Academic Programs Coordinator at ASA Perú. Each interview ranged from 20-

60 minutes and all answers were confidential. The only interview that was not confidential was one conducted with Juliet Aranibal, who has consented for her name to be publicly used. The interview questions for the farmers focused on three sections: basic information, productivity, and perception of soil. The interview questions for the local expert were different than the questions for farmers. Still, they had the same themes in the questions: general questions, specific questions concerning implementing agroforestry, and perception of soil.

Of the fourteen total farmers interviewed, one farmer was not farming in the Madre de Dios region, so their answers were eliminated from the study. Another farmer who rented their property from a new individual every year had their responses eliminated as well; their answers could not accurately be compared to the other farmer's responses because they had not farmed the same soil over a prolonged period of time. Therefore, only 12 farmers were accounted for in data analysis.

Data Analysis

Based on general information provided at the beginning of each interview, the amount of forest loss and agricultural expansion was calculated. The common land uses in the region are forest, agricultural field, purma[1] and grassland. With the objective of quantifying the disturbances, proportions for each land use were obtained from the interviews. Using the total proportions of all the groups except for forest, the proportion for disturbance of land was created for the past and present. The percentage of forest change was found by subtracting the past forest proportion from the present forest proportion. The number of hectares of changed forest and years of ownership were compiled. Therefore, we were able to extrapolate, rate of forest loss by dividing hectares of changed forest by years of ownership.

Values calculated for disturbances are approximations, given that two out of the 12 farmers did not provide enough data to explain their land-use changes. The same process was done for agricultural expansion, which is land that is actively being used for agriculture. The percentage of agricultural expansion was determined by dividing the proportions of agriculture in the past to the proportion of agriculture done in the present. Hectares changed to agriculture were recorded from the interviews as well as years of ownership. The rate of agricultural expansion was determined by dividing hectares changed to agriculture by years of ownership.

Results

General Questions

The perception of soil by local people is presented based on interview data of 12 farmers of the study site and a local expert on

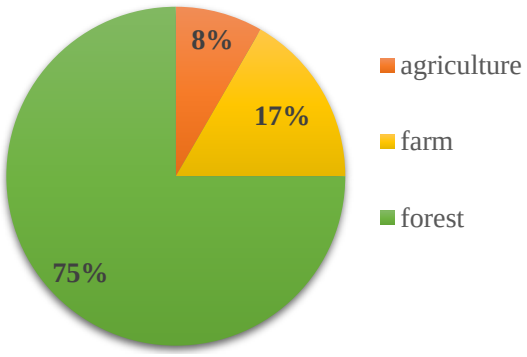

Figure 1: Land use before the property was acquired.

[1] Young Forest

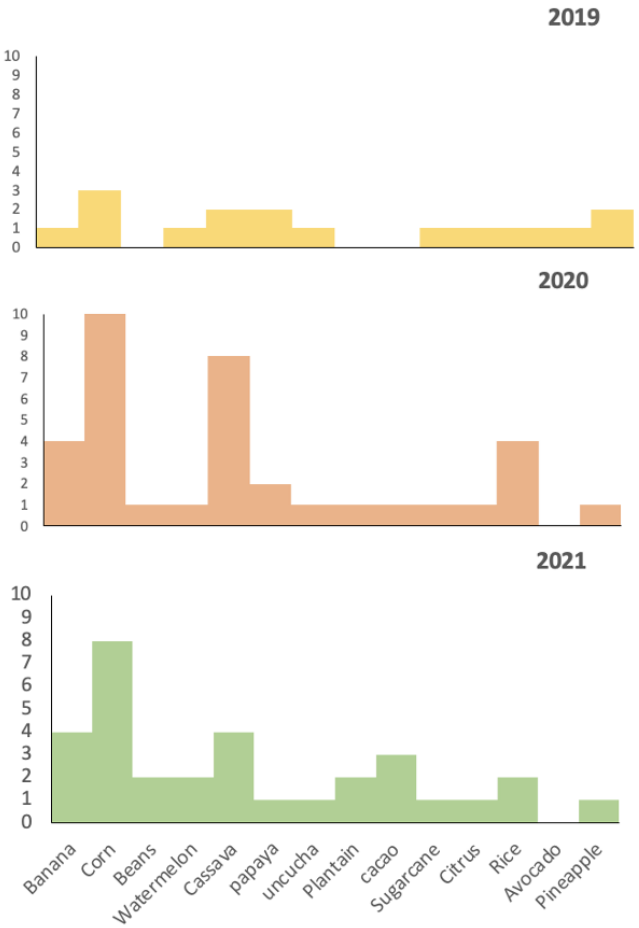

Figure 2. Common crops planted in the past three years.

agroforestry systems for further comments. Farmers' plots varied widely in size, with a maximum of 96 hectares and a minimum of 2.5 hectares (X=42.46 hectares, SD=25.79, n=12). The agricultural lands were owned for a maximum of 60 years and a minimum of 6 years (X=29.64, SD=15.96, n=12).

The majority of farmers reported that, before their farming, forest was the initial condition of their land; very few started from an already cleared agriculture field (Fig. 4.1a). The average rate of forest loss was 1.04 hectares per year (SD= 1.93 hectares per year, n=10). The minimum number of hectares lost per year was 0.00 hectares, with all the forest already being cleared, while the maximum

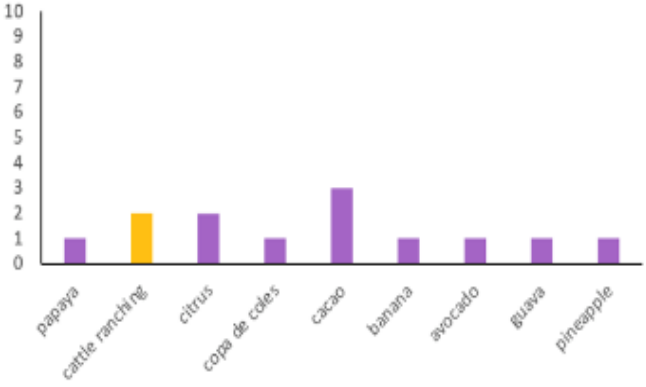

Figure 3. Land use that farmers want in the near future. Purple bars for crops. Yellow bar for the only non-crop.

number of hectares lost per year was 6.43 hectares. The average rate of agricultural expansion was 0.46 hectares per year (SD= 0.87 hectares, n=10). The minimum number of hectares gained for agriculture was 0.00 hectares, while the maximum number of hectares gained for agriculture was 2.86 hectares.

The crops farmers had grown for the last three years was recorded, as well as crops the farmer would like to plant in the future (Fig. 3). The most common reason for changing crops was a decrease crop market value (Fig. 4)

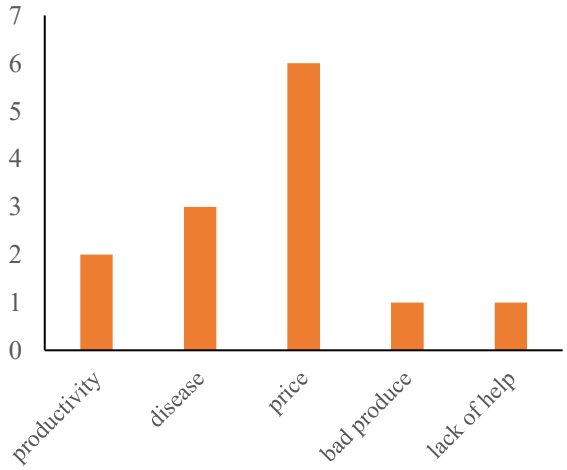

Figure 4: Reasons farmers changed their crops

Productivity Questions

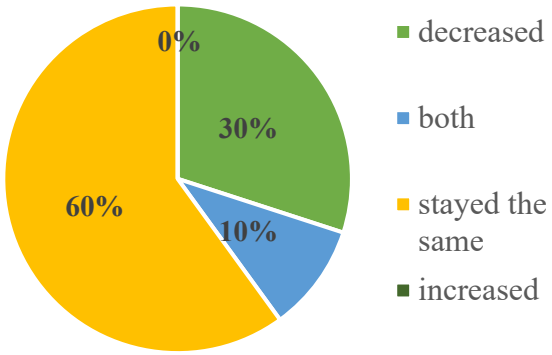

Figure 5: Productivity fluctuations. The category that says "both" is when the farmer answered that some of their crops decreased while others increased.

Productivity in this study is defined by increase or decrease in crop yield. 60% of farmers said their productivity stayed the same, 30% said their productivity decreased, 10% said their productivity both increased and decreased depending on crop, while 0% said their productivity increased (Fig. 5). Two farmers were not asked this question; one reported on their first harvest with no basis of comparison and the other had planted fewer crops than previous years.

When asked, nine out of the 11 farmers answered that their crops were not growing as well as they would like (Fig. 6). When asked why they did not grow as well, 28% said lack of water, 27% said disease, 18% said no rest to land, 9% said soil was damaged, 9% said friajes[2], and 9% said fires. Two answered no, their crops are going as they would like. One farmer did not answer this question.

Nine out of 12 farmers reported that they moved crop placement when they noticed a crop wasn't growing, two farmers said they did not move crop placement regardless of crop growth, and one farmer did not answer. Of the farmers that said yes, four farmers said they cleared a new piece of land using slash and burn, two farmers said they moved the crop to a piece of land with nitrogen fixers, two said they moved the crop to an empty plot that has already been cleared, two said they moved the crops to a location with purma[3], while one said they let the land rest.

Seven out of the 12 farmers used fertilizer and nine out of the 12 used pesticides. Two farmers did not use fertilizer or pesticides. Seven of the 12 farmers go to the agroveterinaria[4] when they need advice on when to use fertilizer and pesticides, two farmers get advice from family and friends, two farmers have previous personal knowledge, one farmer looks at the directions on the bag, while two farmers get advice from agricultural engineers. Farmers said that they use fertilizers and pesticides in varying amounts. When asked how often fertilizer was used, two farmers said every year, one farmer said every three years, one farmer said when the plant is little, one farmer said they use it when needed, and one farmer said when their engineer said so. Four farmers did not answer this question. When asked about pesticides use, two farmers said every year, one farmer said they've used pesticides for the past three years, one farmer said when the engineer says so, and one farmer said three to four times a year. Five farmers did not answer this question, while two said they do not use pesticides.

[2] Cold front
[3] Young forest
[4] Agriculture store where farmers can buy products and receive help from sellers

Perception Question

Importance of land was noted by 11 out of the 12 farmers. Four of the 12 farmers said their land was important because it represented family, three farmers said it provides food, two farmers said it was valuable, one farmer said it gives him a job, one farmer said it provides opportunity for the future. The one farmer who said that the land was not important reasoned that they were old and that the land was becoming a lot of work.

When asked about how farmers felt towards their land, eight farmers said they were not worried that their land would not produce, while four said they were worried. Reasons farmers were not concerned with production were: two farmers said, 'the land would always be able to produce', two farmers said they are improving the land, one farmer said no one has had that problem yet, one farmer said, 'it's the Amazon and everything grows here', and two farmers did not give a reason. The four farmers that were concerned with production reported as follows: one farmer said they know the land can be unproductive, one farmer said disease and fire are problems, one farmer said they had bad productions in the past, and one farmer did not give a reason. All farmers said that they wanted their kids or family to use the land after them. Four farmers said that they were planting nitrogen fixers like kudzu[5], mucuna[6] and copoazú[7] to help the soil stay productive, two farmers said they were fertilizing (both organic and inorganic methods were mentioned), one farmer said they were letting the land rest, and one farmer said they were planting timber trees around the property to protect the property from fires. Two farmers did not answer, one farmer said that they were doing nothing, and one farmer was not asked because they were not planning on farming in future years.

Discussion

General Perception

This research focused on exploring the level of knowledge possessed by local farmers regarding soil health and its importance in Madre de Dios. After completing the interviews with farmers in Madre de Dios, inferences can be made about the knowledge and perceptions of local farmers as well as some trends on agricultural practices. The

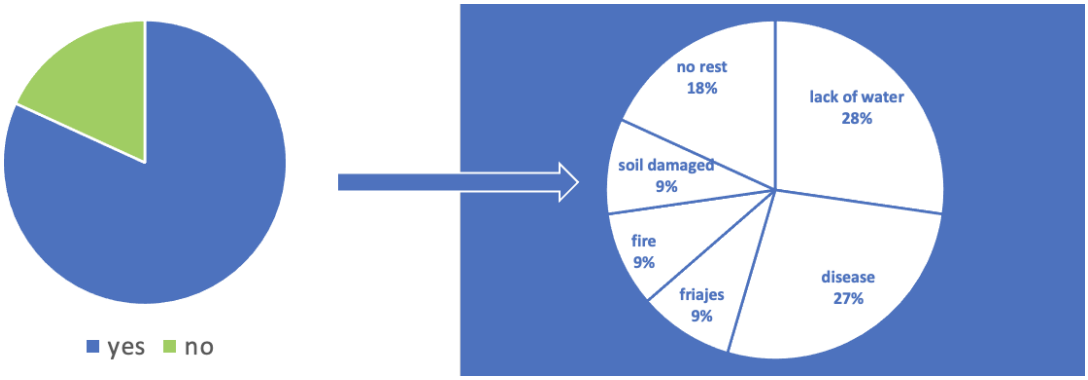

Figure 6: Question if farmers think their crops are growing as well as they would like (left). Reasons farmers think their crops are not growing well (right).

[5] Group of vines native to East Asia, Southeast Asia, and Pacific Islands but an invasive species in other parts of the world

[6] Mucuna pruriens is a tropical legume native to Tropical Asia and Africa

[7] Theobroma grandiflorum, also known as copuazú is a tropical rainforest tree related to cacao

overall answers suggest that the local level of scientific knowledge of soil was minimal, but general perceptions of fertility and soil type were correct. No farmer knew about the essential ecosystem services performed by soil, soil biota, micro and microorganisms or the fact that soil is a living organism on its own.

If productivity was a problem, the main reason they thought crops were not growing well was lack of water and the presence of disease, not soil health. It is important to note that agriculture has not been practiced for many years in the area; therefore, productivity may not be perceived as a serious problem yet because the soil is fairly new compared to area where farming has been practiced for hundreds of years.

Additionally, farmers are conscious of the soil type present in the region, given that they assume their soil is of poor quality and lacking nutrients. Juliet Aranibal, the local expert, did note that the soil in this region is between 4 or 5 on the pH scale, which is acidic.

Perception of Emotional Connection to Land

A strong emotional connection to the land was found in most people interviewed. The value of the land and its importance were related to family ownership, food provision, investment, job, or the opportunity for the future. Farmers reported that they care about their land. The most popular answer has to do with maintaining a sense of family connection.

The second most popular response had to do with food security, which is important for many because, without their land, they may not be able to feed their families. Another popular answer was that it was valuable and provided the farmer with a job. The land represents income and a way for his family to survive. The farmer who rented their land did not develop strong ties to the land and was not invested in its long-term quality. They were disconnected and when asked the value of the land, they stated that they use the land and pay. It can be inferred that this is because they don't own the land, thus they may not care about how the land fairs in the long-term. Yet overall, most farmers expressed care and gratitude for the land they farmed.

Efforts to Improve Soil Health for Future Generations

Eight of the 12 farmers did mention that they needed to take care of the soil for the following generations. They planted nitrogen fixers to improve soil quality, used fertilizers to enrich the soil further, or let the land fallow to regain nutrients and organic matter. The three nitrogen fixers mentioned were kudzu, mucuna and copuazú.

No one initially stated that soil health was their reasoning for a decrease in productivity, but their solutions for the future were inherently related to soil health. Their thoughts for the future were also important since it showed that farmers were thinking about the productivity of the land and want the land to remain healthy for years to come; they have the longevity of the land in mind. Even if the farmers perceived the soil as dead and unfertile, they were taking small steps to improve soil quality. If they can improve the soil they now have, then the need to cut down more forest may become less attractive because the farmers will be able to work with the land they already have. Thus, deforestation in the region and workload on farmers will decrease. This will keep more ecosystems intact and enable future generations to experience the forest, its significance, its benefits, and its history.

Impacts of Fertilizer, Pesticides and Fire

Juliet Aranibal, a local expert implementing agroforestry in the region, mentioned that many farmers see the soil as a dead organism; they view it as something that they need to add fertilizers and pesticides to so bad events can be avoided. This is important because fertilizers and pesticides impact soil organic carbon content, pH, moisture, and activities of soil enzymes. They directly affect substrate availability in the soil, which indirectly affects population dynamics in soil communities in negative ways (Prashar & Shah, 2016). Fires also impact some macro and microorganisms in the soil, which are essential for organic material needed nutrient availability. Slash and burn, and fires in general, are used in this region to clear the land from forest to purma to grass; fires may be more detrimental than beneficial. This is very important to note because soil organism communities have a direct and indirect positive impact on productivity (Barrios, 2007). Fire, pesticides, and fertilizers may harm key organisms that help increase productivity and soil fertility. These organisms help with processes that humans cannot do and are free. These processes include nutrient cycling, soil structure modification, decomposition of organic matter and pest and disease control (Barrios, 2007). Soil is a living organism. It is vital for farmers to understand that protecting and nourishing the soil, enable it to remain fertile and healthy for the benefit of current and future generations. A positive feedback loop of farmers taking care of the soil, the soil taking care of them is vital for the future of agriculture everywhere but especially in a place where the soil is infertile to begin with. If farmers act proactively, then they can start to mitigate problems.

Land Use Change

The rate of forest loss shows that the forest is being converted to other land-use at about a hectare per year per farmer. In comparison, the rate of agriculture expansion is almost half a hectare per year per farmer. The rate of agriculture expansion does not match the rate of forest loss because farmers stated that they would sometimes clear forest and not use all the land they cleared. In all situations but one, there were no outside investors. The one farm that did have an investor allowed the farmer to use all the cleared land compared to farmers that did not have investors. The outside investor provided money to afford a workforce and irrigation infrastructure. This farmer had the highest rate of agricultural expansion with 2.86 hectares per year. That farm also had the highest rate of forest loss with 6.43 hectares per year. This situation shows that if there is money to invest, the land can be used more efficiently for agriculture. Two of the farmers interviewed also complained that the ministry of agriculture in the region does not provide them with enough resources or support. This is a problem because if farmers are not being educated or being given the resources they need, then they will not be able to adopt sustainable practices and ensure the longevity of the land.

Productivity

In terms of productivity of crops, 30% of farmers said their crop yield decreased. The reasons individuals said crops were not growing well were disease, lack of water, no rest to soil, damaged soil, friajes, and fire. Some of the farmers who said that their production decreased had some perception of soil deterioration; they noted that the soil is damaged and is not given adequate time to regenerate nutrients. Lack of water was also

one of the more popular reasons why crops were not growing well because many farmers did not have irrigation infrastructure. The interviews were also conducted in August and September, some of the driest months of the season, leading to their crops being exposed to very dry and hot weather. 60% of farmers said that their productivity stayed the same; some reasons for this may be that fertilizers are helping the soil produce and farmers are not noticing a decrease in productivity. Another reason could be that farmers are clearing forest and using newer soil. Yet, a challenge that could arise in the future is that with too much fertilizer and pesticides, the soil can become too toxic for plants.

Most farmers reported that they changed their crops because of price and disease. Price dictates why certain crops are grown over others because popular crops are more profitable. Disease was another problem reported because disease kills crops and then farmers have nothing to sell, leaving the farmer in financial danger and putting the family at risk for food security. Productivity was the third most popular reason, if the productivity of a particular plant or type of plant is lesser than that of another plant then the farmer said that they would switch the crop from one to the other. The hybrid seeds of corn and watermelon would produce much more compared to the common seed. One farmer said that with the common seed of watermelon, they would get 5,000 kilos per hectare, while with the hybrid seed, they would get 30,000 kilos per two hectares. This stark difference in production and profit are the main reason farmers chose certain crops over others.

Solutions for the Future

A way to combat the problems these farmers are facing would be to implement agroforestry systems in the future. Juliet Aranibal says that agroforestry helps agriculture systems become more resistant to changes caused by climate change like extreme droughts or heat. The combination of planting crops with trees has two important benefits: pest control and enrichment of the soil due to biodiversity, compared to a monoculture. This type of system helps with pest control and disease devastation since pests and diseases that infect one plant will not infect and kill others. Juliet Aranibal also said that farmers in monoculture systems might need to increase their dependence on fertilizers and pesticides since they want to increase their yield and protect against pests. Yet this can lead to the soil becoming dryer and more depleted because of all the chemical additives, impacting soil populations. Crops growing in depleted soils are increasingly weaker because of poor nutrition. There is a vicious cycle of using more chemicals that leads to crops becoming weaker and weaker as a result (Barrios, 2007).

In agroforestry plots, different types of crops are planted: short, middle, and long-term crops. The different crops create shade and help with organic material, therefore not drying out the soil. Juliet Aranibal also mentioned that by growing so many types of plants, the farmers will benefit from trees such as cacao and copuazú that yield fruit on a yearly basis. In agroforestry systems, crops are harvested at different times, the short-term crops like watermelons and cucumbers are first, and middle and long-term crops would follow. Lastly, the trees that are planted, are for the next generations. Therefore, not only do agroforestry systems offer hope to the future of farming but also provide several remedies to current complaints of farmers; enhancing soil

fertility, encouraging nutrient cycling, reducing soil erosion and desertification, improving water quality, and increasing biodiversity (Arévalo-Gardini et al., 2015). These systems are sustainable and sequestering carbon. As we now know, the Amazon is no longer a carbon sink but a carbon producer. Integrating these systems seems to be a bright idea for the future since they will improve soil conditions.

There is some opposition to the implementation of agroforestry. Many farmers do not want to implement agroforestry systems because they think they are not profitable enough. These systems take a few years to become profitable and productive, therefore they are not desirable since farmers need to profit from their crops and provide food to their families immediately. Yet, in monoculture systems, farmers get very good production for about six years but then production starts to decline. There is an increase, peak, and decrease. The production goes up very fast and farmers cannot maintain the production for long. But with an agroforestry system, production slowly increases over time and plateaus, productivity is maintained over a longer period of time. Caritas, the company Juliet Aranibal works for, is trying to work with farmers to explain that the midterm and long-term crops can be a legacy for them and their families. Even if agroforestry plots take several years to become productive, they are economically viable for farmers in the long term.

Based on interviews with local farmers and an expert working in the region, the Madre de Dios region in Southeastern Peru needs more educational programs that focus on the soil health and how it can be improved. The increase of knowledge of soil is necessary for the longevity of land in a sustainable and manageable way. This paper sets the foundation for future exploration on perceptions of soil and promotes more research to be done on farming practices in the region.

Conclusions

The level of knowledge of soil health in the Madre de Dios region of Peru, according to local farmers, is scientifically insufficient. Local farmers perceive the soil as a dead organism. Still, they are acting in proactive ways to improve soil quality; planting nitrogen fixers, letting the land rest, and adding amendments to allow the soil to become more nutrient dense. Specific actions taken by farmers at times damage the soil rather than improve the soil; adding too many inorganic chemicals and engaging in slash and burn techniques to clear the land. Although these methods present as positive, they have several consequences like altering soil populations, impacting soil properties, and nutrient cycling in ways that are disadvantageous to farmers. Solutions for the future point towards implementation of agroforestry systems and increasing local knowledge of soil to protect microbial communities. Future studies and efforts should focus on educational programs in the region which would increase knowledge to support sustainable agriculture while also considering the needs of local individuals and their communities.

Acknowledgments

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interview questions and conduct the interviews themselves, translating for me and advising me on correct interview protocol. I also want to thank Geoff Gallice for helping me develop my research question.

Literature Cited

Arévalo-Gardini, E., Canto, M., Alegre, J., Loli, O., Julca, A., Baligar, V. (2015). Changes in Soil Physical and Chemical Properties in Long Lerm Improved Natural and Traditional Agroforestry Management Systems of Cacao Genotypes in Peruvian Amazon. PLoS ONE 10(7): e0132147. doi:10.1371/journal. pone.0132147

Barrios, E. (2007). Soil biota, ecosystem services and land productivity. *Ecological Economics*, 64(2), 269–285. doi:10.1016/j.ecolecon.2007.03.004

Benítes, J., R. 1981. Soils of the Peruvian Amazon; their potential for use and development. *Management of Low Fertility Acid Soils of the American Humid Tropics.* 85 – 94.

Farella, N., Davidson, R., Lucotte, M., Daigle, S. (2006). Nutrient and mercury variations in soils from family farms of the Tapajós region (Brazilian Amazon): Recommendations for better farming. *Agriculture, Ecosystems and Environment.* 120, 449-462. doi: 10.1016/j/agee.2006.11.003

Marquardt, K., Milestad, R., & Porro, R. (2012). Farmers' Perspectives on Vital Soil-related Ecosystem Services in Intensive Swidden Farming Systems in the Peruvian Amazon. *Human Ecology*, 41(1), 139–151. doi:10.1007/s10745-012-9522-3

Mendes, L. W., de Lima Brossi, M. J., Kuramae, E. E., & Tsai, S. M. (2015). Land-use system shapes soil bacterial communities in Southeastern Amazon region. *Applied Soil Ecology, 95, 151–160.*doi:10.1016/j.apsoil.2015.06.005

Pokorny, B., Robiglio, V., Reyes, M., Vargas, R., Carrera, C. F. P. (2021). The potential of agroforestry concessions to stabilize Amazonian Forest frontiers: a case study on the economic and environmental robustness of informally settled small-scale cocoa farmers in Peru. *Land Use Policy*, Volume 102,https://doi.org/10.1016/j.landusepol.2020.105242.

Phillips O.L., Vargas P.N., Monteagudo A.L., Cruz A.P., Zans M.E.C., Sanchez W.G. et al. 2003b. Habitat association among Amazonian tree species: a landscape-scale approach. Journal of Ecology 91: 757–775.

Prashar, P., & Shah, S. (2016). Impact of fertilizers and pesticides on soil microflora in agriculture. Sustainable Agriculture Reviews, 331-3361. Doi:10.1007/978-3-319-26777-7_8

Sanchez, P. A., Bandy, D. E., Villachica, J.H., Nicholaides, J.J. (1962). Amazon basin soils — management for continuous crop production. Science; 216:821–7.

Supplementary Material

Appendix I: Abstract for the interviewed Madre de Dios farmers, in Spanish

Mi Proyecto:
Estudio sobre las prácticas agrícolas en Madre de Dios

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Para mi proyecto de investigación, entrevisté a 12 agricultores que viven y cultivan en Madre de Dios. El objetivo de mi proyecto es conocer cómo los agricultores cuidan sus tierras y aprender cómo hacen ellos para que sus terrenos se mantengan productivos cada año.

12 agricultores	En promedio, cada agricultor posee un terreno de **42.46** hectáreas	Los cultivos NO CRECEN BIEN debido a: **Escasez de agua y enfermedades.**

¿Cuáles fueron los cultivos más comunes?

- Los agricultores de Planchón, Monterrey y Primero de Mayo cultivan en su mayoría: maíz, yuca y arroz, pero muchos agricultores quieren sembrar cacao en el futuro.
- La mayoría de los agricultores cambiaron sus cultivos porque el precio del cultivo en el mercado disminuyó.

¿Cómo ha cambiado la producción en los últimos tres años?

- Los niveles de producción de cultivos de la mayoría de los agricultores (60%) se mantuvieron iguales. El 30% de los agricultores dijo que los niveles de producción disminuyeron. Pocos agricultores (10%) dijeron que algunos de sus cultivos aumentaron, mientras otros disminuyeron.

Solución: Si quieres que tu tierra sea productiva planta mucuna y copoazú para ayudar a que el suelo gane nitrógeno, ¡esto ayuda a mejorar el suelo!

¿Los agricultores usan pesticidas o fertilizantes?

- 9 de cada 12 agricultores usan pesticidas, mientras que 7 de cada 12 usan fertilizantes. Los agricultores se quejaron de que los fertilizantes y pesticidas eran caros y, a veces, arruinaban sus cultivos en lugar de ayudarlos.

Solución: Si un vecino tiene gallinas, pregunta si puedes usar las heces de sus animales, ¡es fertilizante gratis y natural!

¿Por qué los agricultores piensan que la tierra es importante?

¡Porque su tierra representa a la familia, proporciona alimentos y es valiosa!

Los agricultores también mencionaron cómo deben cuidar el suelo para las siguientes generaciones.
Y lo están haciendo cuando siembran fijadores de nitrógeno, usan fertilizantes naturales y dejan descansar la tierra para recuperar nutrientes y materia orgánica.

+ descansar =

cosechas felices