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Poor soils need organic matter

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The author, who has a great deal of experience in organic farming and is building up his own organic vegetable farm, describes the main farming systems in the valleys of the Ecuadorian Andes. Using practical examples he makes some suggestions about how these farming systems could be improved using an 'organic' approach. There are, however, still many questions that farmers and researchers still have to work on.

In the valleys of the Ecuadorian Andes most of the soils farmers cultivate originate from the volcanic ash ejected during the last quaternary. What geologists and soil scientists call "volcanic ash", is, for farmers, nothing more than infertile sand. How long it will be before this sand becomes fertile soil depends on precipitation. In the rainy mountain regions the soils are heavily weathered, a process that is accompanied by accumulation of organic matter. In these 'páramos' there is soil with between 5 and more than 30 % organic content.

However, in the valleys located in the rain shadow of Andean Cordilleras, there has been very little weathering. The soil consists mainly of sand and coarse silt and often has less than 1 % organic matter. Low precipitation usually coincides with an extremely poor soil water−holding capacity. In addition, there is very little nitrogen in these soils and although volcanic ash has relatively large amounts of phosphorus, it is often not available to the plants.

Main farming systems

There are many farming systems in these valleys and I have analysed the effects a few of them have on long−term soil fertility.

- *Rainfed farming*. Where there are no irrigation facilities, or irrigation water is scarce, peasants often grow corn and in some regions this is part of a complex mixed cropping system. Very few external inputs are bought. The soil is often fertilised by leaving animals on the field the night before planting. This effects some nutrient transfer from the natural pastures and waysides where the cattle have been grazing during the day but the external input is far less, and particularly less energy−intensive than in irrigated farming, for example.
  Usually the straw from corn and associated legumes is conserved carefully and returned to fields by feeding it to cattle during the dry season. Nobody has yet studied whether this system leads to an increase in the organic matter content of soils. Nevertheless, where the crop mix is sufficiently diversified and farmers care for nutrient−recycling, this seems to have been a stable system for many centuries.

- *Irrigated farming*. Where irrigation is available, small farmers often engage in intensive vegetable growing and follow a high−input strategy: in addition to large quantities of water, they also use considerable amounts of chicken manure, biocides and, increasingly, chemical fertilisers. The chicken manure comes from chicken or egg "factories", most of which are located on the Pacific Coast Plain. Many surveys have shown that this manure has the ability to increase production.
  Nevertheless, there is always the risk of antibiotic, hormone and insecticide residues and, therefore, it cannot really be considered an "organic" fertiliser. In the sandy soils of the Andean valleys where there is good airing, the mineralisation of these manures with a close C/N ratio is so fast that their effect is similar to chemical fertilisers. The extremely intensive tillage and mechanical weeding employed in vegetable production accelerates this process. One of the most positive elements in these systems is alfalfa which is used as a component of many crop rotations. Alfafa remains on the fields for up to five years.
- *Market−oriented organic farming*. These farms take a step towards organic agriculture by composting organic materials before applying them to the soil. This may lead to more stable organic complexes although, as yet, there is no clear scientific evidence for this. Some people make earthworm compost (*lombricultura*), which is, perhaps, even better in this respect. But even organic vegetable growers often buy enormous quantities of chicken and cattle manure, sometimes from very far away.
  Thus, no real recycling takes place because the organic matter is transferred from one system to an other. In strict "organic" terms the farm itself is seen as an "organism" and a high percentage of nutrients should be recycled within the farm itself. The attempts of organic growers to solve the phosphorus problem by using raw phosphate or bone meal does not seem to be very promising, since these forms of phosphorus are easily fixed as calcium phosphate in neutral soils.
- *Ranging*. Landlords in the Andean valleys often raise cattle in extensive systems. Their most important external input is water and nitrogen with an increasing tendency to use herbicide. There is a considerable accumulation of organic matter under pasture cover which can be very beneficial to other crops.
- *Peri−urban farming*. In the vicinity of the larger towns, peasants have found their own way to recycle nutrients: they pay a little *propina* to municipal refuse collectors who, in return, dump urban waste on their fields. After they have ‘manured’ their properties in this way a couple of times, it is difficult to distinguish corn fields from the nearby refuse tips. It is a common misconception that there is less toxic waste in the urban refuse of poor countries than in the waste produced by more industrialised communities. This opposite is probably nearer the truth: batteries, medicines and syringes are just some items regularly found in this kind of this kind of ‘manure’.

Nutrient transfer from poor to rich

The main challenge in developing sustainable systems on the type of soils described here lies in increasing the organic content of the soil organic whilst keeping nutrient imports to the minimum. Manure is scare and its price is continually increasing. Better−off farmers buy manure from poorer smallholders. It is questionable whether this type of soil fertility transfer is sustainable.

Promising organic approaches

The integration of elements found in the farming systems described above combined with new insights could offer a solution to the problem of sustainability. Very little advantage is being made of this potential at the moment and should be explored. First, the integration of agriculture and animal

husbandry is part of peasant farming systems in the region. This can be considerably intensified by reducing grazing on natural pastures, growing fodder shrubs and undersowing main crops with fodder legumes. Second, in intensive irrigated systems, an alfalfa−grass−ley combination would help build up the level of organic matter in the soil more effectively that the traditional system of growing alfalfa as a row crop and hoeing it in after every harvest . This would let humus build up in the soil.

However, care should be taken that *kikuyu* (*Pennisetum clandestinum*) is not allowed to invade the fields too much. Two years seem to be a reasonable time. Third, mixed cropping, as practised by small corn growers, mostly in dryland farming appears to be one good way of conserving soil fertility, especially when one or more legumes are included. Ways of covering the soil as soon as possible after planting and keeping it covered during the period when no main crop is being grown should be investigated. Mulching appears to be one of the most promising approaches. Material for mulching can be grown in the margins of the fields using low−input−grasses or shrubs, for example.

There are many simple ways in which nutrient losses from organic fertilisers can be reduced. Earthworm compost might be one of these although this still requires research. Manure heaps can be covered very simply, thus reducing leaching of N and basic cations. When cattle are left in the fields overnight in order to fertilise them, the manure should be turned under as quickly as possible. Some booklets for farmers' still recommend adding lime to compost heaps. This should be avoided, however, as it increases the amount of nitrogen lost and the pH of many young volcanic soils is more often too high than too low.

Recycling of nutrients from urban waste is desirable, but involves many difficulties. Attempts have been made to collect organic household waste separately, but this was not very successful because there was little awareness of why this was necessary.

Basic questions unresolved

In spite of the many projects aimed at improving soil fertility, a number of basic questions remained unresolved. Which cover and fodder crops are most suitable for irrigated farms? Which drought−resistant legumes and low−input grasses could be used to increase the amount of pasture and cover soil available throughout the year? What is the best way of including these within the existing system in such a way that they do not make heavy and competitive demands of the water and nutrients available? How can the amount of phosphorous available to the plants be increased? How can biological Nitrogen−fixation be optimised? How can manure be best used for the various crops and systems?

There are many solutions that can be drawn from farmers' experiences. Some of these experiences need to be developed and complemented by research. Solutions to the problems of achieving and maintaining an optimal amount of organic matter in poor soils is a task for farmers and researchers working together.

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Back to Top