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Restoration of Degraded Agricultural Land: A Review

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Abstract

Restoration of agricultural land is important for sustainability of agriculture and environment. Land is under immense pressure due to ever increasing population thereby ensuing growing demand for food, fiber and shelter. Agricultural land is being deteriorated due to different anthropogenic and natural factors. The basic factors causing soil erosion-induced degradation are wind and water erosion. Acidification, compaction and salinization are some other causes of agricultural land degradation. The main causes of erosion on agricultural land are intensive cultivation, overgrazing, poor management of arable soils and deforestation. Restoration of eroded agricultural land is achieved through several agronomic and biological techniques. Crop rotations, agro-forestry, reduced tillage, cover crops, vegetative filter strips, residue, and no-till are important among these. Biological measures such as buffers, conditioner application in direct contact with the soil surface, crop residues using manure protect the soil from erosion. Restoration of saline agricultural land can be achieved through recharge stabilization and reconstruction of saline land through fencing, retain remnant vegetation, revegetation, runoff interception earthworks, and water table lowering.

Keywords: Agricultural land; Soil erosion; Restoration

Introduction

One-third to half of the world's agricultural land was in a degraded state in 2010, and a quarter was severely degraded (Dubois, 2011). Even as pressure grows to boost agricultural production, another 12 million ha are lost each year due to poor soil and water management and other unsustainable farming practices (Zucca et al., 2014). The United Nations estimates that degradation of agricultural landscapes cost US$40 billion worldwide in 2014, not counting the hidden costs of increased fertiliser use and the loss of biodiversity and of unique landscapes (Bai et al., 2008).

In many developing countries, land degradation is often exacerbated by expansion onto fragile hillsides and wetlands under population pressure (FAO, 2011). Risks are also increased by excess removal of trees and shrubs in the landscape for fuel and feed. In other places, inadequacies of land tenure and governance have allowed destructive short-term timber, pulp or palm oil production to leave large areas of severely degraded lands behind, including high-carbon peatlands in Southeast Asia.

Chirwa (2014) reveals that native forests in western Tanzania region of Shinyanga have been subjected to intense human pressure in recent decades, resulting in severe deforestation and degradation. Uganda loses approximately from 4 to 12% of her GDP due to land degradation (Bolwig, 2002). The most severely affected areas include highlands, mountains areas under agriculture. Soil erosion has been recorded as a single major physical driver of agricultural land degradation in the country. The worst affected agricultural land (85 – 90 %) is in highland areas in the Southwest, Kabale and Kisoro, and those severely affected (75 – 80%) include Mbale, Rakai and Kotido cattle-grazing districts (Bolwig, 2002).

Drivers of agricultural land degradation

The widespread prevalence of agricultural land degradation in sub-Saharan Africa, a classic example of a downward spiral, is attributed to over exploitation, extractive farming, low external inputs, and improper management (Figure 1). Accelerated degradation is shrinking the finite soil resource even more

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rapidly in these regions of harsh climate and fragile soils. In this context, restoration is important to sustain soil fertility and agronomic productivity (Tiessen et al., 1994). Simply adding chemical fertilizers or improved varieties, as is often erroneously recommended even by well-intended advocates, is not enough.

The self-reinforcing soil degradation process (Figure 1) is strongly exacerbated by the interaction between processes, factors and causes of soil degradation (Figure 1). Processes include the mechanisms of soil degradation. Factors comprise agents of degradation related to natural or anthropogenic drivers such as climate, physiography, socio-economic or cultural parameters. Causes of soil degradation include specific activities which aggravate the adverse effects of processes and factors. Examples of specific causes include activities such as deforestation, land use conversion, extractive farming practices or over-exploitation, excessive grazing, excessive plowing among others (Figure 1). The process-factor- cause nexus is strongly impacted by site-specific conditions. Thus, understanding the nexus or connectivity is critical to restoring soil quality and mitigating degradation.

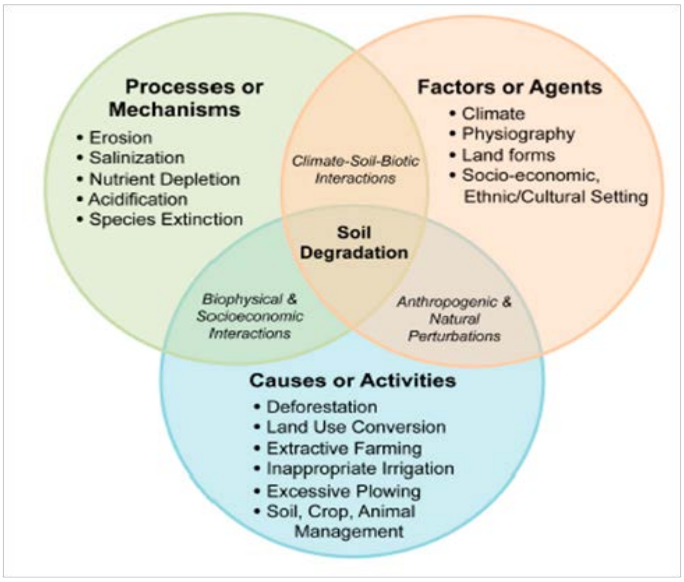

Figure 1: The process-factor-cause nexus as a driver of soil degradation

One of the most powerful approaches to countering the negative impacts of agricultural expansion and intensification is ecological restoration. Ecological restoration aims to recover the characteristics of an ecosystem, such as its biodiversity and functions, which have been degraded, generally as a result of human activities. Ecosystem management that attempts to maximize a particular ecosystem service often results in substantial declines in the provision of other ecosystem services (Bennet and others 2009). Benayas et al. (2009) showed a positive relationship between biodiversity and provision of ecosystem services in restored versus degraded ecosystems in a wide variety of ecosystems. However, restoration of ecosystem services is not the same thing (Bullock et al., 2011). In this article, we review approaches to enhance agricultural land.

Key aspects of restoration project

Left alone for long enough, degraded land may recover to an extent, but it rarely recovers to its original condition. More often, degradation will get worse before it gets better and restoration action is required to reverse the trend. There are four key aspects to a restoration project:

a) Recognizing cause and effect and targeting the cause;
b) Site stabilization;
c) Environmental reconstruction
d) Monitoring

Cause and effect – target the cause: For every effect of degradation, there is an underlying cause. To restore degraded land the cause of the degradation must be identified and addressed. Agricultural land is unstable if the degrading influences are still active, as the condition of the land will continue to decline. For example, fencing off and planting trees in a dieback will not ultimately restore the health of the vegetation if the tree death is resulting from salinity or a lack of flooding. The fencing and revegetation may slow the rate of decline, but the site will be unstable and continue to degrade until the water management issues are addressed.

Site stabilization: Once you know where to target your efforts, the degraded land should be stabilized by implementing action to remove the degrading influences. Removing the degrading influences help to reduce the rate of decline in condition at the site, and it can also initiate immediate improvement. However, stopping the active degradation will not necessarily restore a degraded land to its former condition. For instance, a clay pan caused by overgrazing will still be very slow to recover if it is fenced to exclude stock. In situations like this, additional work is required to fully restore the degraded land. Stabilization is the minimum level of restoration that should be undertaken in any degrading landscape to prevent the situation from becoming worse.

Environmental reconstruction: Following stabilization and the removal of the degrading influences, works can be undertaken to restore the land to the desired condition. This is the environmental reconstruction stage. The extent and nature of the reconstruction works will depend on what you are trying to achieve for the site. Most restoration projects will aim to achieve one of the following objectives:

a) Improve agricultural production.
b) Reconstruct natural environment and ecosystem.
c) Partial restoration for a mix of production and environmental benefits

The extent of restoration will also depend on the resources available to commit to the project. In reconstructing a natural environment or ecosystem you should find out what the land, vegetation and habitat characteristics were like before degradation. This can be done by referencing similar vegetation communities and soil landscapes that are in good condition.

Monitoring: For any restoration project, it is important that monitoring is undertaken to ensure that the degraded site is stabilized and improving in condition and that no new degradation is occurring.

Restoration Techniques of Agricultural Land

In this sub section we present the various techniques for restoration of degraded land. It is important to note that restoration of degraded agricultural land may require different techniques depending on the agent of degradation and the restoration goals. For instance, techniques for restoration of eroded land may be different from those one would apply in restoration of saline land and the restoration techniques for purposes of increased agricultural production may be different those whose primary goal is to restore biodiversity and ecological services.

In the subsequent sections 4.1 and 4.2, we discuss the possible restoration techniques for eroded and saline agricultural land respectively, for purposes of improved on agriculture production. Section 4.3 discusses the techniques for restoration of agricultural land with the intention of restoring biodiversity and ecological services.

Restoration of Eroded Agricultural land

Soil erosion is initiated when there is low vegetation cover on the soil surface. Wind erosion is the dominant force but water erosion can also cause significant degradation. Restoration of degraded agricultural land is achieved through several agronomic and biological techniques. Crop rotations, agro-forestry, reduced tillage, cover crops, vegetative filter strips, residue, canopy cover management and no-till are important among these (Lamb, Erskine, & Parrotta, 2005). There are differences among these biological practices in relation to their mechanisms of restoration of agricultural land. Biological measures such as buffers, conditioner application in direct contact with the soil surface, crop residues using manure protect the soil from erosion.

Techniques for restoration of degraded agricultural land can grouped into two broad categories; agricultural conservation techniques and soil management techniques.

Agricultural Restoration Techniques

a) Crop management: Wind and water erosion reduce by good crop management practices. Keep soil covered is fundamental principle in restoration of degraded agricultural land. Soil protection from erosion by leaving crop residues on soil surface after harvesting is also helpful approach.

b) Inter-cropping: The impact of raindrops is reduced with the soil cover by the fast-growing legumes such as cowpeas and beans early in the season before a canopy is developed by cotton or maize to shield the soil. This practice reduces soil erosion and helps the agricultural land to regenerates since it significantly checks on degradation agents of agricultural land particularly soil erosion.

c) Crop selection: If the gap is too long between harvesting one crop and sowing of the next crop than the additional cover crops may be required. The stability of the conservation agriculture system is increased by cover crops and erosion impacts are reducing by the improvement of soil properties and this biodiversity in the agro-ecosystem are promoted for their capacity. The more effective crops in soil erosion are perennials than annual crops. The most effective are sugar cane, fodder grasses, sweet potatoes and tea.

d) Crop rotation: The practice of growing a series of dissimilar types of crops in the same space in sequential seasons is crop rotation for benefits such as such as avoiding pathogen and pest buildup that occurs when one species is continuously cropped. Soil nutrient depletion is avoided by the crop rotation that balances the nutrient demand of various crops. The replenishment of nitrogen with the use of green manure and legumes in sequence with cereals and other crops is a traditional component of crop rotation. Soil structure and fertility by alternating shallow-rooted and deep-rooted plants can also be improved by crop rotation. The multi-species cover crops between commercial crops are also another technique. Restored soil fertility, reduction of diseases and pests, addition of humus and control of erosion is ensured by crop rotation. In a study conducted by Bationo and Ntare, (2000) in Niger found out that legume–millet rotation with 30 kg Nha maintained a high level in soil organic carbon pool and sustained crop yields.

e) Cover cropping: Cover crops are "close-growing crops that provide soil protection, seeding protection, and soil improvement between periods of normal crop production or between trees in orchards and vines in vineyards" (Saxton & Rawls, 2006). These are also referred to as green manure crops. The use of cover crops is an ancient practice and dates back to the ancient civilizations in Greece, Rome, China, and others (Lamb et al., 2005). The practice of growing crops to cover the soil surface to reduce wind and water erosion is called cover cropping. This practice creates a favorable habitat for microorganisms by regulating the soil heat and temperature. These also sources of organic matter in soil as the fallen are decomposed.

f) Shelterbelts: These are used to protect both irrigated and rainfed farms. Their main function, at present, is to protect valuable agricultural land and irrigation canals from creeping sands. This occurs in North Africa and Northern Sudan. Shelterbelts reduce wind velocity, improve the microclimate and increase livestock yields. Field investigations in dry areas show that crop production may be increased by as much as 300% while the increase in average years is often 30 to 50%. By ameliorating the microclimate, shelterbelts commonly improve fruit production by a third or more, and in windy years, the fruit value may be increased by over 75%. By protecting livestock from strong winds and heat, shelterbelts have a great influence on the production of flocks. Under protection, the lambing percentage is greater by about 30% (FAO, 1978). Excellent examples of shelterbelts have been established in Libya, Egypt, Syria and Iran during recent years. The farmers at large are, however, reluctant to sacrifice cultivated areas for them. The species used are mostly Eucalyptus, Casuarina sp., populus and prosopis. Seedlings are used for establishment.

g) Strip Cropping: Strip cropping refers to the practice of growing crops in alternate strips of row crops or forage/grass. This cropping system is an effective practice to reducing soil erosion because it breaks sloping landscapes in wide segments with diverse vegetative cover which intercepts runoff and promotes water infiltration, thereby reducing runoff and soil erosion. Strip cropping is often integrated with rotations where strips are planted to different crops each year. Hay, pasture or legume forages are also commonly used in strips in rotation with row crop crops. Bravo and Silenzi, (2002) recommend a strip width of about 30 m while on steeper slopes the width must be less than 20 m.

Land/Soil management techniques

Soil conditions are often changed by the inappropriate land use practices which ultimately result in soil erosion. Optimum soil management aims to provide favorable conditions for plant growth through improved soil nutrient availability and aggregation. Optimum soil management practices improve infiltration of water and improve soil capacity to hold water and in result reduce runoff and erosion.

a) Use appropriate tillage practices: Optimum soil physical conditions for better crop production are the main objectives of tillage. It also ensures timely seedbed preparation, planting and weeds control. Tillage practices should be adopted by keeping in mind that; soil is neither too fine nor powdery; and it breaks up the hardpan if necessary.

The main tillage methods are slash and burn, hand hoeing, ploughing and harrowing, conservation or minimum tillage, deep tillage.

b) Applying organic manures and mineral fertilizers: Application of manure and fertilizers provide essential in restoration of agricultural land. Manure and fertilizers provide essential plant nutrients in the soil for better crop growth. The crops with fast growth cover the soil quickly and give higher yields. Essential plant nutrients such as nitrogen, phosphorus, potassium, and sometimes Sulphur required by plants are provided by inorganic fertilizers. There is no substitute of inorganic fertilizers therefore integrated use of organic and inorganic fertilizers should be adopted. Farmyard manure, green manure and composts are the main sources of organic fertilizers. Grande et al. (2005) reveal that manuring can reduce water runoff by 70 – 90% and sediment loss by 80 – 95% as a result of increased organic matter content. A study carried out in West Africa by Yamoah et al. (2002) reported that a combination of crop residues and fertilizer restored the degraded agricultural land thus led to the highest millet grain and straw yields production.

c) Mulching and the use of crop residues: Spreading on the bare soil surface or placement of plant materials such as dry grass, straw, dry leaves, banana leaves, sugar cane trash, and other crop residues around the stem of the plants is helpful in controlling soil erosion and moisture conservation (Bashir et al., 2017).

d) Agro-forestry: Planting of trees or shrubs or protecting the naturally sustaining trees is called agroforestry. Trees decrease the magnitude of splash erosion by reducing the raindrops impacts on the soil. They regulate soil temperature by shading the soil thus reducing the water evaporation. They also minimize the wind erosion by acting as wind breaks. They also play important role in nutrient recycling in the deep soil; leguminous trees fix nitrogen that benefits food crops (Bashir et al., 2017).

e) Contour farming practices: Cultivation across the slope rather than up and down is called contour farming. Soil loss as much as 50% has been reported to be reduced by contour farming on gentle. The main objective of contour ridges is water harvesting. Plant residues are placed in lines along the contour for construction of trash-lines. These trash-lines slow down the runoff and trap the eroded soil. Grass barrier strips of Napier or other fodder grasses are planted along the contour.

f) Physical soil conservation measures: Physical structures in restoration of agricultural land are permanent features made of Earth, stones, designed to protect the soil from uncontrolled runoff and erosion and retain water where needed (Bashir et al., 2017). In subsequent paragraphs, we discuss some of the physical techniques for restoration of degraded agricultural land:

Cut-off drains: Cut-off drains are made across a slope for intercepting the surface runoff and carrying it safely to an outlet such as a canal or stream. Their main purpose is the protection of cultivated land from uncontrolled runoff, and to divert water from gully heads.

Retention ditches: These are made along the contours to capture and retain incoming runoff water and hold it until it seeps into the ground. They are alternate to cut-off drains when there is no channel to discharge the water nearby. In semiarid areas, retention ditches are sometimes used for water harvesting.

Restoration of Saline agricultural land

Soil salinity describes the soluble salt content of soil. Saline soils contain large concentrations of soluble salts, usually the chlorides (Cl^-) and sulfates (SO_4^{2-}) of sodium (Na^+), calcium (Ca^{2+}), potassium (K^+), and magnesium (Mg^{2+}) salts. Only rarely are nitrates present in appreciable quantities (Abrol, Yadav, & Massoud, 1988). It is generally not possible to fully restore saline land to natural condition. However, it can be rehabilitated to a point where some production and environmental benefits may be realised. The various for restoration of saline soils are discussed in the subsequent sections.

Recharge stabilization

For saline land restoration, the first step is to determine the source of the recharge. If this can be identified, action should be taken to reduce the leakage of water into the ground. Where irrigation is causing the recharge, options include:

a) Improved crop water use efficiency.
b) Improved irrigation layout.
c) Improved surface drainage and recycling.
d) Subsurface drainage such as tile drains.

Where the recharge is from local runoff or from cleared land, the options include:

a) Revegetation with locally native trees and shrubs.
b) Introducing perennial pastures.
c) Management of grazing to promote perennials.
d) Surface water drainage/interception works.

Reconstruction of saline land

With measures in place to stabilize recharge, restoration of the discharge site can commence. Restoration measures can include the following:

a) Fencing: Stock will often preferentially graze or camp on saline areas. Fencing out a saline area allows grazing to be better managed without affecting the entire paddock. Stock exclusion will allow natural regeneration of ground cover to occur. Saline sites should only be grazed when plants are established and the ground is dry.

b) Retain Remnant Vegetation: Protect and retain existing vegetation to ensure a source of seed for regeneration. Retain dead trees for habitat.

c) Revegetation: Revegetation works through tree, shrub or grass planting will accelerate the restoration process and enable the reintroduction of species that may be lost from the site. Halophytes can accumulate quite high concentrations of salt in their shoots (Barrett-Lennard, 2002). It's argued that the use of the halophytes can significantly lower salt concentrations in most saline soils since can transpire sufficient water to lower water tables, thereby ameliorating water logging (Barrett-Lennard, 2002). In revegetation, two factors key points should be noted:
Ground preparation: Mounding of planting sites to a height of 30 to 50 centimeters creates better drainage allowing salt to be washed away from the roots of the establishing plants (Figure 1).
Species selection: If the restoration objective is production oriented, species could consist of a plantation of salt tolerant pasture species. If the aim is to partially reconstruct the ecology, you will need a range of salt tolerant trees, shrubs and ground covers that are (where possible) locally native.

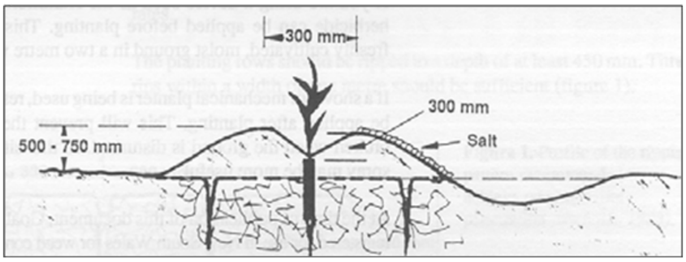

Figure 2: The mounding technique recommended for use in saline ground.

d) Cultivation: Cross ripping or cultivation of bare ground can improve salt leaching and trap wind-blown seed.

e) Runoff Interception Earthworks: Surveyed diversion banks up-slope of a saline discharge area may be used to prevent clean runoff water flowing over the site and adding to the problem or transporting salt off site.

f) Water Table Lowering: Because shallow groundwater contributes to soil salinity drainage and resultant lowering of the water table can assist in saline soil prevention and remediation. If the natural subsurface drainage and aquifer transmissivity is insufficient to limit mounded groundwater conditions, the installation of an artificial drainage system may be necessary to reduce the groundwater table to an adequate depth. The principal types of drainage systems are horizontal relief drains, such as open ditches, buried tiles or perforated pipes, or vertical pumped drainage wells. The water table will be lowest near the ditch due to the conveyance of water downgradient, and groundwater will be drawn down over an area of influence dependent on soil hydraulic properties. Generally, coarse-grained (sandy) soils will have a larger area of influence than fine-grained (clayey) soils.

Restoration of Ecosystem Services on Agricultural Land
There is a range of possibilities to reverse the negative environmental impacts on agriculture land. Some of these options have the potential to both enhance biodiversity and ecosystem services including agri-cultural production, but others may enhance bio-diversity and ecosystem services other than agricultural production. They can be considered within two major approaches:

Land sharing
We can classify five types of intervention following this approach. Four involve extensive actions on agricultural land with a focus on productivity that is, making agriculture more wildlife friendly:
a) Adoption of biodiversity-based agricultural practices: Conservation of existing biodiversity in agricultural landscapes and the adoption of biodiversity-based practices have been proposed as ways of improving the sustainability of agricultural production through greater reliance on ecological goods and services, and with less damaging effects on environmental quality and biodiversity (Jackson et al., 2007). Management of biodiversity, that is, the biota dwelling in agroecosystems as well as habitats and species outside of farming systems in the landscape, can be used to benefit agricultural production and enhance ecosystem services. Examples of agrobiodiversity functioning at different hierarchical levels include the following:

a) Genetic and population characteristics for example, the use of traditional varieties and wild species for continuing crop and livestock improvement for increased pest resistance, yield, and quality (Tisdell, 2003).
b) Community assemblages that influence agricultural production, such as pest control based on toxin biosynthesis, crop mixtures, release of natural enemies, and pest suppression by a complex soil food web.
c) Heterogeneity of biota in relation to biophysical processes within ecosystems, such as nutrient cycling and retention or carbon accumulation.
d) Landscape-level interactions between agricultural and non-agricultural ecosystems that enhance resources for agriculture, and potentially, resilience during environmental change.

b) Learning from traditional farming practices: Traditional farming describes practices that developed through human history to produce a variety of agri-cultural goods, largely for local use. Forms of traditional farming persist in many parts of the world, particularly in developing countries, but also in more developed countries, where such methods are remnants or have been re-introduced to meet specific needs. Traditional farming methods are extremely diverse, by their nature, but they often share a number of distinguishing characteristics in comparison to intensive systems: on-farm cycling of nutrients and resources, the development of local varieties and breeds, high spatial and temporal structural diversity, use of local pollination and pest control services, and effective exploitation of local environmental heterogeneity (Altieri, 2004).

Traditional farming has been shown to have many environmental and societal benefits, including enhancement of soil carbon sequestration and nutrient cycling, reduction of soil erosion, more efficient water use, and maintenance of crop genetic diversity, as well as pro-viding resources for endangered species (Badalucco et al., 2010)

However, it is important to note that certain traditional methods may sometimes be damaging to biodiversity and to soil and water resources (Ziegler et al., 2011). It is therefore more appropriate to learn lessons from traditional approaches which can be applied to modern agricultural systems. Traditional management approaches are being implemented, for example, through the European agri-environment schemes. Options within these include; a return to traditional livestock grazing rates, which can help weed control and maintenance of plant and animal diversity, replacement of inorganic fertilizers with farmyard manure, with positive impacts on soil organic matter, or re-creating traditional species-rich grasslands, in which increased plant diversity enhances forage production (Bullock et al., 2011).

c) Transformation of conventional agriculture into organic agriculture: There has been a considerable expansion of organic farmland area in the world, chiefly in developed countries. The demand for healthy and environmental friendly food and subsidies to producers of organic food and fiber has favored this process. However, organic farming remains a tiny fraction of the farming activity.

The benefits of organic farming to the environment include less contamination by fertilizers, herbicides and pesticides, increases in biodiversity, enhancement of soil carbon sequestration and nutrients, enhancement of natural pest control and conservation of the genetic diversity of local varieties of domestic plants and animals (Gabriel et al., 2010).

In addition, positive effects of organic farming on species richness might be expected in intensively managed agricultural landscapes, but not in small-scale landscapes comprising many other biotopes as well as agricultural fields. Consequently, measures to preserve and enhance biodiversity should be more landscape- and farm-specific than is presently the case (Gabriel et al., 2010).

d) Transformation of "simple" crops and pastures into agroforestry systems: Agroforestry is the purposeful growing of trees with crops or pasture. These approaches offer opportunities in both tropical and temperate regions (Bergmeier et al., 2010). Agroforestry can augment biodiversity and ecosystem services in agricultural landscapes, while also providing income for rural livelihoods. It can be a management tool of buffer zones and biological corridors to enhance landscape connectivity and landscape-level biodiversity. Agroforestry represents an intermediate step between natural secondary forests reclamation of severely degraded land in terms of high versus low provision of biodiversity and ecosystem services, state of degradation, and time and costs of forest restoration.

e) Restoring or creating specific elements to benefit wildlife and particular services without competition for agricultural land use: This is another method of restoring agriculture land. The intervention encompasses highly specific actions intended to benefit wildlife and ecosystem services such as pollination. These actions are so characterized because they occupy a tiny fraction of the agricultural land if any at all, meaning that they hardly compete for farmland use. These actions include the following (Noordijk et al., 2010)

a) Strategic revegetation of property boundaries, field margins, and track edges to create living fences.
b) Planting isolated trees to take advantage of their disproportionate positive value for biodiversity conservation and potential for seed dispersal.
c) Creation of pollinator-friendly areas using plant enrichment
d) Introduction of perches and nest boxes for birds.
e) Introduction or restoration of drinking troughs.
f) The reconstruction of rural architecture is specifically intended to restore and value cultural services.

Land separation

Land separation in the farmland restoration context involves restoring habitat in agricultural landscapes at the expense of field-level agricultural production. This approach does not necessarily imply high-yield farming of the non-restored, remaining agricultural land.

Setting aside farmland to restore or create non-farm habitat rarely happens as farmers tend to use and expand into all available land because this is usually the most profitable choice in terms of direct use value. There are some examples of habitat restoration at the expense of farmland, including both terrestrial and wetland ecosystems (Moreno-Mateos et al., 2010). Two major contrasting approaches for terrestrial ecosystem restoration in agricultural landscapes are;

a) Passive restoration through secondary succession following abandonment of agricultural land, for example, cropland and pastures where extensive livestock farming has been removed.
b) Active restoration, for example, through addition of desired plant species. These approaches have been contrasted for a variety of ecosystem targets, including species-rich grassland and heathland.

Active restoration basically comprises the planting of trees and shrubs. It is needed, for example, when abandoned land suffers continuing degradation, local vegetation cover cannot be recovered and secondary succession has to be accelerated. There are differences in ecosystem services provided by passive versus active restoration, and there is much debate about the ecological benefits of tree plantations.

Techniques in popularly used in active restoration of agricultural land include artificial shading, irrigation in the dry season, elimination of herb competition, use of gels that absorb and very slowly release water, ground preparation to increase infiltration, and micro-topography modification to canalize run-off toward the reforested plots (Rey Benayas, 2005). When nutrients are limiting, manure and compost from agricultural, industrial, or sewage plants' residues have to be utilized.

Planting the seedling below the canopy of naturally established nurse shrubs, which provide an ameliorated microenvironment for the introduced seedlings, is another technique that has successfully been used. It should be noted that the choice of technique will need to be determined by the climatic, biophysical, and socioeconomic conditions (Rey Benayas, 2005).

Passive restoration is by far the main force that turns abandoned land into "original" or healthy ecosystems. It has the advantage of being cheap (Myers and Harms 2009). On the other hand, the disadvantage includes that it can be very slow in low productive ecosystems, involves few people, and may turn into a more degraded land or auto succession loops. Secondary succession can be aided by simply eliminating grazing in certain areas after agreement with local users and land managers. Fencing can be used for this purpose, although this can add substantially to the cost in some situations (Dwyer et al., 2010).

Conclusion and Recommendations

We conclude that, although agriculture is a major cause of environmental degradation, ecological restoration on agricultural land offers opportunities to reconcile agricultural production with enhancement of ecosystem services other than production.

Restoration of eroded agricultural land is achieved through several agronomic and biological techniques. Crop rotations, agro-forestry, reduced tillage, cover crops, vegetative filter strips, residue, and no-till are important among these. Biological measures such as buffers, conditioner application in direct contact with the soil surface, crop residues using manure protect the soil from erosion. Restoration of saline agricultural land is possible through recharge stabilization and reconstruction pf saline land. It however import important to note that that some of the techniques involved are expensive and rarely applied by local farmers and peasants such techniques include: improved irrigation layout, revegetation, runoff interception earthworks, and water table lowering.

Restoration by land sharing through environmental-friendly farming has the potential to enhance agricultural production, other ecosystem services at both the farmed field and landscape scale. However, restoration by land separation would provide these triple benefits only at the landscape scale as this restoration type is at the expense of field-level agricultural production.

Beyond scientific and technical research, an increase in such restoration projects is needed if we want to halt environmental degradation. We need widespread expansion of agricultural management based on ecological knowledge: biodiversity-based agricultural practices, organic farming, agroforestry systems, learning from traditional practices, highly specific actions to benefit wildlife and particular ecosystem services, and conversion of some agricultural land into natural ecosystems such as forests.

Financial support, public awareness, education and training, particularly of farmers, are necessary to accomplish such objectives. Restoration actions can act as an engine of economy and a source of green employment, so policymakers have an extra incentive to restore degraded farmland habitat.

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