

Forest Restoration in Landscapes

Beyond Planting Trees

Stephanie Mansourian • Daniel Vallauri
Nigel Dudley
Editors



 Springer



51

Restoring Forests After Land Abandonment

José M. Rey Benayas

Key Points to Retain

Land that is abandoned for a number of ecological and socioeconomic reasons can regenerate either naturally or through management interventions.

Significant public and private funds are being invested in abandoned land reforestation, often without good planning.

Abandoned lands offer a huge potential for restoration.

Restoration of abandoned land must be viewed as an investment in ecosystem goods and services.

1. Background and Explanation of the Issue

Globally, degraded land due to agricultural activities is estimated at about 12,400,000 km².⁴³² In addition, large areas of cropland and pasture land have been abandoned during the last few years for different ecological and socioeconomic reasons. Ecological factors leading to land abandonment are in many cases ultimately the result of mismanagement at a landscape level (e.g., unadapted agriculture and

overgrazing), and include productivity loss or the land exceeding cattle carrying capacity. Socioeconomic factors leading to land abandonment include a loss in farmland productivity, diversion of labour toward the industrial and service sectors, reduced subsidies for many crops and regions, and subsidised set-aside programmes.

These and other deforested areas can be (1) left to undergo secondary succession or passive restoration or (2) subjected to active restoration processes, mostly consisting of planting and managing native shrubs and trees. In the world, land abandonment and passive restoration have restored much more, and at a lower cost, than active restoration. However, active restoration is needed when the abandoned land suffers continuous degradation (e.g., soil erosion in dry regions), when the natural vegetation cover cannot recover in the area (e.g., abandoned cropland colonised by dense weeds in the tropics), and when accelerating secondary succession is desirable (e.g., reforestation of abandoned Mediterranean cropland). An additional benefit of active restoration is the creation of labour associated with ecosystem management in rural areas.

This issue is also important because public and private funds are being invested in abandoned land reforestation. From a holistic perspective, these actions must be viewed as the restoration of the world's natural capital, the services that ecosystems provide to humankind. Thus, research is needed to optimise the investment-benefit ratio.

⁴³² Bot et al, 2000.

FIGURE 51.1. A plot of abandoned agricultural land in a Mediterranean landscape that was actively revegetated with *Quercus ilex* 12 years ago. (Photo © Jose M. Rey Benayas.)



2. Examples

A large number of worldwide examples of ecosystem restoration are related to land abandonment and associated secondary succession. The scientific and technical literature reports a number of case studies that highlight both successes and failures. Typically, secondary succession has led to renewed functional ecosystems in scenarios where abandoned cropland and pastures had not been intensively used in the past, vegetation colonisation and growth was not limited by climate and/or soil constraints, the abandoned land was relatively small in size and there were remnants of natural vegetation nearby. Some examples are related to tropical slash-and-burn fields and paddocks that have turned to forest, Mediterranean mountain pastures and cropland that have turned to forest or shrubland, and abandoned rural areas in Africa that have turned to savannah or dwarf shrubland.

Failures are reported for abandoned lands where the environmental conditions are unfavourable to natural regeneration. Examples include all areas under desertification in the arid and semiarid regions of the world, large tropical paddocks with very compacted ground, and abandoned tropical cropland colonised by a dense carpet of weeds such as *Saccharaum spontaneum* that impedes the establishment of

natural vegetation. For instance, seedling mortality in abandoned tropical pastures has been found to be above 50 percent, whereas it drops to less than 25 percent with appropriate management.⁴³³ Active restoration is essential where ecosystem breakdown has occurred. The functioning of natural ecosystem processes such as seed dispersal are key factors to address when assessing restoration requirements. Many moist tropical forests depend on animal dispersal (as much as 90 percent of tree species). In the eastern rainforests of Madagascar, arboreal lemurs are essential for forest maintenance and regeneration. As lemur populations are decimated, most of the former rainforest regions in Madagascar are now severely degraded, representing an arrested succession dominated by alien species.⁴³⁴

2.1. Planting in Euro-Mediterranean Environments

In European Mediterranean environments public funds from the European Union have been available to encourage farmers to turn their cropland into forest plantations (Fig. 51.1). In these ecosystems, different abiotic and biotic factors hinder the establishment and growth of shrubs and trees, and some research

⁴³³ Hooper et al, 2002.

⁴³⁴ Holloway, 2000.

has been devoted to study how plantation projects benefit from appropriate management. The mortality of native *Quercus* species' seedlings during the first year is often above 60 percent if nothing is done to facilitate their establishment, and around 10 percent if management is applied.⁴³⁵ Further, some studies have shown that appropriate management may provide a rapid plot cover by the introduced seedlings and reproductive saplings of slow-growing species by the seventh year. For instance, it has been reported for an experimental *Q. ilex* plantation in central Spain that, after 3 years of management—artificial shading and summer irrigation—and six additional years of interrupted management, the plot cover attained by the managed seedlings was 50 percent higher than that attained by the unmanaged seedlings; additionally, 15 percent of the managed seedlings produced acorns, whereas only 1.5 percent of the unmanaged seedlings were capable of producing seeds.⁴³⁶

2.2. Passive and Active Restoration in Mosaic Rainforest Landscapes of Latin America

Landscape mosaics are typical of many rainforest areas of Latin America, consisting primarily of a mix of cleared areas, secondary forest, and limited residual patches of primary forest. A portion of the cleared area is agriculturally marginal, and in many cases is being abandoned. Natural regeneration of forest cover from neighbouring seed sources on this land is typically rapid. For instance, in cloud forest landscapes in Oaxaca (Mexico), it has been reported that abandoned paddocks attain, after 35 years, an average of 63 percent of the tree basal area that is characteristic of the mature forests in the region.

However, species' diversity after natural regeneration is usually low, with stands typically dominated by a few fast growing pioneer species. Natural regeneration of a species' mix more typical of a primary forest will only occur over the long term. Planting seedlings of inte-

rior forest species after land abandonment could sharply accelerate the process of restoration of complex communities. Pioneer stands or monocultural plantations may be enriched with seedlings of late-successional animal-dispersed trees, or initial plantings could be done with mixes of late-successional and pioneer species. Active ecological research related to this topic is being undertaken in a few places such as the Highlands of Chiapas (Mexico). There, broad-leaved tree species have declined because they are intensively harvested by the local Mayan communities for firewood, and pines are consequently in expansion. Seedlings of the broad-leaved trees are being introduced at the fringe between the pine-dominated forests and clear cuts, with survival rates higher than 50 percent after 3 years due to the positive effect of pines on the introduced seedlings. However, pines may inhibit establishment of native vegetation in some environments.

3. Outline of Tools

The tools at hand for favouring restoration of abandoned land are a mix of ecological and socioeconomical actions (and sometimes "inaction") and techniques. Passive restoration is by far the main force that turns abandoned land into "original" or healthy ecosystems.⁴³⁷ It has the advantage of being cheap. On the other hand, the disadvantages include that it can be very slow in low productive ecosystems, involves few people (no labour is needed), 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.

3.1. Active Restoration Techniques

A number of techniques have been proposed in active restoration programmes in those parts of the world where shortage of water availability

⁴³⁵ Rey Benayas, 1998.

⁴³⁶ Rey Benayas and Camacho, 2004.

⁴³⁷ Running, 2003.

is a major limiting factor for seedling establishment of native shrubs and trees. These techniques 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 microtopography modification to canalise run-off toward the reforested plots. When nutrients are limiting, manure and compost from agricultural, industrial, or sewage plants' residues have been utilised. Another technique that has successfully been used is planting the seedling below the canopy of naturally established nurse shrubs, which provide an ameliorated microenvironment for the introduced seedlings. Many of these techniques are discussed in more detail in other chapters of this book. It should be noted that the choice of technique will need to be determined by the climatic, biophysical, and socioeconomic conditions.

3.2. Socioeconomic Tools

Socioeconomic tools can also be passive and active. In a free market economy, the ratio between benefits and costs of livestock or agricultural production has triggered the abandonment of large extensions of land throughout the world. In other cases, removal of perverse subsidies—such as elements of the Common Agricultural Policy in Europe that has encouraged farming on uneconomic and marginal lands—could help stimulate natural regeneration. Active financial tools that foster abandonment of livestock grazing and agricultural production also exist.

An innovative and promising tool is payment for the environmental services that forests provide to humans, which favours forest conservation first and encourages forest restoration second. This programme is already widely applied in Costa Rica (see "Payment for Environmental Services and Restoration").

Another tool is to subsidise set-aside programmes for agricultural lands and to convert those into forest plantations or restore the natural vegetation. This tool has been widely applied in the European Union (EU) Mediterranean countries. However, its success has been

limited by the fact that the subsidies have encouraged some landowners to plough and reforest lands that had already been abandoned and were undergoing passive restoration.

Further socioeconomic tools—which are still very marginal—are related to the links between active restoration and environmental education and local sustainable development. For instance, the reforestation of vast extensions of abandoned land or the enrichment of secondary forests in developing countries requires the creation of a labour force and small industries such as specialised nurseries.

4. Future Needs

4.1. Evaluating Ecosystem Values

Before initiating any restoration programme after land abandonment, it is necessary to answer this question: Active or passive restoration? The answer necessarily goes through an evaluation of costs and benefits of the various options. We must never forget that the environmental benefits that humans receive from functional ecosystems or the loss of these benefits is part of the balance. We need better knowledge and awareness of what could enhance natural succession after abandonment, and the temporal terms, in various ecosystems. Natural regeneration should be properly monitored and mapped by field work and remote sensing and geographical information system (GIS) techniques. We must also take into account the potential social benefits of active restoration, particularly in developing countries. There is a need for scientific research to correctly assess such benefits.

4.2. Rethinking the Concept of Reforestation

It seems that we need a different concept of reforestation of abandoned cropland where plant production is limited as it occurs, for example, in dry Mediterranean regions. Nowadays, these reforestation efforts are based on extensive plantations of aligned trees, often of exotic species, that provide artificial monocul-

tures that are rarely managed. Restoration ecology and forest landscape restoration present more integrated approaches to restoration. After land abandonment, the reforestation approach should be replaced by little, dense, diverse, strategically placed, and wisely managed reforested patches. These patches would actually be islands of functional ecosystems in a sea of intensively used or abandoned land, thus being compatible with other land uses (e.g., livestock grazing or crop production) and passive restoration in their surroundings. The islands would act as "sources and traps" of propagules of different species of plants and animals since many organisms would find refuge and food. These biodiversity reservoirs could function as nuclei for passive restoration of large extensions in the world. Such experiences need to be started rapidly and their lessons shared and replicated widely.

References

- Bot, A.J., Nachtergaele, F.O., and Young, A. 2000. Land Resource Potential and Constraints at Regional and Country Levels. Land and Water Development Division, FAO, Rome, Italy (available on line at <ftp://ftp.fao.org/agl/agll/docs/wsr.pdf>).
- Holloway, L. 2000. Catalysing Rainforest Restoration in Madagascar. In: Lorenzo, W.R., and Goodman, S.M., eds. Diversity and Endemism in Madagascar. Orstom Editions, Paris.
- Hooper, E., Condit, R., and Legendre, P. 2002. Responses of 20 native tree species to reforestation strategies for abandoned farmland in Panama. *Ecological Applications* 12:1626–1641.
- Rey Benayas, J.M. 1998. Growth and mortality in *Quercus ilex* L. seedlings after irrigation and artificial shading in Mediterranean set-aside agricultural lands. *Annals of Forest Sciences* 55: 801–807.
- Rey Benayas, J.M., and Camacho, A. 2004. Performance of *Quercus ilex* saplings planted in abandoned Mediterranean cropland after long-term interruption of their management. *Forest Ecology and Management* 194:223–233.
- Running, S.W. 2003. Climate-driven increases in global terrestrial net primary production from 1982 to 1999. *Science* 300:1560–1563.
- Bakker, J.P., van Andel, J., and van der Maarel, E. 1998. Plant species diversity and restoration ecology: introduction. *Applied Vegetation Science* 1:3–8.
- Perrow, M.R., and Davy, A.J. 2002. Handbook of Ecological Restoration. Vol. 2. Restoration in Practice. Cambridge University Press, Cambridge.
- Temperton, V.M., Hobbs, R.J., Nuttle, T., and Halle, S. 2004. Assembly Rules and Restoration Ecology. Bridging the Gap Between Theory and Practice. Island Press, Washington.

Additional Reading