Safeguarding investments in forest ecosystem restoration

Policy Brief
Keys to success

**Use adapted and genetically diverse seed:** Long-term forest ecosystem restoration success requires choosing species and seed sources that are both suited to local site conditions and also sufficiently genetically diverse to be self-sustaining over time with changing environmental conditions.

**Allow ample planning and implementation time:** Restoration is a long process. From start to finish it includes defining objectives, identifying planting locations and sources of planting material, setting up nurseries, managing planting stock, planting, monitoring, and more. This can take 20 years or more and requires a long-term strategy.

**Monitor success at multiple stages:** Practical indicators are needed that reveal whether planted seedlings have sufficient genetic diversity to thrive. The number of hectares planted or the percentage of seedlings surviving after a few years are not sufficient measures of long-term restoration success. Number and locations of seed sources and germination levels in the nursery are equally important indicators.
Photo: Village chief Ngoutsimi Onana holding a gnetum (okok) tree seedling, Minwoho, Lekié, Centre Region, Cameroon.
Credit: CIFOR/O. Girard
Meeting global targets for restoring forest landscapes

The restoration to tree-based ecosystems of vast areas of degraded landscapes that currently provide minimal economic returns or ecosystem services represents an opportunity to expand productive land area while recovering biodiversity and mitigating climate change. Many countries have committed to meeting the Aichi Biodiversity Targets, including Target 15: to restore 15% of the world’s estimated 2 billion hectares of degraded ecosystems by 2020. Many have made specific pledges towards meeting ambitious targets, including the Bonn Challenge of 2011 to restore 150 million hectares of degraded and deforested lands by 2020, and Initiative 20x20 to restore 20 million hectares in Latin America and the Caribbean by 2020. The 2014 New York Declaration on Forests, a commitment to end deforestation and restore 350 million hectares of degraded land by 2030, has also been endorsed by many world leaders.

Meeting these goals involves overcoming major challenges. Restoration of self-sustaining tree-based ecosystems is a complex process and many efforts fail, often because people plant tree seeds or seedlings without paying sufficient attention to their suitability for the site. Native species are generally well adapted to local conditions. Planting a diversity of native species contributes to ecosystem resilience more than planting just one exotic species. However, restoration requires more than just planting the right combination of native species: choosing well-adapted, diverse seed sources within species can be just as important and this is frequently neglected.

The importance of genetic composition of seed sources

Because trees are long-lived, appropriately adapted planting material must be able to survive today’s conditions as well as the predicted environmental conditions of the near future. High diversity among planted seedlings allows natural selection to choose adapted individuals as conditions change. This means that seed must be collected from a large enough number of trees of each species (20-50 per population) to ensure that they comprise sufficient diversity to adapt to changing conditions.

If only a few trees remain in a forest patch, pollination between related trees becomes more likely. This often results in inbreeding, which reduces the viability of seed and seedlings and, thus, their probability of survival. Even if the seed is not inbred when it is collected, if it is collected from only a few individual trees per species, it is likely to lead to inbreeding in the future. This may not be detected until planted trees reach maturity, possibly after 30 years, but the next generations will reveal low viability of seeds and reduced vigour of seedlings, reducing the potential for ecosystems to become self-sustaining across generations. Changing climatic conditions and corresponding changes in the abundance, distribution or virulence of pests and diseases means that restoration planning must also integrate sufficient seed diversity so that the next generation has the potential to adapt and survive these new challenges.
20 years to ensure success

Forest landscape restoration initiatives that aim to establish self-sustaining forest ecosystems including planted trees, require multiple phases spanning years. Countries and agencies implementing restoration need long-term strategies to ensure success. The starting point varies between countries, but for some, it will be determining seed collection zones for target species, based either on ecological classification or field (provenance) trial results, to ensure that planting material can be matched to planting sites. After identifying and characterizing sites for restoration, seed collection from large, healthy, diverse populations of target species must be planned and carried out with ample time to collect when seed production is high and to grow seedlings in local nurseries. New local nurseries may be necessary to produce the required volume of native tree seedlings. Seed must be collected from enough (20-50) trees per population of each species to ensure adequate levels of genetic diversity. Nursery practices must ensure that the diversity is not inadvertently lost by discarding the slower growing or smaller seedlings. Monitoring success after out-planting also adds years. The timeline for restoration projects must be long enough to include every necessary step.
Measures of success: beyond counting hectares

Restored sites must be monitored using standards to ensure that investments are achieving their goals. Too often, restoration success is measured by counts of hectares treated, numbers of seedlings planted or short-term survival rates. None of these measures can detect problems associated with inbreeding or low diversity. Indicators are needed that can show that the planted material comprises sufficient diversity to reproduce, adapt and thrive through generations to come, for example, number and distribution of populations and individual trees from which seed is collected. Practical tools and protocols are needed to monitor the suitability of planted trees to planting sites and the adaptive potential of restored seedlings. Standards, indicators and monitoring protocols should be developed through a broad consultative process.

A synthesis of knowledge for scientists and practitioners

The 280-page book, *Genetic considerations in ecosystem restoration using native tree species*, presents the scientific foundations and evidence for the importance of genetics in restoration. This scientific review, carried out by Bioversity International and co-published with the Food and Agriculture Organization of the UN (FAO) in 2014, provides practical recommendations for researchers, policymakers and restoration practitioners to maximize the potential for success and safeguard restoration investments. It can be downloaded free at the following link: [www.fao.org/3/a-i3938e.pdf](http://www.fao.org/3/a-i3938e.pdf)
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