Importance of genetic considerations in forest landscape restoration

Restoring forest landscapes is recognized as one of the strategies for tackling some of the major environmental problems of our time, notably climate change, loss of biodiversity and desertification. The latest strategy of the UN Convention on Biological Diversity (2011-2020) sets the bold goal of restoring at least 15% of the world's degraded ecosystems by 2020.

The huge scale of this undertaking presents opportunities and risks. The restoration of vast areas of wastelands that currently provide minimal economic or ecological value to landscapes producing goods and environmental services represents an opportunity to increase our productive land area. However, to create these transformations requires addressing and overcoming risks of failure, many of which are associated with the qualities and the composition of planting materials, and the processes needed to restore a self-sustaining ecosystem.

Native tree species and their diversity

The value of using native tree species in ecosystem restoration is receiving growing recognition among practitioners and policymakers. Native species are well-adapted to local environments and should support native biodiversity and ecosystem resilience to a greater extent than would exotic planting material.

However, restoration requires more than just planting the right species. The genetic composition of reproductive material significantly affects the success of restoration both in the short and the long term. Matching seed sources within species to site conditions is essential for short term success.

Why are genetic considerations crucial for success?

Using planting material that is adapted to the changing environmental conditions of a restoration site is fundamental to ensure that the trees planted today will become the healthy forests of tomorrow. Tree populations need genetic variation for survival, good growth and viability in the long term. Genetic variation also enhances populations' resistance against acute and chronic stressors, such as pests and diseases and the effects of global warming.

Inadequate consideration of the source of planting material has led many restoration projects to fail. The widespread practice of collecting seed from only a few trees is a well-known contributor to such failures. It is also common to collect seed from remaining forest patches near restoration sites, but often these forests are too small or fragmented to sustain viable tree populations. When tree populations are small, mating among relatives increases, resulting in elevated inbreeding rates. Inbred seed tends to produce seedlings, and ultimately trees, that have reduced vigour and are vulnerable to pathogens and less able to survive new climatic conditions. Guidelines exist that describe how to carry out seed collection in a way that captures sufficient genetic diversity, but too often they are not followed.

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Photo: Women caring for tree seedlings in a nursery in Niger.
Credit: Bioversity International/L. Snook

What is needed?

The adoption of collection and propagation protocols that ensure the maintenance of broad genetic variation in planting material needs to become mainstream practice.

Plant nurseries are key players in the restoration process, but are often considered as simple service providers rather than as fundamental partners responsible for ensuring the genetic quality of planting material. Inappropriate nursery management can result in a drastic loss of genetic diversity, which compromises the potential for future survival of trees.

Monitoring tools and protocols that take into account indicators of genetic diversity in evaluation of the success of ecosystem restoration need to be developed. Traditionally, restoration success has been measured by counting numbers of hectares planted or calculating percentages of seedlings that survive till a certain age. Neither of these is an indicator of successful restoration in the long term. A more holistic approach is needed to evaluate the success of restoration projects in establishing tree populations that are genetically diverse and appropriate to the restoration site.

The way forward

Bioversity International is dedicated to creating awareness of the relevance and role of tree genetic resources in ecosystem restoration and disseminating knowledge to help practitioners and policymakers take the right decisions regarding the identity and quality of the most appropriate planting material.

Practitioners should promote resilience by choosing species and genetic diversity from sources that have similar conditions to the restoration site and will restore forests that provide food and fuel wood for the local populations. To ensure that optimal material for the site and restoration objectives can be identified and produced, they need to work closely with nurseries well before the intended planting or seeding time to plan for the sourcing of propagation material of the desired species and associated information. Bioversity International supports capacity development of restoration practitioners to increase the use of native tree species with a broad genetic base by promoting their awareness of best practices.

Bioversity International carries out research and develops protocols for the selection of reproductive material that is genetically diverse and adapted to the conditions of restoration sites, and to monitor and evaluate the effectiveness of restoration efforts in establishing genetically diverse tree populations, an indicator of long term ecosystem viability. Several restoration methods hold promise to create functioning ecosystems, but more research is needed to evaluate their effectiveness.

Bioversity International is also committed to working with policymakers to create enabling national policy environments that provide adequate financial support and foster long-term, ecologically-based forest management, explicitly favouring genetic conservation and the use of native species in ecosystem restoration. Bioversity International seeks the development of regulatory frameworks to guide the production and supply of propagation material of native tree species and the use of sufficiently diverse material of appropriate origin in restoration efforts.

A synthesis of knowledge for scientists and practitioners

Bioversity International scientists coordinated the thematic study on 'Genetic considerations in ecosystem restoration using native tree species' as an input to the first report on The State of the World's Forest Genetic Resources (2014) by the Food and Agriculture Organization of the United Nations (FAO).

The study reviews the scientific evidence on the role of genetic diversity in maximizing seedling survival and the regeneration potential of future tree generations, as well as in ensuring that restored forests are able to adapt to future biotic and abiotic stresses. It also synthesizes information on current practices in ecosystem restoration using native tree species and analyses how much attention is devoted to genetic considerations in the selection of planting material. The study presents a number of practical recommendations for researchers, policymakers and restoration practitioners to maximize the potential for success in ecosystem restoration.

The thematic study can be downloaded from www.fao.org/3/a-i3938e.pdf

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