Sharing the Land: Restoring Degraded Ecosystems and Improving Livelihoods Through Agroforestry

The challenge is daunting: how to feed more than 7 billion people – nearly 10 billion by 2050[1] – even as key resources become scarcer. Roughly 24% of the world's land area is degrading, including more than a fifth of the cropland and nearly a third of the forests – yet 1.5 billion people directly depend on degraded areas. Some countries are particularly hard-hit: 95% of Swaziland's land is degraded, as is 66% of Angola's, 64% of Gabon's, 60% of Thailand's, and 60% of Zambia's. In China, 457 million people are affected by land degradation.[2]

Land degradation corrodes the three pillars of sustainable development: environmental, social and economic sustainability. This has made conserving and restoring land a priority in many countries, and an estimated 16% of the world's land area is now improving.[3] Still, much greater efforts are needed to protect vital ecosystems, preserve resources and ensure there is enough productive land.

Restoring degraded land involves a wide range of approaches: from reforestation, to agricultural interventions to reduce harmful practices such as excessive tillage and overgrazing. This brief examines how agroforestry approaches in particular – growing trees with crops, and sometimes with animals – can advance land restoration and conservation while also strengthening livelihoods.[4]

We are far from the first to recognize this potential; in some regions, agroforestry has been a key land restoration strategy for more than 20 years.[5] A more prevalent approach, however, has been monoculture reforestation and, separately, intensified production on croplands. The focus then is to optimize land use for maximum productivity, while protecting wildlife and ecosystems through conservation. At the scale of agricultural landscapes, however, the effect may be to exacerbate sustainability challenges by growing low-biodiversity forests and isolating croplands from key ecosystem services, increasing the need for irrigation and chemical inputs that further degrade the land.[6]

'Mosaic restoration'

In 2011, the Global Partnership on Forest Landscape Restoration published a map of forest restoration opportunities around the world: 2 billion hectares from northern Canada, to sub-Saharan Africa. Up to half a billion acres, the project found, would be suitable for wide-scale restoration of closed forests; the remaining 1.5 billion hectares, it showed, were best-suited for "mosaic restoration", in which forests and trees are combined with agroforestry, smallholder agriculture, settlements and other uses.[7]

A cacao agroforestry system demonstration at the Cacao Research Sub Station in Sulawesi, Indonesia. Photo by Enggar Paramita/ICRAF (Flickr).

The map offers a big-picture perspective on the balance between "land-sharing" – the mosaics – and land-sparing: fully restoring forests where feasible. In fact, we would argue, land-sharing can contribute to land-sparing, by improving the quality of land available to meet human needs, helping ensure that croplands are used sustainably, and thus reducing pressure to cut down forests to expand agriculture. In that context, the agroforestry strategies that have emerged in the developing world, with their dual emphasis on arresting land degradation and reducing poverty and hunger, are particularly useful.[8]

Agroforestry also offers a more viable option in densely populated landscapes where arable land is in high demand, and complete reforestation may not be feasible from a socio-economic standpoint.[9] Rather than not reforesting at all, trees and shrubs can be planted along farm or field borders, on slopes and as wind breaks, in-between crops, or in clusters around homes – bringing environmental and economic benefits without sacrificing agricultural land.

The benefits of diverse plantings

Reforestation of degraded tropical lands can be slow and challenging, particularly in areas that have been fully deforested, and/or where severe soil erosion has occurred.[10] Several proven techniques exist, but they are costly, and land owners who engage in reforestation often choose to plant monocultures of exotic, high-value timber species. The resulting systems do increase the tree cover, but they do little to restore the biodiversity and ecosystem services of the original forests. As a result, the benefits to local communities are limited – as are the options for changing the future usage of the restored areas.

A more beneficial alternative, from an ecosystems perspective, is to create a multi-functional land use system. For example, native tree species can be planted together with shade-tolerant agricultural cash crops – such as coffee, cocoa or cardamom – or non-timber forest products such as rattans or medicinal plants. Such an approach also ensures economic viability and may improve biodiversity, ecosystem services and carbon capture, benefiting local communities and society as a whole.[11]

Tree seedlings in the Bendougou Nursery, in Mali, where agroforestry strategies have been widely implemented on cropland. Photo by Trees for the Future (Flickr).

By combining production and protection, agroforestry thus advances conservation, and it brings together two often-divergent groups to pursue a common goal: sustaining (and improving) the overall productivity of marginal land. This is vital because research suggests that the implementation of policies to avoid land degradation can only succeed if land users have control over the resources and are committed to maintaining their quality.[12] Thus, in developing programmes to restore degraded land, it is important to understand how humans interact with ecosystems; this is especially critical in biophysically marginal areas, which are particularly sensitive to misuse.[13]

Case study: Land degradation in Vietnam and Sri Lanka[14]

Land degradation is a major environmental problem for both Sri Lanka and Vietnam, affecting current livelihoods as well as the prospects for future development. In Sri Lanka, 32% of the land is degraded, affecting more than a quarter of the population; in Vietnam, 41% of the land is degraded, affecting more than a third of the population.[15] For both countries, agroforestry has become a key element of policies aimed at restoring degraded land while improving human well-being.

Sri Lanka, a densely populated island in the Indian Ocean, has seen its forest cover decline rapidly over the decades, to 44% in 1956 and 21% in 1997; the rate of decline has now slowed, but forest continues to be lost to development and human settlements.[16] Aiming to ease the pressure on natural forests, the government has focused on promoting tree-planting and intensification in home gardens, which are kept by large shares of both urban and rural dwellers – to the point that an estimated 13% of the country's land is devoted to home gardens.

Sri Lankan home gardens are highly biodiverse, multi-layered structures, with a canopy of mature trees and smaller trees, shrubs and various plantings underneath. Home gardens play an important role in households' food security and nutrition, and they are the most important single source of timber and fuelwood beside forests.[17] Land tenure reforms and major policy initiatives to foster food security, such as "Api Wawamu Rata Nagamu" (Let us grow, and uplift the nation)[18] have supported the establishment and expansion of these gardens by providing extension services and facilitating the sale of produce.

The national tree-planting programme "Deyata Sevana" and, more recently, "Divi Neguma" (Livelihood Development) aimed to add 1.5 million home gardens to help achieve self-sufficiency in vegetables and reduce vegetable prices; the target was later increased to 2.5 million gardens. Now Sri Lanka is considering ways to include home gardens in its national climate change mitigation and adaptation strategies, as well as in the REDD+ reforestation and land restoration programme.[19]

In Vietnam, meanwhile, forest cover declined for many decades, but has actually been recovering in recent years, driven by reforestation by farmers and private enterprises. During 1990–2005, the productive forest plantations area in Vietnam increased by 5% annually, and farm-based plantations increased significantly. Private farm-based plantations emerged after 1987, when the free market was introduced and most of the barren or degraded forest land was privatized and allocated. Farm forestry is one of several forestry and tree production systems supported by Vietnam's ambitious reforestation policy, which includes several measures but is best known for the target set in 1998 to reforest 5 million hectares, including 2 million by individual entities such as households and entrepreneurs.

Vietnam has explicitly used forestry policies to help alleviate poverty, which has declined sharply in the last two decades. As households have received allocated forest land, many have

A fledgling "forest garden" grows on degraded land in Vietnam. Photo by Matilda Palm.

converted it into agroforestry systems, or "forest gardens", with a combination of tree plantations, grown for a profit, and agricultural crops for household consumption and for sale. Rural livelihoods have improved in many places as a result, in terms of both cash flow and resilience to stresses such as climate change.

Notably, Sri Lanka and Vietnam came to support small-scale agroforestry systems for different reasons, but the results have been similar: both are achieving an increased tree cover, a decrease in degraded lands, and improved livelihoods and resilience.

A growing body of knowledge

Home gardens are only one of multiple agroforestry approaches that have been extensively tested in different countries. Millions of hectares around the world are now covered with agroforestry systems, including, for example, 2.8 million ha of jungle rubber forest in Indonesia; 7.8 million ha of cocoa agroforests worldwide; 9.2 million ha of silvopastural systems in Central America; and 5.1 million ha of diverse agroforestry systems in Mali (90% of the country's agricultural land).[20]

A recent review[21] found that in some parts of Borneo, rubber cultivation had led to increased tree cover, as farmers moved from an extensive to a more intensive land use system. Farmers in the cases studied created "rubber gardens" in fallow or secondary forest areas or added rubber trees to their home gardens, and also planted fruit trees and other economically valuable species.

The same review found that in Côte d'Ivoire, land scarcity and government enforcement of forest-clearing bans had led cacao farmers to shift to more sustainable practices, planting grasslands and shrubby fallows with cacao, fruit trees and high-value timber trees. And in Central America and Mexico, the review found, proposals were being developed to leverage the environmental services provided by shade-grown coffee plantations – such as watershed protection, biodiversity benefits, and carbon sequestration – to improve rural livelihoods.

Yet another case study, of the use of the nitrogen-fixing species *Sesbania Sesban* and *Tephrosia Vogelii* in Zambia, found that maize yields after two years of fallow with those species were similar to those of fully fertilized fields. The same species plus *Crotalaria grahamiana*, meanwhile, doubled maize yields in western Kenya. And across Africa, the use of the nitrogen-fixing tree species *Faidherbia albida* has been well proven to boost maize yields, especially in low-fertility soils.[22]

Ways forward

Much remains to be learned about the potential benefits and limitations of different agroforestry strategies. The evidence so far suggests that solutions must be carefully chosen to fit the local context; for example, one effective strategy, hedgerow intercropping, can be problematic in water-scarce areas, as the trees or shrubs will compete for water with the crops.[23] Excessive tree shade can hinder crop maturation, and while some tree species improve the soil chemistry for crops, others can harm it.

It is also crucial to understand the needs, motivations and constraints of local farmers and forest owners. Changing practices will often be challenging, and the choices made "on the ground", while economically beneficial to individuals, may not bring broader environmental or social benefits. Policies and incentives must thus be crafted and enforced carefully; in the many countries where forestry and agriculture fall under different ministries, close inter-agency collaboration is also essential.[24]

Agroforestry strategies have the potential to rehabilitate degraded land to support livelihoods, improve food security, restore ecosystem services, and ease pressure on forests – but achieving these gains is not easy. The process takes time and effort, good policies and enforcement, and substantial investments to help small-scale farmers, who are unlikely to have the resources to restore degraded lands without support. Secure land tenure is crucial, as many of these investments take years to pay off. Monitoring before and after is also essential, to ensure that interventions achieve the desired goals, and if they don't, make the necessary adjustments.

Endnotes

1 See UN-DESA (2013). World Population Prospects: The 2012 Revision. United Nations Department of Economic and Social Affairs, Population Division, New York. http://esa.un.org/unpd/wpp/index.htm.

2 All land degradation data come from Bai, Z. G., Dent, D. L., Olsson, L. and Schaepman, M. E. (2008). *Global Assessment of Land Degradation and Improvement. 1. Identification by Remote Sensing*. GLADA Report 5/ISRIC Report 2008/01. ISRIC World Soil Information, Wageningen, Netherlands. http://www.isric.org/projects/land-degradation-assessment-drylands-glada.

Maize grows under a canopy of *Faidherbia albida*, a nitrogen-fixing tree species that has been successfully used across Africa. Photo from ICRAF archives (Flickr).

3 Ibid.

4 We draw our agroforestry definition, and many key insights, from Nair, P. R. (2007). The coming of age of agroforestry. *Journal of the Science of Food and Agriculture,* 87(9). 1613–19. DOI:10.1002/jsfa.2897.

5 For examples, see Nair (2007), op.cit., as well as: Cardoso, I. M., Guijt, I., Franco, F. S., Carvalho, A. F. and Ferreira Neto, P. S. (2001). Continual learning for agroforestry system design: university, NGO and farmer partnership in Minas Gerais, Brazil. *Agricultural Systems, 69*(3). 235–57. DOI:10.1016/S0308-521X(01)00028-2.

And: Garrity, D. P., Akinnifesi, F. K., Ajayi, O. C., Weldesemayat, S. G., Mowo, J. G., Kalinganire, A., Larwanou, M. and Bayala, J. (2010). Evergreen Agriculture: a robust approach to sustainable food security in Africa. *Food Security*, 2(3). 197–214. DOI:10.1007/s12571-010-0070-7.

6 For a succinct discussion of these issues, see DeClerck, F. (2013). Land sharing or sparing? Considering ecosystem services in the debate. *Agriculture and Ecosystems Blog*. http://wle.cgiar.org/blogs/2013/09/20/land-sharing-or-sparing-considering-ecosystem-services-in-the-debate/.

7 See Minnemeyer, S., Laestadius, L., Sizer, N., Saint-Laurent, C. and Potapov, P. (2011). *Global Map of Forest Landscape Restoration Opportunities.* Global Partnership on Forest Landscape Restoration. World Resources Institute, International Union for Conservation of Nature and South Dakota State University. http://www.wri.org/resources/maps/global-map-forest-landscape-restoration-opportunities.

8 See Nair (2007), op.cit.

9 See Erdmann, T. K. (2005). Agroforestry as a Tool for Restoring Forest Landscapes. In *Forest Restoration in Landscapes: Beyond Planting Trees*. S. Mansourian, D. Vallauri, and N. Dudley (eds.). Springer New York. 274–84. http://link.springer.com/chapter/10.1007/0-387-29112-1_40.

10 See Lamb, D., Erskine, P. D. and Parrotta, J. A. (2005). Restoration of Degraded Tropical Forest Landscapes. *Science*, 310(5754). 1628–32. DOI:10.1126/science.1111773.

11 Along with Lamb et al. (2005), op.cit., see Erdmann (2005), op.cit., and Mattsson, E., Ostwald, M., Nissanka, S. P. and Marambe, B. (2013). Homegardens as a Multi-functional Land-Use Strategy in Sri Lanka with Focus on Carbon Sequestration. *AMBIO*, 42(7). 892–902. DOI:10.1007/s13280-013-0390-x.

12 See Palm, M., Ostwald, M., Berndes, G. and Ravindranath, N. H. (2009). Application of Clean Development Mechanism to forest plantation projects and rural development in India. *Applied Geography*, 29(1). 2–11. DOI:10.1016/j.apgeog.2008.05.002.

13 See Sanchez, P. A. (1995). Science in agroforestry. *Agroforestry Systems,* 30(1-2). 5–55. DOI:10.1007/BF00708912.

14 Unless otherwise noted, all the material in this section is drawn from Palm, M. and Mattsson, E. (2014). Cultivating resilient landscapes - opportunities for restoring degraded and vulnerable lands with agroforestry systems. Presented at the World Congress on Agroforestry, New Delhi, India, 10-14 February.

15 See Bai et al. (2008), op.cit.

16 See Pushpakumara, D. K. N. G., Marambe, B., Silva, G. L. L. P., Weerahewa, J. and Punyawardena, B. V. R. (2012). A review of research on homegardens in Sri Lanka: the status, importance and future perspective. *Tropical Agriculturist*, 160. 55–125.

17 Ibid.

18 See Ministry of Agriculture (2013). Api Wawamu Rata Nagamu Programme. 3 December. http://www.agrimin.gov.lk/web/index.php/en/project/12-project/164-api-wawamu-rata-nagamu.

19 For an overview of REDD+ activities, see UN-REDD Programme (n.d.). Sri Lanka. http://www.un-redd.org/AboutUNREDDProgramme/NationalProgrammes/Sri_Lanka/tabid/79595/Default.aspx. [Accessed 4 February, 2014.]

20 See IIASTD (2009). *Agriculture at a Crossroads: Global Report*. International Assessment of Agricultural Knowledge, Science and Technology for Development. Island Press, Washington, DC. http://www.unep.org/dewa/Assessments/Ecosystems/IAASTD/tabid/105853/Default.asp.

21 See Erdmann (2005), op.cit.

22 See Garrity, D. P., Akinnifesi, F. K., Ajayi, O. C., Weldesemayat, S. G., Mowo, J. G., Kalinganire, A., Larwanou, M. and Bayala, J. (2010). Evergreen Agriculture: a robust approach to sustainable food security in Africa. *Food Security*, 2(3). 197–214. DOI:10.1007/s12571-010-0070-7.

23 Ibid.

24 For an in-depth discussion of policy implications, see Buttoud, G. (2013). *Advancing Agroforestry on the Policy Agenda: A Guide for Decision-Makers*. Agroforestry Working Paper No. 1. Food and Agriculture Organization of the United Nations, Rome, Italy. http://www.fao.org/docrep/017/i3182e/i3182e00.pdf.

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