# Agroforestry for an Evergreen Revolution

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M. S. Swaminathan, an outstanding agricultural scientist and statesman, is hailed as the Father of Green Revolution in Asia. Time Magazine recognized him as one of the 20 most influential persons of Asia in the twentieth century. A winner of numerous prestigious recognitions and awards including the First World Food Prize, 1987, Prof. Swaminathan was the chairman of ICRAF Board of Trustees in the early 1980s.

**Abstract** Africa needs an "evergreen revolution" that increases productivity in perpetuity without causing ecological damage. Agroforestry clearly has a key role to play in this evergreen revolution. Novel solutions and technological advances must be married with ecological thinking to drive a truly sustainable agricultural revolution. Building a successful evergreen revolution requires four components: technology, services, favorable public policies, and farmer enthusiasm.

**Keywords** Ecological thinking • Africa • Germplasm conservation • Anticipatory research

Today, African agriculture faces two major challenges. First, farmers need higher farm productivity to provide them with a marketable surplus and cash income. In Africa, 80 % of food production is from smallholder farmers, for whom agriculture is the backbone of their livelihood and food security. The productivity of these farms has traditionally been very low. Higher productivity must be achieved, but without

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harming the ecological foundations essential for sustainable agriculture. Second, climate change threatens agriculture in many parts of the world, especially in Africa. Risks rise rapidly with temperature. Once the temperature increases by about 2 °C, up to four billion people could be experiencing growing water shortages. Agriculture could cease to be viable in some parts of the world, particularly in the tropics, and millions more people will be at risk of hunger. To respond to these challenges of climate change, food security, and ecosystem degradation, Africa needs an "evergreen revolution" that increases productivity in perpetuity without causing ecological damage. Agroforestry clearly has a key role to play in this evergreen revolution.

Novel solutions and technological advances must be married with ecological thinking to drive a truly sustainable agricultural revolution. A key aspect of this effort will be conservation of the germplasm of locally available plant materials and their genetic diversity. The conservation continuum in the case of annual crops starts from the field and the farmers and their in situ (on-farm) conservation traditions. For example, today we have about 140,000 varieties of rice. More than 100,000 of them are in the IRRI (International Rice Research Institute) Gene Bank. They are all indigenous land races that farmers had conserved. If these races are lost, we will be losing a lot in intraspecific variability.

Today, we have various kinds of conservation mechanisms for rice, starting with on-farm conservation to gene banks of various kinds including the Svalbard Global Seed Vault, where rice germplasm is retained under permafrost conditions. We need the same continuum of conservation mechanisms for agroforestry and forestry tree species, starting with farmers' conservation complemented by gene banks and other methods of conservation, including tissue culture and so on.

In some of the program areas of the MS Swaminathan Research Foundation in India, we assist farm women and men to conserve their own plant genetic materials because such materials have a high level of resilience and resistance to drought, flooding, and other natural disasters. The farmers are encouraged to create seed banks of their own preferred grains such as *Pennisetum* spp., *Setaria* spp., and so on. These seed banks help rural people overcome the potential danger of the seed source being wiped out by a drought or other such calamities.

The farmers are also encouraged to maintain "water banks" or "rain banks" along similar lines. This overall approach of farm level or in situ conservation won for this group – composed largely of tribal women in the remote areas and lower echelons of the society – the Equator Initiative Award at the World Summit on Sustainable Development, 2002, in Johannesburg, South Africa.

There are several wonderful indigenous plants – medicinal plants, food plants, horticultural species, and so on – that are used in local agroforestry systems that are gradually disappearing. *Prosopis juliflora*, which is a common shrub in the arid and semiarid tropics and is usually considered a weed, is nevertheless a wonderful species that is tolerant to drought and salinity. It is now sought after as a source of genes for drought and salinity tolerance.

It is absolutely critical to conserve these genetic materials. Their conservation can be stimulated through economic rewards to farmers, thus creating economic

stake in conservation. Today, when there is a high economic stake in exploitation and destruction, it is time that we reverse the paradigm and create an economic stake in conservation.

Agroforestry opportunities in mangrove areas are another important issue. This has tremendous potential and is attracting attention only now because of the alarm about the rise of sea levels. The sea level obviously is going to rise. In Africa and India, we have long coastal shore lines, and many of our major cities are along the coasts. We at the MSSRF are trying mixed cropping in mangroves as part of our experiments on agroforestry systems along the coastal shoreline of India. Halophyte mangrove trees that tolerate saline conditions, such as *Salicornia* species and *Atriplex* species, have a great deal of value. They could be a wonderful repository of genes for salinity tolerance.

Root and leaf exudates of the mangrove forests that are rich in nutrients support shrimp and fish production. One of the strategies we are testing is integrated sea water farming, or "agro-aqua" farm cultivation with halophytes. The wood needs of the local community will be met by incorporating woody species such as bamboo and casuarina into these systems. After the 2004 tsunami in Asia, people started realizing the great value of mangroves, which acted as speed breakers during that event. The tsunami damage was comparatively less in areas wherever there were dense mangrove forests along the coast, compared with those that did not.

Carbon sequestration has both a direct and an indirect role in agroforestry. Direct carbon sequestration rates vary from species to species. Indirectly, agroforestry also has some other important consequences for carbon sequestration since it helps to reduce the pressure on natural forests and helps to avoid deforestation. The IPCC (Intergovernmental Panel on Climate Change) recognizes that agroforestry systems have the highest carbon sequestration potential among managed land use systems, followed by grazing management, forest management, and crop plant management in that order.

Interest and awareness about the importance of trees and agroforests has increased tremendously in India lately, such that today there is enormous support for it among all sectors of the society – public, media, political, and professional – as a way to regreen India. For the first time, we find not only that we are no longer losing ground but the area in India under tree cover is now increasing, particularly because of the expansion of agroforestry. The Government of India just announced a scheme involving over one billion US dollars per year for the rejuvenation of degraded forests and the planting of trees in new areas, including establishment of agroforestry systems.

In conclusion, as noted by Edward Wilson while acknowledging a copy of my 1974 book on *Evergreen Revolution:* "The problem before us is how to feed billions of new mouths over the next several decades and save the rest of life at the same time." Because the population is growing rapidly and may reach ten billion by 2050, we are very worried that the population supporting capacity of the ecosystem has already been exceeded in many parts of the world. Indeed, it is a daunting challenge to feed the billions of new mouths without compromising our freedom and security.

An "evergreen revolution" is the best approach to address this problem. The aim of this new thrust is to lift food production well above the level attained by the green

revolution of the 1960s, but using technology and regulatory policy more advanced and even safer than that used now. Building a successful evergreen revolution requires four components: technology, services, favorable public policies, and farmer enthusiasm. The issue of regulatory policy is very important: With the increasing application of biotechnology, it has become very important to ensure that the new tools are used in a safe and responsible manner, and that the risks and benefits are measured without exaggerating either. We must also embrace regulatory mechanisms so that the ethical dimensions of the use of new technologies are not forgotten.

We need to be proactive so that we remain prepared to address the occurrence of natural calamities such as more droughts, more floods, and higher temperature as a consequence of climate change. That is called anticipatory research. Anticipatory research and participatory research are two pillars of sustainable agriculture. Participatory research refers to involving farmers and their families in the research so that their traditional wisdom is meshed with modern technology. Both of these approaches must be combined together, so that we have opportunities for both of them to contribute their full measure. I hope this congress will show the way for that. Africa urgently needs further research and scaling up to create a real evergreen revolution.