



AGMARDT Keynote Address

Seed Futures: Biodiversity and the Future Use of Seeds presented by Prof. Hugh W. Pritchard, Seed Conservation Department, Royal Botanic Gardens Kew, Wakehurst Place, West Sussex, United Kingdom (E-mail: h.pritchard@kew.org)

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The keynote address discussed the opportunities biodiversity provides to humanity, challenges to its conservation and the essential role seeds will play in enabling the future use of this biodiversity.

The value of biodiversity

Our reliance on plant diversity for medicinal purposes is considerable, with about three-quarters of the world's population depending on traditional medicines for primary health care. Chinese medicine employs more than 5,000 plant species, and Indian medicine has been estimated to use 7,000 species. In contrast, a mere 12 domesticated plant species (8 cereals and 4 tubers) provide about 80% of our plant-based food intake, yet there are over 30,000 edible plant species. Clearly much biodiversity is underused, raising the question of whether the world can afford to rely on such a tiny fraction of edible plant diversity for all future needs. Relative to the world's flora, there is limited genetic variation in approximately 70 crops that form the basis of the International Treaty on Plant Genetic Resources for Food and Agriculture¹. One of the main obstacles to the wider use of plant species is the lack of characterisation data for useful traits, such as nutritional quality, energy source, growth under marginal conditions. It will take some time to create, document and share such information. In the meantime, it is imperative that the precautionary principle continues to be applied with respect to the need to value and conserve biodiversity, i.e., that all species deserve

protection from loss. In the words of Aldo Leopold in *Round River* (OUP, 1993²):

“If the biota, in the course of aeons, has built something we like but do not understand, then who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering.”

But is the cost of maintaining biodiversity economically viable? Recent analyses of the value of services that ecosystems provide suggest that it is [see *The Economics of Ecosystems and Biodiversity* (TEEB³)]. For example, ecosystem services have been estimated to be worth USD 30-40 trillion per annum, globally. In contrast, the cost of preserving tropical forests, one of the natural areas that provide these services, is estimated at USD 0.8-27.50 per ha per annum. Similarly, it has been suggested that the cost of protecting the Cape Floristic region would be a one-off charge of about USD 522 million, plus an ongoing cost of USD 25 million per annum. Despite the value of these ecosystems, only approximately 12% of the world's land area is protected (e.g., as reserves). Nonetheless the protected area provides essential *in situ* conservation for many plant species.

Threats to biodiversity

Climate change will clearly have a major impact on food production. Crop yields will decrease in many areas as global average temperatures increase and there will be greater

¹ <http://www.planttreaty.org/>

² <http://gargravarr.cc.utexas.edu/chrisj/leopold-quotes.html#various>

³ <http://www.teebweb.org/>

threat of water shortages, coupled with rising sea levels, damage to coral reefs and extreme weather events (Inter-governmental Panel on Climate Change⁴). As a result of these many changes to the environment, increasing numbers of species are facing extinction, perhaps as many as 60,000-100,000 plant species. The current rate of extinction is 100-1,000 times that of the background rate estimated from the fossil record (Millennium Ecosystem Assessment⁵). It is important to recognise (and therefore target action appropriately) that not all biome threats are equal. Montane and forest, particularly tropical, areas are particularly vulnerable as evident by the fact that about one-fifth of the world's tropical forests were destroyed between 1960 and 1990.

Over the last 10 years the international effort to, *inter alia*, combat the loss of plant biodiversity has been mobilised under 'Global Strategy for Plant Conservation (GSPC⁶)' within the Convention on Biological Diversity (CBD). The GSPC has four main themes, within which there are specific targets for action. The themes are: (1) understanding and documenting plant diversity; (2) conserving plant diversity, *in situ* and *ex situ*; (3) using plant diversity sustainably; (4) promoting education and awareness. The targets for the next phase of the GSPC (2011-2020) are currently being finalised.

The Millennium Seed Bank Partnership

The greatest recent effort to conserve biodiversity *ex situ* has been through seed banking within the Millennium Seed Bank Project (MSBP), which has been managed by the Royal Botanic Gardens, Kew, UK. Seed banks are an ideal way to store plant genetic diversity, as most species produce large numbers of seed through out-crossing. Not only seeds are conserved but also valuable information associated with the collection, e.g.,

date of harvesting the seed, site location and habitat information, etc.

From 1997-2000 the MSBP completed the conservation *ex situ* of >95% of the UK seed-bearing flora. During the same interval the Wellcome Trust Millennium Building was constructed, containing a seed vault and state-of-the-art science and training facilities. From 2000 to 2009 the MSBP conserved 10% of the world's flora (24,200 species) through a global network of collaborators in countries from Chile to China. The Project has evolved into the MSB Partnership, with >50 countries engaged in collaborative practical conservation and scientists in about 60 countries involved in science, technology and innovation projects. Issue 17 of SAMARA, the project newsletter, provides a 10-year summary of the project/partnership⁷.

Seed futures

The international seed trade in 2006 was estimated at >USD 5 billion⁸. The trade is mainly of species of agricultural, industrial and forestry value, and much of this is through multi-national companies. However, local people already put a much broader range of biodiversity to work, contributing to poverty alleviation. Greater benefits to local people will accrue, however, only if there is an enhanced commitment to development science⁹. Plants are simultaneously part of the problem (deforestation) and solution (carbon capture-mitigation) to climate change and associated development challenges. Undoubtedly, meeting the challenge will require the availability of high quality seeds of local adaptive value. However, the characteristics of biodiverse seeds are often unknown. Generating information on the seeds' chemical, biophysical and physiological properties – and making that information available as public goods – will increase the future use of seeds.

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<http://www.kew.org/msbp/scitech/publications/samara.htm>

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http://www.worldseed.org/isf/evolution_seed_trade.html

⁹ <http://www.ukcids.org.uk/>

⁴ <http://www.ipcc.ch/ipccreports/ar4-wg1.htm>

⁵ <http://www.millenniumassessment.org/en/index.aspx>

⁶ <http://www.cbd.int/gspc/>

Two recent examples in the bioenergy/seed oil sector serve to illustrate the point. *Jatropha curcus* is currently being trialled across the world as a biofuel crop (40% of the seed is oil) on marginal lands. Some agronomic features remain to be improved, including the production of low phorbol ester (a toxin) cultivars. It is hard not to believe that the future improvement of this new crop will be highly dependent on traits found in associated species; with about 170 species in the genus, there are many to locate, protect and assess. Another example is *Allanblackia*, which is now being cultivated, in Ghana and Tanzania especially, for its edible seed oil (about 70% of seed weight). The tree is being grown on a commercial scale with a view to the oil replacing palm oil in the manufacture of products like margarine and soaps¹⁰. As the future market for seed oils will increase with population growth, where might we look for new sustainably harvestable species? In dryland regions, cactus seeds, e.g., of *Stenocereus thurberi*, are a potential source of amino acids, minerals and highly nutritious oil. To date less than 15% of the 1,500 species of cacti have been characterised for seed oil.

Traits other than seed oils will contribute to future markets. For example, as desertification increases so does the amount of land affected by salinisation. Halophytes have evolved in saline habitats and are an untapped source of food, fibre and bioenergy¹¹. Part of the competitive advantage of halophytes comes from the tolerance of the seeds to salt during the germination and establishment phase. In matching species to the environment it thus becomes important to understand how germination rates and thresholds vary between species under salt stress.

Human capital

Many of the studies referred to above could be delivered in the developing world. However, there is a general shortage of seed scientists and technologists in developing countries. Thus to increase the future use of seed of biodiverse species, strategies will need to be developed to recruit, train and retain seed biologists, particularly in the tropics. Apart from the development of appropriate academic and practical courses, student projects need to be focussed on environmental challenges that can be addressed through hypothesis-driven research.

Conclusion

The future sustainable use of plants will be highly dependent on the provision of biodiverse seed. However, the seed will contribute to future markets only if it has been fully characterised.

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<http://www.worldagroforestry.org/treesandmarkets/allanblackia/>

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http://www.cost.esf.org/domains_actions/fa/Actions/FA0901-Putting-Halophytes-to-Work-From-Genes-to-Ecosystems-End-date-May-2013