Biodiversity IN Development

Biodiversity Brief 6

Food security and biodiversity

The husbandry of domesticated species and the harvesting of wild plants and animals are the mainstay of human food production. 840 million people in the world do not have enough to eat – and the population is growing. This means that food production will have to increase 50% by 2020. Biodiversity is part of the solution, in that it provides the genetic information used in plant and animal breeding. Furthermore it makes vulnerable livelihoods more resilient by providing risk spreading options across a range of domesticated and wild species rather than relying on a few staples that may become susceptible to disease, pests, climate changes, and market collapse. It also provides diversity for a varied diet.

Biodiversity pyramids

The greater part of the world's food supply depends on a very limited number of plant and animal species. About 7,000 plants (2.6% of all plant species) have been collected or cultivated for human consumption. Of these, a mere 200 have been domesticated and only a dozen contribute about 75% of the global intake of plant-derived calories: bananas, beans, cassava, maize, millets, potatoes, rice, sorghum, soya, sugarcane, sweet potatoes and wheat. On the animal side, more than 95% of world consumption of livestock protein derives from poultry, cattle and pigs. There are about 1,000 commercial fish species, but in aquaculture fewer than 10 species dominate global production. Human food production therefore rests on the tips of pyramids of biodiversity, leaving the majority of species little-used and undomesticated.

Long-domesticated species tend to be highly diverse: for example, there are some 25,000 cultivars of wheat, more than 1,300 breeds of sheep, and over 20 varieties of common carp. In recent years, however, this variety has been reduced by genetic erosion. It is estimated that the number of wheat cultivars in China has dropped from 10,000 to 1,000 in 50 years; that over 90% of cabbage, field maize and pea varieties no longer exist; and that over 30% of livestock breeds are at risk of extinction. The causes of this genetic erosion are many, but replacement of local varieties as a result of the spread

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Biodiversity and nutrition

The quality of food, especially in terms of supplying essential vitamins and other nutrients, is central to achieving food security and avoiding nutritional diseases. Although staple crops and stock provide most protein and energy requirements, they are often deficient in other nutrients. In rice-consuming countries, for example, common nutritional deficiencies include: iron, vitamin A, iodine, thiamine, riboflavin, calcium, vitamin C, zinc, fat, and ascorbic acid. Many of these nutrients are supplied by foods gathered from wildlands and fallows, upon which millions of people rely. They include green leafy vegetables which are cooked and eaten along with the meal, and which can provide important iron and vitamin A supplements. Other such 'minor' products include nuts, oils, insects, mini-fish, birds, roots/tubers providing a range or fats, vitamins, minerals, and oils.

European Commission

DFID
Department for International Development

IUCN
The World Conservation Union

Estimates of the number of rice varieties in the world vary; however their importance in providing a reliable and robust staple food for millions of people is undeniable.

of modern agriculture is the most consistently cited reason.

This loss of agro-biodiversity presents risks to food production, in three main ways:

- a narrowing of future options, through the loss of genetic information and genetic material that could be introduced into domesticated crops and stock through breeding;
- an increased susceptibility to disease and pests because fewer varieties and species are grown over large areas, which may also lead to pesticide (and even fertiliser) dependence;
- the destabilisation of ecosystem processes, through disrupting soil formation, predator-prey cycles, etc.

These risks apply particularly to poor farmers who have little access to technology or gene-banks for solutions, but they also apply to commercial breeders who depend on the diversity inherent in local crops and breeds, as well as in wild relatives of domesticated species, for future breeding programmes. Many varieties that have been developed locally, such as the 3–5,000 potato cultivars in the Andes, offer a vital starting point in future breeding programmes.

Crop and livestock biodiversity hotspots (areas with high genetic diversity), together with *ex situ* gene-banks, are the main repositories of genetic information. As a result they are at the centre of a conflict over ownership, because genetic resources have been treated as 'global goods', and multilateral agencies which develop gene-banks have sent seeds, semen and other materials to researchers anywhere in the world. The Convention on Biological Diversity (CBD) urges nations and communities to assess their biodiversity and establish their rights to its exploitation, but access to genetic resources that were gathered before the CBD came into force remain largely unregulated.

Small-scale and subsistence agriculture

Many poor farmers, especially those in environments where high-yield crop and livestock varieties do not prosper, rely on using a wide range of crop and livestock types. This helps them maintain their livelihood in the face of pathogen infestation, uncertain rainfall, fluctuation in the price of cash crops, socio-political disruption and unpredictable availability of agro-chemicals. So-called 'minor crops ' (more accurately, companion crops) play a disproportionately large role in food production systems at the local level. Plants that will grow in infertile or eroded soils, and livestock that will eat degraded vegetation, are often crucial to household nutritional strategies. In addition, rural communities, and the urban markets with which they trade, make great use of companion crop species, especially green-leafed pot-herbs.

Fallow fields and wildlands can support large numbers of species useful to farmers. In addition to supplying calories and protein, wild foods supply vitamins and other essential micro-nutrients. In general, poor households rely on access to wild foods more than richer ones (see table), although in some areas pressure on the land is so great that wild food supplies have been exhausted.

Government and donor policies to promote food production through monocultures may overlook these resources, distort farmers' decision-making and threaten biodiversity. A common problem has been the introduction of new varieties, or species, with high input-

Proportion of food from wild products, for poor, medium and relatively wealthy households

Survey site	Date	Very Poor	Middle	Better off
Wollo – Dega, Ethiopia	1999	0–10%	0–10%	0–5%
Jaibor, Sudan	1997	15%	5%	2–5%
Chitipa, Malawi	1997	0–10%	0–10%	0–5%
Ndoywo, Zimbabwe	1997	0–5%	0	0

Source: Save the Children Fund (ANA).

needs, and then subsidising chemical inputs. Programmes for maize production in drought-prone environments of southern Africa, for example, have deterred the use of a wide range of local crop varieties. And redirecting Indus River water to irrigated agricultural schemes, caused salination of the river's mangrove delta which changed from a diverse and highly productive region, supporting a large human population, to a sparsely vegetated area dominated by a single species, *Avicennia marina*.

Ecosystem disruption: introductions and agro-chemicals

Despite the benefits to local farmers of biodiversity-rich agriculture systems, indigenous varieties often have co-evolved pests and pathogens and may therefore have relatively low yields. In this sense, the introduction of crop species from outside their centre of origin has been extremely beneficial, and much agricultural development has relied upon it. But some introductions, accidental and intentional, have had significant impacts on local ecosystems, often with major implications for food security.

A common pattern is for a newly-introduced crop to be initially successful and then show declining yields, either through attack by evolving local species or from the introduction of a pest or pathogen from its region of origin (see BB7).

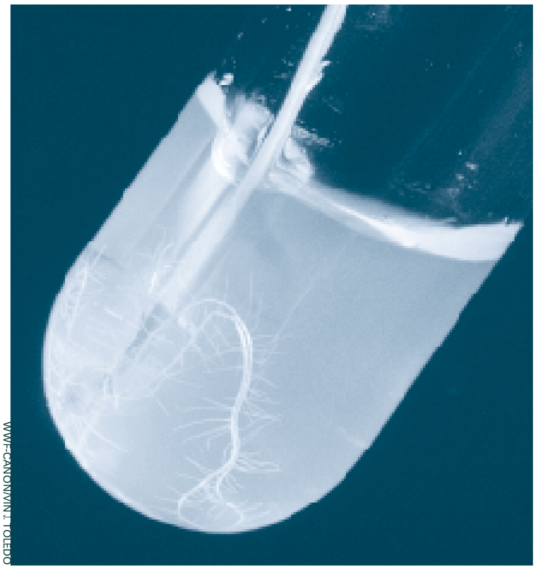
A different ecosystem balance that needs to be maintained for food production is in the soil, where invertebrates and microbes are central to decomposing dead materials and recycling nutrients as part of soil formation processes. Furthermore, there are important plant-soil relationships which should not be disrupted: certain soil fungi form mycorhizal associations on plant roots which enhance nutrient uptake from the soil; *Rhizobium* bacteria produce nitrogen-fixing nodules on plant rootlets. Applications of organic fertiliser, such as manure in mixed farming systems, tend to fortify these interactions and increase soil fertility, but loss of organic matter and/or large applications of inorganic fertilisers can lead to reduced soil fertility and pollution of waterbodies.

Breeding and biotechnology

A large part of the success of the Green Revolution can be attributed to genetic biodiversity that was harnessed to breed new, high-yield crop varieties. Modern plant breeding often aims for wide adaptability and tries to develop varieties that are insensitive to daylight length (and can therefore grow anywhere). It has often been directed to producing varieties that respond to fertiliser applications, and may be grown where pesticides and irrigation are available. The result is an increase in production, but a narrowing of the number of varieties grown. This can make them less accessible to poor farmers, and lead to the various problems noted above. A careful balance needs to be struck.

Part of the solution to addressing this clutch of problems is through participatory approaches to plant breeding and selection of new varieties. These attempt to decentralise plant breeding and incorporate the priorities and constraints of farmers more closely into the selection of new varieties. Farmers test them, often with low- level or no fertiliser, adopting them only if they outperform local varieties grown under the same conditions. In western India, participatory plant breeding has helped to conserve plant genes by crossing indigenous rice varieties that are more heterogeneous than those resulting from centralised breeding.

The most well-known and controversial examples of biotechnology are transgenic crop varieties, or genetically modified organisms (GMOs). These are the product of the transfer of genes from one organism to another, often resulting in genetic exchange between unrelated species (e.g. daffodil genes into rice). Most GMOs offer herbicide tolerance or insect resistance and are commonly directed at commercial farming in the North. The potential of GMOs to outcross with wild relatives of crops is prompting concerns: if a trait from a GMO conferred adaptive advantage on a wild relative it could alter the plant populations that act as a reservoir of genes for cultivated species in the future.



Biotechnology is used here to transfer a trait from a wild *Oryza* sp. to domesticated, high-yield rice. While such techniques are highly controversial in the West, estimates by CGIAR suggest that biotechnology might improve food yields in developing countries by up to 25%.

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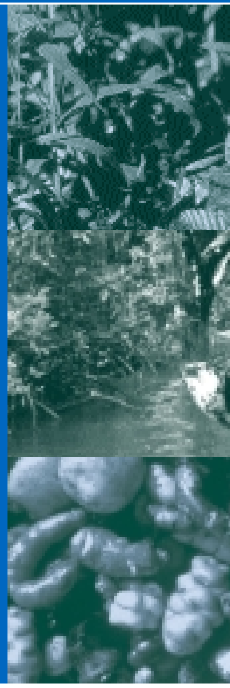

Conclusions

- Programmes of collection and characterisation of indigenous crop, livestock and fish stock varieties should be supported and extended, paying particular attention to their ability to yield under low-input conditions. In conjunction with this, economic incentives and institutional barriers to maintaining crop, livestock and fish biodiversity, and biodiversity-rich farming systems must be reviewed.
- Support should be given to developing countries in their efforts to assess their genetic resources, establish systems for its use which brings benefits to the country, and ensure that the benefits from international and national breeding programmes reach rural communities. Many rural communities were involved in the production of a broad genepool of domestic and semi-domesticated populations in the first place, and recognition of this contribution is important.
- Plant and livestock breeding needs to be decentralised, and efforts made to include local needs and constraints into the criteria for selection of new varieties. This will reduce the risk of imposing high-input varieties on farmers that do not have the resources to pay for them.
- All introductions of alien species, varieties and breeds, especially from other continents, should be subject to increased vigilance, through risk and impact assessments to ensure environmentally sound and sustainable food production, and pose no threats to human health.
- The potential risks of GMOs underline the importance of establishing adequate biosafety procedures. However, the capacity to implement the provisions of the CBD Biosafety Protocol is weak, and needs substantial strengthening in many developed and developing countries.
- Priority should be given to projects seeking environmentally-friendly ways of improving soil fertility, and reducing pesticide applications (e.g. through biological control approaches).
- Development programmes must ensure that areas providing wild foods remain productive and accessible.
- A global policy is urgently required on who owns the genes in international and national genebanks, and these policies must clarify the CBD principles of intellectual property and benefit sharing.

Further information

- FAO 1998. *The State of World Fisheries and Aquaculture.* FAO, Rome.
- FAO 1998. *The State of World's Plant Genetic Resources for Food and Agriculture.* FAO, Rome.
- FAO's database on livestock breeds http://dad.fao.org
- Groombridge, B. & M.D. Jenkins 2000. *Global biodiversity. Earth's living resources in the 21st century.* Cambridge: WCMC & Hoechst.
- Hammond, K. & H.W. Leitch 1995. Towards better management of animal genetic resources. *World Animal Review,* 84/85:48-53.
- reference to other Biodiversity Briefs is denoted as (see BB#).

Website

All Biodiversity Development Project (BDP) documents can be found on the website: http://europa.eu.int/comm/development/sector/environment