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Adaptation to climate change and the role of agrobiodiversity

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Abstract:
The world's biological diversity is eroding. This concerns in particular the entire agricultural diversity of genes, species and their agrarian ecosystems, the resource base for food. With species becoming extinct, mankind is jeopardised. With climate change becoming reality, genetic resources are getting a new value as they are of vital importance for adaptation. This calls for a revision of present conservation approaches. Emphasis has to be placed on in-situ conservation in order to allow a maximum of species conserved and to enable species adaptation to environmental change.

Climate change - a menace to food security

The implications of climate change for agriculture have opened a new window in the discussion of agrobiodiversity. Five climate change-related factors can be identified: the rise of temperature, changes in precipitation patterns, the rise of sea levels, increased incidence of extreme weather events and the increase of greenhouse gases in the atmosphere, of which carbon dioxide is the most prominent.

The rise in temperature - commonly known as global warming - is probably the most obvious phenomenon of climate change. Since 1861 the global mean annual temperature has increased by 0.6℃ as atmospheric carbon d ioxide concentrations have risen by 32%. Emission scenarios suggest that we will have 550 ppm within the next 40 - 100 years, almost double the pre-industrial concentrations. This rise will be accompanied by a further increase in temperature. Depending on the geographical region, scientific estimates propose an additional mean annual temperature rise of 1 - 5.8℃. It is expected that the increases will be highest in tropical and subtropical regions. There, the increasing temperature will reduce farming system's diversity, lower agricultural yields and change land use patterns. Indirect temperature effects may not be less important. The evaporation of soils is increased, decomposition of organic matter accelerated, the incidence of pests and diseases aggravated.

Changes in precipitation patterns pose another problem of increasing importance. In the last century, subtropical regions were confronted most likely with around 3% less precipitation and more frequent droughts. Contrary to this, the northern hemisphere likely experienced 5 -10% higher rainfall. At the same time, increasing seasonal and regional rainfall irregularity has been observed and scientific research suggests that this trend will become more pronounced.

Among the various greenhouse gases it is not only carbon dioxide that matters. Chlorofluorocarbons, for instance, have severely reduced the atmosphere's protective ozone layer. High levels of UV radiation may nurture pests and diseases and reduce crop yields. For example, fungus infection rates in wheat increased by 9-20% when experimental UV radiation was increased by 8-16% above "normal".

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Adaptation of agriculture is needed

Dramatic implications are expected for global agriculture and food supply, but with enormous regional differences. Ironically, the poorest are most at risk. It is predicted that by 2080 the 40 poorest countries, located predominantly in tropical Africa and Latin America, may lose 10-20% of their basic grain growing capacity due to drought. It is also argued that many rain-fed crops in the tropical belt of Africa and Latin America are already near their maximum temperature tolerance, and their yield may fall sharply with a further rise. By contrast and for temperate regions, yield increases are expected due to higher temperatures, increased carbon dioxide levels and partly higher rainfall; a country like China could experience a rise in production by 25%.

As a consequence, not only mitigation of climate change is required but also adaptation to changes that have become irreversible. This concerns agriculture in particular and agrobiodiversity is of key importance in this. Adaptation describes a plant's, animal's or ecosystem's capacity to adjust to changes such as heat, drought, or salinity – an adjustment enabling them to overcome constraints, take advantage of new opportunities and cope with the consequences of changing environments. The adaptation capacity of agricultural ecosystems relies fundamentally on genetic diversity. Plants with no economic value so far - may it be a drought resistant millet variety or a heat tolerant race of goats - may become important, and serve as genetic material for new breeds that can tolerate better environmental stress. The continuous loss of such species is a serious matter of concern.

Adaptation to drought: neglected millets save the poor from starvation

"Sankappa is a small farmer owning three hectares of dry land in Vittalpura village of Bellary district in Northern Karnataka, India. This village is situated in the semi-arid Deccan Plateau and receives annual rainfall of 500 mm in two to three months a year, which allows one crop during July to October. Sankappa like his forefathers and other farmers of the village is growing foxtail millet. (…) The amount of rainfall during the last four years continuously dropped during the last four years in this part of the country. It was below 300 mm in 2003. 'All other crops failed due to extreme drought, and my family and livestock were saved from starvation by the harvest from foxtail millet,' says Sankappa. The (…) varieties grown and conserved by the villagers have excellent drought resistance."

"Eight minor millet crops grown in different regions of Africa, Asia and Eurasia are finger millet (*Eleusine coracana)*, proso millet (*Panicum miliaceum*), little millet (*Panicum sumatrense*), barnyard millet (*Echinochloa crusgalli* and *E. colona*), kodo millet (*Paspalum scrobiculatum*), teff (*Eragrostis tef*) and fonio (*Digitaria iburua*). Little millet and kodo millet were domesticated in India."

"The long history of minor millet cultivation and its spread to different regions of the world that are notable for extremely harsh farming conditions generated considerable genetic variability in these crops. (…) Global neglect of the minor millets and increasing emphasis on few elite food crop species are precariously narrowing the food security basket. The most disadvantaged by this food production policy are the poorest of the poor (…) The shrinking number of food crops in the regional and global food basket is restricting the opportunity of farmers in difficult regions to use their land resources, environment and traditional knowledge."

Cited from: BALA RAVI (2004): LEISA India, Vol.6, Issue 1. 34-36.

Agrobiodiversity – how much shall be conserved?

As conservation is costly, the question arises: how much agrobiodiversity do we need? Scientists propose mathematic models by which priorities shall be set and the optimal degree of conservation shall be calculated. But, can we base public conservation strategies on mathematical modelling, or must we conserve all we have because the future needs for human survival are unknown?

It is often argued that conserving all – irrespective of any valuation – is unrealistic. But as a basic principle it can be formulated that a maximum of genetic resources has to be conserved at the lowest possible public cost. If this holds true, a conservation concept is required that goes far beyond the predominant approach of *ex-situ* conservation. Storage of seeds in refrigerated banks or botanical gardens is essential. But this method exceeds the capacity of public funding, is of limited scope and of limited security.

Such a more comprehensive approach relies primarily on *in-situ* concepts, managed by farmers and farming communities doing conservation and breeding on their farms and in their villages. Farmers have done so over thousands of years, have been ignored or neglected by the formal seed sector during the past 40 years and, since recently, are slowly being rehabilitated. On-farm conservation is not necessarily less costly, but the costs are mainly borne by farmers whereas the benefits are private and public.

Latest concepts of *in-situ* conservation follow the idea that conservation and use of genetic resources are closely linked. True to the slogan “use it or lose it”, plant species or animal breeds should be used whenever possible, should contribute to securing rural livelihoods and to rural culture. As long as farmers themselves find it in their own best interest to grow genetically diverse crops, both farmers and society as a whole will benefit at no extra cost to anyone.

As a consequence, economic or social benefits have to be found for seemingly useless crops or farming systems and value has to be discovered in them. Some examples of adding economic value are: wild plants may be used for medicinal purposes, wheat landraces grown under organic agriculture may get a higher price, farming communities as a whole may profit from agro tourism if they maintain their diversity, etc. However, it will not be possible to find a market for everything that should be protected. Therefore, a remainder will have to be protected without “using” it - a service that has to be paid for by the public.

Species adaptation – but how?

Another argument that calls for a revised understanding of agrobiodiversity conservation is adaptation to climate change of single crops and animals, a process of selection and breeding. What matters within this process, is not so much the drought-resistant minor millet landrace, well stored in isolation and deep-frozen in a gene bank, but rather, exposure to the environment, on farmers’ fields and considering the wide agro-ecological variations of sites. Resistance of plants to environmental stress (e.g. drought tolerance) is mostly a multi-genetic characteristic best developed by *in-situ* exposure to it. In contrast, it is difficult to achieve such traits through genetic engineering.

The social dimension is no less important. Adaptive capacity building has to address the poor and should enhance their human and social capital.

The focus on women addresses the fact that in rural societies everywhere women have always been the seed keepers, the preservers of genetic resources.

Such a strategy as outlined above addresses regional and local agro-ecological variations. It offers site-specific solutions contrasting with those of the corporate sector that follows the law of economy of scales and aims to distribute a standardised variety or a whole cropping system technology as widely as possible.

Urgent action is required

There is little awareness among the various international development initiatives of the close relationship between climate change and food security and the role agrobiodiversity has to play. This concerns without distinction the programmes to fulfil the Millennium Development Goals (MDGs), the National Adaptation Plans for Action (NAPAs) by the United Nations Framework Convention on Climate Change and others. Adaptation to climate change in agriculture - if discussed at all - deals mainly with improved water management (in view of more frequent drought and flooding events). Agrobiodiversity - although being a fundamental resource for adaptation - is almost forgotten.

Instead, it must become imperative to manage agrobiodiversity in a sustainable way and to use it systematically to cope with the coming environmental challenges. The following aspects deserve consideration:

- Stronger coordination is needed between main global programmes such as the United Nations Framework Convention on Climate Change, the Convention of Biodiversity and the International Treaty on Plant Genetic Resources for Food and Agriculture.
- Agrobiodiversity conservation is to be made a basic component of adaptation strategies to climate change.
- Programmes that manage agricultural genetic resources require re-orientation in their strategies. Formal institutional systems based on gene banks (*ex-situ* conservation) must be broadened to an integrated management system that includes the farmer based (in-situ) conservation.
- *In-situ* conservation of agricultural biodiversity must be made an integral part of agricultural development and be supplemented by *ex-situ* conservation.

Only the public sector can take the lead in implementing such a comprehensive approach, in which the private sector has an important supportive role. National and intergovernmental laws and regulations will have to provide the necessary legal frame, and civil society organisations as well as the corporate sector are more than ever in demand to fill this frame with development reality on the ground. Genetic resources must remain largely a public domain with well-balanced benefit-sharing concepts among the various stakeholders that use and conserve agro-genetic resources. Climate change-induced environmental stress may in fact go beyond the reach of adaptation. But the *in-situ* approach offers a great chance to shape a future worth living.

References:

Kotschi J. (2006): Coping with Climate Change and the Role of Agrobiodiversity. Conference on International Agricultural Research for Development. Tropentag 2006 University of Bonn. October 11-13, 2006. http://www.tropentag.de/2006/abstracts/full/625.pdf.