3.7 Conservation of agrobiodiversity in landscape mosaics, Nepal

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Introduction

Landscape approaches have garnered increased attention as a means to harmonize food production, biodiversity conservation, rural livelihoods, the provision of ecosystem services and other objectives (Sayer et al. 2013). Agricultural biodiversity or agro-biodiversity is a key link among these multiple objectives, and can make an important contribution to supporting food production and biodiversity conservation goals in the face of environmental change.

Agrobiodiversity is the variety and variability of animals, plants and micro-organisms at the genetic, species and ecosystem levels that sustain the structure, functions and processes of production systems (FAO and PAR 2011). It includes crop genetic diversity and wild and cultivated non-food species as well as species of importance to ecosystem function for pollination, control of plant, animal and aquatic pests, and soil formation and productivity.

Crop genetic diversity comprises local crop varieties and crop wild relatives (CWRs), the wild species genetically related to crops and other domesticated plants. Areas that are particularly rich in diversity are known as centres of origin and diversity. In these places, crops have been domesticated and differentiated into a large number of varieties as a result of a long history of cultivation, environmental heterogeneity (e.g., altitude gradients), genetic interactions between crops and CWRs, and cultural diversity. Worldwide, there are 50,000–60,000 CWRs, largely found in uncultivated parts of pastoral and agricultural landscape mosaics (Vincent et al. 2013). Genetic exchange between CWRs and cultivated varieties is a part of the evolutionary processes of crop adaptation to changing environmental and ecological conditions. CWRs contain important traits for resistance to biotic and abiotic stresses, including pests, disease, drought and salinity.

The conservation of agrobiodiversity increasingly requires a landscape perspective.

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Spatial patterns of crop genetic diversity

Spatial patterns of crop genetic diversity can be the result of certain crop varieties being selected for planting in different soil types, at different altitudes, or by different ethnic groups within an area. Generally, spatial patterns are shaped by the interaction of environmental, ecological, cultural and economic factors. This is illustrated by an interdisciplinary study in the Ethiopian highlands, where the crop genetic diversity of barley is a combined function of biophysical features (e.g., gradients of elevation and associated geographical isolation), difference in farmers' planting preferences and seed exchange networks (Samberg, Shennan and Zavaleta 2010; Samberg, Fishman and Allendorf 2013).

In traditional agricultural systems, the management of genetic resources is closely related to that of forests, wetlands and other types of habitats that host CWR, pollinators and other components of agrobiodiversity. The interactions between cultivated and wild components of agricultural landscapes contribute to agricultural productivity by providing ecosystem services, including soil erosion control and the moderation of extreme weather events such as floods and droughts. In this way they increase the landscape's capacity to support crop genetic diversity in the face of climate change (Philpott et al. 2008; Reij, Tappan and Smale 2010). To benefit from these links between the cultivated and "wild" parts of the landscape, agrobiodiversity requires spatially explicit, community-based management of its various components, including local varieties, wild species and land-use diversity. These are some key dimensions of such an approach, whereby conservation of crop genetic diversity is integrated with forest conservation and restoration:

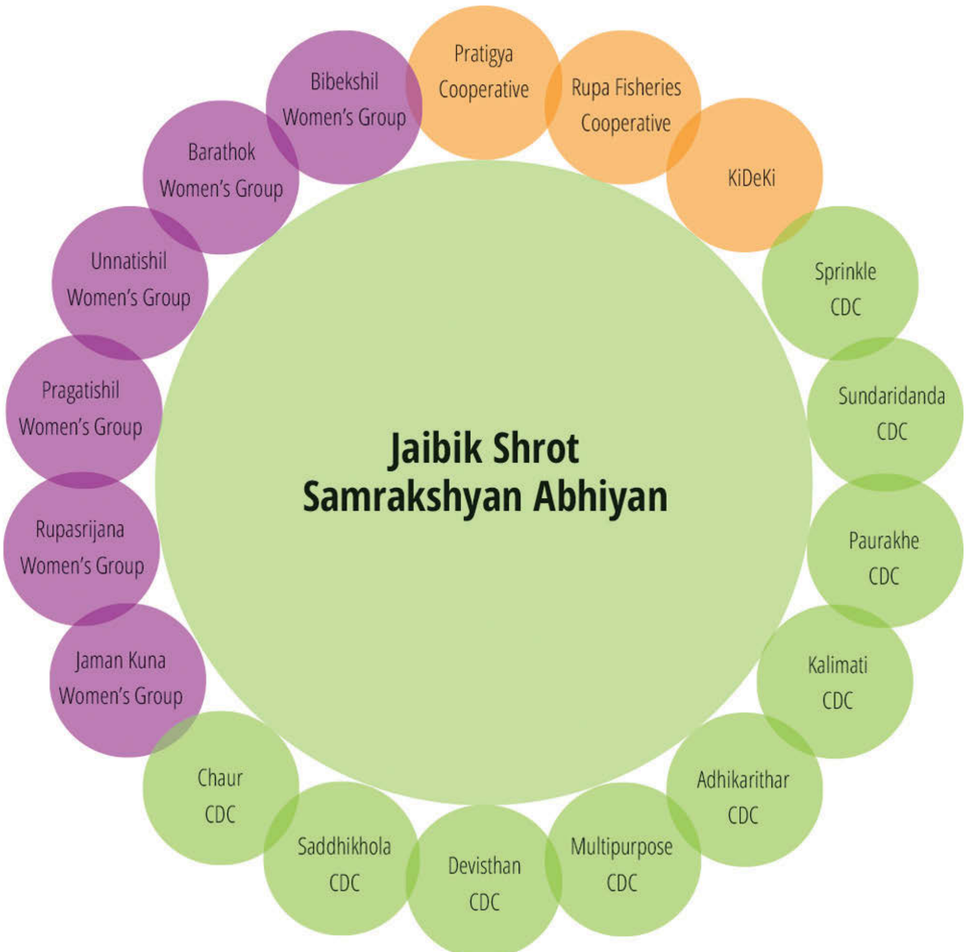
- cultivation of local varieties adapted to diverse soil and climatic conditions;
- development of a mosaic of land uses, including wild and cultivated habitats;
- community-based ecosystem protection and restoration;
- conservation of crop wild relatives;
- use of biodiversity-friendly low-input farming practices (e.g., organic agriculture); and
- documentation and monitoring of biodiversity and associated traditional knowledge.

Agrobiodiversity Conservation Area in Begnas and Rupa, Nepal

An Agrobiodiversity Conservation Area in Nepal illustrates this landscape approach. Located in Kaski District, the landscape is formed of rice terraces, agroforestry gardens, community-managed forests, wetlands and Begnas and Rupa lakes. It is very rich in both wild and cultivated biodiversity. It harbours dozens of local rice varieties that are adapted to various agro-ecological niches as well as a significant number of local varieties of vegetables. Thirty years ago, uncontrolled deforestation of the hillsides took place. This caused the lakes to silt up and undermined the local livelihoods that depended on the fish in the lakes. Reforestation of the hillsides began with the support of CARE Nepal and local community organizations. Over the last three decades, the Rupa Lake watershed has been transformed through community-based biodiversity management (CBM), an approach developed and promoted by a Pokhara-based NGO, Local Initiatives for Biodiversity, Research and Development, or LI-BIRD (Sthapit, Shrestha and Upadhay 2012).

CBM aims to improve the livelihoods of local communities by strengthening local institutions for conservation, documentation and monitoring of crop biodiversity. The local umbrella organization Jaibik Shrot Samarachyan Abhiyan (Bio-Resources Conservation Movement, or Jaibik Shrot), established a decade ago, oversees three cooperatives/ farmers' organizations and 15 interconnected farmers' and womens' groups (Figure 1).

Figure 1. Members of umbrella organization Jaibik Shrot



Biodiversity-based livelihoods

Every year approximately 110 of a total of 700 member households have access to small loans and skill development opportunities for biodiversity-based income activities (e.g., agroforestry, apiculture). Annual monitoring in 2012 showed that 3,295 of the 5,060 saplings (about 65%) of fodder, medicinal plants and fruit trees that have been distributed since 2008 have survived. This has significantly reduced soil erosion and lake siltation.

Ecosystem and land restoration through cooperation among communities

Land and forest degradation have been addressed through the joint activities of upstream and downstream communities, who are connected through Jaibik Shrot. Upstream communities have undertaken reforestation activities, which have helped to revive the Rupa Lake fishery. In return, 25% of the fishery's profits is invested in upstream areas. This cooperation between the communities has encouraged the enforcement of fishing regulations, the transition to organic biodiversity-rich agriculture, and reforestation, all of which helped to restore the Rupa Lake fishery. Upstream communities can become members of the Rupa Lake Cooperative at a reduced fee; membership earns them dividends from the lake fishery. From 2002 until 2013 the cooperative has grown from 35 to 746 members, which includes most of the households in the Rupa Lake watershed.

Community-protected areas

Habitats for wild rice *(Oryza rufipogon)*, white lotus *(Nelumbo nucifera)*, indigenous fish and migratory birds are protected under community rules. Forests are managed by 18 Community Forest Groups; other groups perform or contribute to various conservation activities. For example, the *Sundari danda* women's group runs a botanical garden with 34 wild orchid species. General awareness and support for biodiversity conservation has increased significantly over the years, as indicated by the undisturbed populations of wild rice and white lotus in and near community-protected areas.

Conservation, monitoring and value addition of local varieties and wild species

Each of the 15 groups affiliated with Jaibik Shrot is entrusted with specific conservation activities, ranging from value addition of local produce to the documentation of biodiversity and associated local knowledge. Community Biodiversity Registers recorded 111 medicinal wild plants and 92 wild species used for food and timber in one landscape (e.g., wild fruits, wild yams, and various timber species). Crop genetic diversity is conserved through a dynamic network of people and institutions who perform critical activities such as documentation, monitoring, crop improvement and value addition. For example, a local variety of sticky rice called *Anadi* — consumed only in special ceremonies — was on the verge of extinction. It has been successfully revived after the last 15 kilos of the rice were distributed to the farmers throughout the landscape. At this time *Anadi* is found in all its agro-ecological niches. Other examples of rare varieties whose production has increased include aromatic *Basaue ghiraunla* (a sponge gourd), *Madale* cucumber and *Panchmukh*e taro. Through participatory plant breeding, a number of local rice varieties have been improved, including Biramphool-3, a cross between local low-yielding aromatic variety Biramphool and the commercial high-yielding aromatic variety Himali. This has increased productivity while maintaining suitability to local agro-ecological conditions.

Some challenges remain with respect to the conservation of the dozens of local rice varieties. They are adapted to various habitats in the landscape, which range from irrigated valleys to rain-fed uplands. Annual monitoring showed a decrease in a number of local rice varieties over the last decade, especially the rice varieties — broadly called

Ghaiya — that are grown in rain-fed uplands. The main reason for the decline of *Ghaiya* is that they require weeding and have a low yield. In order to conserve the important adaptive traits of these varieties, germplasm should be send to the national gene bank for medium- to long-term storage. In the same time, various participatory activities are needed to ensure that farmers have continuous access to such rare varieties (e.g., seed exchanges, seed fairs and a community seed bank).

Finding the right balance between development and conservation

The restoration of the Rupa Lake watershed was achieved through the promotion of biodiversity-based livelihoods (e.g., farm diversification). Perennial and fruit crops are becoming increasingly popular due to their high market value, low labour requirement and high tolerance to elevated temperatures, changing precipitation patterns and drought. The growing network of restored forests, fodder trees, fruit orchards and agroforestry gardens has improved ecosystem services, including soil erosion control and water quality. However, while tree cover on the hillsides has increased, infrastructure development, especially rural road construction, has become a new cause of soil erosion and lake siltation. Jaibik Shrot is working with the local government and its development agencies to find the right balance between development and conservation.

Nonetheless, the transformation of the Rupa watershed has inspired action in surrounding areas and across Nepal. Jaibik Shrot is bringing together the local government, the forestry, agriculture and soil conservation offices, the private sector and local groups to promote biodiversity-based livelihoods in neighbouring areas. In recent years, the local government, LI-BIRD and other stakeholders have expanded the watershed management system employed in Rupa Lake watershed to Begnas Lake; these efforts received the 2014 International ReSource Award for Sustainable Watershed Management. CBM, an approach that largely emerged from the experiences of Begnas, has been widely studied and replicated. Jaibik Shrot and LI-BIRD have been working to incorporate the CBM approach in local, regional, national and global programmes, policies and laws to encourage its wide-scale replication.

Conclusions: linking forests and agrobiodiversity conservation

In the face of environmental and land-use change, conservation of agrobiodiversity increasingly requires a landscape perspective. Greater consideration is needed of the interdependence of the conservation of crop genetic diversity and the restoration and protection of landscape mosaics through community-based approaches. Crop genetic resources are embedded in agricultural landscapes, which are a matrix of agricultural fields, forest and wetlands. The conservation of these resources depends on the ecosystem and evolutionary services provided by wild ecosystems within mosaic landscapes.
To maintain these services, negative agricultural impacts on ecosystems can be reduced

through greater use of agrobiodiversity in production practices, such as locally-adapted low-input varieties and agroforestry. The success of such a landscape approach depends on the existence of community-based institutions that guide collective action and ensure an equitable distribution of resources, benefits, opportunities and knowledge across the landscape.

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