Briefing

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Biocultural innovation: the key to global food security?

Sustainable Development Goal 2 — zero hunger — seeks to double productivity and incomes and ensure sustainable and resilient production by 2030, and maintain genetic diversity by 2020. Achieving these aims simultaneously in particular sites requires integrating traditional knowledge and community innovation with formal knowledge. Research by IIED and partners with 64 communities in four countries identified over 500 traditional knowledge-based or 'biocultural' innovations that enhance food security, resilience, livelihoods and biodiversity — some very effectively. Yet community innovation is rarely supported and cultural values and biodiversity that sustain it are eroding. Strengthening community innovation systems requires investment in co-innovation processes such as participatory plant breeding and biocultural heritage territories.

Policy pointers

Biocultural innovations in farming — blending traditional knowledge and science — are critical to simultaneously enhance food security, climate resilience and livelihoods, and maintain genetic diversity, as required by Sustainable Development Goal 2: zero hunger.

But promoting biocultural innovation requires a shift in agricultural policy and investment to support more collaborative and farmer-led agricultural innovation, targeting resource-poor farmers, women and ethnic minorities.

Climate adaptation and agriculture policies should strengthen local adaptive capacity by supporting the biocultural innovation systems of vulnerable farmers and the cultural values, biodiversity, landscapes and collective institutions that underpin them.

Urgent investment is needed to establish community-led biocultural heritage territories that can maintain the genetic diversity of major food crops, and co-evolutionary processes, for local and global food security and climate adaptation.

Small-scale farmers have always domesticated, improved and conserved crops and livestock using traditional knowledge; this includes over 7,000 plant species[1] that are the basis for all food crops. Today, smallholder innovations are crucial to confront new climatic and market challenges, particularly in remote areas poorly served by extension services.[2] Smallholder innovation also contributes to global food security by maintaining and enhancing genetic diversity in climate-constrained environments.

This briefing presents the key findings of a five-year participatory action research project: Smallholder Innovation for Resilience (SIFOR). The project sought to explore and strengthen smallholder innovation systems for food security in the face of climate change. It defined 'biocultural innovations' as new ways of doing things (including new technologies) that emerge from interaction between components of biocultural heritage[3] (traditional knowledge, biodiversity, landscapes, cultural and spiritual values, customary laws), or between traditional knowledge and science (and are at least 50% derived from the former).

SIFOR conducted qualitative and quantitative baseline studies involving 945 households in 64 indigenous or traditional farming communities in coastal Kenya, India's Central and Eastern Himalayas, the Peruvian Andes, and the Guangxi and Yunnan provinces of Southwest China. We explored trends in livelihoods, food security, crop diversity, climate and biocultural heritage. We examined biocultural innovations developed by communities alone and with external partners, in response to climatic and socioeconomic challenges.

The Convention on Biological Diversity recognises traditional 'knowledge, innovations and practices' as important for the conservation and sustainable use of biodiversity, and requires Parties to 'respect, preserve and maintain' them. An assessment of agricultural knowledge in 2008, involving over 400 scientists, concluded that simultaneously achieving productivity, profitability, sustainability and development goals in particular sites requires integrating traditional and local knowledge and community-based innovation with formal knowledge.[4]

Most farmer-led innovation remains invisible to formal scientists and researchers

Yet agricultural science has focused on delivering technologies to farmers through linear transfer. This model has achieved significant increases in productivity but has been criticised for failing to reflect the complexity of agricultural systems, bringing limited benefits to farmers, and contributing to unsustainability in agriculture and the loss of biodiversity and traditional knowledge.[2]

A more integrated approach to agricultural knowledge and science is needed, primarily for those served least by previous approaches: resource-poor farmers, women and ethnic minorities.[4] Despite shifts towards a more participatory, innovation systems perspective, most farmer-led innovation remains invisible to formal scientists and researchers, and its contribution to food security, livelihoods and agroecosystem resilience largely unexplored.[2]

Key trends and biocultural innovations

All the communities we studied observed adverse climatic changes between 2003 and 2012, including more erratic rainfall, increased drought and pests and diseases, shorter growing seasons and increased variability, leading to a decline in agricultural productivity. Income from farming declined in most communities, partly due to reduced productivity, while temporary urban migration grew, increasing women's workloads. Declining food self-sufficiency means increased reliance on markets for food security, although crop production remains crucial for both food security and income generation.

SIFOR identified over 500 biocultural innovations — mainly technological but also market and institutional — developed in response to climatic or socioeconomic challenges. They have contributed to enhanced productivity, incomes, climate resilience, nutrition, environmental health and climate change mitigation — often to many or all of these (see Table 1). For example, in the central Himalayas, women revived the cultivation of finger millet that is rich in calcium, less water and labour intensive, and has high market demand.[5]

Endogenous innovations — those stemming from within a community — that increase productivity and climate resilience included new crop varieties, new or improved cropping systems, more intensive traditional farming techniques, switching to more resilient crop types, revival of traditional varieties and farming practices, and changing planting times and locations. All the communities surveyed have developed or re-introduced effective biopesticides, and soil and water conservation practices.[6]

Endogenous innovations were largely technological, while collaborative innovations were more institutional and market related.

Many biocultural innovations have increased crop productivity by 15–30% (see Table 1). In India, farmers developed new varieties of radish and cardamom that are higher yielding and more resilient, as well as a new variety of black rice bean with higher yield and market value. In semi-arid coastal Kenya, farmers reported four- to five-fold yield increases from planting pruned cassava tops,[7] and the domestication of various trees has increased incomes by 11–48%. In India, Kenya and Peru, new or modified cropping systems and crop diversification reduced risk and ensured the productivity of whole cropping systems. In the Eastern Himalayas, broomstick grass domesticated by communities is now an important cash crop.

In China and Peru, collaborative innovation has increased productivity, incomes, social capital and biodiversity, and stimulated further endogenous innovation. In Guangxi, yields of rice and maize increased by 15–30% through participatory plant breeding (PPB). One farmer reported a three- to four-fold increase in income from the sale of organic rice through Community Supported Agriculture (CSA), which links farmers to urban restaurants.[8] Food self-sufficiency is notably higher in CSA villages, which have also revived heritage varieties and agroecological practices. These innovations, supported by the Centre for Chinese Agricultural Policy, have led to the formation of informal women's groups for landrace conservation, five farmer cooperatives, and a platform for farmers to work with breeders, scientists and market actors.

In Peru's Potato Park, collaborative innovations with Asociacion ANDES have had significant impacts. Household incomes almost doubled in 2003–2012, largely due to biocultural products and services like ecotourism; and potato yields slightly increased despite severe climate change impacts.[9] Social capital and biocultural heritage have been significantly enhanced, including traditional festivals and cultural values, social cohesion between the five communities and collective institutions. The repatriation of native potatoes has greatly increased diversity and revived associated traditional knowledge and cultural practices.

Adoption of biocultural innovations by farmers appears to be affected by levels of community participation and severity of challenges. In the Potato Park, adoption of institutional innovations is particularly high, such as crop repatriation, an inter-community crop experts' group and communal seed production. Among the Mijikenda in Kenya, some biocultural innovations were also widespread: planting more diverse crops varieties, the domestication of wild food and medicinal

Table 1. Key biocultural innovations identified by SIFOR

	Potato Park, Peru	Southwest China	Coastal Kenya	Indian Himalayas
Examples of innovations that enhance agrobiodiversity	Collective landscape management Repatriation of 410 native potatoes Community seed bank Community genetic reserve	Conservation and improvement of drought-tolerant maize, wheat and rice landraces Conservation of 1,000 landraces (PPB) Women's seed fairs	Revival of traditional farming practices, and traditional cowpeas and sweet potatoes Revival of traditional maize and cassava varieties that tolerate pests, disease and water stress	Central: new mixed cropping systems near homes to reduce crop raiding Women cultivating fodder trees on farm for shade and forest conservation
Examples of innovations that enhance food security, resilience and livelihoods	Collective management of agriculture at landscape level optimises productivity Selecting resilient varieties and developing new mixes of cultivars Improved organic farming techniques Collective micro-enterprises for biocultural products and services	PPB has generated eight drought-tolerant maize varieties and increased yields by 15–30% Supply to organic restaurants has tripled rice incomes, increased maize incomes by 30%, and revived heritage varieties and ecological practices	Planting landrace, improved varieties and hybrids of maize and cassava together, reducing crop failure by 20% Domestication of medicinal and fruit trees, increasing incomes by 11–48% Planting pruned cassava tops for a four- to five-fold yield increase	Central: new variety of radish (25% higher yield and more resilient) Eastern: new high-yielding variety of cardamom requiring less water and shade Participatory Variety Selection to revive high yielding, resilient rice landraces
Examples of innovations that strengthen social capital	Revival of traditional seed and knowledge exchange networks Revival of traditional potato ritual and ceremonies Strengthening cultural identity and customary laws	PPB has established a platform for seed exchange between villages Women's groups and farmers' cooperatives Revived customary laws	Rabai cultural village generates income from tourism, conserves landraces and enhances social cohesion Herbal groups and women's groups	Eastern: adapting traditional farm labour-sharing practices and collectively producing paddy seedlings to overcome labour and climate challenges

plants, and improvement or revival of traditional farming practices. In India, innovations have tended to remain small scale in the Central Himalayas, where there are less collective activities than in the Eastern Himalayas.

What affects biocultural innovation?

SIFOR explored the role of social factors in the development and spread of biocultural innovations under four main categories: people, institutions, networking and the community. The most important factors across the studied communities were: elders and women; traditional values, beliefs, institutions and ceremonies; community organisations; capable and committed community leaders; inter-village networking and seed exchange; and interaction with scientists and innovative external partners. Key factors at each study site included:

- **Kenya:** elders' councils promote biocultural innovation through collective activities and community networking
- **China:** traditional basic values and beliefs — such as balance and harmony, sharing and exchange — are important for both endogenous and collaborative innovation
- **Peru:** traditional knowledge and networking amongst communities and with external actors (such as scientists)
- **India:** institutions such as the updated traditional practice of pooling farm labour and women's self-help groups, kinship relations, ceremonies and interaction with scientists.

SIFOR also explored the relationship between cultural values and innovation, focusing on reciprocity, solidarity, equilibrium and collectivity with the human, natural and spiritual worlds.[10] It found that cultural values and identity are direct drivers of innovation and experimentation, underpinning the resilience of smallholder innovation systems.

Cultural and spiritual values promote the maintenance of traditional knowledge and biodiversity, the raw materials for innovation (such as traditional crop varieties, crop wild relatives and medicinal plants). They also promote collective activities (such as ceremonies), and the sharing and exchange of seeds, knowledge and innovations (reciprocity). However, some cultural norms may be a barrier to innovation, such as the caste system in the Central Himalayas.

Box 1. Seed systems and gender

In all the SIFOR communities surveyed, women play a major role in selecting and saving seeds, particularly landraces. Men play a larger role in decision making for hybrid seeds. In the Central Himalayas, men play a greater role in sourcing both landraces and improved varieties, probably due to the restricted mobility of women. However, in the Eastern Himalayas, women also play a significant role in sourcing hybrid seeds where they have easy access to markets.

In the Potato Park, women select the seeds, decide on the use of harvested crops, and source, store and disseminate native seeds.[9] Seed selection and conservation techniques are handed down from their mothers/parents. Women have the most knowledge of native potato varieties; their participation in local seed fairs is vital for conserving diversity. However, male migration is increasing women's workloads and threatening this role.

At all the study sites, kitchen gardens are key centres for experimentation. But access to wild gene pools in the landscape is also essential for biocultural innovation for climate resilience and income. Landscapes (and access to sacred sites) are important for sustaining cultural values, and support innovation and adaptation by enabling crop evolution, adaptive management and seed exchange over large areas.

Biocultural heritage and local seed systems

SIFOR's findings show that biocultural heritage and local seed systems are vital to smallholder innovation. However, biocultural heritage is becoming weaker in all communities except the Potato Park. Native language — an important carrier of traditional knowledge — is declining, along with traditional festivals and food cultures.

Crop diversity is declining in all the communities studied, apart from the Potato Park and Guangxi CSA villages. The decline is notable for maize in China, and maize and cassava in Kenya, where it coincides with the promotion of modern hybrids and agricultural practices. In Yunnan, the area planted with maize landraces (ie traditional varieties) declined massively from 56% to 2% in 2003–2012.[8] The loss of varieties increased after China joined the World Trade Organization in 2001. In India, several crops are now cultivated at almost negligible rate due to crop raiding (Central Himalayas) and prolonged dry spells (Eastern Himalayas), as well as changing food cultures. Even in the Potato Park, seven potato varieties were lost since 1982 due to rising temperatures and soil pests.

However, there is still high dependence on diverse landraces and self-saved seeds that can be freely accessed and replanted for innovation without losing vigour. Productivity in the local environment, climate resilience and taste were cited as key reasons for sustaining landraces. The communities in India depend on self-saved seeds for 80–90% of their seed. The Potato Park communities mainly use native varieties from self-saved and community sources and barter markets (but no hybrids). In coastal Kenya and Southwest China, communities use both hybrid seeds purchased from extension agents and self-saved landrace seeds. Women and elders play a vital role in saving and sharing traditional varieties and landraces (Box 1).

The SIFOR findings show that biocultural innovations contribute significantly to achieving multiple SDGs in climate-constrained contexts. Biocultural heritage territories like the Potato Park provide an effective tool for sustaining the interlinked cultural, biological, spatial and social foundations for community innovation. Policymakers seeking to support the SDGs should consider policy and investment decisions that support biocultural innovation.

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Notes

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Knowledge Products

The International Institute for Environment and Development (IIED) promotes sustainable development, linking local priorities to global challenges.

The Association for Nature and Sustainable Development (ANDES), is an international NGO involved in poverty alleviation, biodiversity management and strengthening traditional resource rights.

The Center for Chinese Agricultural Policy (CCAP), Chinese Academy of Science, aims to analyse and help formulate policies related to agricultural R&D, natural resources and sustainable development.

The vision of Lok Chetna Manch (LCM) is to transform the conditions and opportunities for communities in the Indian Himalayas.

KEFRI is a centre of excellence in forestry whose mission is to conduct research and provide information and technologies for sustainable development in Kenya.

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