Bioversity International

On-farm conservation of neglected and underutilized species:

status, trends and novel approaches to cope with climate change

Padulosi, S., N. Bergamini and T. Lawrence, Editors

Proceedings of the International Conference
Friedrichsdorf, Frankfurt, 14–16 June, 2011

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Bioversity International is a world leading research-for-development non-profit organization, working towards a world in which smallholder farming communities in developing countries are thriving and sustainable. Bioversity's purpose is to investigate the use and conservation of agricultural biodiversity in order to achieve better nutrition, improve smallholders' livelihoods and enhance agricultural sustainability. Bioversity International works with a global range of partners to maximize impact, to develop capacity and to ensure that all stakeholders have an effective voice.

Bioversity International is part of the Consultative Group on International Agricultural Research, which works to reduce hunger, poverty and environmental degradation in developing countries by generating and sharing relevant agricultural knowledge, technologies and policies. This research, focused on development, is conducted by a Consortium of 15 CGIAR centres working with hundreds of partners worldwide and supported by a multi-donor Fund.

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Cover
Top photo: Genetic diversity of quinoa in Bolivia (Wilfredo Rojas/PROINPA); bottom photo: Quinoa seeds' genetic diversity from Bolivian germplasm (Michael Hermann/Crops for the Future).

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Abbreviations used in the On-farm Conservation Workshop

ABD	agrobiodiversity
ARSIAL	Lazio Regional Agency for Development and Innovation in Agriculture [Italy]
BEAF	Advisory Service on Agricultural Research for Development [Germany]
BiK-F	Biodiversity and Climate Research Centre
BMVEL	Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz
BMZ	German Federal Ministry for Economic Cooperation and Development
BSF	Benefit-sharing Fund
CAS-IP	Central Advisory Service on Intellectual Property
CBD	Convention on Biological Diversity
CBM	community biodiversity management
CBO	community-based organization
CBR	Community Biodiversity Register
CCAFS	[GIAR Research Program on] Climate Change, Agriculture and Food Security
CF	champion farmer or custodian farmer
CGIAR	Consultative Group on International Agricultural Research
CGRFA	FAO Commission on Genetic Resources for Food and Agriculture
CIAT	Centro Internacional de Agricoltura Tropical – International Center for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Center
CIRAD	Centre de coopération internationale en recherche agronomique pour le développement
COP	Conference of the Parties
CRP	Consortium Research Programme
CWR	crop wild relative
Danida	Danish International Development Agency
DED	Deutscher Entwicklungsdienst [German Development Service]
DFID	Department for International Development [UK]
DOP	Denominazione di Origine Protetta [Protected Designation of Origin]
EC	European Commission
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FCA	Four-Cell Analysis [or Five-cell Analysis]
FFS	Farmer Field School
GAP	Good Agricultural Practice
GCDT	Global Crop Diversity Trust
GEF	Global Environment Facility
GFU	Global Facilitation Unit for Underutilized Species
GI	Geographical Indication
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GMP	Good Manufacturing Practice
GPS	Global Positioning System
GR	genetic resource
GRPC	CGIAR Genetic Resources Policy Committee

GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit GmbH [German Technical Cooperation]
HACCP	Hazard Analysis and Critical Control Point [system]
HNV	High Natural Value [farmland]
HYV	high-yielding variety
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDRC	International Development Research Centre [Canada]
IFAD	International Fund for Agricultural Develeopment
IITA	International Institute for Tropical Agriculture
IK	indigenous knowledge [often termed traditional knowledge – TK]
IPGRI	International Plant Genetic Resources Institute
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
IUCN	International Union for the Conservation of Nature
LI-BIRD	Local Initiatives for Biodiversity, Research and Development
LR	landrace
MAB	Man and Biosphere
MFSC	Ministry of Forest and Soil Conservation [Nepal]
MSSRF	M.S. Swaminathan Research Foundation
NARC	Nepal Agricultural Research Council
NGO	non-governmental organization
NUS	neglected and underutilized species
PACS	payment for agrobiodiversity conservation services
PDO	Protected Designation of Origin
PGR	plant genetic resource
PGRFA	plant genetic resources for food and agriculture
PRA	participatory rural appraisal [or assessment]
PVS	participatory variety selection
R&D	research and development
SDC	Swiss Development Cooperation
SGRP	System-wide Genetic Resources Programme [of CGIAR]
SHG	self-help groups
SMEs	small- and medium-sized enterprises
SWOT	Strengths, Weaknesses/Limitations, Opportunities and Threats
TEEB	Economics of Ecosystems and Biodiversity
TK	traditional knowledge [often termed indigenous knowledge – IK]
TRIPS	Agreement on Trade-Related Aspects of Intellectual Property Rights
UNCCD	United Nations Convention on Combating Desertification
UNCTAD	United Nations Conference of Trade and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UPOV	International Union for the Protection of New Varieties of Plants
WHO	World Health Organization
WIPO	World Intellectual Property Organization
WTO	World Trade Organization

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Welcoming address by Luis Waldmüller
on behalf of Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

On-farm conservation of neglected and underutilized species: status, trends and novel approaches to cope with climate change

Dear Distinguished Guests, Ladies and Gentlemen

Adaptation of agriculture to changing climatic conditions including utilization and promotion of suitable crops and tree species (underutilized and neglected species, wild relatives of crops, etc.) will be one of the central tasks of future agricultural activities. It will be especially important in view of the need for securing the food basis and providing balanced nutrition for the rural population of many developing countries. The inclusion of agrobiodiversity measures in the project setup is already gaining increased attention as “risk insurance”.

Important components of agrobiodiversity are neglected and underutilized plants that have a lot of traits and properties important for our future nutrition base. These species are often traditionally used, or are wild species that contribute to nutrition and a balanced diet for poor and underprivileged folks. In addition, these plants may have a variety of additional properties, such as potential for future adaptation to climate change (heat or salt tolerance), medicinal properties, as well as resistance genes against pests and diseases, thus helping us to reduce use of pesticides.

Neglected and underutilized species (NUS) comprise a broad variety of agricultural and wild crops in different countries. Many of them are traditional crops that are still cultivated by farmers; others include wild vegetables and wild relatives of crops. Farmers have an increasing role as guardians of traditional as well as neglected and underutilized crops, vegetables and tree species. This responsibility should be valued, not only by the government but also by private industry and other stakeholders who up to now have benefited from farmers’ traditional knowledge of plants and biodiversity resources. I would like to refer to the Nagoya Agreement and the International Treaty on Plant Genetic Resources for Food and Agriculture (2001) which acknowledges “Farmers Rights” as guardians and users of the genetic resources and traditional knowledge and demands equitable sharing of access to and benefits from plant and animal genetic resources.

We should not forget that many NUS have an economic potential and in future we have to tap this potential because farmers will only maintain and promote those species if they have an economic benefit. Hopefully, international discussions on the Economics of Ecosystems and Biodiversity (TEEB), Payment for Ecosystem Services (PES) and increasing orientation towards a green economy has to include the promotion and use of NUS. Here it is our task to emphasize inclusion of those species into those discussions and to promote their conservation and use

GIZ has been in the forefront of promoting NUS for the past 30 years within the framework of various projects relating to organic farming, promotion of agrobiodiversity and sustainable agriculture. Even now, the agrobiodiversity component of the sector programme on Sustainable Utilization of Resources in Agriculture includes NUS in six activity areas:

- Agrobiodiversity, resource management and agricultural development.
- Agrobiodiversity and international agriculture research.
- Agrobiodiversity and agricultural policy.
- Agrobiodiversity and promotion of economic development.
- Agrobiodiversity, disaster preparedness and reconstruction.
- Agrobiodiversity and climate change.

I wish this conference a successful outcome and encourage members to promote on-farm conservation and use of NUS.

Thank you very much for your attention!

Luis Waldmüller

Welcoming message presented on behalf of Dr Julia Krohmer

Dear participants of the conference on On-farm conservation of neglected and underutilized species.

On behalf of our scientific coordinator, Prof. Volker Mosbrugger, and our director, Prof. Katrin Boehning-Gaese, as well as all my colleagues at the Biodiversity and Climate Research Centre (BiK-F), I wish you a warm welcome here in Frankfurt/RhineMain.

We are grateful that we were given the opportunity to support this important conference. The Biodiversity and Climate Research Centre, a joint venture of the Goethe University and the Senckenberg Research Institute in Frankfurt, is working on all kind of interactions between biodiversity and climate, on almost all continents, scales and disciplines, in the past as well as in the present and future.

One of our most important aims is to produce results that are relevant not only for the scientific community, but also for the world outside, and to transfer them to stakeholders and practitioners. That is why BiK-F is very interested in the scientific exchange with the agrobiodiversity community. Agrobiodiversity is a highly important asset for the worlds's agriculture in adapting to and coping with climate change.

We at Bik-F ourselves are doing only little research in the agriculture area, but we might have data, methods, climate models or projections that are relevant for your work, and I would be very happy if this constellation would result in a possible future exchange and cooperation.

I am really very sorry for not being present personally today, but I invite you all cordially to visit our website (www.bik-f.de), and do not hesitate to contact me directly if you see any possible prospects for cooperation

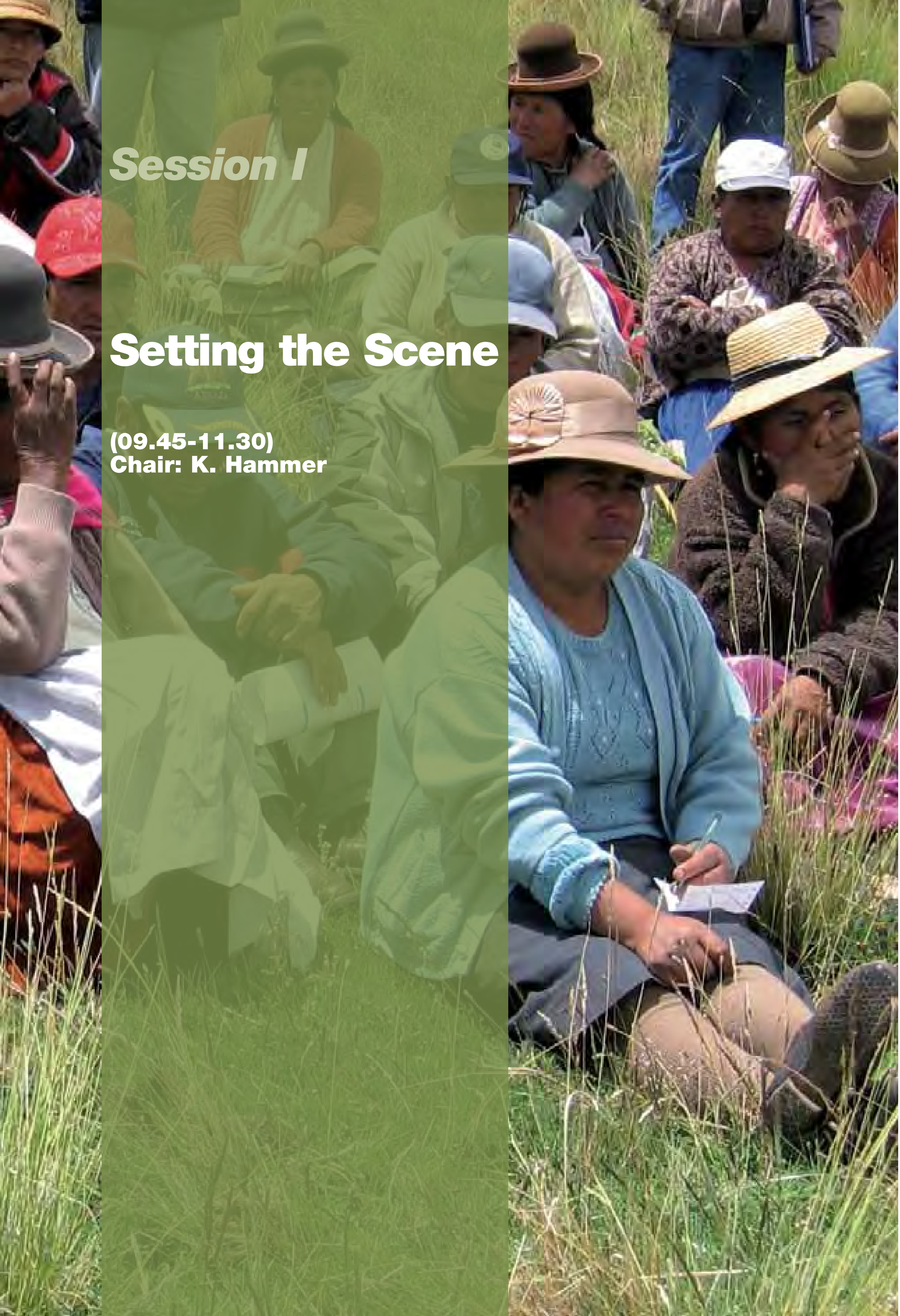
By the way, although the Frankfurt region is generally perceived as a Bank and Business area, there is a third important B to add: the B for biodiversity, which is surprisingly high in this region.

And there is even a great example for an agricultural species with a particular high intraspecific diversity: Would you believe that there are roughly 150 apple varieties growing in the region? Fortunately, they are not underutilized at all. They are the essential raw material for the tasty local apple wine, the state of Hesse's national beverage, which probably you will have the chance to enjoy during the next days.

I wish you all constructive discussions and exciting and successful days in Frankfurt!

Stefano Padulosi/Bioversity

Stefano Padulosi/Bioversity



Session I

Setting the Scene

(09.45-11.30)
Chair: K. Hammer

A new international collaborative effort on traditional crops, climate change and on-farm conservation

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Introduction

Agricultural intensification today is increasingly relying on a narrow range of crops (Schmidt *et al.,* 2010). Of the several hundred thousand known plant species, some 120 are cultivated for human food, but just nine supply over 75 percent of global plant-derived energy intake, and, of these, only three—wheat, rice and maize—account for more than half (FAO, 1996, 2009a). Our dependence on this relatively small number of food species raises serious concerns about the sustainability of feeding the world today and in the future (Frison, 2006; Raschke and Cheema, 2008).

More than one billion people today suffer from hunger and food insecurity, while at the same time the problem of adequate nutrition is even more dramatic (Ruel, 2003; Frison *et al.,* 2006; FAO, 2009b). At the international workshop of agriculturalists, nutritionists and health specialists held in Ethiopia in August 2010 for the development of the CGIAR Consortium Research Programme (CRP) on *Agriculture for improved nutrition and health* (CRP4), nutritious foods have been defined as those comprising

> "high nutrient content, including foods derived from animal sources (fish, meat, eggs and dairy products), fruits and vegetables, bio-fortified staples, fortified foods, as well as traditional local crops (including neglected and underutilized species (NUS) and wild foods)."

The last-named categories of foods include crops that historically have been highly marginalized by mainstream agricultural research. The reasons why these species have been neglected or marginalized may vary (Padulosi *et al.,* 2002; Padulosi and Hoeschle-Zeledon, 2004), but typically have nothing to do with the usefulness of these resources to the livelihoods of local communities. On the contrary, the fundamental role played by these species in income generation (Mwangi and Kimathi, 2006; Chadha and Oluoch, 2007; Joordan *et al.,* 2007; Hughes 2009; Mahyao *et al.,* 2009), adaptation to climate change (DEFRA, 2005;

Padulosi *et al.,* 2011) and nutrition and food security (Frison *et al.,* 2006; Hawtin, 2007; Erlund *et al.,* 2008; Smith and Longvah, 2009) is today broadly acknowledged and increasingly appreciated (Padulosi, Hoeschle-Zeledon and Bordoni, 2008)

An important contribution to raising awareness on NUS has been provided by two major international efforts that have been focusing specifically on such species, namely the IFAD NUS I (TAG 533) and IFAD NUS II (TAG 899) Projects, implemented in 2001–2005 and 2007–2010, respectively. Other relevant efforts on NUS have been those supported by IDRC, McKnight, GTZ, Danida and DFID (GFU, no date) in various regions. The contribution of IFAD NUS I and II (which represented the very first UN global research endeavours focusing specifically on NUS) has been particularly valuable with regard to the substantiation of the nutritional and economic benefits of NUS in improving people's livelihoods, particularly among the poor (Padulosi, 2008a, b; Padulosi, Hoeschle-Zeledon and Bordoni, 2008; Padulosi *et al*., 2003, 2009; Jäger *et al.,* 2009; Rojas *et al.,* 2009; Taranto and Padulosi, 2009; Bala Ravi *et al.*, 2010; Vijayalakshmi *et al.,* 2010; Yenagi *et al.*, 2010).

These research projects have also confirmed that NUS are fast disappearing because of the standardization of agricultural practices, mono-cropping trends and changes in food habits skewed towards a few commodity crops dominating food systems at local, national and global levels (Rojas *et al.,* 2009). Such a situation is responsible for the heavy genetic erosion affecting traditional crops around the world, as well as the erosion of cultural diversity intimately associated with their use and appreciation. The unprecedented loss of traditional agricultural species has also been reiterated in the recent FAO report on the State of Plant Genetic Resources for Food and Agriculture (FAO, 2010a). This document underlines that despite considerable progress having been made with regard to *ex situ* conservation, there has been very limited impact in terms of curbing genetic and cultural erosion in farmers' fields.

Furthermore, it is also important to note that such a situation is not helped by the fact that the main international funding mechanism for the conservation of agrobiodiversity, namely the Global Crop Diversity Trust, lends its support only to a limited number of crops and related wild relatives corresponding to those of Annex I of the International Treaty for Plant Genetic Resources for Food and Agriculture ('Treaty'), namely breadfruit, asparagus, oat, beet, brassicas (the cabbage family including broccoli and cauliflower), pigeon pea, chickpea, citrus, coconut, aroids (including taro and cocoyam), carrot, yams, finger millet, strawberry, sunflower, barley, sweet potato, grass pea, lentil, apple, cassava, banana/plantain, rice, pearl millet, beans, pea, rye, potato, eggplant, sorghum, triticale, wheat, faba bean, cowpea, maize and more than 80 forage species from 30 different genera. For the full list see GCDT (no date). That list is indeed a narrow representation of the large agrobiodiversity wealth maintained by farmers *in situ* or on-farm and used by people in local food systems. This is discussed in Padulosi *et al.,* 2002.

The recent initiative of the Treaty in support of 'non-Annex I' crops, namely a competitive grant scheme for supporting the conservation and sustainable use of agrobiodiversity with special reference to local crops (FAO, 2010b), needs certainly to be mentioned here, but in fact much more is needed to support the sustainable conservation and use of local agrobiodiversity today if we want to be effective in safeguarding the food security of today's and future generations.

In this context, "agrobiodiversity" refers to all those biological components of agriculture production systems that work together to produce food for human societies: plants, livestock, fish and other aquatic resources, soil biota, and pollinators. Another integral part of these systems is the human element, which includes traditional knowledge of biodiversity and traditional agricultural practices.

It is widely acknowledged that most agrobiodiversity is maintained on-farm and that only a very small portion of this wealth of crop diversity (wild or cultivated) is conserved in *ex situ* genebanks (FAO, 2010a). As earlier mentioned, traditional crops maintained by farmers are being rapidly lost because of their low economic potential, reflecting lack of technology, infrastructure and value addition methods. According to FAO (1999), an estimated 75% of the world's agrobiodiversity richness has already been lost in the course of the 20th century, and what is left for current generations is destined to disappear within the next few decades in the absence of urgent and consistent rescue efforts. To halt this process, more research investments are needed to investigate how to strengthen the conservation of agrobiodiversity on-farm and to address a number of critical factors. These factors include understanding the distribution of traditional species and varieties on-farm, the role played by custodian farmers and the challenges they face. This research implies a more rigorous analysis of genetic erosion threats, coupled with the development of documentation and monitoring systems to raise awareness and help prevent loss of diversity on-farm.

The conservation of crop genetic resources through either seed or field genebanks was initially developed by N.I. Vavilov in the early part of the twentieth century (Pistorius, 1997). This type of conservation—defined as *ex situ* conservation—received a major boost during the so-called 'plant genetic resources movement', which started in the early 1970s and led to the establishment of large genebanks around the world, including those of the CGIAR, which have traditionally focused on major staple food crops. Calls for alternative ways of conservation, outside the *ex situ* method, started in the middle of the 20th century, and increased during the 1980s. Scholars such as Altieri and Merrick (1987) and Brush (1981, 2004) have been advocating greater attention to '*in situ* conservation' as a method highly complementary to *ex situ* conservation, to allow the maintenance of useful species either in their natural habitat ('*in situ* conservation') or in the production systems where they are grown ('on-farm conservation'). The conservation of crops on-farm has several advantages compared with *ex situ* conservation as it allows for evolution of crops through continued natural and human-driven selection, which contributes to greater adaptation and resilience in cultivation. It makes possible the maintenance of crops whose seeds cannot be stored at the low temperatures of genebanks, and supports the maintenance of traditional knowledge (TK, often termed indigenous knowledge – IK) associated with their use. Its disadvantages include the limited access to germplasm for breeders and other users, the vulnerability of crops to natural disasters, and the fact that less diversity can be stored at any single location.

In reality, on-farm conservation has been the oldest agrobiodiversity method of conservation ever practiced by humankind since the discover of agriculture.

Farmers maintain crops through their continued cultivation, and although they may not be aware of the genetic diversity they harbour on their farms, they contribute through their work to informally safeguard traditional crops that meet local needs both for their own families and for their communities (Mekbib *et al.,* 2009).

Farmers can be also organized as so-called ‘community genebanks’, whereby leader custodian farmers maintain the diversity on behalf of all others members (Ramprasad, 2002). Some of these community-based approaches are further structured and include multiple objectives in their work, as in the case of the ‘gene-seed-grain’ banks being practised in some regions of India (MSSRF, 2010).

Another type of on-farm conservation is represented by home gardens. These are reservoir of diversity that contribute to the conservation of agrobiodiversity and at the same time serve as trial plots for farmers and their families to test the value of species with regard to their livelihood needs before growing them extensively in the field (Eyzaguirre and Linares, 2004). They also contribute towards environmental regulation, generation of occasional income, and the aesthetic value of the farming landscape (Sunwar *et al.,* 2006).

Unfortunately, in spite of the undeniable strategic roles played by on-farm conservation, attempts to develop a cohesive global system dedicated to on-farm conservation has never been consistently pursued at the international level. Whereas a great deal of research has been invested in studying how to manage *ex situ* conservation, starting from the early 1970s, the very first international project dedicated to on-farm conservation was only launched in 1996 (Jarvis, Padoch and Cooper, 2007). This project addressed the scientific understanding of methods and practices behind on-farm conservation, and contributed *inter alia* to clarify the reasons behind farmer choices and shed light on the ways they deploy diversity for meeting their livelihood needs. It also contributed to highlighting that species composition in farms may be more important to farmers than absolute number of species, that genetic diversity within populations is important for continued adaptation to changing conditions, and that farmer’s needs evolve. Such local, almost gentle, evolution ultimately supports the continued provision of ecosystem goods and services. The greatest agrobiodiversity is particularly found in marginal areas, where it plays a strategic role in the livelihood management strategies of farmers and their families.

A fundamental element of on-farm conservation, is its ‘conservation-through-use’ dimension. This is highly challenging, particularly with regard to local crops, because what is local has often a local value and may not attract enough investment and resources for developing value chains and tools necessary to support use-enhancement goals. Nevertheless, on-farm conservation is a commitment that the international community has promised to honour in the framework of the Convention on Biological Diversity (CBD). The following text, extracted from a joint Bioversity-DSE publication (Engels, 1995) is repeated here as it summarizes clearly the CBD concerns on the theme of *in situ* and on-farm conservation, and reiterates several of the issues mentioned above:

> “The CBD interprets *in situ* conservation to mean conservation of both wild and domesticated species and when the Convention refers to *in situ* conservation, on-farm conservation is included. Of relevance

to *in situ* conservation is first of all Art. 8 CBD which lists a whole set of obligations addressing, among other, agrobiodiversity: Art. 8(b) CBD obliges the Contracting Parties to develop guidelines for the selection, establishment and management of areas where special measures need to be taken to conserve biological diversity; according to Art. 8(c) CBD, a state should regulate or manage biological resources important for the conservation of biological diversity with a view to assuring their conservation and sustainable use; Art. 8(e) of the said article wants to promote environmentally sound and sustainable development in areas adjacent to protected areas to further the protection of these areas; Art. 8(i) calls for endeavour to provide the conditions needed for compatibility between present uses and the conservation of biological diversity and the sustainable use of its components; and Art. 8(m) requests cooperation in providing financial and other support for all these measures of *in situ* conservation, particularly to developing countries. These legally binding norms provide a broad basis for on-farm conservation. Countries have to develop political guidelines for on-farm conservation, develop strategies for the management of relevant areas and ensure that agricultural methods in use are no longer detrimental to existing (agro)biodiversity. The Convention clearly pleads for protection of traditional lifestyles, i.e. *inter alia* maintenance of local crop varieties and participation of local people in decisions that are affecting them within their surroundings."

I trust that the considerations exposed insofar may have adequately introduced key concerns behind the justification for this new Project that we are going to launch today through this Conference.

With regard to its general purpose and objective, the IFAD NUS 3 Project will contribute towards the development of mechanisms for enhancing on-farm conservation and, in particular, its work will aim at developing community-based documentation and monitoring approaches that would assist resource-poor farmers in preventing the loss of crop genetic diversity. At the same time, these methods should also help strengthen the resilience of production systems in the face of biotic and abiotic stresses brought about by climate change and that are particularly affecting the poor. The larger the genetic diversity in the hands of farmers, the greater will be their ability to cope with change. From a global perspective, the Project will also work to support the advancement of on-farm conservation at a global level, thanks to innovative approaches expected to be delivered, which would be useful to the broader international community and not just to those countries partnering more closely in the Project's implementation.

Rationale and relevance of the new IFAD Project

IFAD NUS 3 will be contributing to strengthening on-farm conservation through the development of innovative community-based participatory methods for documenting, monitoring and promoting agrobiodiversity on-farm. Through case studies in representative regions of three target countries (Bolivia, India and Nepal), the work will shed light on how local crops are currently cultivated and associated knowledge safeguarded, how local populations and individuals carry out their role as custodians, what agrobiodiversity use practices result in income generation opportunities, and how such work could be enhanced in the face of critical challenges faced by farmers and other users, including those related to climate change. The Agencies that will be working closely with Bioversity for the implementation of the Project's Agenda (namely PROINPA for Bolivia, LI-BIRD for Nepal and MSSRF for India) have a consolidated record of experiences in the field of on-farm conservation and NUS, as well as a solid presence at the community level and excellent records of collaboration and synergy with other relevant national agencies and influential decision-makers.

The implementation of this Project will build on important experiences regarding use-enhancement methods for NUS acquired by previous IFAD Projects. Those best practices, ranging from improved cultivation to more effective value addition and marketing of NUS species and their varieties, will be disseminated to target communities, and in particular to women groups (such as self-help groups in India and Nepal). In particular, the new Project will assess how such interventions are useful in leveraging the conservation of the diversity of target species and associated IK by the communities while promoting greater appreciation by users resulting from improved valorization and product quality. Examples of these practices are provided in Rojas *et al.* (2009) and Taranto and Padulosi (2009) for Latin America, and in Padulosi *et al.* (2009), Bala Ravi *et al.* (2010), Yenagi *et al.* (2010) and Vijayalakshmi *et al*. (2010) for South Asia.

This international collaborative effort will also address ways to enhance community-based agrobiodiversity documentation systems, which are considered strategic for addressing many important aspects, including for monitoring uses, threats and losses of genetic diversity at the local level. Apart from a few isolated cases (e.g. Regione Lazio, 2008; Vögel and Meyer, 2005), monitoring systems are today almost totally lacking for cultivated species. Monitoring biodiversity is today geared almost exclusively to wild species (plants and animals) through the IUCN monitoring system now well established globally (Rodrigues *et al.,* 2006). This project will therefore contribute to share current isolated experiences, develop a robust methodology based on these lessons, and test its feasibility and efficacy in three countries. Efforts to be supported through this project are expected to produce, *inter alia,* diversity and threat maps for local species, better understanding of who the custodian farmers are and how their role can be enhanced, methodologies for organizing diversity fairs meant to facilitate access and sharing of diversity among farmers, and participatory approaches for Red Listing of cultivated species and varieties. Although the project will not deal with the verification of genetic diversity at the detailed agro-morphological and molecular levels, and will be based only on main descriptors and farmers' criteria, it should certainly provide the international community with an opportunity to test innovative and participatory methods for monitoring the status of agrobiodiversity on-farm.

As part of the documentation methodology relevant also for payment for agro-biodiversity conservation services (PACS) (see Syngenta, 2011), information will also be gathered on the intrinsic or ethical value of target species and varieties as a complement to the anthropocentric value comprising direct and indirect economic benefits that these resources mobilize for people. Maps and baseline data from the participatory surveys will be useful to scientists interested in assessing in greater depth the extent of agrobiodiversity distribution for further studies related to climate change and its impact on food security. Outputs will also be used to enrich the debate over the possible inclusion of NUS in Annex I of the Treaty, and to explore mechanisms and opportunities for effective conservation through a blending of *ex situ* and *in situ* complementary methods.

The main group targeted by the Project will be the resource-poor farmers whose agrobiodiversity livelihood assets are being gradually eroded. The Project will contribute to the development of methods and tools for enhancing capacities for conserving and using agrobiodiversity (and in particular traditional crops, including NUS) in ways that reinforce income generation, local food systems and adaptation to climate change. Other target groups include national agrobiodiversity researchers, extension workers and community-based organizations (CBOs), whose skills in supporting use enhancement and monitoring of diversity on-farm will be developed. A special focus of the Project will be women in view of their unique role (for so long poorly appreciated and valorized) in conserving and using agrobiodiversity for the benefit of children and other family members.

Goal and objectives of the new Project

The goal of the IFAD NUS 3 Project is to facilitate more effective and sustainable use, management and conservation of local agrobiodiversity by communities and stakeholders, particularly in the context of food security, nutrition, income-generation potential and adaptation to climate change. Its programme of work, which will be implemented in Latin America (Bolivia) and South Asia (Nepal and India), will address four main objectives:

- Develop and test new methods and tools in close partnership with farmers and value-chain actors, aimed at enhancing their capacities to sustainably conserve traditional crops and associated knowledge at the farm level.
- Explore ways of integrating the monitoring of diversity on-farm, along with use-enhancement goals, through inter-disciplinary and multi-sectoral approaches.
- Promote a more balanced complementary conservation agenda in national programmes, based on the need to combat genetic erosion and to meet the needs of agrobiodiversity users.
- Provide useful findings to guide further research related to climate change and its impact on species and varieties deployed in local production systems.

The Project's activities can be also clustered around three main focus domains:

- Developing and testing highly participatory, community-based approaches, methods and tools for documenting local agrobiodiversity and assessing the values, threats and competitiveness of crops relevant to the rural poor, within a climate change context.

- Enhancing capacities of stakeholders in documenting, monitoring, conserving and using local agrobiodiversity and associated knowledge on-farm.
- Exploring relevant policy options and collaborative frameworks, at national and international levels, aimed at strengthening pro-poor on-farm conservation.

The list of activities that form the core part of the Project's framework is provided in Annex 1, while the full logical framework of the Project is given in Annex 2 to this paper.

Among the expected outputs and outcomes from the Project, the following are particularly relevant:

(1) Evidence for better understanding of the distribution of local crops on-farm, their competitiveness and the status of threats.

(2) Documentation of local and traditional knowledge of use of diversity in developing strategies for coping with specific situations and recommendations becoming available on how to enhance good practices through their blending with scientific findings

(3) Human capacities enhanced for coping with change through pro-diversity community-based mechanisms and frameworks

(4) Networks and systems developed or strengthened for promoting greater access, sharing and conservation of diversity and knowledge

(5) Policy options to promote greater use of local diversity addressed, and recommendations made at national and international levels.

(6) Raised awareness at national and international levels of the importance of on-farm conservation, monitoring mechanisms and livelihood benefits from local biodiversity will be among the indicators related to the realization of the outputs of the Programme.

Objectives of this Conference

This Meeting, which could be organized thanks to financial support by IFAD, CCAFS, The Senckenberg Institute of Frankfurt, and BMZ/GIZ, is an important step in laying the foundations of the methodological work to be followed during the implementation of IFAD NUS 3. The outcome of this Experts' Conference will be further refined during three National Workshops due to take place in 2011 in Nepal (1–2 September), India (5–6 September) and Bolivia (21–22 September).

This current meeting has two main goals:

- Review biodiversity-rich practices dealing with NUS and identify approaches, methods and tools for participatory assessment of where, when and how these facilitate adaptation to climate change (the so-called 'insurance function' of traditional crops and NUS).
- Develop a methodological framework for community-based agrobiodiversity documentation and monitoring systems for NUS (and in so doing contribute to enhance best practices for on-farm conservation).

The specific objectives of this meeting are to:

- Review the state of on-farm conservation of NUS through country-based case studies.

- Share experiences and lessons regarding on-farm participatory documentation and monitoring of agrobiodiversity.
- Understand how best practices on adaptation are influenced and managed by farmers according to gender and other social factors.
- Review experiences so far on Red Listing approaches for cultivated species and explore participatory methods to allow assessment of extent of cultivation, thus providing baseline bench marks for future monitoring.
- Review the status of custodian farmers in target countries, their motivations, needs and options for strengthening their role.

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Annex 1. Project main activities and expected outputs of the IFAD/Bioversity International project on "Reinforcing the Resilience of Poor Rural Communities in the Face of Food Insecurity, Poverty and Climate Change through On-farm Conservation of Local Agrobiodiversity"

	Activity	Expected Outputs
1	Training of partners in participatory approaches and surveying methods	Researcher and developers trained for the implementation of activities planned under the project
2	Training of community members in data gathering	Community members trained in documenting diversity and IK and monitoring
3	Surveying and documentation of diversity, IK, conservation efforts and threats	GPS-generated maps of distribution of diversity prepared and information on IK, custodian farmers and threats of erosion gathered
4	Establishment of community seed banks (CSBs) and on-farm networks of custodian farmers in target areas	On-farm network established and tested
5	Establishment of linkages with *ex situ* conservation efforts (national genebanks will be linked with CSBs, which will in turn be linked with networks of farmer groups)	Linkages with *ex situ* activities established and gap analyses carried out to complement *ex situ* with *in situ* conservation
6	Development of a documentation system in support of on-farm monitoring systems	Documentation system developed and tested At least 5 Community Biodiversity Registers (CBRs) made operational in each target country Information on genetic diversity and IK of target species documented and safeguarded through the established community registers Central documentation depository established in each country
7	Development of Red Lists for target species through use of tools such as Four-Cell Analysis	Red lists developed and tested for target sites
8	Carrying out use-enhancement activities for target species in close cooperation with community-based organizations (CBOs) and grass-root movements	Capacity of self-help groups (SHGs) and CBOs built in cultivation and use practices Diversity Fairs organized and integrated within the on-farm conservation monitoring systems

	Activity	Expected Outputs
10	Testing the feasibility of payments for agrobiodiversity conservation services (PACS) Use of community-based biodiversity management funds to provide credit to farmers in exchange for conservation of Red List varieties	PACS approach developed and tested for project sites
11	Raising awareness of the importance of on-farm conservation and its strategic complementary role with *ex situ* conservation	Awareness raised over the need for greater attention on-farm conservation and closer synergy with *ex situ* conservation
12	Exploring the launching of a global mechanism for promoting on-farm networking	Study paper developed and published addressing opportunities and challenges for establishing global on-farm mechanism
13	Exploring policy options for supporting community-based monitoring systems	Policy meeting to address options held and proceedings published

Annex 2. Logical Framework of the IFAD NUS 3 Project

	Objectives hierarchy	Objectively verifiable indicators	Means of verification	Assumptions
Goal	Facilitate more effective and sustainable use, management and conservation of local agrobiodiversity by communities and stakeholders, particularly in the context of food security, nutrition, income-generation potential and adaptation to climate change.	Greater levels of preparedness of communities to face climate change in terms of wider availability of agrobio-diversity, tools and methods to enhance resilience of production and use systems.	Impact assessment reports. Government reports.	Willingness of all stakeholder groups to participate in the project.
Objectives	Develop and test new methods and tools in close partnership with farmers and value-chain actors aimed at enhancing their capacities to sustainably conserve traditional crops and associated knowledge at the farm level. Explore ways of integrating the monitoring of diversity on-farm, along with use-enhancement goals, through inter-disciplinary and multi-sectoral approaches. Promote a more balanced complementary conservation agenda in national programmes, based on the need to combat genetic erosion and to meet the needs of agrobiodiversity users. Provide useful findings to guide further research related to climate change and its impact on species and varieties deployed in local production systems.	Capacities of stakeholder groups to sustainably conserve traditional crops and associated knowledge at the farm level is enhanced. Greater attention by policy-makers towards on-farm conservation. Number of adoptions of recommended policy options for supporting on-farm conservation.	Availability of data through national databases and relevant publications, scientific publications and project reports.	Cost-effective and reliable monitoring systems for NUS can be identified.
Key Outputs	Methods and tools for documenting and monitoring diversity on-farm using community-based approaches. Enhanced capacities of researchers, developers in training community members on documenting, monitoring and use-enhancement methods. Maps on distribution of diversity and IK, custodian farmers and threats of erosion. Networks established and tested for project sites. Monitoring systems developed and tested. Community Biodiversity Registers (CBRs) and central documentation depositories made operational in each country, and relevant information safeguarded. Red List methods for cultivated crops and IK for target sites. Diversity Fairs integrated within on-farm conservation monitoring systems. PACS approach developed and tested for project sites. Awareness raised regarding on-farm conservation needs and policy options for support to on-farm monitoring.	Baseline data and maps on distribution of and threats to target crops on-farm. Number of stakeholders and community members. trained in monitoring and enhancing use of local agro-biodiversity. Methods for documentation, monitoring on-farm in use. Number of CBRs established in target sites. Number and quality of diversity fairs organized by project. Number of recommendations adopted for PACS methods related to on-farm monitoring. Number of recommendations adopted for policy options for on-farm conservation/ monitoring.	Scientific publications and project reports and articles in newspapers. Policy fact sheets. Notes from the Web page and discussion blog maintained by the project.	No extremely adverse climate conditions or civil unrest occurs during project implementation.

	Objectives hierarchy	Objectively verifiable indicators	Means of verification	Assumptions
Key Activities	Organizing International Conference. Training of partners and community members. Surveying and documentation of diversity, IK, conservation efforts and threats. Establishment of on-farm network of custodian farmers in target areas. Establishment of linkages with *ex situ* conservation. Development of documentation system in support of on-farm monitoring systems. Development of Red Lists for model species. Carrying out use-enhancement actions for target species. Testing feasibility of PACS (payment for agrobiodiversity conservation services). Raising awareness on the importance of on-farm conservation and its strategic complementary role with *ex situ.* Exploring the launching of a global mechanism for promoting on-farm networking. Exploring policy options for supporting community-based monitoring systems.	Soundness of methodologies developed in international workshop and further refined in national meetings. Quantity and quality of maps/data generated by surveys. Number of courses carried out and personnel trained. Number of communities actively involved in the use enhancement activities. Degree of participation of women in project activities. Number of meetings, discussions covering on-farm conservation and its enhancement. Raised awareness at national, international levels of importance of community-based approaches. Participation and representativeness of relevant stakeholders in policy meetings.	Scientific publications and project reports; fact sheets. Notes from the Web page and discussion blog maintained by the project.	Local-level partners and communities motivated to join project. Incentives identified can be provided within project context.

The insurance function of agrobiodiversity and the importance of monitoring its conservation and use to cope with change

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Introduction

Agricultural biodiversity encompasses all components of biological diversity relevant to agricultural production, such as the diversity of plants, animals and micro-organisms across all scales, from ecosystem and landscape to single plant, cell and genetic level, which contribute to sustainable production in the agro-ecosystem, and confer an insurance function for food production. In this context, cultural diversity and traditional knowledge play a cross-cutting role, linking soil and water conservation to cultivation of crops and livestock and their use in human diets. A crucial pre-requisite for sustainable agricultural production in a healthy environment is the conservation of agrobiodiversity at all scales and across all spheres.

Diversity's dimensions

At a spatial scale, services to agricultural production are provided by a diverse ecosystem, which exhibits landscape-wide biodiversity and a spill-over between managed and natural habitats, contributing (1) regulating services through providing a habitat for natural enemies and antagonists of pests and diseases, water retention and reduced soil erosion, and buffering of extremes and unpredictable changes in climate and weather, mitigating storms and floods, and (2) providing services such as pollination and non-timber forest products, where both services contribute to the insurance function of agrobiodiversity. Such diversified agro-ecosystems are represented by agrosilvicultural and mixed crop-livestock production systems, including homegardens.

At the cropping system level, diversification includes cover crops, mixed-cropping or intercropping, use of neglected and unterutilized species (NUS), supported by agronomic measures for climate-smart agriculture, enhancing soil fertility and pastoral systems based on sustainable rangeland use with a high diversity of forages and multipurpose trees.

At a species scale, inter- and intraspecific diversity are indispensable pre-requisites to sustain or regain and re-introduce traits that confer tolerance and resilience to abiotic and biotic stress—drought, salinity, pests and diseases—and functional traits such as adaptation to low-input agriculture, resulting in yield stability under environmental change. In this context, crop wild relatives and traditional breeds need to be monitored and conserved on a species level, and genetic variation in landraces, neglected varieties and livestock races at intraspecific level (Sikirou and Wydra, 2003; Wydra *et al.,* 2004; Wydra, Banito and Kpémoua, 2007). Monitoring of this genetic variation is a pre-requisite for improving existing varieties and breeds by introducing traits from a gene pool into a breeding pool.

Other important traits often lost through breeding activities directed at high yield affect the nutrient quality of crops. Neglected genotypes often possess higher contents of micro-nutrients and vitamin A, and can serve for breeding for biofortification. Examples of nutrients targeted in crops are zinc and iron content in rice and wheat; β-carotene and zinc in maize; β-carotene in cassava, sweet potato, banana and plantain; and iron in beans, potato and sorghum. For screening and monitoring these traits, an approach at the genetic scale is recommended, to identify genes with useful traits at the cell or even single gene level, using molecular high-throughput technologies. These molecular methods will help avoid redundancies in characterization of diverse genotypes, and are also useful for characterization of diversity on another trophic level, that of beneficial micro-organisms, leading to an important role in soil functional diversity (decomposition, fertility, nutrient cycling, soil formation).

At the multi-trophic scale, the interactions of pests and their predators or parasites, of pathogens and antagonists, and of other beneficial micro-organisms with crops are connected to (agro-)ecosystem and soil diversity (Wydra and Verdier, 2002). Here, the diversity of vectors of pests and pathogens may have a negative effect on agricultural production and may be a disadvantage. Thus, diversity in the context of agrobiodiversity and its value for crop and livestock production needs to differentiate between beneficial organisms for agricultural production and harmful organisms .

The temporal scale, with its short-, intermediate- and long-term dimensions, implies maintaining the adaptive capacity of neglected crop wild relatives and genetically distinct animal breeds, which might have value in the future, and recognizing the value of biodiversity in agricultural landscapes. The diversity of traits contribute to evolutionary breeding, which has been performed by farmers over 10 000 years of crop improvement, resulting in increased yield, resistance to biotic and abiotic stresses, genetic diversity and in adaptability of a crop population over time (Murphy *et al.,* 2005). Natural selection in combination with site-specific farmer selection in early segregating generations of a heterogeneous crop population is a useful breeding system in low-input and organic agriculture, utilizing skills and knowledge of both breeders and farmers in a participatory breeding collaboration. Thereby, farmers are involved in a participatory approach in breeding processes on site, and their knowledge and expertise are utilized to improve crop varieties specifically adapted to their individual farming systems and the prevailing environmental conditions.

The economic dimension differentiates the value of agrobiodiversity into (1) a use value, e.g. for NUS that play a role in food security, nutrition, health and income generation, or of a gene or gene pool as components of populations, species and genotypes, providing traits to develop a gene pool portfolio for resilience; (2) a non-use value, such as ethical value or food culture; and (3) an option value, to realize a value in the future, and providing the background for generation of novel genetic variation through evolution.

The use value is related to cultivation practices and may decrease when suitable other methods are applied to cope with stress. Detailed studies on the economics and valuation of biodiversity are still rare, but would support the development of policies for sustainable resource management. The analytical economic level needs to be supported by monitoring of biodiversity as well as of the impact of incentives and interventions, with suitable indicators and metrics, and collected data should be made available through an informatics platform that provides information for all stakeholders, including decision-makers in management and policy.

Combining the temporal and the economic dimensions, the use value of a gene can change depending on the economic damage caused by a specific disease or other stress, in relation to growing region and time. The insurance value of agrobiodiversity is closely related to the use value.

Thus, sustaining agrobiodiversity along the production chain across all scales from soil biota to the consumer of diverse agricultural products (including wild edible plants and wildlife, raw materials for goods, wood for shelter and fuel), and conserving biodiversity in ecosystems, improves human, animal, plant and ecosystem health (the one-health concept). This in turn increases the resilience and adaptation of agricultural production systems in the face of threats from climatic stress, assures yields and income generation through marketable products, and provides dietary diversity and fodder rich in micronutrients and protein through well adapted livestock, including aquatic resources. Globally, sustaining agrobiodiversity contributes to climate regulation and carbon sequestration.

Agrobiodiversity conservation has certain pre-requisites: on a socio-cultural level there must be preservation of traditional knowledge, and at economic and institutional levels there must be markets, infrastructure, NGOs and a supportive policy and conducive institutional and legal framework.

Insurance hypothesis

The insurance function of agrobiodiversity is two-fold: providing various options to farmers to produce sufficient and healthy food for subsistence under stressful environmental conditions; and income insurance, when marketable produce is used for income generation. In this sense, agrobiodiversity can help insure against environmental and socio-economic risk through provision of ecological resilience, regulating services (see above), adaptation to climate change, protection of crop and livestock health, promoting beneficial organisms and improving soil quality. These activities have effects at all scales, thereby increasing the capacity to recover from disruption of functions and mitigating risks caused by disturbances (Di Falco and Chavas, 2008, 2009; Tscharntke *et al.,* 2005; Jackson, Pascual and Hodgkin, 2007). This definition of insurance function is also applicable for landscape-mediated insurance, considering the regulating and provision services of an intact ecosystem encompassing natural and managed habitats.

At the farm level, natural insurance through biodiversity and financial insurance are substitutes, with greater agro-biodiversity increasing the mean level, and decreasing variability in crop yields and farm income (Di Falco, Chavas and Smale, 2007; Di Falco, Bezabih and Mahmud, 2007; Baumgärtner and Quaasb, 2007). Farmers face a wide variety of production and marketing risks, to which they react by (1) growing a diverse portfolio of crop species and varieties as a form of natural insurance, and (2) buying financial insurance, where financial and insurance markets exist (Baumgärtner and Quaasb, 2007). Therefore, the insurance hypothesis involves a "portfolio" approach and a risk management approach. Thus, a greater variety of species increases the probability that at least some will continue to provide functions under environmental change or unforeseen disturbances (Neam and Li 1997). An optimization of both biodiversity and crop production benefits is possible (Clough *et al.*, 2011), meaning that increased agrobiodiversity is not necessarily related to a trade-off against lower yield, but rather confers higher yield stability, and thereby also harvest quantity despite stress, calculated in land-equivalent ratios (Sikirou and Wydra, 2008). Farming strategies that maintain biodiversity and can produce in an environmentally friendly manner with low inputs will be more sustainable in the long term than high-input strategies relying on the substantial external provision of energy and nutrients. The economic dimension of insurance through agrobiodiversity connects the agricultural production to income and reduces the risk and vulnerability of a farm household through its portfolio approach. On the societal level, uncertainty in provision of public-good ecosystem services is reduced (Baumgärtner and Quaasb, 2007).

To ensure conservation of agrobiodiversity, thorough monitoring and characterization is necessary. Data are needed at farm and landscape levels, such as the amount and distribution of crop genetic diversity and biodiversity resources, accompanied by data collection on characterstics of gene pools (crop, livestock, wild relatives) and management practices for diversity maintenance. At the research level, high-throughput screening using molecular techniques to identify desired genes in neglected and wild genotypes are a useful tool for monitoring, in order to minimize redundancy and loss of valuable traits. Data for mapping and documenting should be connected into a globally available data platform.

Monitoring of agrobiodiversity has to result in conservation efforts for valuable genotypes in order to provide the basis for continuing improvement of crop and livestock populations. *Ex situ* conservation in genebanks has to date mainly focused on major crops, with neglected crops and wild species barely covered. Specifically for landraces and neglected species, *in situ* conservation plays a major role, which will be elaborated in various articles throughout these proceedings.

To support agrobiodiversity, conducive policies and institutions are needed, such as legal frameworks and regulations that promote the use of agrobiodiversity, including appropriate seed legislation, national development strategies and agricultural policies. Extensive networking needs to be established between the different stakeholders, from farmers, NGOs, scientists and researchers, to political institutions, government agencies, education institutions and national and international networks, and the networking strengthened at all stages.

System-wide policies and related legal instruments on biodiversity conservation should be harmonized, and global action plans for conservation and use of agrobiodiversity developed. Strong, complementary and synergistic collaboration of the major institutions and organizations in this field is needed: Bioversity International; Food and Agriculture Organization of the United Nations (FAO); the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA); the FAO Commission on Genetic Resources for Food and Agriculture (CGRFA); the Convention on Biological Diversity (CBD); the World Intellectual Property Organization (WIPO); the System-wide Genetic Resources Programme (SGRP) of the Consultative Group of Agricultural Research (CGIAR); the CGIAR Genetic Resources Policy Committee (GRPC); the Central Advisory Service on Intellectual Property (CAS-IP); the World Health Organization (WHO); to name just some. Responsibilities and duties should be clearly defined in order to avoid unnecessary duplication of work, while some 'coordinated overlapping', although with different foci, may be useful.

In conclusion, agricultural biodiversity at all scales provides an insurance function for food security, specifically in confronting the adverse effects of climate change, which are expected to present currently unforeseen threats to food production systems and to animal and plant health.

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On-farm conservation of neglected and underutilized crops in the face of climate change

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Abstract
Genetic diversity is a key element in farmers' livelihood strategies, particularly in areas with high ecological, climatic and economic stresses and risks. Informal seed systems are important practice to the maintenance of traditional crop diversity on-farm. Global food security has become increasingly dependent on a limited number of varieties of a few major crops, and in the wake of climate change such a situation renders farmers more vulnerable with regard to their food, nutrition and income security. This paper discusses the importance of the multi-functionality of informal seed systems and need to strengthen the systems that support on-farm/in situ conservation in adapting and mitigating climate change impacts on the livelihood of farming communities. A few good practices are highlighted that support the management of local crop diversity and improve livelihood options of farmers.

Introduction

The Convention on Biological Diversity (CBD) within its broader framework defines two conservation strategies: *ex situ* conservation and *in situ* conservation. *In situ* or on-farm conservation refers to the maintenance of cultivated plants (often in association with their wild relatives that may be present in the same field or near vicinity) in the very place where they developed their present-day characteristics (Altieri and Merrick, 1987; Brush, 1995; UNEP, 1992; FAO, 2010) and where they continue to evolve (Frankel, Brown and Burdon, 1995). On-farm conservation is therefore generally used to describe the dynamic management process by which farmers maintain traditional crop varieties that were developed in their local conditions and that they continue to modify through their management practices and crop selection efforts. Thus, the conservation of specific genotypes becomes a secondary objective to the continuation of the processes that allow the material to evolve and change over time (Jarvis and Hodgkin, 2000).

Climate variability and risk has always been a part of agriculture, and farmers have developed many ways of managing that risk. From a farmer's perspective, climate change is not seen in terms of major disasters such as floods, drought or hurricanes, but rather as increased uncertainty, such as shifts in onset of rain at planting time or end of rain at harvest time; some years bring excessive rainfall while others are very dry, with a greater irregularity within and between annual rainy seasons. Such uncertain weather is directly affecting crop production and farmer incomes. It is difficult to assume that the current research system has the capacity to develop a set of technologies and suitable varieties that match the many needs within a changing climate scenario. Plant genetic resources conserved *ex situ* might not have evolutionary adaptive capacity equivalent to the traditional varieties grown year after year in the farmer's fields (*in situ*). During the process of on-farm management (planting, growing, selectiing, harvesting and storing) of farmer varieties, the crop populations are subjected to the forces of natural selection. In a cycle of sowing and re-sowing seed from the plant population year after year, those plants favoured under prevailing growing conditions are expected to contribute more seed to the next generation than plants with lower fitness (Harlan, 1992). When these plants are selected by humans for specific colour, taste and other qualities on thousands and thousands of small farms, socio-economically acceptable and locally adapted crop varieties develop and are then spread from farmer to farmer, or through local markets, to find new niches and colonize the area by increasing population size (Hasting and Harrison, 1994). These processes require the intervention of human knowledge and decision-making as to whether or not to plant a particular seed lot, or whether or not to select a particular trait for future cultivation (Doring *et al.,* 2011). Landraces or traditional varieties are products of such evolutionary plant breeding (Frankel, Brown and Burdon, 1995). They are reservoirs of adaptive variation in crops. Farmers have a good understanding of the qualitative and adaptive traits of their landraces and the interaction between ecosystems and landraces.

Informal seed systems (often described as farmer or local seed systems) allow the dynamic change that characterized crop landrace systems—namely open, decentralized genetic systems that are constantly evolving to fit farmers' needs and environmental changes—to help in coping with the uncertainty generated in agriculture by climate change (Bellon, 2010). Millions of small-scale farmers continue to depend on 'informal' or 'local' seed systems around the world. The formal seed sector is not producing and delivering the diversity of crop varieties that farmers need in fragile environments to meet their current and future needs, particularly to address their vulnerability to crop losses. This problem is compounded by: (1) globalization and the consolidation of seed industry; (2) the erosion of traditional seed systems; and (3) restrictive national seed policies. Hence, in order to contribute to the enhancement of the lives of farmers in these environments, there are two options: either to promote more responsive formal seed systems that are diverse in terms of actors and provide a range of crop varieties, which in turn requires 'better' national seed policies to enable this; or to strengthen informal seed systems by empowering local institutions in basic breeding and community seed production strategies. The purpose of this paper is to highlight the importance of the informal seed system and the associated social networks in terms of management of portfolio diversity as a means to cope with adversity and therefore to find ways to support the system for sustainability of agriculture in the future.

Challenges

Since the time that the CBD provided a general framework for *ex situ* and *in situ* conservation strategies, most agencies dealing with plant genetic resources conservation have been facing the dilemma of how to implement *in situ* conservation in practical terms of agricultural biodiversity (Sthapit, Padulosi and Bhag Mal, 2010).

Central to the issue is the recognition that if crop genetic resources (including landraces) are to be conserved successfully and sustainably on-farm, such an outcome should be the result of farmers' productive activities directed to improve their livelihood (i.e. conservation through use) (Sthapit, 2007). This means that on-farm conservation efforts must be carried out within the framework of farmers' livelihood needs, and hence the mobilization of support for on-farm conservation needs to be conceived and designed within the broader objective of creating a more enabling environment for agricultural development in its various dimensions.

To date, the organizations engaged in the promotion of conservation of plant genetic resources for food and agriculture (PGRFA) are facing the dilemma of how best can *in situ* conservation be implemented on-farm. Since the farmers and their social networks play a key role in maintaining the dynamic process of evolution of varieties through selection and adaptation of useful diversity in the changing climate, it is important to understand that on-farm conservation is a constantly changing and complex system of relations between people, plants, animals, other organisms and the environment: all continuously challenged by new problems. Under such conditions, the broader the diversity employed on-farm, the more resilient will be the production system (Jarvis, Padoch and Cooper, 2007).

Role of *in situ* conservation on-farm in the context of climate change

In the debate on climate change and agriculture, the roles of *in situ* conservation and on-farm management of agricultural biodiversity are seldom discussed with the attention they deserve. The various climate change predictions make it clear that many regions around the globe are going to witness change in various ways (IPCC, 2007). In such a situation, it is important to consider whether such change will affect on-farm management of cultivated landraces and their wild relatives. Jarvis, Lane and Hijmans (2008) and Jarvis *et al*. (2008) used current and projected future climate data for ~2055 coupled with a climate envelope species distribution model to predict the impact of climate change on the wild relatives of groundnut (*Arachis hypogaea*), potato (*Solanum tuberosum*) and cowpea (*Vigna unguiculata*).

In terms of species extinction, wild groundnut is most vulnerable, whereas cowpea appears to be the least affected by the projected climate changes. These results suggest that there is an urgent need to identify and effectively conserve landraces and crop wild relatives that are at risk due to climate change. At the same time, there are many reports indicating that new strains of pathogens and pests (e.g. the Ug99 strain of stem rust in wheat; bacterial fire blight in apples; and new strain rice blast) are emerging, which means that breeders need landraces and wild relatives as sources of resistance genes (Qualset and Shands, 2005). Due to climate change, it is difficult to predict which new pest or pathogen will develop, or how the rainfall will be next year, but agricultural biodiversity can be used as farmers always have done, to have a set of crop varieties in farming systems to increase the options to buffer against unpredictable changes (Holger *et al.,* 2004). This requires access to a wide ranging portfolio of local crop diversity accessible to the community for countering these threats. This one major reason why on-farm conservation can play a critical role in the future, as well to solve emerging problems.

Role of neglected and underutilized species as a buffer for climate change

Neglected and underutilized crop genetic resources are vital for sustainable agriculture (Eyzaguirre, Padulosi and Hodgkin, 1999; Bhag Mal, 2007). Traditionally, these species contribute significantly to the well-being and livelihoods of rural households, and some priority species that are already threatened are listed in Table 1. Despite the general notion that NUS are neglected for specific socio-economic reasons, the role of these species used by indigenous farming communities becomes extremely important when reducing risks and adapting to adversity caused by climate changes. Many of these species are well adapted to stress conditions of extreme environments and hence form part of sustenance farming systems.

Many underutilized species occupy important niches, adapted to risky and fragile conditions of rural communities, and have a comparative advantage in marginal lands as they can better withstand stresses. They also contribute to the diversity and stability of agro-ecosystems and are potential crops for the diversification of agriculture (Jarvis, Padoch and Cooper, 2007). These species often play a strategic role in fragile ecosystems such as those of arid and semi-arid lands, mountains, steppes and tropical forests. Most of the these crops do not require high inputs and can be successfully grown in marginal, degraded or waste lands, with minimal inputs and at the same time can contribute to increased agricultural production, enhanced crop diversification and improved environment, and have the potential to contribute useful genes to breed better varieties capable of withstanding and the climate change scenario and sustaining production (Padulosi *et al.* 2009).

Table 1. Top 30 priority neglected and underutilized crops of Nepal and South Asia

Crop	Type	Threat to diversity	Importance to livelihood and potential scale up
Fingermillet (*Eleusine coracana*)	Cereals	Medium (MHH, SA)	High for nutritious crop
Proso millet (*Panicum miliaceum*)	Cereals	High (FHH, SA)	Low
Foxtail millet (*Setaria italica*)	Cereals	High (FHH, SA)	Low
Buckwheat (*Fagopyrum* spp.)	Pseudo-cereals	Medium (MHH, SA)	High for healthy and export
Amaranthus (*Amaranthus caudatus*)	Pseudo-cereals	High (FHH, SA)	High for healthy and export
High altitude rice (*Oryza sativa*)	Cereal	Medium (MHH, SA)	High for local food security
Naked barley (*Hordeum vulgare*)	Cereal	High (FHH, SA)	High for local food security
Beans (*Phaselous vulgaris; Lablab purpureus*)	Legumes	Medium (MHH, SA)	High for local market
Rice bean (*Vigna umbellata*)	Legumes	Medium (MHH, SA)	High for nutritious crop
Black gram (*Vigna radiata*)	Legumes	High (MHH, SA)	High for local market
Lathyrus (*Lathyrus sativus*)	Legumes	Medium (FHH, LA)	Medium for regional market
Horse gram (*Macrotyloma uniflorum*)	Legumes	High (FHH, SA)	High for healthy crop
Taro (*Colocasia esculenta*)	Root crops	Medium (MHH, SA)	High for local market
Yam (*Dioscorea* spp.)	Root crops	High (FHH, SA)	Medium for local market
Oal; arum (*Amorphophallus campanulatus*)	Root crops	High (FHH, SA)	Medium for local food culture and climate resilient crop
Rayo (*Brassica juncea*)	Leafy vegetable	High (MHH, SA)	High for local and international seed market
Chayote (*Sechium edule*)	Young shoots, fruits and yams	Medium (MHH, SA)	Medium for local food culture and climate resilient crop

Crop	Type	Threat to diversity	Importance to livelihood and potential scale up
Sponge gourd (*Luffa cylindrica*)	Young fruit vegetable	Medium (MHH, SA)	Medium for local food
Sesame (*Sesamum indicum*)	Oilseed	High (FHH, SA)	High for local and export market
Niger (*Guizotia abyssinica*)	Oilseed	High (FHH, SA)	High for export market
Drumstick (*Moringa oleifera*)	Fruit vegetable	Medium (FFH, SA)	High for healthy and nutritious crop
Kaphal (*Myrica esculenta*)	Fruits	High (FHH, Few trees)	High for healthy fruits in local market
Bael (*Aegle marmelos*)	Fruits	Medium	High for cultural value and value added products
Chiuri (*Aesandra butyracea* (syn. *Madhuca butyracea*; *Bassia butyracea*)	Fruits	High	High for cultural value and value added products. The Chepang community gives Chiuri seedlings as dowries to daughters indicating its significance in the livelihood of the Chepang community.
Amala (*Phyllanthus emblica*)	Fruits rich in vitamin C	High	High for healthy fruits in local market
Pummelo (*Citrus maxima*)	Fruits rich in vitamin C	High	High for cultural value and value added products
Jammun (*Syzygium cumini*)		High	High market value fruits for diabetic patients

NOTES: MHH = many households; FHH = few households; SA = small area

Genetic diversity that is currently underutilized may become more attractive to farmers as a result of climate change. Many neglected and underutilized species which are currently maintained through *in situ* conservation on-farm could be the important options for the future. Their adaptability, plasticity and resilience to stresses provide farmers with needed coping strategies to confront climate change. Because of changes such as shifts in rainfall patterns and temperature deviations from normal, community-based management of a wide portfolio of plant genetic diversity is required to retain adaptive capacity in available local crop diversity. The suitability of current crop genotypes to local conditions will change in both positive and negative ways, depending upon the crop and region, but will affect many production systems. On-farm management of genetic diversity has traditionally allowed farmers to cope with adversity, and this process will continue to serve that function in the future.

Role of informal seed systems and social seed networks

Informal seed systems are those ways in which farmers produce, select, save and acquire seed outside of official or commercial channels. Such seed systems are important to maintenance of crop genetic diversity on-farm. Most rural and poor farming communities in developing countries save their own seed or they obtain seed from social seed networks and local markets independently of formal seed sources. This informal or farmer seed system, plays a central role in the provision of planting materials in developing countries, and studies have estimated that over 95% of the seed of the main staple crops came through the informal sector, and approached 99% in the case of underutilized crop species (Baniya *et al.*, 2003; Tripp, 2001; Hodgkin *et al.,* 2007).

In order to understand the role of *in situ* and on-farm conservation of agricultural biodiversity in the wake of climate change, it is also important to understand how communities obtain information on new diversity, how they search, select and exchange seed with relatives and friends, and in what context farmers look for seed in local markets and other sources.

There are two ways to acquire new varietal diversity. Either seed selection by farmers over seasons exerts selection pressure on populations of genotypes through the environment and through the criteria used by the farmers to select seed for propagation (Harlan, 1992), or new genetic diversity is introduced into the farmer's seed system through the introduction of new varieties or new selection and introgression of genes from hybridization with wild species or varieties. New varieties enter farmer seed systems through social seed networks or as seed from local markets or other outside sources (Almekinders and Louwaars, 2002). This system is very dynamic and integrated, with the resilience to cope with all kinds of pressures.

The interaction of traditional knowledge and practices with local genetic resources plays a key role in the capacity of farmers and communities to adapt to climate change. Farmers' ability to cope with the impact of climate change will be strengthened if the research and development institutions can build upon the traditional knowledge and practices of informal seed and germplasm management systems. This requires strengthening social seed networks through policy supports that promote farmer-to-farmer seed exchange systems. Informal seed systems are maintained through the interactions of economic, social and cultural institutions that ensure availability of planting materials. Individual farmers search, select and keep their own locally adapted seeds and breeding stocks, but practice social forms of exchange, including as gifts, barter or sales, thus deploying agricultural biodiversity across landscapes and communities. In the context of climate variability and risk of crop failure in a local condition, communities with strong social seed networks are better equipped to cope with the effect of climate change compared with communities with weak or disturbed social seed networks (Subedi *et al.,* 2003; Poudel *et al.,* 2007). In many traditionally managed agro-ecosystems, local populations of domesticated crops maintain a high level of genetic diversity by the function of migration and re-colonization (sink-source) of meta-populations (van Dusen, 2003; Hastings and Harrison, 1994). It has been observed that populations of local varieties suffering as a result of a climate problem can be re-colonized by a simple flow of seed or planting materials through farmer-to-farmer networks. Commercial and centrally-planned seed companies and government institutions have difficulty in coping with climatic unpredictability and planning for the seed provision needed for diverse types of small-scale farmers, often in marginal environments. In fact, on-farm conservation and management of a wide range of crops, trees and animals play key roles in buffering such situations and are the most reliable way to provide access to locally adapted materials and thus sustain livelihoods.

Multi-functional role of informal seed systems

Informal seed systems have many functions. However, government policy-makers and donors often do not appreciate the value of such multi-functionality, and support the component of interest to them, resulting in weakening the farmer seed system. Informal seed systems (producers, networks, etc.) that are so important for small-scale farmers to maintain their planting material and hence to help guarantee household food security for their families, are gradually losing ground, due to the weakening of social networks, connections and institutions at the local level that formerly supported and sustained informal seed systems.

A healthy seed system has four important components: (1) it maintains a germplasm base that provides diversity, flexibility and a basis for selection; (2) it produces good quality seed for production (free of seedborne diseases, and with high germination and vigour); (3) it ensures seed availability and distribution (seed sources, social networks, markets); and (4) it involves sharing of knowledge and information about seed (growing methods, utilization, knowledge of new materials, trade-offs between traits) (Hodgkin *et al.,* 2007). These four broad functions provide farming communities with a degree of resilience to cope with adversity.

Germplasm base: diversity, flexibility and selection

Informal seed systems involve locally adapted germplasm of diverse crops. In general, farmers maintain few varieties on-farm at the household level (1.38 to 4.25 richness) whereas at the community level farmers throughout the world continue to maintain and manage substantial diversity (varietal richness ranging from 4 to 60 in 27 crops species in 8 countries) in agricultural production systems (Jarvis *et al.,* 2011). Traditionally, farmers use both a portfolio of farming practices and a portfolio of crop varieties of staple crops to manage socio-economic and environmental adversity (Sthapit, Padulosi and Bhag Mal, 2010). Informal seed systems maintain all this crop diversity and intra-specific diversity, and are used by poor farmers in difficult production environments. Major staples have higher richness and evenness than non-staple crops. Community richness and evenness is much higher than household level richness. If community divergence of local diversity is high, then the system probably has greater resilience in the face of any environmental impacts. This diversity provides farmers with an element of selection flexibility when choosing appropriate varieties through informal networks and social connections. In the context of increasing difficulty of material exchange, informal seed systems provide new sources of genes for local innovation.

Seed production and quality

Seed production of local varieties of minor and neglected crop species is not a priority for formal and commercial seed companies, despite the local importance of such species. Private seed companies and the formal seed sector are not able to provide seed or other planting material that meet the demands of small-scale farmers in developing countries, and even less able to assist those farming in marginal and vulnerable ecosystems. Nevertheless, the informal seed systems, that are essential for small-scale farmers to maintain their planting material and to guarantee household food security, are gradually losing ground due to weakening of social institutions and structures at the local level that are fundamental to supporting and sustaining local seed systems.

Quality can refer both to the physiological quality of seeds in terms of acceptable seed health, and also to genetic quality, i.e. the specific adaptations and varieties that are socio-culturally acceptable (Cromwell, 2000; Remington *et al.,* 2002). Generally, "seed quality" equates to certified seed with standardized germination, purity and health parameters (Tripp, 2001). Locally produced seed is usually trusted by farmers and considered quality seed and preferred in local seed transactions. Such trust can be enhanced if the technical expertise of small-scale farmers and their community seed production groups are systematically enhanced.

Seed availability and distribution

Seed availability is whether sufficient seed of appropriate crops is available within reasonable proximity and at the time of planting (Cromwell, 2000; Remington *et al.*, 2002). Weltzien and vom Brocke (2000) use a more farmer-oriented framework for understanding the function of a seed system; they suggest that seed systems have to fulfil a series of functions, so that healthy, viable seed of the preferred variety is available to farmers at the right time, under reasonable conditions and in ways that ensure choice of seed that land and labour resources can use optimally. Farmers meet this function through saving their own seed, exchanging with neighbours, friends and relatives, or using the market. Availability of multiple seed sources improves access of preferred crop varieties and thereby enhances richness of local crop diversity *in situ*. Access to diversity refers to people having adequate land (natural capital), income (financial capital) or connections (social capital) to purchase or barter for desired varieties (Sperling, Cooper and Remington, 2008).

Most seed flow occurs within a community as gifts, exchange and bartering within the context of social custom. Social networks play a key role in supplying traditional varieties and maintaining crop genetic diversity on-farm in changing climate conditions and evolving pest and disease threats (Subedi *et al.*, 2003). Any community-based interventions that support or strengthen farmer-to-farmer seed exchange or access of new diversity will broaden the germplasm base of farmer seed systems.

In many traditionally managed agro-ecosystems, local populations of domesticated crops maintain a high level of genetic diversity by the function of migration and re-colonization (sink-source) of meta-populations (van Dusen, 2003; Hastings and Harrison, 1994). However, farmers often assume that the traditional varieties are usually maintained by someone within the community and that they can obtain them from fellow farmers should they need them. Studies have shown that this assumption is often wrong because of the pressures and stresses on traditional seed systems from various commercial and policy forces.

Despite a strong awareness programme, loss of traditional crop varieties continues even in those areas where access to markets, technological interventions and information is high (Chaudhary *et al.*, 2004). Shrestha *et al.* (2006) reported from the Bara ecosite in Nepal that farmers are increasingly willing to purchase seed of local varieties and the system of seed exchange (as a gift or loan) is declining. In some instances, many farmers may not even be aware of the fact that useful resources are available within their community. For example, Sthapit, Shrestha and Upadhyay (2006) reported that a good quality sponge gourd variety (*Basune ghiraula*, literally, aromatic sponge gourd) was grown by few households and its existence and seed availability was unknown to most others until a diversity fair was organized and locally multiplied seeds were distributed to other farmers. The variety is now grown by 120 households in contrast to only a single household in 1998. Practices such as diversity fairs, community biodiversity registers and community seed banks enhance seed availability and its distribution.

Knowledge and information

Farmers will seldom appreciate a variety and demand for it without adequate knowledge and information about the variety, its growing methods, utilization and any trade offs between key traits. Farmers generally have imperfect access to information about varieties (Tripp, 2001). Social connection is a significant source of information for most local varieties, as official or private companies provide information only for their own products. Access to unique and locally adapted traditional varieties is often poor within the community, even when a sufficient quantity of seed is available (Badstue, 2006), simply because of poor access to information, weak social networks, social exclusion and weak institutional mechanisms for collective actions. A platform for collective learning and change is essential to strengthen community capacity to use existing genetic resource for managing any kinds of adversity.

Strengthening farmer capacity through R&D to cope with climate change

Access to a wide range of local crop diversity through community actions such as biodiversity fairs, diversity kits and establishing community-based resource centre, such as community seed banks or fruit nurseries, are important lessons learnt (Table 2). First, situation analysis within the four main components of interventions (assessment, access, use and benefit) can, and most probably will, lead to a number of different community actions. Second, the decision to implement a particular community action, and therefore its success, will depend on farmers and the farming community having the knowledge and leadership capacity to evaluate the benefits that this action will have for them. This in turn emphasizes the importance of empowering farmers and local institutions so as to enable farmers to take a greater role in the management of agricultural biodiversity.

Table 2. Tools, methods and good practices for ensuring knowledge and skills in a CBM approach

Activity	Tools and methods	Datasets required	Reference
On-farm diversity assessment	Four-cell analysis using FGD and HH	Names of varieties and areas under each	Sthapit, Shrestha and Upadhyay, 2006 Jarvis *et al.,* 2011
Access to diversity	Diversity fair Diversity kits Community seed bank CBR register Increase sources e.g. CBSPG	Before and after No. of transactions Diversity measures	Sthapit, Shrestha and Upadhyay, 2006 Shrestha *et al.,* 2006 Subedi *et al.,* 2006
Improving use through better information, materials and management uses	Diversity kits Grassroots breeding PPB FM Radio	Do farmers and local institutions have knowledge and information to cope with vulnerability?	Jarvis *et al.,* 2011 Sthapit, Shrestha and Upadhyay, 2006 Sthapit and Rao, 2009
Benefiting use of diversity	PVS; CBSPG Exchange visit Value addition	How to measure diversity, capacity and benefits enhanced?	Sthapit, Shrestha and Upadhyay, 2006 Gyawali *et al.,* 2009 Jarvis *et al.,* 2011

NOTES: FGD = Focus group discussion; HH = Household; CBR = Community biodiversity register; CBSPG = Community-based seed producer group; PVS = Participatory variety selection; PPB = Participatory plant breeding.

On-farm assessment of diversity

Understanding the community richness, evenness and community divergence of local crop diversity provides the scientific knowledge needed not only to manage crop genetic resources on-farm, but also to develop options for better livelihoods and income that provide incentive for conservation efforts (Sthapit, 2007; Jarvis *et al.,* 2011). There are different methods, tools and approaches to assess diversity on-farm. In order to engage and empower farming community and rural institutions, a participatory Four-Cell Analysis (FCA) tool can be used to quickly assess the conservation and use status of different varieties within a crop in a community. It generates information on why particular varieties have their status and helps the community identify and agree on appropriate interventions for those varieties (Sthapit, Shrestha and Upadhyay, 2006). This tool is helpful for both researchers, development workers and farmers to share knowledge and information for designing livelihood and conservation strategies. Biodiversity fairs and competitions are other methods that can also quickly assess locally available diversity and provide information and materials for implementing CBR and community seed banks.

Access to diversity

Farmers may not have the capacity and facility to predict climatic variability before crop seasons or which new pest or pathogen will develop as a problem, or how the rain will fall during the crop season. However, they can and do use a set of crop varieties in agricultural production systems to increase options to buffer against an unpredictable change. In this context, easy access to diversity for local innovation is essential. Today, many small-scale farmers in developing countries have limited access to the range of crop diversity needed to improve resilience and response capacity for a number of livelihood problems, such as food security. Access to local seed is increasingly difficult because the areas under local varieties are not only decreasing but the number of households cultivating local varieties are also becoming fewer compared with those growing modern varieties (Shrestha *et al.*, 2006). Studies have been carried out in Bara site of Terai. Terai refers to the southern flat, low-lying Indo-Gangatic plains of Nepal bordering on India. This region stretches for more than 1000 km from east to west along the Indian border. The studies revealed that social networks in Terai Nepal are weak, closed and not connected with other networks. They are therefore more vulnerable to lack of access to local seed when in need during times of climatic adversity (Poudel *et al.,* 2007).

Improve the materials

One factor often cited as being one of the most limiting factors in the use of crop genetic resources to increase crop productivity is the lack of sufficient numbers of well-trained plant breeders, as reported by a recent (2006, but unpublished) FAO survey that was a major influence in the establishment of the Global Partnership Initiative for Plant Breeding Capacity Building (GIPB; http://km.fao.org/gipb). There is a lack of capacity among ground-level service providers to identify and use new and useful sources of variation, whether conserved in the many genebanks around the globe or found in farmers' fields, for traits useful now and in the future. There will never be enough plant breeders to develop specific varieties for specific situations in specific crops, particularly minor and underutilized species. So what is needed is a simple approach that can be employed by large number of researchers, extension workers, NGOs and local institutions to maximize the use of useful diversity (Hardon and de Boef, 1993). Sthapit and Rao (2009) put forward an idea of Grass-roots Breeding (GB) as a simple plant breeding process that enhances the capacity of grass-roots institutions to assess existing diversity, select niche-specific plant material, multiply and produce sufficient good quality seed, and distribute it within the community.

Strengthening informal seed system for ensuring benefits to farmers

Strengthening farmer seed systems of neglected crop species and other associated biodiversity implies promoting open, dynamic and integrated genetic systems to cope with climate change at the local level through a combination of community-based conservation actions (e.g. seed fairs, diversity kits, community-based register (CBR), community seed banks, community-based seed production schemes) to improve access to materials and knowledge, and their exchange, coupled with grass-roots breeding, participatory variety selection and participatory plant breeding to develop farmer's skills and capacity in selection in the changing context (Table 2) (Sthapit, Shrestha and Upadhyay, 2006). This is only possible if the farmer's roles as conserver and promoter of diversity and dynamic innovator is consolidated by strengthening farmer seed systems and agronomic practices, with compensation or other rewards for services to conservation.

In order to ensure benefits to farming communities and other stakeholders, it is essential to consolidate the roles of farmers as conservers, promoters of diversity and dynamic innovators through an enabling policy environment for on-farm management, farmer innovation and strengthening of farmer seed systems, coupled with scientific capacity building of these communities. As an integrated conservation and development approach, community biodiversity management (CBM) reinforces the capacity of farming or user communities and their institutions. The focus is on increasing decision-making power and securing community access to and control over the resources required for CBM (Sthapit *et al.,* 2008a, b). The CBM process is guided by the following principles:

- Building on local knowledge, resource, innovation and assets.
- Capitalizing livelihood assets for diversifying biodiversity-based livelihood options.
- Empowering farmer and community institutions as legitimate actors in the national agricultural biodiversity system.
- Providing a platform for social learning to cope with vulnerability in a climate change context.
- Promoting good governance for CBM management.

CBM methodology comprises a number of steps and a set of practices suit to the particular contexts (Sthapit, Shrestha and Upadhyay, 2006). These include: (1) enhancing community awareness; (2) understanding local biodiversity, social networks and institutions; (3) capacity building of community institutions; (4) establishing institutional working modalities; (5) consolidating community roles in planning and implementation; (6) establishing a CBM Trust Fund (payment system for community conservation efforts); (7) community monitoring and evaluation; and (8) social learning and scaling up for community collective action.

Lessons learnt

The experience gained from Bioversity International's global on-farm and home garden projects amply demonstrates that community-based biodiversity management facilitates the process of community empowerment and local decision-making for collective action. This therefore reinforces the process that supports farmer decision-making in management of genetic diversity, and is considered as a proxy methodology to realize *in situ* and on-farm conservation of PGRFA. This can be achieved by consolidating the role and capacity of farmers and their rural institutions.

This approach is not easy for those working in genebanks as they are used to controlling all decisions, as is typical of an *ex situ* system. Clearly this mindset has to be changed when implementing on-farm work. Many researchers find this challenging in current plant genetic resources conservation organizations as the institutions have to develop new kinds of partnership with crucial and legitimate actors of on-farm management. Plant genetic resources institutions that have worked with community-based organizations have been able to do this effectively by mutually defining clear roles and responsibilities for different actors. During the CBM process, all actors can find their respective role to cultivate partnership in research and development.

This process allows farmers to gain scientific insights into knowledge related to climate change scenarios, access to new varieties and technologies, and to blend or integrate this new knowledge into their own traditional knowledge and farming system, thus acquiring the resilience to cope with new problems and to find new ways to deal with them. This allows the communities to be better prepared against the unpredictable nature of climate and socio-economic environments.

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Supporting initiatives on agrobiodiversity in the context of food security and nutrition

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Introduction

From 1 January 2011, GIZ brought together under one roof the long-standing expertise of DED (German Development Service – Deutscher Entwicklungsdienst), GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit GmbH – German technical cooperation) and Inwent. It currently employs approximately 17 000 staff members worldwide, with 1135 technical advisors, 750 Integrierte Fachkräfte (Integrated Experts, i.e. German professionals sent from Germany to developing countries – CIM-IF) and 324 Rückkehrende Fachkräfte (Returning Experts, i.e. foreign professionals currently working in Germany and willing to return to their home countries – CIM-RF).

The services delivered by GIZ draw on a wealth of regional and technical expertise and tried and tested management knowledge. All sector projects related to the Agriculture, Fisheries and Food division are usually supraregional projects or programmes with a thematic focus, funded by a sectoral division of the German Federal Ministry for Economic Cooperation and Development (BMZ), normally coordinated by GTZ's Planning and Development Department (P&D).

Methods and approach

Current sector projects related to agrobiodiversity (ABD) involve various fields, such as social and environmental standards, agricultural policy and food security, agricultural trade, and networks and knowledge management for rural development. Other fields are also covered, such as chemical safety, development-oriented drug policy, promotion of responsible fisheries, land policy and management, and territorial development in rural areas. Sustainet (Sustainable Agriculture Information Network) and NAREN (Sustainable Management of

Resources in Agriculture) are two other programmes that address sustainable production systems.

GTZ has been extensively involved in agricultural research for over 30 years and has channelled more than € 500 million of funding from the German Government (via BMZ) into research-centre budgets for project-linked development, together with communicating the importance of ABD. As part of GTZ Programmes, BEAF (the Advisory Service on Agricultural Research for Development) aims to sustain biodiversity. BEAF has some priority areas. Its main goal is to promote conservation and characterization of underutilized plant genetic resources to increase the income of the poor, as well as to conserve and enhance the contribution of underutilized plant genetic resources (UPGR) to the income, health and nutrition of the poor. In addition, BEAF also aims to implement sustainable management of water, land and forest resources, integrating land, water and forest management at landscape level. The aim of all these activities is to improve land use practices, which contribute to increased and sustained productivity, optimal conservation, reduced conflicts and equitable use of land, water and forest resources in multi-use landscapes.

As previosuly mentioned, NAREN is a programme that relates to different themes in agricultural biodiversity. Thus, it is important to higlight that ABD refers to all components of biodiversity of relevance to food and agriculture, including organisms that sustain agro-ecological key functions, such as:

- cultivated or domesticated animal and plant species and their wild relatives;
- managed stocks of wild animals and plants; and
- organisms maintaining key functions in agro-ecosystems (more relevant today because of the Economics of Ecosystems and Biodiversity discussion – TEEB).

Discussion

ABD is an important element in international cooperation because it is considered a source of food, income, raw materials for clothing, medicine, building materials and fuels, and because ABD also has other less tangible functions, such as maintenance of soil fertility, and soil and water conservation. It is therefore a basis for breeding and adaptation of species to meet new requirements in food and raw materials—a sort of living library, we could say. ABD is particularly essential for small-scale farmer food security and is humanity‘s cultural heritage from thousands of years of selection and breeding. Indeed, potato culture is almost a religion in the Andes, where it is considered an essential element in local cultural heritage. ABD conservation and its sustainable use is of course part of GIZ‘s international agenda.

Within GIZ, ABD is regarded as an “old” issue (since 1980) and a cross-cutting topic. GIZ’s “Moving agenda” relates to the following activities:

- Support of genebanks, such as for potatoes in Lima, Peru.
- International agricultural research on ABD.
- *In situ* conservation and community-based conservation.

- Legal frameworks (implementation of the ITPGRFA, Farmers' Rights, TRIPS/ UPOV).
- Value chain development for ABD products.
- ABD and climate change.
- Payment for environmental services.

The ABD theme is prominent in German International Development Cooperation. The sectoral project *Sustainable management of natural resources for agriculture* started in 1999 as a service project for bilateral GTZ projects and for the Ministry (BMZ), which aims to develop concepts and strategies to reduce loss of genetic resources for food and agriculture, whilst raising awareness and providing information to decision-makers and the public about the importance of ABD for food security and poverty reduction. It also aims to advise on valorization of underutilized crop species and animal breeds and to promote empowering legal frameworks.

As far as the project results are concerned, there are various aspects worthy of note, such as studies on new themes, including underutilized species; valorization of ABD (value-chains, market development); international gene flows; legal frameworks; supported by production and dissemination of manifold information material (issue papers, photographic exhibitions, calendars and press articles). In support of capacity development, curricula for schools, training events for decision-makers and experts, conferences and workshops have been promoted. Among the project's results are the initiation and backstopping of ABD activities with bilateral projects (product and market development, income generation, public-private partnerships – PPP) and networking with other organizations and partners.

In order to integrate ABD promotion into projects, and recognizing the fact that promotion of ABD is just one activity among others in projects (e.g. GTZ has currently only one pure "ABD project"), typical project situations suited for ABD measures are:

- Agriculture, horticulture and forestry projects.
- Natural resource management projects.
- Rural development projects.
- Nature protection projects.
- Rural economic development and income promotion.
- Policy advisors in "green" ministries.
- Linking relief, rehabilitation and development (LRRD) projects.

Conclusions and recommendations

In conclusion, we would like to give an overview of a few projects that have been undertaken in Ecuador and Bosnia Herzegovina.

ABD promotion in a NRM project in Ecuador

Goal: Improved natural resource management and resource protection and increased income.

Initial components: Policy and strategy advice; promotion of community forests; and water basin management.

Discovery of the high potential of local cocoa variety 'Nacional':

- High quality, fine flavour cocoa;
- threatened by hybrids with consumer cocoa;
- introduction of activity for promotion of production and commercialization of cocoa;
- analysis of premium cocoa value chain;
- strengthening of existing local cocoa producer associations;
- improvement of production and pre-processing quality;
- certification of farmers (fair trade, rainforest alliance); and
- establishment of contact with high quality chocolate producers for direct marketing.

Some effects:

- Increased production and 30% higher cocoa prices;
- conservation of the high quality cocoa variety 'Nacional';
- protection of forest biodiversity through cocoa inter-cropping;
- reduced logging through alternative income options; and
- sustainable supply of raw material for foreign chocolate producers.

Economic development project in Bosnia Herzegovina

Goal: Initiate re-structuring process of selected areas in the agricultural sector.

Components:

- Strengthen self-help organizations;
- support agricultural service providers;
- improve agro-industry;
- introduce EU-compatible laws, regulations and standards;
- identification of medicinal and aromatic plants subsector as one type of agro-industry;
- intensive baseline survey of existing plants, potentials and stakeholders;
- advice to private companies (quality, sustainability and economic aspects; training of trainers for collectors);
- marketing support (seller-buyer meetings, bio-certification, participation in international trade fairs);
- strengthening of producer associations and business support; and
- introduction of EU-standards, legal frameworks and national sustainability strategy.

Some effects:

- Improvement for 100 000 collector families earning about € 1300/yr from wild collection;
- strengthened associations in sector;
- improved product quality, diversification and sales volumes of companies;
- bio-certification and control ensure sustainable exploitation of wild plants;
- legal regulation of resource access by forest law and formulation of sustainability strategy; and
- establishment of product standards compatible with EU regulations.

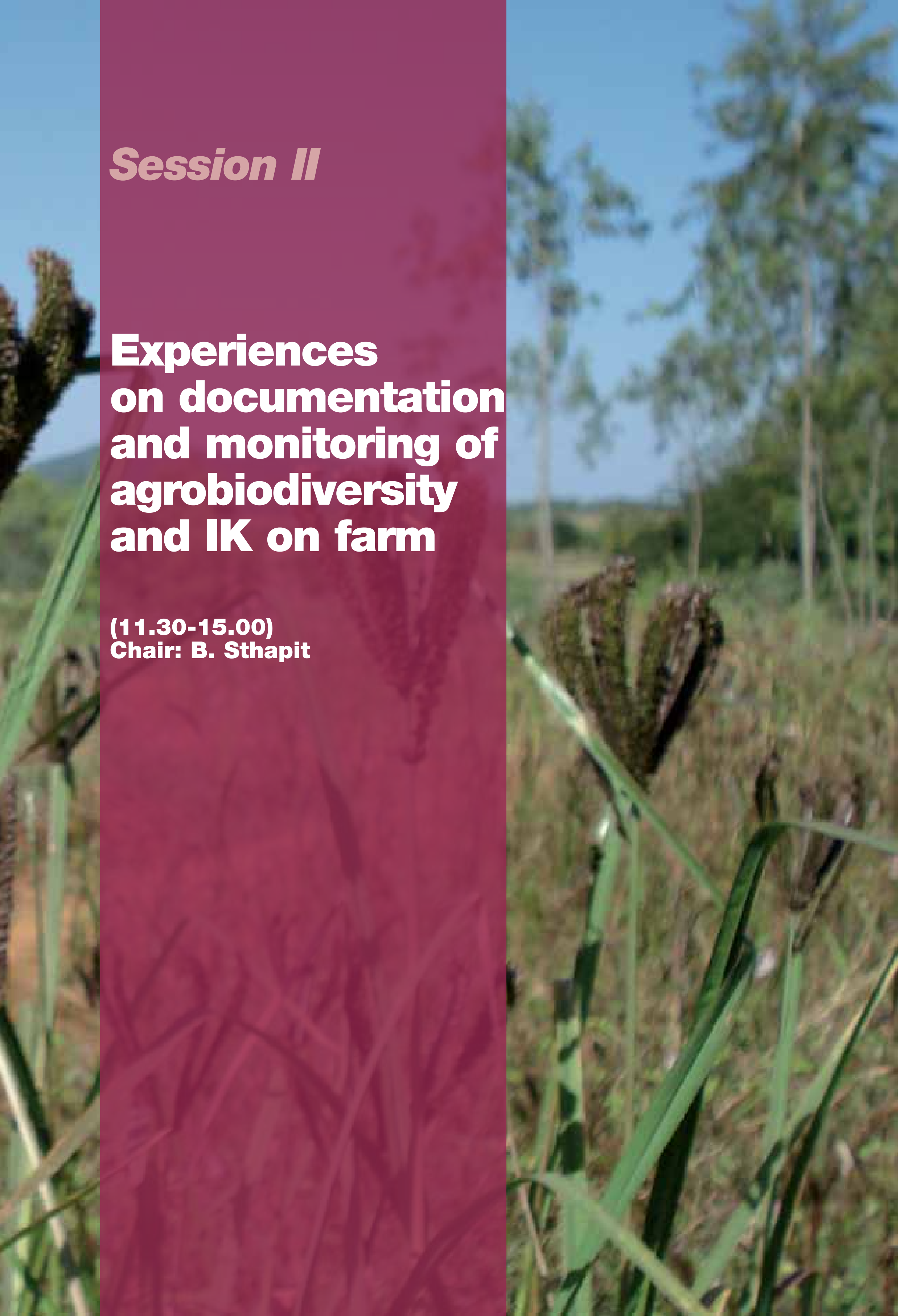
Discussion on Session One

In summary, the conference made the following points:

- Agrobiodiversity is needed to create awareness among consumers.
- It is importance that agrobiodiversity be incorporated in university curricula.
- What kind of research regarding on farm conservation is really necessary in order to scale up?
- Creation of stakeholder platforms is important for sustainability of on-farm conservation efforts.
- Research is needed in various spheres, including evaluation of nutrition traits of NUS since there are still a lot of knowledge gaps in this domain.
- There is need to link research to real livelihood benefits.
- What would be the impact of this project?
- For FAO, it is important to link seed banks, local seed and breeding systems in order to achieve the impact to be expected from the project.
- There must be awareness of the necessity to influence national policy, particularly linkages between local and national levels.
- The issue of intellectual property (patents) associated with local varieties remains contentious.

Questions from the floor
On Waldmüller's paper on Southern China
Q: What were the main challenges?
A: Getting the government officers to go to the villages and engage with the farmers.

Stefano Padulosi/Bioversity



Session II

Experiences on documentation and monitoring of agrobiodiversity and IK on farm

(11.30-15.00)
Chair: B. Sthapit

Documentation and monitoring of agrobiodiversity and indigenous knowledge on-farm – experiences from India

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Introduction

Tribal and rural communities have contributed to conservation of nature and natural resources (Swaminathan, 2000). The traditional knowledge associated with agro-biodiversity resources is important in on-farm conservation. There is rapid erosion of agro-biodiversity evident across the world, particularly in the case of neglected and underutilized crops (NUS) (King, Nambi and Nagarajan, 2009). Nutri-millets like Little millet, Italian millet, Finger millet, Kodo millet and Common Millet are notable among the NUS crops as these crops are nutritionally rich and being neglected, yet are also known to be climate-resilient crops. These crops play a crucial role in the food and nutritional security of the poor communities in marginal environments (Bhag Mal, Padulosi and Bala Ravi, 2010). This paper shares experiences and lessons regarding on-farm participatory documentation and monitoring of millet diversity in the Kolli Hills of southern India.

Since the early 1990s, the M.S. Swaminathan Research Foundation (MSSRF) has been facilitating community-based programmes in three agro-biodiversity hotspots in India, namely the Kolli Hills in Tamil Nadu, Koraput in Orissa and Wyanad in Kerala. Working with the tribal communities in the regions, with their varied cultural traditions, MSSRF has demonstrated integrated approaches in conservation and use of bioresources in the case of small millets in the Kolli Hills, rice in Koraput and medicinal plants in Wayanad (Anil Kumar *et al.,* 2010). This present paper focuses primarily on experiences from the Kolli Hills.

Folk knowledge: songs, street play and cultural art forms

The Malayali tribes, who live in the Kolli Hills, have a rich cultural tradition. Historically, they have been interacting with forest and agricultural landscapes. Their culture and values are embedded in the surrounding nature and natural resources, and this is reflected in their art forms, such as folk songs, cultural ceremonies, street plays and drama. Analysis of the folk songs documented by MSSRF shows that they have songs for all the events of life (Vedavalli *et al*., 2002). Table 1 list some of the categories of songs that reflect their social and cultural interaction with natural resources in their neighbourhood. Songs reflect biodiversity; landscapes; lifestyles; inter-personal and family relationships; traditional cultivars and related landscapes; change in cultivation practices from the early periods; beliefs, religious faith and spiritual activities; socio-cultural events and their dilution; customs and beliefs; migration issues and related problems; relationship between the power structures and the native people; modern developmental changes and its impact; poverty and economics; and impact of modernism.

Table 1. Songs of the Malayali tribes of Kolli Hills

History of the Malayali tribes through folk song	*Nattu kattu*
Songs in praise of Gods and Goddesses	*Arappaleeswarar* *Kongayai Amman* *Kali* *Mariamman*
Songs during Pongal festival	*Servai pattu* *Andikulam Pattu* *Komali Pattu*
Songs related to birth and death	*Talattu Pattu* *Oppari Pattu*
Songs related to agriculture	*Oozhavu Ottuthal* (Ploughing) *Parambu adithal* (Land levelling) *Nattu Naduthal* (Transplanting) *Nellu Kuthuthal* (Pounding) *Kulavai iduthal* *Kavu Pattu* (Love and romantic songs in the forest areas)
Dance songs	*Kummi Pattu* *Servai Pattu* *Andikulam Pattu*
Songs related to mariage ceremonies	During bridal march to brides village
Teasing Songs	*Naiandi Pattu*
Children Songs	Lullabies
Kuravan, Kurathi Songs	Malayali sings about *Narikuravars* and *Tappa kuravars*.

Traditional agriculture, crop diversity and associated knowledge

During the process of settlement, Malayali tribes cleared forests and utilized the land for cultivation of food crops such as little millet, Italian millet, finger millet, Kodo millet and common millet. Tribal farmers of the Kolli Hills continue to cultivate a diversity of forms of millet (Table 2), matching crops to different micro-climatic conditions.

Farmers have evolved a variety of locally suited cropping practices, such as mixed cropping as well as crop rotation suited to micro-climatic conditions of various landscapes in the Kolli Hills (Tables 3 and 4). Based on soil types, rainfall, seed and labour availability, farmers apply mixed cropping and crop rotation. Mixed cropping is practised to maintain the food security system of the farm family. This conventional cropping system involves a combination of crops having different food value, maturity period, input period and capacity to withstand the vagaries of monsoon, and thus helping to minimize risks and to stabilize household food supply. Crop rotation also helps in maintaining soil health through enrichment and recycling, making optimal use of precipitation while meeting multiple household needs. Many such practices that have evolved through traditional knowledge have a strong subsistence focus, which has supported local food and nutritional security.

Table 2. Landraces of millets in the Kolli Hills

Common name	Species name	Vernacular name	Local landrace names
Little millet	*Panicum sumatrense* Roth. ex Roem.& Schult.	*Samai*	*Vellaperumsamai*, *Sadansamai*, *Kettavettisamai*, *Malliyasamai*, *Karumsamai*, *Thirikulasamai*
Italian or foxtail millet	*Setaria italica* (L.) P.Beauv.	*Thinai*	*Senthinai*, *Perunthinai*, *Mokkanathinai, Koranthinai*, *Palanthinai*
Finger millet	*Eleusine coracana* (L.) Gaertn.	*Kelvaragu*	*Sattaikelvaragu, Karunguliankelvaragu, Sundangi kelavaragu Perunkelvaragu, Karakelvaragu, Arisikelvaragu*
Common millet	*Panicum miliaceum* L.	*Panivaragu*	
Kodo millet	*Paspalum scrobiculatum* L.	*Varagu*	*Thirivaragu*

Table 3. Crops, duration and sequence of harvest in conventional mixed cropping in the Kolli Hills

Crop	Scientific Name	Duration (days)	Harvest sequence
Amaranthus	*Amaranthus* spp.	60–70	I
Italian Millet (*Thinai*)	*Setaria italica* (L.) P.Beauv.	100–110	II
Maize	*Zea mays* L.	125–130	III
Finger Millet (*Ragi*)	*Eleusine coracana* (L). Gaertn.	150–160	IV
Cucurbits	*Cucurbita moschata* (Duchesne ex Lam.) Duchesne ex Poir.	150	V
Avarai	*Lablab purpureus* (L.) Sweet	190–240	VI

Table 4. Crop rotation followed in the Kolli Hills

Type of Land	Crop Rotation
Upland	Tapioca (*Manihot esculenta* Crantz) (July–July) + Mixed crops with millets (two-year rotation) in parcels
	Paddy (Apr.–Sep.) + proso millet (*Panicum miliaceum* L.) (Sep.–Dec.) + Fallow till April
	Upland rainfed paddy intercrop with beans (*Phaseolus vulgaris*) (Apr.–Sep.) + wheat/coriander/beans
	Upland rainfed paddy (Apr.–Sep.) + *Coriandrum sativum* L. (Nov.–Jan.) + *Sorghum bicolor* (L.) Moench. (Feb.–Apr.)

Drivers of change in on-farm millet diversity and associated knowledge

The area under cultivation with millets has substantially declined over the last three decades in the Kolli Hills. Introduction of commercial crops with good market linkages, such as tapioca [cassava], coffee and pepper, with the concomitant conversion of smallholdings to estates (Table 5), has been the key driver. Profitability and promotion of such crops by government policy; peoples' access to Public Distribution Systems, where they get food grains like rice at highly subsidized rates; lack of market channels for small millets; drudgery in processing millets; onset rainfall variability; conversion of land to agroforestry; culinary preferences for rice and wheat; land fragmentation; and limited availability of farmyard manure—all these have played a part as drivers of the erosion of millet diversity on-farm in the Kolli Hills.

Table 5. Conversions to estates in the Kolli Hills, India

Period	Cumulative area (acres)	Cumulative number of estates
1970	2	1
1980–1989	225	8
1990–1999	1453.5	59
2000–2007	1976.5	97

The Payment for Agro-biodiversity Conservation System (PACS) and millets in the Kolli Hills

MSSRF, with the support of Bioversity International, Rome, conducted a study on a Payment for Agro-biodiversity Conservation System (PACS) for millets in the Kolli Hills between the 2008/09 and 2009/10 crop seasons, with the aim of identifying the number of minor millet-growing households, and trends in cropping habits, the extent of areas planted to specific minor millet species and varieties, and any trends in change (Bioversity International, 2010). The study sought to identify reasons for the decline in some of the species and varieties, and the study involved household interviews; stated preference approaches using Contingent Valuation and Choice Experiment as tools to understand the willingness of farmers to cultivate the most threatened species and varieties in the future; and focus group discussions. The PACS study involved 450 sample households in 5 zones (panchayats) of millet cultivation, namely Devanur, Selur, Thirupuli, Alathur and Gundani.

PACS findings in the Kolli Hills

- Between 58 and 63% of all households in the 5 panchayats were minor millet growers.
- There was a 20% decline in the number of millet-growing households between the 2008/09 and 2009/10 crop seasons.
- Species and varieties identified as being at risk (planted on less than 5 acres or by fewer than 20 to 30 farmers across the 5 panchayats) were:
  - all varieties of Italian, common and kodo millets;
  - all but one of the varieties of little millet;
  - an average of only 6.7% of household agricultural land area dedicated to these species; and
  - 3.5–3.7% in Gudani and Selur.

Availability of quality seed of varieties of millets is critical. Invariably, farmers expressed their lack of access to good quality seed, with lower market prices for millets and poor credit facilities for millet farming noted as key constraints in continuing millet farming in the changing socio-economic context.

Table 6. Farmers preferences to continue with millets in farming

Preference	D	A	T	G	S
Quality Seed Supply		I	I	I	
Higher market prices for millet	I				
Access to pre-planting season credit/loan, repayable at end of harvest season	II				I
Fixed-sum cash payment (as incentive)		II			
Milling facility			II		
Agriculture machinery and tools					II
Land cleaning and shaping				II	
Non-monetary rewards (school material, construction material, mobile phone credit, seeds, fertilizer)					III
Threshing yard			III		
Vehicle for marketing	III				
Irrigation facility for ragi cultivation				III	
Need for traditional knowledge holders in the community		III			IV
Need for bullock (draught animal)		IV			

NOTES: Key to areas: D = Devanur; A = Alathur; T = Thirupuli; G = Gundani; S = Selur.

Summary

The experience of the case study from the Kolli Hills on millet diversity indicates that there is a rapid decline in traditional knowledge and material in the changing socio-economic context.

This confirms the need for a number of interventions:

- Assessment of adaptive capacities of traditional farming practices.
- Studies on climatic resilience practices, like mixed farming with millets at farm level.

- Strengthening mechanisms for availability of good quality seed of landraces.
- Strengthening the value chain for NUS farmers, particularly small-scale farmers.
- Assessment of appropriate incentive mechanisms for custodian farmers, community institutions, collectives or individuals for their conservation efforts.
- Validation of traditional knowledge on landraces for their climate resilience traits.

Acknowledgements
The authors thank Professor M.S. Swaminathan, Chairman, MSSRF, for his guidance and constant encouragement. This paper forms a part of work carried out under the Biodiversity programme of MSSRF, which is supported by SDC, IFAD and Bioversity International, whose support is gratefully acknowledged.

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The contribution of community genebanks to *in situ* conservation of quinoa and cañahua: the experience of Bolivia

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Introduction

The Andes is one of the most important mountain systems in the world. This great eco-region contains many special niches, with lots of plant associations. Man developed significant cultures from 4000 BPE onwards, resulting in about 70 species at different stages of domestication and use worldwide (Cardenas, 1989, cited by Holle, 1996).

Several efforts are underway in the Andean region to gain better knowledge and understanding of strategies for *in situ* conservation of agrobiodiversity, and studying conservation approaches used by farmers, which are firmly based on their knowledge. All these investigations suggest different approaches and strategies in the use of agricultural biodiversity.

Information on the different uses of plants, the preferences of farmers and farming methods have been passed down for centuries from generation to generation. However, the lack of documentation of local knowledge, together with socio-economic pressures, are causing the loss of local crop diversity and traditional knowledge. Local societies are changing rapidly and the younger generations do not have the same interest in learning the methods of their elders.

The area around Lake Titicaca, considered the centre of origin and diversity of several Andean crops, is suffering genetic erosion of quinoa (*Chenopodium quinoa* Willd.) and cañahua (*Chenopodium pallidicaule* Aellen), due to loss of local varieties (Rojas, Pinto and Soto, 2003, 2004). In order to help reverse this process, work has been done on the implementation of Community Genebanks in both crops, due to their strategic value to food security and as part of an *ex situ–in situ* relationship strategy to promote local conservation.

Materials and Methods

Phase I*: Participatory evaluations

This work was carried out in the agricultural year 2004-2005 in four communities located in three provinces of the department of La Paz (Table 1). Among the criteria for the selection of the communities were the potential for the production of both crops and the willingness of families to carry out activities destined to revalue quinoa and cañahua.

Table 1. Communities in which participatory evaluations were conducted (2004-2005)

Department	Province	Community
La Paz	Pacajes	Antarani
	Ingavi	Patarni; and Rosapata
	Omasuyo	Coromata Media

The genetic material evaluated corresponds to accessions, lines and improved varieties from the Andean Grains Genebank, whose administration from July 2010 came under the responsibility of INIAF (Rojas *et al.*, 2010). Two demonstration plots of cañahua and two of quinoa were established (Table 2), all in farmer's fields in the four communities.

Participatory technology evaluations are methodological tools that allow the systematic capture of knowledge, practices and farmers' preferences regarding different technological alternatives. In Latin America, the experiences of CIAT (Ashby, 1992) and CIMMYT (Bellon, 2001), among others, were extrapolated in the region, resulting in the adoption of these tools by various research and development institutions. In Bolivia, a series of techniques for participatory technology evaluation with farmers have been validated and adapted (Gandarillas, 2002).

As the objective of the work was to classify the varieties, lines and accessions of quinoa and cañahua according to the preference of farmers, a combination of the methodologies of 'absolute evaluation' and 'order of preferences' were used. The first methodology was applied at the flowering stage of the crop and the second after harvest and post-harvest processing.

The absolute evaluation assesses the technology on a fixed scale (or absolute). The farmer assesses each technology independently, expressing and arguing their likes or dislikes (Gandarillas, 2002). The range of the assessment scale can be variable, but for this particular case three response options were used (good, fair, poor). At the end of each assessment, justification is further elaborated to identify the evaluation criteria used by farmers and the level of importance of each one (Quiros, Garcia and Ashby, 1992). For the tabulation of data, scores are assigned to each choice of the assessment scale to help the tabulation of data and the subsequent statistical analysis.

NOTE: * Phase I refers to the IFAD NUS I Project

Table 2. Communities and genetic material evaluated with farmer participation (2004-2005)

Crop	Community	Genetic Material	
		Accession	Variety or line
Quinua	Antarani	1659	Intinaira
	Patarani	2516	Surumi
		2031	Jacha Grano
		1927	Línea Púrpura
		1655	Patacamaya
		0575	Local
		1667	
Cañahua	Coromata Media	081*	Local
	Rosapata	472**	
		479	
		116	
		300	
		476	
		616	
		771	
		636	
		381	
		100	

NOTES: *Accession 081 was released as variety Illimani in 2007; ** Accession 472 was released in 2007 as variety Kullaca. Source: Rojas and Pinto, 2007.

Evaluation by order of preferences is a relative evaluation method because it evaluates each technological alternative against others (Gandarillas, 2002). Farmers rank technological alternatives according to their preference, later elaborating on the reasons why some alternatives are preferred over others (Guerrero, Ashby and García, 1996). This justification of the ranking will reveal the priorities of farmers, and especially non-explicit assessment criteria.

Phase II**: Installation of community genebanks

In the 2005-2006 agricultural year, coordination and planning meetings were held with native authorities, farmer group leaders and community stakeholders of the communities of Anatarani, Patarani, Rosapata and Coromata Media, in order to establish community genebanks. Each community assigned a plot for the community genebank, and assumed responsibility for the preparation of the land and farming practices.

Sowing of plots was carried out in a participatory manner between municipal authorities, farmers and PROINPA technicians. All farming practices (sowing, thinning, weeding, mowing, threshing and venting) were performed under the

NOTE: ** Phase II refers to the IFAD NUS II Project traditional management system practiced in the communities. Follow-up visits were scheduled at the flowering stage for the evaluation of the morphological and phenological state, and at harvest to record the amount of grain produced, the storage system and destination of the product obtained.

Results and discussions

Phase I: Participatory evaluations

Quinoa

In the community of Antarani, accession 2031 and varieties Surumi, Jacha Grano and Intinaira were selected for their acceptable yield (579 kg/ha on average), white grain colour, and grain size from medium to large (2.0 to 2.2 mm). This last feature is required by traders and agribusiness. Of the total grain harvested (202.7 kg), 91 kg was allocated for use as seed, and by common agreement distributed among the 14 families who participated in the work. 6.5 kg of seed was given to each family (Soto and Pinto, 2005).

In the community of Patarani, varieties Surumi, Patacamaya, Intinaira and Jacha Grano were selected. These were chosen by farmers as varieties with white grains, large diameter (≥2.2 mm) and good yield (850 kg/ha on average). Of the total grain harvested (454.5 kg), 264 kg was allocated for use as seed and by common agreement distributed among the 21 families who participated in the work, with 12.5 kg of seed for each family (Soto and Pinto, 2005).

In both communities, 1 kg of quinoa seed per selected variety was reserved for the implementation of the community genebank in the next agricultural year, 2005-2006.

Cañahua

In the community of Coromata Media, accessions 166, 081, 479 and 472 were selected for having large grains (≥1.2 mm), light grain colour (white-lead) and good yield (725 kg/ha on average), higher than the national average yield of 641 kg/ha. The selected accessions were distributed among the 15 families who participated in the work (2 to 4 kg per family) (Soto and Pinto, 2005).

In the community of Rosapata, accessions 081, 771 and the local variety were selected as presenting large grains (≥1.2 mm), light grain colour (white-lead) and good yield (average 746 kg/ha), higher than the national average yield of 641 kg/ha. The selected genetic material was distributed among the 21 families who participated in the work (4.8 kg per family) (Soto and Pinto, 2005).

As in the case of quinoa, in both communities 1 kg of cañahua seed was reserved out of each lot, for the implementation of the community genebank in the next agricultural year 2005-2006.

Phase II: Installation of community genebanks

The community genebanks of cañahua and quinoa were implemented in the

2005-2006 agricultural year in four communities of the northern highlands of Bolivia, where the work on participatory evaluations was previously done.

Quinoa community genebanks

In the community of Patarani, participating families agreed to establish the community genebank in the field of Mr Rosendo Quispe, located at 16°34′10″ S, 68°45′02″ W and 3826 masl. The community is part of the Municipality of Guaqui in Ingavi province of the department of La Paz, 85 km northeast of the city of La Paz (Figure 1).

Figure 1. Geographical location of 4 community genebanks of cañahua and quinoa in the Northern Altiplano of Bolivia

The main income generating activity of the community is cattle raising for milk and cheese. The production of other crops, such as potatoes, barley, quinoa and cañahua, is destined almost entirely for home consumption. Families formerly grew two varieties of quinoa ‘Chimi Juire’ and ‘Churi Juire’ (Alanoca *et al*., 2004). As a result of the project activity, the quinoa diversity increased in the community and currently six varieties are planted. In this context, the community genebank plays an important role in the restoration of material to families in the event of possible loss.

During the year of the genebank implementation, 23 farmers participated (14 women and 9 men), the plot extended over 2835 m^2 and each variety was planted on between 455 and 700 m^2 (Table 3). All farming is done in a participatory manner and under the traditional management system used by the community. The quantity of grain obtained ranged from 35 to 47 kg per variety, which is equivalent to 671 to 769 kg/ha.

In the community of Antarani, participating families agreed to establish the community genebank in the field of Mr Miguel Poma, located at 16°51′57″ S, 68°31′03″ W and 4038 masl. The community is part of the Municipality of Comanche in Pacajes province of the department of La Paz, 77 km southwest of the city of La Paz (Figure 1). The community's main feature is milk and cheese production derived from cattle. The production of other crops, such as potatoes, barley, quinoa and cañahua, is fully earmarked for home consumption.

Table 2. Detail of varieties and accessions of quinoa conserved in two community genebanks of the northern altiplano of Bolivia

Province	Community	Variety or accession	Area sown (m²)	Yield (kg)
Pacajes	Antarani	Intinaira	830	10
		Surumi	830	12
		Jacha Grano	830	8
		2417	830	20
		2031	830	6
		2857	830	2
		Total	**4980**	
Ingavi	Patarani	Local	525	35
		Intinaira	700	47
		Surumi	630	45
		Jacha Grano	455	35
		Patacamaya	525	45
		Total	**2835**	

During the year of the implementation of the genebank, 18 farmers participated (8 women and 10 men), the plot reached an area of 4980 m^2, each variety or accession was planted on 830 m^2 (Table 2). All farming is done in a participatory manner and under the traditional management system used by the community. The quantity of grain obtained ranged from 2 to 20 kg per variety or accession, which equates to an average yield of 116 kg/ha. The crop was affected by drought in the period of sowing and by frost during grain formation. Nevertheless, farmers decided to continue with the community genebank because they see it as a seed source in the eventuality of potential losses.

Regarding the destination of production, farmers of Antarani and Patarani decided to allocate nearly 100% of the production of quinoa for the community genebanks to use as seed. This benefited families that due to climate (flood, hail or frost) lost their planted plots. Some of the production was also sold to neighbouring communities that expressed interest in producing the varieties. Revenues were used for the management of the genebanks in the next agricultural year.

Cañahua community genebanks

In the community of Coromata Media, participating families agreed to establish the community genebank in the field of Carlos Quispe, located at 16°08′7.11″ S, 68°32′2.01″ W and 3957 masl. The community is part of the Municipality of Huarina in Omasuyos province of the department of La Paz, 75 km northwest of the city of La Paz (Figure 1).

The main feature of the community is its wide variety of crops. At the same time, the agroecological characteristics of the area favour the production of cañahua (Alarcón, 2011) although the occurrence of hail seriously affects the region. Families used to grow four varieties of cañahua: ‘Uma Cutama’, ‘Shock Chilliwa’, ‘Pumpkin cañahua’ and ‘Choco cañahua’ (Flores *et al.,* 2004). With the work done, the diversity of cañahua in the community was increased and currently eight varieties are planted. In this context the community genebank plays an important role in the restoration of material to families in the event of possible loss.

Table 3. Lines of cañahua conserved in two community genebanks in the northern altiplano of Bolivia

Province	Community	Line	Area (m²)	Yield (kg)
Omasuyos	Coromata Media	166	405	12
		081	188	3
		300	255	3
		472	342	12
		Total	1190	
Ingavi	Rosapata	Local	950	30
		771	1425	60
		081	2070	80
		Total	**4445**	

During the first year of genebank implementation, 15 farmers participated (8 women and 7 men), the plot covered 1190 m² and each accession was planted on an area between 188 and 405 m² (Table 3). All farming is done in a participatory manner and under the traditional management system used by the community.

The quantity of grain obtained ranged from 3 to 12 g per accession, which is equivalent to an average yield of 252 kg/ha. This low yield was due to two hailstorms in February.

In the community of Rosapata, participating families agreed to establish the community Genebank in a community plot (*aynoca*), located at 16°50′39″ S, 68°53′13″ W and 3827 masl. The community is part of the Municipality of San Andres de Machaca in Ingavi province of the department of La Paz, 110km southwest of the city of La Paz (Figure 1).

During the first year of genebank implementation, 15 farmers participated (6 women and 11 men), the plot covered of 4445 m^2 and each accession was planted on an area between 950 and 2070 m^2 (Table 3). All farming was done in a participatory manner and under the traditional management system used by the community. The quantity of grain obtained ranged from 30 to 80 kg per accession, which is equivalent to an average yield of 315 to 421 kg/ha. This low yield reflects a prolonged drought in the sowing period.

Regarding the destination of produce, farmers of Coromata Media and Rosapata reserved all of the production of cañahua from the community genebank for use as seed. This had the objective of restoring family plots that might be lost. In other cases, seed was distributed to other farmers from both communities that did not participate in the work during the agricultural year but wanted to plant cañahua for the first time.

Acceptance of the community genebanks

Table 4. Relative acceptance of a community genebank by age group

Age group	Percentage acceptance	
	Men	**Women**
Young adults (20-34 years old)	30	25
Adults (35-60 years old)	80	70
Elderly (>60 years old)	50	45

NOTES: The respondents were 75 farmers from the communities of Rosapata, Antarani, Patarani and Coromata Media.

Table 4 summarizes the acceptance or rejection of having a community genebank in relation to the age of 75 farmers from the communities of Rosapata, Antarani, Patarani and Coromata Media. Farmers between the ages of 35 and 60 showed more interest and willingness to maintain community genebanks and participate in the work involved. This group of farmers is also looking for new genetic material with which to experiment, with a vision of marketing and income generation.

In contrast, young farmers showed little interest in working with community genebanks, primarily because of other activities, and in some cases because they are not in the community due to migration. Adults over the age of 61 were indifferent to the production of new varieties because they do not have many plots available and because they live with a smaller number of family members.

Testimonies from farmers

Rosendo Quispe (Patarani): "The community Genebank can not only serve to provide seed to our community, but also to sell or deliver to neighbouring communities and even to other institutions that require it."

Rosendo Quispe (Patarani): "In the community genebank we also have to plant those seeds of quinoa that are being lost, such as the 'Acu Juire', which is good for toasted flour, and the 'Cundur Naira' of cañahua that appears sometimes."

Miguel Poma (Antarani): "Despite the low production of the community genebank, we decided to continue planting it next year, because we want to conserve our seeds, but this time we will be more careful."

Maria Chain (Coromata Media): "It's nice and colourful to see various colours of cañahua in the plot as it was in the community genebank. I would like to have those varieties in my house. I have land and would like to handle those cañahuas separately, although the grain in the end is the same colour and with very little variation.

Carlos Quispe (Coromata Media): "It seems good to have a seed bank in the community. There are good years and other bad ones, and we don't know what will happen, but if we have seed saved we could use it for bad years.

Maximo Quispe (Coromata Media): "Since we already know the Andean Grains Genebank in La Paz, we could contribute by family in order for our cañahuas to be saved and in bad years we could ask for them back to continue planting. It is also good that we have a genebank in the community; we may even sow the wild cañahuas."

Conclusions and recommendations

The information collected on the evaluation criteria used by farmers and their technological preferences according to usage are an important input to re-orient the Andean grains breeding programme. The inclusion of other types of actors in the productive chain of quinoa and cañahua in this type of evaluation can also help identify genetic material specific to various needs and demands, thus helping increase the use of these crops.

The work with the community genebanks of quinoa and cañahua is the first experience in the country. These genebanks are located in the area surrounding Lake Tititcaca, considered the centre of origin and diversity of Andean tubers and grains.

Community genebanks are spaces that contribute to the recovery and restoration of the local diversity of quinoa and cañahua, where the participation of farmers is of great importance because of the role they play in the management of genebanks and the re-valuation of their practices and customs.

In the structure of the National System of Genetic Resources that Bolivia will implement, it is recommended that community genebanks be considered, because they are an alternative to strengthen *in situ c*onservation and the use of agricultural biodiversity. Additionally, these genebanks strengthen the relationship between *ex situ* and *in situ* conservation.

It is necessary to promote a network of community genebanks through which capabilities of farmers for monitoring, conservation and use of local agrobiodiversity can be strengthened. In parallel, this network would reinforce the resilience of communities facing food insecurity, poverty, climate variability and climate change.

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Community Biodiversity Registers: Empowering community in management of agricultural biodiversity

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Summary

A decade of experience with Community Biodiversity Registers (CBRs) in Nepal has shown that effective management of traditional knowledge and skills of farmers and indigenous communities can make a significant contribution to sustainable development. This paper provides an overview of community-based practices of traditional knowledge and genetic resource (GR) documentation, and their use for sharing benefits to the local communities through CBR. Diverse types of institutions use CBR methods for different purposes and as a consequence methodologies for CBR have evolved in varying ways. Critical review of existing practices in implementation of CBR in Nepal has revealed two distinct typologies: either listing (inventory) of economically valuable biodiversity at the local political unit level by a group of government professionals or university scholars; or empowering a local community to document important GRs and traditional knowledge and analyse information for developing conservation as well as development plans. Lessons learnt and good practices from various projects are discussed to harmonize a common methodology that can be mainstreamed for its sustainability and productiveness.

What is a Community Biodiversity Register?

The concept of a Community Biodiversity Register (CBR) refers to a record maintained by community members of the genetic resources (GRs) in a community, including information on their custodians, passport data, agro-ecology, cultural and use values. It is a farmer-level information database recorded in a register by a community-based organization for keeping inventory of biodiversity and traditional knowledge and for monitoring local crop diversity for the community's benefits and needs (Subedi *et al.*, 2005b). Christine (1998) defined CBR as an effort by community to document and conserve both the biodiversity that is used within a given area, and relevant knowledge about it. CBR is a dynamic method developed as a participatory process to address a range of objectives, including documentation, monitoring, protection of traditional knowledge and genetic materials from bio-piracy, promoting bio-prospecting, monitoring genetic erosion, and developing local ownership for development and conservation actions. (Rijal *et al.*, 2003; Subedi *et al.,* 2005b). Basically, the CBR process aims to empower local communities and institutions to develop better understanding of their own biodiversity assets and their value, so that they play an important role in research, development and conservation strategies at the local level.

Why do we need CBR?

CBR is needed for three major reasons: documentation to prevent knowledge erosion; for bio-piracy protection; and empowerment for development and conservation actions.

Documentation of Traditional Knowledge (TK) is important in the CBR process. TK refers to the body of wisdom, innovations and practices of indigenous peoples and local communities around the world (CBD, 1992). The knowledge is embedded in their agricultural practices and uses, and associated songs, dances and customary laws. Quek (2005) reported that oral transmission of traditional knowledge from generation to generation is vulnerable and needs to consider four key components: the knowledge holder; the recipient (those willing to learn and practise); the material (GRs); and the situation (social, cultural and economic contexts) where the material is used. Knowledge becomes just a story if the plant genetic resource (PGR) (the material) is not available, while knowledge is lost if there is no knowledge holder to pass down information to the next generation. In the present context, young generations from farming communities are increasingly reluctant to learn traditional livelihood practices and knowledge, therefore, traditional knowledge is threatened (Figure 1). Because of increasing erosion through lack of oral transmission of traditional knowledge about agricultural biodiversity, the importance of documentation of GRs and associated knowledge has received great attention from the global community. In this context, particularly where the traditional knowledge is threatened due to missing one of the components, CBR can be an intervention methodology to bridge the gap.

PGRs and associated traditional knowledge are increasingly appreciated and valued not only by those who are currently dependent on them for daily subsistence, but also by modern industry, particularly the health industry, and agricultural research. There has been increasing concern among NGOs and civil societies that GRs and traditional knowledge can be misappropriated by multinationals for commercial interest (Christine, 1998; Gadgil *et al.,* 1997; Utkarsh, 1999; Rijal *et al.*, 2003; Subedi *et al.,* 2005b). Protection against bio-piracy by outsiders is only possible if the local communities value the importance of biodiversity and are willing to contribute time and resources to document their GRs and associated TK. One of the strategies for internally-driven, community-based agricultural biodiversity documentation is to empower communities and local institutions to manage their own biodiversity *in situ*. Strengthening local capacity to manage a biodiversity information system for the community's benefit will eventually protect TK from misuse, through having a written record that allows the community to challenge misuse of knowledge by scientists and people from outside the community. The availability of documented knowledge that can be produced as evidence will enable the community to make claims on the benefits derived from their TK.

	A missing component			
Knowledge holder	✓	✓	✓	×
Recipient	✓	✓	×	✓
Situation	✓	×	✓	✓
Material	×	✓	✓	✓
Outcome: Knowledge is	a story	threatened	threatened	lost
Intervention methodology		CBR	CBR	

Figure 1. Missing components of traditional knowledge and CBR as intervention methodology to bridge existing gaps (modified from Quek, 2005)

Evolution of CBR in Nepal

Pilot stage (1998–2001)

CBR was initially piloted by the Global On-farm Diversity Project in 1998, jointly implemented by NARC, LI-BIRD, IPGRI and farming communities as a participatory method to strengthen *in situ* conservation of crop diversity on-farm in Nepal (Rijal *et al.,* 2003; Subedi *et al.,* 2005a). CBR was piloted at three sites to cover different mandate crops, with the primary objectives of developing crop inventories and monitoring the dynamism of PGR at household level. It further aimed to develop sense of ownership regarding the value of GRs among the farming communities by analysing and sharing the documented information to derive conservation benefits at local level.

Consolidation stage (2001–2002)

The focal ministry for biodiversity in Nepal—the Ministry of Forest and Soil Conservation (MFSC)—together with IUCN Nepal started to explore the method to document the nation's biodiversity and associated traditional knowledge to fulfil its obligations towards the Convention on Biological Diversity. MFSC and IUCN Nepal used one of the global on-farm diversity project sites to learn the CBR methodology and then further refined it to develop a national format for CBR that covered not only crops but that was also suitable for a wide range of biodiversity, including forests, wetlands and wildlife. The key objective of CBR in this case was to protect biodiversity and associated TK through documentation and registration, to facilitate access and equitable benefit sharing, and to raise awareness on use values of biodiversity (Subedi *et al.*, 2005b). In this CBR process the documentation part was mainly implemented through District Biodiversity Coordination Committees (DBCC) that involved various district-based government line agencies and academic institutions.

Scaling-up (2003 onwards)

MFSC, LI-BIRD, IUCN Nepal, USC Nepal and Ministry of Agriculture and Cooperatives (MOAC) started to implement and scale up the CBR process in different parts of Nepal. These stakeholders used nominally similar register formats for documentation, but a critical review showed that they differed in crucial objectives and the implementation process. Two clearly distinct CBR implementation frameworks were identified: (1) implementation of CBR by external

Table 1. An overview of evolution of CBR in Nepal

1998–2001	Pilot stage establishing the CBR methodology by Global On-farm Agrobiodiversity Project (NARC; LI-BIRD; IPGRI).
2001–2002	Development of national database format for CBR by Ministry of Forestry and Soil Conservation (MFSC) and IUCN Nepal, with support from LI-BIRD, ACAP and others.
2002	Recognition of CBR as a policy instrument to document and protect TK and GR within the National Biodiversity Strategy and draft bill on access to and benefit sharing mechanisms.
2002–2004	Mainstreaming documentation through CBR by MFSC and IUCN Nepal through District Biodiversity Coordination Committees (DBCCs), academia and selected NGOs. Refinement in methodology: community empowerment and livelihoods approach.
2005	National Stakeholder Workshop on CBR to harmonize CBR methodology.
2005–2008	Scaling-up by Department of Agriculture (MoAC), LI-BIRD and other NGOs.
2009–2010	Extending development of the CBR concept to encompass livestock and aquatic organisms (Department of Livestock Services, LI-BIRD; NARC).

stakeholders, with documentation as a major goal; and (2) implementation of CBR by local communities themselves through empowerment, resulting in conservation and development plans at local level. The first approach was discontinued after 2005. The latter CBR framework has further evolved and continues, including successful piloting of a CBR suitable for animal GRs in 2010. In this case, CBR become not an isolated action but rather an integral practice of a Community Biodiversity Management (CBM) approach that strengthens the capacity of local communities to analyse local information and develop both development and conservation plans for their social, economic and environmental benefits (Subedi *et al.,* 2005b). An overview of the evolution of CBR in Nepal is shown in Table 1.

Key components, steps and the process of CBR

Nepal's experiences with CBR can in essence be broken down into five components that follow in sequence to achieve the objectives of CBR. These are (1) documentation in the register; (2) validation of the documented diversity and knowledge; (3) compilation and analysis of the different register information; (4) sharing results with relevant stakeholders; and (5) translating the priority results of CBR into local conservation and development plans. To successfully implement these key components of CBR, different steps have been employed, as outlined in Table 2. These steps may vary and be adapted depending upon the situation existing in any given community. It is not necessary to start with the first: it could be any step that forms the entry point for CBR.

Table 2. Summary of steps in CBR development

Step 1	Select the area and community
Step 2	Share the rationale and objectives of CBR with farmers and the community
Step 3	Identify and strengthen local institutional capacity to implement CBR at village level
Step 4	Select the form of CBR (paper register; tape; video″ and prepare the minimum data set for the CBR
Step 5	Documentation and validation of the CBR by the local community
Step 6	Develop a Code of Conduct for community-based access and benefit sharing
Step 7	Analysis of CBR and sharing of results with the community and other stakeholders
Step 8	Facilitate community to prioritize and develop and implement conservation and development plans
Step 9	Registration and maintenance of CBR at local level linking with national repository

Selecting the area and community

Usually CBR has been implemented as one of the components of biodiversity projects to achieve its specific objectives. However there are some situations where CBR could be implemented as the main project (Subedi *et al.,* 2005b).The key criteria of selection of area and community could be based on the availability of rich diversity in local GRs, or where diversity has been used and valued as a crucial livelihood asset by local communities. Secondary information sources and consultation with relevant stakeholders at project sites would optimize the information further. Before finalizing sites and communities, transect walks or rapid participatory surveys usually validate the secondary information to provided the basis for final decisions.

Sharing the rationale and objectives of CBR with farmers and their community

This can be organized as a series of village-level workshops, where representative stakeholders should be invited that represent farmers' groups, various natural resource-user groups, schools, youth clubs, local administrative bodies, private sector entities, governmental local extension agents, etc. The basic principle of the sharing programme is to develop common understanding and to formulate agreed action plans to implement CBR. Key decisions to be made at this stage are:

- What is the main objective of CBR?
- What is the unit of documentation (household level, group level or village level)?
- Which local institution has the capacity and long-term interest to coordinate CBR implementation?
- Who are the relevant stakeholders to be engaged in CBR?
- Where should it be registered for legal purposes?
- How can databases be linked nationally?

Identify and strengthen nodal local institution capacity to implement CBR

Various participatory tools—such as Venn Diagrams; Rainbow Diagram; or Strengths, Weaknesses/Limitations, Opportunities and Threats (SWOT) analysis—can be used to finalize identification of the relevant local institutions to be responsible in coordinating the CBR implementation in a community. Usually a committee is formed representing all major local institutions as an institutional support and to monitor the whole process. Projects need to provide the necessary training and orientation programmes or exposure visits for participants that contribute to strengthening relevant capacity. There could be differentiated roles among the various members based on their own strengths and interest in coordinating CBR activities for field crops, horticulture, forest GRs, wetland GRs, animal GRs, etc.

Selecting types of CBR and preparation of minimum data set for CBR

After empowering the nodal local institution or committee, the actual implementation of CBR can be started, such as developing the register format with the minimum datasets required for CBR. The requirement of a minimum dataset also depends upon the purpose of the CBR programme. For example, the datasets required for documentation of traditional knowledge, skills and techniques (TKST) of indigenous communities will differ depending on whether the information is used for monitoring valuable GRs and development of conservation strategies, or for empowerment of local communities. However, there are some crucial questions that should guide the formulation of datasets, which is community focused and supportive of Article 8 (j) of CBD. The dataset of CBR should answer the following fundamental questions:

- What do we have?
- How do we utilize it?
- What is the local status of diversity?
- Why do we need to conserve it?
- What are the values of the material?
- Who has the traditional knowledge and how is it transmitted from one generation to the next?
- Who make decisions in management of particular biodiversity (planting, harvesting, processing, marketing) (men or women)?
- What are the GRs that could be shared within and outside the village or community?

The CBR should be maintained in the vernacular language and included the important data sets required to meet the CBR objectives. Since a community maintains its register under its local conditions, physically it should not be too large because of requiring detailed documentation. The size of CBR registers should be compact and easily portable so that a community can take it from one place to another.

Data sets identified from CBR registers in Nepal include:

- Site and community descriptions (address, number of households, major crops, altitude, etc.).
- Species/variety/cultivar/breed information (scientific and ethnic names, both local and general).
- Distinguishing characters of species/variety/breed (farmer's descriptors).
- History at a given location (year of introduction; address of locality).
- Origin of species/variety/breed (original place; source of knowledge; source of planting material or stock).
- Nature of the species/variety/breed (e.g. annual, perennial, evergreen, deciduous, herb, shrub, tree, etc.).
- Mode of reproduction (e.g. means of propagation are described: seed, clones, saplings, stems, leaves).
- Natural habitats (as defined by farmers).
- Extent and distribution of genetic diversity: rare, medium, widely grown.
- Useful parts, stages and seasons.
- Local techniques and TK (practices that describe processing of products linked to a specific variety; maintenance).
- Uses (goods and services from species: direct uses, options and exploration values).
- Level of decision-making (men or women) in management of particular biodiversity (planting, harvesting, processing, marketing).

- Information on custodians (address and digital photo).
- Photographs/drawings/herbarium specimens of diversity (illustrating distinguishing traits and farmer descriptors)

Documentation, compilation and validation of CBR by local communities

This step is the most crucial and resource demanding exercise. The nodal local institutions or committee has to build further capacity in each group therefore they are able to document their own diversity by their own efforts. Monitoring and necessary follow up should be provided by the trained members of CBR committee. Linking documentation activity with Diversity Fairs has resulted in rapid documentation, minimizes the resources and increased interest of community in Nepal. Further, such documented information can be validated during the diversity fair event itself due to gathering of large number of custodians and comparable diversity exhibited from different parts of a given landscape. The diversity which still can not be validated in a diversity fair can be further maintained in diversity block. During different cropping season such doubtful diversity can be validated by the help of custodian' farmers.

Analysis and sharing of CBR results with the community and other stakeholders

Analysis of CBR information needs to be done so that can easily be interpreted and shared with communities and other stakeholders. The Four-Cell Analysis (FCA) tool has been found effective analysing CBR results (Figure 4). This tool facilitates understanding of why many farmers grow some crops or cultivars on large areas, whereas some crops or cultivars are grown on small areas by many farmers. There are also many cases in which a few farmers maintain large numbers of cultivars on small areas. A series of village-level stakeholder workshops should be organized to share the results of CBR analysis. The nodal institutions can further disseminate such information to their network members

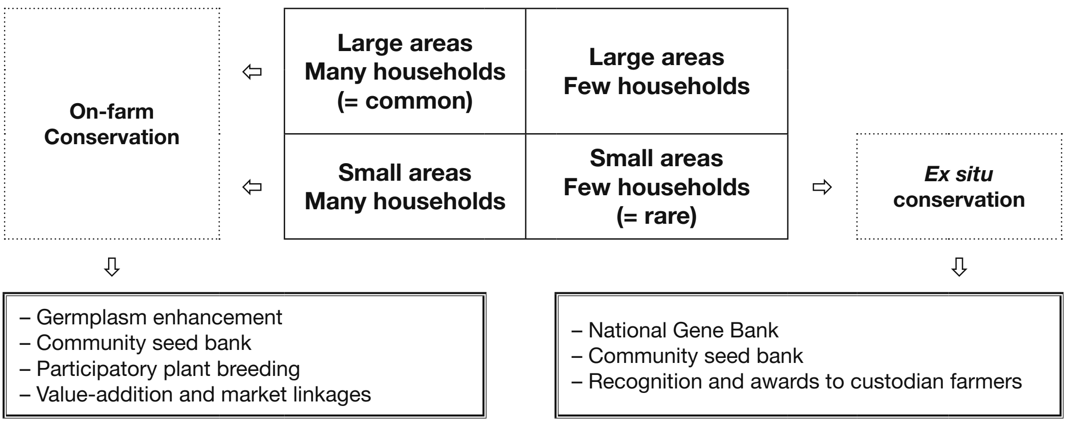

Figure 2. Four-cell analysis tool to analyse and facilitate the sharing of CBR results

in monthly meetings or community platforms. Various communication tools such as posters, pamphlets or sharing information through radio programmes can be employed to reach a wider audience.

Facilitate the community to prioritize, develop and implement conservation and development plans

During CBR results sharing, the CBR committee members should facilitate progress of decisions to become conservation and development plans called Community Biodiversity Management (CBM) plans. For this, partnership and collaboration should be sought from different stakeholders. Priority actions would be:

- Enhance the value of the landrace population by improving farmer preferred traits by selection from existing diversity.
- Increase competitiveness of local landraces by improving specific traits through participatory plant breeding.
- Increase demand for landraces by value addition through better processing, packaging and marketing.
- Expand seed multiplication through community seed banks and encourage distribution.
- Encourage custodians through awards and recognition.

The CBM fund should be established and linked with any existing local financial mechanisms that support the priority CBM plans resulting from CBR. This is a crucial step in supporting the sustainability of any conservation actions.

Registration and updating of the CBR at local level linking with national repository

The compiled CBR should be the responsibility of the CBR committee at village level, with a current copy deposited with the respective governmental body at national level. This type of registration and compilation duplicated at local and central levels will provide the basis to claim ownership and facilitate benefit sharing from any commercial use of GRs. At 3 to 5-year intervals the CBR register should be updated to monitor any important changes in diversity in the community.

Good CBR practices

Locating custodian farmers and custodian farmer groups

CBR has been found an effective tool to locate who maintains unique and rich genetic diversity at household and at community level. In Begnas village, a single household has been maintaining more than 20 different landraces of rice, while a community has been maintaining over 40 landraces of rice. When this information was shared by CBR committee members in their village, the impact was immediately seen. The custodian farmers and groups who have been maintaining unique and very diverse PGR were publicly recognized and awarded through the CBF. This is the social recognition generated by CBR.

Locating unique traits for value-addition

The CBR can provide important information on unique uses and potentials, which can be useful to farmers and local communities. In Begnas village, the unique traits in rice, finger millet, taro and sponge gourd have been shared with relevant stakeholders by local communities. Table 3 gives examples of two crops. This information was used in participatory plant breeding, value-addition and market linkage programmes. This case demonstrates clearly how CBR information could be mutually shared among the farming communities and other relevant stakeholders.

Table 3. Unique traits and uses of rice and finger millet diversity in Begnas village, as documented in the CBR

Crop	Farmer descriptors	Unique use values
Rice	Aromatic, early maturity, non-lodging, produced in off-season, delay appetite, disease resistant, flood tolerant, drought and shade tolerant, low moisture and nutrient required, more tillers and long straw.	Cultural value, good quality for *latte, siramla, chiura, khatte.* Medicinal value (specially for cooling effect and suitable for maternity period), straw mat, quality cooked feed for livestock.
Finger millet	Early maturity, disease resistant, less damaged by birds, large and compact head, white flour, easily digestible, long straw with more tillers, high yield.	Cultural value, medicinal value, *puwa*, bread, porridge, quality cooked feed for livestock

SOURCE: Subedi *et al*. 2005a

CBR as a source of information for a community seed bank

The important lesson derived from CBRs is that farmers have realized that a large number of local cultivars are conserved by only a few households and thus are highly vulnerable to genetic erosion and eventual loss. This realization has encouraged 22 farmer groups to form a nodal community-based organization (CBO), namely the Agricultural Development and Conservation Society (ADCS) in Bara, one of the global on-farm conservation project sites in Nepal. ADCS established a community seed bank with seed money from local government, IPGRI and SGP-GEF/UNDP Nepal to store unique landraces of rice, local crops and vegetables. The purpose of the community seed bank is to maintain the CBR, multiply local traditional seed for increased access, and to maintain small quantities of seed in traditional storage for short-term purposes (Shrestha *et al.*, 2005). The ADCS has further created a CBM committee to manage the community seed bank and to formulate procedures for seed collecting and distribution. This ADCS has developed capacity to voice their needs and is able to source the funds (financial capital) from both local government and developmental NGOs. It is unlikely that biodiversity registration alone by the government or a local institution is a viable and sustainable strategy for TK protection unless the process is internalized for the benefit of the local community.

Conservation of wetland resources and sharing benefits

In 2002–2006, LI-BIRD implemented a CBR project in the Rupa lake basin area of Nepal, with financial support from SGP/GEF UNDP Nepal. Rupa Lake Conservation and Rehabilitation Cooperative was established as the nodal local institution to implement the CBR. Documented information was shared with local communities and relevant stakeholders. The result has shown that many wetland resources, such as native aquatic living resources, including *Sahar* fish, white lotus and freshwater otter, are endangered due to illegal hunting or overuse by local communities, particularly those living in upstream areas. Under these circumstances the cooperative has started commercial fish farming as an income generating activity. The project provided CBM fund support (about US$ 2800) to start the commercial fish farming. In 2002–2003, when the project was initially launched, the annual income of the cooperative was about US$ 4200, but in 2010 the annual income exceeded US$ 98 000. Every year 25% of the annual income of the cooperative is allocated to conservation of local fish diversity, protection of breeding habitat for wetland birds, conservation blocks of wild rice, and conservation activities for several other GRs identified as rare in the CBR. At same time, it share the benefits with upstream communities for management of local agrobiodiversity, promoting organic farming and promoting forestation, with a scholarship programme for school children and helping employment in indigenous fisher communities. The cooperative has also expanded its membership to include upstream communities, reaching over 700 shareholders. This is one of the exemplary cases showing how CBR can provide social, economic and environmental benefits, now being termed mechanisms for payment for ecosystem services.

Lessons learnt and future areas for CBR implementation

Size of CBR documentation unit

Maintenance of the CBR at household level was found very resource demanding, so therefore one CBR per community or village has been found a more practical strategy.

Biodiversity fairs as documentation and validation method for the CBR

Biodiversity projects often organize biodiversity or seed fairs as part of their regular activities. If documentation of CBR has been linked with such events, it will reduce costs significantly. Further validation of CBR information will be more rapid during the diversity or seed fair.

Institutional framework to link community-based CBR with a central level repository

There is a general lack of institutional framework to link CBRs with national systems of biodiversity conservation, including exchange of GRs for research and development purposes, and inclusion in access and benefit sharing mechanisms. In Nepal, though there is provision for such a mechanism in the draft bill on Access to and Benefit Sharing (ABS), but the practical implementation need to be developed.

Continuous updating and maintenance of a CBR

This requires strong socio-political and economic incentives to encourage community members to continuously engage in community actions required to maintain a dynamic CBR. Linking CBR results into development and community well-being supported by local financial mechanisms should be a priority and mandatory step in CBR development.

Digital database systems for a CBR, with video clips

It is realized that a digital database system for CBRs could be an efficient option if the required resources and capacity were available in the communities. A digital CBR would overcome existing critical limitations of register-based CBRs, by (1) eliminating space limitation, as often there is need for detailed documentation of particular diversity; (2) minimizing the resources required for compilation and analysis of different CBR registers; and (3) rendering it easy to deposit centrally.

There are GRs with unique traditional knowledge of its specific importance or use values. This type of diversity and the associated knowledge should be documented through proper video clips that can be used to maximize its future use.

Acknowledgments

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Sustainable agrobiodiversity management in the mountain areas of southern China

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Introduction

Thanks to the project on 'Sustainable Agrobiodiversity Management in the Mountain Areas of Southern China', farmers implement biodiversity-friendly farming practices in selected mountain areas of Southern China in a sustainable way, with support from local agricultural authorities, institutions and private enterprises. The project was developed in the Wuzhi, Wuling and Dabie mountains, and project parameters are summarized in Table 1.

These areas are characterized by a high incidence of agrobiodiversity (ABD), small-scale farm agricultural production, and in many cases there are members of minority groups, such as Miao, Tujia and Li.

Table 1. Parameters of the project 'Sustainable Agrobiodiversity Management in the Mountain Areas of Southern China'

	Wuzhi Mountains	**Wuling Mountains**	**Dabie Mountains**
3 Climatic zones	Tropical	Sub-tropical	Sub-tropical to temperate
5 Provinces	Hainan (1)	Hunan, Hubei, Chongqing (3)	Hubei, Anhui (2)
13 Counties	3	6	4
26 Villages	6	12	8

Methods and approaches

Project approach

The project approach focuses on sustainable ABD management, which is carried out through different tools, such as: ABD assessment; Participatory Village Planning (PVP); farmer cooperatives for marketing; capacity building; awareness creation; and ABD mainstreaming (policies). Together these represent a comprehensive concept for sustainable ABD management. This is a multi-level approach, which is undertaken through a vertical integration or elevator principle: from national level to the provinces, prefectures, counties and villages, and vice versa.

Project results on awareness raising

In order to raise awareness about ABD, the project has mainly focused on three elements: the involvement of local farmers in ABD assessment; exhibitions (e.g. at universities) as a means to gain more media attention; and cooperation with universities as a useful tool for further activities and sustainability. Several important documents were produced:

- The exhibition brochure for the travelling exhibition "When man meets nature – Food security, biodiversity and traditional culture", describing (in English and Chinese) the 3 sets of panels, each with 42 elements.
- Two Project Documentary Films, each in English and Chinese.
- An *ABD Manual*, in cooperation with the MoA-GEF Project on Wild Relatives of Crops (in English, Chinese and German).
- A *Sourcebook on Sustainable ABD Management*, as teaching material at high school and university levels (6000 copies in English and Chinese).
- Project calendars for 2009, 2010 and 2011 (in English and Chinese).

As a result of this project implementation, stakeholder awareness of ABD conservation was increased at all levels, including villagers, government officers at different levels, university teachers, students and the general public. Awareness was engendered through various measures such as conferences and workshops, travelling exhibitions, TV and print media, project documentary films shown on local TV channels, and at universities, project publications and involvement in the Go4BioDiv event at CBD COP10.

Project results at community level

At a community level, it was shown that facilitators from the village community are essential for sustainability, and that training on ABD conservation needs to be attractive to farmers. Thus, both incorporating economic benefit in training contents and carrying out training in the fields, according to farmer needs and time availability, are two extremely important aspects. Furthermore, we think that eco-compensation as well as awareness raising need to be considered in the project design. Farmer Field Schools (FFS) provide a perfect platform to combine the project's key elements, with the participation of local farmers and helping them build their skills and confidence, rather than just transferring knowledge;

conserving ABD and sharing traditional knowledge on ABD and experience in agricultural production; marketing of traditional ABD crops; and enhancing FFS to be transformed into farmer cooperatives.

The documents produced to implement ABD at a community level are: ABD posters for villages; a farmer training manual; a training of trainers sourcebook; and ABD calendars.

Subsequently, Participatory Village Plans (PVP) were implemented in 26 villages, where village development measures (motivation and eco-compensation) were applied and ABD measures piloted. Moreover, 26 Farmer Field Schools (FFS) were established and training plans, training and study tours for FFS facilitators provided. Farmers increasingly practised biodiversity-friendly farming, and 14 farmer cooperatives were established or strengthened; ABD planning and monitoring concepts at village level were applied through training for county staff and farmer representatives, with implementation in villages through FFS. Finally, participatory methods were increasingly applied in the villages, including by Government officers.

Discussion

Project results on ABD mainstreaming

Biodiversity and ABD issues need to be tackled from different angles (awareness raising, capacity building, pilot implementation, mainstreaming) and at different levels (village, county, province, national). Other aspects that should be taken into consideration are that well-prepared study tours increase partner awareness of ABD issues in agricultural policies. However, influencing policies takes a long time and involves effort by many actors, whereas project implementation periods are usually limited.

Documents produced by the project include a study on the impacts of agricultural policies, laws and regulations on biodiversity; guidelines on ABD mainstreaming; a draft regulation on sustainable ABD management in Zhangjiajie, which is awaiting approval; and a policy advice paper on Hainan ABD conservation and utilization (November 2010).

Immediate project achievements

- ABD management integrated in village by-laws and codes of conduct developed at village level,
- An analysis report on ABD-related laws and policies was submitted to the Ministry of Agriculture, and awareness increased among policy-makers.
- Awareness creation and experience exchange on ABD mainstreaming through international study tours and national and international conferences and workshops.
- An ABD policy paper was presented to Hainan policy-makers in 2010.
- Awareness of ABD among the members of the Wuling Mountain Economic Cooperation Network was increased.

- ABD was integrated in relevant government strategies, e.g. Five-year development plans.
- Establishment of an ABD management leading group, with formulation of ABD regulation in Zhangjiajie in August 2010.

In number terms achievements included:
- 520 training events for farmers, involving 10 400 person-time participation.
- 192 training events for county staff, involving 2065 person-time participation.
- 7 study tours (5 domestic and 2 international), involving 162 person-time participation.
- 21 workshops, involving 643 person-time participation.
- 2 international conferences, involving 390 person-time participation.
- 3 seed fairs.
- 2 publications for high schools and universities (an ABD manual, and an ABD Sourcebook).
- 2 training manuals (for trainers and for farmers).
- 2 documentary films.
- A travelling exhibition that was displayed 18 times, with ca 90 000 visitors.
- A project website www.agrobiodiversity.cn

Conclusions and recommendations

To sum up, our Sustainable Agrobiodiversity Management in the Mountain Areas of Southern China project has increased awareness on ABD at different levels. Capacity on ABD also increased at different levels (core trainer team, training material elaborated, teaching material for universities and high schools produced) and ABD was integrated in government strategies in different ways, such as the establishment of ABD-supporting institutions like Sustainable Agrobiodiversity Management Centre at the Southern China University for Tropical Agriculture, in Danzhou, Hainan, in 2008; the Hainan International Agrobiodiversity Research Centre (under the Department of Agriculture), which was initiated in June 2010; and the Research Centre on Biodiversity and Climate Change, Hainan University, initiated in 2010. At government level, the MoA national Farmer Field School (FFS) programme reached 27 provinces, 850 counties and 3700 villages.

Furthermore, during 2009, a demonstration phase was held for 500 villages in 50 counties in 27 provinces, while in 2010–2014 a fully-fledged phase extended to 4 villages each in 800 additional counties. MoA integrated ABD issues into its five-day training course for village heads, advanced farmers and university graduates, and an MoA Project on Wild Relatives of Crops (with Global Environment Facility (GEF) support) has also been implemented.

Lessons learnt and perspectives from a global effort to support the deployment of underutilized species, with special reference to documentation of knowledge and information

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Introduction

During the first Conference of the Global Forum on Agricultural Research (GFAR) in 2000, participants recommended a greater involvement in underutilized species at the regional level and a facilitation mechanism that would operate at the global level. Reasons for these demands were issues such as the fact that food security and income generation were relying on only a few crops, diet diversification was needed to improve the health of poor people, and agricultural biodiversity was narrow and further shrinking. Better utilization of underutilized plant species was considered a means to reverse this situation.

As a result, the Global Facilitation Unit for Underutilized Species (GFU) was established at Bioversity International (formerly International Plant Genetic Resources Institute, IPGRI) with funding from the German Government.

The mission of the GFU was to promote and facilitate the sustainable deployment of underutilized plant species to increase the security of food and nutrition and alleviate poverty among poor rural and urban communities. It aimed at engaging a growing number of research institutions, extension services, development agencies, donors, and policy- and decision-makers in research and development programmes on these crops.

In 2008, the GFU merged with the International Centre for Underutilized Crops in the new entity *Crops for the Future* (GFU, 2009).

Methods and approach

Scope and thematic focus

To complete its mission and achieve the goals, the GFU focused on three activity areas:

1. Policy analysis and policy recommendations.
2. Increasing awareness about underutilized crops in civil society, with policy-makers and donors.
3. Generating and documenting information and knowledge, and facilitating communication.

The realization that underutilized species do not receive much attention was the basis for this thematic focus. Farmers grow them less often because they are less competitive than the major commodities in the market. Therefore, their existence is threatened and knowledge about their cultivation and uses is destined to be lost.

A large number of species can be categorized as underutilized. GFU therefore did not promote any particular species, but worked on cross-cutting issues, such as national and international policy constraints to the deployment of underutilized species, obstacles to functional value chains, and on the formulation of recommendations and guidelines for their development. The intention was to improve the institutional environment for a wider use of these plant species. However, case studies on particular species were used to draw general conclusions and develop a broadly applicable strategy, policy recommendations and best practices.

The most important instrument to document and disseminate information was a one-stop searchable internet-based portal developed by the GFU. Regularly, static versions of the web portal were made available to those individuals and institutions with limited access to the internet. The Web site allowed access to publications and information from other stakeholders worldwide. It informed users of current discussions on important topics, such as the placement of food products derived from exotic underutilized plants in the market of the European Union (EU) under the EU Novel Food Regulation. It provided links to other relevant sites and informed users of past and upcoming related events. There was also a database on ongoing projects; a comprehensive list of experts; a compilation of underutilized species and their characteristics in terms of distribution, cultivation requirements, use and economic and nutritional values; a database on funding opportunities; and many promotional materials produced by GFU. The content was compiled through searches for information and with voluntary contributions. This process and additional interviews with stakeholder allowed existing gaps to be identified and closed in making necessary information, tools and guidelines available for broader deployment of the target species. To this end, GFU commissioned and conducted its own studies on specific topics.

In addition to the internet-based tool, GFU also distributed printed materials to many in the international community.

Regular workshops, seminars and conferences were organized in partnership with others to stimulate exchange and linkages among stakeholders, initiate new activities and create greater awareness at all levels.

Target groups

The activities did not directly target the farming communities but were aimed at research institutions, extension services, development agencies, donors, policy- and decision-makers, and the consumers, in developing and developed countries, who through their culinary and shopping habits can greatly increase the demand for these species and hence stimulate their cultivation and commercialization. It was expected that these target groups would directly benefit from the lobbying activities carried out by the Unit. In the mid-term, the rural and urban poor were expected to be the ultimate beneficiaries, benefiting from greater awareness about underutilized species at all levels, from improved policies and from a broader engagement of research, development and donor organizations, eventually leading to greater production of currently underutilized plants and better availability of products derived from them.

Discussion

Scientific research and development work on underutilized species is scattered and access to information is often difficult. These species are limited in their distribution. Their conservation and use are taken care of mainly by local farmers, who are not used to documenting their knowledge and practices. Local scientists also often publish in national journals, thus making their publications difficult to access. A large number of plant species fulfil the criteria of being neglected and underutilized, and that is why concrete and exhaustive information on all of them is hard to gather and document.

Therefore, the GFU felt that a Web portal was needed with free access to as much documented information as possible. Internet connectivity would most likely be limited in places where information would most be needed. Hence the distribution of the static web site as a Compact Disk.

Since the GFU did not have direct linkages with local communities, their knowledge was not included. Farmers also did not have the opportunity to use this web portal. Gray literature was largely excluded as it is not traceable.

The organization of workshops, consultations, conferences, etc.; a Question and Answer-service; the distribution of print materials on specific topics, with monthly updates via e-mail—all these partly compensated for the limitations of the Web portal, but also did not provide a solution to capture community-based knowledge and improve documentation at that fundamental level. However, as mentioned above, local communities were not the target group of the GFU. The international scientific, policy and donor community, however, benefited from this well organized and structured medium.

In the course of setting up this information and documentation system it became evident that issues related to the marketing and commercialization of underutilized crops domestically, regionally and internationally, with enabling policy environments, were particularly interesting to the user community. Information, guidelines and best practices for the development of functional value chains and attractive local and international markets were very much in demand. Between 2003 and 2005, the expertise of the international community was predominantly in the field of genetic resources conservation (40% of respondents to a questionnaire). Only 11% of the experts stated that they were familiar with marketing and 8% with policy and legal issues. Therefore, the projects that these experts carried out dealt mainly with applied research on the conservation and characterization of underutilized crops, followed by information on and documentation of particular species, and creation of public awareness (Padulosi, Hoeschle-Zeledon and Bordoni, 2008). This could be considered a positive situation. Without conservation there cannot be much commercialization as these activities are based on the natural genetic range found within these species, which allows the development of marketable products. However, a strong move from the conservation to the marketing stage was still lacking. A workshop co-organized by the GFU identified the main areas for intervention in the promotion and development of underutilized species, and confirmed the importance of conservation and access to genetic resources as a first priority (GFU, 2004):

1. Access, conservation, and improvement of genetic resources.
2. Post-harvest handling and processing.
3. Policy and legislation.
4. Awareness creation and lobbying.
5. Marketing.
6. Capacity building.
7. Information generation and management.
8. Inter-sectoral interventions.

Within (1), a number of strategic elements were established that should be addressed: *in-situ* and on-farm conservation and crop improvement; selection and evaluation of local cultivars; improvement of seed supply; development of appropriate technologies; *ex situ* conservation and support to genebanks; targeted collection of new germplasm; and farmers' experimentation and innovation. To improve and establish systematic Information generation and management, the following were considered important: documentation and synthesis of existing information and success stories; linking with databases of the Convention of Biological Diversity (CBD); identification of local focal points for information sharing (and documentation); documentation of indigenous knowledge (IK) on all uses (nutritional, medicinal, etc.); scientific validation of IK; identification and documentation of local species (creation of biodiversity registers); knowledge generation through farmer experimentation and innovation; and the development of information tools and decision-support systems.

With regard to the documentation of farmer knowledge and expertise, a number of questions need to be answered:

1. Do local communities want their knowledge and practices to be shared and made public?

2. How important are their knowledge and practices to other rural communities and scientists?
3. How can local knowledge be accessed and documented for use by scientists?
4. How can scientific knowledge be made available to and used by farming communities where extension services are weak?
5. How can local custodians of knowledge and practices be acknowledged for making these available (access and benefit sharing)?

Conclusions and recommendations

Now that greater awareness on underutilized species has been created at the international level, a better involvement of communities in documentation should be explored. Community-based documentation of knowledge on and practices for the conservation and use of underutilized species is essential for the development of these crops, yet it is a field that has been given little attention. Internet-based documentation systems are needed for the scientific community and for long-term management and conservation of information. As these crops are mainly of local importance, local knowledge has to be captured, documented and built into research and development programmes for these localities. Existing organizational structures within the communities should be used to organize the documentation. Local focal points should be identified by the community leaders and trained in information gathering and the electronic documentation of existing biodiversity, best practices, IK, etc. Consent needs to be obtained from communities to document and use information through formal agreements that include benefit sharing arrangements (and adds to the correctness of information). To reach this consent, the communities must understand and accept the purpose of the information gathering and documentation. Since there are many crops and communities, systematic documentation activities could start in those communities that are already linked to scientific institutions. Existing National Genetic Resources Centres should be strengthened and involved. To improve information sharing in general, other technologies, such as mobile phones, are superior to Internet-based information systems because of wider coverage, easier access and cost efficiency.

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Summary notes only

Coping with climate change: using agrobiodiversity to enhance resilience and adaptability

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Platform Goal: enhance the sustainable use and management of agrobiodiversity in all its different aspects.

Objectives

Support development of an adequate knowledge database.

- Identify ways in which agrobiodiversity can contribute to global challenges.
- Identify and facilitate new research partnerships.

The project on climate change

- Database on coping strategies by farmers.
- Adaptation strategies using agrobiodiversity (diversity as a safety net).
- Adaptation dynamics.

Conclusions

1. Adapting involves a range of different actions at the three level of species, ecosystem or landscape, and agricultural systems.
2. Innovation is based on traditional knowledge and new information.
3. Use of traditional crops and livestock with new material has been always a common practice.

2nd part of project in Bolivia and Malaysia: Strengthening adaptability, resilience and innovation.

- Aim to relate the genebanks to the farmers.
- Set up agreement with the communities (FPIC).
- Select the varieties with the communities.
- Farmers' perspective of climate change (issues that farmers are raising and their needs).

Questions from the floor

Q: Were there links to the Climate Change, Agriculture and Food Security (CCAFS) platform?
A: Not at the moment, but it will be considered.

Using indigenous knowledge and participatory plant breeding to improve crop production and regenerate crops and tree species in West Africa

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Introduction

Sub-Saharan Africa consists of several ecological zones, which are characterized by annual rainfall of less than 300 to more than 1000 mm, with high and unpredictable temporal and spatial variability. Sorghum (*Sorghum bicolor* (L.) Moench) is a staple crop of semi-arid sub-Saharan Africa (~30% of cereal area). Four of the five sorghum races are present in Burkina Faso and Mali (Barro-Kondombo *et al.*, 2010). Sorghum is cultivated on diverse soils, under varying climatic conditions with diverse production objectives across more than 1.3 million hectares, representing mainly low-input cropping systems. Farmers grow mainly guinea-type landraces that are well adapted to the harsh and unpredictable conditions of the sub-Sahelian zone, but which produce relatively low yields (ca 1 t/ha). Indeed, land degradation—mainly through water erosion and decline in soil fertility—is a serious threat to sustainable agricultural land use as it affects soil productivity (Laflen and Roose, 1998). In this region, erosion is worsened by poor soil and crop management, which jeopardize the integrity of the soil's self-regulatory capacity (Lal, 1998). Indeed, erosion by run-off water is responsible for negative nutrient and carbon balances in most farming systems in West Africa (Zougmoré *et al.*, 2004a). To restore their soils, farmers, researchers and agriculture extentionists have developed a range of measures, including adopting traditional methods that were once abandoned.

Seed is obtained mainly through traditional channels, the formal seed system being rarely used. In Mali, for example, Yapi *et al.* (2000) showed that the increase in adaptation of improved sorghum varieties of around 15% in the early 1990s was for the most part attributable to varieties derived from selections in local germplasm and not improved varieties based on exotic materials. Even though the sorghum production system is based on local varieties, Kouressey *et al.* (2003) observed a decrease in varietal diversity between 1978 and 1999. Genetic erosion in Mali and Burkina was attributed to demographic growth, reduced rainfall (Somé, 1989) and preference for cotton-maize systems. In recent years an increased interest in modern varieties and their commensurate dissemination has been observed among farmers, which can be attributed to a refocusing of breeding priorities on local germplasm, farmer production objectives (participatory plant breeding approaches), and a need for cropping intensification (reduced fallow periods, government policies).

With the goals of enhancing germplasm and preserving local agro-biodiversity, which implies the dissemination of varieties, decentralized participatory plant breeding was deemed the best approach for working with sorghum farmers in Mali and Burkina Faso. In this paper we describe the participatory approaches and the use of local integrated land rehabilitation practices to meet these needs. Approaches include germplasm collection, analysis of the local seed system and assessment of farmers' seed management practices. This research was a collaborative effort between the Centre de Coopération Internationale en Recherche agronomique pour le développement (CIRAD) of France; the Institut de l'Environnement et de Recherches Agricoles (INERA) of Burkina Faso, together with a number of development projects and farmer organizations (vom Brocke *et al.*, 2005) in Burkina Faso; and the Institute of Rural Economy (IER) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in Mali.

Methods and approaches

General approach

In order to improve productivity, diversity and dissemination of enhanced germplasm, research was focused on three activities, namely local seed system analysis, germplasm collection and plant breeding (Figure 1). Participatory methods, as described in Christinck and Weltzien (2005), were implemented.

Germplasm collection

The germplasm collection, as described by Barro-Kondombo *et al.* (2010), was founded on collaboration with farmer organizations and the extension service, working together in a participatory germplasm enhancement project (vom Brocke *et al.*, 2005). Collecting was carried out in ten villages in three agro-climatic zones of Burkina Faso, and combined with a participatory diagnostic survey in each village using participatory rural appraisal (PRA) methods. PRA enabled participants to learn about local production systems, village history, varietal diversity and variety change (INERA, unpublished data). The objective of the collection was to assemble all sorghum types present in the villages that were viewed as different

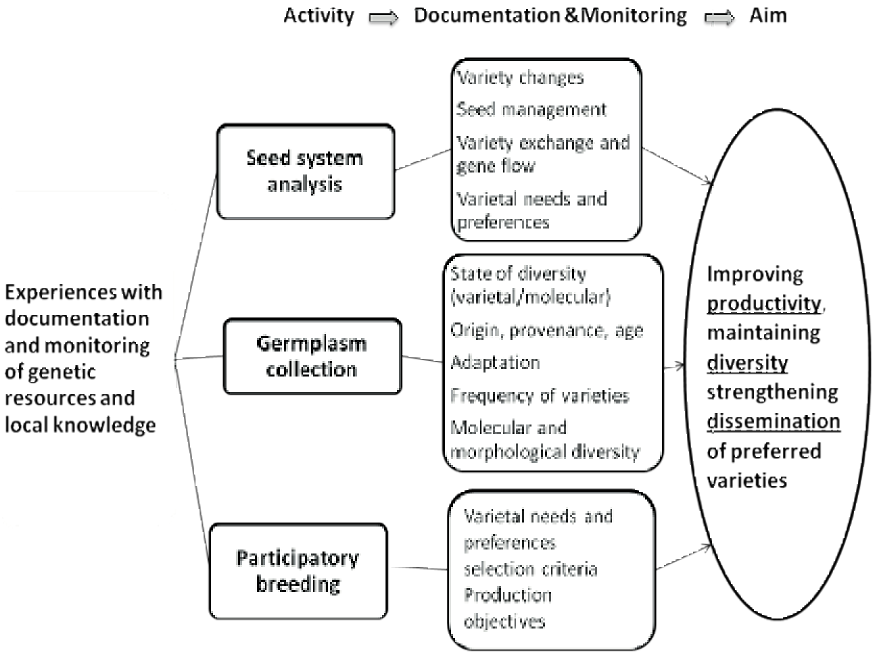


Figure 1. General scheme of documentation and monitoring of genetic resources and local knowledge in sorghum systems, as applied in Burkina Faso

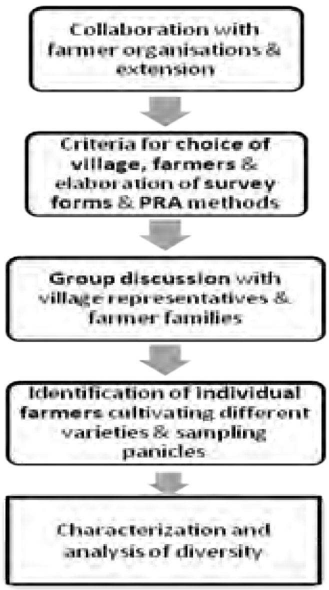


Figure 2. Different steps of planning and carrying out the participatory germplasm collection

varieties by the farmers themselves. The identification of varieties and farmers who could provide samples was decided in group discussions with village representatives (organized by the farmer organizations and extension service). The qualities or characteristics of each variety sampled were documented on variety identification forms, covering farmer seed management; preferences or drawbacks of the variety; provenance of seed; year of introduction; uses; pest and disease resistance; quality; adaptation; and other plant type characteristics. Figure 2 sums up the different steps associated with the germplasm collecting.

Seed system analysis

Informal seed systems in Burkina Faso and Mali are the source of more than 80% of sorghum seed for farmers (Siart, 2008). Understanding of these systems can contribute to the development of effective systems that help to improve farmer access to new varietal diversity. Knowledge of the modalities of the informal system can provide insight into farmers' varietal needs and the factors that contribute to the evolution of varietal and genetic diversity at the local level. Several studies have been conducted in Burkina Faso and Mali to learn about:

1. Regulation and social-cultural traditions of seed networks and seed exchange.
2. Seed selection and criteria.
3. Temporal evolution of varietal diversity.

Surveys using PRA methods, such as semi-structured individual interviews, group discussions and in-field observations, were used to gain data on seed exchange regulation and varietal diversity. The present paper presents results from five different villages in the Center-West (Velia and Togo), the Center-North province (Raguitenga) and the Boucle du Mouhoun (Siby and Kéra) provinces of Burkina Faso. Geographical and ethnic characteristics are given by Delauney *et al.* (2008). In Mali, 56 farmer households were interviewed, representing 90% of households of Magnambougou village and more than 50% of Gonsolo village in the Dioila Circle of Mali. Some results have been presented by Ehret (2010) to demonstrate varietal changes between 2004 and 2009. The villages in Mali were chosen due to their participation in participatory variety testing schemes. In Burkina Faso, villages were chosen due to their contrasting ethnic, geographical and socio-economic characters. Altogether, 89 households were interviewed in Burkina Faso, identified through the "snowball method" proposed by Subedi *et al.* (2003) to study informal seed networks.

Participatory breeding

Participatory plant breeding (PPB) is a breeding method that involves farmers and users in the breeding process so as to produce more client-orientated products (Witcombe *et al.*, 2005). Participatory breeding is ideally carried out under target conditions, i.e. farmers' fields. The national breeding programmes of both Burkina Faso (INERA) and Mali (IER), in collaboration with CIRAD and ICRISAT, have begun to integrate participatory approaches into the different stages of national breeding programmes (Weltzien *et al.,* 2008). Figure 3 gives an overview of PPB process in Burkina Faso.

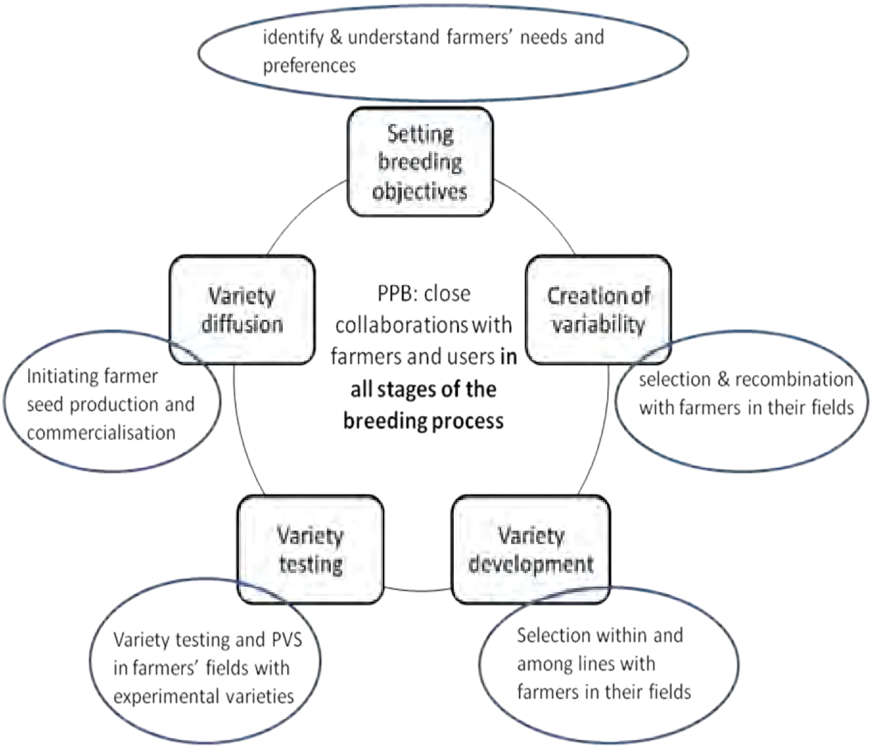


Figure 3. Examples of farmer participation in the breeding process (Source: adapted from Weltzien *et al*., 2000)

The present paper shows how participatory variety selection (PVS) trials contributed to the identification of preferred plant traits and varieties, and how the dissemination of those varieties contributed to making lost varieties available to farmers. The PVS trials were conducted in collaboration with INERA and the Union des groupements pour la commercialisation des produits agricoles de la Boucle du Mouhoun (UGCPA) farmer organization, with the objective of better understanding farmers' varietal needs in the Boucle du Mouhoun area, a zone with between 800 and 1000 mm rainfall and where the maize-cotton system predominates, although sorghum is regaining importance due to increasingly unpredictable rainfall patterns. trials involved 36 entries with two replications each, in two villages of the Bawan and Kossi provinces during 2002 and 2003. Lines included were improved varieties, landraces from the Boucle du Mouhoun region and other regions in Burkina, as well as landraces from the Saria/INERA genebank that had been collected 40 years earlier. Participatory evaluation, comprising voting and semi-structured group and individual interviews, proceeded over two years in the form of trials incorporating 30 to 40 farmers (vom Brocke *et al.*, 2011).

Local practices of integrated soil fertility and water management for improved crop production and regeneration of plant and tree species

Zaï and half-moons are Sahelian indigenous techniques to rehabilitate degraded land and improve crop productivity, while also inducing biodiversity regeneration. Zaï holes are a traditional technique that has been used to combat land degradation and restore soil fertility in the Sahel for many years, though not on as wide a scale as could be beneficial (Mando *et al.*, 2001; Fatondji, 2002). That it uses locally available materials and needs only small amounts of external inputs (organic amendments and fertilizers) makes it accessible to most farmers. The name zaï, it appears, is derived from the word zaïgre, which in one of the languages of Burkina Faso means to get up early and prepare one's land (Roose, Kaboré and Guenat, 1999). In the zaï technique, called *tassa* by the Hausa in Niger, desirable physical and chemical properties of the soil are restored by mixing small quantities of organic material (e.g. compost or manure) and fertilizer (when available) in small holes (20–40 cm diameter and 10–15 cm deep) that have been dug into the degraded, crusted soil. At the same time, the half-moon is a water collection device implemented on bare and crusted soils with gentle slopes (<3%). Animal manure can be added to the basin to optimize crop growth (Zougmoré, Kambou and Zida, 2003.). The farmers dig the pits in alternate rows, as shown diagrammatically in Figure 8 (Zougmoré *et al.*, 2004b).

Results and discussion

The three different approaches (germplasm collection, seed system analysis and participatory breeding) allowed one to monitor and document the state of sorghum diversity and to learn about farmers' ways of managing and using plant diversity. These approaches also gave an insight into what variety types are sought after by farmers or have the tendency to be abandoned by farmers; in other words, identifying traits that researchers need to consider carefully.

Villages are a pool and source of diversity

Great morphological and physiological diversity characterizes the sorghum varieties of Burkina Faso. Barro-Kondombo *et al.* (2010) concluded that variation is mainly due to growing cycle and grain type. The authors explained that this diversity is only weakly attributable to geographical boundaries, and the majority of varietal diversity is found at a village level. Similarly, genetic studies (single-sequence repeat (SSR) markers) show that gene flow is limited to village proximity (Sagnard *et al.*, 2008; Barro-Kondombo *et al.*, 2010). The visualization and comparison of panicles during village discussions helped to identify varieties thought to be different by the farmers. This approach showed that up to 40% of varieties that bore the same name were viewed by the farmers as being different varieties (during germplasm collections and discussions). Germplasm documentation has in fact shown that it is possible for 6 to 14 different varieties to exist within a single village of Burkina Faso. On average, however, farmers of this region only grow between one and five varieties of sorghum, with an average of 2.4 varieties.

Why diversity

Farmers' motivations to grow a range of different varieties can be summarized in five points:

1. To address the diversity of cropping environments (farmland fields, compound fields, waterholding lowland fields, etc.).
2. To diversify production objectives: fodder, human nutrition, cover hunger period, commercialization (e.g. for beer), etc.
3. To minimize risks and optimize harvesting (e.g. different maturity times).
4. To maintain tradition (medical uses, cultural customs).
5. To control striga or pest infestations.

Table 1. Local sorghum varieties cultivated in Pana village in north-central Burkina Faso

Variety name	Race	Cycle (days)	Field type	Land-form	Striga tolerance	Usage			
						Food use	Customs	Fodder	Other
Wangré	D	120	farmland	Low land (water-holding)	No	porridge	traditional medicine	stems	sweet stems (market)
Wed-wangré	D	120	farmland	Low land (water-holding)	Yes	porridge		stems	
Koki or peelogo	G	150	farmland	Low land (water-holding)		porridge, local beer		stems	used as compost
Zononbdo	Gmg	70	compound	Plain	No	porridge, local beer, replaces rice			for hunger period
Yadtenga	G	80	compound			porridge, local beer			
Kourboul-fiibmiiga	G	120	compound		No	porridge, local beer			
Ganbré	GC	150	farmland	Low land (water-holding)		porridge, local beer			
Kazin-miiga	G	150	farmland	Low land (water-holding)	No	porridge	traditional medicine		market
Balinga	G	120	farmland		No	porridge, replaces rice	traditional medicine		
Kourboul-fiibsablga	G	120	compound	slope	No	porridge, local beer			
Pag rayi	G	70	compound	slope	No				

NOTES: Sorghum races: D = durra; G = guinea; Gmg = guinea margaritiferum; GC = guinea caudatum intermediate.

Table 1 gives some examples of sorghum diversity in the Pana village of Burkina Faso and the differences in cropping and usages between varieties. What is distinctive for Burkina Faso is its red-grained sorghum varieties. This type appears to be genetically distinct from all other guinea landraces (Barro-Kondombo *et al.*, 2010). The authors pointed out the specific uses attributed to this type of red sorghum. For example, it has a short growing cycle and serves as the first cereal for the "hunger period". Due to the earliness of these red-grained varieties, they are mainly grown in compound fields. Red sorghums are frequently used for beer brewing and animistic religious purposes. In some regions of Burkina Faso only red sorghums are believed to be resistant against the sorghum midge, which prevents grain formation and causes crop failure.

Accessing diversity

In Burkina Faso and Mali, between 80 and 90% of farmer households produce their own seed during the growing season (Delaunay *et al.*, 2008; Siart, 2008). In the villages surveyed in Burkina Faso, around 40% of the seed will be used as food, 20% will be used for seed exchange and 40% will be sown by the family. Farmers mainly use informal seed networks to meet their varietal needs. In Burkina Faso, more than 50% of seed exchanges between farmer households take place within the same neighborhood, and up to 23% of exchanges are practiced with other villages. Between 80 and 90% of exchanges are within the same ethnic group. Seed generally exchanges across distances of around 10 km, although farmers travelling more than 100 km to exchange seed is not unheard of. Siart (2008) has stated that seed exchange strengthens traditional solidarity networks, which are the basis for collective risk management in precarious cropping conditions. These exchanges are guided by traditional rules that are specific for each village. In the Centre of Burkina Faso for example seed is given during two periods, harvest time and sowing time. During harvest, the head of the family can give panicles to all who are passing by his field. However, a farmer does not give seed to a farmer of the same village before the beginning of the planting season, as "if you give

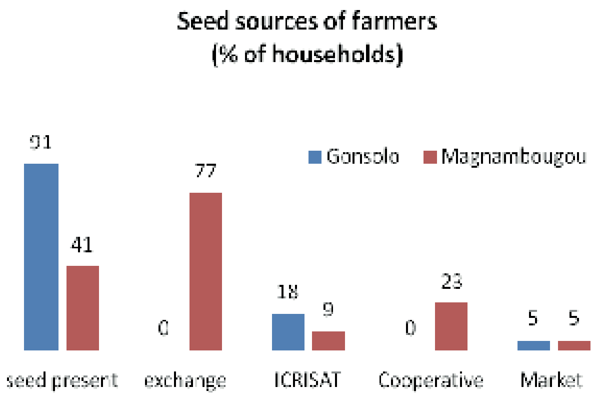


Figure 4. Diverse seed sources of farmers in Gonsolo and Magnambougou villages in Mali in 2009

at any moment, there is no certitude that the seed will be really used as such". In the Centre-North of Burkina Faso, the family head does not give seed before starting their own sowing, as "if you give your seed to another farmer, who is sowing before you, you are transferring all your luck for having a good growing season to them". The three main modalities practiced by farmers in the Mali and Burkina Faso are: seed presents; exchange of seed for other commodities, such as grain; and buying seed in the local markets (Delaunay *et al.,* 2008; Siart, 2008). In some regions, seed cooperatives are operating, and overlaps between informal and formal seed systems occur (Figure 4).

Reasons for varietal changes

More than half of the varieties introduced into the villages surveyed in 2003 in Burkina Faso had come by informal channels in the previous 40 years. These were, according to farmers, mostly varieties with shorter growing cycles than local varieties they replaced. They were introduced because of unfavourable changes in rainfall patterns. Similar results were found in surveys in Mali in Magnambougou and Gonsolo villages, where the primary reason for variety change was rainfall related (Figure 5). In these two villages, farmers grew more than 13 varieties between 2003 and 2008, and on average 9.8 (Gonsolo) and 8.6 (Magnambougou) varieties per year (Table 2). The abandonment of cotton in the Magnanbougou village by many farmers led to an increase in cereal area after 2004. Ehret (2010) recorded changes in varietal types among farmers in three villages in the Mandé Cercle in Mali. Ehret (2010) pointed out that almost all farmers had changed their varietal portfolio in the previous five years, changing mostly from growing one variety type to growing several variety types with the purpose of being better able to cope with changing climatic conditions (Figure 6).

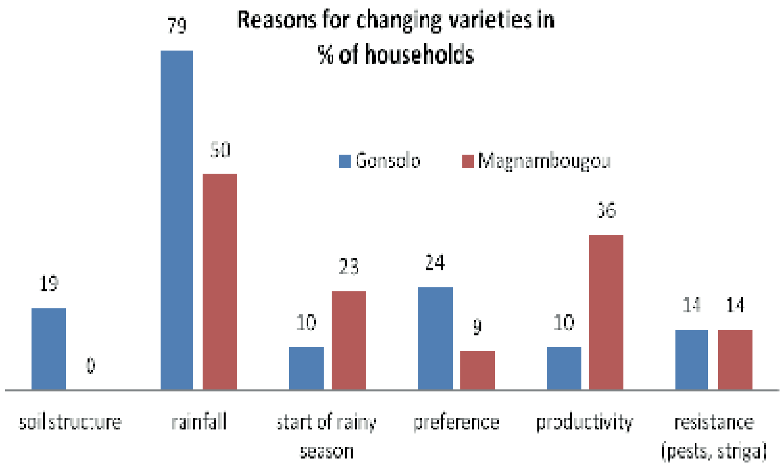


Figure 5. Reasons for variety change in households in Gonsolo and Magnambougou villages in Mali

Table 2. Frequency of households growing a variety between 2003 and 2008 and before 2003 in Magnambougou and Gonsolo villages in Mali

Gonsolo								Magnambougou							
Variety	.08	.07	.06	.05	.04	.03	<03	Variety	.08	.07	.06	.05	.04	.03	<03
Kalosabani	xxx	xxx	xxx	xxx	xxx	xxx	xx								
Soumalemba	xx	xx	xx	xxx	xx	xx	x	Bamtoukablé	xxx	xxx	xxx	xxx	xxx	xxx	xxx
Flatièba	x				x	x		Bamtoukafing		xx	xx	xx	xxx	xx	xxx
Drongonba							xxx	Foulaniochi							xx
Kendé						x	xxx	Segetana		xx	xx	xx	xx	xx	xxx
sorgho sucré	xx	xx	xx	xx	xx	xx	xxx	Algerie	xx	x					
Sokouba							x	Soumba	xx	xx	xx	x	x		
Sibirinioni				x	x	x		Niogomé	xx	xx	x				
Tiémarifin	xxx	xx	xx	xx	xxx	xxx	xxx	Saunion	x						
Fakotoumate	x	x	x	x	x	x	x	Tiémarifing	x	xx	xx	xx	xx		xxx
Tiébélé	x	x	x	x	xx	xx	xx	Bobojé	x	x					
Tama Diakité				x			x	Déréblé		x	x	x	x	x	xxx
Touroukani(mifin)	x	x				x	xx	Nioba	xx						xxx
Séguétana	xx	xx	xx	xxx	xxx	xxx	xx	Baguibaguifing	xx	xx	xx	xx	xx	x	xxx
Niogomé	x	x	x	x	x			Dafourougba							x
Kalaguénio	xx	xx	x					Baguibaguiblé							x
Bibagalawili							x	sorgho sucré	xx	xx	xx	xx	xx	xx	xx
Total	10	10	9	10	10	10	13		10	11	9	8	8	6	11

NOTES: xxx=>5 households xx=2-4 households x=1 household

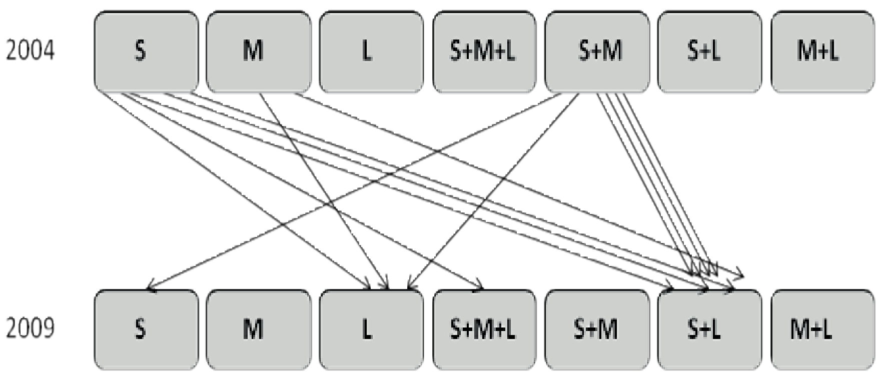


Figure 6. Choice of cycle length of varieties in Keniero (Mandé Cercle, south Mali) in 2004 and 2010. Rectangles are variety types grown simultaneously; arrows are households. (Source: Ehret, 2010)

The danger of losing varieties

Table 2 illustrates for both villages that at least one or two principal varieties were grown with a relatively high frequency during the previous 5 years and longer. These “stable” varieties are grown on large areas in Bamtoukablé and Kalosabani, or on only small portions of the field when it is sweet sorghum. However, about 18% (Gonsolo) and 50% (Magnambougou) of varieties which were documented for 2003 were no longer grown in 2008. At the same time 30% (Gonsolo) and 70% (Magnambougou) of varieties were considered as introduced into the farming systems as they had not been documented in 2003. This shows a general tendency of increased varietal biodiversity in the two villages, but also that specific variety types are subject to genetic erosion. Similarly, farmers interviewed during the 2003 collection trip in Burkina Faso reported that between one and four varieties in the surveyed villages had been abandoned in the previous four years, due to their long maturity or susceptibility to the parasitic weed striga. Striga is associated with low soil fertility, which can in turn be related to increasing demographic pressure. Furthermore, results of the survey show that, on average, two of seven different varieties currently cultivated in the villages face being abandoned and lost. Nevertheless, farmers repeatedly stressed during the individual and group interviews that lost varieties had strongly preferred plant traits, such as high yield potential and superior grain quality for food and storage (Sorgho-Millogo, pers. comm.). Also, it has been observed that production systems evolving in favour of cotton, vegetables and maize led to a reduction in red sorghum types in certain regions of Burkina Faso. Farmers most often preferred white sorghums, which can be used for both beer and porridge preparation.

Traditional seed systems assuring germplasm enhancement, diversification and preservation

The results of the survey in three villages in Burkina Faso indicated that 91% of farmers practised panicle selection in the field at harvest, while others used grain out of the granaries for sowing. The selected panicles are often tied together into bundles by the family head and during this work a second selection is often performed. Farmers’ main selection objectives were to assure and ensure vigorous seed emergence, maintaining the variety and food security. In Zikiémé village (north-central Burkina Faso) it was observed that two to four family members performed panicle selection (wives, brothers, children and the family head). The family head is responsible for the selection activity, teaching selection criteria to the family members. Farmers reported that women can contribute new selection criteria learned in their respective families; they also apply additional criteria related to grain quality. In general, the main selection criteria documented were: morphological plant characteristics (genotypic uniformity); vigorous and healthy plants; good panicle maturity; good grain filling; and high grain quality (depending on usage). Panicle selection exercises indicated that criteria to distinguish and select varieties can differ between villages: Zikiéme focused on morphological traits, whereas Pouni (in west-central Burkina Faso) focused on adaptation and usage (Figure 7). Farmers apply in general high selection intensities as 0.1–0.7% of total plants grown in the field were selected for seed grain at Zikiémé for those varieties frequently grown on a relatively large area. Lower intensities were observed in specific varieties grown on small portions of land. Here, between 5–11% of total plants grown in a field were selected for seed grain (Table 3). The strong selection intensities applied can contribute to fast evolution of varieties and the "same" varieties managed by different farmers are likely to differentiate. These findings support the results of Sagnard *et al.* (2008), who analysed sorghum seed samples from farmers using molecular markers. The authors stated that the genetic differentiation among seed lots cannot be attributed to the reproductive system of sorghum varieties alone, but that genetic drift due to selection practices most probably contributes to the dynamics of genetic diversity.

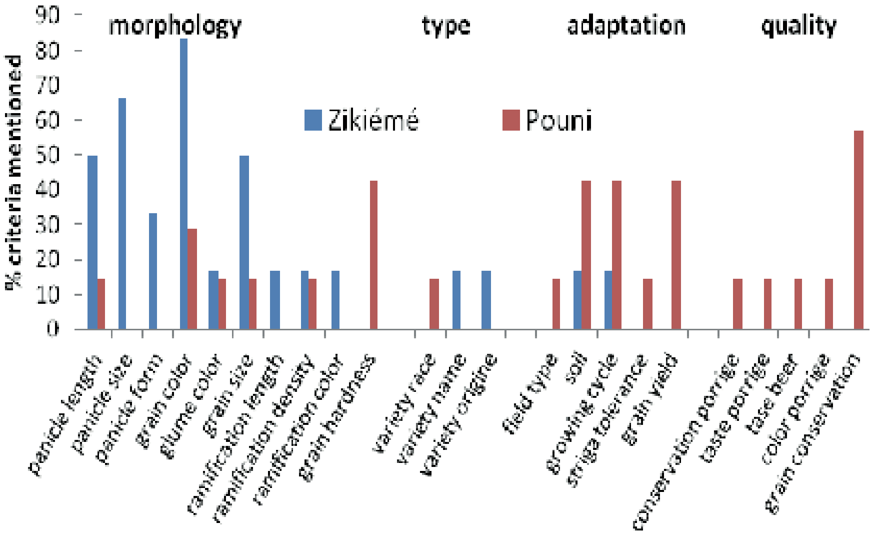


Figure 7. Different criteria for characterizing varieties in Pouni and Zikiémé villages in Burina Faso

Farmers reported that in drought years there is a risk of losing the special varieties, as food security will be more important than maintaining varietal characteristics. A smaller number of panicles will be selected for seed preservation, with less emphasis on varietal purity. Some characters, such as glume colour, are also difficult to assess under drought conditions. Varietal mixtures are found commonly in fields where there have been several re-sowings due to drought spells. Considering out-crossing rates of about 20% (Ollitrault *et al.,* 1997) for local guinea races in Burkina Faso, genetic introgression and an increase of heterogeneity will be the consequence.

Table 3. Farmers selection intensity (percentage of selected panicles of total number of plants in the fields) in the field by different farmers in their varieties in Zikiémé village in Burkina Faso

Variety name	% intensity	Number of selected panicles
Special varieties (rare or small areas)		
Makiéma (Gmg)	0.5	60
Kankansido (ICSV 1049)	0.3	80
Balinger (used in traditional medicine)	10.6	25
Kazin miuga (used in traditional medicine)	5.5	13
Namoinsomba (recently introduced)	5.5	59
Main varieties (frequent, large area)		
Kourbouli-Fiibmiugou	0.2	77
Kourbouli-Fiibsablega (Farmer 1)	0.3	108
Kourbouli-Fiibsablega (Farmer 2	0.4	183
Fiibmiougou (Farmer 1)	0.4	120
Fiibmiougou (Farmer 2)	0.7	87
Fiibmiougou sous-guilsi	0.1	279
Fiibsablega	0.1	211
Fiibmiougou de Ziniaré	1.1	236

NOTES: Gmg = sorghum race guinea margaritiferum. ICSV = ICRISAT Sorghum Variety.

Supporting farmer access to useful diversity through participatory variety testing

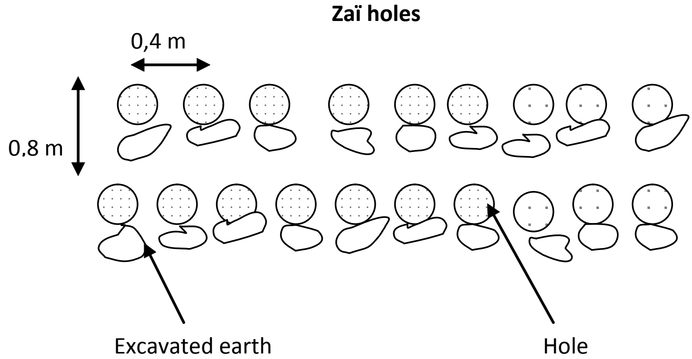
The most important results from the participatory variety selection (PVS) trials in the Boucle du Mouhoun region were their success in offering and making available new varietal options to farmers in a sustainable way. Germplasm collections, seed system analysis and PVS point out the need for varietal diversity, and out of the wide range of diverse varieties (improved varieties, landraces from the same and other regions), farmers choices concentrated on the landraces, both from the same and other regions, which had been collected in 1969 and since them preserved *ex situ* in the Saria/INERA genebank. As these landraces had short growing cycles, they were cultivated in the past in order to provide food during the hungry period. However, their maintenance was in doubt. Rainfall was enough for most other cultivated varieties with longer growing cycles, and the early varieties did not resist bird damage. Today these landraces had been were lost to farmers, but they remembered their good productivity and high yield stability and the farmers would like to see these varieties introduced again since short-cycle varieties are needed nowadays in the light of climate change.

The experience above shows that the informal seed system is very effective at a village level and within social groups, but diffusion is slower outside of these networks. Also, genetic drift and difficult environmental situations can lead to changes within a variety or even the loss of the landrace. In order to provide access to seed and to assure the maintenance of the four preferred landraces (two local varieties from other regions and two local landrace from the same region from the *ex situ* collections), seed production and commercialization schemes were developed together with breeders, the farmer organization and the national seed service (vom Brocke *et al.*, 2011). Even though commercialization of local varieties is traditionally difficult (Delaunay *et al.,* 2008), farmers were relatively successful in diffusing these varieties. This may be related to the advantages the varieties offer in view of newly evolving needs (climate change, new commercialization options), to the improved capacity of farmers and the farmer organizations to promote the advantages of certified seed, and to the efficient network of the farmer organizations to link variety testing, seed production and cereal commercialization. The farmer organizations are also selling their certified seed to other regions in Burkina Faso, as well as to Mali, where the varieties are in demand in the south Sahelian zones. The number of farmer organizations has expanded and production has flourished, with production of 2.55 t by 10 groups in 2006; 5.7 t by 14 groups in 2007; 30.3 t by 19 groups in 2008; and 51.63 t by 26 groups in 2009.

Zaï effects on crop performance

Because of its ability to improve water status in the soil, to increase decomposition and nutrient release, and to reduce soil resistance to root penetration, the zaï system has a great impact on crop performance under semi-arid conditions. The zaï hole technique (Figure 8) improves soil structure and water availability, leading to improved nutrient uptake and use efficiency by plants in the Sahel (Fatondji, 2002). All studies in the region indicate that crop performance in zaï holes depends on the quality and the nature of the inputs made to them, suggesting an important role of nutrients in sustaining production. A study in Burkina Faso by Roose, Kaboré and Guenat (1999) helps us to understand this. The following treatments were compared during two cropping seasons:

1. Control (no zaï hole, no inputs)
2. Pits alone
3. Pits + leaves of neem tree
4. Pits + NPK fertilizer (10-20-10 kg/ha)
5. Pits + compost at 3 t/ha
6. Pits + compost (3 t/ha) + NPK fertilizer (10-20-10 kg/ha)



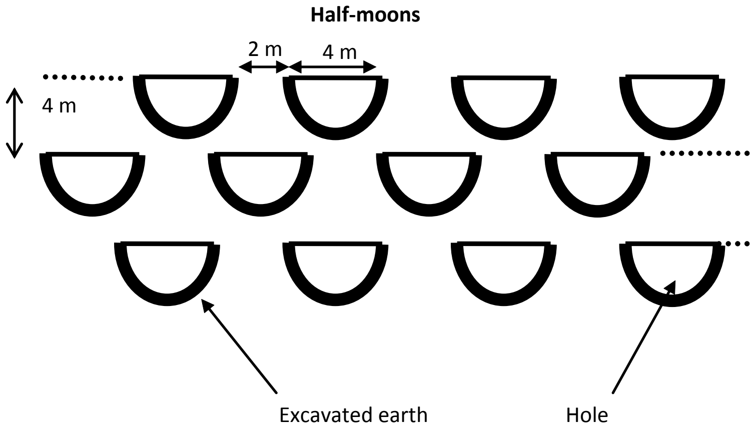


Figure 8. Zai (top) and half-moons (bottom) systems (After Zougmoré, Kambou and Zida, 2003; Zougmoré et al., 2004b)

The plots were all sown with sorghum, and Table 4 presents the yield data. Control plots and pits alone resulted in similar grain and biomass production, suggesting that under the semi-arid conditions, lack of water was not the sole limiting factor, but also nutrients. The addition of neem leaves increased yield and biomass production, but this was important only during the first year. The application of compost was only effective during the first year, suggesting that it improved crop nutrient uptake but the effect was short-lived. The large differences in yields between 1992 and 1993, reported by Roose, Kaboré and Guenat (1999), were due to nutrient shortage in 1993, as no input was brought in in 1993. Fatondji (2002) reported that the total amounts of N, P and K brought in through manure were 41, 19 and 20 kg/ha, respectively. At harvest, N uptake was twice the amount applied and K uptake was four times the amount applied. This suggests that the additional nutrients were taken from the soil stocks to meet plant demand and that the technology therefore contributed to soil nutrient mining.

The improved physical and biological conditions of the soil in the zaï holes increase the decomposition of native soil organic matter and therefore the availability of nutrients endogenous to the soil system. Furthermore, the improved soil conditions in zaï holes contribute to rooting systems that are able to better explore the soil for nutrients than are the roots developed in crusted soils. The soil nutrient mining effect of zaï holes is worsened where heavy rains induce leaching losses (Fatondji, 2002). The addition of fertilizer greatly improved the production of grain and straw primarily when inorganic fertilizer was combined with compost fertilizer (Table 4).

Table 4. Grain and biomass production (kg/ha) on deep, brown eutropept soil in 1992 and 1993 at Taonsogo, Burkina Faso

Treatment	1992			1993		
	Kg/ha	± SD	Test(1)	Kg/ha	± SD	Test(1)
			Grain Production			
Control	150	± 154	a	3	± 0.6	a
Pit	200	± 63	a	13	± 4.2	a
Pit + neem leaves	395	± 151	ab	24	± 7.3	a
Pit + Compost(2)	654	± 145	abc	123	± 82.5	a
Pit + Mineral fertilizer	1383	± 236	bc	667	± 256.3	b
Pit + Compost + Mineral fertilizer	1704	± 305	bc	924	± 346.8	b
			Biomass Production			
Control	946	± 529	a	167	± 75	a
Pit	1329	± 549	a	292	± 49	a
Pit + neem leaves	1990	± 207	ab	875	± 172	ab
Pit + Compost(2)	2843	± 945	abc	1417	± 511	bc
Pit + Mineral fertilizer	4839	± 1105	bc	2375	± 706	bcd
Pit + Compost + Mineral fertilizer	5333	± 1490	bc	3250	± 857	cd

NOTES: (1) Tukey-Kramer test ($P < 0.05$). (2) Compost applied at 3 t/ha as a mixture of dry manure, straw and various crop residues composted during 3 dry months. SD = standard deviation of the mean. SOURCE: Table from Roose, Kaboré and Guenat, 1999.

Having reviewed the research on zaï holes in Mali, Burkina Faso and Niger, Mando *et al.,* (2001) reported results that confirm the results observed in Table 4. Neither the alleviation of water constraints nor the addition of organic resources alone was able to boost crop productivity. Recycling organic inputs grown on poor soils is unlikely to sustain crop production in the Sahel because of their limited amount and their limited nutrient content. However, the combined use of organic inputs and inorganic fertilizer-enhanced nutrient use efficiency reduced leaching due to immobilization, improved water use efficiency, and increased decomposition. Mechanisms involved in fertilizer and organic input interaction in the soil are *inter alia* the capture of fertilizer nutrients by the soil microbial population, whose activities are boosted by the organic input. This appears to improve synchrony between crop nutrients supply and demand, and to reduce nutrient losses to the environment. The alleviation of nutrient limitations on decomposition, mainly when poor quality organic inputs are utilized, is another mechanism of significant importance in nutrient dynamics.

Zaï effects on vegetation rehabilitation

All studies throughout the sub-region have indicated that zaï practices lead to the establishment of diverse woody and herbaceous vegetation on formerly bare soil. Kaboré (1994) and Zombré, Mando and Ilboudo (2000) reported the re-establishment on formerly bare soil of over 20 herbaceous species and 15 woody species following two consecutive years of zaï in the central part of Burkina Faso. The plants derive either from herbaceous seeds survived in the soil or were transported by wind or runoff and trapped in the micro-catchments.

Most of the woody seeds are brought in through the addition of manure as it contains a lot of seeds, given the diets and foraging practices of many animals in the Sahel. Roose, Kaboré and Guenat (1999) identified the seeds of 13 different woody species in manure in Ouahigouya, Northern Burkina Faso. The germination of seeds that have passed through animal guts is enhanced because the acidic conditions in the gut weaken the integument of the seeds that could have impeded germination. The zaï technique could become an efficient technique for forestation because of the high germination potential of seeds brought in in manure and the improved moisture condition in the zaï holes. Furthermore, the voids made by termites in the pits facilitate root development.

Similar positive effects on tree regeneration were observed with a half-moon technique (Kagembega *et al*., 2011; Yaméogo, Somé and Hien, 2009).

Conclusions

- Farmers have a great range of selection criteria and production objectives.
- The informal seed systems are very dynamic and contribute to the evolution of varietal and genetic diversity.
- There is a need to access varietal diversity in order to adapt to variable climatic conditions and changing cropping systems.
- The present study demonstrates that germplasm from between the Sahelian and Soudanian regions (i.e. short maturity lines) could be transferred and

offered to farmers in more southern regions as a new option for adapting to changing rainfall patterns.
- Farmers are already adopting local varieties from other regions, either through the traditional seed system or by adapting varieties to local use.
- The formal seed system can be linked to the informal seed system in order to support the maintenance and broader diffusion of useful varieties.
- Tapping traditional knowledge is crucial to ensure future wide dissemination of well-adapted crop varieties and plant species in the changing climate in semi-arid West Africa.

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Discussion on Session Two

In summary, the conference made the following points:

- The methods used are not new but the justification is: the need to adapt to climate change. Breeding should receive greater attention.
- Selection of good quality seeds for farmers is a fundamental first step in breeding work.
- Example from India: the *Kalagira* variety of rice was selected by farmers and then conserved.
- CGIAR International Agricultural Research Centres are working on breeding and they are working on drought resistance.
- Seed systems need to be strengthened. At national level there is no investment in breeding programmes, their national capacity is disappearing and very few people are able to work in breeding.

Individual points made

Wydra: National programmes still have breeding programmes.
Kotschi: Breeding should be a common practice of farmers.
Zougmore: Seed systems are still week and although ICRISAT has developed many varieties not many are distributed.
Hoeschle-Zeledon: Breeding programmes do not address NUS species.

Queries on specific papers

On Waldüller's paper:
Q: What were the main challenges?
A: Getting the government officers to go to the villages and engage with the farmers.

On Bordoni's paper:
Q: Were there links to the CCAFS platform?
A: Not at the moment, but it will be considered.


Stefano Padulosi/Bioversity

Session III

Red Lists for cultivated species

(15.00-17.00)
Chair: A. Subedi

Red lists for cultivated species: experiences with the IUCN list of threatened plants

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Introduction

The area where this symposium is being held, close to Frankfurt am Maine, is a centre of great historic botanical achievements. Only three highlights will be mentioned here. The *Sylva Hercynica* of Thal (1588) can be considered the first true local flora, not only in Germany but also the world (Greene, 1905; Wagenitz, 2008). The *Flora der Wetterau* [Flora of Wetterau – an area very close to Frankfurt] is an important document of floristic investigation, also extensively dealing with cultivated plants (Gärtner, Meyer and Scherbius, 1799–1802, and see also Buttler and Klein, 2000). Later Alefeld (1866), working in the southern part of the province of Hessia, wrote the first flora of cultivated plants for Germany strictly according to the botanical rules of his time, thus stressing the unity of wild and cultivated plants as products of comparable evolutionary forces (Landsrath and Hammer, 2007).

Taxonomic and evolutionary developments in wild plants played always the leading role in comparison with cultivated ones. This gave an incentive to test the very successful red-list-approach for wild plant species (IUCN, 2001) for its usefulness for crop species (Hammer and Khoshbakht, 2005). During this first step all species considered by Hanelt and IPK (2001) have been considered, i.e. plants cultivated for many different reasons, apart from ornamentals and forestry species (Schultze-Motel, 1966). For the great number of ornamental plants a species approach had to be made. Whereas, in general, crop plants are decreasing in number, mainly due to globalization effects, ornamental plants have increased strongly in number, especially in recent decades (Khoshbakht and Hammer, 2007). The assessment of Khoshbakht and Hammer (2010) was that of the 250 000 higher plant species, cultivated plants based on the Mansfeld approach (Hanelt and IPK, 2001) were about 7000 and cultivated plants (mainly ornamentals) were 28 000 (calculated by Khoshbakht and Hammer, 2008b).

Methods and approaches

The species treated by Hanelt and IPK (2001) as crop plants have been used as a target. They have been checked against those species listed in IUCN (2001). The method proposed by Hammer and Khoshbakht (2005) was used, although similar approaches have been considered (e.g. Joshi *et al.*, 2004).

As there is no comparable encyclopedia available for the ornamental plants, a special approach was developed for them. The list of Glen (2002) was found to be an excellent and reliable example for ornamentals of a larger area. This list, except for some crops already known from Mansfeld's Encyclopedia (Hanelt and IPK, 2001), was checked against IUCN (2001) data. The species detected were classified on the basis of IUCN (1994).

Discussion

The list of extinct crop plants and ornamentals is reported in Table 1. Apart from the IUCN list (2001), a number of other sources have been used for compiling these data (see Khoshbakht and Hammer, 2010). Only 0.17% of the crop plants belong to the extinct category. This is a figure well within the extinction rates observed in wild plants (Groombridge, 1992). Extinction at the species level is a relatively rare event in view of the relatively short period of plant domestication (in comparison with the evolution of wild plants).

Roughly 10 000 years of domestication have created a tremendous amount of domesticated variation in plants. In the last two centuries, especially since the beginning of the industrial revolution, globalization and specialization have drastically diminished the diversity of these domesticates. Therefore, the number of the extinct domesticates seems to be relatively low. But a quick survey of literature shows that there is limited information. In his seminal treatment on cultivated plants, de Candolle (1883) included a chapter "Cultivated plants which are extinct or becoming extinct in a wild state". He listed seven species: *Vicia faba, Cicer arietinum, Vicia ervilia, Lens culinaris, Nicotiana tabacum, Triticum aestivum* and *Zea mays*. Additionally he mentioned two candidates for extinction: *Ipomoea batata*s and *Carthamus tinctorius*. None of these species shows any indication for extinction today, and consequently do not appear in Table 1. Only *Vicia ervilia* has really become rare. A selected translation of Vavilov's treatments concerning *Origin and geography of cultivated plants* (Dorofeev, 1992) provided the opportunity to search for extinctions in cultivated plants. In this respect, the South American cereal *Bromus mango* turned out to be the only successful hit. It was characterized by Vavilov as "almost extinct" or "no longer cultivated". The long route to extinction of this crop has been accompanied by seeming re-detections and other hopes, as described by Khoshbakht and Hammer (2010). In another example, Li (1982) reports vegetables of ancient China that were "lost because of their gradual replacement by other crops": *Malva verticillata, Angelica japonica, Crepidiastrum denticulatum, Rorippa indica, Polygonum hydropiper, Viola verecunda* and *Xanthium strumarium* (in modern nomenclature). These

Table 1. Extinct crop plants and ornamentals (after Khoshbakht and Hammer, 2010)

Plant group, category and species	Family	Remarks
Crop Plants (Extinct)		
Anacyclus officinarum Hayne	Compositae	
Bromus mango Desv.	Gramineae	
Triticum ispahanicum Heslot	Gramineae	OC
Triticum jakubzineri (Udacz. et Schachm.) Udacz. et Schachm.	Gramineae	OC
Triticum karamyschevii Nevski	Gramineae	OC
Triticum macha Dekapr. et Menabde	Gramineae	OC
Triticum militinae Zhuk.et Migush.	Gramineae	OC
Triticum parvicoccum Kislev	Gramineae	OC
Triticum timophevii (Zhuk.) Zhuk.	Gramineae	OC
Triticum zhukovskyi Menabde et Ericzjan	Gramineae	OC
Ornamentals (Extinct)		
Asiura rosea Lindl.	Sterculiaceae	
Astragalus robbinsii (Oakes) A. Gray var. *robbinsii*	Leguminosae	
Encepholartos woodii Sander	Zamiaceae	
Erica verticillata P.J. Bergius	Ericaceae	
Holarrhena pubescens (Buch. – Ham.) Wall. ex G. Don	Apocynaceae	
Pitcairnia undulata Scheidw.	Bromeliaceae	
Solanum baurianum Endl.	Solanaceae	
Streblorrhiza speciosa Endl.	Leguminosae	
Ornamentals (Extinct or Endangered)		
Cosmos atrosanguineus (Hook.) Voss	Compositae	OC
Franklinia alatamaha Bart. ex Marsh.	Theaceae	OC
Graptopetalum bellum (Moran ex J. Meyrán) D.R. Hunt	Crassulaceae	OC
Lysimachia minoricensis Rodr.	Primulaceae	
Pritchardia affinis Becc.	Palmae	
Sophora toromiro Skottsb.	Leguminosae	OC
Tecophilaea cyanocrocos Leyb.	Tecophilaeaceae	OC
Vicia dennesiana H.C. Wats.	Leguminosae	

NOTES: OC = occasionally cultivated in collections traditional vegetables are in fact not extinct at the species level. They exist as wild plants, as weeds or are cultivated today in other countries.

Apart from the cases of truly extinct plants, which are partly still contested concerning their botanical identity, the large group of *Triticum* species is of interest. Only *Triticum aestivum (*more than 80% of world production*)* and *T. durum* belong to the most important crop plants of the world. This shows the concentration process that has led to a very few important crop plants. Their estimated number reaches from 30 (FAO, 1996, 2010) to only "six columns of world nutrition" (Brücher, 1982). The many extinct *Triticum* species (on farm) clearly show the general tendency. The example of *Triticum ispahanicum* should be mentioned particularly, a wheat described only in 1958 which could not be found again during recent collecting missions (Khoshbakht, 2009), but which is still available in some collections, highlighting the value of the *ex situ* system.

Globalization leads to an additional reduction, namely genetic erosion. Morphological reduction is evident. In Germany nearly all grown cultivars of *T. aestivum* belong to var. *lutescens* (Scholz, 2008). The morphological uniformity of modern varieties in comparison with traditional landraces is quite evident. The recent use of molecular markers results still in an indifferent picture dependent on the choice of material. At any rate, the landraces with their not only morphological diversity are disappearing and should be maintained for further use in breeding modern varieties.

Table 2. Annual worlwide production and area under cultivation of economically important crops in the Compositae. Pyrethrum is used for its insecticidal properties (Source: after Funk *et al.* 2009)

Crop	Area harvested (ha)	Production (t)
Artichoke	121 970	1 205 505
Lettuce	1 015 339	22 382 600
Chicory root	27 446	891 554
Safflower	813 387	776 327
Sunflower seed	23 397 543	31 065 709
Pyrethrum (dried flowers)	26 710	13 405

Notes: Data from the FAO database available at http://faostat.fao.org/. Figures are for 2005. These are the only crops listed in the database for Compositae. Based on Khoshbakht and Hammer (2008a), 284 species in the Compositae should be considered, not counting ornamentals.

The species level needs additional investigation, as will be shown for the Compositae family. Only six species of important crop plants are contained in a list (Table 2) published by Funk *et al.* (2009). Consequently the number of cultivated species in this large genus is considered to be low. But, in fact, 284 species have to be considered (Khoshbakht and Hammer, 2008a). Most of the cultivated species of this family have the status of underutilized and neglected crops. As the data for the evaluation are based on Hanelt and IPK (2001), an actual account of the species is necessary (e.g. see Hammer Laghetti and Pignone*,* in prep.) and will possibly lead to several new entries. One cultivated species of the family is extinct, two species belong to the endangered category, two species belong to the rare category, and one species is in the indeterminate category (see Khoshbakht and Hammer, 2010).

When working with red lists, apart from the species level described above, the infraspecific level should also be considered. The categories var. and subsp. may be the most important in crop plants. As the *International Code of Nomenclature for Cultivated Plants* (ICNCP) (Brickell *et al.*, 2009) focuses only on the categories of cultivar and group, its use becomes rather difficult when dealing with infraspecific levels. The *International Code of Botanical Nomenclature* (ICBN) (McNeill *et al.,* 2006) refers to and contains also the classical categories subsp. and var. (but not the typical convar., which is confined to cultivated plants). At present the ICNCP refers to commercially important plants in current agriculture and horticulture as registered cultivars and groups, and some further items, but not to landraces and unregistered items. As stated by Pickersgill and Karamura (1999)

> "… the application of the Cultivated Plant Code have concerned plants grown in developed countries, with well-organized trades in harvested products, planting material or both, and often with International Registration Authorities to regulate the application of cultivar names."

Table 3. Selected wild relatives of crop plants from Khoshbakht and Hammer (2010)

Taxon	Family	Notes
Brassica bourgaei (Webb in Christ) Kuntze	Cruciferae	E
Brassica hilarionis Post	Cruciferae	V
Brassica macrocarpa Guss.	Cruciferae	E
Brassica villosa Biv.	Cruciferae	R
Magnolia officinalis Rehder et Wilson	Magnoliaceae	R
Mandragora officinarum L.	Solanaceae	R
Myristica dactyloides Gaertn.	Myristicaceae	V
Secale cereale L. var. *ancestrale* (Zhuk.) Kit Tan	Gramineae	R
Theobroma cirmolinae Cuatrec.	Sterculiaceae	I
Triticum urartu Thumanjan ex Gandilyan	Gramineae	I
Zea perennis (A. Hitchc.) Mangelsd. et Reeves	Gramineae	E
Zea diploperennis Iltis, Doebley et Guzmán	Gramineae	V

Notes: IUCN categories are: E = Endangered; V = Vulnerable; I = Indeterminate; R = Rare.

Landraces are not considered, but they are most important material in plant genetic resources (Zeven, 1998; Hammer and Diederichsen, 2009) and still predominantly grown in many developing, countries. Landraces provide the basis for future breeding work and they should play a special role in a future red list approach.

As has been expected, the crop wild relatives have become extremely important in recent years (Ford-Lloyd *et al.*, 2011) and naturally fit very well into the red list approach. A selected sample is shown in Table 3. The number of crop wild relatives has been estimated to be ca 115 000 (Hammer, 1998; Hammer, Diederichsen and Spahillari, 1999), approaching half of the total number of higher plants. These species can be easily included into the approach applied for red list species.

The IUCN approach offers also more possibilities with respect to cultivated plants. The numbers of species in the other IUCN categories for crop plants vs ornamentals in summary form are: for the endangered category as 22/115, for the vulnerable category as 45/148, for the rare category as 54/212, and for the indeterminate category as 30/37. An enumeration of the species is given by Khoshbakht and Hammer (2010). Therefore, estimation of the ongoing reductive processes is more possible. We not only know about reductions and have an estimation of their scope, but also we have now a species list for comparison. From the calculated cultivated species of threatened crop plants there are now 21% contained in species lists (Khoshbakht and Hammer, 2010). The percentage for the threatened ornamentals is 13% (see Table 4). This shows also the limits of our methodology.

Table 4. Threatened plants belonging to the group of domesticates

Categories	Calculated(1)	Listed species(2)
Species according to the Mansfeld definition(3)	940	200
Threatened ornamentals	3760	500
Total	4700	700

Notes: (1) Calculated on the basis of Lucas and Synge, 1996, by Hammer, 1998; (2) Species listing from Khoshbakht and Hammer, 2010; (3) Mansfeld definition from (Hanelt and IPK, 2001)

Conclusions and recommendations

According to Khoshbakht and Hammer (2010) there are several reasons for problems with cultivated plants when trying to give them a similar treatment to wild species. Cultivated plants are neglected by the majority of botanists doing classical botanical investigations, with taxonomic work even more neglected than other fields.

Consequently, comprehensive treatments of cultivated plants, or floras of them, are rare. Mansfeld's *Encyclopedia* (Hanelt and IPK, 2001) is an exception, in both scope and volume. Covering nearly 7000 species, it provides a global treatment. Yet new input is necessary, only 11 years after its appearance, especially with respect to the many neglected and underutilized crop species since identified through area-specific approaches. From the latest results, one example deserves mention, as it provides more than 200 mostly neglected and underutilized species new for the Mansfeld lists (Li *et al.*, 2011).

The mode of use of cultivated plants can change, so that the same species in other areas can have different use(s).

Cultivated plants are on different evolutionary levels with respect to domestication, as has been recently shown by Dempewolf, Rieseberg and Cronk (2008) for the Compositae. Even within one species there can be found different levels with respect to domestication (e.g. landraces vs highly-bred cultivars). Only highly domesticated cultivars cannot survive without human care. Most races are able to evolve to weeds (often by means of backcrossing with weedy or wild relatives).

Cultivated plants have a relatively short history of only about 10 000 years under the care of man, but typically they show great variation, often exceeding that of wild plants. As cultivated plants have evolved under the influence of artificial selection they are different from the wild ones, but these differences are not so great because the selection methods used by man have been and are still mostly within Darwinian selection. Red lists may be, therefore, a useful tool for dealing with crop plants. The IUCN approach has been used as a method for selecting candidates, especially from the large group of neglected and underutilized crops.

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Red List for crops – a tool for monitoring genetic erosion, supporting re-introduction into cultivation and guiding conservation efforts

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Introduction

Red Lists for threatened plant and animal species are an important tool for nature protection (IUCN, 2001). They are in worldwide use for discussing protection measures and they are an important background for international conventions and treaties (e.g. Convention on Biological Diversity (CBD) and the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA)). For international debates on the loss of biodiversity, inventories of threatened plant and animal species are basic tools in establishing strategies to arrest the decrease. In the nature protection community they are a proper, commonly accepted and useful instrument to monitor the process and to identify success or failure of measures for target species. Although Red Listing is not the output of a scientific evaluation of status of threats, but rather a compilation of reference data from experts, it is a commonly-accepted tool for regional and international nature protection efforts. Red Lists are increasingly being used to guide actions, as a quasi-scientific tool for identifying reasons for decline and to provide a baseline for monitoring, alongside raising public awareness about the purpose. Also, Red Lists provide substantial information and improved arguments for environmental planning and legislation. In European environmental policy they help to identify targets and focus measurements for the NATURA 2000 network of the European Union (EU), and help in management of the CBD rules and the convention's special output, the Global Strategy for Plant Conservation Protocol (GSPC-protocol; http://www.cbd.int/gspc/).

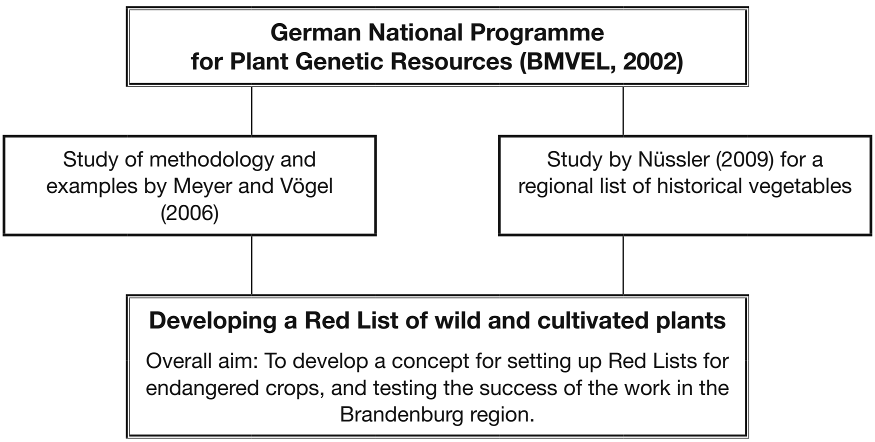
Compared to these important roles for Red Lists for wild species, Red Lists for crops have yet to be properly developed. Initial studies and internal discussions launched ideas about situations where Crop Red Listing might help, raising recognition of agrobiodiversity loss and giving options for mitigative actions. In general, only a few crop species are actually used in the world's food production system, with dependence on only a very low number of favoured cash crops seemingly intensifying. Nevertheless, mainly for less developed regions,. underutilized, minor crops have a significant importance for self-sustainable agriculture, food security and stability in rural areas.

For industrialized countries, crop diversity in commercial production systems has reduced very much in the past few decades. The newly-awakening interest comes mainly from organic farmers and gardeners, the private home-gardening sector and, surprising, from a new urban gardening movement in cities.

Methods and approaches

Nationally, Germany has introduced an important national programme of plant genetic resources, launched in 2002 (BMVEL, 2002). An initial study developed a methodology for a Red List of wild and cultivated plants (Meyer and Vögel, 2006). The study was the responsibility of the Federal Ministry of Food, Agriculture and Consumer Protection (BMELV), and published by the Brandenburg State Agency for Health, Environment and Consumers Protection (LUGV) (Meyer and Vögel, 2006). In parallel, a second study focused on a regional list of historical vegetables (Nüssler, 2009), so an inventory of endangered vegetables suitable for reintroduction work is available. The concept is shown diagrammatically in Figure 1.

Figure 1. Red List for crops, developing a concept



The purpose and background for the studies by BMELV was to prove a concept for further actions and programmes for propagation of neglected, underutilized or threatened plants in use, together with plants historically used. The potential for and limitations of transferring the wild species Red Listing to a Crop Red List were carefully researched and described.

A basic question of the study was: Can we identify crops that are endangered? To answer this, the conceptual vision has to be extended to encompass different levels and aspects of endangerment in terms of genetics, species and landscape or habitat diversity. Diversity risks for cash crops are normally not on a genus level, but they might be evident on a phenotype or variety level, potentially caused by changes in processing and modernization.

As a basic study at crop species level, Khoshbakht and Hammer (2010) gives an exhaustive overview of crop species loss, using the IUCN principles of Red Listing.

Available and useful data for crops can be found by searching historical sources. In the German agricultural situation, statistical records (from the 19th century), official lists and inventories of cultivars (available since 1850), agronomic and horticultural literature, scientific literature, cookery books (since ca 1800), catalogues and brochures of commercial seed enterprises and, since 1990, genebank and institutional databases provide evidence and are of major interest. Careful analysis of these many sources provides a good and reliable impression of the vanished crop biodiversity. By using these sources, a record of historical use and the former availability of crop species and cultivars can be prepared, a record that shows the continuing process of degeneration and disappearance of species and cultivars in use.

For the plants used, it is not only the formal botanical qualities that are important, but values and flavour diversity have to considered alongside processing, food preparation and kitchen use, extending to traditional use, cultural and regional differences. These less tangible qualities are also threatened and presumably endangered by modern technologies, rationalization and social "modernization".

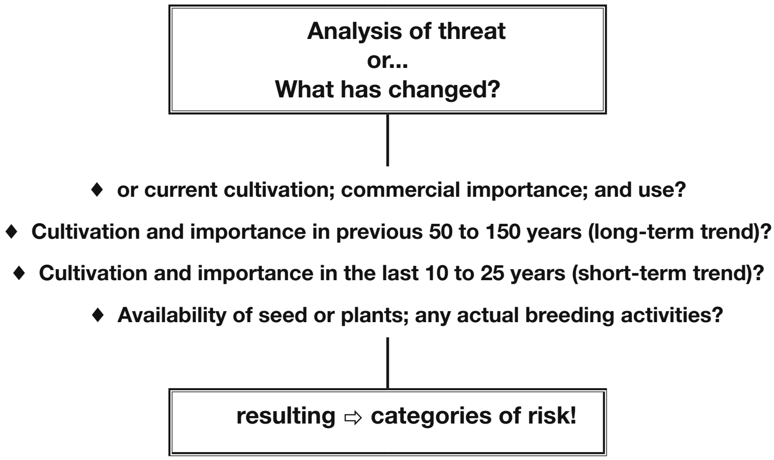
The objectives for a crop Red List in these circumstances are to improve the diversity of agrobiology and to broaden uses. As a focus of major interest, species and cultivars with a greater chance for successful propagation and sustainable re-introduction could be identified by an adapted Red List methodology.

Methodology of risk assessment

A specific factor in evaluating the threat situation is the crop's date of introduction. This means the first noted use of the selected species or cultivar, and reliable information about its geographical spread and its ecological and social adaptation. Of further interest is the kind of historic use and processing, and an overview of the phenotype diversity within the selected species.

Analysing the current threat or the reason for extinction needs data of the actual cultivation, the given commercial importance and use. Also helpful is any knowledge of the long-term trend, importance and cultivation over the previous 50–150 years, compared with short-term situation (10–25 years). Last, but not least, is the availability of seeds or plants, and actual breeding efforts. Together these data are basic for predicting the further use of a threatened cultivar or species. The approach is summarized diagrammatically in Figure 2.

Figure 2. Analysis of threat, categories and traits



The scheme of the threat thus developed has to be categorized according to the Red List method: abandoned, missing or disappeared from use – 0; giving up – 0; threat of disappearing – 1; use heavily reduced or very low – 2; reduced use – 3; to G, where continuously reduced use is presumed or a continuous decline of use of a crop species has been reported .

For the relation between species and cultivar or variety level, an example is the genus *Triticum,* containing 290 described species, 23 of which were in cultivation at the end of the 19th century; currently *T. aestivum* and *T. durum* species are the dominant species remaining in use. In parallel to the disappearance of species diversity in the genus *Triticum*, there has been erosion of phenotypic diversity. As a result, not only *Triticum* spp. in general but specific phenotypes and adapted varieties are threatened or extinct.

Other examples can be given of regional cultivated crops. Table 1 shows the relation between the defined historic use, the confirmed reasons for extinction and the regeneration possibility for a range of typical regional field and garden crops.

Evidence from regular agricultural crop statistics monitoring of outstanding crop species and crop groups can be utilized (Wetterich, 2003). Examples include traditional regional crops, such as buckwheat (*Polygonum esculentum*), protein crops (beans, lupins, etc.), which show decline or increase. Thus cultivation of spelt wheat (*Triticum spelta*) has expanded in area sown, reflecting changing consumer tastes and appreciation of high value products derived from NUS.

Table 1. Regional crops, historical use and regeneration options

Species	Historical use	Reason for extinction	Regeneration possibility
Papaver somniferum	Cereal, cakes, oil	Drug legislation	Small-scale level possible
Sium sisarum	Vegetable, use of sweet roots	Concurrency, loss of knowledge	Niche markets, home garden
Panicum miliaceum	Traditional crop of poor sandy soils	Low yield, loss of processing technology	High, favoured by climatic change
Mesembryanthemum crystallinum	Fine salad, vegetable	Unknown	Niche market, speciality (weed/ neophyte)
Portulaca oleracea	Salad, vegetable	Modern food culture, loss of knowledge	Home gardens and fresh market. Worldwide weed!

Conclusions and recommendations

The current background of crop selection in modern agriculture and horticulture is an emphasis on commercial aspects (prices, relative advantage, consumer tastes, yield, standardized product and uniformity of maturity). Varieties falling outside these parameters become “missing links” and are ignored in commercial agriculture and horticulture, marginalizing them to niche markets. They continue in home garden or subsistence-level production, but are no longer in common use, becoming so-called “neglected or underutilized crops”. Their future is uncertain, with potential for further decline to almost extinction in gardening and agriculture, closely combined with a loss of the associated cultivation and processing knowledge.

A structured and detailed Red List for Crops on the basis of historical inventories must analyse the reasons for abandonment of crop species. It has also to define the attributes and characteristics that block modern use, and it has to search for future possibilities for crop development and re-introduction of NUS.

Red Lists can help primarily in raising public awareness and creating greater knowledge of the importance of crop diversity. They can help create incentives for the use and conservation of PGR and help remove obstacles and handicaps preventing better, sustainable use, especially in terms of legal and commercial constraints.

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Red Lists for crop species and their role in adaptation strategies

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Introduction

During almost ten thousand years of human history, with the exception of the last two centuries, it is estimated that around seven thousand species have been introduced from the wild (Khoshbakht and Hammer, 2010). Of these, about one hundred are of great importance, while only thirty species belong to the group of those crops most important worldwide (FAO, 1996). Based on today's economy, some seven crop species constitute the "columns of world nutrition" (Brucher, 1982, cited by Khoshbakht and Hammer, 2010). Considering crops at the species level historically cultivated in the world they would represent 2.17% of the 321 212 plant species described today, or only 1.79% of the 390 800 plant species estimated to exist in the world (Nexus, 2011). Since the Green Revolution, thousands of varieties worldwide have been created and marketed, and in the same period many of them have been forgotten and vanished from the marketplace.

Usually, crops species are characterized by high genetic variation, which often exceeds that of wild plants (Khoshbakht and Hammer, 2010), and most of them are extremely inbred because farmers or breeders are trying to retain the most desirable genetic features associated with cultivation and productivity. According to Hendry and collaborators, this has been possible because (1) humans learned to provide beneficial conditions for cultivation and breeding, (2) frequent use of polyploidy buffers crops and helps avoid inbreeding problems, and (3) deleterious mutations were probably purged through past bottlenecks and selection (Hendry *et al.,* 2011) in the same manner that it happens in natural populations (Crnokrak and Barrett, 2002). However, it is generally accepted that inbreeding reduces not only population mean fitness but also capacity to adapt to environmental changes (Hendry *et al.,* 2011). On this basis, threatened crops can be equated to plant species evolving low dispersal habits that render them more vulnerable to extinction when facing anthropogenic disturbances, habitat loss and climate change (Kotiaho *et al.*, 2005). Thus, neglected and underutilized crops species and varieties, including wild crop relatives, constitute today a valuable genetic pool for supporting food security under climate change conditions (Padulosi, Hoeschle-Zeledon and Bordoni, 2008). For food security, the conservation of all plant genetic resources is therefore of utmost importance, and appropriate adaptation measures should be adopted and implemented (Pauw, 2007; Willis *et al.*, 2008). Furthermore, developing coherent joint breeding and conservation programmes will be a necessity as crop evolutionary limits have frequently been pushed to incorporate resistance against pests and diseases (Denison, Kiers and West, 2003), temperature and drought tolerance (Hendry *et al.,* 2011) considered to be the main threats implicit in climate change.

At the global level there is broad consensus that climate is changing faster mainly as a result of human activities (IPCC, 2001), and more than ten years ago it was estimated that the social and economic costs of taking action in response to its impacts would be huge (OECD, 2001). Based on decisions taken under the United Nations Framework Convention on Climate Change (UNFCCC), based on scientific evidence, agriculture is considered as being one of the main sources of greenhouse gases emission (GHG), but only if we take into consideration the use of fertilizers and pesticides, and the effects of land use change (UNFCCC, 1996; Lal, Kimble and Follet, 1998). At the same time, climate change drastically affects agriculture and food security. As a consequence, it is generally agreed that agriculture may play an important moderator role in the climate change process, involving both carbon sequestration and greenhouse gas emission (FAO, 2003).

Developing adaptation strategies to mitigate climate change and its impacts will be a great challenge for agriculture, implying that new tools might need to be developed to ensure that plant genetic resources for food and agriculture will support food security for the poor. Considering plant genetic resources, it would be almost impossible to apply joint conservation and breeding programmes for all of them, and it will therefore be important to prioritize our efforts in a cost-effective manner. At the same time, we need to consider that agricultural biodiversity will also be absolutely essential to cope with the predicted impacts of climate change, not simply as a source of traits but as the underpinnings of more resilient farm ecosystems (Frison, Cherfas and Hodgkin, 2011). As a consequence, we consider that developing a methodology for Red Listing crops species would be a valuable tool in the global attempt to develop adaptation strategies, thus supporting the coherent integration of appropriate joint conservation and breeding measures in agriculture for food security under climate change.

Methods and approaches

This paper is developed based on a SWOT analysis of political commitments under the International Treaty for Plant Genetic Resources for Food and Agriculture (ITPGRFA, hereinafter “Plant Treaty”) and other relevant multilateral agreements, especially those that are environmentally oriented, such as UNFCCC, the Convention on Biological Diversity (CBD) and the United Nations Convention on Combating Desertification (UNCCD).

Legal frameworks at the European and national levels were analysed for relevance to plant genetic resources conservation for food and agriculture. All Official Catalogues published in Romania between 1988 and 2011 have been compared with the species listed under Annex I of the Plant Treaty in order to investigate the cancellation process.

Social and economic vulnerability assessments are based on analysis of statistics officially published by the National Institute for Statistics [of Romania].

The study involved:

- Study area. Sibiu County is situated in the central part of Romania, and almost half of its area is covered by protected areas.
- Data collection. Focus groups were families saving crop seeds, and were carried out in two villages, seeking a balanced gender representation, and including older members of local communities. Participants were asked to contribute small samples of crop seeds.
- Data analysis. In the case of old crops, our results have been discussed with a former agronomist, Ing. Samoilă Geleriu, with more than 40 years of involvement in the seed certification system in Romania.

Discussions

Adaptation strategies

Very often, adaptation as a concept is misused, or even confused with resilience of ecosystems, and therefore we support the approach proposed by Gallopín in 2006. Thus, even though resilience and adaptation are related concepts, we should emphasize that resilience is broader and extends to natural capacity to recover in the event of a perturbed ecosystem in the wild, and this may also be used for characterizing any other anthropic ecosystems. In other words, adaptation is related to human direct and indirect impacts on nature. Once the definitions and terms used are agreed, it is possible to start the development of an adaptation strategy, with an important focus on drivers, facilitators, vulnerabilities and risks (Nelson, 2011). This paper refers to adaptation in the same manner as it is defined by the Intergovernmental Panel on Climate Change (IPCC, 2007), but taking also into consideration Gallopín's approach (Gallopín, 2006).

According to political commitments adopted under the UNFCCC, Parties and non Parties worldwide started to develop adaptation strategies, either regionally or at national level. Based on the European Climate Change Programme, set up in 2000, European Member States, as the Western European Group Countries, started to also develop and put in place adaptation strategies. According to Swart and co-workers some of these strategies are more formal, but there are also some good examples, and all of them highlight that agriculture and biodiversity remain extremely vulnerable to climate change (Swart *et al.,* 2009). Moreover, depending on geographical position, all adaptation strategies may differ in emphasizing either water availability (i.e. the northern countries) or drought (i.e. the southern countries), but in the end these should co-act for reducing vulnerabilities in the most cost effective way (Adger *et al.,* 2007).

The relationships between vulnerabilities, climate change and adaptation were studied in depth, and a conceptual diagram for integrated assessment and adaptation measures development was proposed, stressing that vulnerabilities are determined by both potential climate change impacts and adaptive capacities (Isoard, Grothmann and Zebisch, 2008). However, before framing adaptation measures for agriculture it is important first to visualize the risks for agro-ecosystems, potential for crop extinction and danger of extinction of crop-associated knowledge as the basic for supporting food security. Also, we should keep in mind that it is already accepted that, historically, agriculture continuously adapts to climate because of the knowledge associated with crops and livestock, with many autonomous actions being actually adaptation measures put in place by farmers, and later adopted by agricultural planners (Brooks, Adger and Kelly, 2005). However, for crops we should also consider crop-associated knowledge, both traditional and scientific, because once a crop is disappearing, its associated traditional knowledge is also at risk of extinction. Following this approach, for adaptation to climate change in the general attempt to develop a Red List for crop species, three elements are extremely important: crop species and varieties, crop-associated knowledge (i.e. traditional and scientific knowledge) and crop agro-ecosystems. As a consequence, scientific assessments will be required to assess the need for supporting the three main pillar of this process. Having this, it will be possible to start assessments for developing adaptation measures.

Political commitments

At the international political level, the need for additional adaptation efforts is first required by the original text of the United Nations Framework Convention on Climate Change (UNFCCC), through the provisions of Art. 4, and later by the Nairobi Five-year programme of work on impacts, vulnerability and adaptation to climate change (UNFCCC, 2006), the National Adaptation Plans of Actions (NAPAs) (UNFCCC, 2001) and the Bali Action Plan (UNFCCC, 2007). For the international political agenda, adaptation strategy development has become more and more significant and it is explicitly addressed in the Copenhagen Accord in 2009 and one year later in the Cancun Agreement, which, based on Document FCCC/CP/2010/7/Add.1 point 14 (UNFCCC, 2011), the COP

> "... invites Parties to take action on adaptation under the Cancun Adaptation Framework, taking into account their common but differentiated responsibilities and respective capabilities and specific national and regional development priorities, objectives and circumstance".

These worthy objectives of the UNFCCC resonate with decisions taken under other two Rio Conventions, namely the CBD and UNCCD. Thus COP 10 of the CBD adopted the new Biodiversity Strategic Plan, which at point VI 6.1. supports agricultural biodiversity by introducing a strategic goal for reducing the direct pressure on biodiversity as a whole by promoting sustainable use (The Strategic Plan for Biodiversity 2011-2020 and the Aichi Biodiversity Targets, CBD/COP/10 Decision X/2, 2010). According to Target 7 of the new Strategic Plan, an international commitment is adopted that states that by 2020 areas under agriculture, aquaculture and forestry should be sustainably managed, ensuring the conservation of biodiversity. In the same document, the COP is inviting the Food and Agriculture Organization of the United Nations (FAO) and the Commission on Genetic Resources for Food and Agriculture (CGRFA) to work together in designing the second phase of their joint work plan, covering until at least 2017, and to note that this second phase should consider, *inter alia*: (1) the sustainable use of agricultural biodiversity, particularly underutilized crops, wild relatives of cultivated plants and other potential food sources, to improve human nutrition, to address the impacts of climate change and to contribute to food security; and (2) on-farm, *in situ* and *ex situ* conservation of agricultural biodiversity, in accordance with Decision IX/1 adopted at the ninth meeting of the Conference of the Parties (In-depth review of the programme of work on agricultural biodiversity, CBD/COP/9 Decision IX/1, 2008)

In essence, these political commitments placed neglected and underutilized crops and wild relatives at the highest possible political level due to their potential contribution to food security in the face of the impact of climate change. At the same time, UNCCD COP 9 recommends to the Parties that knowledge of interaction between climate change adaptation, drought mitigation and restoration of degraded land in affected areas should be improved to develop tools to assist decision-making. Thus, there is great risk of agro-ecosystem degradation in agriculture and appropriate practices should be implemented in our attempt to adapt to climate change (ICCD/COP(9)/18/Add.1, 2009, point 3.4.).

In 2011, under the Plant Treaty, which has joint goals with the CBD, the Governing Body adopted the Bali Declaration (ITGRFA, 2011), which states *inter alia* that Parties are deeply concerned over current global challenges, in particular the continuing erosion of agricultural biodiversity, the threats posed by food insecurity, extreme poverty, and the effects of climate change. The Plant Treaty recognizes that the erosion of agricultural biodiversity is reflected at both the species and infraspecific levels. Moreover the Parties to the Plant Treaty recognize that plant genetic resources are essential as raw materials for crop breeding (whether through farmer selection, classical plant breeding or modern biotechnology), in the development of new market opportunities, and in adapting to unpredictable environmental changes. This highlights the major role of farmers in the conservation and development of plant genetic resources. This declaration also touches on the subject of traditional knowledge, through which Parties are recognizing the importance of the protection of traditional knowledge relevant to plant genetic resources for food and agriculture, and the enormous contribution that local and indigenous communities and farmers from all regions of the World—particularly those in centres of origin and crop diversity—have made and will continue to make towards the conservation and development of plant genetic resources that constitute the basis for food and agricultural production worldwide.

Summarizing, it can be said that crops that do not reach the market, and without clear protection for their conservation and sustainable use, are nevertheless essential for food security, based on different political commitments. Moreover, even the potential of neglected and underutilized crops has been highlighted by the food crisis, and it is emphasized at international level that such crops are not subject to international food prices and therefore are not directly affected by the crisis (FAO, 2009), the lack of action may drastically affect food security for the poor because of climate change. As a consequence, developing a methodology for Red Listing these plant genetic resources will be a necessity to be used as a valuable tool in our attempts to integrate appropriate agriculture measures in adaptation strategies to ensure food security.

Red Listing crops and adaptation strategies

Nikolai Vavilov noticed for the first time that traditional crops species and varieties are disappearing from the field or gardens starting with his mission in 1919 (Loskutov, 1999). Crops as species or varieties continue to disappear, and new varieties of the most common crops are replacing old crops for specific requirements. Thus, crop erosion is a fact and climate change may dramatically influence crop disappearance, and thereby contribute to food insecurity if no conservation and breeding measures are in place. Under such circumstances, plant genetic resources for food and agriculture that are not marketed (i.e. as commercial varieties), neglected and underutilized species, and even crop wild relatives, should be assessed for their conservation status, and their conservation supported by relevant actions. As a consequence, a methodology for prioritizing our efforts in conserving plant genetic resources for food and agriculture should be elaborated.

It is well known that the International Union for Conservation of Nature (IUCN) has already adopted at the global level methodology for assessing the status of conservation of wild species (at the species level) and elaborated the Red List of Threatened Species. This methodology may apply to crop wild relatives and also to neglected and underutilized plant species as far as these species are living in the wild. However, there are unresolved issues regarding the IUCN methodology and its application for crop species and varieties cultivated on-farm. For consistency here, "crop variety" will be used as it is defined by the Plant Treaty. Furthermore, for consistency with the Parties to the International Convention for the Protection of New Varieties of Plants (UPOV) (UPOV, 1991), the variety definition should be accordingly completed.

Regarding crop species, Hammer and Khoshbakht published in 2005 for the first time a widely accepted Red List for crops, at the species level, based on Mansfeld's Encyclopedia (Hanelt and IPGCPR, 2001) and the IUCN Red List of threatened plants (IUCN, 2001). Later, in 2010, they published the first book exclusively dedicated to threatened crops species (Khoshbakht and Hammer, 2010). In the same period, Joshi and collaborators also proposed a methodology for assessing not only the specific but also the infraspecific level of crops, based on a bottom-up approach (Joshi *et al.*, 2004). They stressed especially socio-economic and socio-cultural vulnerabilities.

Still, for crop varieties, based on the conceptual framework of the IUCN, it might be possible to develop and agree at international level a methodology for domesticated crop species—for the infraspecific level—and under such conditions the IUCN approach should remain a benchmark basis for the development of such a new approach.

The overall aim of the Red List of Crop species should to attract attention to the value of plant genetic resources cultivated on-farm, together with crop-associated knowledge. Conserving this genetic reservoir it should be possible to ensure the maintenance and further development of new varieties and hybrids resistant to environmental factors. Nevertheless, such a Red List would support the consistent implementation of commitments under the Plant Treaty and also other multilateral environmental agreements, such as the CBD (i.e. provisions related to traditional knowledge, based on Art. 8 j.), the UNCCD (i.e. decisions related to soil erosion), and the UNFCCC (i.e. adaptation strategy implementation). Also, it would provide a basis for the consistent implementation of other multilateral instruments, such as the International Convention for the Protection of New Varieties of Plants. This has great significance in the case of dramatic political changes.

Under such circumstances, based on generally accepted principles, we propose that a Red List of Crop Species to be adopted at the global level and implemented at national level, based on their own capacities and needs for ensuring food security under adaptation strategies.

Considering the diagram proposed by Dessai and Hulme in 2003, such a Red List should be part of vulnerability assessment at the social level, mainly because maintaining crops on-farm (i.e. landraces or neglected species) is a matter of societal choice and needs a bottom-up approach as foundation for successful implementation of any adaptation strategy. Considering that adaptation measures can be implemented either pro-actively or reactively (Iglesias *et al.*, 2009), crop cultivation already implies an existing capacity for development of pro-active adaptation measures, and at the same time communication for adaptation in agriculture would be of outmost importance for their successful implementation. Thus, such a Red List should be a pro-active tool deployed in climate change adaptation strategies through adaptation measures covering general and specific crop management (crops, agro-ecosystems), associated knowledge, communication tools and methods.

On-farm and *ex situ* conservation

Once a Red List for crops species is adopted, than joint conservation and breeding programmes should imply on-farm or *ex situ* conservation measures, or a combination, in a cost-effective manner. A valuable model for crop species distinguishing the two primary complementary conservation strategies was proposed in 1997, each of which includes a range of different techniques that can be implemented to achieve the aim of the strategy (Maxted *et al.*, 1997). Still, today it is difficult to find the appropriate balance between on-farm and *ex situ* conservation in support of a cost-effective strategy, but there is scientific evidence regarding on-farm conservation needs under climate change (Sthapit, Padulosi and Bhag Mal, 2010; Frison, Cherfas and Hodgkin, 2011).

The term ‘on-farm’ should be used instead of *in situ* in order to avoid confusion regarding the meaning of *in situ* according to the IUCN Red Listing methodology, where it applies exclusively to wild species living in the wild. The crop Red Listing methodology should refer to farming or potential farming plant genetic resources for food and agriculture. The definition of ‘on-farm conservation’ is widely accepted as being the sustainable management of genetic diversity of locally developed crop varieties (i.e. landraces), with associated wild and weedy species or forms, by farmers within traditional agricultural, horticultural or agrisilvicultural systems (Maxted *et al.*, 1997).

In the context of broadening the scope of the definition of 'on-farm, we consider that it should also cover crop species never cultivated (e.g. crop wild relatives, neglected and underutilized crop species existing in the wild) and varieties developed based on scientific breeding programmes for ensuring the transfer of technology and know-how from science to the farmers in a general attempt to fully implement a coherent adaptation strategy. If, at least at a conceptual level, on-farm conservation means to empower the small-scale landholders to maintain crop landraces or introduce new crops into cultivation, then *ex situ* conservation is mainly dedicated for crop varieties conservation within breeding and conservation programmes. Based on this argument, a Red List methodology for crops should also assess at national level the cost effectiveness of strategies regarding on-farm versus *ex situ* measures associated with joint conservation and breeding programmes, and further appropriate measures should be introduced into adaptation strategies.

Crop-associated knowledge

CBD has for the first time addressed concerns regarding traditional knowledge loss in relation to biodiversity loss in the context of indigenous and local communities. Traditional knowledge is considered an asset for achieving the three goals of the Convention. In 1992, after rounds of negotiations, Art. 8 j. was adopted addressing this subject as a very important issue not yet resolved at international level. At the same time, crop-associated knowledge implies scientific knowledge associated with the process of crop breeding and the transfer of technology from the laboratory to the farm, which should be in line with Decision 14 of CBD/COP 9 regarding technology transfer and cooperation (COP 9, Decision IX/14).

The concept of traditional knowledge implies people living in rural and isolated areas and encompasses a collection of facts, locally developed concepts, beliefs and perceptions regarding their existence. Traditional knowledge includes the processes whereby knowledge is generated, stored, applied and transmitted to others (Guendel, 2005) and implies knowledge related to crops, agricultural systems and practices, weeds, pests, invasive alien species, water management, land use and also the biodiversity behind agrobiodiversity, with multiple dimensions (Jarvis, Padoch and Cooper, 2007). It is considered important that such traditional knowledge should be preserved, as in many cases the oral transmission of local knowledge between elder and young generations is not always officially supported (Kargıoğlu *et al*., 2010). Once crop erosion results from local socio-economic vulnerabilities, the crop-associated knowledge is also lost.

In traditional systems, crop management has certain similarities to adaptive management, with its emphasis on feedback learning, and its treatment of uncertainty and unpredictability intrinsic to all ecosystems (Berkes, Colding and Folke, 2000). Therefore, subsistence farming or family gardening as tangible spaces that might reflect cultural acts over time are ideal scenarios for the analysis of change in human and crop interaction (Eyssartier, Ladio and Lozada, 2011).

The main factor dramatically influencing the conservation and development of crop-associated knowledge is governance stability from local up to the central level. In short, crop erosion is linked with crop-associated knowledge erosion, and therefore the Red Listing methodology should assess this risk and trigger the inclusion of specific measures into adaptation strategies. Such risks can be further evaluated based on the list of descriptors for assessing farmer knowledge, developed by Bioversity International and The Christensen Fund in 2009, in their attempt to provide a standard format for gathering, storing, retrieving and exchanging information.

IUCN methodology as a benchmark for developing a Red List of crop varieties

According to the IUCN's scientists, species extinction or disappearing phenomenon depends on the chance of survival of each taxon. For the Red List of Crops this methodological approach should apply at the infraspecific level as well, as it is already mentioned in the definition of the taxon according to IUCN methodology. Listing a crop taxon in the 'extinction threatened' category immediately draws attention and expectation regarding the imminent extinction of a taxon and associated knowledge unless conservation measures are immediately applied. The immediate risk for populations with high levels of socio-economic vulnerability losing their crops and associated knowledge is food insecurity and famine.

The scope of listing criteria for a Red List of Crops should be the same as for wild biodiversity, and should therefore apply to all unprotected taxa for trade, conservation and breeding based on official documentation. Thus, crop varieties already duly protected by other instruments should not be subject to Red Listing. It is extremely important to first assess international and regional political commitments under different political instruments, and to consider the specific associated legislative framework.

For the Red List of Crops, a base year must be chosen for the inventory of species and varieties based on official documents, which should conform to requirements under the Kyoto Protocol in our attempt to apply the Red List in adaptation strategies.

Quantitative criteria developed and adopted by IUCN are numbered from A to E, being derived from an analysis of risk factors for extinction of the whole range of taxa, and also covering the history of their existence. In parallel, distinct levels within categories were set independently by IUCN based on generally accepted standards. Considering the experience of the IUCN to set quantitative criteria, it becomes clear that for crops such criteria must also be used from the species to the infraspecific level, based on those already developed by Brown and Hodgkin in 2006 (Brown and Hodgkin, 2007). Certainly these quantitative criteria, globally harmonized, should be equally applied at the country level.

Based on the IUCN model, conservation measures should be addressed for crops including proposals for supporting their inclusion in joint breeding and conservation programmes, including on-farm and *ex situ* conservation. Thus, crop conservation measures should include, in a pragmatic way, conservation and breeding programmes, crop-associated knowledge, agro-ecosystems and the direct connection between farms and the scientific community.

Cadastral maps may provide precision and safety in farmland surface and distribution assessments, and estimations that can be appropriately used for the cultivation of certain taxa, whether for conservation purposes, subsistence farming or even for breeding on-farm by joint scientific breeding programmes. Such maps, corroborated with soil, water, temperature and topographical maps, can help in projecting the future development of soil quality based on cultivated crops and applied agricultural practices.

Territorial administrative units and border characteristics are essential for characterizing down to the smallest landscape units when describing any agro-ecosystem in planning to apply adaptation measures for a specific agro-ecosystem. This is impossible without the local authorities acting in these units and applying ecosystem-approach principles.

Difficulties regarding uncertainty in data analysis and interpretation of domesticated species may be encountered, especially for old varieties and landraces that can have different names in different areas, or the same name for different landraces associated with the certification system based on molecular markers (Sadiki *et al.,* 2007). Scientific certification for seed commercialization should be supported for genetic uniqueness even for a local population for a certain agro-ecosystem through genetic molecular markers analysis (Hodgkin *et al*., 2007). Following the guidelines of IUCN, recommendations for domesticated species should also be adopted regarding error management. Since there are fundamental differences between wild and domesticated species, criteria for documentation must follow formal analysis of official data based on political commitments as well as on the existing technical and scientific data.

It should be compulsory to evaluate the associated traditional knowledge based on the provisions of Art. 9.2. of the Plant Treaty, which should be synergistically implemented with the provisions of CBD Art. 8. j. Traditional knowledge assessment for crops will not be enough for all crop varieties, so new methodology should include crop-associated knowledge such as tradition and scientific knowledge associated with cultivation and sustainable use. In other words, for adaptation strategies, socio-economic vulnerability assessment should provide the basis for risks of varietal extinction, in association with traditional and scientific knowledge.

According to IUCN, assigning a category to a threatened taxon is not a reason to prioritize conservation actions, and in the same way listing a crop variety would not require domestic prioritization of conservation efforts without taking into consideration crop-associated risks identified.

If the IUCN recommends the re-evaluation of wild species after certain periods, then for re-assessing the status of conservation of domestic taxa times of major socio-economic impact can be particularly taken into consideration.

Another important factor studied by IUCN is the transfer between different categories of degrees of threat, and for domesticated taxa it can range among not being marketed, *ex situ* or on-farm conservation, and governmental programmes, with the direct involvement of farmers supported by the relevant scientific community.

Similar to the IUCN rules for wild species, if a domesticated taxon is subsequently found to be not on the market or has not been introduced into a governmental programme for breeding or conservation, there will be an urgent need for re-classification into a threatened category, based on reference documentation.

If for wildlife taxa the IUCN methodology considers the population size (criteria A, C and D), sub-population, mature individuals, generation, numerical reduction, continuous decline, etc., then those criteria might not be applicable for domesticated taxa and so general discussion becomes impossible. A proposal in this regard for crop species, varieties and landraces has been developed by Joshi and collaborators (Joshi *et al.*, 2004), based on specific vulnerability assessments.

Based on these discussions, the IUCN methodology for Red Listing wild species should be considered as a basis for further developing a Red Listing methodology for crop taxa (i.e. species and varieties).

Case study – Sibiu County in Romania

To support the need for Red Listing of crops in the adaptation strategy, a case study of Sibiu County, Romania, is discussed below. We try to apply the bottom-up approach in our attempt to assess the main crop vulnerabilities and risks. Thus, we focus on both the external context (international and national legislation) and the internal context of a crop inventory. Based on the specific national legislation, all crops listed in Annex I of the Plant Treaty have been surveyed for their incorporation in the national official catalogue, starting with 1989, the base year according to the Kyoto Protocol adopted under the UNFCCC. At the same time, two villages have been surveyed for crops and the associated knowledge, evaluating crops erosion, risks and vulnerabilities.

International legal framework

At the international level, Romania is a Party to the Plant Treaty since 31 May 2005 (Law 42/2005, published in the Official Gazette no. 208/2005), to the CBD (Law 58/1994, published in the Official Gazette no. 199/1994) and to UPOV (Law 255/1998, re-published in the Official Gazette 65/2007). At the regional level, Romania is a European Member State since 1 January 2007, and has transposed a series of legislation through: [1] Ministerial Order 1348/2005 regulating the process of testing and registering the varieties of agricultural species in accordance with Directives 53/2002/EC and 90/2003/EC, and with Regulation (CE) 930/2000, amended by Regulation (CE) 1831/2003; [2] Ministerial Order 188/2010 transposing Directive 2010/46/EC amending Directives 2003/90/EC and 2003/91/EC setting out implementing measures for the purposes of Article 7 of Council Directives 2002/53/EC and 2002/55/EC, respectively, as regards the characteristics to be covered as a minimum by the examination, and the minimum conditions for examining certain varieties of agricultural plant species and vegetable species; [3] Ministerial Order 1349/2005 regulating the process of testing and registering varieties of vegetables in accordance with directives

55/2002/EC and 991/2003/EC, and with Regulation 930/2000 as amended by Regulation 1831/2003/EC; [4] Ministerial Order 8/2002 regulating the process of testing and registering varieties of vine, fruit species and ornamental plants in accordance with directives 56/98/EC and 34/92/EC.

However, as the national transposing acts of the European legislation incorporate no enforcement measures, it means that this legislation will not be fully and coherently implemented at the local level.

National legal framework

At the national level, Official Catalogues for crops varieties and hybrids are legal acts protecting crop varieties for placing on the market and controlling seed marketing. The Suceava Genebank is the National Focal Point for the Plant Treaty and it is officially designated as responsible for *ex situ* conservation of plant genetic resources at national level. A series of public research institutes maintain *ex situ* collections of valuable crop varieties, but they do not provide open access to their catalogues of holdings via the internet, reflecting a lack in crop communication capacity at the national level.

The base year for adaptation strategies

Our study investigated all Official Catalogues, starting with 1988 and ending with 2011, to assess the disappearance rate for registered varieties and landraces. Based on Kyoto Protocol Decision 9/CP.2, 1989 was considered the base year for Romania's climate change reporting.

Proposed methodological assessment

In this model assessment, only plant genetic resources listed in Annex I of the Plant Treaty were surveyed for the period. In parallel, the database for *ex situ* collections of the Suceava Genebank were analysed, but no old crop varieties were found. Some crop varieties still exist in some collections belonging to public research institutes, and hence future investigations should assess the existence of old varieties in these collections and also on-farm.

For an example of wheat cultivars maintained without official cataloguing consider the following. During 1960, cv. Bezostaia I was placed on the market. This cultivar has as a genetic base cv. Bezostaia 4, produced in the Krasnodar Institute in Russia. Later, in 1966, cv. Favorit was placed on the Romanian market. This cultivar was produced by the Romanian Research Institute at Fundulea, having as a genetic ancestors cvs. Otvos and Bezostaia 4. Genetic studies continued for both cultivars up to the present, but they are missing from the Official Catalogues starting with 1986. Thus, analysing the complete set of substitution lines for Favorit/F 26-70 showed a more complex genetic control for high protein content in the donor parent F 26-70 compared with previously known sources worldwide. Today, it is known that several chromosomes are involved in the genetic control of this characteristic, namely 4B, 4D, 5B, 5D and 7B (Giura and Ittu, 1986; Giura, Ittu and Oproiu, 1986). Later, chromosome 7B, because of its controlling effect on some quality properties (i.e. rheological properties), and precocity, was considered for creating recombination lines with

7B for identification and mapping of its specific genes (Giura, 2003). This is clear evidence that Romanian researchers are interested in working with old cultivars best known for their genetics, and hence maintained unofficially, despite there being no official conservation or breeding programme in place.

From this example, we also consider that official legislation such as the Official Catalogue for varieties and hybrids, and the database of the Suceava Genebank, should be complemented by a survey of scientific research in order to have a more complete inventory of plant genetic resources for food and agriculture.

Political pressure on crops plant genetic diversity

Based on the survey of all Official Catalogues for crop varieties from 1988 to 2011, and taking into consideration the public database of the Suceava Genebank, the constraints of not having public access to data collections belonging to public research institutes involved in crop breeding, and confining attention to only the species listed in Annex I of the Plant Treaty, it could be concluded that the loss of plant varieties has also been associated with political regime change.

Thus, 1989 is the year associated with, on the one hand, Romania's commitments for climate change, and, on the other hand, with the complete change of national political regime. That year is associated with the disappearance of 133 varieties, among which 103 were produced by Romanian breeders, when comparing data for 1958 and 1960 in the Official Catalogues. In the next four years (i.e. by 1994) another 76 varieties have been removed, of which 33 were of Romanian origin. In total, in the first five years, 237 varieties disappeared, of which 136 were Romanian plant varieties. In the next years the disappearance of old varieties from Official Catalogues slowed, and ranged between 1 and 21 cultivars up to 2004, when a massive removal process started again. That was the year when it was decided at the political level that Romania should join the European Union, and it was considered that by the beginning of 2007 national legislation should be harmonized with European legislation, based on the European Treaty for accession. Therefore, due to the lack of political will for maintaining varieties in conservation programmes, 103 varieties disappeared from the Official Catalogues, of which 71 varieties were of Romanian origin, almost 70% of the cancelled crop varieties. Romania was also to comply with European Union legislation in this domain, and in 2007 negotiated a list of varieties under cancellation based on the general provisions of Decision 2007/69/EC authorising Romania to postpone the application of certain provisions of Council Directive 2002/53/EC with regard to the marketing of seed of certain varieties of agricultural plant species. As a consequence, a lack of political will to support the certification of Romanian varieties, at least for a conservation programme in line with the Directive 2002/53/CE, resulted in massive crop erosion. In total, in 21 years a total of 338 varieties were cancelled, of which 191 were Romanian varieties produced by public breeding institutes. Thus, 56.5% of Romanian varieties have gone, with no conservation strategy in place for supporting the official commitment in preserving plant genetic resources for food and agriculture. In the Official Catalogue for 2011 only three varieties have conservation status, but there is no information regarding the period for which these varieties will be in an appropriate conservation programme.

First conclusions regarding historical shifts in crop diversity evolution

Based on our investigations, Romania saw at least five historical shifts into the evolution of plant genetic resources for food and agriculture officially placed on the market, starting with 1958. The periods are summarized below.

[1] Before 1958, which is the year of forced communist collectivization, agriculture was characterized mainly by the presence of crop landraces, not highly productive but well managed by the small-scale landholders, with some crop varieties resulting from scientific breeding programmes started after 1927 (Agronomist Samolilǧ Geler, pers. comm.).

[2] Between 1962 and 1989 the old landraces were replaced *en masse* by modern crop varieties, based on national agriculture reform in support of intensive agriculture (Agronomist Samolilǧ Geler, pers. comm.). It was a time when small-scale landholders practically disappeared, together with a huge amount of the crop-associated knowledge. This was the period of so-called cooperativization; the new type of property was defined as administrative property. As a consequence, the state owned the whole land and implemented a taxation system through a hierarchy of officials. Very few exceptions, due to difficult relief conditions, remained on small areas in quasi-private ownership. These small-scale landholders were also forced to use new introduced and developed cultivars. Thus were formed the state-run agricultural farms led by groups of state-trained technicians.

[3] Between 1989 and 2004 the marketplace shifted from communism to democracy, and large numbers of cultivars of Romanian origin disappeared from Official Catalogues. This reflected the lack of a sustainable strategy for agriculture. The change of political regime resulted in the complete abolition of about 3776 state-run agricultural farms, with land restitution as 40 million parcels to over 5 million landowners entitled before 1962. However, due to both the erosion of crop-associated knowledge and the lack of agricultural machinery the result was increasing land abandonment, In parallel there was also loss of the valuable human resources associated with the former state-run agricultural farming (e.g. agronomic engineering).

[4] Before entering into the European Union, between 2004 and 2007, Romania negotiated the list of crop varieties to comply with the European Union legislation already in place. It is important to remember that, after 1989, old seeds had been saved and used by the new small-scale landholders that by now belong to an ageing population. Just before 2007 a study by Savoiu, Manea and Manea (2007) showed that in rural area there was a sharp increase in the ageing rate of the population, with a life expectancy virtually two years lower than in cities and, most importantly, the rural population was still defined, in its majority, by the Romanian villager's traditional husbandry, and to a much lesser extent by modern agricultural farming. In the same study, it was concluded that about 1.24 million agricultural holdings in Romania had an economic size of about 1 European Size Unit (ESU) and nearly 69% of the produce was mainly for own consumption (i.e. subsistence farming). They concluded that the Romanian rural economy in its traditional form is so aged and dominated by women, that it would

disappear in a short period of less than one generation (among the 1.24 million sole holders, 20% were women, of which 71% were aged 55 or more, and only 4% were younger than 35 years; 16% had another gainful activity as their major occupation). The article concluded that after perhaps 20 years, traditional rural economy would no longer exist in this part of Europe if no mitigatory measures were introduced (Savoiu, Manea and Manea, 2007).

[5] After 2007, as a European Member State, Romania should comply with the provisions of Directive 53/2002 regarding crop genetic resources. Unfortunately, Romania took no measures for conservation either *ex situ* or *in situ* of crop varieties, even though some of them are valuable plant genetic resources for plant breeders. Article 20 of this Directive states at point 2 that, without prejudice to Council Regulation (EC) No 1467/94 of 20 June 1994 on the conservation, characterization, collection and utilization of genetic resources in agriculture, firstly, specific conditions shall be established in accordance with the procedure referred to in Article 23; and, secondly, to take account of developments in relation to conservation *in situ* and the sustainable use of plant genetic resources through growing and marketing of seed of landraces and varieties that are naturally adapted to the local and regional conditions and threatened by genetic erosion. Paragraph 3 of the same article specifically notes landraces and varieties that it is compulsory to accept in accordance with the provisions of the Directive. In fact, the article's provisions are in line with UPOV regarding acceptance, in particular regarding the results of unofficial tests and knowledge gained from practical experience during cultivation, reproduction and use. The detailed descriptions of the varieties and their relevant denominations, as notified to the Member State concerned, shall be taken into account and, if sufficient, shall result in exemption from the requirement of official examination. Upon acceptance of such a landrace or variety, it shall be indicated as a 'conservation variety' in the common catalogue. In view of these European Union legal provisions we suspect that Romania's integration into the European Union was associated with a tremendous loss of Romanian crop varieties with no effort to integrate them into a public conservation and breeding programme as required by the European legislation.

Sibiu county plant genetic resources case study

An inventory among all Official Catalogues revealed that all 35 varieties maize varieties registered in 1988 for the 1989 growing season had gone by 2011. Considering the cancellation process as a whole, there were 456 maize varieties cancelled at national level between 1988 and 2011, including cultivars newly registered after 1989. There are at least two very popular varieties cv. Lovrin 400, first officially registered in 1969, and cv. Turda 200, first officially registered in 1976. These two cultivars had been listed for cancellation, but they have been officially re-introduced into the Official Catalogue as of 2009. Even though Turda 200 maize is very popular in Sibiu County, public and private research institutes are constantly trying to introduce new cultivars, mostly of foreign origin. The Sibiu Centre for Testing Varieties and Hybrids is officially responsible for trials for crops according to national legislation harmonized with UPOV and European Union requirements. The centre usually tests some 40 maize cultivars each year, and, based on the results of the trials, about 10% may undergo further procedures for certification. As control, they use Turda cultivars, produced by the Turda Agricultural Research and Development Station in Romania, These include cvs. Turda 165, Turda 201 and Turda Star. Although the Turda cultivars have many of them a long history in the same agro-ecosystem, at least nine old varieties produced by Turda Research Station before 1989 had been deleted from the Official Catalogue by 2011. The same applies to the Fundulea Research Institute in the south of Romania, where at least 12 varieties were officially deleted between 1989 and 2011. This does not necessarily mean that these plant genetic resources have disappeared, as they may be conserved in these institutes and available for further investigation. The implication is that, at the national level, all these varieties and their ancestor lines should be included in a national strategy for a joint conservation and breeding programme, with specific adaptation measures for *ex situ* and on-farm approaches.

With a total area of 14.7 million hectare of agricultural land (64% arable land, 23% grasslands, 10% meadows and 3% orchards), Romania ranks sixth amongst EU Member States. The central region of Romania is recognized as preserving the highest percentage of High Natural Value farmland (HNV) in the country, which is a valuable asset for the conservation of biodiversity in Europe. The main threats for HNV farming are intensification of agriculture and abandonment.

Figure 1. Protected areas in Sibiu County. Map prepared by Laurian Gheorghe, 2011

Based on the scenario of Swart and collaborators, Romania is a country that will fall into two distinct areas: the area inside the Carpathian mountain arc will belong to the "water available" category; outside the Carpathian arc will be a high drought area (Swart *et al.,* 2009). As a consequence, it is probable that agriculture will be extremely vulnerable, and food insecurity will progress from being merely an issue to becoming a serious problem.

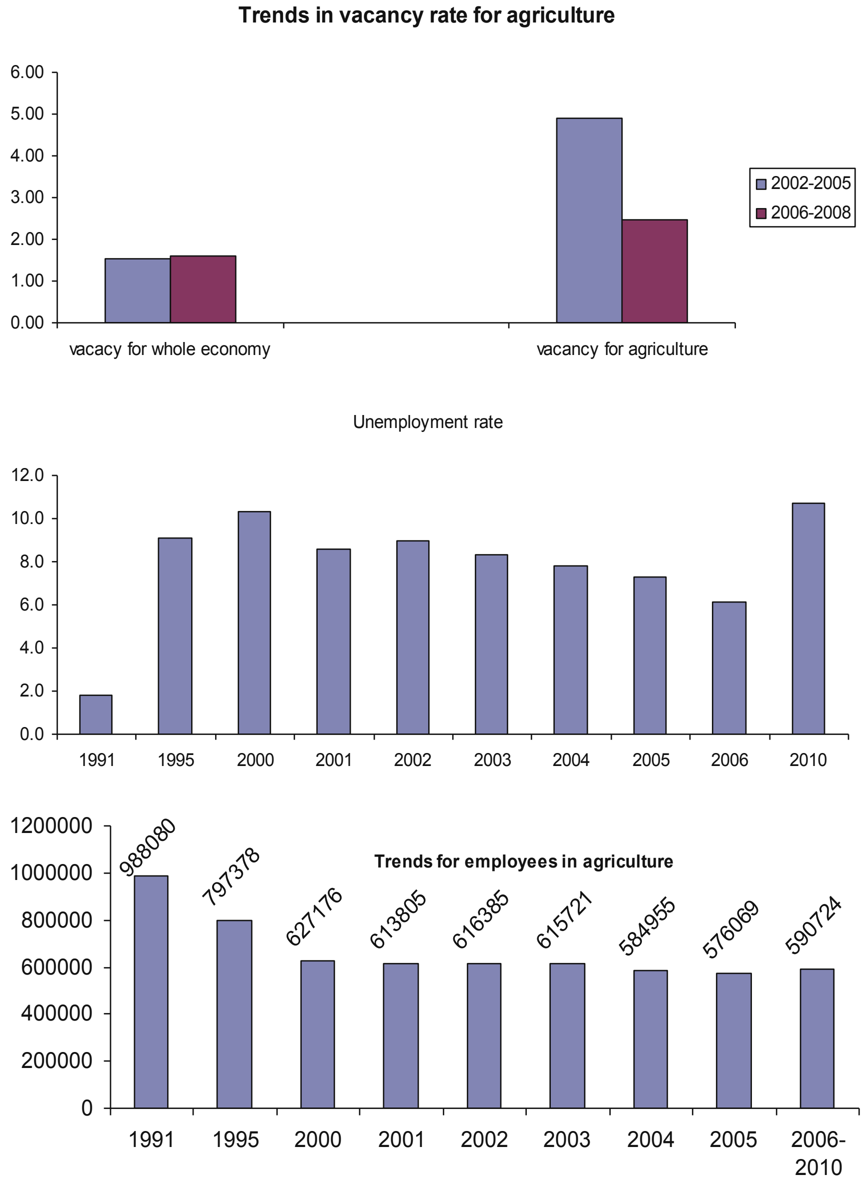

Figure 2. Agriculture-associated social vulnerabilities for Sibiu County, Romania. SOURCE: Based on data from the National Institute for Statistics

Almost half of the Sibiu County surface is declared as protected areas (Figure 1), and outside of these areas conservation of HNV farmland mainly depends on the EU support (European Agricultural Fund for Rural Development EAFRD 2007-2013 through the Council Regulation (EC) No 1698/2005), through schemes for Less Favoured Areas and for Agrienvironment. These measures, however, do not specifically target HNVs (EEA 2004, 2007).

According to data provided by the National Institute for Statistics (NIS), the vacancy trend for agriculture sector was doubled in the last 10 years compared to the whole economy trend. In the same time in Sibiu County the current unemployment rate is five times higher compared to 20 years ago, having halved

Figure 3. Cartogram for maize cultivation. Map courtesy of the Soil and Agrochemical Research Office - Sibiu.

in the last 20 years in the agricultural sector (Figure 2). These social characteristics are associated today with land abandonment and the massive spread of invasive alien species such as *Solidago canadensis* L.

Based on official data reported by the Ministry of Agriculture, the financial contribution of agriculture to GDP shows a decreasing trend, from 5.8% in 2007 to 3.3% in 2010 (MADR, 2011).

In order to assess maize genetic resources it is important to know the minimum land unit of each surveyed territory. For Romania, the minimum territorial unit equates to the smallest administrative unit, which is the village or commune.

In the central part of Romania villages are usually demarcated by obvious topographic relief features, such as rivers, forests or hills, contributing to creating agricultural landscapes as functional units, or grouping multiple functional landscape sub-units. As a consequence, such a landscape pattern helps preserve the natural value of the village as a territorial unit.

Regrettably, due to traditional knowledge erosion at the village level and inappropriate agricultural practices and systems, the last 20 years has seen a continuous decrease in crop quality, and only few small-scale landholders still saving seeds and preserving crop varieties.

From missions conducted during 2010 in Săliște and Ațel villages, and from discussions with local authorities and farmers, it was clear that soil quality is not enough to determine crop diversity. Even if the soil is of poor quality for maize cultivation, a lot of people still prefer this crop, especially due to their lack of agricultural machinery (Figure 3). It should be noted that these villages are situated in the buffer zones of protected areas. We collected two maize landraces: "Lăpușneac" is a maize with an 8-row cob, not highly productive, but important for feed and food for the local community. This landrace's history dates back to before 1958, and according to the local community it is resistant to *Fusarium*. The other landrace is of red colour on a 12-row cob, and is more productive and

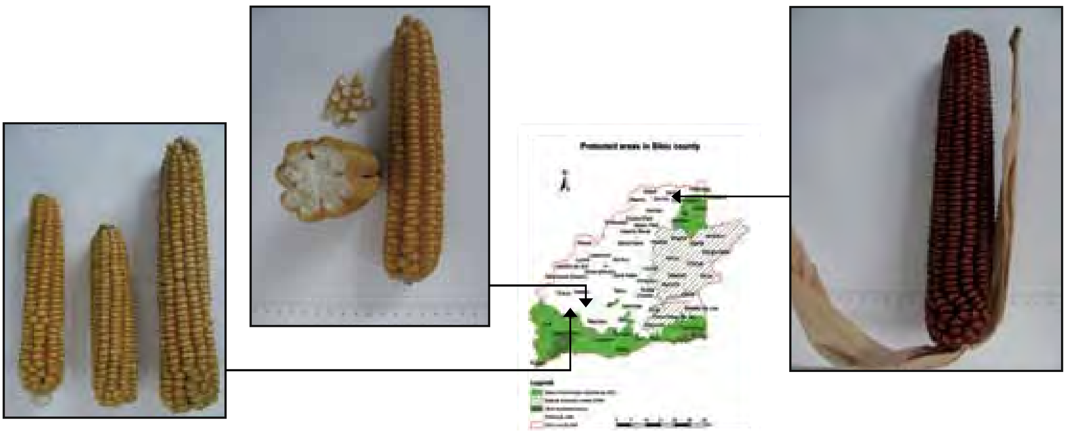

Figure 4. Maize landraces from Săliște (Lăpușneac; centre) and Ațel (right-hand side – red cob)

especially used for feed and seems to be adapted to the poor soil quality of Aţel arable land (Agronomist Samoilă Geleriu, pers. comm.) (Figure 4).

Statistical data from local authorities revealed that the area sown to Aţel represented 1% of all land cultivated with maize in Sibiu County, reflecting the commitment of the local community in cultivating this crop. Moreover, official data regarding productivity show less productivity than obtained by local communities, remarkable in view of the lack of access to farm machinery by the small-scale farmers. The aging process is increasingly obvious in village communities and it is associated with a dramatic erosion of crop-associated knowledge. As these communities are either inside protected areas or in the buffer zones, it is important to stress that adaptation measures should also be in place in the management plans of the protected areas.

Based on this experience, one needs to answer questions such as:

- How to quantify the conservation status of a variety or landrace, whether or not registered in the Official Catalogue, taking into consideration climate change?
- If we consider that these varieties are threatened, how can we scientifically quantify their status of conservation?
- If these varieties or landraces are endangered, how can we prioritize efforts for supporting their conservation, and in what context?
- How to find a balance between on-farm and *ex situ* conservation?

It is clear that adaptation to climate change using a Red List for crops will support food security at the local level by applying a bottom-up approach in a pro-active manner and involving local communities. Increasing awareness from the local level to the political level of the value of crops and their associated knowledge seems to be necessary to secure long-term food security and further to contribute to crop diversity.

As discussed above, these villages are on the boundary of protected areas, and local communities have been using the same varieties for more than 50 years. Therefore we consider that crop varieties with a long history of being established in a specific agro-ecosystem which is associated with the protected area network should be considered for conservation in adaptation strategies, thus supporting the goals of protected areas in their attempts to conserve habitats and wild species. Such adaptation strategies and management plans should support and promote on-farm conservation in the same way that wild species are protected. Also plant genetic resources long used in a vulnerable local community should be further supported for on-farm transfer and conservation in similar ecosystems.

Based on this experience, and considering that a bottom-up approach should characterize a Red List for crop species and should be a cross-cutting issue, conservation should remain a matter of societal choice, and should not be affected by the vagaries of uncertain maintenance by trade or the effects of political crisis. This represents a conservational buffer zone in avoiding food insecurity in less favoured areas. In other words, such a Red List would provide the opportunity to standardize the assessment of farmer knowledge regarding agrobiodiversity as a whole, integrated into the wild biodiversity of the ecosystem to which it belongs.

Clearly, some descriptors will be hard to apply, especially for rare varieties in use at the farm level. A Red List of Crops could therefore help in generating awareness regarding the danger of losing these plant genetic resources for food and agriculture, together with the associated farmer knowledge regarding cultivation and use of the crops, with all factors integrated at the local level.

Conclusions and recommendations

Based on the IUCN Red List methodology, it is possible to further develop a methodology for Red Listing crop species, and this should be used as a pro-active measure to be deployed in climate change adaptation strategies. The methodology should be based on a bottom-up approach for agriculture and the biodiversity environmental context, based on current international political commitments. For adaptation strategies, this Red List should be measured from a base year, as applies in the Kyoto Protocol.

Three key elements are of outmost importance in Red Listing:

- crop species and varietal vulnerability to climate change;
- erosion of crop-associated knowledge (both traditional and scientific knowledge); and
- agro-ecosystem vulnerability to climate change.

If crop-associated knowledge is at risk of loss once crop erosion is occurring, political regime change may negatively affect crop diversity, and a Red List might help in preserving plant genetic resources for food and agriculture under climate change and political regime change.

For the bottom-up approach, it is important to assess the landscape unit and the natural borders, promoting crop conservation on-farm, and then further to define the smallest landscape unit on a case-by-case basis for each variety.

We consider that such a Red List for crops species would act as one of the missing links in our attempts to halt biodiversity loss in the face of a changing climate.

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Towards a viable system for monitoring agrobiodiversity on-farm: a proposed new approach for Red Listing of cultivated plant species

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Abstract

The development of a system for the monitoring of agrobiodiversity *in situ* or on-farm is of paramount importance for every country and urgently needed. Its importance arises from the fact that by and large the greatest amount (inter- and intra-specific levels) of agrobiodiversity (plants and animals) is maintained *in situ* or on-farm and no monitoring system yet exists. Its urgency is justified on the grounds of the extensive genetic erosion taking place in farmers' fields, and the need to prevent this before it is too late. Concerns for the loss of traditional crops seem to be increasing today among decision-makers, particularly in the context of climate change and the reduced adaptation and resilience of production systems with which this phenomenon is associated. In fact, from a livelihood perspective, loss of agrobiodiversity has a far greater impact, particularly on the poor, in terms of reduced options related to food security, income generation, environmental health and loss of many other intangible benefits. Monitoring of cultivated agrobiodiversity has, not surprisingly, received extremely poor attention by researchers so far. Reasons for that may include the sheer number of varieties of crop species on-farm, the diffuse presence of diversity, varying from large areas to small patches of land and home gardens, the dynamic nature of cultivation that deploys various crops and varieties in different ways, the absence of farmer-based mechanisms to which to anchor a possible monitoring system, and important policy aspects, such as those related to access and use of information generated during the monitoring. After reviewing the importance of on-farm conservation, we present an initial framework for the monitoring of cultivated plant biodiversity on-farm.

Introduction – Why do we need on-farm conservation?

The loss of genetic diversity of cultivated species continues unabated in all regions of the world (FAO, 2010). *Ex situ* conservation has been a vital tool to rescue and safeguard thousands of varieties from being wiped out in the aftermath of the Green Revolution (Pistorius, 1997). The paradox of the Green Revolution is that while it has made a tremendous contribution towards saving millions of people from starvation through the development and dissemination of high yielding varieties (HYVs), the very genetic diversity that allowed the development of these improved varieties was lost because of the widespread adoption of these HYVs by farmers, with such loss being estimated to be 75% (FAO, 2004).

The so called 'Plant Genetic Resources Conservation Movement' that came into being in the early 1970s fuelled the organization of countless germplasm collecting expeditions that led to the rescuing of thousands of landraces and traditional varieties of major food crops. However, thousands other (minor) crops (important as well for the nutritional security of the world) were not included in those conservation and R&D efforts in view of the low priority that they were given at that time. The outcome of these conservation efforts over the last 40 years or so have led to the establishment of an estimated 1740 *ex situ* genebanks that are maintaining an estimated 7.4 million germplasm accessions (FAO, 2010). However impressive and possibly re-assuring such a figure of conserved plant genetic diversity might be, a closer analysis of these collections reveals a major shortcoming: the agrobiodiversity safeguarded in these *ex situ* genebanks is very biased towards major cereals, root and tubers, and the main pulses.

These genebanks contain very limited representations of the wealth of diversity inherent in minor cereals, fruit species, vegetables, condiment crops and medicinal plants. For example, the diversity of vegetable crops conserved in *ex situ* genebanks amounts to only 7% of the total, which is indeed a disproportioned percentage compared with the 45% share in conservation of the cereal group, a far less diverse category of crops. With regard to the representativeness of vegetables in *ex situ* collections, according to a study carried out in 1996 on a subset of five million database entries of the global *ex situ* collection (Padulosi, unpublished data), the top 10 conserved genera (*Abelmoschus, Allium, Brassica, Capsicum, Citrullus, Cucurbita, Daucus, Lycopersicon, Raphanus, Solanum*), representing some 28 species of major crops, were represented by 320 000 accessions, corresponding to 4% of the total crop *ex situ* samples of the whole database investigated. Currently, the vegetables crop accessions in *ex situ* genebanks account for 7% of the total, which is indeed a very small representation of the sheer wealth of vegetables diversity used around the world. For example, consider the 210 African leafy vegetable species (wild and/or cultivated) used in Kenya (Abukutsa-Onyango 2002), the 175 species of traditional vegetables documented from Zambia (Ogle *et al.,* 1990) or the 522 cultivated vegetable species recorded in Italy alone (Hammer *et al.,* 1992). A similar situation exists for fruits and nuts, represented today in genebanks by a meager 6% of all accessions, in spite of the incredible array of diversity encountered in cultivation or in the wild, with 1500 nut species recorded at global level and 3000 fruit species across the Tropics (Vietmeyer, 1990).

In fact, from a general point of view, almost 80% of conserved samples maintained in genebanks are of major crops (and their wild relatives), leaving out the largest portion of agrobiodiversity, estimated to be some 7000 if we consider only food species (Padulosi, Hodgkin and Williams, 2002.). Such an extraordinary wealth of genetic diversity and traditional knowledge associated with it, albeit used at local level, is therefore far from being adequately conserved, documented, studied, deployed and promoted in mainstream agriculture. Its conservation relies today almost exclusively on the work of millions of farmers and local users. But such a condition is extremely precarious, and poorly addressed by research if compared with the investment resources directed towards *ex situ* conservation. Many are the questions that need to be urgently addressed if we are to develop proper conservation of agrobiodiversity on-farm. The following is just an initial list of critical issues in that regard:

- What is the extent of agrobiodiversity maintained on-farm and how this is distributed on the territory?
- What is the degree of its use and relevance to people's livelihood?
- What are the threats to its genetic diversity arising from various causes, including marginalization from markets or climate change?
- How do people conserve this biodiversity and what are the challenges they face in doing so?
- What are the challenges and the opportunities related to the sustainable use of this diversity?
- What policies and legal frameworks are needed to support the sustainable conservation and use of agrobiodiversity on-farm?

The increasing concern over the future of agriculture in the wake of climate change is steering an important debate on ways to make agricultural production systems more resilient and adaptable to such change. Such a debate seems to be leading towards a greater appreciation of crop genetic diversity in coping with change, and in that context it is helpful in rediscovering the wealth of so-called traditional or minor crops (often referred to as neglected and underutilized species – NUS) (Padulosi, Hoeschle-Zeledon and Bordoni, 2008). NUS are described by many workers as strategic allies in building the much-needed adaptation and resilience of local production systems (Sthapit, Padulosi and Bhag Mal, 2010; Padulosi *et al*., 2011, and references therein). But while such an awareness seem to be slowly emerging, the loss of diversity on-farm of local species and varieties continues unabated, due to a combination many factors, such as the overwhelming superiority in economic competiveness of commodity crops, coupled with changes in food habits and life styles, and the erosion of traditional food cultures. Furthermore, even though the current global *ex situ* conservation network is strengthening itself with additional conservation facilities (the latest addition being the Svalbard Genebank established in 2004 in Norway), these facilities continue to be dedicated almost exclusively to the conservation of major commodity crops. Among those, beneficiaries of conservation funds are particularly those crops listed under Annex I of the FAO International Treaty for PGRFA. There is therefore an urgent need to augment these *ex situ* efforts with complementary interventions on-farm, which are absolutely vital to stem the loss of traditional crops that is affecting everybody, and especially the vulnerable people for whom these species are part of a unique and irreplaceable livelihood asset (Rojas *et al.,* 2009).

As this contribution deals with monitoring of cultivated species as a strategic component of on-farm conservation, it may be worthwhile recalling some essential facts about this conservation method and its strategic role.

Biological considerations

On-farm conservation plays a strategic role in the maintenance of evolutionary and dynamic processes which ensure adaptation of species and varieties to existing and future biotic (such as new pests and diseases) and abiotic stresses (such as those due to climate change).

Many plant species cannot be conserved in seed genebanks because they produce so-called ‘recalcitrant’ seeds) and can best be maintained in the field through *in situ* and on-farm conservation. Examples are many tropical fruit species whose seeds are rich in water such as mango and jackfruit, or whose fruits do not produce seeds at all such, as the cultivated bananas.

Financial considerations

Owing to the high costs associated with the establishment and maintenance of *ex situ* genebanks, it is unlikely that the world will have the necessary means to conserve in genebanks all species useful to humankind. This consideration is particularly true for species of local importance, which may never command national or international attention.

Cultural considerations

Owing to its nature, on-farm conservation allows maintenance in a de-localized fashion of many species and varieties, as well as helping preserve the incredible wealth of indigenous knowledge (IK – also often termed traditional knowledge, TK) associated with them. This knowledge relates to their cultivation, harvest, use and valorization, and the safeguarding of this IK is thus critical for their conservation itself and for valorizing local food systems, with traditions as well as strengthening the self-esteem of local populations whose identity often rests also on local biodiversity.

Ecological considerations

On-farm conservation also makes important contributions to the conservation of ecosystems and landscapes of which they are an integral and representative part.

Social considerations

Strengthening peoples’ capacities to safeguard agrobiodiversity and associated IK is also a strategic way to contribute towards their empowerment. These interventions will allow them to better play their role as custodians of biodiversity and IK in line with the expectations of the CBD (Art. 8) and of the International Treaty for PGFA (Art. 6).

On-farm conservation (and ideally as a 'movement' or 'global network' in its own right as is already in place for *ex situ* conservation) would strategically leverage support to an array of different and highly inter-linked pro-livelihood activities, ranging from the participatory selection of varieties, through informal seed networks and their linkages with formal supply systems, development of post-harvest technologies, value addition, marketing and extension services, enhancing competitiveness to exploring new opportunities (such as new foods and lifestyles trends and ecotourism) and better policy frameworks (e.g. to support nutritionally-rich species). All these activities would have a beneficial impact on peoples' livelihood, particularly for the rural and urban poor whose life is highly dependent upon agricultural activities.

Documentation and monitoring – key pillars of *in situ* and on-farm conservation

We trust that the reflections provided above are helpful enough to introduce the relevance of documentation as a fundamental activity for effective on-farm conservation that would prevent loss of local agrobiodiversity. Examples of best practices for the on-farm documentation of agrobiodiversity and associated TK exist and include Community Biodiversity Registers (CBRs), such as those used in Nepal, which are effective tools for addressing documentation, monitoring, marketing, exchanging, fighting bio-piracy and engendering a spirit of ownership (Sthapit and Quek, 2006). Also FAO, in collaboration with Bioversity International, have developed indicators for monitoring the implementation of the Global Plan of Action, which includes six indicators specifically for priority action on supporting on-farm management and improvement of plant genetic resources for food and agriculture (FAO, 2001). However, despite these attempts at monitoring diversity, these methods still fall short of establishing the degree of threat to diversity on-farm.

Within the overall scope of on-farm documentation, monitoring is a very special aspect. It requires careful consideration in view of its complexity and the challenges related to its practical implementation and sustainability. The following sections deals with some of the issues related to monitoring of cultivated species. Here we are proposing an initial framework for monitoring on-farm diversity so as to determine the level of threats to local cultivated species and to promote conservation to prevent genetic erosion. Such a method will be tested out through the newly launched IFAD NUS 3 project to be implemented in Nepal, India and Bolivia.

When dealing with monitoring of species diversity, the IUCN approach of Red Lists for species and animal represents the best-established mechanism worldwide (Rodrigues *et al.,* 2006). The criteria used by IUCN to categorize the degree of threat for a certain species are based on the careful assessment of the status of its populations, range size and trends, distribution, numbers of individuals, threats and conservation actions currently in place or otherwise needed. The outcome of such a detailed analysis allows the listing of species into the IUCN Red List categories, which range from least concern, data deficient, not threatened, to the threatened categories, which include vulnerable, endangered, critically endangered and ultimately extinct in the wild. The results of such studies carried out by trained experts capable of applying the criteria to target species and through standardized approaches are now published online by IUCN (www.iucnredlist.org). In addition, Red Lists of threatened species are also published as books at different scales, either globally (Hilton-Taylor, 2000), regionally, such as the recent assessment of the conservation status of European Diversity (European Commission, no date) or for different taxonomic groups (Oldfield, Lusty and MacKinven, 1998; Gibbs, Chamberlain and Argent, 2011). Many countries in all continents also produce and publish their national Red Lists (see http://www.nationalredlist.org/site.aspx?pageid=139). These have become important documents for guiding governmental conservation strategies for wild flora and fauna. Red Lists for crop wild relatives (CWR) also exist and are very important for preserving valuable source of genetic diversity useful in crop improvement programmes, such as that produced by Bolivia in the framework of a UNEP Project on the conservation of CWR in that country (VMABCC-Bioversity, 2009).

In contrast, the development of Red Lists for cultivated species has received very little attention thus far, and has been explored by very few countries, with little or no involvement of IUCN. Examples of monitoring and Red List approaches for cultivated species are those of Germany (Meyer and Vögel, 2005) and Romania (Antofie, 2011). It is somehow a paradox of our days that while there are so many efforts by the international community for the monitoring of wild species, very little is being done for the monitoring of crop species, which could be argued to be far more important in view of their role in sustaining the life of billions of people on the planet! Perhaps, as mentioned earlier, the answer to this paradox can be found in the incredible challenges related to such a system, challenges that have discouraged pursuit of such investigations until now. We truly hope that debate prompted through this paper can contribute to fostering a lesson-sharing process among experts on this important but neglected topic of research.

A new approach for monitoring cultivated species

The monitoring approach for cultivated species which we would like to propose would be based on a different paradigm from that used for the monitoring of wild species. First, it is important to clearly distinguish between cultivated and wild species. For wild species, it is the taxonomic identity of a species that is the unit being monitored. In the case of cultivated species, the monitoring unit is the variety, often the local variety or landrace of a crop, which by virtue of the location where it evolved has unique and distinctive characteristics compared with other varieties of the same crop elsewhere. This in itself is a big challenge for developing a monitoring system. In our view, the ultimate objective of monitoring cultivated species is to secure their effective use by people so as to sustainably meet their livelihood needs, as well as to prevent genetic erosion in order to ensure future options for the diversity present in locally cultivated varieties. This objective is quite different from that pursued through the IUCN Red Listing approach for wild species, where attention is directed towards the conservation of the species itself. Our central argument is that when dealing with the monitoring of cultivated species we should aim at surveying and inventorying the local varieties of cultivated species, mapping their distribution, identifying the relevance of their use by people, assessing the maintenance of associated knowledge and traditions associated with them, and documenting extent of use. Possible drops in their use below a certain threshold implies a variety or species no longer providing the expected benefit to the community as a whole, but to just a few of its members, and thus leading to varietal extinction. In such a scenario we are not interested in monitoring the-last-plant-standing or last population of a certain crop or variety, but instead we are aiming at assessing current trends and possible decline in its cultivation over time. This approach would allow us to 'raise the red flag' whenever such a decline goes below a certain level where its benefits (nutritional, income generation, etc.) are no longer reaching the community members at large, and are confined to a small number of users. In other words, while the IUCN-driven approach would possibly detect vulnerability or endangerment only when the variety or species has reached a certain population size, this use-driven approach is meant to raise the alarm for intervention at a much earlier stage. In our view, when use of a variety has declined dramatically and its benefits are no longer reaching the local users at large, such a variety in real terms is *de facto* already lost, and listing it into a Red List for cultivated species would be very helpful to guide its rescuing, promotion and effective use, and in so doing possibly prevent its complete disappearance. The idea behind this approach is to build an initial baseline that can be useful for awareness purposes and for further refining. Such a system might be limited initially, but we do believe that accepting a system with some limitations is definitively better that accepting that varieties (and knowledge) continue to disappear, with realization of such losses continuing to emerge only in what we might call post-mortem situations!

This approach would serve the purpose of guiding on-farm conservation to maintain uses (and their benefits for the community) alive so as to prevent the decline in the use of species and varieties from affecting people, depriving them of an important livelihood asset. Obviously the outcome from such a monitoring process would also serve conservationists and guide sampling strategies for possible *ex situ* conservation purposes.

Characteristics of the proposed monitoring approach

In our view, any monitoring system targeting cultivated species or varieties should be characterized by a few fundamental features to make it effective and practicable. To that end, we recommend that such system be based on four fundamental qualities, namely: simplicity; community-based; participatory; and flexible, as considered below.

Simplicty

In order to be viable, such a system should be based on simple and easy-to-understand criteria. Implementation should adopt the least cumbersome and least bureaucratic approaches compatible with the purpose. The challenge in the sheer number of crops and varieties to monitor can be addressed with a focused approach: regular monitoring would be carried out only on varieties that from initial surveys emerge as lost or falling below a certain threshold of use.

Community-based

The system should be managed by community members in order to be really effective and sustainable. Community members are the people most familiar with their traditional crops; they are also familiar with the territory where these crops are grown, besides being depositaries of the IK associated with their cultivation, use and valorization. Another reason for involving communities reflects the sheer number of species and varieties of local crops that still exist on-farm: the task of documenting and monitoring such a wealth of biodiversity would be impossible if restricted to experts and researchers.

Participatory

The success of the proposed system would also rest on the participation of people across ethnic groups, sex, age and other possible categories. This is fundamental in order to be able to mobilize the wisdom and knowledge maintained in each group that comprise societies and communities, while simultaneously building up the necessary cohesion and cooperation needed for the implementation of on-farm conservation as a whole. In our view, the proposed system should be managed by local communities with minimal intervention of experts, who would nevertheless be available to lend their advice on possible procedures while promoting linkages with formal documentation systems that might be operational in the country.

Flexible

The method should be flexible enough to account for variations across years related to normal community uses and other considerations. Its scope is to ensure continued benefits from the use of varieties and species by local communities. It is expected that this approach would lead to some possible errors, such as different varieties bearing same name or the same genotype with different names. However, such errors can be factored in and in the end the many benefits deriving from the availability of maps and initial baselines for these species would counteract the limits of this approach. Maps and lists emerging from the initial monitoring would be refined and made more precise as these are shared with more and more communities.

Implementation of a novel approach

We would envisage an implementation process consisting of five steps

Step 1 – General assessment and inventory

First of all, a general assessment on the existing agrobiodiversity in the target area has to be carried out for baseline or benchmark purposes. Annex 1 to this paper provides a possible format for the survey needed for such an assessment. The survey, which can be accompanied by (focus-)group discussions, will also provide, *inter alia*, information on species or varieties that farmers (on project sites) believe have been lost or whose cultivation has shrunk to very low levels over the previous few years. The data on status and trends of local agrobiodiversity emerging from this general assessment will be recorded into CBRs and possibly also copied to national databases (where they exist) for safety duplication. These will be the instruments whereby information will be stored and made available to farmers as needed. CBRs will also be used as reference sources for consultations in connection with monitoring activities (see below).

Step 2 – Red List and vulnerable variety list establishment

Based on the outcome of the general assessment, an analysis of the degree of endangerment (or threats) will be carried out on those species selected as focus by the Project. The methodology we propose to test originates from the Four-Cell Analysis (FCA) method and Focus-Group Discussions (FGD) developed in the framework of the Global UNEP *in situ* Project by LI-BIRD, and the following description draws heavily on the best practices paper by Sthapit *et al.* (2005) referring to such an international effort.

First of all, as in its original conception, the FCA method applied here will aim at three main goals, viz. (1) identify common, unique and rare crop varieties; (2) document the reasons behind their current state of use by the community; and (3) identify the level and type of interventions needed for their conservation within the intervention area. While the FCA takes its name from the matrix of four cells that is the core of the methodology, in the proposed version of this method, the number of cells will be five. The matrix, which is usually drawn on the ground (or on a large sheet of paper) will be used to cluster the responses from community participants on five key questions:

- What are the varieties that are grown on large areas by many households?
- What are the varieties that are grown on large area by only a few households?
- What are the varieties that are grown on a small area by many households?
- What are the varieties that are grown on a small area by only a few households?
- What are the varieties that are believed to have been lost?

The application of the FCA method will require baseline survey data to decide cut-off points that would allow the clustering of the varieties in their respective cells. For instance, in the case of Nepal, the cut-off point for many households versus few households was identified by community members as 5 households. With regard to the size of the area (large or small), since these are also relative measures, they are defined by participants on the basis on type of crop and production purpose. In Nepal this threshold was identified as being 0.2 ha.

In synthesis, this Step would be basically organized around four stages.

Stage 1: Preparation of a list of farmer varieties (local and modern) for the selected crops

One way to do this is to carry out a brief transect walk through the village for direct observation of key informants (male and female) participants before the focus discussion group (FGD). During this stage, participants will collect a list of varieties and review it during the FGDs by asking the participants to add possibly missing varieties.

Stage 2: Implementation of the participatory FCA (five-cell) analysis of distribution of local crop diversity

This work will be carried out with 6 to 12 key informants to be selected based on a balanced blend of gender, age, well-being and locations representation. Participants will lay a large sheet of paper on the ground, draw two perpendicular axes of area (large vs small) and number of households (many vs few) yielding the four quadrants, A, B, C & D. A fifth cell (E) will be also included in the centre of the drawing, which will be used to include all those varieties that are believed to have been lost (see Figure 1).

The varieties assigned to cell E will form the basis of the initial Red List for cultivated species (which will be refined in further steps). Each crop will require a separate drawing for the FCA method. Participants will need to develop a shared understanding of the terminology to be used, which is crucial for the proper implementation of the method. For each crop, the varieties that have been listed in the previous stage of the work, will be called out and farmers will then discuss into which of the five sectors each variety should be placed.

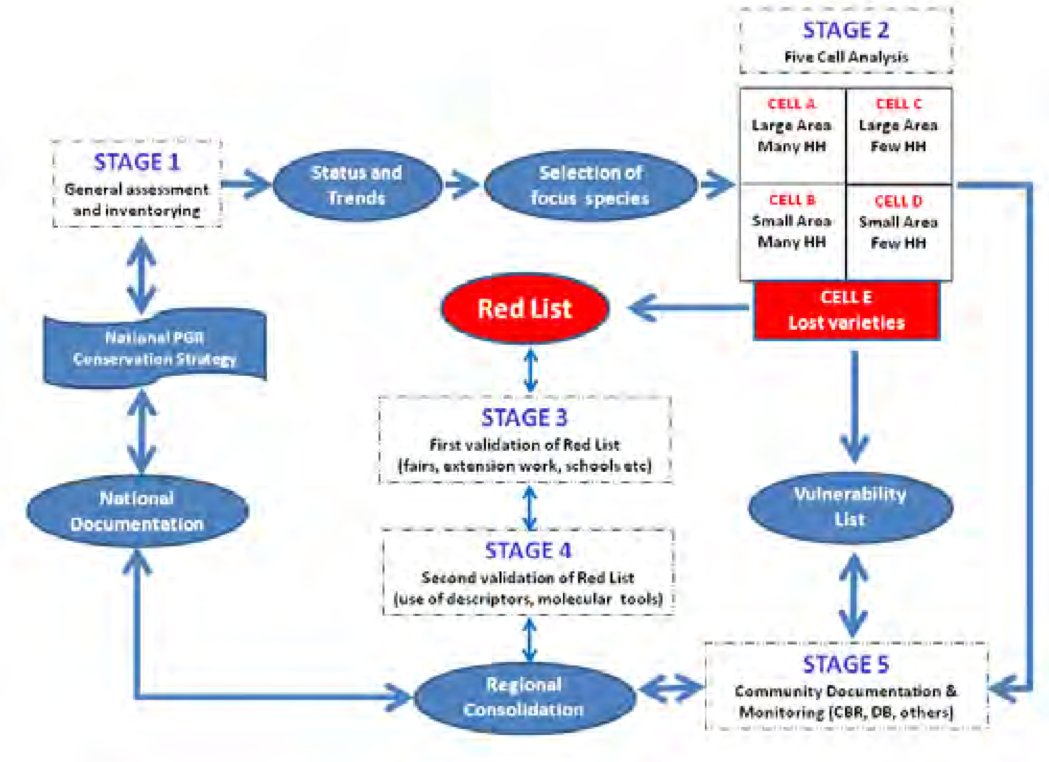

Figure 1. Schematic view of the proposed participatory on-farm documentation and monitoring framework to be tested by the IFAD NUS 3 Project in Nepal, India and Bolivia

Stage 3: Explore use values of landraces in each cell

After assigning each variety to one of the five cells, farmers will be asked why they have placed each specific variety in particular cells. Group discussions should take place and consensus reached on the final placement of each variety in its appropriate cell. The use values of each landrace falling into each category need to be documented in order to better understand farmer rationale in the process.

Stage 4: Participatory analysis of results

This stage involves validating the rationale of managing cultivars at household level. Based on the work in Nepal, there are some broadly applicable considerations regarding the rationale for each of the five cells:

- **Cell A** (large areas and many households): here we usually find varieties grown for food security or for the market or with multiple use values;
- **Cell B** (small areas and many households): here we find landraces cultivated for socio-cultural purposes (traditions, religious rituals, food culture);
- **Cell C** (large areas and few households): here we find varieties with specific adaptation traits (cultivars adapted to swampy lands, poor soil fertility, drought, shade, etc.);
- **Cell D** (small areas and few households): these are usually varieties with specific uses or limited use value to particular families; and
- **Cell E**: the cell will have varieties that farmers believe lost.

Because the Five-Cell Analysis will be carried out on several sites within the project, we would develop a Red List for each site being covered by the FCA exercise. These Red Lists will then be combined into one single Red List for the country (retaining the information on the geographical origin of the various lists). This process is further discussed below.

In the process of developing Red Lists at Project sites, we would need to have some criteria for guidance. Table 1 provides an initial set of guiding criteria meant to help facilitators to better characterize or focus their analyses of loss of varieties as reported by interviewed farmers and assigned to Cell E (Figure 1).

Within Step 2 activities, while working on the Five-Cell Analysis method, in addition to the Red List we propose to also develop a Vulnerable Varieties List that would include those varieties allocated by farmers to cell D [small areas + few households], perceived as being under threat of severe genetic erosion and hence vulnerable. The fact that some varieties are being cultivated in small areas and by few households is in itself not synonymous with genetic erosion. There might be some specific reasons that could make some of these varieties more vulnerable than others that happen to also be in Cell D, because of specific biological, social or environmental factors. For instance, a perennial, highly resilient tree, which can be reproduced easily and which is used sparingly by people might not be in a state of vulnerability even though it is cultivated on small areas and by few householders. In contrast, a species that is annual, less resilient and more difficult to propagate would raise more concerns for its reproduction capacities, and thus imply that it should be included on the Vulnerable List.

Table 1. Lost varieties – guiding criteria

Was the lost variety an old variety (say at least 30-50 years old)?	□ Yes □ No □ Do not know
Was the variety introduced from neighbouring villages a long time ago (say at least 20–30 years)?	□ Yes □ No □ Do not know
How long since the variety disappeared?	□ Over last 5 years □ Over 5–10 years □ More than 10 years □ Do not know
Was it a sudden loss or a gradual process?	□ Sudden □ Gradual □ Do not know
How popular was the variety?	□ Very popular □ Popular □ Not so popular □ Do not know
Was seed or planting material of the variety obtained through the informal seed system or purchased?	□ Informal □ Purchased □ Both □ Do not know
Do you think it is likely that some custodian farmers in neighbouring villages are still keeping seed or planting material of this variety?	□ Yes, very likely □ No, very unlikely □ Do not know

It should be noted that the idea of considering "Cell D" as the basis for the development of a Red List approach for cultivated species is not new. Joshi *et al.* (2004) are among those scholars that have proposed such an approach, establishing cut-off points or thresholds for the 'small areas' and 'few households' categories as 0.2 ha and 5 households, respectively. as mentioned earlier. These thresholds were tested successfully both in Nepal and Viet Nam.

With regard to considerations that would guide the inclusion of varieties in the Vulnerable Varieties List, we would suggest those included in Table 2.

It should be emphasized that the decision to consider a variety vulnerable is not the result of a mathematical exercise, nor should it be based on rigorous scientific criteria (as used by IUCN), but should rather emerge from a participatory assessment made by users (particularly farmers) based on the criteria in the 'vulnerability test'. These vulnerable varieties will be subject to participatory monitoring, whose aim is to prevent a complete loss of the diversity. The monitoring exercises for these vulnerable varieties should ideally take place at least every three years.

Table 2. Vulnerable Varieties List: guiding criteria ('vulnerability test')

Multiplication ability	□ Plants produce abundant seeds or it is easily propagated vegetatively □ Few seeds/ difficult to propagate □ Do not know
Level of use	□ Massive use of plant parts □ Moderate use □ Limited use of few plant parts □ Do not know
Growth cycle	□ Annual or biennial □ Perennial □ Do not know
Adaptation or resilience	□ Resistant to abiotic stresses □ Not resistant □ Do not know
Access to seed or planting material (e.g. custodian farmers few and isolated, or many and common)	□ Many farmers maintain seed, easy to access □ Few farmers, difficult to access □ Do not know

Step 3 – First validation of Red Lists

Through this process we aim to gathering further confirmation of Red List varieties beyond the constituency of farmers on the target sites. The idea is to validate the judgments by comparison with judgements made by farmers on target sites in other areas, or during events attended by a larger constituency of farmers and users originating from sites outside the areas covered in previous steps. One way could be to have group discussions during the agricultural events that are usually organized on a regular basis in agricultural areas. Additional validation methods could also involve school students through *ad hoc* awareness material containing illustrations and descriptions of lost varieties. The same material could be disseminated to extension workers and extension agencies, who could then disseminate it to farmers. Another way to verify Red Listed varieties in neighboring villages or areas, with little cost, is through radio broadcasting and publishing in newspapers. This method has been used by LI-BIRD in Nepal for the rice variety *Sampundraphinj*, which was reported lost in Pokhara Valley, but thanks to these announcements and debates in the local press it was eventually rediscovered.

At the end of the validation process, the information could be then acquired formally by the governmental agencies who could use it for compiling Red Lists on lost varieties, and in case there was the possibility to retrieve germplasm of a lost variety, promote re-introduction programmes or other relevant actions. Brochures and fact sheets in national and local languages are also needed here for public awareness purposes and to stimulate possible feedback or updates on status of varieties of concern.

Step 4 – Second validation of Red Lists

Another level of validation regarding the Red List could come from a more scientific approach. Government agencies could use the Red List during their routine extension work and gather possible material of varieties of dubious Red Listing for their molecular characterization in the laboratory. This authentication process can be also supported by the use of farmers' descriptors based on IK of senior farmers.

With regard to the expected variability that might be encountered in this third level of verification, IK would continue to play a helpful role: the combination of traits described using farmers' descriptors with the IK information regarding the use of the variety would be very useful to characterize the use of each variety. Yet, as stressed earlier, it is the safeguarding of different uses of PGR that should be the scope of the Red List exercise and monitoring, and in this context molecular characterization could be seen to have a minor role compared with its use for IUCN Red Lists.

Once also this validation process has been carried out, its outcome should be shared back to those communities who originated the initial information. Brochures and technical papers should also be made here.

Step 5 — Documentation and monitoring

This step will again involve the CBR and implement the monitoring process in its true role. The monitoring would involve the varieties included in the Vulnerable Lists, which will be reported in the CBRs. Their data will have to be updated regularly; ideally, we would suggest a time interval of 3 to 5 years. The information regarding the Red List will of course also be duly documented in the CBR, and possibly amended if possible news or additional information might emerge regarding the discovery of reportedly lost varieties.

Monitoring for Vulnerable Lists (and also Red List updating) should be done by those community members trusted as reliable focal points for such updates. Updates can be made through feedback from extension agencies (who would coordinate Red Listing at district, regional and country levels) and through farmer group discussions held on a regular basis in the village or during agricultural fairs.

The monitoring should be flexible enough to account for variations across years related to normal community uses and other considerations (as discussed earlier). The monitoring should be also managed by those community members most familiar with the target crops, with the territory where these are being grown and with the associated IK.

In the longer term, the consolidation of Red Lists and Vulnerable Varieties Lists would ideally also take place at higher levels, such as regional and national. Such consolidation would obviously come about once a proper national documentation system for on-farm conservation becomes well established in each country, so as to allow comparison and harmonization of datasets originating from various regions.

Ultimately, the development of a national documentation system for on-farm conservation, complemented by *ex situ* conservation documentation, would provide a robust strategy for the conservation of plant agrobiodiversity in each country. Such an ideal situation would finally bring about the needed synergy between *ex situ* and *in situ* conservation methods, and in so doing strengthen the preparedness of farmers for climate change through a more effective deployment of diversity in production systems.

Some final observations

The sustainability of documentation and monitoring needs to be linked to existing conservation efforts promoted by countries. We believe that governments would play an important role in promoting their implementation, including the mobilization of resources, at least for their initial launching. Ideally, long-term sustainability could be ensured through use-enhancement practices. Central databases can be created to collate maps and act as a depository and hub for national efforts. This should also include collation of CBRs and associated TK for safe conservation in national repositories. Possible modelling based on data gathered could be created and verified in hot-spots of crop diversity. Training should be provided for implementing these novel approaches.

The documentation practices being proposed here have a strategic relevance in the context of climate change and farmer preparedness in coping with it, which is indeed at the core of the IFAD NUS Projects. Data on resistance to biotic and abiotic stresses (such as those elicited by the general survey schema shown in Annex 1 to this paper) will be very valuable to both researchers and policy-makers in support of pro-adaptation and resilience actions and also to understand the impact of climate change on on-farm diversity. The data resulting from the survey can be used to generate initial maps of the distribution of local and traditional crops about which we know so little: these maps would be extremely useful instruments in guiding conservation strategies of national governments (both *ex situ, in situ* and on-farm).

From a policy perspective, the monitoring of local agrobiodiversity should be part of a decentralized system managed by local administrators and communities. A decentralized, community-based system is the only solution for a viable monitoring system. Lastly, such a system would represent an invaluable tool to assist countries in meeting their genetic diversity monitoring obligations in the context of international agreements and conventions, such as the International Treaty for PGRFA Global Plan of Action and CBD.

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Annex 1. IFAD NUS 3 Project – Agrobiodiversity benchmark survey

SECTION 1: General and respondent profile

1.1	Questionnaire number	
1.2	Interviewer name	
1.3	Date of interview	
1.4	Village name	
1.5	District name	
1.6	Latitude	
1.7	Longitude	
1.8	Altitude	
1.9	Respondent's name	
1.10	Respondent's gender	□ male □ female
	Ethnicity (These examples refer to Bolivia. Please amend using your own relevant country situation)	□ Aymara □ Quechua □ Colon □ Other (specify) ………………………....................……….
1.12	Respondent's age	□ <40 □ 40–49 □ 50–59 □ 60–69 □ >69
1.13	Highest level of education of the respondent	□ No formal schooling □ Primary school □ Secondary school □ Intermediate □ University degree □ No response □ Other – which? ………...…….

1.14	Details of family members in household (NOTE: these classes have been created for impact assessment purposes. These are actually only examples and should be revised based on the socio-economic condition of each country and project site. The rational of this question is to understand the labour force present in the household in order to establish a dependency ratio)	Number of children from 0-5 …………………………………… Number of children from 6-12 …………………………………… Number of males from 13-20 …………………………………… Number of females from 13-2 …………………………………… Number of males from 21-41 …………………………………… Number of females from 21-41 …………………………………… Number of males from 42-52 …………………………………… Number of females from 42-52 …………………………………… Number of males older than 52 …………………………………… Number of females older than 52 …………………………………… Number of members who earn income ……………………………
1.15	How big is your farm? NOTE: remember to write down the units in which the farm size is measured)	……………………………………………… (unit………………) Of which rainfed land is …………………………………… Of which irrigated land is …………………………………… □ Do not know □ No response
1.16	Farming experience (years)	……………… □ Do not know □ No response
NOTE: the following questions (17 to 21) are included in order to understand the level of wealth in the household. They might need to be changed from country to country. Please verify.		
1.17	Do you have an irrigation system?	□ Yes □ No
1.18	Do you own a car?	□ Yes □ No
1.19	Do you own livestock?	□ Yes □ No
1.19	List three most important animals in terms of providing income and consumption	
1.20	Do you own tractor a or agricultural machinery?	□ Yes □ No
1.21	Do you hire labour from outside the household?	□ Yes □ No

SECTION 2: Participation and NUS Projects

2.1	Was household a participant in IFAD-NUS phase 1?	□ Yes □ No
2.2	Was household a participant in IFAD-NUS phase 2?	□ Yes □ No
2.3	Have you ever been provided with information on NUS? NOTE: here we need to explain properly what is a NUS. The idea of so called 'minor or traditional crops' would be fine to that end.	□ Yes □ No
2.4	Have you ever been provided with information on climate change and its risks?	□ Yes □ No
2.5	If 2.4 is positive use follow up question: – From where did you get the information?	1 Ministry of Agriculture 2 Research (e.g. a research centre) 3 University 4 NGO (specify……………………) 5 Friend or relative 6 Other (specify…………………..)
2.6	Have you ever received visits from Ministry of Agriculture extension officers providing information on how to cultivate and market NUS?	□ Yes □ No
2.7	How do you get NUS seeds?	1 Ministry of Agriculture 2 Research (e.g. a research centre) 3 University 4 NGO (specify……………………) 5 Friend or relative 5 Private seed Company 6 Own seed 7 Other (specify…………..…………)

SECTION 3: Crops grown by the household

<table>
<tr><td rowspan="13">3.1</td><td rowspan="13">Which food crops have you grown on your farm over the last 5 years?

NOTE: the idea is to take a snapshot of the crop diversity in the farm in a dynamic way at both the inter-specific and intra-specific level. We are referring to several years and not just to the previous year because we do not want to miss data related to previous cultivations. We understand that the number of varieties could be an approximation, but at least we would have a general idea of the portfolio of food crops used. This could be a tedious process, but very useful for the Project! The list can contain local names of crops that are understandable by the community (scientific names will be added later).

QUESTION: would a 5-year period be OK according to your judgement?</td><td>List of Crops</td><td>Number of varieties</td><td>Major use
1 Self consumption
2 Market sale
3 Both</td></tr>
<tr><td>Wheat</td><td></td><td></td></tr>
<tr><td>Barley</td><td></td><td></td></tr>
<tr><td>Broad bean</td><td></td><td></td></tr>
<tr><td>etc.</td><td></td><td></td></tr>
<tr><td>etc .</td><td></td><td></td></tr>
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<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>3.2</td><td>Which were the top 5 crops grown on large areas in your farm?</td><td colspan="3">1. ……………………………………………………
2. ……………………………………………………
3. ……………………………………………………
4. ……………………………………………………
5. ……………………………………………………
□ Do not know
□ No response</td></tr>
<tr><td>3.3</td><td>Which are the crops / varieties more susceptible to climate change?</td><td colspan="3">List crops and varieties
……………………………………………………
□ Do not know
□ No response</td></tr>
<tr><td>3.4</td><td>Which are the crops and varieties more resistant to climate change?</td><td colspan="3">List crops and varieties
……………………………………………………
□ Do not know
□ No response</td></tr>
</table>

3.5	From where do you get the seed of resistant varieties? (*multiple responses possible – record all responses*) (DO NOT READ OUT OPTIONS; MARK ALL MENTIONED)	□ Own saved seed □ Relative □ Non-relative □ From Extension □ Aid Agency □ Community Seed Bank □ Market □ Do not know □ No response □ Other (specify)
3.6	Do you know of varieties no longer grown that would be useful today to cope with climate change? And would you know how to get access to them (through other farmers in other areas, institutions, NGOs)?	□ No □ Yes □ Do not know □ No response List varieties …………………………………………………… Tick possible sources of seed □ Own saved seed □ Relative □ Non-relative □ From Extension □ Aid Agency □ Community Seed Bank □ Market □ Do not know □ No response □ Others (specify)

SECTION 4: Crop relevance

4.1	Which are the top 5 income generating crops for the household?	……………………………………………………..…………… ……………………………………………………..…………… ……………………………………………………..…………… ……………………………………………………..…………… ……………………………………………………..…………… □ Do not know □ No response
4.2	Which species or variety do you consider most nutritious? NOTE: Some people may have a different perception of the term ´nutritious´. For instance in some communities, nutritious food might be considered food that makes people look more robust, i.e. that has a high % of carbohydrates but lacks micronutrients. Interviewer should thus explain that nutritious crops are in fact those that provide both macronutrients (fat, carbohydrates and protein) and some micronutrients (vitamins and minerals). The concept of nutritious diets resulting from the use of different species with different nutrient traits that complement each other should be also mentioned.	……………………………………………………..…………… □ Do not know □ No response
4.3	Which nutritious species or variety do you regret is no longer being cultivated, and why?	……………………………………………………..…………… □ lack of seed, □ poor market □ drudgery in food preparation □ pests and diseases □ children do not like it □ Other (specify) ……………..................…………….. □ Do not know □ No response
4.4	Which other species or variety do you regret is no longer being cultivated in spite of its potential income value and why?	……………………………………………………..…………… □ lack of seed, □ poor market □ drudgery in food preparation □ pests and diseases □ children do not like it □ Other (specify)……..................…………………….. □ Do not know □ No response

SECTION 5: Climate perception

5.1	Have you noticed any major change in the weather (in terms of major change in temperature or rainfall) from year to year in the past 20 years?	□ Yes □ No □ Do not know □ No response
5.2	If 5.1 is YES: What is the change? (*multiple responses possible – record all responses*) (DO NOT READ OUT OPTIONS; MARK ALL MENTIONED)	□ Increased temperature □ Severe winter □ Mild winter □ Increased unpredictability of weather □ Reduced length of winter season □ Reduced length of summer season □ Reduced amount of rainfall □ Rains do not fall at expected time □ Rains arrive late □ Rains arrive earlier □ No response □ Other (specify)
5.3	What are the reasons for the changes you have seen? (DO NOT READ OUT OPTIONS; MARK ALL MENTIONED)	…………………………………………………………… □ Do not know □ No response □ Other (specify)
5.4	What has the impact been? (*multiple responses possible – record all responses*) (DO NOT READ OUT OPTIONS; MARK ALL MENTIONED)	□ Change in start/end and/or length of growing season □ Desertification □ Food insecurity □ Land use change □ Pests and diseases □ Soil degradation □ Suitability change □ Yield decline □ Other (specify) □ Do not know □ No response
5.5	Who would you say has been most affected by the change in weather between now and 20 years ago? NOTE: The option "other" is given because sometimes farmers do not separate by gender or age and may have other ways to describe affected groups.	□ Men □ Women □ Children □ Elderly □ Entire family affected the same □ Other (who?) □ Do not know □ No response
5.6	Do you think that the role of women has changed as a consequence of climate change? And if so, how? (*multiple responses possible – record all responses*) (DO NOT READ OUT OPTIONS; MARK ALL MENTIONED)	□ Yes □ No □ Do not know □ No answer HOW? □ Spend more time in the field □ Spend more time at home □ Spend more time in the market □ Other (specify) □ Do not know □ No response

5.7	Do you think that the role of men has changed as a consequence of climate change? And if so, how? (*multiple responses possible – record all responses*) (DO NOT READ OUT OPTIONS; MARK ALL MENTIONED)	□ Yes □ No □ Do not know □ No answer HOW? □ Spend more time in the field □ Spend more time at home □ Spend more time in the market □ Other (specify) □ Do not know □ No response

SECTION 6: Practices & support

6.1	Have you done anything to deal with climate changes? (*multiple responses possible – record all responses*) (DO NOT READ OUT OPTIONS; MARK ALL MENTIONED)	□ Plant different varieties of existing crops □ Plant new crops altogether □ Increase frequency of exchange of seeds among farmers □ Changes in cropping systems □ Plant fast maturing varieties □ Plant disease resistant varieties □ Change planting locations of crops □ Change planting time □ Move crops across land □ Keep more livestock, instead of crops □ Plant trees □ Do more water harvest □ Do more off-farm work, instead of farming □ Soil management □ Weather forecasts □ Risk management instruments □ Livelihood diversification □ Land use and management □ Do nothing □ Other (specify) □ Do not know □ No response
6.2	What difficulties do you encounter in pursuing these best practices? (*multiple responses possible – record all responses*) (DO NOT READ OUT OPTIONS; MARK ALL MENTIONED)	□ Lack of proper information □ Lack of seeds □ Extra burden to on-farm work □ Lack of money □ Lack of labour □ Do not know □ No response □ Other (specify)
6.3	Who decides to grow different crops or to change cropping patterns?	□ Men □ Women □ Do not know □ No response
6.4	Do you feel that farmers are today less prepared than previous generations in coping with climate change?	□ Yes □ No □ Do not know □ No response
6.5	Is the knowledge to cope with climate change easily accessible or shared within the community?	□ Yes □ No □ Do not know □ No response
6.6	If so, who has better access to such information?	□ Men □ Women □ Equal access □ No response

6.7	Do you get any information on best practices to cope with climate change from any agency?	□ No response □ No □ Yes □ if Yes, which agencies give this information? ……………………......………………….……..
6.8	Do you know of any community-based initiative meant to assist farmers in dealing with climate change?	□ No □ No response □ Yes □ If Yes, specify…………………………........…….
6.9	Would you benefit from a community-based documentation system that would provide farmers with information regarding crops more adapted to climate change and how to access their seeds?	□ Yes □ No □ Do not know □ No response

Discussion on Session Three

Discussion

Padulosi: In general on the project's approach to red listing: it may well be that some of the crop populations (we are talking about NUS crops) are still in cultivation, scattered and thus, according to existing red listing approaches applied to wild species, may not be considered seriously endangered. But this reduction in population may have determined a significant loss in terms of livelihood benefits that the genotype or variety was able to produce for a relevant number of people within and outside the community. So it is a matter of establishing different thresholds which take into account the more complex aspects of use and livelihood benefits derived from such use.

Therefore, the scope and perspective of this monitoring or red listing approach are completely different from that undertaken for wild species (i.e. the IUCN approach).

Hammer: one crucial point is that of clearly defining genetic erosion and by this means also clarifying if it actually does occur and at what scale. Some authors question the severity of genetic erosion but they are referring to a given scale at which it may indeed be questionable (see van de Wouw, M., Kik, C., van Hintum, T., van Treuren, R. & Visser, B. 2010. Genetic erosion in crops: concept, research results and challenges. *Plant Genetic Resources-Characterization and Utilization*, 8(1) 1–15).

Genetic erosion in the strict sense is defined following Harlan and considers the disappearance of landraces in the development of the economy and industrialized agriculture. This form of erosion certainly happens. In a broader sense, genetic erosion covers all processes somewhat connected to the disappearance of our crops, which is more tricky, as sometimes it will be true and sometimes not. If we take this broader ecological approach it is easy to get confused as there are continual introductions of new crops and new genes, and it depends a lot on the scale and breadth of the picture.

Padulosi: the emphasis should be placed on what is happening as from TODAY, identifying which species are less in use and yet have greater potential, especially in the context of combating the effects of climate change and supporting food security. Referring to the presentation by Dr Vögel, for us the historical data, although definitely valid as a scientific exercise, are not so relevant in the context of this Project, and in our target countries may also be far more difficult to retrieve.

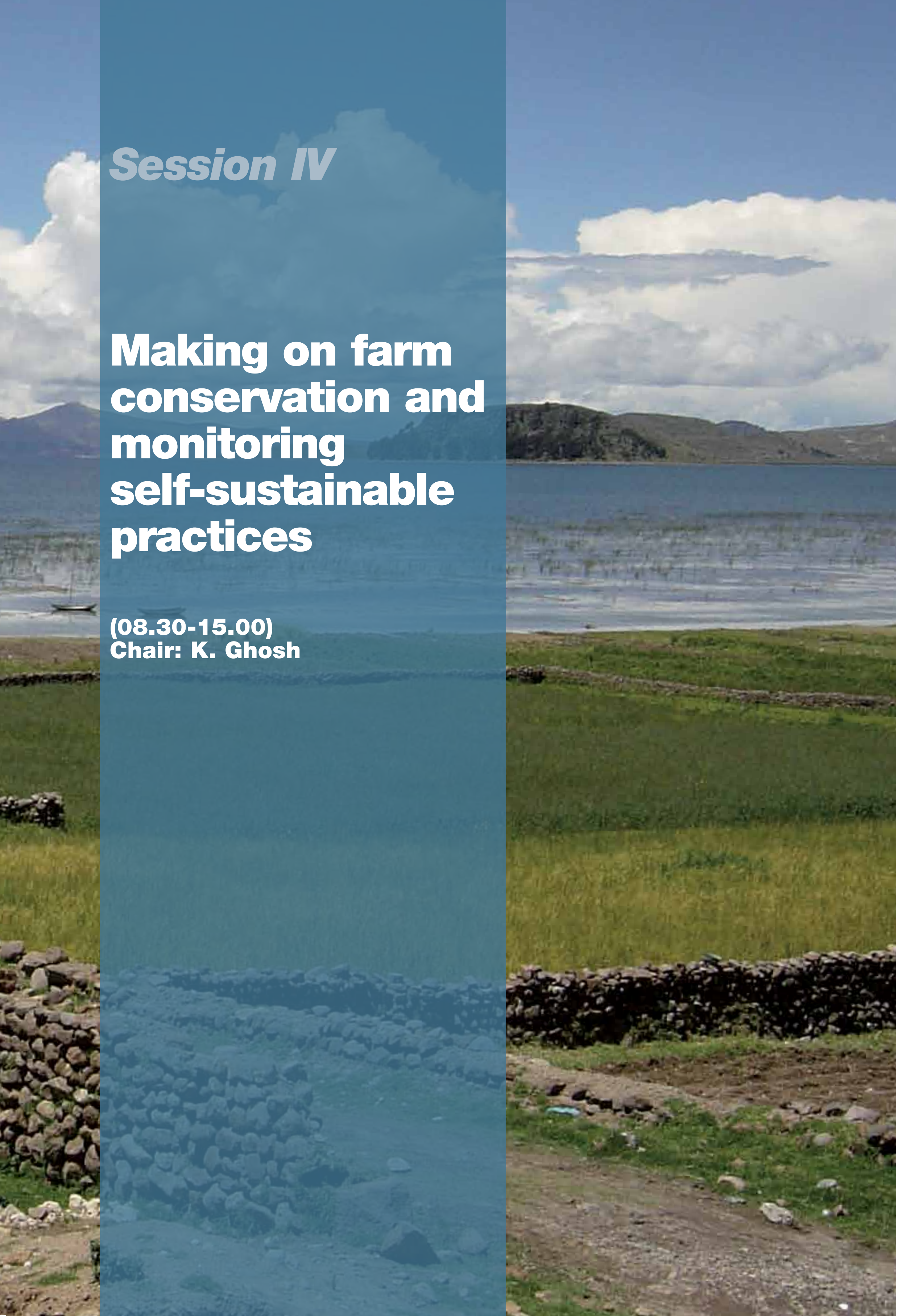
Vögel: Nevertheless, historical data may provide information on the previous state of the resource, a sort of reference baseline and, most importantly, were used as a source of information on the potential for re-cultivation of a species or variety, based on the recovery of uses that have been lost. Of course, that does not solve the data availability problem.

Sthapit: Do we want to work at a species or a landrace level? The approaches would be different, and if we wanted a general model adaptable at both levels

we would have to work very carefully to make it adaptable. It appears the IUCN method can accommodate work at these two levels.
Hammer: I suggest working at species level and then at infraspecific level.
Padulosi: The work on variety characterization during the IFAD NUS on Andean Grains and Indian minor millets showed the potential for use and livelihoods of different varieties, so it would be essential to accommodate variety-level assessments in the framework in order to capture these aspects.

It was noted that the prioritization of conservation of a large number of varieties would also serve the breeder community.
Eshan: It is and will be very difficult to find a global methodology applicable to the whole world and at all levels. One should also keep in mind that with crops there will inevitably be variations in the demand for a given species or a given variety compared with another another. These decisions and market influences are strong drivers of conservation, and can be difficult to accommodate.


Stefano Padulosi/Bioversity



Session IV

Making on farm conservation and monitoring self-sustainable practices

(08.30-15.00)
Chair: K. Ghosh

Supporting on farm conservation in Switzerland: Challenges and opportunities

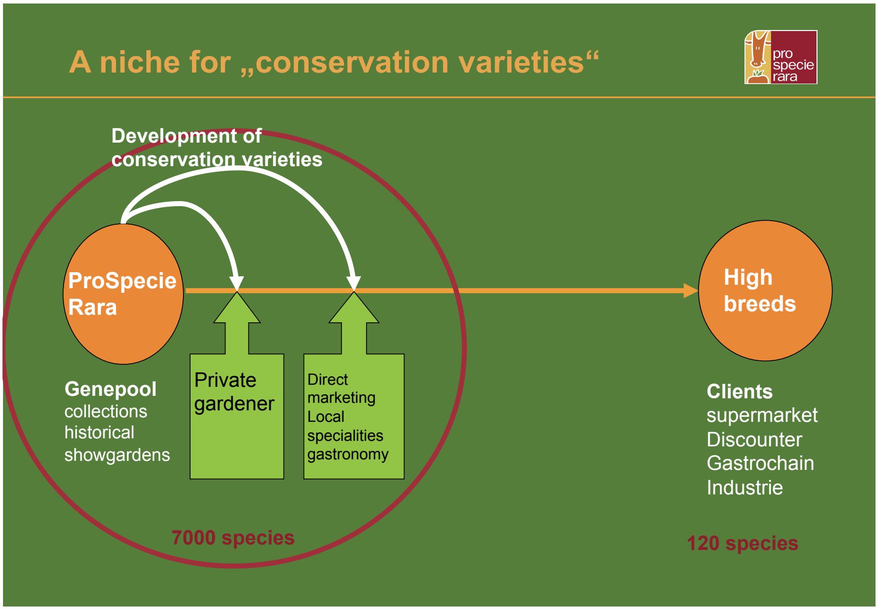
Béla Bartha
ProSpecieRara
E-mail: bela.bartha@prospecierara.ch

About the organization

ProSpecieRara is a non-profit and non-governmental organization that has been conserving and actively promoting biodiversity in agriculture since 1982. In close cooperation with farmers, private and public institutions and many volunteers, ProSpecieRara guarantees the survival and sustainable use of endangered cultivated plants and rare breeds.

The organization has its head office in Aarau (Switzerland), with branch offices in Geneva (Switzerland) and Bellinzona (Switzerland) and Freiburg (Germany). There are 20 employees, supported by 9000 donors and 2500 volunteers.

The ProSpecieRara-breeding associations have 26 rare breeds of animals, while the plant collection encompasses some 1800 fruit varieties, 1000 garden and field crops, 450 berries, 250 ornamentals and 250 grape varieties. Besides a



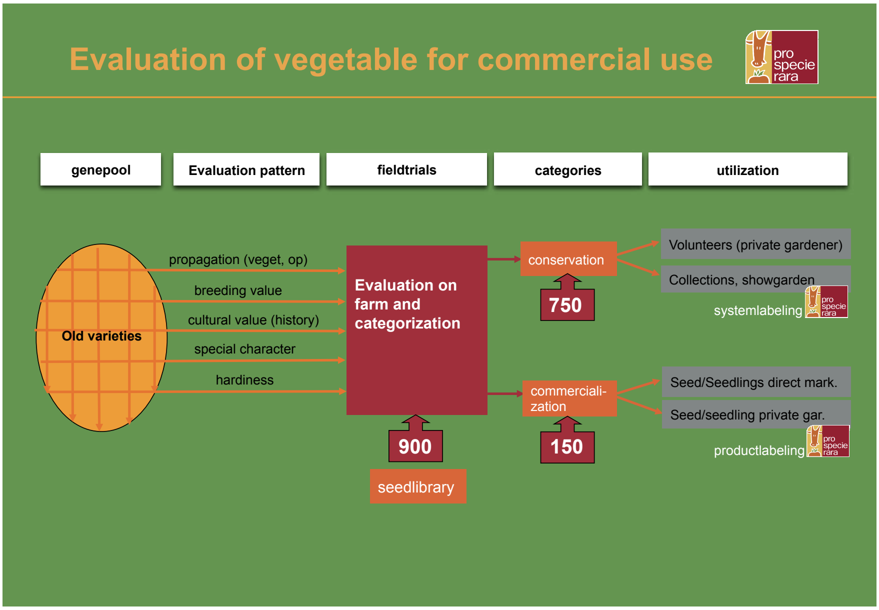
small genebank, ProSpecieRara coordinates an on-farm network with about 160 different orchards, demonstration farms, vineyards and show gardens. Over more than two decades the organization has developed a powerful database that is specialized for managing on-farm conservation work and collaboration with many volunteers.

Development of the collections and conservation varieties

The collection consists mainly of landraces and formerly commercialized crop varieties that were never protected or have lost their protection and are freely available. At the moment only varieties that are open pollinated or can be propagated vegetatively are included in the ProSpecieRara genebank.

Within the last twenty years we have had to face the fact that the public collections and their gene pool were not developing very much because of the loss of state-supported breeding programmes, whereas the gene pool belonging to private seed companies was being used and developed for private breeding work. Many new varieties have been created but due to intellectual property protection laws they have never found their way to the public domain. The extent of exchange between public and private gene pools is very small. The modern varieties that have been developed fit only into international and highly intensified agriculture systems, and are not appropriate for local specialized and amateur markets. To fill this gap, ProSpecieRara wants to evolve new activities. For example by supporting breeding work for neglected and underutilized crops within the existing public gene pool to provide better varieties for private gardeners, with some small-scale direct marketing activities.

During the last 12 years has ProSpecieRara evaluated its collection to determine which varieties could be interesting for commercialization. The result of this



examination was that about 150 varieties—so-called flagship varieties—could be re-introduced into the marketing system. Some of the varieties could find their way into the supermarket again as fresh vegetables; others are commercially available as seeds and seedlings in big garden centres. The other 750 varieties were not suitable for marketing, and are maintained within the conservation network.

Methodology

For ProSpecieRara, one of the main steps to get some of their varieties back into a marketing chain was the development of a brand with its own label. This label was essential to promote the diversity of cultivated plants and to improve the visibility of the ProSpecieRara conservation work that stands behind a flagship variety.

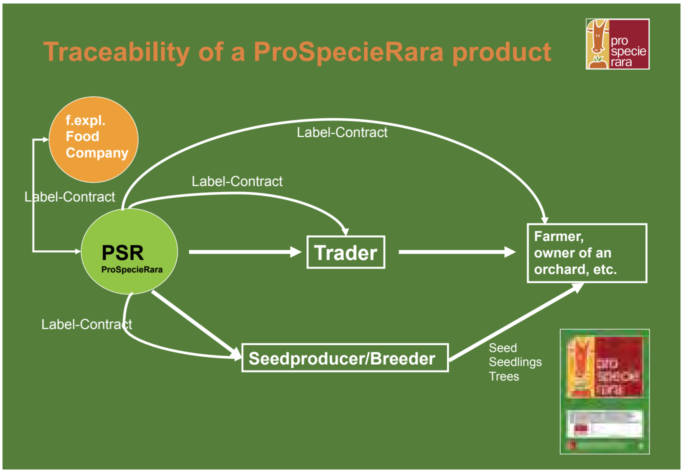
The label of ProSpecieRara stands for:

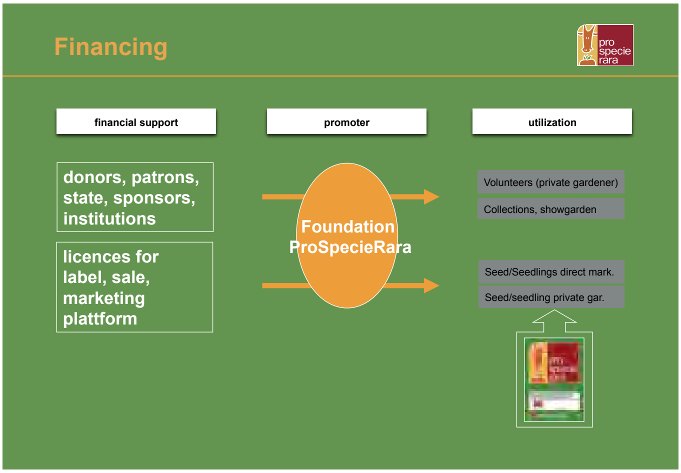
1. Fulfilling the following criteria:
   - provenance of seed is defined;
   - the variety name has to be approved;
   - breeds are registered in a herd book; and
   - the breeder is a member of a breeder association.
2. Saving and promoting genetic diversity in agricultural systems.
3. Supporting sustainable conservation work on-farm and in gardens.

Since 1999, Coop, one of the biggest supermarket chains in Switzerland is promoting its "diversity" fresh food-products, seed and seedlings under the ProSpecieRara trademark. At the moment about 100 different, mostly vegetable varieties, are available to consumers. Today the trademark is known to about 22% of Swiss consumers. Most of the products are grown in an organic agriculture system.

The system is based on contracts between the partners and the ProSpecieRara headquarter. The crucial point within the contracts is that the traders or farmers are required to obtain their seeds from a approved source (seed producer). The specialists of ProSpecieRara can monitor and verify variety identity only on the fields of the seed producer. At the same time the seed producer must know the seed quantities they have for sale to the farmers and ProSpecieRara must know the product quantity that ordered by the supermarket.

Today the financing of ProSpecieRara work is based on several pillars. The basic conservation activities are financed by donors, private sponsors and governmental programmes. Marketing expenses are covered by licences that are paid by the marketing partners that use the label and by fees that are paid for participation on marketing platforms.





Peliti programme: promoting on-farm conservation of NUS in Greece

Panagiotis Sainatoudis
Peliti P/R Paranesti, T.K. 66035 Paranesti, Greece
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"From hand to hand and from generation to generation,
So that we don't lose tomorrow what we have today," Peliti.

Context

First of all I would like to thank the organizers of this conference for the invitation to present the activities of Peliti.

I come from Greece, one of the 17 regions on earth whose plant diversity is of global origin. Of Europe's 12 000 plant species, 5700 grow in the country, with 740 (13%) of them being endemic. Crete alone has 1800 self-sown plants, and 10% of these are endemic to the island. In comparison. UK is four times bigger than Greece, but has only 2000 self-sown plants—not many more than Crete—and not one of them is endemic.

The Peliti alternative community

The Peliti (www.peliti.gr) was established in 1995 by Panagiotis Sainatoudis. In the early years expeditions were carried out in Greece searching for persons holding their own seeds. In 5 years this resulted in the gathering of 1200 varieties of local crops. Peliti was the first non-governmental organization active in rescuing local varieties in Greece, and is now the major non-governmental organization in the area of conservation of local varieties in Greece.

The basic aims of Peliti are:

- The collection, preservation and dissemination of local varieties.
- The exchange of goods and services on a barter (non-monetary) basis.
- The creation of an alternative community.

Our base

Peliti is situated in Mesoxori, a village in Drama, northern Greece. This area is very rich in biodiversity. In 100 km from source of the river Nestos in the Rodopi mountains to its estuary on the Aegean all kinds of vegetation exist, typical of a large area of Europe.

Exploratory expeditions

The exploration missions continue, looking for people who maintain their own seed, with a view to rescuing these varieties.

www.peliti.gr

"A child was born tonight – God still has hope in people…"

From 1995 we started activities with schools. For example, recently the pupils of a primary school in Paranesti prepared bread and I was telling them the story of wheat. We encourage and support the creation of school gardens. The students grow traditional plants from seeds that are shared in open events. Thus the 9th Primary school of Komotini shares 4000 traditional plants from local seed. We support the introduction of networks between schools that cultivate local varieties, and there are now two networks in Crete.

There was a environmental education programme—"1/10 of an acre farmers"—where students grew 10 traditional varieties of wheat and raised sufficient quantities to be able to share these with professional farmers.

We have happily accepted offers invitations to collaborate with further education colleges, such as the evening high school in Xanthi, where the students are working by day but have the opportunity to be involved in the process of rescuing the local traditional crops.

From 2002 the day of 7 April has become established as a day dedicated by Peliti to local varieties, where, in collaboration with primary schools, plants are grown from local seed and shared with the public.

Peliti has a network of growers called Local Farms, and through this everyone can find free seed. At the moment 219 farms participate in this. This name is used also for the main publication of Peliti. Other recent events have been Pan-Hellenic Festivals for the exchange of local seed varieties, held at the Peliti site. We have established the Saturday after the Orthodox Easter every year as a Pan-Hellenic (National) day of seed exchange. In 2011 there were more than 5000 visitors from Greece and abroad. Last year 80 cultivators and 4 breeders participated and we donated more than 15 000 seed lots and over 5000 plants.

The 12th Pan-Hellenic Festival for the Exchange of Local Varieties has been planned for 21 April 2012 at the Peliti site in Mesochori, Paranesti Municipality, Drama Prefecture, Greece. For the 12th Pan-Hellenic festival we have invited as guests cultivators from all over Greece but also from many corners of the earth. The festival is open to anyone interested, regardless of whether they have seeds or not.

Something lost – something gained

For us the most important success is that we have been able to rescue and spread the primitive Einkorn wheat, *Triticum monococcum*, which has a history in cultivation dating back to 9000 before present according to archaeological findings. This conservation has been carried out in collaboration with the Greek Gene Bank. This crop had almost disappeared from cultivation but has now been rescued and is increasing in cultivation in view of its role in health.

Take your share of the responsibility

Daily, we vote with our forks for the kind of agriculture that we will have tomorrow. It is important to be aware of what food supports, its origins and route to your plate, and the way that our choices influence and affect the planet and other people, who might live far distant to us.

We have led the world to this situation through our choices. We can now lead it to something better by our choices and our dreams.

A. Ganatsios

Policies supportive of on-farm conservation and their impact on custodian farmers in Italy

Valeria Negri
Department of Applied Biology, University of Perugia, Italy
E-mail: vnegri@unipg.it

Introduction

Many landraces (LRs) are still maintained on-farm in Italy, including not only all the main crop species but also neglected and underutilized species (NUS). A recent inventory listed over 1300 LRs in central Italy alone (Negri *et al.*, 2011). These LRs are maintained for various reasons, including better quality than commercial varieties, better performance (yield or persistence) under harsh agro-environmental conditions, traditional uses such as particular traits appreciated by the farm family, and ritual or religious use (Negri, 2003). Note that they are not maintained under 'traditional farming systems', but 'maintained because of tradition', especially related to food. However, most of them, especially garden and neglected crops, are highly threatened because they are cultivated primarily by aging farmers (Negri, 2003; Galluzzi, Eyzaguirre and Negri, 2010).

Regional, national and European legislative frameworks and their impact on on-farm conservation

Italy was the first country in Europe to protect Genetic Resources (GR) and LRs with legislation, including National Laws (no. 212/2001, setting a section for conservation varieties in the National Register of varieties; no. 101/2004, adopting the International Treaty on Plant Genetic Resources for Food and Agriculture; and no. 46/2007, defining 'conservation varieties' and terms of seed commercialization) and Regional Laws (Tuscany Laws no. 50/1997 and no. 64/2004; Lazio Law no. 15/2000; Friuli Venezia Giulia Law no. 11/2002; Marche Law no. 12/2003; and Emilia Romagna Law no. 1/2008), all protecting local GRs.

These laws are now being harmonized with recent European legislation (Commission Directives 2008/62/EC, 2009/145/EC and 2010/60/EU) that allows seed commercialization of 'conservation varieties', by which is meant LRs, ecotypes and old varieties. The sale of conservation varieties seed is allowed provided that, *inter alia*:

- it is limited in quantity,
- it is restricted to the 'region of origin' (i.e. the region(s) in which the variety has historically been grown, and to which it is naturally adapted),
- the conservation variety is under threat, and
- the conservation variety is listed in the relative section of the European Variety Catalogue.

Previous European seed regulations made it impossible to commercialize LR seed. This was a severe constrain on use of LRs on-farm. Italy has already implemented these Directives and, as of January 2011, 16 Italian LRs (8 maize and 8 horticultural crops) were registered in the European Conservation Variety Catalogue and used in the regions of origin.

The Directives generally aim "to ensure *in situ* conservation and the sustainable use of plant genetic resources", but it should be noted that they focus on seed production and marketing *per se*, rather than on agrobiodiversity conservation. As a consequence they will probably not be useful for preserving LRs with limited commercial potential, such as those maintained in single home gardens or LRs of NUS.

In contrast, the Italian Regional legislation clearly aims to protect local agro-biodiversity, with the declared goals of:

- reducing the "genetic erosion threat" of local (autochthonous) GRs,
- promoting GR conservation *in situ* or on-farm,
- developing an economic interest for food products based on from local GRs, and
- enhancing information and information exchange regarding local GRs.

All the Italian Regional legislation is quite similar, so the example of Lazio Regional Law no. 15 (1st March 2000) "Protection of autochtonous genetic resources of agricultural interest" is typical. It is discussed by Costanza *et al.*, 2011.

Article 1 of the law states what is protected:

> "… autochthonous plant and animal genetic resources, including wild plants, such as species, races, varieties, populations, cultivars, ecotypes, and clones for which there is an economic, scientific, environmental, or cultural interest, threatened by genetic erosion."

Here autochthonous implies GR 'of Lazio origin or introduced and integrated into the Lazio agro-ecosystem in the past 50 years'. This also includes GRs that have disappeared from the Region but have been maintained in botanical gardens, public or private institutions of other regions or countries.

In the context of farmer's rights, this law clearly states (Art. 5, Ownership of genetic resources)that

> "… the heritage and ownership of the GRs belongs to the indigenous local communities, within which the benefits must be distributed equally...".

The law is implemented by the Lazio Regional Agency for Development and Innovation in Agriculture (ARSIAL), with funding coming from the European Agricultural Fund for Rural Development (EAFRD) under EU Regulations EC 1698/2005 and 1974/2006 through the Lazio Rural Development Plan.

The implementation plan foresees several implementation phases (Costanza *et al.*, 2011):

Phase 1. GR inventorying (the GR is identified; its actual existence checked by field inspections; data on the GR in the field are collected and cross-checked against other sources of information).

Phase 2. The GR is characterized for morpho-phenological traits and, eventually, also for genetic traits by using molecular markers.

Phase 3. On the basis of the information gathered in the previous phases, the GR's identity, autochthony and threat is assessed by a scientific committee.

Phase 4. Only after this assessment can a particular GR be registered into the Regional Voluntary GR Register and enter into the planned protection scheme. The Regional Voluntary Register is an official record of the Lazio Region and includes one Plant and one Animal Section (Porfiri, Costanza and Negri, 2009).

Phase 5. The protection scheme is realized: as *in situ* conservation by a Farmer Conservation and Safety Network, and as *ex situ* conservation by ARSIAL, which collects and stores propagation material in its genebank and field collections.

Members of the Farmer Conservation and Safety Network can be public and private institutions, 'associations of interest' and single or associated farmers; the conservation activities of the network are coordinated by ARSIAL. Through the network the GR is cultivated across years in the area where it was initially found, but enlargement of a GR's cultivation area through seed increase and seed exchange among local farmers is also foreseen.

The network currently involves 255 farmers (Costanza *et al.*, 2011). To maintain the GRs on the farm these farmer receive monetary incentives, established on the basis of the type of cultivated crop (rates are in the range of € 250–300/ha for cereals and € 500–600/ha for vegetables).

At the time of writing 172 plant LRs were protected in the Lazio Region (138 fruit tree LRs belonging to 13 different species, and 34 herbaceous crop LRs, belonging to 14 different species) (Costanza *et al*., 2011).

Overall, it appears that the Italian Regional laws facilitate:

- the compilation of National Inventories based on the Regional Inventories, which are the information base necessary for any conservation action;
- further registration in the European Conservation Variety Register;
- wider commercialization of seed of (some) LRs; and, consequently;
- wider on-farm and *in situ* conservation.

Other activities supportive of on-farm conservation

Other activities supportive of on-farm conservation of LRs are (and have been in the past) implemented by several Local Authorities (Regions, Provinces, Municipalities) and other entities.

Local authorities, although not in response to legislation, create and make public lists of typical regional products (some from LRs), fund research on LRs, give help to local farmer associations for developing products obtained from LRs, support requests for quality marks (such as DOP – *Denominazione di Origine*

Protetta [Protected Designation of Origin]) and fund various other activities, such as supporting local fairs and exhibitions, and LR seed multiplication and redistribution among farmers (for example, see Polegri and Negri, 2010).

Related but non-institutional activities include organic farmers sometimes requesting LRs for their production systems; farmer associations promoting the commercialization of local products in their locality; national and regional radio and television programmes regularly talking about local products from LRs; Slow Food adherents making 'visible' the products obtained from LRs and thus promoting local diversity preservation; gourmet academies maintaining alive certain preparations from LR products; and some community gardens promoting the maintenance of local diversity, including LRs.

The impact of policies supportive of conservation on custodian farmers and home garden keepers in Italy

The impact of the many supportive activities described above mostly appears at the local level, i.e. within the local environment and economy and benefiting local farmers. The benefits can be described not only in terms of direct income to farmers, but also in terms of indirect benefits that can not easily be quantified in monetary terms, i.e. the those coming from an environmentally friendly agro-ecosystem.

The 16 LRs registered in the Conservation Variety Register are marketed locally as high quality products, as are other LRs not yet listed.

It is not easy to gather exact figures. However, taking as an example the emmer wheat business in Italy (which is based on LRs), it is estimated to be about € 2 million annually.

In particular, for the DOP 'Farro [emmer] di Monteleone di Spoleto' (Umbria Region), which is grown under certified organic agriculture conditions, the business turns over € 250 000 annually in the Monteleone di Spoleto Municipality (Torricelli, Quintaliani and Falcinelli, 2009). Interestingly enough, this figure refers to the main products only—the grain and the flour—obtained from the LR, while additional farmer income comes from selling new products from the LR, like anatomical pillow filler and fuel pellets, products that have been recently developed by the farmers themselves. The DOP organic emmer sold in the local market also functions as a driver for other local products (e.g. pulses), which also are souvenirs appreciated by tourists.

Finally, the local tourism economy also benefits from the coupling of traditional products with beautiful and unpolluted agro-ecosystems, and, of course, an enhanced quality of life for those living and working in such an environment.

Conclusions

The supportive policies described above appear to be helping to maintain diversity on-farm and sustaining farmer income, but nevertheless threats remain for the diversity still present on-farm and in home gardens, especially for NUS.

The promotion of a different type of agriculture, where the local economy is based on LRs and food production is at least partially derived from local farms and home gardens, is needed to encourage on-farm conservation of local diversity. To promote on-farm conservation of GR, activities that should be actively promoted are better education concerning the environmental issues, better awareness of environment services that can come from agriculture, farmer empowerment, and fostering farmer's pride in being the stewards of their own environmental resources.

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Discussion on first part of Session Four

Marino: Market is very important as geographical distribution and exchange of materials go well beyond a certain region. Facilitating access to genetic resources is a priority of the Treaty.

ProSpecieRara: How does one decide what to use to commercialize? By joint assessment using scientific opinion, field trials and the market.

Benefits should remain with the local community.

First of all make landraces fit for the market, and then protect these with label measures.

Importance to work on genetic erosion! GPA, Treaty, CBD, etc., – all these convention can be stimulated to intervene, and the Project can promote this cooperation and awareness.

Q: How to assess what goes to the market?

A from Bartha: It needs field trials, involvement of different people and the participation of value chain actors.

Making on-farm conservation a self-sustainable practice: an Indian perspective

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Introduction

On-farm conservation of useful crops and varieties is very important as these crops and their cropping systems play a vital role in fulfilling the food, nutritional and other requirements of those living in marginal environments. In the face of changing climatic conditions, these crops and varieties, and their associated traditional knowledge, could play a vital role in enhancing resilience among rural communities and enabling them to adapt to climate change (Bhag Mal, Padulosi and Bala Ravi, 2010.). Due to rapid changes happening in the socio-economic sphere of traditional farming systems and their practitioners, traditional community-based agro-biodiversity management practices have been disappearing at an alarming rate in the last three decades. The M.S. Swaminathan Research Foundation (MSSRF) is a non-profit research foundation that, *inter alia,* is facilitating community-based participatory research in India among the Tribal communities in the Kolli Hills, Tamil Nadu, and the Koraput region in Orissa. MSSRF is attempting to revive the on-farm conservation tradition for millets in the Kolli Hills and for landraces of rice in Koraput, with the involvement of Tribal communities (Gruère, Nagarajan and King, 2009; Anil Kumar *et al*., 2010).

This paper highlights MSSRF-initiated participatory research in these regions, with various innovative approaches, invoking the 4 C Paradigm. The four Cs are: Conservation, Cultivation, Consumption and Commercialization. The 4 C paradigm simultaneously addresses various dimensions of biodiversity, nutrition, hidden hunger and poverty. This paper also summarizes the role of MSSRF in mainstreaming concepts of agro-biodiversity conservation in national programmes and highlights its role in influencing policies on conservation and sustainable use of plant genetic resources.

Conservation

Strategies for conservation of millets involve seed collection, multiplication, seed distribution and farmer-to-farmer exchange through the traditional seed storage system. Over time, many of the *dhombais* and *kuthirs* [traditional seed and grain stores] had fallen into disuse and abandoned due to changes in cropping systems. As a first step, seed of landraces collected from various locations were multiplied in plots with the participation of local communities, to produce good quality seed material. Documentation of traditional knowledge related to ethnobotany, agronomy and culinary uses of millets was undertaken. A subset of seed material collected from the farmers, with the associated passport data, was provided to *Scaracia mugnosa* gene-bank at MSSRF, Chennai. The ethnobotanical details related to the landraces of millets were documented (Rengalakshmi and Balasubramanian, 2002) and stored in the FRIS (Farmers' Rights Information System) database of MSSRF (Rengalakshmi *et al.,* 2002). Proper cleaning of seeds, good nursery preparation, use of farmyard manure, sowing in the right season, and proper irrigation schedules were some of the practices adopted for producing good quality seeds. When harvested, seed was cleaned and stored in traditional seed storage systems, such as *thombai* and *kuthir*, that now became a part of the Community Seed Bank. The projects revitalized some of these practices in a new social context. These traditonal structures were used for storing the landraces of millets. Self-Help Groups (SHGs) were established for storage, exchange and distribution of millet seed among farmers. For greater outreach, seed was also distributed to interested farmers during the annual temple festival.

Cultivation

MSSRF had observed that availability of seed stock within local communities encourages some to cultivate the crop. One complaint by farmers was the poor return from traditional crops such as millet compared with commercial crops like tapioca [cassava; *Manihot esculenta*]. MSSRF therefore decided to establish a number of participatory yield enhancement trials that involved agronomic practices such as line sowing or row planting, and intercropping with tapioca. Trial plots were established on farmer's fields with their active participation, and used as a means of teaching and demonstration for members of the tribal community. Participatory plant improvement training covered use of reduced seed rates, crop density management, and use of organic and inorganic fertilizers in the cropping systems. The activity enhanced production potential and thereby economic returns per unit area of land. Farmers could see the yield doubling in *Panicum sumatrense.* Farmers harvested 500–600 kg/acre from line sowing, compared with 250–300 kg/acre from conventional broadcasting. In the case of *Eleusine coracana,* yield increased about 40% in the Kolli Hills and 65% in Koraput. These efforts effectively promoted cultivation of millets in different landscapes and ensured seed availability in villages. These in turn support conservation of several landraces in the Kolli Hills and reinforces food and livelihood security in the region.

Consumption

Small millets are consumed as gruel, *kanji* and de-husked kernel. Little millet and Italian millet are pounded using mortar and pestle to get the kernel out of the grain. For Finger millet, a stone quern is used to produce flour. It is mostly women that are involved in manual processing like de-husking and grinding of these millets. Profound drudgery is involved in processing millet for food due to the presence of multiple seed coats in Little and Italian millet compared with Finger millet. It was observed that provision of a low cost milling unit for removal of the hard seed coats could revive interest in processing and consumption, and thereby encourage their cultivation. Therefore, simple de-husking mills for processing Little and Italian millets were obtained, and established in three locations in the Kolli Hills in 1998, 2003 and 2009. Since then the inhabitants of the hamlets in the region have had the benefit of the mills. In 2008, six additional pulverizers with de-stoners were installed, and managed by the SHGs, facilitated by MSSRF. It is estimated that 55 hamlets benefit through these small mills, thereby reducing the drudgery involved in the processing of small millets and helping to increase the local consumption of millets. However, it should be noted that a refined version of a de-husking mill that provides maximum recovery for Little and Italian millets has yet to be developed.

Commercialization

MSSRF has taken steps towards conserving nutritious millets by creating an economic stake in millet cultivation. This has been made possible through a network of SHGs. A chain of actors from farmers, through SHG members as procurers and processors, to SHGs for marketing are involved. SHGs were trained to operate mills, and process, pack and label produce. MSSRF also trained SHG members in culinary preparation of value-added products from millets, involving professionals from the Home Science Divisions of University of Agriculture Sciences (UAS), Dharwad, and UAS, Bangalore, in India.

Different landraces of millets are procured from the farmers in millet-growing regions in the hills and brought to the mills for processing. Various forms of millet whole grain, processed kernel, flour and value-added products have been prepared. Millets have been made into nine different products, and are being supplied to diverse markets at the local, regional and national levels. The *Kolli Hills Natural Foods* label for Kolli Hills products is registered as a Trademark in India. Introduction of mills to reduce drudgery and provision of skills enhancement for preparation of new recipes, coupled with labelling efforts, have helped consumption of valued-added millet products at the household level, and also to reach out to external markets.

The Kolli Hills Agro-biodiversity Conservers Federation (KHABCoFED) millet supply chain

The supply chain comprises producers (millet farmers), procurers (SHGs), processors (SHGs), marketing (collective or individual) and the end-consumer (individual).

The entire process began in 1997. This Participatory Community Biodiversity Management is process-oriented and involves steps like community mobilization, group formation, technology incubation, system management and role change. Initially, a core group of knowledgeable individuals on millets was mobilized for organizing participatory research in millets. In 1999, MSSRF facilitated formation of 9 SHGs with of 108 members in different hotspot regions of millet cultivation, with the involvement of core group members. In 2009, MSSRF facilitated formation of 36 SHGs and 4 Farmers' clubs across the Kolli Hills, with the participation of around 500 members under the Kolli Hills Agro-biodiversity Conservers Federation (KHAbCOFED), which is a Tribal Farmers' association registered under the Society Act. This process has provided strength in the form of social and financial capital for the initiative, thus sustaining efforts for conservation of millets. These SHGs are assisted to obtaining financial and material support from banks, the District Rural Development Agency (DRDA), MSSRF's Community Banking Programme, and donor support from McGill University, Canada. Through this support, infrastructure such as *Kolli Hills Natural Foods* shops, processing mills and equipment, buildings, godowns, threshing yards and seed banks were created in various locations in millet growing areas. MSSRF has also made consistent efforts to build capacities of the tribal farmers on various aspects related to conservation, natural resource management, poverty reduction and community institutional building in general, with a particular focus on millets (Assis *et al.,* 2010).

These strategies have helped: (1) farmers to revive the traditional millet farming systems and grow minor millets as mixed crops as well as mono-cropping; (2) reduced the rate of erosion of millet diversity and reinforced on-farm conservation of the local landraces; (3) reduced drudgery through de-husking processes, which has resulted in increased consumption; (4) stimulated demand for NUS crop-based products in the market, with such market linkage providing opportunities for additional income. Such an integrated approach is essential for conservation of neglected and underutilized millets, their sustainable use and promotion.

Role of MSSRF in influencing issues related to agro-biodiversity conservation at national level

MSSRF has successfully demonstrated integrated management of agro-biodiversity strategies, not only in the Kolli Hills but also in Koraput (Orissa) and Wayanad (Kerala). MSSRF has also contributed immensely in persuading the federal and state governments to develop programmes that sustain on-farm conservation at a greater scale. Some of key initiatives are summarized below.

- MSSRF played a key role in drafting two important items of national legislation in India: Protection of Plant Variety and Farmers Right Act 2001, and Biological Diversity Act 2002. These two Acts promote on-farm conservation and sustainable use, and equitable sharing of benefits and rights of the farming community.

- The National Advisory Council, of which Professor M.S. Swaminathan is a board member, has advised the Indian Government to include millets in the Public Distribution System through the Food Security Bill.
- The Government of India has introduced a Nutricereal programme with a budget of € 4.6 million. This programme addresses issues related to the availability, access and absorption of small millets.
- The State Government of Orissa and Karnataka has plans to introduce millets in the noon meal programmes.
- Tamil Nadu State Government announced in 2010 the establishment of Genetic Heritage Gardens, based on the advice of MSSRF in five locations in Tamil Nadu, using the classical Tamil landscape framework of *Tinai – Kurunij* (hills and associated biodiversity)*, Mullai* (forest and associated biodiversity)*, Marutham* (agriculture and associated biodiversity)*, Neythal* (ocean and associated biodiversity) and *Palai* (dry and semi-arid regions). Each garden could cover an area of about 25 ha, out of which 10 ha could be reserved for animal breeds, and the remaining area used for preservation of food crops, medicinal plants, farmer varieties, and salt- and drought-tolerant strains. The Genetic Gardens can be used for educational and awareness-generation purposes.

Conclusion

Active community participation in integrated agro-biodiversity resource management, facilitation of innovative ideas of change agencies and favourable state policy support are essential elements in on-farm conservation and sustainable use. Such partnership is needed to effectively handle the issues related to conservation, food and nutritional security, and climate change.

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Sustainable conservation and use of neglected and underutilized species: A Nepalese perspective

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Introduction

There is an increasing realization among researchers, development practitioners and the general public regarding the positive role played by neglected and underutilized species (NUS), not only in food security and improving people's livelihoods but also due to their providing a greater range of nutrition options (Padulosi *et al*., 2009). In order to capitalize on increased awareness about NUS, a three-country (Bolivia, India and Nepal) multi-year research project coordinated by Bioversity International and focusing on conservation and utilization of NUS in the face of climate change has been funded by IFAD/EU. As a first step, the project intended to understand current status, trends and novel approaches in conservation, promotion and utilization of NUS. This paper presents a case from Nepal.

In 1995, Bioversity International (then IPGRI), together with nine national partners, initiated a global project 'Strengthening the scientific basis of *in situ* conservation of agricultural biodiversity on-farm' (hereafter 'the *In Situ* Project'), and Nepal was one of the two participating countries from Asia. In Nepal, the partnership, involving the Nepal Agricultural Research Council (NARC), Local Initiatives for Biodiversity, Research and Development (LI-BIRD) and Bioversity International, has been successful in piloting some innovative methods, approaches and practices for sustaining on-farm conservation. External agencies referred to in this paper are LI-BIRD and its main contributing partners NARC and Bioversity International; the UNDP Small Grant Programme; and the Development Fund, Norway. LI-BIRD and its partners, with financial support from various funding agencies, have maintained a presence in the Begnas area for over 15 years, primarily focusing resources on conservation-oriented actions. The case presented here is the direct outcome of those efforts.

The local institution referred to here is Pratigya Cooperative, located in Begnas village. It was established in 1996 with support from Care Nepal, but remained dormant for some years, and was revived by the *In Situ* Project in 1999, with a new impetus towards conservation and use of biodiversity. The cooperative currently has 39 women, 32 men and 6 institutional members as shareholders. The objectives of the Cooperative include: collection, processing and marketing of agricultural products; conservation of biodiversity though diversity blocks; mobilizing savings for income generating activities; division of work amongst members depending on their skills; provision of competitively-priced milling services to members; and giving continuity to community biodiversity registration processes. Guided by its objectives, the Cooperative has had several activities relating to: sustainable biodiversity conservation; developing Begnas village as a chemical fertilizer- and pesticide-free area; promoting 'one village – one product'; continuing work on community biodiversity registration; and establishing Begnas as a permaculture village. Pratigya Cooperative has over US$ 6000 of funds in its account, and has been distributing a bonus to its members based on annual transactions and profit earned. In the last fiscal year, members received a bonus worth US$ 35 each. The transformation of Pratigya Cooperative from dormancy to a vibrant entity is discussed in the following sections, and we highlight its NUS-related activities over the years.

Methods and approaches

The organization adopted a multi-pronged approach to promote conservation and utilization of NUS in the community. The actions undertaken by different projects over time fall broadly into major three methods or approaches, as described below.

Strengthening local institutions

The *In Situ* Project team realized the need to harmonize service delivery at grass-roots level through existing groups to avoid duplication of work, reduce transaction costs, and improve efficiency of operations. Hence, the project staff spent considerable time with the community in the beginning, identifying local institutions (agencies), understanding their status (strengths and weaknesses) and capacity building needs using different participatory rural assessment (PRA) tools. Based on in-depth analysis of the capacity building needs of these groups, customized training modules were developed for imparting training to group members.

Training concentrated mainly on social mobilization and group dynamics, saving and credit, project planning, book-keeping, conducting meetings and taking minutes, participatory monitoring and evaluation, etc. Since project staff were stationed in the community, it was feasible to conduct training in participatory action research mode, with action and reflection taking place continuously. Apart from regular training sessions, the group members had opportunities for exposure visits to observe and learn from some of the success stories from Nepal, Bangladesh and India. As part of the local empowerment process, the project encouraged and promoted group leaders to share their experiences and success stories in national and international level workshops and conferences. All these actions were intended to empower local institutions and make them efficient and effective in delivering services to the community, while at the same time making them accountable to their constituencies.

Creating income by linking rural-urban markets through strategic value chain alliances:

By definition, NUS are those species with a potential, not yet fully exploited, to contribute to food security, health, income and environmental services (Jaenicke and Hoschle-Zeledon, 2006). Among NUS crops, the project focused its work in the region on finger millet (*Eleusine coracana* L.) and taro (*Colocasia esculenta* L.). However, we shall be highlighting the case of taro along with Anadi rice here because they represent a success story of our interventions along the value chain. Anadi rice is the only glutinous rice available in Nepal, and is grown by many households, but on small areas. It has sociocultural values and is mainly consumed as *Latte* during festivals and on special occasions (Rana *et al.*, 1999).

Figure 1. Interventions along the value chain by LI-BIRD

Project staff had consultation meetings with members of Pratigya Cooperative and various farmer groups, primarily to understand who was engaged in NUS crops; what types of value-added products they were making; and where they actually marketed these products, if any. The idea was to start with community local knowledge and practice, and then build on it. The next step consisted of detailed problem analysis within the production, post-harvest value-addition (processing, grading and packaging) and market-linkage chain. The team jointly developed action plans with budgets, which included interventions in production technologies, value addition and market promotion (Figure 1) (Bhandari *et al.*, 2006). The team also devised clear roles and responsibilities for individual members, institutions and the project to accomplish specific activities. Again, the actions were organized in participatory action research mode, with joint monitoring and reflective action, and learning embedded in the system. From different exercises it was obvious that the driving force was there, i.e. a strong demand for local products by urban consumers. At the same time, the raw materials and traditional knowledge were being underutilized in the rural community yet there was the potential to translate them into rural income. In the rural context, as most households grew the crop, taro products did not have a monetary value in the local rural market. However, there was high potential demand for these products from urban consumers and emigrant Nepalese, who want to take local products away with them. The community of Begnas, however, was unaware of this demand, due to lack of access to market information and linkages.

The project played a facilitating role in establishing on-farm experimental plots to study the varietal characteristics of different taro landraces and their suitability for producing various value-added products such as *masaura* (triangular-shaped dried balls prepared from chopped and dried taro petioles mixed with black gram paste, which is consumed mainly as an off-season vegetable); *tandra* (taro stems cut into long threads and dried for consumption during the off-season; *gava* (prepared by rolling and curling tender leaves of taro, then steaming and drying them for consumption during the off-season (Rijal *et al*., 2001); and *Gundruk* (fermented leafy green vegetables such as broad-leaf mustard or radish leaves, and a popular dish in Nepal).

Similarly, agronomic research was conducted to increase the yield of these landraces. Hands-on training to women members of the groups was provided on hygienic ways of preparing value-added products. These members were provided with nutritional information to be included in the package to increase consumer appeal.

Group marketing was adopted because of the higher transaction cost involved at individual household level; hence, aggregation of agroproducts at Pratigya Cooperative was initiated. Since production was at an individual household level, there was bound to be variation in the quality of products being supplied. Therefore, group members were trained regarding quality aspects of value-added products, and the concept of quality was reinforced from time to time during monthly meetings of group members. The project staff facilitated local institutions in establishing market links with grocery stores, supermarkets and intermediaries for continuous supply of their produce in Pokhara market. The project also facilitated in promoting local products in urban centres by running awareness campaigns through regular FM radio programmes, through school awareness programmes and promoting local groups to sell their produce through stalls in trade fairs, which are regularly organized by municipalities and local government bodies.

Diversifying livelihood options of impact groups

Enhancing livelihood options of rural communities based on agro-enterprises has been one of the core competencies of LI-BIRD. Hence, LI-BIRD, while promoting conservation, has simultaneously focused its attention on diversifying livelihood options of impact groups. Towards this end, the project provided some seed money. The *In Situ* Project phases 1 and 2 combined contributed Rs 130 000; the UNDP Small Grant Project on Community Biodiversity Registration project contributed Rs 250 000 and Development Fund, Norway through different projects contributed Rs 110 000 towards the working capital of a revolving group fund. Cooperative members can access the fund at a low interest rate for starting income-generating micro-enterprises in the village. The group fund has been termed the Community Biodiversity Management (CBM) Fund (Shrestha *et al.,* 2011), which members can access for initiating any income-generating activity. It has become a major stimulus for group members to function smoothly as a team. As a group norm, any group member who takes a loan from the group fund for income generation activity has to undertake one conservation-oriented activity as well. Linking development activities with conservation-oriented activity is an innovative approach, which has directly created incentives for conservation-oriented activities in the community. The project also supported training for group members in different income-generating enterprises, and some material support has been provided to ultra-poor households.

Agro-enterprises adopted by farmers of the Pratigya Cooperative and other groups operating in the Begnas area have been guided by an organic agriculture ethos. The community members have opted for agro-enterprises such as beekeeping, fresh mushroom production and goat rearing that require minimal chemical inputs in terms of fertilizers and pesticides. Spontaneously, these groups have been promoting the preparation and use of bio-fertilizers and bio-pesticides on their farms. Increasingly, local-level institutions are taking initiatives to start new rural enterprise (e.g. ‘home stays’ for domestic and foreign tourists) to supplement member incomes.

Discussion

This section has two immediate foci: analysis of how mobilizing social and human assets transformed Pratigya Cooperative, which is now contributing to collective conservation efforts at community level; the second focus analyses sales figures for taro products, indicating how value addition and market linkage of NUS actually contributed to conservation of taro landraces on-farm. Sales figures for Anadi rice represent a case where market promotion of a unique landrace (glutinous trait) contributed to its conservation on-farm, while simultaneously providing economic benefits to growers. Finally, we present the diversity of livelihood options, number of households involved and the magnitude of the benefits derived from the services, and the link to conservation agriculture.

Pratigya Cooperative contributing to on-farm conservation of NUS

Since Partigya Cooperative members fully comprehended the value of conserving agricultural biodiversity on-farm, the members have unanimously decided to collect and maintain a diversity block of twelve taro landraces on-farm. The Cooperative has continued this every year on a regular basis even after the project phased out in 2006. Anyone wishing to try one of the taro landraces can purchase planting materials from the Cooperative.

A diversity block of finger millet with eight landraces is also maintained in the village. The diversity block serves two purposes: first, the diversity block demonstrates the extent and characteristics of diversity available in the area to community members, schoolchildren and outside visitors; and, second, the block acts as micro-plot seed multiplication of these landraces (i.e. a field genebank).

Similarly, the Pratigya Cooperative has supported the maintenance of a diversity block with 151 species of medicinal and herbal plants in the village, which is drawing a lot of attention from visitors. In fact, medicinal and herbal products displayed on the stall during trade fairs in different parts of Nepal have received an overwhelmingly positive response from urban consumers.

Market promotion of taro products leading to conservation of landraces on-farm

The market value of agricultural produce can be increased through development of new markets, improved marketing, value addition and high-value product differentiation, supported by improved processing equipment adapted to diversified sustainable use of plant genetic resources for food and agriculture (Jarvis *et al.,* 2010).

Here we would like to present the case of taro, i.e. value addition and market promotion efforts and conservation of taro on-farm (Figure 2). The Pratigya Cooperative has been active in collection of value-added taro products such as *masaura*, *tandra*, *gava* and *gundruk* from group members and supplying these products to the urban market in Pokhara. Since these products, apart from *gundruk,* are made from different parts of the taro plant, no one landrace has all the traits suitable for preparing these products. For instance, farmers use the petioles and stems of *Panch Mukhe* and *Khajure* for preparing *masaura*, whereas *Khari* and *Kaujure* stems are considered best for *tandra*. Likewise, *Khajure* and *Assame Kalo* are used for preparing *gava*. For selling corms, *Hattipau* is considered best because of its high yield. For cormlets, *Lahure Seto* and *Lahure Kalo* are preferred because they yield numerous cormlets. Hence, farmers maintain a diversity of taro landraces for a diversity of purposes.

Supplying value-added taro products started in 2001, during the *In Situ* Project phase, but the amount handled was small, hence disaggregated data was not gathered. However, over years, the volume of transaction has gradually increased, so the Cooperative in 2006 started maintaining disaggregated data for all the items that made it to the market. From the graph in Figure 2 it can be seen that the amount of taro products reaching the market more than doubled over five years for most of the products except *masaura*. Still, remember that we are talking about only a few hundred kilograms of dried taro products. One of the major challenges for expansion is how to ensure uniform hygienic quality of products. Perhaps the time has come for the Cooperative to review its progress to date and explore ways forward based on learning from others.

LI-BIRD/Nepal

Finding new markets for traditional food; promoting traditional food in the market; new products of local crops

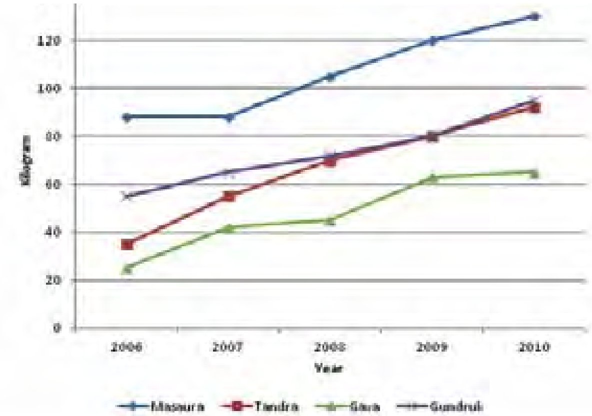

Figure 2. Trend in sales of agriculture products (taro products) by Pratigya Cooperative, Nepal

In addition, we would like to present two lessons learnt from our work, which might be useful for others who wish to initiate similar ventures.

First, linking farmers to urban markets was found to be the quick way to generate income from local products. The project encouraged local entrepreneurs to purchase the produce, process and pack the products and sell them through various market outlets. Pratigya Cooperative and local entrepreneurs together identified a list of local products and the amount required for marketing. However, the idea was short-lived as the cooperative could not supply the agreed quantity with a standard quality at the price offered, resulting in consumer complaints to the entrepreneurs. The project team thus tried to strengthen the capacity of the cooperative to organize a group of women farmers to produce one product and train these women in quality control and hygiene with regard to one product. They agreed to produce the minimum amount of produce to meet consumer demand. Local entrepreneurs helped to train farmers and the entrepreneur was invited to join as one of the shareholders of the cooperative. As the business gained momentum, conflicts of interest arose with regard to price and the cooperative decided to set up their own market outlet by opening a shop (*Gaule Pasal* – Rural Shop specialized in selling local products) in Pokhara, Nepal. The shopkeeper (a paid employee of the cooperative) realized that he could not make an independent decision to change the price and sell to consumers to reflect market dynamics, since the cooperative is driven by collective action and based on maintaining a system of transparent transactions. The project team, however, was ill-equipped to help farmers make informed decisions about the market strategy for the outlet, and within a year farmers realized that marketing of local products is a "hard nut to crack" without specialized skills, networks, and risk-bearing capacity, so the shop pulled down its shutter. Now the cooperative is supplying the value-added products to the market through another intermediary.

Second, not all farmers are capable of utilizing market signals. Another lesson learnt from the above failure was that farmers were good at producing the agricultural goods and semi-processed materials, but it was too risky for them to take up value-addition and marketing by themselves, as the skills and investment required were not readily available. Strategic alliances with NGOs and the private sector were required to overcome the problems in the stability of quantity and quality, and timely delivery of the product. The community-based organizations (CBOs) and women's groups were encouraged by the project team to make their own annual work plans and assign specific roles and responsibilities for monitoring the progress of activities, simultaneously empowering the community to achieve long-lasting success in rural innovation.

LI-BIRD/Nepal

Figure 3. Joint monitoring of Anadi production plots by researchers and farmers

Another product considered here in this presentation is Anadi rice. Unlike taro products, Anadi rice only involves limited value-addition, primarily milling and packaging. The Cooperative has a sheller rice mill, which mills 60% of Anadi rice purchased from farmers, and milled rice is sold to Janaki Agro-Products (an intermediary), which again supplies packaged Anadi rice to grocery stores, departmental stores, supermarkets, hotels and restaurants in Pokhara valley. About 30% of the purchased Anadi rice is sold direct to Janaki Agro-Products without milling, and the remaining 10% is processed into *siraula* and *chiura* (beaten rice), and these products are again supplied through the same chain to the market. *Siraula* is prepared by soaking husked Anadi rice in water, then roasting the soaked rice till they pop. It is left to cool, and then de-husked either by huller machine or manually operated paddle pounder. Siraula is consumed as a snacks, or mixed with milk and then consumed (Rana *et al.,* 1999).

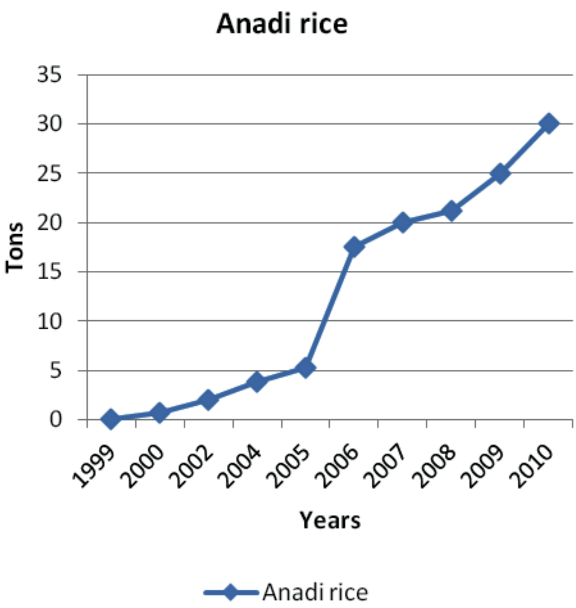

Figure 4. Trend of sale of agriculture product (Anadi rice) by Pratigya Cooperative, Nepal

Figure 4 shows that within a decade the volume of Anadi rice handled by Pratigya Cooperative increased from almost zero to about 30 tonne/year. A remarkable jump in the amount handled was observed in 2006 when the Cooperative started collection of Anadi rice not only from within the village but also from adjoining villages. The demand has been such that Janaki Agro-Products is exploring other production sites in Nepal, such as Nawalparasi District. This study provides empirical evidence that market forces, as Gauchan *et al*. (2001) argued, could play an important role in conserving landraces with unique traits—traits that consumers value, but which cannot be easily transferred into modern varieties. However, for NUS, the challenge lies in making them attractive or appealing for consumers, so that they take notice and increase their demand, which in turn will induce cultivation on-farm.

Promoting biodiversity rich livelihood options

LI-BIRD, through various projects, has been making efforts to address community desire to increase their household income as well as diversifying their livelihood options. While promoting livelihood options, efforts are being made to ensure that conservation-friendly practices are promoted. Some of the livelihood options, number of households involved and amount of income earned have been summarized in Table 1.

Table 1. Diversity of livelihood options for community members in Begnas, Kaski, Nepal

Income Generating Option	No. of households involved		Income (Rs)	
	2007	2010	2007	2010
Fresh vegetable production	60	90	80 000	100 000
Beekeeping	80	100	129 000	160 000
Value addition (taro)	40	60	300 000	450 000
Mushroom production	25	25	80 000	80 000
Goat rearing	137	250	685 000	915 000
Lotus conservation	15	60	15 000	40 000
Eco-tourism (home stay)	–	>20	–	ca 400 000

Cooperative members and the general public in the community have taken soft loans from Pratigya Cooperative to initiate or expand their income generation activity. For instance, many farmers have been taking loans for goat rearing and beekeeping. These rural enterprises are suitable for the locality because of an abundance of forage and fodder from community and private forests. With the expansion of apiary enterprises in the community, farmers have been promoting the use of bio-pesticide. Lotus conservation and eco-tourism (home stay) are recently introduced interventions that contribute to conservation as well as livelihood diversification for rural communities. With individuals deriving direct benefit from income generating activities, their economic status has steadily improved, and thus they are encouraged to engage in conservation-oriented activities.

Conclusions

Although rural–urban market links for value-added produce is an attractive strategy for sustainable livelihood, there are many challenges, and the lessons from previous projects and the constraints described highlight that. On a positive note, empirical evidence presented here clearly demonstrate that community-level institutions (the Pratigya Cooperative in this case), with some support from external agencies, can play a significant role in conservation and utilization of NUS crops. Provided community members are aware of conservation and see a clear link between conservation of NUS and their livelihood improvement, community members are more than willing to contribute their fair share to conservation efforts. However, the case presented here represents consistent and coherent engagement with the community for over a decade, even though the formal projects ceased in 2007. We can see that in recent years there has been a significant jump in volume of commodities handled by the Cooperative, suggesting that initiatives take time for reasonably large number of households to adopt them and have some visible impact at community scale. Therefore, external agencies should be prepared to work with multi-stakeholders while making interventions along the value chain for a sustained period to bring about positive change in people's livelihood, and at the same time contribute to conservation of NUS crops on-farm. Finally, it is clear from this case study that farmers are unaware of market opportunities, but not all local crops can be marketed equally well. Capacity to differentiate traits for high value products from existing diversity seems lacking in research and development programmes.

Better appreciation and understanding of constraints and the difficulties for value chain actors are essential. Although the idea of value addition of local products is very appealing to local communities and policy-makers, successful implementation requires a concerted and integrated long-term professional approach from multiple partners. Marketing local products is a specialized field, and therefore requires special attention to enhance the skills of cooperatives, farmers, local entrepreneurs and national companies. The most important lesson derived from these cases was that different stakeholders with varied expertise playing different roles in the market chain were required to develop a partnership, thus using the comparative advantages of each partner for mutual benefit. The success of part of the chain does not ensure benefits to all actors in the chain. It is essential to understand the constraints of each link in the chain (actor) and to try to overcome these from the outset through capacity building, research and awareness programmes.

Recommendation

Our experience has shown that longer-term engagement by external agencies within the community is absolutely necessary to have an impact on NUS conservation and utilization. In addition, the support of external agencies becomes crucial for addressing second-stage (disease and pest control; processing) and third-stage problems (marketing), which require different sets of skills to solve the problems. Thus, empowering the local community to overcome these problems and sustaining the growth of the enterprise would aid conservation efforts on-farm, and serve as a model to demonstrate that the community can derive benefit by conserving NUS on-farm. As community members become better off in economic terms as a result of the intervention, the terms of engagement with external agencies could evolve into community members paying for some of the services on a cost-recovery basis. There is potential for piloting the cost-sharing model in some areas.

Diversification of agriculture-based livelihood options leading to increased income at household level really motivated people towards conservation. Coupling community development goal with conservation goals through the Community Biodiversity Management (CBM) Fund has proved to be incredibly useful, and an innovation that has been replicated to other areas, and proved very effective in conserving local crops and landraces on-farm. Mobilizing the CBM fund has enabled community-level institutions to reach more farmers and address their developmental needs. The fund also helped local institutions to become more inclusive by engaging resource-poor and marginalized households in conservation activities. By reaching a larger number of households and becoming more inclusive, the local institutions have increased harmony in the community, and amassed support for conservation of NUS crops at local level.

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Discussion

On key polices needed and sustainable practices for sustainable conservation and use of GR.

- Supportive Policy measures:

Could be visibility of the community. Actions in support of the activities of the communities. The institutions are there (local ones; farmer groups) and we should build on those that are more active

- Education

Informal community building (participation, aspiring to a higher goal)
Global network of custodian farmers.
Better organization of farmers

- Policies to keep the market local

Custodian farmers, education and market recognition of these by the local, regional level governments

- Linking the custodian farmers to genebanks, and how do we link them to the other farmers. Sensitizing genebanks that NUS should be conserved.
- Custodian farmers need recognition by the policy-makers!!

However, we should be careful in identifying and incentivizing Custodian farmers as the rest of the community may feel disengaged.
Important point: we need in fact to focus not on single farmers but on communities. Initially we should focus on champion farmers to give visibility, and later we can broaden attention so as to engage more members and the whole community.

- Quick access to varieties for small-scale seed companies.

Facilitate the exchange of varieties among Custodian farmers – Platform?
Modify seed legislation to recognize NUS
Label for custodian farmers
Genebanks are:

- providing a service

Field genebank = decentralized conservation bank.
Importance of linking community gene banks directly with *ex situ* collections!
Issue of access to international genebanks by farmers.
Note: seed policies for NUS are different from those of major crops!
In the case of trees, we only have custodian farmers!! This is a really fundamental issue!! Must be taken into consideration.
Incentives (money level)

- Using the money for education, awareness in farmers

Promote knowhow exchange
Promote the products at the regional level, and as niche products
Products should be kept locally
Marketing strategy

Discussion on second part of Session Four

It is important to remember that NUS are mainly local crops whose value can be appreciated by local people as part of traditional food systems, etc. We are not advocating making them global crops! So we should focus on local traditions and customs to leverage attention and promote them locally.

We need better policies that encourage and support cultivation of resilient AND nutritious crops!

Negri: there is no ONE solution in promoting NUS. There are many solutions and we need to choose those that best fit with the local contexts.

Empowerment of farmers is again very important!

Reflections on market-based strategies for enhancing the use of agrobiodiversity

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Introduction

Plant genetic resources are the basis of agricultural production, providing important economic benefits to both developed and developing nations. In the case of neglected and underutilized species (NUS), such as Andean grains (quinoa, amaranth, *cañihua*) or Amazonian fruits (*camu camu, aguaje*), the realization of these economic benefits is seriously hampered by agronomic, commercial, policy and social constraints, which demand urgent attention by R&D and legislative actors (Rojas *et al.*, 2010). NUS are part of a large biodiversity portfolio comprising thousands of species (Padulosi *et al.,* 2002) and characterized by individual characteristics, including strategic roles in local consumption and production systems, and carrying high levels of adaptation to agro-ecological niches and marginal areas. Despite these useful traits, their use and enhancement is currently poorly addressed by national policies, which continue to place emphasis on major crops in their agricultural development programmes. The obstacles in the way of promotion of these species are numerous and highly interconnected, and include the limited availability of improved varieties, the lack of adequate levels of genetic diversity in *ex situ* genebanks, the presence of fragile or non-existent seed supply systems, poor transformation technology and limited value addition in disorganized or nonexistent value chains (Rojas *et al.,* 2009). Furthermore, difficulties in logistics, traceability and communication, as well as a recurrent negative image of being ‘food of the poor’ are also additional factors that challenge the development of these species.

This contribution covers some of the obstacles encountered along the NUS promotion pathway, focusing in particular on four aspects related to the performance and sustainability of their value chains, namely the elimination of non-tariff commercial barriers; value addition through product differentiation; ecological recognition; and fair trade certification.

The elimination of non-tariff commercial barriers

Currently the commercialization of biodiversity and its products, particularly those originating in developing countries and exported to industrialized nations, encounters a number of obstacles, one of this being the presence of non-tariff commercial barriers. One example of these comes from Europe. According to European Union Regulation No. EC 258/97 on Novel Food (EC, 1997), all food products (many of which include traditional food and natural ingredients from developing countries) not commonly eaten in the EU prior to 1997 must undergo a special approval process that involves production of dossiers to substantiate their safety for consumers. The impact of this policy on the exportation of biodiversity products (and particularly NUS) to Europe is heavy: products are authorized to be imported and commercialized as food only in those cases where scientific proof has been provided regarding their safe use, and such a process too often can be very lengthy and expensive. For instance, this is the case for *yacon*, *camu camu* and *sacha inchi*, well known species with centuries-old traditions in their countries of origin, but whose commercialization in Europe would now require detailed and exhaustive dossiers to prove their safety before being allowed to enter the European market. Such a policy represents a non-tariff barrier to the export of traditional food from Latin America and other developing countries to the important market that is the EU, and it translates into a heavy obstacle to sustainable promotion, particularly of traditional crops and NUS characterized by relatively small niche markets (Hermann, 2009). If we are to be really effective in promoting agrobiodiversity in order to support people's livelihood that depend on their cultivation and marketing, we need to pay more attention to enabling policies in support of free trade in these resources. In the case of the Novel Food regulation, for instance, one way to improve the current situation would be to have food safety requirements in proportion to the risks they pose, which would reduce some of the pressure currently experienced by NUS producers wanting to export to Europe.

Another relevant set of policies regarding food safety certification of biodiversity products intended for international markets are so-called Good Agricultural Practice (GAP) requirements, which cover a variety of issues related to environmental, economic and social sustainability for on-farm processes, and result in safe and quality food and non-food agricultural products. The objectives of GAP (codes, standards and regulations) include (1) ensuring safety and quality of produce in the food chain; (2) capturing new market advantages by modifying supply chain governance; (3) improving natural resources use, worker health and working conditions; and (4) creating new market opportunities for farmers and exporters in developing countries (FAO, 2003). There are several advantages related to the application of GAP, such as assisting countries to comply with national and international regulations, standards and guidelines (such as those of the *Codex Alimentarius*) regarding content of pesticides, contaminants in food and non-food agricultural products, as well as other chemical, microbiological and physical contamination hazards. While these practices can indeed be beneficial to ensure the quality of the final products, at the same time their implementation may increase in production costs and—as noted for novel food regulations—may well marginalize small- and medium-sized enterprises (SMEs) in view of their inadequacy with regard to the technical and organizational aspects required to implement GAP effectively.

Other relevant practices that may create a non-tariff barrier to the marketing of biodiversity and its products are Good Manufacturing Practices (GMP). These are guidelines regarding practices for the manufacturing, quality control and quality system related to production and testing of a diversity of products (including foods) that can affect their ultimate quality. They are not prescriptive instructions on how to manufacture products, but rather a series of general principles that companies are advised to establish in building their quality-control programme and manufacturing process. A good example of GMP is that of the U.S. Food and Drug Administration (FDA, no date). Worth mentioning is also the Hazard Analysis and Critical Control Point system (HACCP), a procedure required by the EU since 2006, for the marketing of processed food from developing countries and destined for EU markets (EU, 2004).

While there is no doubt that these regulations play an important role in ensuring greater food safety (within Europe and elsewhere), it should be also recognized that their execution is challenging for many SMEs of developing countries in terms of the financial resources, infrastructure and human capacity needed for their proper implementation. It would therefore be appropriate that within the framework of the newly launched IFAD NUS Project some attention should be given to these policies and the constraints they present. In particular, the author proposes that opportunities be explored for:

(1) building capacities of partners in target countries in addressing these guidelines and practices (explaining what they are, what they require and how they can best be addressed);

(2) promoting associations and synergies among producers for strengthening their infrastructural capacity in addressing the policy requirements within a group or cooperative approach); and

(3) promoting national and international policies that are more supportive to the sustainable use of traditional biodiversity, such as NUS, in recognition of their valuable role in income generation among poor, rural, small-scale farmers.

Value addition through product differentiation

Consumers today show an increasing interest in natural and healthy (both cosmetics and food), authentic, novel and exotic products. There is a growing preference for the so-called functional foods, which are defined as ‘food or food ingredients that may provide a health benefit beyond the traditional nutrients it contains’ (IFIC, 1999). These healthy ingredients include vitamins, minerals and antioxidant, anti-carcinogen and anti-diabetic compounds. Crop species being commercialized as functional foods include many NUS, such as *yacón* (*Smallanthus sonchifolius*), *noni* (*Morinda citrifolia*), *açai* (*Euterpe oleracea*) and *camu camu* (*Myrciaria dubia*). Moreover, more attention is being also given to ethical practices related to the marketing of biodiversity products. These may include absence of child labour, human rights protection, absence of product testing using animals (in the case of cosmetics), a fair price for producers or fair remuneration of workers. For a growing part of consumers, buying sustainable products from biodiversity is becoming a source of personal satisfaction or some kind of concrete support towards the building of a better world.

Indeed, the loss of biodiversity as well as its sustainable conservation and use are linked in many ways with economic activities of companies and their growing corporative social responsibility (CSR) commitment that responds to consumer demands. Many companies see sustainable and ethical practices as a way to differentiate themselves from others and increase the value of their product. But in order to realize effective integration of ethical practices through product differentiation strategies, there is a need to develop adequate business models. In fact, many SMEs in developing countries involved in biocommerce have great difficulties in differentiating their products in the market in order to justify a premium price that covers the additional costs related to sustainable use practices. More and more enterprises are thus searching for tools, processes and practices that would help them to adequately differentiate products and make them more competitive with others without unsupportable effects on production costs. This is another aspect that could be explored by the NUS Project in the context of sustainable on-farm conservation of NUS.

Ecological certification

According to the Research Institute of Organic Agriculture (FiBL) worldwide annual sales of organic certified products in 2011 were approaching US$ 60 billion (Organic World, 2011). While this is an impressive figure it must be added that current ecological certification standards do not deal sufficiently with fundamental issues such as sustainable production, maintenance and promotion of social structures within communities, nor deployment and promotion of plant species diversity in the market. Problems with weak inspection procedures and cases of inspectors without appropriate knowledge are also being reported as additional issues. Moreover, cases of overexploitation of crops (*camu camu*, quinoa) have been recorded along with weak ethical standards in relevant regulations dealing with ecological certification. More attention should therefore be given to improving these certification schemes, with greater attention to ethical, social and biodiversity concerns. It is the author’s view that such improvements would be seen very positively by the market and serve as an additional element of support in NUS promotion.

Fair Trade Certification

The Fair Trade Labelling Organization International (FLOI) has performed an excellent job in promoting fair commerce through international markets. According to the latest estimates, the total number of farmers and workers in the Fair-trade system was 1.15 million at the end of 2010, and expected to exceed 1.2 million in 2011, while in the 2009–2010 business year, total reported Fair-trade sales revenues by farmer organizations amounted to US$ 550 million, a 24% increase over the previous year (FLOI, 2011).

However, the Fair-trade system is not perfect, and several flaws in current standards, as well as a lack of rigorous controls, have often been reported. A very low percentage of fair trade ingredients are allowed as part of the final product yet retain the Fair-trade cachet. There are eligibility limitations for producer organizations, and environmental sustainability is not a key issue. Another issue is the need to develop standards product by product. These are yet other issues that could be considered of interest within the context of the NUS project just launched.

Geographical Indications

According to Article 22(1) of the World Trade Organization (WTO) 1995 Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS), geographical indications (GIs) are defined as

> "indications which identify a good as originating in the territory of a Member, or a region or locality in that territory, where a given quality, reputation or other characteristic of the good is essentially attributable to its Geographical origin" (WTO, 2012).

GIs serve to identify goods as originating in a specific territory, and as indicators of quality to let consumers know that the goods originate in an area of a given quality and reputation. According to the organization OriGIn, that is world leader in the promotion of GIs, the idea behind GI is

> "a Geographical name used to identify goods that can only be produced in a given geographical and cultural zone. The environment, by virtue of its soil composition, climate, biodiversity, local know-how and other human factors, confers specific characteristics on these products that make them unique [..].The quality and characteristics linked to the geographical origin of a product must be sufficiently specific to differentiate it from other goods. The concept of quality can be defined in relation to the product's nutritional properties, flavour, appearance, or the process and raw materials used to produce it. The product's characteristics can be determined by various standards, such as physical/chemical and/or organoleptic traits. Reputation refers to the opinion consumers have of a given product; this generally requires a substantial period of time to be formed. (Ngo Bagal and Vittori, 2011).

Examples of Geographical Indications in Latin America can be found in Colombia (Café de Colombia; Café Nariño), Peru (Pisco del Perú; Maíz Gigante del Cusco), Mexico (Tequila; Queso de Cotija), Ecuador (Cacao Arriba), Venezuela (Cacao de Chuao), Costa Rica (Queso de Turrialba), Brazil (Café do Cerrado) and Bolivia (Quinoa Real del Altiplano Sur). In India, well known GIs include Basmati rice, Darjeeling tea and Alphonso mango.

Geographical Indications are increasingly seen as alternative instruments for supporting small-scale producers and niche products based on NUS. If developed, the GIs for NUS can translate into incentives to promote knowledge of traditional production, ecological production and sustainable use methods for agrobiodiversity, something that is very much also at the heart of UNCTAD BioTrade Initiative (WTO, 2012). Applied as a marketing and product differentiation strategy, the existing limitations in marginal areas could in fact turn into a strength. Additionally, agritourism can become an important complementary activity based on producers' identity (Taranto and Padulosi, 2009). With regard to NUS, we should however be aware of a number of challenges that might make the obtaining of the GIs first and then its implementation later a rather challenging task: the successful marketing of products with Geographical Indications requires the elaboration of a legal and administrative framework (which might not be yet solid enough in a target country), financial resources (often very limited when dealing with the promotion of local crops and NUS), producer organizations (often lacking or very poor for NUS), experience (not very common in developing countries), clear quality criteria (requiring research investments and knowledge when dealing with poorly studied crops like NUS) and political commitment (not necessarily a given for many countries).

Discussion and conclusions

Agricultural biodiversity is a strategic asset for poor communities living in harsh environments and represents a source of livelihood options to improve their quality of life in terms of income, food security and health.

The rediscovery and promotion of NUS needs to be supported by research and coherent, holistic and multidisciplinary approaches. Within such framework, more attention needs be devoted to strategic market-based elements such as non-tariff commercial barriers, product differentiation, ecological recognition and fair trade certification.

The elimination or modification of non-tariff commercial barriers in the EU as mandated by Regulation EC 258/97 could become an important incentive to increase the use of NUS and generate income. There has been a move to review the 1997 regulation (EU, 2011).

Due to the increasing consumer interest in biodiversity-friendly products that are socially responsible (ethical, ecologically benign, fair), a considerable range of product differentiation mechanisms (local specialties, brands, designation of origin, quality) have been developed. But in order to benefit the broader range of NUS crops and products, it is necessary that these standards become recognized worldwide and verified through adequate and fundable certification mechanisms for enterprises with the purpose of acquiring market credibility and transparency. It is also necessary to develop sustainable and integrated standards (ethical, social, ecological) for biodiversity products, including intangible values, in order to improve the livelihoods of the poorest groups in society. The standards must be applied worldwide and for this a considerable global consensus is required.

The premium prize for organic quality, fair and biodiversity together must provide the necessary extra value for all the actors of the value chain to promote the sustainable use of NUS.

More support needs to be directed to SMEs so that they can process their products, adding value in regions of origin and contributing in this way to local development and social cohesion. Geographical Indications as a marketing tool for traditional food can become an important mechanism for product differentiation. Tax incentives and adequate access to credit mechanisms for enterprises that invest in sustainable businesses are required.

However, in order to pursue these objectives effectively and sustainably, solid alliances among research agencies and other actors (development agencies, public organizations, NGOs, private sector, etc.) need also to be developed. One way to do that is to promote collaborative platforms that would foster the needed synergy and complementarity among these actors and that could play a crucial role in sustaining value chains of NUS products even after specific project interventions have ended. Valuable experience in the establishment of collaborative platforms among different value chain actors can be found in Jäger *et al.* (2010). These linkages among different stakeholders would be crucial in order to support producers in complying with market requirements for quality, quantity and safety, as well as excellent functional, visual and aesthetic quality.

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oriGIn – The Organization for an International Geographical Indications Network

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Background

In 2003, in response to the increasing risks of abuse and misappropriations faced by Geographical Indication (GI) producers worldwide, they joined forces and established oriGIn – the Organization for an International Geographical Indications Network. oriGIn is based in Geneva, Switzerland, and registered as an international non-governmental organization.

Conceived as a network for the exchange of information and 'best-practices' among GI producers, oriGIn's goals are to:

- promote GIs as a tools for sustainable development for local producers and communities; and
- advocate for more effective legal systems for GI protection at the national, regional and international levels, through campaigns aimed at decision-makers, the media and the public at large.

Why oriGIn?

Ensuring and preserving the unique qualities of origin of products

Geographical Indications (GIs) ensure and preserve the quality and reputation of origin of products. Consumers benefit greatly from GIs, which convey valuable information concerning the product's characteristics, obtained in accordance with strict specifications verified by independent bodies. Differentiating the production based on its geographical origin provides revenues and ensures pride to millions of producers around the world.

Unfortunately, GIs constantly face the challenge of third parties trying to take advantage of their hard-earned reputation. For example, fake "Champagne" is sold as if it was an original product from the Champagne region of France, and products are marketed as "Colombian Coffee" that are not 100% Colombian in origin. The phenomenon of GI misappropriation is increasing, putting at stake the reputation of origin of products and the GI-associated jobs. Why make the effort to produce a high quality product, abide by strict internal rules, and gain reputation in the marketplace, if anyone can use a GI and exploit the reputation producers have built over decades of hard labour?

At oriGIn, we think this is unfair. In response, we have become the voice of GI producers within the main international and regional forums, including the World Trade Organization (WTO), the European Union (EU), and the World Intellectual Property Organization (WIPO). In 2008, oriGIn played a key role in forging the coalition (including a large majority of WTO Member States) that supports the extension of the high protection of Art. 23 of the TRIPS Agreement to all GIs, as well as the establishment of a truly multilateral register for all GIs within the WTO. Moreover, oriGIn helps its members reduce monitoring costs in foreign markets and reach out to policy-makers in cases of abuse. Our members send us information concerning potential infringements taking place in their regions, and oriGIn acts to stop them through public campaigns and legal advice.

Unity is strength

oriGIn represents some 200 organizations of producers from 40 countries. Through this international network, GI groups and organizations exchange experience and best-practices.

At oriGIn's regular international events (conferences, exhibitions, round-tables, etc.), GI producers have the chance to meet other producers facing similar challenges, as well as experts and potential business partners.

oriGIn has also become a partner to all relevant international actors. There is no seminar, symposium or workshop dealing with GIs that can be considered complete without oriGIn's participation and the private sector point of view that our organization brings.

Promoting sustainable development

GIs play a key role in the sustainable development of local communities. Deeply rooted in the local culture and traditional knowledge, GIs ensure conservation of local resources, which also contributes to food security. Moreover, GIs prevent the delocalization of production. A GI can only be produced in a given area, which gives the product—by virtue of the climate, "terroir" or human factors, alone or in combination—its specific characteristics. As a result, big corporations are prevented from "capturing" the added value of traditional products and related methods through the appropriation of these techniques and production outside the area of origin.

oriGIn is involved in various technical assistance projects aimed at helping producers and communities take full advantages of the local GI potential. oriGIn also advocates for an increase in the development funds devoted by multilateral and bilateral donors to GI-related projects.

Knowledge is power

GIs have become a global phenomenon. As a result, national laws are rapidly evolving. oriGIn provides invaluable technical support in the form of periodical reports, newsletters, studies, information on court decisions and national laws, as well as other material on GIs. oriGIn's network represents a unique source of information on the main issues dealing with GIs (legal protection in major markets, quality control, marketing, etc.).

oriGIn also provides specialized services, among them:

- Advocacy
- Legal Advice
- GI Market Watch
- oriGIn Info Service
- Technical Assistance

For more information, see www.origin-gi.com and https://twitter.com/oriGInNetwork

Geographical Indications, biodiversity and on-farm conservation

Geographical Indications (GIs) are distinctive signs that associate products of quality and reputation with their place or area of production. Indeed, the specificity of certain GIs relies on the use of specific natural resources, notably native plant varieties and animal breeds. Nevertheless, the interaction between the human factor and the environment is fundamental to preserve environmental resources.

The GI producers' choice of production methods might have implications for the local environment. In this sense, the definition of the rules in the code of practice with specific references to animal breeds or vegetal species has an important role in their preservation and promotes a positive impact on local sustainable development. This should be taken into consideration when setting up a code of practice to prevent overexploitation of natural and local resources. In this respect, local producers and stakeholders play a key role for a GI to be a successful approach for preserving environmental resources.

Several case studies show that a GI can be a tool for the valorization of local assets and preserve natural resources if certain characteristics of production might be linked to valoriszation of endemic species or specific local resources. To include breeds and species in the code of practice is necessary, but not sufficient as different strategies can lead to significant differences. Taking into account the protection of natural resources is a challenge for GI products.


oriGIn/Switzerland

Case studies

1. Argan Oil (Morocco)

Argan oil is produced exclusively from the fruit of the Argan tree (*Argania spinosa*), endemic to the southwest of Morocco and perfectly adapted to the harsh heat, poor soil, and droughts typical of the area. It prevents desertification and soil erosion.

The extraction of Argan oil is ancestral knowledge developed by the women living in the territory.

In the 20th century, nearly half of the Argan forest disappeared due to the demand for charcoal and the conversion of land to the production of export products like tomatoes. In 1998 UNESCO declared the Argan forest region a biosphere site.

The GI recognition increased the local valuation of biological resources, inducing conservation of the Argan forest.

For more information see: http://www.argane-igp.org/cahier%20des%20charges1.pdf


oriGIn/Switzerland

2. Comté (France)

Since the 11th century, farmers have joined forces and pooled their daily milk to produce Comté cheese at the local cheese dairy. Comté is a hard cow's milk cheese in the form of a wheel. It is recognized as Protected Designation of Origin (PDO) in the European Union.

The code of practice establishes that the only milk permitted for use in Comté is from two local breeds, Montbéliarde and Simmental, fed exclusively on forage in the region covered by the appellation, unless there are exceptional circumstances. Soil fertilization is strongly limited to preserve the richness of the natural flora. The presence of particular herbs gives the milk a specific flavour, delivering the uniqueness of the cheese.

A study carried out by "Comité Interprofessionnel du Gruyère de Comté" found 426 different plant species in 20 zones. With 30 to 65 species per field, the Comté region is very rich in plant biodiversity.

For more information see:
http://ec.europa.eu/agriculture/quality/door/registeredName.html?denominationId=262


oriGIn/Switzerland

3. Manx Loaghtan sheep (Isle of Man, UK)

This Protected Designation of Origin is for fresh meat from a specific breed in the Isle of Man in the United Kingdom.

The meat is required to come from pure-bred Manx Loaghtan sheep, which are born, reared and slaughtered on the Isle. The breed has a distinct appearance and is thought to have been on the island for more than a thousand years, descended from those introduced in historical times, originating with the Celts or perhaps the Vikings.

At the end of the 18th century, the breed declined due to the introduction of new breeds that yielded more wool and meat. During the 20th century, the popularity of Loaghtan sheep began to increase again due to the recognition of how well adapted it is to the local environment.

oriGIn/Switzerland

Thanks to the GI recognition, the valorization of the specific characteristics of this meat helped the survival of this distinctive, ancient breed.

For more information, see:
http://ec.europa.eu/agriculture/quality/door/registeredName.html?denominationId=356

4. Cacao Arriba (Ecuador)

"Arriba" is one of the world's finest cocoa sources, grown only in Ecuador. It is also known as "Cacao Nacional" because of the name of its unique traditional cocoa variety. Cocoa Arriba is characterized by a very short period of post-harvest fermentation, a floral aroma and smooth flavour. It is grown on small- to medium-sized farms.

The unique aroma and flavour of Nacional cocoa is highly valued amongst cocoa specialists. It has acquired an international reputation that has resulted in a market premium of 15–30% and makes growing Cocoa Arriba an economically viable option instead of cloned varieties such as the CCN51 grown on larger plantations.

Local stakeholders, convinced that the value of certified cocoa would increase in the near future, decided to apply for denomination of origin for Cacao Arriba, as well as to preserve the variety Cacao Nacional by setting rules in a code of practice. The process for the recognition is continuing.

For more information see:
http://www.fao.org/ag/agn/agns/Projects_SQP_Santiago/Documentos/Estudios%20de%20caso/Cacao_Ecuador.pdf

oriGIn/Switzerland

5. Maiz blanco gigante de Cuzco (Peru)

The "Maiz blanco gigante de Cuzco" is an ancient variety. The maize is unique to Peru, grown exclusively in the Andean mountains in the Sacred Valley of the Incas in Urubamba, Cuzco. In this valley, over 96% of the farmers have 2 ha or less.

So important is the maize variety that it is recognized as part of the Peruvian cultural patrimony.

Unfortunately, this special maize is threatened by floods, pests and climate change, and was at risk of extinction. Faced with this situation, relevant stakeholders considered that the GI approach was the most effective response available to preserve this variety.

For more information, see: http://www.fao.org/ag/agn/agns/Projects_SQP_Santiago/Documentos/Estudios%20de%20caso/Mais_Peru.pdf

The Slow Food Movement and its approach to supporting on-farm conservation

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Ladies and Gentlemen, it is a great honour for me to be invited here to present the ideas and work of Slow Food in relation to biodiversity.

You are experts in farming, seeds and collecting rare and underestimated plants and I am representing Slow Food, an organization founded in 1986 after a wine scandal in Piemont, Italy. In consequence the Slow Food Manifest was signed in 1989 in Paris, stating:

> We believe that everyone has a fundamental right to the pleasure of good food and consequently the responsibility to protect the heritage of food, tradition and culture that make this pleasure possible.

One wonders whether there is any relationship between pleasure from food and biodiversity?

Pleasure from food develops with eating and drinking, if the taste of food and beverages is exceptional and enables you to recognize where the plants for the food and the fruits for the beverages are grown.

Exceptional is something more than excellent, because taste is linked to experience, education and culture. This means it is associated with the area where and the ways in which the food is produced.

Here is the link between taste and biodiversity. Only if you have a high number of varieties, and I think here not only locally but also globally, do you have different tastes, which are learnt or acquired. It is a heritage that should be kept, not only as a genetic source but also as a cultural identity.

Let me illustrate this using the example of lentils. Lentils grow all over the world in different colours—red, brown, green—with different sizes and they cook differently. The green lentils from Le Puy in France remain firm after cooking, so are ideal for salads. Red lentils from Turkey are ideal for soups, and in the south of Germany there is a regional dish in which lentils are combined with Spätzle, a regional type of noodles. It is, from a nutritional standpoint, a very modern and healthy dish. Our credo is that biodiversity is interconnected with region, local culture and the people who live there.

In defending biodiversity, Slow Food started in 1999 to develop the Ark of Taste. It is the collection of small-scale, high quality produce threatened by industrial agriculture, environmental degradation and homogenization. The Ark of

Taste searches out, catalogues and describes forgotten flavours from all around the planet: products at risk of extinction but surviving, that could be re-born and returned to the market. Slow Food tries to ensure the survival of endangered animal breeds, cheeses, preserved meats, edible herbs (both wild and cultivated), cereals and fruit. In doing so it makes a stand against obsessive worrying about hygiene, which kills the specific character of many kinds of produce.

It is an overall approach where we want to convince different players, such as journalists, institutions, cooks and politicians, to support and promote the idea of the Ark of Taste. Because we are absolutely convinced that application of the slogan "Eat what you want to protect" will enable the endangered product to survive, our approach includes scientific work as well as promotional work.

On the scientific side we:

- Define methods and criteria for research, in particular outlining the very notions of gastronomic asset, typicality, tradition and endangered product.
- Provide an ethno-botanical and historical characterization of cultivars, local breeds and products as a measure for the recognition of what is typical and/or traditional.
- Promote scientific training of experts in the field at a national level.
- Have established a networked data bank managed by a central body for collecting the data progressively obtained on cultivars, breeds, products, research, recipes, producers and restaurants.

On the promotional side we:

- Draw up and circulate a list of endangered products—known to the public at large and steeped in symbolic value—so that the struggle to defend them becomes as encompassing as possible.
- Analyse these products from an organoleptic viewpoint, providing the names and addresses of the remaining producers, and advertise them through the mass media and specialist publications, so that the concept of protection goes hand in hand with that of economic return.
- Invite consumers to purchase and eat these products, convinced as we are that extinction can be avoided only if they are fully re-introduced into the commercial food circuit.
- Identify within each region a series of inns or taverns—to be awarded special recognition—that will become active regional promoters of the Ark products, using them on a daily basis in the preparation of their dishes.
- Invite major restaurants to select a specific Ark product as their "pet product", protecting and introducing it in certain dishes.
- Promote projects aimed at teaching taste to young people right from school age, with a view to developing people's organoleptic faculties so that they can recognize quality in products and draw the utmost pleasure from them.
- Associate with similar projects throughout Europe, convinced as we are that protecting typical and traditional high quality food and agricultural products must become a transnational operation, given the fact that markets and strategies are becoming increasingly globalized and standardized.

In the meantime we have, in 50 countries worldwide, 900 unique 'passengers' in the Ark of Taste.

Results

Is there a story of success? Yes, such as this example from Germany.

Lentils were widely grown until the middle of the last century in the region of Schwäbische Alb, a low mountain range south of Stuttgart, known for its lack of water, rough climate and poor soil. Reasons for the lentils gradual disappearance were small yields and difficulty in harvesting and cleaning. Even the specially adapted lentils 'Alblinse I' and 'Alblinse II' disappeared. In 1985, one organic farmer re-started lentil production with a Le Puy lentil, variety 'Anica'. In 2005, Slow Food took the 'Alblinse' as a passenger in the Ark of Taste. In 2006, the original Alblinse I and Alblinse II were found by chance in the collection of the Vavilow Institute in St Petersburg, and given in portions of 100 g to farmers. In 2007, the first sowing of the original lentil was undertaken. In 2008, the harvest was 1.5 kg of Alblinse II; in 2009, the yield increased to 100 kg, and in 2010, 2.7 t could be harvested from a 4 ha area. In 2011, the area under cultivation of Alblinse I increased to 30 ha.

But this is only one side of the coin. The other side is that the number of farmers who produced lentils in this area under these difficult conditions increased from 13 in 2007 to 40 in 2010. The total area sown to lentils increased from 30 ha in 2007 to 106 ha in 2010.

Even more astonishing is the increase in the number of re-sellers. In 2007 we had 90, and this increased to 340 in 2010. But this is not the end of the story as the number of restaurants and canteens using this typical product increased in the same period from 15 to 110. Unfortunately the farmers sell the Alblinse only in Baden-Württemberg state, because they cannot fulfil the demand from elsewhere.

Eat what you want to rescue!

An extension of our activities are the so called Pesidia. The Presidia go beyond the Ark, as they are local projects that focus on a group of producers of a single Ark passenger. They work together to develop production and marketing techniques to make their work economically viable. They sustain quality production of products at risk of extinction, protect unique regions and ecosystems, recover traditional processing methods, and safeguard native breeds and local plant varieties.

In 2000, at the Salone del Gusto in Turin, the first 90 Italian Presidia were presented. The concept spread immediately to other countries all over the world. The first 19 international Presidia took part in the 2002 Salone del Gusto.

The first Presidia in the Southern Hemisphere, in Africa, South America and Asia, soon followed. Currently there are 314 Presidia projects, involving 10 000 small-scale producers.

As the Presidia project has adapted to hugely diverse contexts, it has shown that it could be effective even in socially and economically complex situations. In many cases, the attention paid to social aspects, such as the involvement of women or promoting literacy among producers, proved crucial to a project's success. Additionally, Slow Food provides food producers in the Southern

Hemisphere with technical assistance, training and equipment. Over the years the Presidia project has become one of the most effective tools for putting into practice and exemplifying Slow Food's policy on agriculture and biodiversity.

Another example is that of potatoes in the Andes Region of South America. It is well known that potatoes are extremely important for the indigenous populations of the Andes area. Historically, there have been more than 900 varieties from 8 different species. They are endangered, and we have projects in Peru and in Argentina, working with farmers to try to help them to continue to cultivate these potatoes and not to lose this tradition, which for them means also life, with the implicit environmental, social, cultural and historical values, and as such relating to their specific identity. We work in two ways: to help them to improve the quality of the potatoes; and to help them to reach the local markets.

We organized a workshop in Cusco on producing potato chips using the Presidium product. The workshop was equipped with a slicer and a fryer purchased with our support. Now there are people working there. They wash the potatoes, peel them by hand and fry them; drying is done using absorbent paper and the chips are then packed in cardboard boxes of 75 g. In 2007, the quality of the chips was improved through the purchase of new machinery for peeling, slicing, frying and drying. A food technologist ran a course to train the young Presidium producers working in the workshop. The Presidium will continue to collaborate with the producers and transformers to improve chip quality and expand the market.

So here is a situation where, thanks to preserving agricultural biodiversity, you can create financial opportunities for poor, indigenous farmers, allowing them to continue to live in their homes and to preserve their culture and their environment.

The Presidia tie together four fundamental factors that are all crucial for success: economic, environmental, social and cultural aspects. With this comprehensive approach we think we can advance human welfare in a sustainable way.

Another initiative to strengthen the local food networks are Earth Markets. They are run as farmer's markets, respecting the Slow Food philosophy. Crucial elements are high quality food bought directly from the producers, with fair prices for both consumers and producers. This fosters local economies. Such markets provide access to good, clean and fair food from the local area to reduce shopping miles and shorten the food chain, and, very importantly, consumers become co-producers. This is achieved when a consumer goes beyond the passive role of a consumer and takes an interest in those that produce the food, how it is produced, and the problems they face in doing so. In actively supporting food producers, we become part of the production process, as products for which there is no demand will not be produced.

Eat what you want to rescue!

All these initiatives are kept together by the Terra Madre network, which integrates all those who wish to act to preserve, encourage and support sustainable food production methods. These methods are based on the importance of the *terroir*, and those distinctive qualities that have permitted the land to retain its fertility over centuries of use. This vision is in direct opposition to pursuing a globalized marketplace, with the ongoing, systematic goal of increasing profit and productivity. Such methods have substantial externalities for which we, the guardians and inhabitants of this planet, pay the price. And the damage begins with small producers, lacking the means to create markets even within their own regions, who become crushed by subsidy systems that render their working conditions unfair.

Terra Madre strengthens, organizes, and defends local cultures and products, and turns the Slow Food concept of Good, Clean, and Fair quality into reality. Good refers to the quality of food products and of their taste; Clean, to a production process that respects the natural environment; and Fair is where there is dignity and appropriate economic return for the people who produce, including respect from those who consume.

In this network of food communities there are people included who are involved in the production, transformation and distribution of a particular food, who are closely linked to a geographical area either historically, socially or culturally. Food community members are small producers who make high quality products in a sustainable way. Included are also cooks and individual academics, because they too are propagators, but of knowledge and enthusiasm.

In summarizing I wanted to point out that, in to our opinion, biodiversity can be maintained on a long-term basis not only through scientific work in sampling and cataloging the endangered species and varieties, but also by bringing people together, by guiding and educating them, by giving dignity to their work, their traditional products and their knowledge, and by creating a network between farmers, artisans, cooks, scientist and co-producers, in order to establish good, clean and fair food.

Eat what you want to rescue!

Thank you for your attention.

Agrobiodiversity and protected areas: another approach to synergies between conservation and use?

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Introduction

Long-inhabited and long-utilized landscapes are shaped by the management practices that have evolved over time, based on the interaction of physical conditions and cultural and social influences. These landscapes typically contain a spectrum of plants from cultivated to wild biodiversity, with occasional blurring between the two. Indeed, many traditional societies do not distinguish between wild and domesticated species or ancient and modern varieties in their agricultural landscapes. The loss of these diverse systems and related agrobiodiversity has important implications for human society and for ecosystem functions in general (Altieri, 1999) regarding resilience to shocks and changes, and provision of food security services.

Traditional land-use patterns, crops and animal breeds are disappearing for a variety of reasons. In most 'developing' countries, monoculture models of agricultural 'development' adopted in the west have encouraged the switch to more uniform practices based on a narrower genetic base (fewer species and varieties). Intensification of agricultural systems, coupled with specialization in plant breeding and the overall effects of globalization, has led to a substantial reduction in the genetic diversity of domesticated plants and animals in agricultural systems, as also worryingly recognized by the Millennium Ecosystem Assessment and FAO (MEA, 2005; FAO, 1998).

The Millenium Ecosystem Assessment itself stresses the importance of including agrobiodiversity amongst the forms of biodiversity to be conserved, insisting that conservation is most successfully pursued through a whole-landscape approach and taking into account the associated management systems.

Among other international instruments, the Convention on Biological Diversity (CBD) also calls for agrobiodiversity conservation within national biodiversity strategies and national plans, and recognizes its role in benefit sharing and sustainable use. However, agrobiodiversity remains a poorly understood concept by most CBD signatory countries (Gemmill, 2001) and it is not mentioned in the CBD's 'Programme of Work on Protected Areas'. Furthermore, the role of protected areas in conservation and monitoring of agrobiodiversity is little recognized and studies on crop diversity in protected areas are hard to find.

Nevertheless, the present contribution highlights numerous examples where conservation of wild species and crops are pursued in synergy, indicating there is significant potential for holistic interventions in the field of biodiversity conservation as a whole, within human-modified landscapes.

This paper does not adhere strictly to a specific theme of the conference but aims at raising interest and awareness on an interdisciplinary approach to *in situ* conservation of agrobiodiversity, which may enhance synergies between actors and initiatives from the agricultural and environmental research and policy areas.

Methods and approaches

The paper was prepared based on a literature review and consultation of Web sites of institutions significant for their work in nature conservation (including WWF and IUCN), but also includes special attention to protection of agricultural systems or traditional rural landscapes where significant agrobiodiversity is found.

Evidence and discussion

Successful experiences in which protection of natural landscapes is combined with sustainable management of farming systems with their crop and associated diversity in a mutually reinforcing way are available from a variety of contexts across the world, and constitute promising examples of holistic conservation approaches.

One of the first and best-known instruments to promote—on both policy and technical levels—such integration of efforts is UNESCO's network of Man and Biosphere (MAB) Reserves (UNESCO, 1996). These are explicitly defined as 'more than just protected areas' and serve as living laboratories for testing and demonstrating integrated and sustainable management of land, water and biological diversity. Each Biosphere Reserve is designed to fulfil both conservation and development functions, while also providing space for research. The balance between strict protection and sustainable use strategies is achieved through zoning, which identifies and separates core and buffer zones, and allows greater intervention in the latter, promoting traditional forms of agriculture and conservation of local landraces. A developing country example of such reserves is available from Cuba. In two of the five MAB reserves on the island, Bioversity is running a project in which the synergies between landscape protection and crop genetic resources conservation are being assessed (Bioversity International, no date).

In Europe, Germany has a number of MAB reserves that are being used as a stage for the *in situ* conservation of crops as well as wild species, such as the

Steckby-Lödderitzer Forest within the Flusslandschaft Elbe Biosphere Reserve. This natural area is being devoted to the conservation of wild relatives of apples and pears. The Oberlausitzer Heide- und Teichlandschaft Biosphere Reserve is used for the *in situ* conservation of cereal landraces, while the Schorfheide-Chorin MAB reserve (a temperate broadleaf forest mixed with agricultural areas) hosts breeding programmes in collaboration with local farmers for ancient grain and vegetable species (Pokorn, 2008).

UNESCO has another instrument, the World Heritage Convention (WHC), which aims at identifying and protecting areas of 'outstanding universal value'. The Convention was adopted in 1972 and gradually increased the listing of so-called cultural landscapes in which much agrobiodiversity is usually found. A significant example is the Cordillleras Rice Terraces landscape in the Philippines. Although the WHC does not place specific focus on active conservation or management of agrobiodiversity, it provided an important inspiration for other instruments that followed, such as the Globally Important Agricultural Heritage Sites initiative (GIAHS) coordinated by FAO (Koohafkan and Altieri, 2011).

Launched in 2002, GIAHS has identified a number of pilot sites across the world matching the definition of

> "worldwide, specific agricultural systems and landscapes created, shaped and maintained by generations of farmers and herders based on diverse natural resources, using locally adapted management practices."

The programme is intended, ultimately, to encompass 100 to 150 systems worldwide. Eight pilot sites in different regions have already been identified and funding has been channelled towards the realization of activities, mostly for *in situ* conservation of local, traditional genetic resources and local knowledge, under the principle of adaptive and dynamic management for the communities' sustainable development.

Not linked to any official body, declaration or convention is the establishment of so-called 'genetic reserves', also referred to as 'gene management zones', 'gene or genetic sanctuaries' or 'crop reservations'. This was the typical approach developed for crop wild relatives (CWRs), primarily due to the difficulty of collecting and conserving their entire genetic diversity *ex situ.* Indeed, the conservation objectives are specifically the management and monitoring of genetic diversity in natural wild populations within defined areas. with the ultimate goal of active, long-term conservation. Genetic reserves are sometimes included within larger protected areas, as in the case of reserves for the conservation of *Vigna* species in Uganda. In other cases, specific programmes are carried out within genetic reserves to support the participation of local communities in conservation: in Viet Nam, incentives are in place to support local communities as 'curators' of crop diversity (Amend *et al.*, 2008).

The conservation of agrobiodiversity within protected areas is fostered also by the International Union for the Conservation of Nature (IUCN). The IUCN Category Ia Armenia Erebuni State Reserve has long been known for its diversity of wild wheat. Species include *Triticum urartu*, discovered in the area in 1935, *T. boeoticum, T. araraticum* and *Aegilops* spp., while rare populations of other species grow on the periphery (e.g. *Amblyopyrum muticum*, taxonomically intermediate between *Aegilops* and *Agropyron*). This has led to the area being granted formal protection since 1981, making this one of the few protected areas worldwide specifically managed for crop genetic diversity (Amend *et al.*, 2008).

Other types of nature protection and traditional management systems at a landscape scale are community conserved areas. These are defined as natural and modified ecosystems, containing significant biodiversity resources, providing ecological services and cultural values, voluntarily conserved by indigenous peoples and local and mobile communities through customary laws or other means. Examples of these areas are found in various countries, such as the experience in the Western Terai Landscape Complex (WTLC, Nepal) where community biodiversity registers have been developed and community organizations strengthened around the sustainable use of biodiversity (Gautam *et al.*, 2008). A significant example of this strategy specifically applied to crop genetic resources is the Potato Park in Cusco, Peru, (Argumedo, 2008). Its objectives are to conserve the landscape, livelihoods and way of life, revitalize customary laws and institutions and to do so through ensuring the survival of the genetic heritage of the Andes, which are a centre of origin and diversity for crops such as quinoa, kiwicha, tarwi, oca, mashua and potato. Among the actions to support this goal, repatriation of varieties from local and international genebanks, and restoration and monitoring of agrobiodiversity, have been carried out and are still supported financially thanks to the development of community-based agro-tourism initiatives.

Peru is particularly active also in terms of policy support to agrobiodiversity conservation and protected areas. A national-level legal and policy discussion was initiated on agrobiodiversity conservation, management and sustainable use, which supports plans for agrobiological zoning, with a focus on neglected and underutilized species (NUS) and native species (Ruiz Muller, 2009).

Conclusions

The examples presented here—of the many more available across the globe!—offer the opportunity to reflect on potential synergies between natural and crop biodiversity conservation efforts, which could be explored within the IFAD NUS 3 project activities and goals. Such synergies could be the basis for bringing together the agricultural and environmental science policy communities towards a holistic approach in the project’s target countries.

Particularly, given the project's strong focus on monitoring of underutilized crop genetic resources with the involvement of communities, the experience in some of the other protected areas and reserves is of clear relevance. The establishment of agrobiodiversity areas in Peru constitutes a model that could be explored in the project's target countries as a measure to enhance participatory activities around agrobiodiversity conservation in micro-centres of crop diversity, such as those already identified in previous stages of the IFAD NUS efforts in Bolivia, one of its target countries. Formally identified and protected areas of this kind may also serve as a privileged stage for testing activities such as those envisaged by the project: monitoring of genetic erosion; assessment of adaptation options against climate change; promotion of agrobiodiversity (fairs, community seed saving and banking, processing and value addition for native products); participatory research (including diversity mapping and participatory breeding); and innovative schemes in support of conservation farmers, such as rewards for agrobiodiversity conservation services.

An important consideration when assessing the scope for involving the above approaches in any new project is the need for policy support at various levels and across disciplines, and the importance of ensuring solid governance. Sustaining agro-biodiversity through a nominally protected landscape or protected area system requires more than a simplistic 'protection' approach, and here governance is fundamental. Various governance models can work (government managed, co-managed, community managed, private), but will always require a careful and well balanced blend of policy and legal support mechanisms (land tenure; organic farming; seed supply of traditional varieties; agro-tourism; community empowerment) to be made fully effective and sustainable over time.

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Discussion on the third and last part of Session Four

GFU documentation exists on the GI and value chain addition, so no need to re-start the process.

Tools and methods for value addition change in different situations, and the challenge is to understand applicability of different tools and methods, and of course to give guidance to policy-makers on how to best apply those selected.

Agrobiodiversity label

- Satoyama initiative: use of good practices in agriculture!
- Galluzzi noted the work in Sibilini Mountains and Mt Pollino in Italy, where farming communities are engaged in sustainable conservation activities.

Experience from Nepal suggests having landscape protection managed by the government but used by farmers.

We need to recognize the dynamic nature of landscape management, which needs to be indeed done by people with the participation of Government. In Nepal, the national conservation strategy identifies agrobiodiversity hotspots and establishes areas where management needs to focus. We need to work closely with the efforts in IFAD NUS 3!

What about credit schemes?

In Nepal they have not had access to credit (i.e. private banks). The same occurs in Latin America. There is a need to develop alternative schemes so that farmer associations can have easier access to credit.

Stefano Padulosi/Bioversity

Session V

On farm conservation within the international policy framework

(14.45-17.00)
Chair: L. Waldmueller

New opportunities for a strategic focus on farmer varieties, landraces and underutilized species

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Introduction

The sustainable conservation and utilization of plant genetic diversity are important means of achieving food security. The global population grows by an estimated 80 million people a year, and is expected to reach 9.2 billion people in 2050, while natural resources are overused for production of food, fodder and fuel. The need for more sustainable agriculture by safeguarding plant genetic diversity and minimizing genetic erosion is thus more pressing than ever. Serious and much closer attention must be paid to the conservation and use of plant genetic resources for food and agriculture (PGRFA), including by increasing the value and contribution of neglected and underutilized species to food security and sustainable livelihoods. This paper briefly discusses recent trends and opportunities provided by the renewed global commitment for better and more sustainable management of plants, which opens up new possibilities for enhancing the conservation and potential use of landraces, underutilized and neglected species within this context.

Options for sustainable intensification

Sustainable intensification is defined as producing more from the same area of land while reducing negative environmental impacts and increasing contributions to natural capital and the flow of environmental services (Godfray *et al.*, 2010). The challenges of decreasing resources and burgeoning demands for food supply indicate that efforts to increase crop production in the coming decades will take place under rapidly changing, and often unpredictable, environmental and socio-economic conditions. Conserved and improved materials will need to be available for variety development, and new varieties will have to be generated at a pace that meets changing demands and requirements. To be better prepared to tackle these challenges, sustainable crop intensification for agricultural production aims to maximize options through the management of biodiversity and ecosystem services.

The 'Save and Grow' model proposed by FAO adheres to this principle, and offers a basket of proven practices, technologies and strategies to achieve sustainable crop production intensification through an ecosystem approach. It points out those options that are harmful (e.g. over-ploughing, over-fertilizing, over-irrigation, overuse of pesticides, reliance on a few varieties with a narrow genetic base) and those options that can provide strong opportunities for tackling agriculture production in a way that increases efficiency and resilience (e.g. conservation agriculture, integrated pest management, use of agrobiodiversity) (FAO, 2011a).

Along with other aspects of farming systems, availability of an extended range of crops and varieties makes a fundamental contribution to ensuring sustainable crop production. In order to ensure resilience and continued availability of food under demanding conditions, it is indeed necessary to make available to farmers and breeders an increasingly diverse portfolio of crop varieties. This is possible when there is efficient management of plant genetic resources, combined with crop and variety development and the delivery of appropriate seeds and planting materials to farmers and breeders. It will depend to a large extent on increasing the use of variability and diversification, involving the use of both intra- and inter-specific sourcing of useful heritable variation. The diversity of underutilized plant species, landraces and crop wild relatives, for instance, represent significant repositories of traits that could contribute to the ongoing efforts to produce food of sufficient quantity and adequate quality with minimum inputs. However, many such crops are currently only just beginning to receive attention from public or private plant breeders.

As mentioned in *The Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture* (FAO, 2010), there is a growing global recognition of the value of farmer varieties, landraces and underutilized species in the face of uncertain climates, malnutrition and rural poverty. Both the general public and policy-makers are becoming more aware of the importance of traditional vegetables and fruits, the emergence of niche or high-value markets for such crops, and the potential inherent in new energy crops. While efforts have increased to conserve such species *ex situ*, overall their diversity is not yet adequately represented in collections. Nonetheless, efforts have focused on capturing the potential market value of farmer varieties, landraces and underutilized species. On-farm management efforts are also on the rise, with more concerted efforts among national, regional and international partners to better integrate the efforts of individuals and institutions with a stake and ensuring the full involvement of indigenous and local communities, taking into account traditional knowledge systems and practices. A much stronger link between the three different parts—conservation, varietal development and seed delivery—is necessary for the whole system and its functions.

Adoption of the Second Global Plan of Action

In November 2011, the Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture was unanimously adopted by FAO Member States and hailed as a major achievement for strategic and effective conservation and use of plant diversity for the benefit of the world community. The first Global Plan of Action was developed in 1996 and adopted through the Leipzig Declaration. Its recent update by governments was necessary to address the new challenges and opportunities of the 21st century. Updating the Global Plan of Action also strengthens its role as a supporting component of the International Treaty on Plant Genetic Resources for Food and Agriculture and facilitates the national implementation of the Strategic Plan for Biodiversity for 2011–2020 adopted in 2010 by the Conference of the Parties to the Convention on Biological Diversity.

The Second Global Plan of Action (FAO, 2011b) aims at enhancing the efficiency of PGRFA conservation and improving the utilization of plant diversity by providing a comprehensive framework of action through a set of 18 interrelated Priority Activities for *in situ* conservation and management; *ex situ* conservation; sustainable use; and building sustainable institutional and human capacities. The Second Global Plan of Action thereby promotes the adoption of enabling PGRFA-related policies, strategies and activities by governments and stakeholders in line with national developmental goals. All priority activities place a strong emphasis on strengthening national capacities in research and development, including through the widespread application of latest scientific and technical advancements. The Second Global Plan of Action also stresses the need to achieve complementarity and mutual supportiveness between environmental and agricultural policy-making in order to increase food security and cope with climate change for the benefit of present and future generations. During its preparatory phase, it received critical inputs from regional consultations as well as experts worldwide, together with information from the *Second Report* that provided the basis for the gaps and needs identified by governments, thus making the Second Global Plan of Action current, forward-looking and relevant to global, regional and national perspectives and priorities.

The full implementation of the Second Global Plan of Action will require a significant increase in the activities currently taking place. Adequate financial resources commensurate with the scope of the Second Global Plan of Action will also have to be mobilized. Developing specific indicators and targets in relation to these new Priority Activities will help monitor its implementation.

Priority Activity 11: Promoting development and commercialization of all varieties, primarily farmer varieties, landraces and underutilized species

Priority Activity 11 of the Second Global Plan of Action focuses on farmer varieties, landraces and underutilized species. It broadly describes the objectives and strategies for promoting the development, commercialization and increasing the use of such species**.** The main objectives of this Priority Activity are to stimulate stronger demand and more reliable markets for the products, promote local processing, commercialization and distribution, and increase public awareness of their value in order to contribute to sustainable livelihoods, including improved food and nutritional security, income generation and risk mitigation.

In this context, policy-makers are encouraged to:

- promote policies that are consistent with the sustainable use, management and development of underutilized species to make significant contributions to local economies and food security;
- develop and adopt policies on extension, training, pricing, input distribution, infrastructure development, credit and taxation that will serve as incentives for crop diversification and the creation of markets for biodiverse food products;
- create enabling environments for managing and monitoring local diversity and develop local and export markets for a wider range of traditional and new products originating from plant varieties, primarily farmer varieties, landraces and underutilized species; and
- foster public–private partnerships and put in place legislation to promote benefit-sharing targeting farmers and traditional custodians.

There is a heavy emphasis on capacity development for value addition, post-harvest management and improving marketing practices through developing marketing strategies, providing the commercial outlets and establishing, running and advising local small-scale enterprises. Simultaneously, there is a call for boosting scientific research to better characterize and evaluate the important species, as well as to document ethnobotanical information and local and traditional knowledge concerning these species. Taking action for the delivery of Priority Activity 11 could greatly contribute to sustainable livelihoods, including improved food and nutritional security, income generation and risk mitigation, through the sustainable management of farmer varieties, landraces and underutilized species.

Establishing national strategies for PGRFA for sustainable production

Implementation of the Priority Activities of the Second Global Plan of Action can ensure sustainable production intensification. However, the efficient management of PGRFA collections is often limited by weak national programmes. One of the major challenges facing national programmes is the inadequate appreciation of the value of plant genetic diversity at all levels. At the policy level, this lack of appreciation means that plant genetic resource-related activities and strategies are not adequately integrated into the various sectoral policies and instruments, such as agricultural and science and technology policies. At the local level, there are many impacts through displacement of landraces by improved varieties, the loss of wild relatives, or land conversion. At the level of urban consumers, traditional crop varieties are frequently viewed as somehow inferior to mainstream commercial commodities. This leads to low or no demand for local varieties, thereby providing no incentive for farmers to produce local products.

An effective plant genetic resources management strategy is necessary for food security, a strategy that links seamlessly the conservation of and access to these resources through their use in developing improved and resilient crop varieties with the provision of their high-quality seeds to growers. Such a national strategy must be result-oriented and an evolving blueprint that responds to clearly defined drivers, such as climate change and variations that are customized to a country's specific circumstances and goals. As such, a national strategy would provide the roadmap for harnessing plant genetic resources to address a country's crop production needs at a given time. Promotion of farmer varieties, landraces and underutilized species should be an integral part of this strategy (Mba *et al.,* 2011).

Conclusion

The implementation of the Second Global Plan of Action will require close cooperation between policy-makers and national agricultural research systems, as well as the support of international centres and non-governmental organizations, breeder and farmer organizations, seed producers, indigenous and local communities and the private seed sector. To work well, the system needs an appropriate institutional framework, as well as policies and practices that support its component parts and the links between them. Plant genetic resources are a strategic resource for the survival and development of human society, and it is important to ensure that this agricultural biodiversity is maintained and nurtured for agricultural growth and food security.

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The relevance of the International Treaty on Plant Genetic Resources for Food and Agriculture as a tangible instrument for sustainable agriculture

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Introduction

Significance of plant genetic resources for food and agriculture

As stated in the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA or 'Treaty'), PGRFA are genetic material of plant origin, including reproductive and vegetative propagating material, of actual or potential value for food and agriculture. PGRFA are of utmost importance to plant breeders and farmers, and indeed for all people on the planet. Thus, PGRFA can and will play an important role in meeting the challenges of local, regional and global food security, as they allow us to optimize crops according to our needs (Schaffrin *et al*., 2006). PGRFA are thus critical for the development of new plant varieties and are an integral component in efforts to:

- meet human needs for food, health and economic security;
- reduce agricultural pressure (chemical inputs, ploughing, etc.) on the environment; and
- adapt to changing climate (drought, salinity) and ever evolving pests and diseases.

To meet the expected increase in food demand by 2050, it is estimated that annual cereal production would have to increase by 1 billion tonne and production of meat by 200 million tonne. FAO estimates that a total of 925 million people were undernourished in 2010, compared with 1023 million in 2009. Most of the decrease was in Asia, with 80 million fewer hungry, but progress was also made in sub-Saharan Africa, where 12 million fewer people were going hungry. However, the number of hungry people was higher in 2010 than before the food and economic crises of 2008–09 (FAO, 2010).

Genetic resources are critical to meeting the food security challenge

Drawing on genes from existing varieties of plants, crop breeders are able, using either traditional crop breeding methods or new genetic technologies, to develop new crop varieties that have desirable traits. By incorporating, for example, genes from a drought-tolerant plant species into an existing crop variety, plant breeders could conceivably develop a new variety that grows particularly well in arid conditions.

The inter-linkages between crop diversity, food security and climate change

Crop diversity, food security and climate change are closely linked in diverse and complex ways. In fact, we are facing a multi-faceted challenge (Secretariat of ITPGRFA, 2011) requiring us to counter the loss of crop diversity and use crop diversity more effectively to achieve and maintain food security in the growing pressures of climate change.

Agricultural crop varieties and the particular traits they contain form the very base of our food security. In this sense, crop diversity is a pre-condition for food security, so the challenge of food security cannot be met if crop diversity is not conserved. New plant breeding strategies will therefore have to aim at improving economic and environmental sustainability by developing crop varieties that produce higher yields with less use of inputs (Secretariat of ITPGRFA, 2011), particularly those industrial in origin. All of this will place increased demands on the availability of a wide range of crop genetic material.

While climate change is one of the drivers of crop diversity loss, it is also an important reason to conserve agricultural crop varieties, exchange them and use them in a sustainable way. The broader the genetic base we can rely on, the better equipped we are to adapt to changing climate conditions and to provide global food security. But there is urgency to act: whereas climate change is occurring at a fast pace, the process for breeding a new crop variety may take from 7 to 15 years (Secretariat of ITPGRFA, 2011). That is why traditional varieties in agriculture are important as a resource that can respond to imminent as well as unknown future challenges. Traditional varieties form a reservoir of particular characteristics that may prove useful for the breeding of new varieties in terms of productivity, pest resistance, drought tolerance and other desirable traits. Meeting new and unexpected challenges will require increased and continuing exchange of crop genetic material for agricultural research and breeding.

Impacts and implications of climate change for PGRFA and associated biodiversity change

Crop productivity

Diversity in species, varieties and cultivation practices has permitted agriculture to adapt to moderate change in climate over the past 10 000 years. Although farmers have always adapted their cropping systems to adverse climatic and environmental conditions, the speed and complexity of current climate change poses problems of a new magnitude. Adapting crop varieties to local ecological conditions can reduce risk due to climate change, but the need for adapted germplasm is urgent and requires characterization, evaluation and the availability of materials now housed in genebanks.

Crop wild relatives will play a crucial role in providing genes and traits to help confront these challenges.

Impacts on crop diversity

Climate change will bring new and enhanced demand for genetic resources. National and international breeding programmes for a number of crops are already targeting new varieties with adaptations to future climatic stresses. The effort to breed for traits valued both today and for the future is likely to increase the general demand for PGRFA.

Demand is also likely to increase for genetic resources of crop wild relatives. These genetic resources are being used to address both biotic and abiotic constraints (Lane and Jarvis, 2007). While demand for such genetic resources is global, their natural distribution is restricted to the centres of origin of crops, often specific sub-regions within continents.

On-farm germplasm conservation

It is important that both on-farm and *in situ* conservation are implemented within the context of agricultural development strategies that promote both development and conservation. On-farm conservation is a dynamic form of plant genetic resources (PGR) management that builds on natural and farmer selection. It is therefore a valid strategy for addressing vulnerability to climate risk in regions, in that it provides a variety of germplasm options for farmers.

The Treaty as a tangible support for sustainable agriculture

Impact of the Treaty on the conservation and utilization of plant genetic resources

The Treaty greatly promotes the conservation and utilization of PGR. First of all, the conclusion and subsequent ratification of the Treaty by 127 Contracting Parties implies that many governments have now recognized the importance of

PGR, the threats to their survival, and the need to develop specific policies in order to conserve and make wider use of them. PGR have reached the agenda and gained the attention of policy-makers and politicians.

A number of more specific impacts can also be distinguished, at both international and national levels.

At the international level, through the creation of the Multilateral System, the Treaty establishes a common pool of PGR for which the Contracting Parties bear a joint responsibility. In doing so, the Contracting Parties recognize the importance of and their common dependence on PGR, and their function as economic assets.

The Contracting Parties also recognize the importance of conservation and utilization of PGR for food and agriculture in Article 1 of the Treaty. In more detail, Part IV of the Treaty focuses on the Multilateral System and deals with the coverage of the Multilateral System, access to PGR held within the Multilateral System, and benefit-sharing over the products derived from resources obtained from the Multilateral System. This set of agreements depends on and pre-supposes proper conservation and utilization of PGR. Without conservation there is no access, and without utilization there is no benefit-sharing.

> *"The Treaty is all about building bridges and connecting countries and people; it is about pooling collaborative, cooperative and common action. It provides a framework to allow the global community to work together for food security, adaptation to climate change and the sound management of agrobiodiversity – always keeping in focus the needs of farming communities, the poor and the hungry , and their right to food"*
>
> Bhatti and De Schutter (2011)

The *ex situ* collections of the International Agricultural Research Centers of the CGIAR have also been placed in the Multilateral System through specific agreements between these Centres and FAO on behalf of the Governing Body of the Treaty. These agreements, which represent key collections of staple crops of utmost importance to developing countries and form approximately 10% of all collections held globally, have clarified and reconfirmed the status of these collections and safeguarded their continued conservation and accessibility.

The Multilateral System and the Standard Material Transfer Agreement regulating the access to and benefit-sharing from the use of the materials held in the Multilateral System provide a transparent and reliable legal framework for recipients of the materials, and therefore greatly facilitate the use of the PGR held in the Multilateral System. The Multilateral System and the Standard Material Transfer Agreement also serve as prototypes used to exchange other genetic resources not covered by the Multilateral System.

The Treaty includes also a quite elaborate article on the funding strategy, to implement activities under the Treaty (Art. 18). Such a funding strategy forms an essential condition for the proper conservation and utilization of PGR, since it recalls the uneven capacity and financial resources of various Contracting Parties, and the need for developed countries to effectively allocate resources for these objectives as well as the need for developing countries to place due priority in their own plans on building capacity. Proper planning and effective allocation of resources form necessary conditions for a better conservation and utilization of PGR.

At the national level, Articles 5 and 6 of the Treaty provide clear guidance to the Contracting Parties regarding the activities to be undertaken to promote the conservation and sustainable use of PGR.

These articles may help Contracting Parties to integrate elements and components into their agriculture and rural development policies and programmes directed at the conservation and utilization of PGR. The articles take an integrated approach and deals with *ex situ* as well as *in situ* conservation. The elements referring to sustainable use and how to promote due attention to and support for diverse farming systems, to privilege participatory approaches involving collaboration between researchers and farmers, to promote the expansion of local and locally adapted crops, varieties and underutilized species. When these elements are given due attention, this will certainly benefit both the conservation and utilization of PGR.

The implementation of Article 6 is a standing priority item on the agenda of the Governing Body of the ITPGRFA, with the aim of promoting an integrated approach to sustainable use of PGRFA among Contracting Parties. The Secretary of the Treaty compiles submissions by Contracting Parties, other governments and relevant organizations and institutions with regards to their experiences and progress related to the sustainable use of PGRFA .

For the first time since the existence of the Treaty, at the Fourth Session of the Governing Body, held in Bali, Contracting Parties requested the Secretary to launch a process towards the development of a Programme of Work on Conservation and Sustainable Use of PGRFA through the organization of a Stakeholders' Consultation and the establishment of an *Ad Hoc* Technical Committee on Sustainable Use of PGRFA.

The Benefit Sharing Fund of the Treaty

Through the Treaty's Governing Body, the international community has also created a new multilateral mechanism, the Benefit-sharing Fund (BSF). The Fund is currently investing directly in high impact projects supporting farmers in developing countries to conserve crop diversity in their fields, and also assisting farmers and breeders globally to adapt crops to changing needs and demands.

To ensure sustainability in its efforts, the BSF focuses on building the capacities of developing countries, enhancing the exchange of information and making the appropriate technology available for the conservation and use of this diversity.

A key area for support by the BSF is the strengthening of systems for the on-farm conservation and management of genetic diversity, with the primary aim of reducing farmer vulnerability to climate change. In this respect, farmers, as custodians and managers of genetic diversity, have much to offer both their own communities and the world more generally as a result of their efforts to conserve PGRFA, improve it through breeding and selection, and through making it available for use by others.

Given the reality of both climate change and the challenge of producing the food needed by expanding human populations, the implementation of the BSF will be a critical element in the implementation of the Treaty, and a tangible support to feeding the world.

Conclusions

In maintaining the "highest technical and policy profile" of the Treaty a number of the required actions can help to ensure the conservation and sustainable use of PGRFA, with particular attention paid to the *in situ* and on-farm conservation of neglected and underutilized crops.

As recommended in a recent FAO publication "Save and Grow" (FAO, 2011), measures that might be considered are, *inter alia*:

- Strengthening linkages between the conservation of PGR and the use of diversity in plant breeding, particularly through improved characterization and evaluation of traits of the relevant crops, with increased support for pre-breeding and population improvement, and much closer collaboration among institutions concerned with conservation and breeding.
- Increasing the participation of farmers in conservation, crop improvement and seed supply in order to support work on a wider diversity of materials, to ensure that new varieties are appropriate to farmer practices and experiences, and to strengthen on-farm conservation of PGR and farmer seed supply systems.
- Improving policies and legislation for variety development and release, and seed supply, including national implementation of the provisions of the ITPGRFA, enactment of flexible variety release legislation, and the development or revision of seed policies and seed legislation.

Finally, particular emphasis has to be given to all efforts aiming to promote participatory plant breeding, whereby farmers should be involved both in the identification of breeding objectives and in the selection of the most adapted and interesting genetic material, taking into account their traditional knowledge and cultural heritage.

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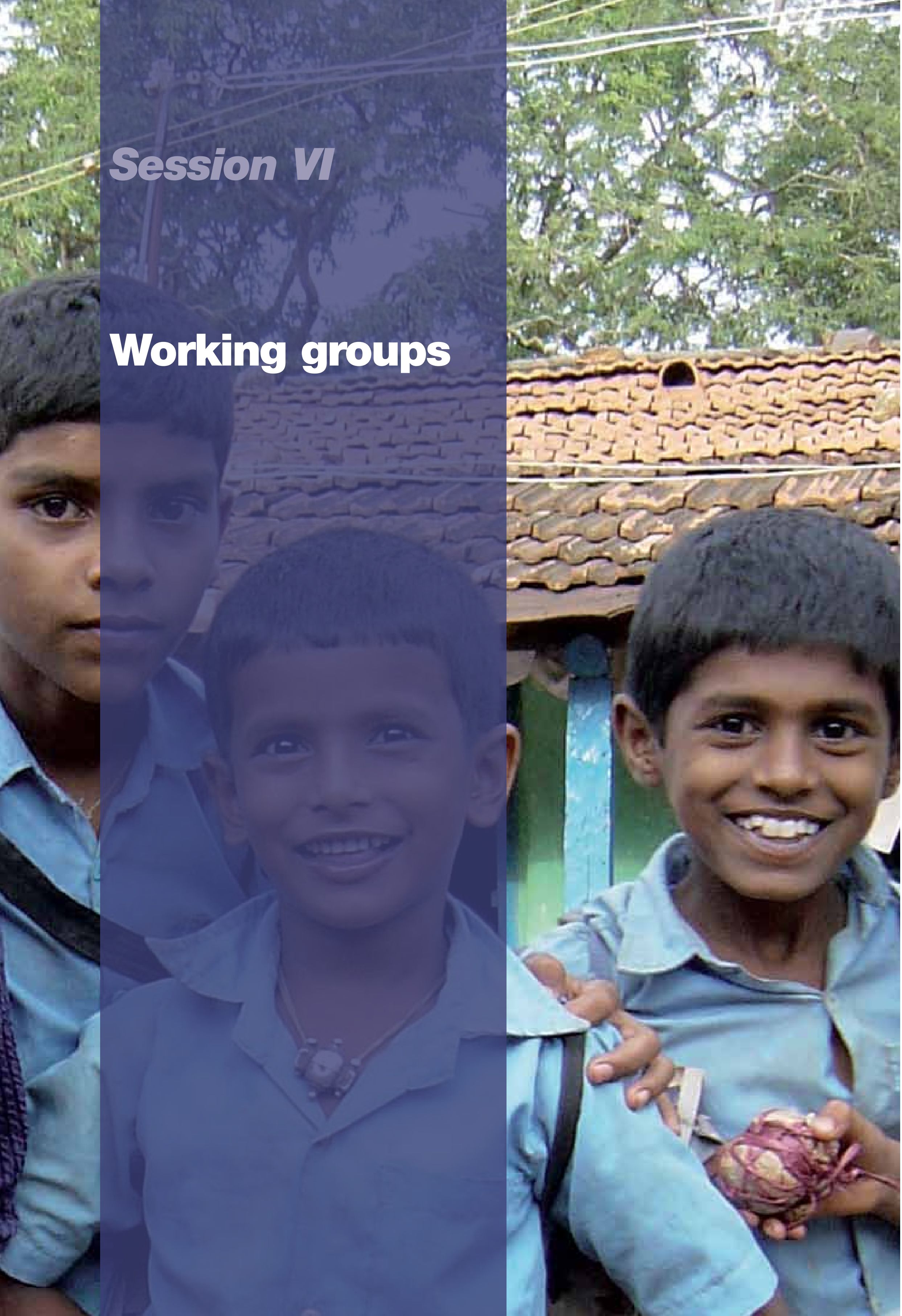
Stefano Padulosi/Bioversity



Session VI

Working groups

Working Group 1. Documenting and assessing best practices based on NUS for climate change adaptation

Participants

Irmgard Hoeschele-Zeledon, Bhuwon R. Sthapit, Wilfredo Rojas, Ram Bahadur Rana, Kerstin Wydra, Gea Galluzzi, Nadia Bergamini and Johannes Kotschi.

Two guiding issues

1. Methodologies for information gathering (CBR, etc.; participatory approaches; definition of scope; area; survey format; gender; relevance of information to communities and clear benefits for them).
2. Use of information gathered by communities for enhancing adaptation and resilience (feeding lessons and experiences into CECASF Global Community, identifying specific products).

Outcome of discussion

1. Methodologies for information gathering

Method	Scope	Strengths and limits
Diversity Fairs	Diversity (inter- and intra-spp.) in use over time	Promotes exchange and movement of varieties relevant for climate change adaptation, as well as exchange of knowledge on practices adopted in different communities and relevant for adaptation. Entry point for discussions at village level. Tool for identifying custodians. Awareness-raising tool as well.
CBR	Diversity (inter- and intra-spp.) in use over time	Limited capture of management practices
Seed network analysis	Assessment of strength of such networks; identification of nodal farmers	Little information on adaptive practices, but does give some information on level of exchange (which may be important for adapting to climate change) and identifies vulnerable (isolated) farmers and resilience of seed systems in the face of climate change.
4-Cell Analysis	Participatory assessment of local crop diversity distribution and use	Entry point for participatory assessment of local situation. Makes community knowledge explicit and can, depending on how it is conducted, incorporate some information on management practices of the varieties assessed. Possibly the method with most flexibility for extracting specific information on practices if conducted specifically for this purpose.
Climate change vulnerability assessments	Assessment of vulnerability of individual households and communities to climate change impacts.	Provides information to be used for land use planning under climate change. Provides factors of climate vulnerability and management practices based on diversity to face this vulnerability (adaptation strategies).

Method	Scope	Strengths and limits
Participatory Land Use Planning	Communities and systems approach; gives information on current use of land and land management practices	Needs to be built in such a way that it includes information on the cropping system in terms of crop diversity in use (inter- and intra-spp.) and specific management practices which could have relevance for climate change
Literature review	Gather existing data, knowledge and experiences on best practices (present state of knowledge).	Important to complement community-based information with state-of-the-art scientific knowledge.
National and international expert consultations to gather existing data, knowledge and experiences on best practices	Gather existing data, knowledge and experiences on best practices (present state of knowledge).	Important to complement community-based information with state-of-the-art scientific knowledge.

2. Use of the information gathered

Use of the information gathered from communities for enhancing adaptation and resilience at different scales (feeding lessons and experience into climate changea FS, global communities, identify specific products).

a) Use of the information at local and community level (benefits to communities for enhancing adaptation and resilience) for:
   - Guiding and establishing FFS, demonstration plots, farmer days, diversity fora, CBM in which dialogue with the scientific, extension and NGO community is fostered.
   - Posters and manuals developed on NUS and climate change adaptation practices in local languages deposited within the communities.

b) Use of the information at national level for enhancing national capacities and developing coping strategies against climate change:
   - Guiding local and national policy decisions on land use planning, breeding priorities, seed system strengthening, improving conservation of and access to improved or adapted germplasm found in communities, supporting conservation farmers, value chain approaches for NUS, education and awareness interventions and any other intervention identified within the target country context.

c) Feeding the information on methodologies and best practice identified into the global community (science, policy-makers, donors) through:
   - Use of existing awareness and dissemination tools (involving CFF, Bioversity, CCAFS), production of policy briefs and reports on effective experiences for climate change adaptation based on NUS, videos (?), publications and case studies.

Note: General principles to be considered:

- Gender specificity of each method.
- Time dimension (How far back in time should information be sought? How to use these methods over time for monitoring?)
- Identify the basic "universal" principles of the best practices identified by any of the above methods for scaling up. Consider the scale at which each best practice is relevant and only extract the basic principles for application elsewhere.

Working Group 2. Red Lists for cultivated species

Participants: Stefano Padulosi, Ehsan Dulloo, Abishkat Subedi, Karl Hammer, Rudolf Vögel

Guiding issues:

1. Scope and objectives.
2. Methods (involvement of communities and other stakeholders, identification of criteria, thresholds, categories of threats, indigenous knowledge and climate change, identification of sites, species within representative agrobiodiversity-rich production systems).
3. Testing and implementation in target sites and countries.
4. Quality control and data validation.
5. Outputs and products (NUS maps and threats assessment, trends, etc.).
6. Uptake of information and methods (from local to regional, involvement of national agencies, development of supportive policies).
7. Suggestions for broadening scope (greater impact of work, PA, links to other projects).

Outcome of discussion

1. Scope and objectives
   - This work being pursued by IFAD NUS 3 has a scope that goes beyond the NUS methods being developed will be valuable also for other crops (major crops).
   - The tool is being developed as an instrument for realizing reduction in the loss of genetic and cultural erosion associated to crops.
   - It will be useful for farmers, scientists and policy-makers.
   - In scope it is a management tool for improving use of PGR.
2. Methods (involvement of communities)

In the development of the Millennium Ecosystem Assessment (MEA), the following work scheme was used:

Drivers (Definition) > Pressures > State (How to define these?) > Response (What to do? How to react?) > Impact (What do we want to have at the end of the day?).

This could be useful as a guide when addressing Red Lists for cultivated species.

Hammer: A fundamental issue is having a good reference book on taxonomy of agrobiodiversity. The best book is currently the Mansfeld Encyclopedia, but it needs to be updated (last update was 10 years ago). This update can be done in a precise manner so as to include all NUS (many are currently absent!!)

There is also the issue of the intra-specific classifications, which is a big gap to fill.

Subedi: In Nepal, we have developed a good crop database which can be used for reference by the project. This is a good basis for exchange of NUS and when developing inventories at local level.

It is important, therefore to ensure that the Red Lists are built in to existing database and recording systems. This is feasible in many situations.

Through this work we could also capture the ecosysytem situation, although how this can be done needs some careful thinking.
Suggestion: we need to gather data from local markets in order to also capture use and livelihood dimensions for the NUS.

On the issue of thresholds, we need to identify the cut-off points. These need to be developed together with farmers. The 4-cell approach will be a very good instrument to do that. It would be a good thing to develop a small committee that would refine the concept.

Indigenous knowledge erosion can be also monitored through the community biodiversity register (CBR), while the 4-cell method would be used for the monitoring of cultivation and use.

We could try to add another dimension to the 4-cell tool by including diversity of cultural or indigenous knowledge). It would first need to be given a trial, and then has the potential for later promoting its use for the purposes of CBD, the Treaty, etc.

When selecting target sites we need to select with due regard for differing situations and probable climate change pressures! Here the DPRSI (?) framework could be useful to choose different agro-ecological zones. Target sites need also to focus on hotspots of crop diversity!! So in each country we should focus on where the change will most likely take place and how that relates to hotspot locations (reference is made to NAPA- Nepal agency?).

regarding which crops to focus on, we need to focus on food (possibly also feed) crops representative of different groups (cereals, pulses, vegetables, fruits.).
Suggestion: another important consideration is that of linking the 4-cell work with custodian farmers, and to use this instrument to link different communities for promoting seed distribution. So through the 4-cell method we would understand the seed network for the various crops, illuminating the NUS situation and how it works. We can also do some verification in neighbouring communities.
Eshan: We should try to apply the seeds-for-needs approach to this on-farm situation, by identifying resistant varieties and promoting their use in other areas where they can provide greater resilience.

In general, we need to involve IUCN and to use its network with CWR and specialist crops as entry points for this work, or do we have to create a totally new group for cultivated species?

Working Group 3. Custodian farmer networks

Participants: E.I.O.D. King, Matthias Jäger, Ida Puzone, Hanns-Ernst Kniepkamp, Kakoli Ghosh, Bela Bartha and Panos Sainatoudis.

Guiding issues:

1. Scope and objectives.
2. Assessment of current situation (identification of NUS nodal farmers, mapping, seed flows, challenges, motivations, incentives, success stories, lessons learnt).
3. Methodologies and activities (how to support networks, establishment of associations, use of market and policy-based incentives, biodiversity fairs, recognition, etc.).
4. Scaling up into movements of custodian farmers (with supportive actions, public awareness, policy debate national international).

Outcome of discussion

Custodian farmer networks

1. Scope and objectives

Characteristics of custodian farmers:

- Individual farmers or family
- Considerable amount of diversity on farm, with associated knowledge
- Contribute to the collective management of seeds
- Attitude positive towards to serving the community
- Low ability to socialize their knowledge with other farmers
- Their work is generally not recognized by society

Objective of a custodian farmer network:

- Stop the erosion of genetic resources and associated knowledge
- Document and share their knowledge with other farmers
- Facilitation body for knowledge sharing and seed exchange
- Enhance technical knowledge of value addition, processing and marketing
- Create visibility for the conservation function
- Advocate for compensation for conservation services
- Protect the knowledge and seed material
- Link to *ex situ* conservation
- Facilitate market linkages

2. Assessment of current situation (identification of NUS nodal farmers, mapping, seed flows, challenges, motivations, incentives, success stories, lessons learnt)

Motivation:

- Historical reasons
- Keep their freedom and independence vis-à-vis multinational companies (Greece)
- Risk aversion, food security (India), survival
- Maintain culinary diversity (Bolivia)
- Improve income generation (Bolivia)

How to articulate NUS issues and intellectual property on traditional knowledge with agreed national frameworks

No custodian farmer networks in Bolivia.

India: Custodian farmer network in place, main objective is conservation, farmers are demanding support with market access, value addition. Success story in terms of conservation goals achieved.

Lessons learnt: National situation, degree of market integration and context varies greatly and needs to be tailored

3. Methodologies and activities (how to support networks, establishment of associations, use of market and policy-based incentives, biodiversity fairs, recognition, etc.).

Market linkages are crucial, with promotion of consumption of local varieties locally. If they are not eaten, they will disappear.

Creating networks between farmers and consumers.

Incentives: Provision of processing equipment addressing drudgery problem.

Establishment of farmer associations as a lobby organization advocating for NUS.

Incentive: Creation of safety net, insurance against crop loss due to climate change.

Lessons learnt: Applicability and sustainability, mapping of diversity is important to know what diversity is present.

Support of municipality at local government level (Bolivia)

4. Scaling up into a movement of custodian farmers/CF (with supportive actions, public awareness, policy debate at national and international levels).

Implementation of platforms involving other stakeholders, such as universities, government, NGOs, private sector and consumers, in order to get society committed.

Public awareness: As a tool, create a Web site to show where centres of diversity are present at a global level, and upload videos showing testimonies of custodian farmers.

Relevance to have a high visibility and its own identity.

Issue of incentives: Are networks sustainable? CF are different from crop to crop, so how shall we deal with this situation? Answer: we should focus on those willing to freely share diversity and knowledge!

Issue: How to recognize CF? Answer: during the diversity fairs! We need also a protocol or process to spell out their roles. Note that CF should be also able to communicate, so we need to train them and give them the proper recognition to empower them in such a role.

The IFAD NUS 3 should train people and these should train others in other communities.

Kotschi: Maybe we expect too much from CF. We need compensation schemes, income generation models and non-monetary payment modalities.

Ideas for the project as a whole: What about a Newsletter for the Project? What bout an on-line platform where people can register and that would deal with all the aspects to be covered by the project?

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