UNFCCC Submission on Agriculture
Krystyna Swiderska, Principal Researcher, IIED
8 March 2016

In accordance with FCCC/SBSTA/2014/2, Parties and observers are invited to submit views on issues relating to the elements referred to in paragraph 85(c) and (d):
(c) Identification of adaptation measures, taking into account the diversity of the agricultural systems, indigenous knowledge systems and the differences in scale as well as possible co-benefits and sharing experiences in research and development and on the ground activities, including socioeconomic, environmental and gender aspects;
(d) Identification and assessment of agricultural practices and technologies to enhance productivity in a sustainable manner, food security and resilience, considering the differences in agro-ecological zones and farming systems, such as different grassland and cropland practices and systems.

This submission draws on research by IIED and partners, notably: "Smallholder Innovation for Resilience: Strengthening innovation systems for food security in the face of climate change" (SIIFOR), conducted with the Centre for Chinese Agricultural Policy (China), Kenya Forestry Research Institute (Kenya), Lok Chetna Manch (India) and ANDES (Peru). This 5-year project initiated in 2012 with support from the European Union focuses on strengthening indigenous knowledge-based innovation. It has conducted a comprehensive baseline study (qualitative and quantitative) in 64 indigenous communities in mountain and dryland areas, exploring climatic changes in the last 30 years and innovation responses.

Introduction
The challenges of food security, feeding a growing population and declining crop productivity due to climate change are generally addressed through agricultural intensification – but this is not necessarily the best solution, particularly in marginal areas such mountains and drylands. Green Revolution agriculture has significantly increased crop yields through high yielding varieties supported by subsidies for inputs such as seed, fertilizer and irrigation. But over time it has also degraded the natural resource base on which agriculture depends, leading to stagnation in crop yields. Its focus on mono-cropping and often-excessive use of pesticides and fertilizers has resulted in poor soil quality, reduction in biodiversity, pest resistance, groundwater pollution, and human health risks[1]. Landscapes have been degraded through overuse of groundwater, the spreading of nutrients and pesticides and encroachment of GR agriculture into ecologically fragile zones such as mountains, forests and marginal lands[2]. This paper presents alternative adaptation measures for marginal lands, that both increase productivity and food security for smallholder farmers, and enhance genetic diversity, indigenous knowledge and the natural resource base. It also identifies agricultural practices that enhance productivity, food security and resilience in a sustainable manner in mountain and dryland mixed crop-livestock systems.

Genetic diversity provides vital options for adaptation, particularly for smallholder farmers in marginal risk-prone environments which are already adversely affected by climate change, but also for future adaptation by national agricultural systems. However, according to the FAO, genetic diversity is being lost at an 'alarming rate'[3]. Since the 1900s, some 75 percent of plant genetic diversity has been lost as farmers worldwide have adopted genetically uniform, high-yielding

[1] Elwyn Grainger –Jones (2011). IFAD Occasional Paper 3. Climate-Smart Smallholder Agriculture: What's Different?
[2] Ibid
[3] FAO Commission on Genetic Resources for Food and Agriculture (2013). Biodiversity for Food and Nutrition: 30 Years of the Commission on Genetic Resources for Food and Agriculture.

varieties[4]. Although many plant genetic resources are held in gene banks, not all can be stored in this way, and gene bank collections are no longer evolving in response to environmental change, or co-evolving through selection and breeding by farmers. Local landraces in marginal areas are often better adapted to local conditions and more resilient than their modern equivalents. For example, most of the maize landraces survived the severe spring drought in Guangxi, Southwest China, in 2010, but maize hybrids did not.[5] DNA analysis of 191 maize landraces in SW China shows that these are far more genetically diverse and resilient to drought than the same lines held ex-situ for 20-30 years.[6] In Tajikistan, mountain farmers have found that local fruit trees can survive the increasingly hot and dry conditions but modern varieties cannot, while local wheat varieties produce higher yields than modern varieties[7]. Many smallholder farmers in marginal areas are experiencing more variable weather, erratic rainfall, pests and diseases and extreme events such as drought, and have started to grow a higher diversity of crops to reduce the risk of crop failure and are increasingly using hardy local varieties for adaptation[8].

Indigenous peoples and local communities have domesticated, conserved and improved most of the crops we use today through indigenous knowledge systems. They continue to conserve much of the world's crop diversity, often in marginal lands, and to innovate for climate adaptation, eg. through domestication of crop wild relatives, plant breeding and revival of traditional farming practices, as SIFOR research shows. Indigenous knowledge is the source of most agroecological practices, that seek to enhance productivity whilst conserving natural resources and maximising resilience, and use organic inputs and natural processes instead of inorganic inputs (reducing greenhouse gas emissions). Examples include mixed cropping, integrated pest management and agroforestry. Indigenous knowledge systems also include worldviews and values that conserve the natural resource base, including crop wild relatives and ecosystem services for adaptation.

However, the promotion of monocultures in marginal areas by agricultural research and extension systems in many countries is eroding remaining pockets of evolving genetic diversity and related indigenous knowledge systems. The increasing focus on developing commercial seeds protected by Intellectual Property Rights is accelerating the loss of genetic diversity. In China for example, 1 IPR protected maize hybrid, developed through a joint venture with a foreign company, has wiped out half the remaining maize landraces in Guangxi province since 2002[9]. The UPOV 1991 Convention for the protection of new varieties of plant, which has recently been adopted by the African Regional Intellectual Property Organisation, could undermine smallholder innovation and food security by making it illegal for farmers to save and exchange conventional seed. National seed laws usually only protect plant breeders' rights and not farmers' rights, and rarely require benefit-sharing with farmers for the use of their varieties for plant breeding, which means that farmers have no incentive to conserve local genetic diversity.

---

[4] FAO (2004). What is Agrobiodiversity? Fact Sheet. Training Manual on "Building on Gender, Agrobiodiversity and Local Knowledge".

[5] Manuel Ruiz and Ronnie Vernooy Eds (2012). The Custodians of Biodiversity: Sharing access to and benefits of genetic resources.

[6] Shihuang Zhang and Yiching Song, Forthcoming. Genetic diversity of 191 farmer maintained maize landraces from southwest China based on fluorescence-labelled SSR markers. Center for Chinese Agricultural Policy.

[7] Krystyna Swiderska and Pernilla Malmer (2016). Climate Change and Biocultural Adaptation in Mountain Communities: Second international learning exchange of the International Network of Mountain Indigenous Peoples, Tajikistan, September 2015. http://pubs.iied.org/14657IIED.html

[8] Krystyna Swiderska (2014). A marriage to save earth: Farmers and researchers innovate to conserve biodiversity. http://biocultural.iied.org/marriage-save-earth-farmers-and-researchers-innovate-conserve-biodiversity

[9] Swiderska et al (2012). Adapting agriculture with traditional knowledge. IIED briefing paper.

Many 'Climate-smart agriculture' projects have focused on developing resilient high yielding varieties for marginal areas, and using monocultures and inorganic inputs, but with reduced use of chemical inputs. This approach has no doubt increased productivity in the short term, but it can also weaken resilience in the longer term by contributing to genetic erosion.

The SIFOR project has explored alternative approaches which increase productivity, resilience and food security, while also enhancing genetic diversity, ecosystem services and indigenous knowledge and innovation systems for adaptation. These important but under-utilised adaptation measures are presented below, notably:

- participatory plant breeding to enhance yields, resilience, genetic diversity and IKS;
- revival of agroecological practices to minimise inorganic inputs and conserve natural resources;
- direct links to consumers to significantly increase revenues;
- community managed landscapes to conserve evolving crop diversity;
- repatriation agreements with gene banks to restore in-situ genetic diversity;
- Community Seed Banks to conserve genetic diversity and recover from extreme events; and
- strengthening IK-based innovation systems;

1. Participatory Plant Breeding (PPB)

Participatory Plant Breeding is a joint technology *development* process, where farmers participate in decision-making at each step of the process. Both local and gene bank varieties, and indigenous and scientific knowledge, are used to develop new higher yielding resilient varieties which are tailored to particular local conditions. PPB is not the same as Participatory Variety Selection, which entails participation in the *selection* of technologies but not in their development (although PPB involves PVS). Numerous studies conclude that selection by farmers offers the greatest yield benefit in low-yield-potential marginal environments[10]. Major PPB initiatives, such as that of ICARDA (International Center for Agricultural Research in Dry Areas) in parts of North Africa and the Middle East, have documented yield increases of 30-50%[11]. Here, conventional breeding programs aimed at improving barley had had little effect, largely because most farmers refused to adopt the new varieties[12].

PPB has also empowered poor farmers, particularly women, and enhanced biodiversity and IKS[13]. These co-benefits are usually associated with PPB rather than PVS. PPB also shortens the technology development time (eg. to 2-4 years) and reduces costs compared to conventional breeding, because of greatly improved adoption rates and farmers' contribution to the R&D process[14]. PPB links often separate formal and informal seed systems for mutual benefit, providing farmers with access to gene bank collections and gene banks with adapted genetic material for future plant breeding. When coupled with efforts to improve market linkages, PPB can also generate significantly higher revenues than conventional farming, and create incentives for reviving agroecological practices. PPB can also bring about transformational change in agricultural research institutions and policies, to support poverty alleviation, climate adaptation and biodiversity conservation. By reviving traditional nutritious crops and promoting adoption of agroecological practices with minimal pesticide use, PPB can also improve nutrition and health of smallholder farmers.

Case Study: PPB and market linkages in Southwest China

In the harsh karst mountains of Guangxi province, where arable land is limited and drought is a growing problem, a PPB program initiated in 2000 by CCAP involving 12 villages in 7 counties, has

[10] Ceccarelli et al (2009). Plant breeding and farmer participation. FAO
[11] Ibid
[12] Ronnie Vernooy (2003). Seeds that Give. Participatory Plant Breeding. IDRC (Canada).
[13] Ibid
[14] Ceccarelli et al (2009). Plant breeding and farmer participation. FAO

boosted maize yields by 30% and improved drought and pest resistance. The program has bred 8 'climate –ready' maize varieties, including 1 hybrid variety, improved 20 farmer-preferred maize landraces and 15 rice landraces, and conserved about 200 maize landraces. It has enabled communities to produce hybrid seed and sell it locally for income. The PPB program, along with the establishment of direct links to urban markets (especially restaurants for healthy/ecological food), has tripled rice incomes and doubled maize incomes compared to farmers growing conventional hybrids, reversed the loss of local crop diversity, revitalised traditional agroecological practices such as duck-in-rice integrated pest management, mixed cropping and soil and water conservation, and has enhanced the scientific capacity of communities. The new PPB varieties have spread rapidly and spontaneously to surrounding villages.

The PPB and market linkages (Community Supported Agriculture) has empowered women in the communities through the establishment of farmers' cooperatives, community seed banks and women's seed fairs, as women play a key role in local seed systems. It has also put an end to health problems related to pesticide use. It has led to increased recognition of the value of local landraces and IKS by farmers, thanks to their recognition by scientists, and to enhanced innovation by farmers. At the same time, it has raised awareness of the value of in-situ genetic diversity and farmers' knowledge amongst plant breeders, established ongoing partnerships between plant breeders and communities, and has been institutionalised at provincial level in Guangxi, with a new budget for PPB. It has also led to the inclusion of a provision to protect farmers' rights in China's new seed law – which now allows farmers to save and exchange conventional seed.

Since 2012, this PPB program has been scaled up to 8 Naxi mountain villages in Lijiang, Yunnan, which have suffered recurring spring drought since 2010. The program has already enhanced maize yields by 15-20% on average, increased resilience to drought, and reversed the loss of crop diversity (the area planted with maize landraces has expanded from 2.2% to 30-40%).

For more information, see: Yiching Song, Yanyan Zhang, Xin Song (2015). Emerging biocultural innovations for climate resilience in Southwest China. SIFOR Qualitative Baseline Study. http://pubs.iied.org/G03916.html

2. Community Managed Landscapes and Repatriation Agreements

Community managed landscapes are an important adaptation measure for vulnerable communities in marginal environments, and a key tool for conserving 'evolving gene banks'. They connect neighbouring communities for collective stewardship of watersheds and biodiversity, ensure wild and domesticated species can move across ecological niches and altitudinal ranges, and enable communities to test crops in different parts of the landscape. They strengthen social networks for sharing seeds, knowledge and innovations, revitalise cultural and spiritual values that underpin ecosystem stewardship, and enable poor mountain communities to generate income (eg. from eco-tourism and medicinal plants). Repatriation agreements between gene banks and communities are also important to restore in-situ genetic diversity for food security and climate adaptation.

Case Study: The Potato Park, Cusco, Peru

The Potato Park is an area of over 9000 hectares collectively managed and owned by 5 Quechua communities in a centre of potato diversity in the high Andes of Southern Peru. It also sustains a high diversity of maize and other Andean crops, through traditional agroecological farming systems. Although originally established for agrobiodiversity conservation in 2000, the Potato Park has proved vital for climate adaptation. Potato is a staple crop, but has seen a significant rise in pests and diseases, correlated with increased temperatures. This has forced the lower planting line up by 200 metres in the last 30 years, reducing available land for potato cultivation.

Establishing a collectively managed landscape and an Association of Potato Park Communities enabled the communities to sign an Agreement for Repatriation and Monitoring of Native Potato Varieties with the International Potato Centre (CIP) in 2004. As a result, CIP has returned 410 native potatoes which it had collected from communities in the area in the 1960s, but which had since been lost through genetic erosion; and CIP gained some 250 potato varieties from the Potato Park. The communities now have a collection of c.1350 different types of potato – about 650 different varieties of native potato. Pooling their land under collective management has allowed them to test the potatoes in different parts of the landscape for adaptation. They have formed an inter-community group of 'potato guardians' who manage and conserve the park's potato seed bank for local and global food security. Planting diverse varieties together is an ancestral strategy against crop failure which is becoming increasingly important as it ensures that some crops will always survive. The Potato Park has shared the repatriated varieties with other communities in the region.

The Potato Park and the highly participatory action-research methodology used by ANDES has strengthened social cohesion and built the capacity of indigenous farmers to conduct collaborative research directly with CIP scientists. The use of indigenous concepts has strengthened cultural values and beliefs and IKS that sustain genetic diversity and ecosystem services for adaptation. Farmers in the park continually select for resilience traits, including drought, frost and pest resistance. Participatory Plant Breeding has been initiated for maize and potato to increase resilience and yield. The return of potatoes and maintenance of landscape beauty has led to growing revenues from tourism and potato-based products, which, along with herbal products and crafts, are reinvested in sustaining the park's 'biocultural heritage' (ie. interlinked traditional knowledge, biodiversity, landscapes, cultural and spiritual values and customary laws).

For more information see: Asociacion ANDES and the Potato Park Communities (2015). Biocultural Heritage Innovations in the Potato Park. SIFOR Qualitative Baseline Study. http://pubs.iied.org/G03917.html

3. Community Seed Banks

As the SIFOR findings show, crop diversity is rapidly declining in many communities in marginal lands, and community seed banks have been lost, largely due to the promotion of hybrids and modern varieties (eg. fast maturing maize in coastal Kenya). Establishing Community Seed Banks (CSBs) is an important adaptation measure, which prevents further loss of crop diversity, ensures seed access for farmers, enables recovery from extreme events, and enables seed exchange between different communities and with gene banks. The Potato Park's seed bank is a building which is specially designed to keep cool at all times, using water and air-flows rather than electricity. It is managed by a group called the 'Potato Guardians' composed of experts from each community. A recent workshop of the International Network of Mountain Indigenous Peoples (INMIP) shared experiences with community seed banks and seed storage techniques, and established an international network of community seed banks for exchange of seeds and indigenous knowledge for adaptation.

For more information see: Krystyna Swiderska and Pernilla Malmer (2016). Climate Change and Biocultural Adaptation in Mountain Communities: Second international learning exchange of the International Network of Mountain Indigenous Peoples, Tajikistan, September 2015. http://pubs.iied.org/14657IIED.html

4. Strengthening Indigenous Knowledge-based Innovation Systems

The SIFOR project identified a number of innovations developed by farmers to improve productivity in the face of climate change using indigenous knowledge alone or IK and science. For example, switching to more resilient crops, reviving mixed cropping practices, planting at different elevations, breeding new varieties, and developing new bio-pesticides. The results show that farmers are actively innovating based on the indigenous knowledge. The China case identified 500 such innovations in 18 communities, largely technological innovations, but also some market and institutional innovations. However, traditional knowledge and innovation systems are becoming weaker following decades of top-down agricultural research and extension, and due to other factors such as declining interest of youth, migration, reduced access to traditional territories and natural resources, and weakening of traditional institutions.

Strengthening IK-based innovation systems requires investment in respectful collaborative research between smallholder farmers and scientists, where IK and science are valued equally, eg. PPB, repatriation agreements and Farmer Field Schools. Strengthening market linkages for IK-based products is also important to encourage innovation. The SIFOR project identified the following common factors which support such 'biocultural innovation':

- Individual innovators, particularly elders and women.
- Networking and information sharing within and between communities, and with external actors (eg. scientists and NGOs)
- Traditional values, beliefs, institutions and ceremonies that ensure transmission of IK: eg. values of sharing and reciprocity promote exchange of seeds and knowledge, and solidarity and kinship promote collective action; and values and beliefs that promote conservation of crop diversity.
- Strong locally owned community organisations; capable and committed leaders, and recognition of innovators.

5. Smallholder innovations and agricultural practices that enhance productivity, food security and resilience sustainably

SIFOR identified a number of indigenous knowledge-based innovations and practices that enhance productivity, food security and resilience in a sustainable manner in mountain and dryland mixed crop-livestock systems – including some which have significantly enhanced productivity. The findings for India and Kenya are summarised below (for Peru and China, see the case study reports above).

Central Himalayas, India

Research was conducted with 5 communities practicing traditional rainfed crop-livestock farming in Almora District, Uttarankhand State, a mountain forest landscape. Crop production has been declining constantly in the last 20-30 years, with a very sharp decline in the last 5-7 years, mainly due to changes in climate, especially more erratic rainfall and water scarcity, and increased crop raiding by wild animals (linked to forest changes). In response, farmers have developed several innovations largely based on IK combined with science:

1) Revival of biodiverse agroecological practices: Farmers have introduced more intensive mixed cropping of vegetables, spices, oil seeds and grains close to the house (eg. buckwheat, pumpkin, radish and French beans and gadheri vegetable grown together). This has increased productivity by improving soil moisture, reducing crop raiding by animals, and making food available throughout the year. The roots of different crops use different zones and beans fix nitrogen. They have also improved soil fertility and moisture by developing new composting techniques, resulting in higher yields and very efficient water use. They have developed bio-pesticides using bitter leaves which has proved very effective for protecting vegetables from pests.
2) Switching to more resilient crops: Increased production of finger millet instead of rice and wheat has enhanced resilience to reduced rainfall; reintroduction of locally extinct crops like flax seed on the edge of fields has prevented bird attacks. Both have also improved nutrition and marketability due to a resurgence in demand.

3) Breeding new varieties: A farmer developed a high yielding variety of radish through 6 years of sustained breeding to stabilise the desired characteristics, by crossing a hybrid with a traditional variety. The new variety can be used as both a vegetable and a salad (unlike existing varieties) and has edible leaves.
4) Changing cropping practices: One farmer has far improved the quality and yield of onions, cauliflower and gadheri compared to other farmers by changing sowing times, planting depth and weeding practices. Women have started cultivating fodder trees on farm in response to forest degradation, reducing dependence on forests.

For more information, see: Ajay Rastogi, Nawraj Gurung and Reetu Sogani (2015). Smallholder Innovation for Resilience: Qualitative Baseline Study, Central and Eastern Himalayas India. http://pubs.iied.org/G03829.html

Eastern Himalayas, India

Research was conducted with 5 Lepcha and Limbu traditional farming communities in a remote sub-tropical mountain forest near Kalimpong, West Bengal State. They practice terrace farming, mixed cropping and inter-cropping, with maize, rice, millet and large cardamom as the main crops, and cows, pigs and goats as livestock. Rainfall has declined and become more erratic, leading to water shortages; and this combined with rising temperatures has led to more pest and disease outbreaks, especially for cardamom planted in forests. Smallholder innovations include:

1. Developing higher yielding varieties: farmers have developed a new variety of cardamom (Bharlang) which requires much less water and shade, by using a variety brought from close to Bhutan and gradually adapting it to local conditions through selection. They also developed a new black cultivar of bean (black rice bean) through careful selection, which is higher yielding and has become the most important local food crop for consumption and sale.
2. New cropping practices: cardamom yields also increased due to a new inter-cropping system with maize and vegetables, allowing cardamom to benefit from irrigation and manure for other crops. Early uprooting of maize has enabled yields to be sustained despite erratic rainfall. Farmers have changed the planting times for millet to adapt to changes in rainfall.
3. Recovery from landslides: After a huge landslide in 1968 destroyed paddy lands and water sources, a farmer tested a new potato cultivation technology learnt from a government seed farm, which enhanced production ten-fold. Farmers also domesticated broomstick grass from the forest to reclaim the landslide area which could not be cultivated with food crops. It grows well on marginal land and slopes, has become the third most important cash crop in the region (after cardamom and ginger), and is a good source of fodder, fencing and fuel.
4. Switching to more resilient crops: Potato is increasingly damaged by dew, which is thought to be linked to changes in climate, deteriorating seed quality and reduced availability of good seed because most of the potato cultivation area has been taken under a government protected area. So farmers are now switching back to traditional mustard cultivation, thanks to seed saving by older farmers, which fits well in crop rotation and is considered a good soil condiment against pathogens.

For more information, see: Ajay Rastogi, Nawraj Gurung and Reetu Sogani (2015). Smallholder Innovation for Resilience: Qualitative Baseline Study, Central and Eastern Himalayas India. http://pubs.iied.org/G03829.html

Coastal Kenya

Research was conducted with 5 Mijikenda communities (31 villages) in Kilifi and Kwale Counties - farming maize and cassava as staple crops in semi-arid coastal forest, and mixed crop-livestock systems in dryland areas more inland. Rainfall has significantly decreased and become more erratic, and temperatures and pest and diseases have increased, resulting in a considerable decline in crop productivity. Key smallholder innovations include:

1. Shift to cassava and livestock: Frequent incidences of hunger and drought have necessitated a switch from maize to cassava as the major crop in all the Mijikenda communities. There has also been a marked shift towards increased reliance on livestock, using hardy local breeds, in the dryland communities in recent years.
2. Return to traditional varieties: 43% of farmers have started to plant improved, hybrid and traditional varieties of maize and cassava together to reduce the risk of crop failure. Traditional varieties take longer to mature but can tolerate pest, disease and water stress, while modern varieties mature fast but cannot tolerate these stresses.
3. New treatments for worsening livestock diseases: farmers developed effective treatments for chickens and cattle based on IKS (eg. using dung from donkeys that graze in the wild). Digging water pans near homesteads has also improved livestock health.
4. Domestication and planting innovations: Famers have successfully domesticated a number of wild fruit and medicinal tree species for increased food security and income, developing the propagation methods themselves. Other innovations include a method of planting coconut seeds that prevents termite attacks, use of nitrogen fixing plants, agroforestry, uprooting of deep rooted cassava to enhance soil nutrients, and the discovery that using pruned cassava tops as planting material greatly increases productivity.

For more information see: Paul Ongugo et al (2014). Smallholder Innovation for Resilience (SIFOR): Qualitative Baseline Study, Mijikenda Community, Kenya Coast. http://pubs.iied.org/G03830.html

For more SIFOR research outputs, see the project website: www.bioculturalheritage.org