Coping with climate change

The use of agrobiodiversity by indigenous and rural communities
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A BRIEFING PAPER

Introduction
The importance of agrobiodiversity
Ecosystem services and sustainable agriculture
Indigenous and rural communities

Land use systems and their functions
Link between wild and cultivated landscapes
Shifting agriculture, agrobiodiversity conservation and climate change – North western ghats, India
Rotational farming and climate change – Chiang Mai, Thailand
Mountain systems, adaptation and mitigation – Tibet
Pastoralists: a neglected group with solutions at hand – Sub-Saharan Africa
Smallholder farmers and pest management

Socio-cultural and institutional dimensions
Indigenous institutions for biocultural diversity
Agrobiodiversity and food sovereignty

Concluding comments

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Introduction

The importance of agrobiodiversity

The livelihoods and survival strategies of indigenous peoples and rural communities throughout the world depend on the maintenance and use of a wide diversity of crops and livestock, and on access to natural resources in the wild. For instance: Nepalese farming communities from the mid-hills areas (1,500-2,000 m.a.s.l.) routinely maintain as many as 60 varieties of rice; indigenous Andean farmers typically plant dozens of different potato varieties on a single farm; African farmers in the Sahel maintain many varieties of sorghum and millet in their fields. The intra-specific diversity (plant varieties and animal breeds) complements the diversity of crops and livestock species and is maintained so as to increase production, enhance resilience and reduce vulnerability, while meeting the multiple needs of local communities. Women and their expertise play a key role in maintaining and ensuring best use of this diversity.

Agrobiodiversity is systematically maintained and used by indigenous peoples and rural communities. It is part of traditional knowledge systems and seed networks with respect to key traits and responses of diverse crop species and varieties to changing production environments and needs. Traditional or "informal" seed systems are maintained through the interactions of economic, social and cultural institutions that ensure availability of planting material. Individual farmers keep their own seeds and breeding stock but practice traditional forms of exchange, including gift, barter, and sales that distribute agricultural biodiversity across landscapes and communities.

The management of this agricultural biodiversity plays a central role in adaptation to climate change. A key concern of indigenous peoples and rural communities is to develop coping strategies for rapidly changing temperature and moisture conditions. Key among these changes are increased inter and intra-seasonal variability and extreme events, increased temperatures, decreased rainfall and reduced availability of water for irrigation. Diversity also helps cope with the increasing frequency of extreme weather events, both through the provision of some buffering and enabling farmers to respond after floods, hurricanes and other disasters. Over the last 20 years the cultivar diversity of millet and sorghum has been maintained by farmers who require an extended range of maturation dates to meet early or late onset of rains and increasing frequency of droughts. Increased diversity in crops and varieties, in livestock and breeds, is therefore an adaptation strategy of proven value.

Adaptation to climate change by indigenous peoples and rural communities typically involve two diversity management strategies. One of these entails the maintenance of high levels of local diversity to ensure adaptability at local level and to improve resilience in local production systems. As such, the unique local systems that have maintained and shaped...
agrobiodiversity over centuries would need to be supported through the survival and sovereignty of the indigenous cultures, local practices, and communities. However, for many communities the impacts of climate change will be so great as to require a second strategy whereby they can acquire varieties and crops with new and different characteristics that fit the new conditions. Change is happening so fast that traditional knowledge systems and seed supply or breeding stock cannot evolve quickly enough to meet local needs. In these cases genetic material, introduced biodiversity, and knowledge will have to come from outside the community. Increased exchange among indigenous and traditional farming peoples is a first step. Improved international exchange of materials and the increased accessibility of materials held in genebanks will also be essential.

Ecosystem services and sustainable agriculture

Societies everywhere benefit from a multitude of resources and processes supplied by nature. Collectively they are known as ecosystem services because these natural assets and processes are essential for human survival and well-being. The extent and quality of these services depend on the interaction between the natural physical processes and the biodiversity of the ecosystems. In agricultural systems, the extent to which ecosystem services are sustained or enhanced depends on how rural communities living within the ecosystems practice and manage agrobiodiversity. The table below illustrates five different categories of ecosystem services all of which are inextricably linked to agrobiodiversity.

For agriculture to be sustainable, it must harness ecosystem services as natural ecosystems do, so that the needs of local communities as well as of the greater society are met at minimum social, environmental and economic costs. Agricultural production and land use techniques employed by indigenous people and rural communities have to maintain ecosystem services in their altered environments for themselves and the greater society. Where parts of natural ecosystems are converted into agricultural ecosystems, it is important that ecosystem services are protected and enhanced, implying that ecosystem service processes must be internalized within the production system.

This can be illustrated by the sustainable land management practice known as Conservation Agriculture (CA). According to FAO, CA is:

"a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment. CA is based on enhancing natural biological processes above and below the ground. Interventions such as mechanical soil tillage are reduced to an absolute minimum, and the use of external inputs such as agrochemicals and nutrients of mineral or organic origin are applied at an optimum level and in a way and quantity that does not interfere with, or disrupt, the biological processes. CA is characterized by three interlocked principles of continuous minimum or zero mechanical soil disturbance (i.e., direct planting of seeds); permanent organic soil cover, especially by crop residues and cover crops; and diversified crop rotation in the case of annual crops or plant associations in the case of perennial crops." (www.fao.org/ag/ca/)

Implementing Conservation Agriculture in a variety of production systems can be beneficial in terms of climate change adaptability and mitigation. Within agroforestry systems, based on the use of woody perennials and annual crops, CA in particular offers better compatibility with tree and field crops since the tree roots cannot be caught by ploughs or deeper-reaching tillage implements. With regards to livestock integration, CA has the capacity to increase biomass production which strengthens the links between crop and livestock production. Farming systems that successfully integrate crop and livestock enterprises stand to gain many benefits that can have a direct impact on farm production as a whole.

In the case of agropastoral systems which tend to occur within resource-poor or degraded areas and can be severely affected by overgrazing, the integration of crops in “crop-livestock” systems is applied to recover degraded pasture lands by rotation of the crops into no-till fields for up to two years. No-till cropping allows not only the inclusion of pasture or forage crops into the rotation (where under traditional tillage-based systems the time would be too short to grow any additional crop), but can also work in areas considered to be permanent pasture unsuitable for “arable” farming, for instance due to erosion risks.

<table>
<thead>
<tr>
<th>ECOSYSTEM SERVICES AND AGROBIODIVERSITY</th>
<th>PROVISIONING</th>
<th>Food and nutrients, water, fuel, animal feed, medicines, fibers and cloth, raw materials for industry, genetic material for improved varieties and yields, pollination, pest resistance, carbon sequestration, biologically fixed nitrogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>REGULATING</td>
<td>Pest regulation, erosion control, climate regulation, natural hazard regulation (droughts, floods and fire)</td>
<td></td>
</tr>
<tr>
<td>SUPPORTING</td>
<td>Soil formation, soil protection, soil health, nutrient cycling, water cycling, climate change adaptability</td>
<td></td>
</tr>
<tr>
<td>CULTURAL</td>
<td>Sacred groves as food and water sources, agricultural lifestyle varieties</td>
<td></td>
</tr>
<tr>
<td>PRESERVING</td>
<td>Genetic material reservoirs, pollinator sanctuaries</td>
<td></td>
</tr>
</tbody>
</table>
CA can also be applied to indigenous farming practices such as **shifting agriculture** which is based on clearing for cultivation and subsequently abandoning it for natural re-growth and reforestation. It is stable under low population-density, but rising population decreases re-growth time available leading to the system becoming unsustainable. With this agricultural practice, by adapting a CA technique such as switching from **slash-and-burn** to a **slash-and-mulch** approach, it is possible for the communities involved to harness a greater range of ecosystem services for themselves and for the greater society. In many cases, the agricultural practices of indigenous and traditional communities have similarities to those that are promoted in Conservation Agriculture systems. This is so because of the complex and multiple dimensions of indigenous agricultural systems as practiced by generations with intimate dependence upon ecosystem services within their territories. A sharing of knowledge between indigenous agriculturalists and scientists involved in developing CA techniques and practices can be fruitful for all.

**Indigenous and rural communities**

Many indigenous peoples and traditional societies inhabit marginal areas with fragile ecosystems or at the boundaries between major ecosystems. These areas include desert margins, steppes and drylands, mountain ecosystems, tropical forests, tidal areas and wetlands, circum-polar regions are experiencing profound effects and rapid change due to climate change. Indigenous and traditional societies use complex strategies for managing these ecosystems and landscapes that mitigate impacts of rapid environmental change by deriving livelihoods that combine complementary resources across ecosystems e.g. terrestrial and aquatic, croplands and forests, pastoralism and rotational farming. They maintain unique ecosystems like mangroves and wetlands to buffer the effects of natural disasters, for example mangroves absorb the energy and reduce the force of tidal surges, they also absorb the impacts of flooding from increased erosion and severity of rainfall.

Indigenous communities living in these areas use a sophisticated set of environmental indicators to chart rates of ecosystem change, such as changes in tree cover or glacial melt in mountains, increased salinity in tidal areas or wetlands, rainfall distribution and changes in vegetation and pests in crop fields and drylands. This information linked to indigenous livelihoods is valuable for the global monitoring and responses to climate change. For example, migratory patterns of birds, leaf fall in the forests can help Sahelian farmers determine or adjust planting dates or choice of crops and crop varieties, gathered foods can become more important for agriculturalists, salinisation of croplands may cause changes in water temperatures and species composition of coastal marine ecosystems and fisheries.

Indigenous people and traditional societies occupy ecosystems that are critical observatories and centres for adaptation to climate change. Coping and adapting to climate change will not involve a single blueprint or mechanism but a plurality of perspectives and options; in this regard the diverse biocultural perspectives of indigenous peoples will need to move from the margins to the centre of our thinking about adaptation to climate change. They are key actors in our understanding of how climate change affects our world, how “climate change teaches us to rethink what we want for ourselves and humanity” (Hulme, 2009). Traditional and indigenous societies can be lighthouses in charting our responses to climate change using biodiversity, but only if their cultural institutions, customary governance, and resource rights are respected, understood and supported.

The main actions proposed are to: (i) support access to biodiversity necessary for survival and adaptation of indigenous peoples and traditional communities in their environments; (ii) respect and maintain the complex ecosystem buffers that also provide livelihoods, sacred spaces, and pathways of traditional peoples; and (iii) include indicators of environmental changes and portents of natural disasters through equitable partnerships between local communities and scientific environmental monitoring activities.
Throughout the world, local communities and indigenous groups have had to deal with many changes as a result of social upheavals which drive people to migrate. Rotation cycles of shifting cultivation have become ever shorter as pressure on land increases due to population growth which in turn leads to increased demand for the various functions of the forest. Compared to these changes, current and projected climate change effects are much slower and milder (even taking into account exceptional local cases such as rapid rise in temperature in the mountains). Karen farmers in Myanmar and Thailand have been able to cope successfully with a rotational cycle that has shortened from 20 years to 7 years with a fallow enriching tree they call *pada* or *letha* (*Macaranga denticulata*). They have observed that the fallow forest regenerates faster and upland rice yields are higher where *pada* stands are dense. Their findings have been verified by sampling vegetation and rice for biomass, nutrient accumulation and yield. The key to this success is the tree’s association with a diverse population of arbuscular mycorhizal fungi (Yimyam et al., 2008). The use of *pada* is only one of numerous experiences and innovations that communities use to manage wild and cultivated landscapes in the face of social and environmental changes in recent years. Many other elements of resilience and adaptation to ecosystem changes and threats exist and need to be identified and verified, as they are likely to be useful for coping with climate change, locally and globally.
Shifting agriculture, agrobiodiversity conservation and climate change  
/ North Western Ghats, India

The northwestern Ghats in India is an orographic mountain range running parallel to the west coast of India and is a hotspot for biodiversity. In the northern region, rural communities practice shifting agriculture patterns and maintain large numbers of local land races of traditional coarse millets and lesser-known food grains, including finger millet (*Eleusine coracana*), Cattail grass (*Setaria pumila* ssp. *pallide fusca*), and Little Millet (*Panicum miliare*). Short-cycle rotational agricultural systems are responsible for the supplementary diet of local land races of vegetables like beans and cucurbits. Agriculture of this kind is labour intensive and has limited possibilities for marketing the produce. Consequently, migration to urban areas is common and the practice of this traditional agriculture, known as *dongarsethi*, is dwindling (Godbole et al., 2000).

However, with the changing monsoon pattern and overuse of fertilizers, the output from flat paddy land is decreasing rapidly. Impact of climate change is evident in the region through reduced number of rainy days per year and low water availability. Paddy yields are decreasing and severe droughts are affecting the very survival of poor farmers in this region. As a result, rural communities have realized the value of some of the previously cultivated varieties of finger millet (*Eleusine coracana*) and *Panicum milliare* which are resistant to drought and require less water. They are therefore planning to reintroduce and cultivate some of the traditional cultivars as a strategy to adapt to climate change. However, obtaining adequate seeds of local cultivars is a challenge. Another major threat is the conversion of non-agricultural uses of land on higher slopes that was once used for shifting cultivation which has been sold for tourism and other urbanization projects which pose a direct threat to reviving this traditional system. It is important to promote the search and cultivation of these important varieties in order to build the capacity to understand the short and long term impacts of climate change on agriculture in general and shifting agriculture in particular. In the north Western Ghats the practice of *dongarsethi* rotational farming or shifting agriculture has not stopped completely and there is a need to promote and reward this farming system. One aspect of the practice which can be improved is the avoidance of burning, and using the plant organic matter to form a mulch cover over the soil surface which can provide protection against erosion and runoff and also become an organic source of nutrients to soil biota and crops. Such a ‘slash and mulch’ rotational system would provide a sustainable basis for cropping with enhanced ecosystem services.

Rotational farming and climate change  
/ Chiang Mai, Thailand

Rotational farming is an agricultural practice that involves alternating cultivation between different plots within the same location whilst leaving the other plots fallow. It is often misunderstood, and is considered to be a destructive farming technique which depletes soil nutrient content as it often involves the clearing of land by burning. When properly understood, it is an indigenous farming technique that takes into account local conditions such as climate, soil and natural biodiversity. It is a versatile technique for farming, particularly in marginal conditions such as mountainous regions. It is also knowledge intensive and culturally relevant in traditional farming communities.

Research is underway to assess its role as an effective strategy in coping with climate change. In the Mae Lan Kham area north of Chiang Mai, the traditional home of Karen communities for many centuries, the community began participating in 2003 in a national programme to regulate rotational farming in a 7-8 year interval according to rotational farming management plans developed at the village level. Based on a permit, the annual shifting area per family is between 3 and 5 *rai* (one *rai* is about 1600 m²). Rotational areas are delineated in the fields by marking stones, and the rotation agreements, which include fire control, are strictly followed. Hill rice is produced in one single year only, followed by a fallow period of 7 years. Right after planting the hill rice, the forest starts to regenerate immediately, through coppice and seeds of secondary species. A closed canopy cover of the resulting secondary forest can be observed three years after cultivation.

The system, applied over an area of more than 1500 *rai*, is sustainable given that forests have been managed in this way for centuries. An interesting additional phenomenon in this respect is the abundance of the tree species, *Ma khwaen* (*Zanthoxylum limonella*), which invades some of the areas rapidly after burning. Its small fruits are used as a condiment and are of commercial value. Areas with dense *Ma khwaen* growth often are taken out of the rotational cycle and transformed into tree orchards. Additionally, the use of rotational farming by these communities is an effective technique for carbon management. Carbon dioxide is released when burning swiddens, but reincorporated into plants when the forest regenerates. Rotational farming has a strict set of fire breaks to control burning and protect swiddens in the fallow period as well as the natural forest. While the primary forest is good in storing carbon, the secondary forest within the fallow system absorbs greater amounts of carbon than the primary forest, possibly due to the fast re-growth of secondary forest. This makes rotational farming more advantageous in comparison to agricultural methods of permanent land use. Problems only start to crop up when pressure of land result in shorter fallow periods. A system of traditional resource rights in the Karen communities can
help to protect the sustainable cycles of different rotational farming practices. Also, mulching instead of burning the vegetation would impart even greater resilience and productive capacity to the Karen rotational farming.

Mountain systems and climate change

/Tibet/

The IPCC predicts Tibetan climate will undergo a 5-6°C temperature increase as well a 20-30% increase in precipitation. This coupled with glacial retreat and loss of snow cover on mountains will lead to unpredictability of seasons and monsoons. Resulting impacts to agrobiodiversity and Tibetan agriculture include dramatic changes in crop varieties and early planting and harvesting seasons. There are also challenges to soil management due to the faster decomposition of organic matter leading to more being incorporated to the collecting seasons becoming unpredictable.

Other effects on indigenous communities’ livelihoods, bioculture, and resource management systems include impacts on health which are of major concern. There is more disease, pests and food spoilage (traditionally Tibetans never dealt with refrigeration because of cool climate). In addition, there is also greater proclivity for landslides and unpredictable river levels with alternating levels of flood and slack. Some of the perceived causes of climate change are culturally based with certain communities believing that the influx of non-believers (e.g., immigrants and tourists), misconduct (due to failure of the Tibetans to observe religious beliefs during the Cultural Revolution as well as the youth today) and pollution (both spiritual and physical) have led to these adverse changes in climate. Tibetan adaptations and mitigations to climate change include a change in crop focus (e.g., grape and wine production), the incorporation of more organic material into soils as well as increased forest cover. There is also a movement towards the preservation of sacred sites which have been found to act as viable carbon sinks.

Pastoralists: a neglected group with solutions at hand

/ Sub-Saharan Africa /

Pastoralists are people who depend primarily on livestock for their living and who are an often marginalized but critical component of the agricultural ecosystem. In Africa there are an estimated 17.3 million pastoralists. Some of them include the Maasai of Kenya and Tanzania, the Pokot of Kenya and Uganda, the Karamojong of Uganda, and the Tuareg of Mali, Burkina Faso and Niger.

Like other pastoralists, these individuals inhabit some of the most extreme and harsh territories. Yet, of all the natural resource-based land uses in the drylands, pastoralism functions the most successfully within the context of wide rainfall variability and unpredictability. It also presents a more logical adaptation route than livelihood activities and land uses, which do not have the advantage of mobility (Nori and Davies, 2006).

Typically, pastoral communities occupy a unique agricultural niche; drylands and areas where little else can grow or thrive and that would not otherwise be occupied. The mobility of their herds brings numerous benefits to rangelands by stomping the soil, reducing soil degradation by fertilizing the land, and contributing to geneflow as the herds eat the fodder and drop the seeds elsewhere. The close connection between animals and people reminds us that farming is not sectoral but an integrated experience; the raising of animals or crops, use of land and water, management of resources are all interconnected.

Pastoralists have developed coping strategies to adapt to difficult times (e.g., diversifying or splitting herds, sharing resources). These strategies increase purchasing power, improve diet, and enhance resilience. In contrast, switching to farming or gathering increases vulnerability of these communities. Although pastoral systems are very diverse, most display some common characteristics: livestock depends on natural pastures for their diets, and rainfall is the most important factor determining the quantity and quality of pastures and water.

Herd systems are composed mainly of indigenous livestock breeds and livestock represents more than just economic assets; they are also social, cultural and spiritual assets, and contribute to the definition of social identity. Natural resources are managed through common property regimes where access to pastures and water is negotiated and dependent on flexible and reciprocal arrangements. While pastoral systems are resilient because they enable people to cope with unpredictable environments, they are also dependent on maintaining a delicate and constantly changing balance between pastures, livestock and people. Unfortunately, pastoralists’ mobility is being strongly compromised due to transborder issues and access to land that is being restricted more and more. Understanding and taking into account that interdependence of elements brings more value added to strategies and policies for responding to the challenges of climate change and population needs. Nomadic pastoralists have learned to conserve rangelands through sophisticated techniques embedded in cultural institutions. All of this renders an ecosystem service deriving from a social network of people capable of living in very harsh conditions. We cannot afford to lose the opportunity to learn from the coping strategies of pastoralists – tapping into the potential they offer to cross-fertilize the findings from formal science with the lessons of informal science. The pastoralists offer important resources and solutions that may be particularly critical in the contemporary context of climate change and need therefore to be taken into account.
Smallholder farmers and pest management

A major and sometimes overlooked function of agrobiodiversity is the natural control of pests and diseases. Were it not for the natural enemies of pests and disease vectors, crops would be devastated on a global scale and the only options for control would be through massive pesticide use and intensive breeding for resistance. It is no exaggeration to say that our very survival depends on the continued existence and impacts of (often tiny) wasps, flies, ants and other organisms that parasitise and kill crop and livestock pests. These natural enemies are of special importance to indigenous peoples and local communities for whom alternative control methods are too expensive, difficult or impossible to implement in the smallholder context.

Natural pest controls are threatened by climate change in three ways: 1) through the spread of Invasive Alien Species (IAS) to new areas outside their existing range where their natural enemies are absent or ineffective; 2) through the spread of indigenous or introduced pests to new areas within their existing range; and 3) through the breakdown of natural controls as a result of changing climatic conditions. Examples of 1) include the cassava mealybug which threatened the livelihoods of 200 million African small scale farmers and the recently discovered fruit fly *Bactrocera invadens* that threatens the fruit industry throughout Africa. Although there are always problems of attribution, at least some of the spread of IAS is influenced by climate change.

Examples of 2) include the coffee berry borer in Eastern Africa and the rice gall midge in Thailand, both of which are expanding their attitudinal ranges under global warming. In the frequent absence of environmentally friendly and affordable pesticides and/or the longer term breeding and introduction of resistant varieties, the only option for the restoration of natural pest controls is through classical biological control. This uses specialized natural enemies found in the home range of an accidentally introduced pest or Invasive Alien Species to combat this species in its new area of distribution. The specialized natural enemy is released in the environment and, when successful, becomes established to permanently suppress the pest. The import and release of the natural enemy follows the strict procedures set out in the International Plant Protection Convention (IPPC) under the roof of the Food and Agriculture Organization (FAO) and the International Organization for Biological Control (IOBC). More recently, Access and Benefit Sharing (ABS) regimes have made procedures more complicated.

When biological control works, it provides a permanent solution at zero further cost. The most spectacularly successful example is provided by the cassava mealybug: the payback from biological control in this case alone has been estimated at $6 billion over 30 years. The systematic observations of insect pests, their behaviour and impacts are often part of traditional knowledge. Indigenous peoples are essential providers of information and experience as well as major beneficiaries of biological pest control.
Socio-cultural and institutional dimensions

Indigenous institutions for biocultural diversity

Indigenous peoples around the world continue to manage their traditional institutions and systems that relate to biocultural diversity. Indigenous socio-cultural institutions incorporate three major dimensions that are interlinked and practiced as one integral system. First is the promotion of traditional values such as conservation and protection of the environment for the common good of indigenous communities. These include good practices incorporated in distinct indigenous systems of resource management which encompass forests, water bodies, agricultural lands and other types of landscapes. Each landscape has its own set of collective regulations for conservation and management. For example, the cutting of trees and hunting of wild animals in communal forest are regulated by certain rules set by villagers for conservation. The various forms of indigenous systems of resource management embody accumulated traditional knowledge that is being transmitted to the younger generations as part of their education and lifestyles.

The second dimension of indigenous institutions is the practice of rituals, beliefs and other cultural activities as the spiritual dimension of their distinct but diverse resource management systems. These are largely expressions of recognition and respect for nature which has provided for the needs of indigenous communities, offering rituals for bountiful harvests and for good weather are conducted regularly, and coupled with festivals during harvest time. Moreover, certain rituals are also performed when calamities happen to appease nature or to ask for forgiveness for abuses done to nature such as the over-exploitation of resources.

The third dimension of indigenous institutions is the practical tradition of collective work, cooperation and mutual assistance among members of indigenous communities as a core value and principle for their collective survival and management of resources. The traditions of mutual cooperation and assistance in times of difficulties, for livelihood activities, and for social events provide a social safety net and better coping mechanisms. This social dimension enables indigenous communities to be more resilient as they collectively address their issues and define their coping mechanisms.

Agrobiodiversity and food sovereignty

Climate change is likely to affect agriculture-based livelihood systems by increasing risk of crop failure, posing new patterns of pests and diseases as well increasing stress on livestock. People living in marginal areas are most at risk (FAO, 2008). Some of these locations are rich in agrobiodiversity as well as the associated traditional knowledge. However, at present, there is a general decline in dependence on local agricultural diversity and self-reliance with a shift towards increased reliance on external sources for food and/or monetary means to fulfill livelihood requirements. This change has had a negative effect on local food sovereignty and contributed significantly to widespread erosion of traditional knowledge related to the use of agrobiodiversity in local food systems.

Many crops varieties grown by indigenous and rural communities have the capacity to withstand intra and inter-seasonal variations in rainfall and temperature. These varieties are suited to produce modest but stable yields from nutrient-poor soils. For example Paspalum scrobiculatum is a millet species that is raised under hardy environments notably nutrient poor soils and in low rainfall areas. Most millet crops like little millet, kodo, foxtail, barnyard and proso millet cultivated by tribal communities in North East and Southern India are suited for less fertile and low nutrient soils. They are also less prone to pests and diseases.

Traditional knowledge related to cultivation practices of local varieties can also contribute to climate change adaptation. A range of mixed cropping patterns is common in areas inhabited by indigenous populations or tribal or rural communities. Mixed cropping using local traditional cultivars offers greater defense against vulnerability and enhances harvest security in the midst of diseases, pests, droughts and other stresses (Altieri, 2009). Farmers have also pointed out that the provision of a varied diet at different times during a season depending on the crop and harvest time fulfils household food security and lessens the need for storage (Nambi, 1998).

During the planting season, indigenous and traditional farmers throughout the world use seeds saved from their previous harvests and exchange, borrow, sell or purchase seeds from other small-scale farmers. For example 80% of farmers in Africa are reported to use seeds saved from a range of diverse ecosystems (African Civil Society Organisations, 2007) and are capable of contributing to adaptive management in the emerging climate change scenario. Farmer led agricultural innovation using local seeds is likely to respond to local needs and contribute to sustainability. Sovereign control over local seeds and local know-how is important for designing sustainable and resilient agricultural and food systems (IIED, 2008).

If climate change makes the production of global food staples more costly, due to water scarcity, increased pests, and competing demands for bio-energy to reduce dependence on fossil fuels, the cost of global staples such as wheat, maize, rice, vegetable oils, and products from livestock industries will become more expensive. Food crises resulting from high food prices have led to civil strife and instability in several developing countries. For the rural poor living in marginal areas (often indigenous and tribal peoples), the costs of growing, transporting, and transforming global staples will be prohibitive. Revitalising and supporting local food traditions and indigenous food systems based on agricultural biodiversity is one clear option (Johns and Sthapit, 2004). This link to food sovereignty underpins cultural identity and development for indigenous peoples. Crops and wild plants belong to the cultural history and identity of indigenous and rural communities and are likely to contribute significantly to adaptation to climate change.
Climate change is now imparting increasing degrees of vulnerability to the social and ecosystem functions of many indigenous and rural communities. It is likely that in some cases, the communities will cope and adapt to climate change. In other cases, they may need to be supported to maintain their ecosystem role and biocultural identity. Indigenous and rural communities rely on collective action for their survival and functional contributions. Thus, the social capital base and the accompanying knowledge systems in the use and management of agrobiodiversity are mainly transmitted through oral traditions in which women play an integral role. Consequently, it is important that researchers who undertake studies on the livelihoods of indigenous and rural communities are sensitive to such socio-cultural aspects and follow appropriate protocols that contribute to preserving and supporting their biocultural knowledge systems (PAR, 2009).

One common theme running through the examples of land use practices of small farmers and indigenous communities illustrated above is that of 360 degree integration of all the different aspects of community life covering socio-cultural, biological, physical and environmental dimensions. It is this total integration with nature for social, material and spiritual well-being and inter-generational survival that makes the indigenous people and their communities the natural custodians of many of the world’s common resources at local, national and international levels. The accompanying knowledge base and the system of livelihood strategies of the indigenous and rural communities, devised over centuries, include many enduring and positive elements of agrobiodiversity management for ecosystem services and community well-being. Consequently, the land use functions of indigenous communities that provide them with ecosystem services also serve a greater international need – that of preserving agrobiodiversity, maintaining watersheds and water resources, contributing to cultural and ecotourism resources, and managing social organizations and institutions for equitable benefit sharing. However, despite their contributions to national and international well-being, indigenous and rural communities are often not recognized for the services they perform.
References

http://www.grain.org/g/?id=179

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“The solutions for the future have roots in the past. Local responses to climate change, the livelihoods of poor rural women and men, and the wellbeing of children and future generations, can be sustained and improved by nurturing the biocultural knowledge systems of traditional small scale farmers and indigenous peoples in managing agricultural biodiversity, enhancing them with formal scientific knowledge.”