POLICY BRIEF

AGRICULTURE AND CLIMATE CHANGE IN THE HIMALAYAN REGION

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Background

Climate change is one of the most serious threats to agriculture and humankind. More frequent and increased events of extreme climatic events such as high temperatures, droughts, heavy rains, storms, and floods are expected to amplify agricultural production risks and losses, particularly among smallholder farmers in developing countries (Morton et al. 2007). The unpredictability of weather and erratic rainfall will reduce production and incomes in vulnerable areas (FAO, 2013). Not to forget that adverse effects will contribute to social and political instability and likelihood of human migrations. On the opposite direction of the climate change impact pathway, agriculture, forestry, and related land uses accounted for around 13% of $CO2$, 44% of methane ($CH4$), and 82% of nitrous oxide ($N2O$) emissions from global human activities during 2007-2016, representing 23% of total net anthropogenic emissions of greenhouse gases (IPCC, 2019). So, there is much potential to reduce these emissions and to mitigate the adverse effects of agriculture on the environment. Therefore, both diverse and context-specific mitigation and adaptation measures are needed with emphasis on building resilience to changing change. In the context of indigenous territories such as North East India, the emissions from low input agriculture are rather low, but this starts to change with external forces and new drivers of agriculture simplification and intensification. The recent Special Report on Climate Change and Land recognized that traditional knowledge and legalization of stewardship of the world's lands and forests are vital for reducing emissions and limiting global warming (IPCC, 2019). The other high-level report confirmed contributions of indigenous peoples to the enhancement and maintenance of biodiversity and landscapes (IPBES, 2019).

Recently, an increasing number of initiatives have embraced the concept of climate smart agriculture (CSA) to respond to climate change adaptation and mitigation challenges. CSA is based on three principles: 1. mitigation of greenhouse gas emissions from agriculture, 2. adapting agriculture and building resilience to climate change, and 3. sustainable maintenance or increase of agricultural productivity (FAO, 2013). However, the CSA practices are very broad with no intervention "one size fits all", but site-specific assessments to identify suitable agricultural practices are required. CSA differs from 'business-as-usual' approaches by emphasizing the capacity to implement flexible, context-specific solutions, supported by innovative policy and financing actions (Lipper et al. 2014). A recent analysis of climate resilient agriculture from Nepal showed that this approach seems to have higher benefit-cost ratio compared to conventional agriculture, yet more capital is needed at the beginning (Rai et al. 2018).

Situation

It is important to realize that local communities have been developing and co-evolving farming systems through their indigenous knowledge. Climate resilient skills are also part of this knowledge and systems (Kumar, 2014). Indigenous farming systems are generally low in emissions and thus contribute minimally to climate change, vice versa, they often suffer from the effects of climate change as they are primarily rainfed and interconnected with climate (Kuhnlein et al. 2013). The Indigenous food and agriculture systems could be considered as climate-smart options based on the key climate resilient principals, i.e., high agrobiodiversity, variety of local farming practices, and landscape diversity. Yet, these principles should be further adapted and strengthened along with sustainable agroecological intensification to increase system productivity. More efficient resource use offers considerable potential for increasing incomes and the resilience of rural livelihoods while reducing agricultural emissions (Dercon and Christiansen, 2011). The expanding conventional agriculture and monocultures with higher input use should be discouraged or at least enhanced by the three above mentioned principles, as they are increasing more emissions, reducing climate change resilience, and undermining climate change adaptation.

Considering the local context, there is a priority for a stronger focus on adapting agriculture to climate change. A need to adapt to climate change as well as to other environmental and socio-economic changes has led to increasing interest in the concept of resilience (FAO, 2019). Adaptability is considered as a part of resilience (Folke et al. 2010).

In the context of this policy brief, we identified and described 3 key practical principles and scales of agricultural resilience in the face of biggest challenges posed by climate change. They all have one cross-sectional element in common – diversity.

Resilience principle 1: Agrobiodiversity and diversification

Agrobiodiversity is the diversity of crop species and varieties, livestock species and breeds, wild plants, pollinators, soil biota and other aquatic and terrestrial organisms that make agricultural and food production possible. ***Meeting the challenges of climate change, improving nutrition and health, and achieving a transformation towards more sustainable and equitable production systems will all require the conservation, restoration, and improved management of agrobiodiversity*** (PAR, 2018). Agrobiodiversity contributes to Earth system resilience through many collective strategies, such as the protection and restoration of ecosystem services, sustainable use of soil and water resources, agroforestry, diversi¬fication of farming systems, biological pest control, and use of stress-tolerant crop species (FAO 2019; HLPE 2017). By using rich portfolio of crop species and varieties (intraspecific diversity), farmers can manage risks, reduce their vulnerability and increase the long-term productivity of their agricultural systems (Mijatovic et al., 2012; Lin 2011). Using agrobiodiversity is particularly suitable and viable for smallholder farmers in less developed countries, where smallholders usually do not have the purchasing power necessary to increase their adaptive capacity by using expensive inputs (Villanueva et al. 2017). Adjustments of seasonal activities and changes in crop diversity (particularly towards climate-resilient agrobiodiversity) can help to adapt to altered seasonal patterns and erratic rainfall. Diversification through the integration of trees into production systems is known to balance onset of rainy seasons, floods, extreme weather events, and erratic rainfall. The presence of trees and shrubs also provides windbreaks, shade, and shelter for crops and animals, and regulates soil moisture and temperature (Mijatovic et al. 2012). Importantly, trees in the farming systems are sequestering large amount of carbon, which can help to reduce the concentration of CO2 in the atmosphere. Native species and indigenous crops are known to be well-adapted to the local conditions, and moreover they can provide stable yield under no or minimal input. Agrobiodiversity should be a central component of CSA approaches for increasing productivity, adaptability and resilience of agricultural production systems (Villanueva et al. 2017). Agrobiodiversity is crucial not only for the climate resilience but also for the overall existence, health and well-being of the indigenous communities (Kuhnlein et al. 2013).

Resilience principle 2: Variety of farming practices

Indigenous peoples have in-depth traditional knowledge and experience with different farming practices and resource use. The local knowledge has been recognized as adaptive management (Berkes et al. 2000). ***Indigenous peoples have experiences with climate change, and local knowledge on weather and climate change is being studied currently. In case of farming practices, local communities have developed diversity of agricultural practices suitable for the local conditions and contributing to biodiversity through altering natural processes with anthropogenic assets of knowledge, practices, and technology*** (IPBES, 2019). Examples of practices that strengthen agricultural resilience are crop-livestock mixtures, intercropping, polycultures, crop rotations, cover cropping, irrigation, sustainable soil management and many others (FAO, 2017; Mijatovic et al. 2012). In the bio-culturally and geographically heterogeneous North East India, many unique practices have developed with examples of bamboo drip irrigation, Apatani irrigation and rice-fish culture, terracing, integration of nitrogen-fixing trees, cattle rotation, and others (Dabral, 2002). Although particular sets of practices and farming systems vary from place to place, it is the overall variety and combination of farming practices and livelihood strategies that secure resilience (see example in table 1). The future potential, gaps, and scalability of individual and combined practices, as well as their impact on climate, should be assessed.

Resilience principle 3: Land-use and landscape diversity

Indigenous territories and land-use systems are crucial for the communities and lead towards diverse "mosaic" and multifunctional landscape which has stronger buffering capacity and high resilience to natural calamities and changes. The indigenous lands are often managed based on culturally specific values such as the health of the land, caring for the country, and mutual responsibility (IPBES, 2019). The soils, forests, and wetlands are the most critical reservoirs of emissions, and they are slowing down global warming. To adapt and mitigate climate change and to improve social, economic and ecological outcomes, it is recommended to take a landscape approach and create "climate-smart landscapes". ***Climate-smart landscapes operate on the principles of integrated landscape management while incorporating adaptation and mitigation into their objectives (Scherr et al. 2012)***. Climate-smart landscapes are characterized by three key features: 1. climate-smart practices at farm level; 2. diversity of land uses across the landscape; and 3. management of land use interactions at landscape level (Scherr et al. 2012). For example, by combining different land uses such as home gardens, rice fields, terraces, agroforestry, pastures, biodiverse shifting cultivation fields and fallows, and aquatic ponds, farmers' individual and collective action creates local agroecological complexity and integrated landscape, essential for climate resilience and ecosystem services. Preserving, connecting, or restoring surrounding forests and ecosystems would further amplify the landscape buffering capacity against extreme weather events and changing climate. More holistic research, technical, and policy guidance is needed to create landscape governance which would allow embracing dynamic and multifunctional landscapes (Padoch and Sunderland, 2013).

Table 1 Examples of key principles of the resilience of agriculture to climate change

Key principles and scales of resilience	**Practical example**
Agrobiodiversity at the species level	A farmer 1 grows a diversity of crops for own consumption and livelihood. A neighbouring farmer 2 is growing only one crop such as rubber tree intended for sale. A sudden humid and long rainy season has caused more prevalent occurrence of powdery mildew, a fungal disease, causing lower yields of a rubber tree. While the farmer 2 have affected whole production, the farmer 1 will have a good harvest of other fruit trees and crops.
Agrobiodiversity at the variety level (intraspecific diversity)	A farmer is planting 5 different varieties of a common bean. While two fast-growing but tender bean varieties get damaged in a storm, the three remaining more hardy varieties have survived and provided harvest.
Variety of farming practices	A farmer in the highlands is employing different farming practices, for example, cropping fruit trees, and raising poultry. The unexpected cold winds have destroyed the flowers or blossoming fruit trees, leading to no fruit harvest in the season. However, he is able to cope with the shock through the poultry harvest.
Land-use diversity	A farmer manages two land-use systems (wet paddy field in the lowland, and fruit agroforestry in the hills). The farmer lost paddy rice due to floods caused by heavy rains, but the fruit agroforestry supported him as back-up land use.
Landscape heterogeneity	A village with a preserved customary sacred forest located in a river watershed have in the dry season still abundant water level and fish stock, compared to a neighbouring village where forests have been degraded.

Policy recommendations

- To adapt to a changing climate, mutually-reinforcing principles of agricultural resilience were identified, i.e., high agrobiodiversity, variety of farming practices, and land-use and landscape diversity. Embracing and scaling these principles is recommended.
- The indigenous food and agriculture systems, as largely adhering to climate-resilient principles, represent good climate-smart options. Yet, these systems should be supported by sustainable agroecological intensification and more efficient yet sustainable resource use to increase not only resilience but also productivity and livelihood.
- It is important to consider indigenous knowledge systems and local resources during the design and implementation of climate smart agriculture. Given the historical expertise of living in the landscape, local communities have always been cooping and adapting to the local climate, and they can provide numerous ideas for future actions.
- Diversification and improved agrobiodiversity management and conservation are needed to meet the challenges of climate change, nutrition and health, and achieving a transformation towards more sustainable and equitable production systems.
- Several guiding tools to facilitate the inclusion of agrobiodiversity as an adaptation strategy in national adaptation plans have been developed and broader use of these tools can be made. An example is the Voluntary Guidelines to Support the Integration of Genetic Diversity into National Climate Change Adaptation Planning developed by the FAO (FAO, 2015).
- More research, investment, and policy conditions are needed to create an enabling environment and landscape governance which would allow embracing dynamic and multifunctional landscapes, fundamental for achieving climate smart objectives.
- When planning climate smart agriculture, cross-sectoral planning with different ministries and institutions should develop strategies and policies to tackle the climate change together with other multifaceted problems (such as nutrition, health, productivity, biodiversity conservation).
- Creating programs and schemes for climate-smart agriculture and ecosystem restoration hand in hand with securing a decent income for smallholders, artisans, and youths would improve the livelihood, regenerate nature, and make the region more climate resilient.
- Making agriculture more climate smart and resilient requires facilitation of farmer learning and innovation processes, through fostering access to new knowledge and information while incorporating local knowledge. This knowledge exchange may come from farmer-to-farmer interaction (e.g., farmer learning circles – see NESFAS pilot work in Meghalaya), or via extension and advisory services with increased participatory approaches.
- The large-scale agriculture and intensively grown monocultures should be discouraged or at least improved by the resilience principles mentioned above, as they are releasing more emissions, reducing climate change resilience, and undermining climate change adaptation of the region.

Conclusion

The policy brief first outlined the impact pathways of climate change. Then, the key principles of agriculture resilience to climate change have been identified, i.e., high agrobiodiversity, variety of local farming practices, and landscape diversity. These three principles also refer to three different levels (scales): 1. Agrobiodiversity level, 2. Farming practise level, 3. Land-use and landscape level. These principles have a mutually-reinforcing (synergistic) relationship. However, agriculture needs to be enhanced not only from the climatic perspective, but it needs to ensure also food security, balanced diet, livelihood, and nature conservation. Tackling these issues while enhancing climate change resilience would be the most optimal and holistic long-term strategy contributing to multiple sustainable development goals. The indigenous food and agriculture systems, as largely adhering to climate-resilient principles, were identified as good climate-smart options. However, they should be supported by sustainable agroecological intensification and more efficient yet sustainable resource use to increase not only resilience but also productivity and livelihood. Where those systems are not existing anymore, the principles of resilience should be applied to the simplified agricultural systems, such as monocultures, which are undermining climate change adaptation and mitigation. Embracing climate smart and resilient agriculture may further require facilitation of knowledge exchange, and developing the technical, investment, and policy conditions to achieve an enabling environment for sustainable agricultural development under climate change. Despite the remarkable agrobiodiversity and landscape heterogeneity of the region, the existing resources and values have been much unrecognized and untapped. This also shows research needs to assess the potential of local agrobiodiversity and to identify the most climate smart farming practices and land-uses. Sustainable land management, creating complex and multifunctional landscapes can significantly contribute to reducing the negative impacts of climate change and other factors. Strengthening and innovating the local food and agricultural systems with sustainability and resilience thinking could further improve the productivity and livelihood of the local communities and rural youth under the changing climate.

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