Ninth meeting of the Technology Executive Committee

Langer Eugen, Bonn, Germany
18–21 August 2014

Background note

TEC Brief on technologies for adaptation - Agriculture

I. Introduction

A. Background

1. At its 7th meeting (TEC 7) the Technology Executive Committee (TEC) established a Taskforce on Adaptation (hereafter referred as "taskforce") and agreed to hold a workshop on technologies for adaptation in conjunction with TEC 8 in March 2014. One objectives of the exercise was to define one or more topic(s) for TEC Brief(s) on technologies for adaptation. The taskforce was requested to lead the organization of the workshop, with support from external experts and secretariat, and to complete the preparation of the TEC Brief(s) by June 2014.

2. The Workshop on Technologies for Adaptation has been successfully held on 4 March 2014. Subsequently at TEC 8, the TEC considered the outcomes of the workshop and requested the taskforce to conduct further work to define topic(s) for TEC Brief(s) on technologies for adaptation, in consultation with the Adaptation Committee members, and report back to the TEC for final approval intersessionally via electronic means.

3. On 13th May 2014 the taskforce sent to TEC its proposal on topics and key elements of TEC Briefs on technologies for adaptation ("the Briefs") for approval by the TEC. Two Briefs were proposed with topics on Agriculture and on Water, while the key elements that should be included in each Brief are policy development/formulation based on lessons learned so far, the complementarity of hard-, soft-, and org- ware, and knowledge management.

4. Subsequent to the approval by the TEC the taskforce, supported by the secretariat and external experts, prepared the two Briefs with inputs from members of Coherence small group of the Adaptation Committee and representatives of non-governmental organisations and inter-governmental organisations representatives participating as members of the taskforce.[1]

5. The taskforce agreed that the draft of the Briefs will be presented at TEC 9 for consideration and approval by the TEC.

B. Scope of the note

6. The annex to this note contains the draft of TEC Brief on Technologies for Adaptation in the Agriculture Sector.

C. Possible action by the Technology Executive Committee

7. The TEC may wish to consider this draft Brief and provide further guidance to the taskforce with a view to finalising this Brief after TEC 9.

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[1] The representatives of NGOs and IGO in this taskforce are from: Munich Climate Insurance Initiative, Action Aid, College of the Atlantic, and South Centre

Annex

Draft TEC Brief Technologies for Adaptation in the Agriculture Sector

TEC Brief: Technologies for Adaptation in the Agriculture Sector

Box: *Why this TEC Brief?*

Around 75 per cent of the world's population are engaged in agriculture in some way and, in the economies of many low-income countries, agriculture represents the single most important sector) (UNFCCC, 2006). As such, countries have prioritized agriculture as a critical area of focus for adaptation. Related technologies are often highlighted as a crucial resource for ensuring that such adaptation is effective. Most recently, the fifth assessment report of Working Group 2 of the Intergovernmental Panel on Climate Change (IPCC WGII AR5) has emphasised the role of technology in supporting agricultural adaptation (IPCC, 2014). Moreover, the third synthesis report of the Technology Needs Assessments (TNAs) highlights the prioritisation of agriculture by 84% of Parties (UNFCCC, 2014a). The Technology Executive Committee (TEC) has recognised the need for appropriate policies to support countries in applying technologies for adaptation in order to meet the objectives of the United Nations Framework Convention on Climate Change (UNFCCC).This brief draws on technology based case studies to highlight lessons learned and provide some relevant policy recommendations to support the application of technologies for agricultural adaptation to climate change. It has been developed in consideration of the Principles for Effective Adaptation as outlined in the IPCC WGII AR5 (accessed at: www.ipcc-wg2.gov/AR5) and draws upon previous TNA recommendations for practitioners and policy makers as highlighted in the United Nations Environment Programme's TNA Guidebook on Technologies for Climate Change Adaptation in the Agricultural Sector (found at: www.uneprisoe.org/TNA-Guidebook-Series).

The water sector has similarly been prioritised as a focus for policy development, and a separate policy brief for this sector can be referred to for further information and an understanding of symmetries, co-benefits and integration between the two sectors.

Part 1: Technologies for Adaptation

The UNFCCC (2005) defines technologies for adaptation as "the application of technology in order to reduce the vulnerability, or enhance the resilience, of a natural or human system to the impacts of climate change". This is a broad definition reflecting the integrally context-specific nature of adaptation, which determines synchronised approaches as inappropriate and so aggregated definitions difficult to apply (UNFCCC, 2014b). In fact, all adaptation actions must give consideration to specific political, economic, social and ecological contexts together with climate stressors. A lack of consideration of particular circumstances, alongside poor planning, overemphasis of short-term outcomes or failure to account for possible climatic consequences and adaptation limits can result in maladaptation, or "an adaptation that does not succeed in reducing vulnerability but increases it instead" (IPCC, 2001: 378). Applying technologies for adaptation is therefore a complex and situation-specific process, requiring the integration of multiple issues, stakeholders and scales. In less developed countries certain procedures have been devised to support technological application. These include the processof TNAs, which identify, prioritise and highlight technology needs, and Technology Adaptation Plans (TAPs), which are developed on the basis of TNAs to address specific barriers, and identify targets, strategies, budgets and responsible stakeholders (UNFCCC, 2014a). Examples of TAPs that specifically address agricultural technologies include those of Cote D'Ivoire, whose TAP supports the increase of water-tolerant plantain and cassava varieties; Kenya, who prioritise the development of drought-tolerant sorghum varieties; and Sri Lanka, who focus on the diversification of crops and site-specific crop management. Resources for such plans and processes can be accessed from the Least Developed Countries Fund (LDCF) and the Special Climate Change Fund (SCCF), which prioritise the agricultural sector; each allocating it over a quarter of their budgets (UNFCCC, 2014c). In applying technologies for adaptation, the significant synergies, trade-offs and co-benefits with mitigation should also be considered. Co-benefits are exemplified through health benefits from improved energy use, reduced urban energy and water consumption achieved via greening and recycling activities, sustainable agriculture, and the protection of ecosystems and, hence, ecosystem services (IPCC, 2014). A technological example comes from the introduction of manually operated pressure irrigation pumps in Africa, which besides raising living standards, also support adaptation, and reduce greenhouse gas emissions in comparison with use of fossil fuel operated pumps (UNFCCC, 2014c). Another example comes from Bangladesh, where waste-to-compost projects aid adaptation by improving soil in drought-prone areas, whilst also contributing to mitigation through reducing methane emissions (IPCC, 2014). As such, the development, introduction, adoption and diffusion of technologies for adaptation and the increasing complexity of interactions both within and between regions and sectors requires significant and continued attention in order to achieve successful and sustainable adaptation to climate change.

Box 1: *Complementarity of hard-, soft-, and org- ware*

Technologies are often classified into three types: hardware, software, and orgware. In considering adaptations, it is important to understand the differences between these technology types, as well as their synergies and complementarities. Hard technologies, or hardware, refer to physical tools; soft technologies, or software, refer to the processes, knowledge and skills required to use the technology; and organisational technologies, or orgware refers to the ownership and institutional arrangements pertaining to a technology (Christiansen et al., 2011, UNFCCC, 2014b). In the agricultural context, hardware is exemplified by different crop varieties, software by farming practices or research on new farming varieties and orgware by local institutions that support the use of agricultural adaptation technologies. Whilst hard and soft technologies are often introduced in isolation, it has been recognised that their simultaneous integration with orgware is necessary for success in adaptation (Christiansen et al., 2011; UNFCCC, 2013; UNFCCC, 2014a; UNFCCC, 2014b). An example of technological innovation that includes all three types of technology can be found in the adoption of zaï water harvesting technologies in the Sahel. In the early 1980s, farmers here developed methods of rehabilitating degraded land by improving soils in their traditional planting pits, known as zaï, which consist of hoeing small holes into the soil, into which farmers put small amounts of manure and plant sorghum and millet (Ouedraogo and Sawadogo, 2005). The pits concentrate water and nutrients precisely to where they are needed, and retain water for a long time, allowing plants to better survive dry spells and thus help to rehabilitate degraded land. The seeds or trees grown in the pits can be considered hardware, the practices around creating the pits and improving the fertility of their soil are software, and the farmer-to-farmer field schools used to share the information with thousands of farmers across the region represent orgware. Though all three technology types are necessary, there is a concern that hard technologies are currently prioritised and often employed in isolation (Christiansen et al., 2011; UNFCCC, 2014a; UNFCCC, 2014b). As such, countries require encouragement and assistance in implementing these technology types in support of one another, to ensure sustainable and effective identification, application, adoption and diffusion of technologies for adaptation.

Part 2: Lessons Learned (UNFCCC, 2014a)

Experiences gained from employing technologies in support of agricultural adaptation have illuminated some key lessons that can be drawn upon to enhance biodiversity and sustainability, and decrease the risk of maladaptation.

Holistic Understandings of Ecosystems to Enhance Sustainability

There is a need to manage agricultural resources with an understanding of ecosystems and the human communities that are part of those ecosystems. Irrigation has been vital in transforming agricultural production, improving food security and reducing reliance on timely rainfall. However, many elements of the host ecosystem must be considered in implementing irrigation technologies, including soil type, water quality, hydrology, scale, and governance of the intervention. In this context, the Aral Sea provides an example of the potentially severe consequences of mismanagement of ecological systems (UNFCCC, 2014a). Here, over-extraction of water for irrigation in support of cotton production had devastating economic, health and environmental consequences due to vast reductions in the area and volume of the sea. Subsequent restoration efforts by the World Bank, the United Nations Development Programme, NATO and others are threatened by climate change impacts that increase irrigation needs and reduce inflow to the Aral Sea (UNFCCC, 2014a). This example also reflects the risk of applying hard technologies in isolation and of overlooking more ecologically appropriate land uses, such as pastoralism in the case of drylands.

Bottom-up and Participatory Processes to Enable Replication of Local Innovations

Bottom-up and participatory approaches can enable the replication of local innovations, ensuring sustainability and suitability to local contexts. Moreover, such approaches can ensure ownership of such technologies by their users and can therefore provide a suitable approach through which to avoid maladaptation. One widespread and evolving approach to achieving bottom-up adaptation is through Community-Based Adaptation (see Box 2). Participatory approaches can also ensure sustainability through increasing understanding between stakeholders. The employment of such an approach by research organisations, for example, allows in-situ testing of technologies to ensure contextual adaptation, validation and adoption by end users. This has been exemplified by Innova, a consortium of three organisations who directly piloted new adaptation technologies with farmers in Bolivia to learn how to adapt their innovations to maximise their application in specific contexts (UNFCCC, 2014a). Another example comes from a collaborative project between the Consultative Group on International Agricultural Research (CGIAR) and Biodiversity International in Nepal, which had success in employing a participatory plant breeding process to improve disease resistance in local cold tolerant rice and barley varieties in mountainous agricultural sites (UNFCCC, 2014c)**.**

Marketing of Technologies to Ensure Citizen Use

Contextually sensitive marketing approaches can encourage the use of new technologies by final users. Experiences have highlighted the need to secure user investment in agricultural adaptation technologies, which is often guided by cultural perspectives and priorities of the society and individuals. This has been exemplified by farmer's perspectives on manually operated water pumps for irrigation in East Africa, where an initial lack of enthusiasm for investment was observed but later championed through effective marketing (UNFCCC, 2014c). In learning from this, potential marketing approaches based on values and priorities of the target end users should be identified and applied in order to appropriately engage users.

Comprehensive Communication in Support of Technology Application

Appropriate and effective communication between stakeholders is crucial for ensuring the successful adaptation, adoption and use of technologies by end users. Effective communication between stakeholders is not only required in the development and introduction of technologies, but also throughout the ongoing use of a technology. Communication challenges are often exemplified in the employment of climatic information and seasonal forecasts to inform action. In Lesotho, the chain of dissemination methods employed to transfer information from the Lesotho Meteorological Services to local-level farmers and institutions was severely limited, meaning that those who had the ability to act received little of the information originally gathered (UNFCCC, 2014a). As such, continuous assessment and improvement of communication methods should be undertaken. In addition, ongoing support for the end users should be provided to ensure informed and progressive problem-solving, understanding and, hence, sustainability of a technology.

Comprehensive Knowledge Management and South-South Learning

Knowledge management is necessary to enhance access to necessary information and know-how including that on technologies worth scaling-up. Networks between stakeholders at various scales are often employed to ensure collaboration in collating, sharing and strengthening appropriate knowledge. The Climate Change Technology Transfer Centres in Europe and Latin America (CELA) focus on engaging the academic community in order to improve quality in higher education institutions and to strengthen the capacity of these institutions to contribute to sustainable development and social cohesion, through research, education, and technology transfer (see www.cela-project.net). Such networks support knowledge management for adaptation technologies at national, regional and global levels and as such can promote the efficient and sustainable transfer of effective technologies for agricultural adaptation. Opportunities for incubation and practical application of technologies to address climate change also exist with the emerging Climate Innovation Centres (CICs) such as the CIC in Nairobi and similar emerging institutions in developing countries. The role of South-South transfer of technologies, including knowledge and know-how, is crucial (UNFCCC, 2014b). Reflecting this need, international networks often have a regional focus (e.g. CANSA – Climate Action Network for South Asia: www.cansouthasia.net). It is necessary that knowledge management approaches for technology diffusion and transfer ensure equity in access to information by all stakeholders. At the local-level, equity in access requires consideration of specific cultural contexts and power structures that determine individual access, rather than merely the straightforward provision of information at the community level.

Box 2: Community-Based Adaptation

Community-Based Adaptation (CBA) aims to integrate consideration of local-level knowledge, barriers and enablers into the adaptation process through the identification of local knowledge, including technological innovations, and improvement and replication to ensure contextual suitability and local acceptance. Spreading local innovations requires coordination and collaboration between many different stakeholders, including governments, farmer groups, NGOs and local leaders. CBA is an ever evolving process and whilst many projects have now been established, particularly in Asia and Africa, comprehensive monitoring and evaluation processes now need to be developed and applied to assess how effective attempts have so far been. A common example of a successful technological innovation replicated through CBA processes comes from the development and replication of floating gardens in Bangladesh (UNFCCC, 2014a). This experience has highlighted the importance of engaging the local government, including the extension system, to promote the technique and ensure access to the necessary water resources. Though the replication of this innovation has largely been considered a success to date, further research is required to investigate its long-term sustainability and health impacts. In many cases, financial, cultural, natural, institutional barriers, or lack of information, hamper the adoption of new and innovative approaches. As a long-term, adaptive and reflective process, CBA allows such barriers to be addressed in consideration of the specific contexts within which they are experienced.

Technologies for Adaptation in Agriculture sector and their enablers and barriers (UNFCCC, 2014a)

The table below provides examples of some existing agricultural adaptation technologies, briefly highlighting their role, the enablers and barriers to their implementation and use and an example of where the technology is being researched, developed or applied.

Adaptation Technology	**Seasonal Forecasts**	**Water-Saving Irrigation**	**Resilient Crop Varieties**	**Farmer-led Sustainable Agriculture**
Role of the Technology	To assist with agricultural & relevant planning decisions and early warning for preparedness	To resourcefully tackle farmer vulnerability to effects of drought and variable rainfall patterns	To enhance plant resistance to a variety of stresses such as water and heat stress, salinity and new pests; for food security	To ensure sustainability of a technology in context
Enablers	Able lead institution, effective stakeholder collaboration, unrestricted access to information and comprehensive communication	Bottom-up and participatory planning & management, application in areas that rely on rain-fed agriculture, accessible support for efficient troubleshooting	Institutional engagement in policy dialogue to speed up process and access	Inexpensive technologies, use of locally available resources, local applicability, policy support to encourage diffusion, CBA to ensure ownership of technologies
Barriers	Communication barriers including channels used, language and literacy issues, understanding and awareness of technology	Availability of water resources, soil type, top-down site governance and management, opportunity costs & cost effectiveness of irrigation, perceptions of resource use by final stakeholders	Perceptions of and access to markets and new varieties, expense of resistant varieties	Financial, cultural, natural and institutional barriers, lack of information, climate change impacts effectiveness and efficiency of implementation
Examples	ClimAfrica project brings together 18 institutions to improve understanding of	Kenya Rainwater Association use water saving drip irrigation in a number of rainwater	The International Rice Research Institute develop rice varieties to withstand changing climates:	Practical Action have developed and replicated floating gardens with farmers in Bangladesh:

	climate change and impacts in Africa: www.climafrica.net	harvesting and management projects: www.gharainwater.org/kenya-projects	www.irri.org/our-work/research/better-rice-varieties/climate-change-ready-rice	www.practicalaction.org/climatechange_floatinggardens

Part 3: Stakeholder Involvement and Collaboration

Multi-stakeholder co-operation and co-ordination across scales can serve to maximise the effectiveness of a technology within its specific context. One example of such collaboration in the agricultural sector comes from the use of citizen science to scale-up participatory crop research in India (UNFCCC, 2014c). Here, a network of farmer groups works closely with NGOs and researchers to test the use of appropriate technologies for agricultural adaptation in context. The engagement of various stakeholders in the application of adaptation technologies is summarised below, yet each stakeholder role should be considered as part of a larger, integral and collaborative process.

- **Communities develop, adopt and use technologies**, and, as the final stakeholders, should be central to considerations in any adaptation technology efforts (see lessons learned).
- **Researchers and research institutions devise and test new technologies**. More recently, efforts are shifting from isolated testing to on-farm testing (see lessons learned).
- **Local governments can support users by assisting the scaling-up of small-scale or community-led technologies or contributing towards an enabling environment for appropriate technologies.** In Africa, the huge success of introducing and diversifying varieties of drought-tolerant maize was enabled by engagement with the government, whose involvement fast-tracked user access to quality, affordable seeds through ensuring efficiency in the release of varieties and access to seed markets (UNFCCC, 2014a).
- **National governments are responsible for devising necessary policies** to promote the scaling-up of successful technologies and to ensure maladaptation is avoided.
- **Non-governmental organisations (NGOs) have various roles in researching, implementing, facilitating, monitoring, evaluating and financing technologies for adaptation**. They can act as a vehicle for communication, particularly from and to the final stakeholders, endorsing successful collaboration with respective custodians of policies and advocating for alignment with and creation of effective policies for technological application.
- **Private sector stakeholders can contribute by securing and effectively employing financial and non-financial resources**. Public Private Partnerships are also a way forward for integrating the private sector. A successful example is found in the Bangladesh Rice Research Institute's development of salt tolerant rice, which was developed by them as a public centre, but disseminated by private companies in southern Bangladesh (Huq, S. Pers. Comm., 2014).

Part 4: Policy Formulation

As many of the underlying principles of adaptation are applicable at local, regional, national and international levels, policies can ensure that the factors that enable success are replicated at different scales (UNFCCC, 2014a). Lessons learned from previous experiences in the use of technologies for agricultural adaptation point to a number of more specific need for relevant policies and policy recommendations to support successful application of technology for agriculture adaptation to climate change:

- The **integration of hard-, soft-, org-ware and the targeting of specific barriers in the technology cycle** can be encouraged by policies aiming to strengthen or preserve agro-biodiversity and to reduce food price volatility (UNFCCC, 2014a).

- Policies for the **strengthening of relevant institutions and infrastructure to include market infrastructure and financial services** can include the strengthening of meteorological services for climate information and the reduction of market barriers for seed access (UNFCCC, 2014a).
- Addressing **political will and political capacity barriers for scaling-up finance for technologies** is a crucial point for attention (UNFCCC, 2014a). In developing countries, financial support is needed for the implementation of TNAs and TAPs. Supportive actions could include private sector encouragement and promotion of foreign direct investment.
- Policy makers need to address potential **iterative risk management approaches** that seek to approach adaptation as a long-term process of risk assessment, monitoring the effectiveness of past decisions, and applying lessons to future plans. In the context of agricultural adaptation technology, approaches include the adaptation of cropping for food security or sustainable livelihoods, and crop micro-insurance schemes (IPCC, 2014).
- Policies to **strengthen collaborative Research and Development and Monitoring and Evaluation of technologies in situ** are needed. Such activities can provide a valuable resource for multi-scalar stakeholders, illuminating how technologies contribute to building adaptive capacity and resilience (Clements et al., 2011). They include on-farm testing of technologies and research networks for investigating new seed varieties (UNFCCC, 2014a).
- **Comprehensive participatory frameworks integrating an awareness of all involved stakeholders**, from farmers, farmer groups and NGOs to government services, such as agricultural extension networks, and private sector organisations, should be defined and communicated from the initial stages. These must integrate effective knowledge management strategies, incorporating producer's knowledge and responding to user's needs (Clements et al., 2011).
- The **mainstreaming and integration of local needs with national development planning** by scaling-up can help to ensure that national-level processes respond to pressures **e**xperienced on the ground (UNFCCC, 2014a). Social safety networks, disaster risk reduction approaches or extension services can be employed as vehicles for this.
- **Planning for national level adaptive processes** can include policy based appropriate land use planning (UNFCCC, 2014a).
- **International and regional cooperation via cross-cutting policies can help to overcome legal or trade barriers** through, for example, import tariffs, subsidies or restrictive patents (UNFCCC, 2014a).

Box: Summ*ary*

The contribution of agriculture to local and national economies, food security and sustainable livelihoods requires successful and sustainable adaptation supported by appropriate technologies. Experiences have highlighted the need for collaboration, communication, and contextual appreciation to ensure that the technologies introduced are appropriate. Where technologies in agriculture enhance response to climate change through adaptation and mitigation as additional co-benefits, due recognition and credit or incentives should be given nationally and internationally through a formally established system. Appropriate policies at multiple scales are needed in support of this proposal to actualise its realization by sensitizing planners to consciously factor in climate change mainstreaming and thus ascertain that future agricultural practices sustainably support the growing global population in the face of a rapidly changing climate.

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About The Technology Executive Committee

The Technology Executive Committee (TEC) is the policy and guidance component of the Technology Mechanism established by the Conference of the Parties (COP) in 2010 by decision 1/CP.16 to facilitate the implementation of enhanced action on technology development and transfer to support action on mitigation and adaptation. Along with the other component of the Technology Mechanism, the Climate Technology Centre and Network, the TEC is mandated to facilitate the effective implementation of the Technology Mechanism.