Summary Report:
Online Learning Event on
"Irrigation in Climate-Smart Agriculture – Challenges and Responses"

June/July 2017

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Acknowledgements

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Key messages of the event

- Irrigated agriculture, which is used to cultivate 40 percent of the crop production worldwide, faces major climate change threats including increasingly variable precipitation patterns, air temperatures and rising sea levels.
- For effective climate change adaptation, participants underlined the need for knowledge sharing related to climate change impacts on agriculture, and a focus on water use efficiency, conservation, waste prevention and less water-intensive crop options.
- Sustainable land management, including approaches which promote integrated soil–crop–water management, build soil-water retention and that manage and increase soil fertility, can enhance the climate resilience and agricultural productivity of irrigated agriculture.
- When planning irrigation schemes, it is important to consult a wider community of water users within the watershed in order to understand the overall costs and benefits, and to avoid maladaptation to current and future climate conditions.
- Focusing investments on irrigation projects can undermine research and development of other sustainable adaptive farming strategies.
- Water harvesting and supplemental irrigation were discussed as two of the adaptive techniques that can be used by farmers to boost crop productivity, increase food security and reduce demands on limited water resources.

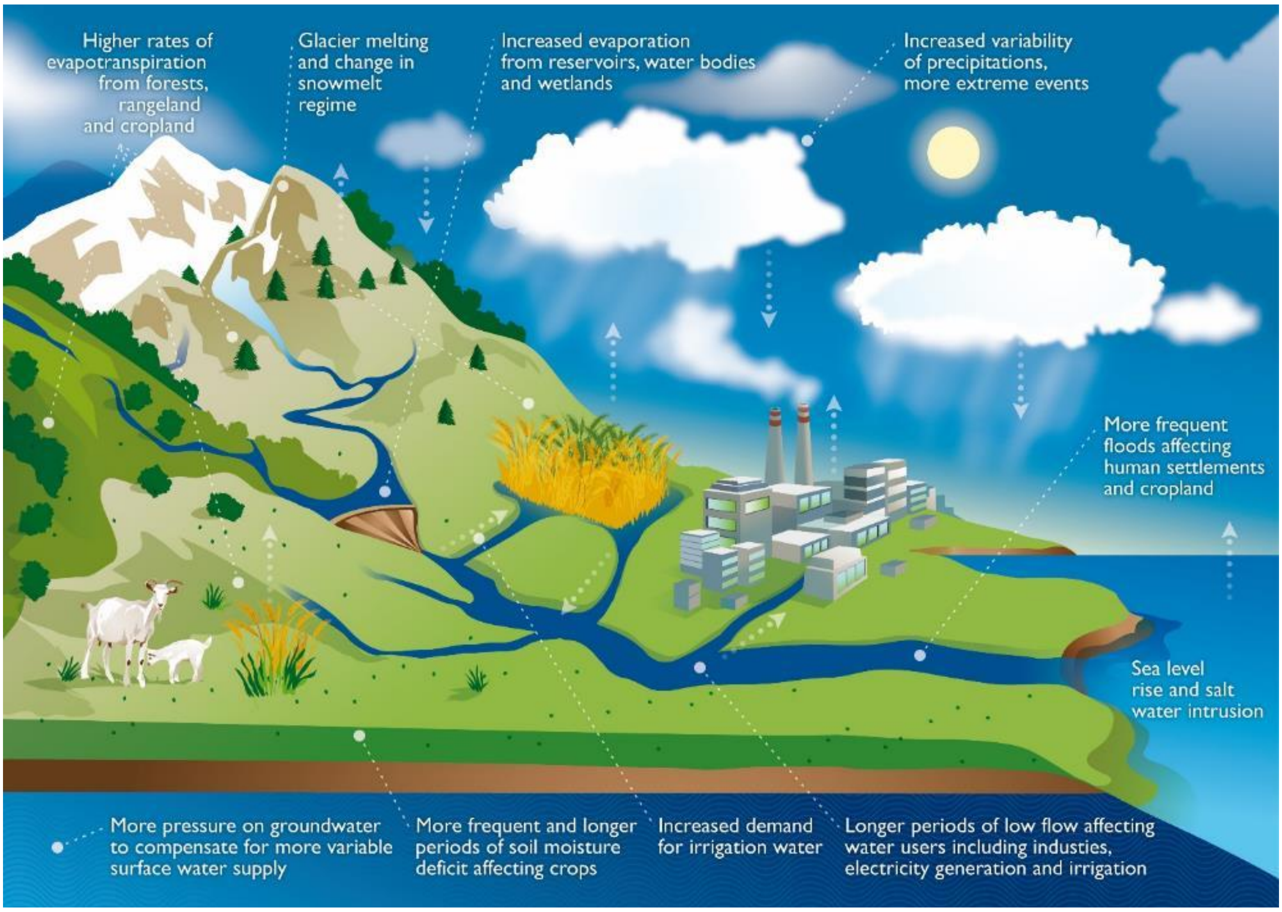

Figure 1: Impacts of climate change on the water cycle (FAO, 2013; http://www.fao.org/3/a-i6344e.pdf)

Introduction: Learning event summary and focus questions

This document summarizes the main content of the online learning event, "Irrigation in Climate-Smart Agriculture – challenges and responses", which was hosted by the Food and Agriculture Organization of the United Nations (FAO) in June–July, 2017. Over 3 700 members of the online Community of practice for Agriculture sectors and climate change from 144 countries took part in the event. The event was a contribution to the Knowledge Action Group of the Global Alliance for Climate Smart Agriculture (GACSA).

The objectives of the learning event were to reply to request of the community's members to strengthen knowledge of irrigation practices within the context of climate-smart agriculture (CSA), to provide practical options for implementation of these practices, and to support the exchange of experiences between members of the online Community of Practice (CoP). The discussion supported the development process of a compendium on climate-smart irrigation.

The event focused on answering three questions:

- What are the major challenges for irrigation in the context of climate change?
- What can be done to address these challenges in a sustainable, climate-smart way?
- What kind of support would be needed to put the actions identified into practice?

The event explored additionally adaptation strategies being used across the globe. Primary issues addressed in the event's webinar and the online discussion forum included:

- climate change impacts on water resources: water scarcity and equitable access to water
- adaptation options: Sustainable Land Management (SLM), integrated watershed planning, building soil water retention capacity, water harvesting
- avoidance of maladaptation in irrigation, and
- cost and financing climate-smart irrigation schemes.

The focus areas of the discussions are further detailed below.

Climate change threats to irrigated agriculture

In her presentation, Patricia Mejias Moreno, FAO, gave an overview of irrigation in the context of climate change. She laid out the different levels for climate change response in irrigation, and highlighted the importance of (a) climate-proofing of investment plans for developing large-scale irrigation systems, (b) location-specific assessments for the identification of response options, and (c) the consideration of non-climatic drivers in the water cycle.

The main climate change impacts on the water cycle that affect irrigation are:

- change in precipitation patterns (including increased intensity or lack of rainfall), causing floods and droughts;
- increasing air temperatures, causing increased evapotranspiration, increased crop water demand; and
- rising sea levels, causing salinization of water resources.

Participants to the learning event shared additional climate change threats to irrigated agriculture that they have experienced in their localities. Several members from sub-Saharan Africa, Nepal, India and Bangladesh reported that drought, variable rainfall patterns, and shifting seasonal rains (including delayed or shortened monsoon seasons), have led to water scarcity, depleted water tables, irregular or unpredictable water availability, seasonal migration, conflict, including upstream/downstream water competition and violence. A Spanish member in added that hail and extreme weather events have decreased crop yield and quality. Increase in occurrence and severity of flooding has resulted in crop failure and irrigation infrastructure damage. In Bangladesh, excessive ground water withdrawals for agriculture have led to increased groundwater salinity, discouraging farmers from planting in coastal plains, ultimately resulting in large uncultivated coastal areas.

A member from Poland commented that long periods of drought or dryness, coupled with increased annual temperatures, has led to a reduction in soil organic matter, fertility and water holding capacity. In South Sudan, higher than average temperatures act as a limiting growth factor for some crops, despite irrigation. In India, successive years of drought have led to crop failure, even on farms employing irrigation strategies. Variable rainfall, high temperatures, and drought during critical growth periods has also had severely negative impacts on crop quality and yield. In hilly regions, such as areas of Bangladesh, farmers are facing challenges in building irrigation infrastructure, and also facing water shortages for agriculture and for drinking supply.

Adaptation

Members shared accounts of adaptive irrigation strategies and practices employed in their areas, as well as related resources and case studies. One of studies exploring farmers' use of irrigation, a household survey conducted across Africa by the International Food Policy Research Institute, found that irrigation was the preferred climate change adaptation strategy employed by farmers. Members highlighted that adaptive behaviors are location- and context-specific, and further research is needed to identify which technologies and behaviors are most climate resilient in the long term, and in which areas, to avoid maladaptation (for more on this, see below). Participants brought up conditions that hinder men and women farmers to take climate action, including inequity of water access, and overall increase in vulnerability of smallholder and marginal farmers to climate change impacts.

Figure 2: Webinar presentation slide: Climate change adaptation options for irrigated agriculture at the farm level (Patricia Mejías Moreno (FAO), 2017)

In Israel, many farmers have reportedly transitioned to precision irrigation techniques, including determining reference evapotranspiration, offering expert irrigation advisory services, weather forecasting and crop specific irrigation information. The use of native crops with a short lifecycle as an alternative to crops requiring irrigation in regions where there is high water competition has been successful in sub-Saharan Africa.

Some members expressed interest in development of genetically engineered or modified plants with lower water requirements or drought adaptability, while others are focused on building biodiversity and researching existing native, short-cycle, or drought-tolerant plants for wider cultivation to reduce demand

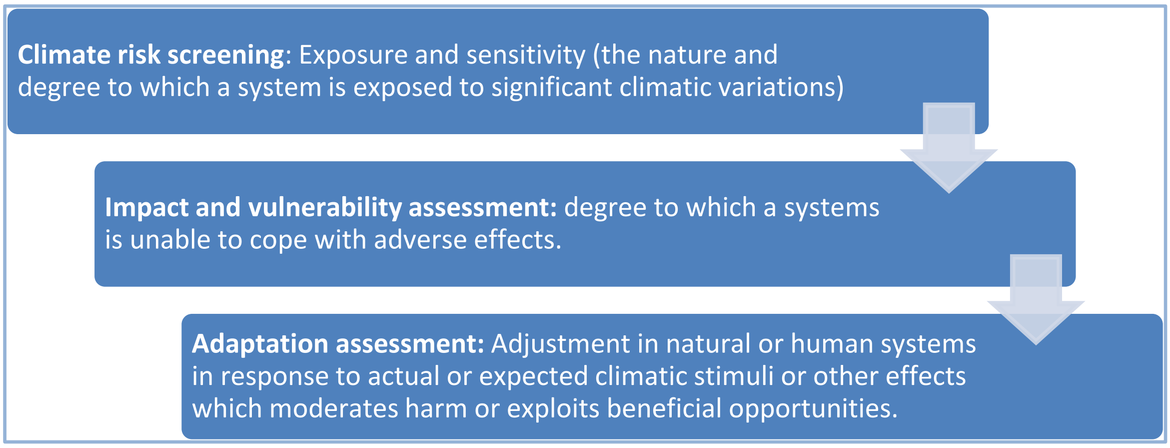

Figure 3 Webinar presentation slide: Three-step process for climate change adaptation planning (Patricia Mejías Moreno (FAO), 2017)

on water resources. Others reported success with organic mulches, composting and vermicomposting and cover cropping to improve soil fertility and to reduce irrigation needs. Other forms of precision agriculture and remote sensing technologies are being researched to optimize water use. Several members recommended referring to traditional and indigenous knowledge systems and practices as models for adapting to climate change challenges, such as hill contouring, clay cistern water collection, and rain water harvesting and storage systems of pre-Columbian civilizations.

Climate-proofing — attempting to minimize the likelihood of climate change undermining the effectiveness and sustainability of agricultural productivity or development interventions — is key in ensuring that appropriate climate change responses are included in investment plans for water management in agriculture sectors.

Participants emphasized the importance sharing knowledge related to climate change impacts on agriculture, and a needed focus on water use efficiency, conservation, waste prevention, and less water-intensive crop options. For example, gravity drip systems save water and energy, and have been very successful in reducing cacao plant mortality on small farms in Nigeria.

Maladaptation

Amaia Albizua, a PhD candidate at McGill University and the Basque Centre for Climate Change, raised the question of whether irrigation can be viewed as a potential maladaptation. The modern irrigation technologies and the movement towards intensification in agriculture can be adaptive responses to drought and climate variability, but in water-scarce regions this may have detrimental effects on other water users.

Many members responded to Amaia with accounts of unsustainable irrigation that erode local adaptive capacities by threatening the ecological balance and increasing socioeconomic inequity. A large-scale irrigation infrastructure in Cambodia is changing water flow and access for farmers. In some cases irrigation is being used in place of addressing root causes of poor productivity, such as soil degradation or erosion.

A participant working in Andhra Pradesh and Telangana, India reported that the government has introduced irrigation mission mode programmes, many of which are employing unsustainable, reverse river engineering methods. According to the participant, these methods are overexploiting an already depleted water reservoirs in a semi-arid region. Lack of regulation and awareness about water-efficient irrigation methods or crops is leading to overuse of synthetic inputs as well as salinization.

Several members were in agreement that systematic climate risk screening, impact and vulnerability assessments, and adaptation option assessments are needed to avoid maladaptation. Irrigation systems will be most effective if they consider long-term resource management, support services, and involve concerned stakeholders in decision-making.

Water management

The following means raised most discussion with the underlining recommendation to aim for holistic and sustainable water management.

Supplemental irrigation

Vinay Nangia, Senior Agricultural Hydrologist at the International Center for Agricultural Research in the Dry Areas (ICARDA), highlighted in his presentation "Supplemental irrigation: A promising climate-smart practice for dryland agriculture" the benefits of supplemental irrigation as an adaptation option for rainfed crops affected by climate change. His presentation underlined the importance of combining supplemental irrigation with good land and crop management practices for successful implementation.

Supplemental irrigation means application of small amounts of water to primarily rainfed crops in order to stabilize or improve yield. In Burkina Faso, supplemental irrigation is being successfully used with pond water harvesting systems during dry spells in the rainy seasons. In Poland, supplemental irrigation is not used to improve yield, but rather to ensure crop survival. Several members confirmed that supplemental irrigation is most economically beneficial when used on high-value crops, such as spices. Other members expressed concern that supplemental irrigation can be time and labour-intensive for farmers, and may require technical support from rural advisory services.

Sustainable land management

A recurring theme throughout the webinars and forum discussions was the importance of Sustainable Land Management (SLM), which the United Nations defines as "the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions". Many of the maladaptive irrigation behaviors and conflicts result from a lack of multi-stakeholder planning.

A member commented that optimization of water resources use should be part of a wide-scale, cross-border water management plan, otherwise water saved in irrigation may be used for other purposes, and overall water saving will not occur. A member from Kenya added that irrigation will be maladaptive unless paired with water-use efficiency strategies and technologies such as mulching, cover cropping, increasing soil organic matter, land-leveling or drip irrigation. In Nepal, the availability of irrigation systems has allowed farmers to switch to more water-demanding crops (e.g. from maize to rice), putting additional pressure on water reservoirs, and increasing overall water use.

Water harvesting

By collecting, storing and utilizing water runoff for irrigation, farmers are able to prevent soil erosion, stabilize water supply, and reduce reliance on other water sources. The AFRHINET project is developing technology and education materials on off-season rainwater harvesting irrigation management, which utilizes rainwater for micro and small-scale irrigation of high-value crops in arid and semi-arid regions. In Kenya, smallholder farmers have been able to recoup initial investment costs in building water harvesting ponds after 2–4 seasons by planting high-value crops, and extending their growing season through the entire year. Several members confirmed that hand-made damns, terracing, contouring, planting in trenches and constructing swales has proved effective in slowing water runoff and increasing yields with the additional water.

A project coordinator from Kenya noted that the initial investment in farm ponds can be high (including costs for excavation, tools, lining material, shade nets, and water lifting/pumps). Some farmers have also feared erratic rainfall will prevent effectiveness or cause flooding, but with advisory service's training and technology these risks could be minimized.

Reducing greenhouse gas emissions

Several members reported on different ways to mitigate climate change in irrigated agriculture. One of the most important one is the use of renewable energy sources, such as solar panels, for water extraction and to power irrigation systems. Water use efficiency is the main factor influencing the greenhouse gas emission intensity of irrigation (see e.g. Zou et al. 2015). More efficient water usage through drip and micro-irrigation systems, supplemental and precision irrigation strategies and practices that build soil organic matter were mentioned as potential ways to reduce greenhouse gas emissions in irrigated systems.

Some members recommended biochar as a soil amendment in trenches between tea plants to increase soil water holding capacity and for sequestering carbon (bamboo is planted on marginal lands and used for making charcoal). Others brought up the importance of agroforestry that provides shade in order to reduce irrigation needs through providing vegetative cover, improving soil moisture and rainfall distribution, cooling effects, as well as carbon sequestration co-benefits. Agroforestry is a widely used practice that also combats deforestation by providing wood for energy and construction, and brings nutrition benefits.

Challenges to implementation

Participants said that the lack of participatory water and irrigation management plans and tools for evaluating water availability, as well as lack of weather forecasting services were challenges to productive agriculture under climate change for example in Poland, the Philippines, Ethiopia and Myanmar. Lack of regionally-specific agricultural strategies or water and landscape planning tools were also mentioned.

The high price of many irrigation systems, especially the start-up costs of drip or micro-irrigation systems and storage ponds, presents barriers for small or marginalized farming populations. Other barriers mentioned include the lack of funds available for irrigation infrastructure establishment, improvement or repair after weather damage, as well as difficulties to access credit, loans or other economic safety nets for farmers.

Many participants said that lack of access to information, education and practical techniques for example through rural advisory services also present barriers for farmers in their areas. For example, in India, chili and cotton farmers have been observed using flood irrigation and other water intensive strategies despite availability of more efficient technologies, such as drip irrigation, due to lack of education about its importance and function. Others noted that lack of integrated water and land management plans present challenges, and that to be effective these plans must consider technological, economic, social, cultural, environmental, demographic and legal context.

In Burkina Faso, water seepage from harvesting ponds has presented an issue, which other members suggested can be remedied with use of geomembrane linings, which may be more suitable on slopes and more cost-effective than clay barriers. Members also recommended enhancing water harvesting with the use of shade nets to reduce evaporation and reducing seepage through proper siting, excavation and sizing. One member recommends the use of silt filtration chambers and positioning ponds near the water runoff path to help avoid clogs and flood damage from overflowing water collection sites. In Zimbabwe, there has been hesitance to adopt drip-irrigation due to limited water sources, lack of lifting mechanisms (pumps), distance from the water source to the drip tank, and lack of technical experience and support from extension service providers. In other areas, salinity or water contamination makes irrigation difficult to manage.

Financing irrigation

Many organizations are working on creative solutions to the economic, technical and social barriers to adoption of irrigation in a climate-smart manner. Civil society and social enterprises in eastern Kenya are developing irrigation equipment loan programs, where farmers can borrow or share water tanks, shade nets and other equipment. Micro-finance initiatives that link investors and equity firms with farmers in regions especially vulnerable to climate change where mentioned as a potential way to access finance. Other ways for farmers to reduce startup costs and to transition to climate-smart practices include programs where farmers provide manual labor in exchange for technical assistance and equipment.

For assessing the economic advantages of employing irrigation practices, the members recommended using cost-benefit analysis, marginal profit analysis, or partial gross margin analysis. Members called for developing simple, affordable irrigation technology for smallholder farmers as they are already the most affected by climate change. The competing priorities in resource allocation were brought up by one member, stating that focusing investments on irrigation projects can undermine research and development of other sustainable adaptive farming strategies.

Conclusions

To cope with changes of the water-cycle due to climate change, participants reported using site-specific adaptive practices and techniques, as well as species adapted to local conditions. Sustainable land management practices were highlighted during the whole event, including building soil water holding capacity, water harvesting, supported in some cases by including supplemental and drip irrigation. Weather forecasting systems help also managing water for irrigation.

A major opportunities for reducing emissions from irrigation lie in reducing the amount of pumped water through more efficient water application and using renewable energy sources for pumping instead of fossil fuels.

There was general agreement that the weakness of enabling environments and support services is a major challenge for the integrated water management and planning of irrigation and its adoption in many areas. Several identified bottlenecks include:

- The high cost of irrigation equipment especially for poor smallholder farmers, due to the lack of accessible financing. Different possible approaches were shared, such as loan programs, work exchanges, micro-finance initiatives and crop insurance programs.
- The need for increased education and extension services on climate change as well as solid planning of irrigation schemes,
- Need for prioritization of climate change and water access issues at the local, regional, federal and international levels,
- Need for access to tools and resources for forecasting and weather prediction, as well as water availability and quality, and finally,
- Lack of coordination between farmers and other actors sharing water resources in the watersheds and at the landscape level.

Identifying solutions to these challenges will be crucial in developing sustainable agriculture systems that can benefit from irrigation systems where appropriate – based on informed decisions and allowing wise use of water resources for all.

To summarize the event underlined the importance of building sustainable, efficient and effective agriculture systems. Sustainable water use needs joint planning at the watershed level and fair sharing of water between different sectors, ensuring water and food security and avoiding maladaptation to changes. Building irrigation systems should be based on careful assessment of water resources, to avoid depleting natural resources.

Further information

- Join the online discussion community on agriculture sectors and climate change:
    - http://bit.ly/join-ag-sectors-cc-email-community
- For listening to the recorded sessions of the webinar:
    - http://bit.ly/irrigation-csa-playlist
- Access webinar summary and selected information resources on the topic:
    - http://bit.ly/irrigation-csa-library (Irrigation; Community of Practice library)
    - http://www.fao.org/land-water/water/en/ (Water; FAO)
    - www.fao.org/climate-change (Climate change - in 7 languages; FAO)