Food and Agriculture Organization
of the United Nations

CLIMATE CHANGE IMPACT ON CROP PRODUCTION IN SRI LANKA

Challenges and adaptation options


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CLIMATE CHANGE IS CHALLENGING THE AGRICULTURE SECTOR IN SRI LANKA

The agriculture sector is very vulnerable to climate change. In the recent past, both prolonged droughts and floods, sometimes in rapid succession, have adversely affected national crop production with cascading effects on farmers' incomes at the household level through to national gross domestic product (GDP) resulting in the contraction of the growth rate of the agriculture sector by 4 percent in 2016 and 1 percent in 2017.

The low predictability of rainfall patterns (in terms of both amount and spatial distribution) and the frequent occurrence of extreme events affect water management and agricultural planning (from farmers' operations to national agricultural policies). Furthermore, the combination of heavy rains, soil tillage and poor nutrient cycling result in soil erosion and soil fertility loss in the uplands. This reduces productivity in upland farmers' fields and causes the siltation of water reservoirs, with negative consequences for irrigation systems and water productivity in the lowlands. Climate modelling studies show that frequency of extreme events and variability/unpredictability of rainfall patterns are expected to increase in the future under a changing and variable climate.

The need to ensure farmers' livelihoods and welfare as well as national food security urges decision makers to effectively tackle the challenges posed by climate change. Understanding how climate change affects the crop sector is essential for identifying appropriate and effective solutions to increase the resilience of the agriculture sector to climate change.

Regenerative agricultural practices can improve soil health, thereby increasing resilience to extreme weather events such as droughts and floods.

HOW DOES CONSERVATION AGRICULTURE WORK?

Conservation agriculture is an ecosystem approach to regenerative sustainable agriculture and land management that combines minimizing soil disturbance, maintaining soil cover and diversifying crop production.
Conservation agriculture seeks to reproduce the most stable soil ecosystem attainable in each agricultural ecosystem in order to reduce producers' reliance on external inputs for plant nutrition and pest management. In this way, it circulates production resources in the biosphere realizing their maximum value and reducing negative externalities of agriculture while rebuilding the natural capital.

- Keeping the soil covered reduces moisture loss, stabilizes soil temperature, reduces erosion by water and wind, restores soil carbon through the decomposition of crop residues, and provides food for beneficial soil organisms.
- Rotating and diversifying crops reduces crop pests and diseases and replenishes soil nutrients.
- Avoiding mechanical soil tillage increases the populations of animals living in the soil. The microfauna takes over the task of tillage, building soil porosity and improving soil structure and water storage capacity, which in turn helps plants to survive longer during periods of drought.
- Practising zero tillage allows the soil to act as a carbon sink by sequestering and storing carbon; for this reason, conservation agriculture has also been recognized for its ability to mitigate climate change.
- Not tilling the soil reduces the number of farm operations required for crop production, which lowers fuel consumption.

This brief has been developed in the context of the Food and Agriculture Organization of the United Nations (FAO) project "Climate-Smart Crop and mechanization systems Scaling-up" (CSCS) funded by the German Federal Ministry of Food and Agriculture (BMEL).

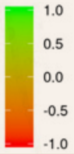
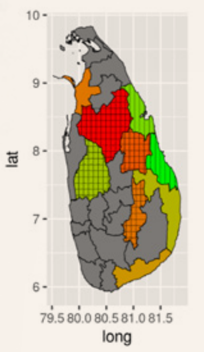
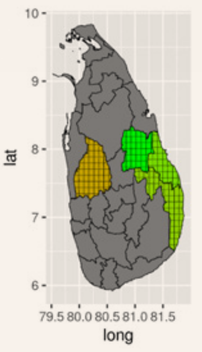
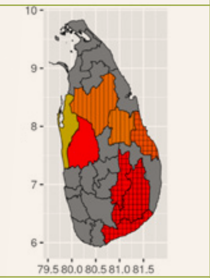
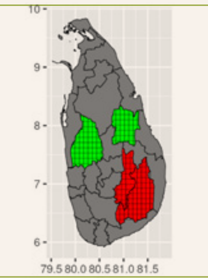
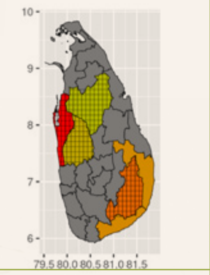
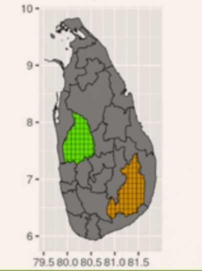
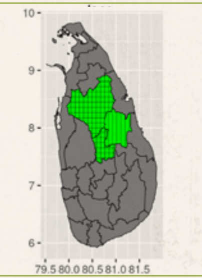
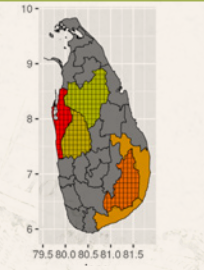
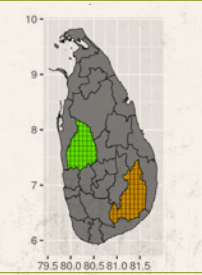
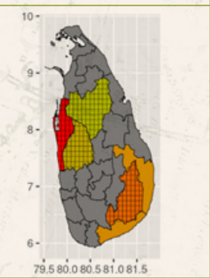
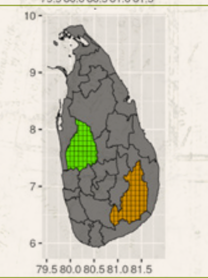
It presents the results of the first assessment of climate change impacts on crop yields conducted in Sri Lanka at the district level, and the climate change adaptation options to strengthen Sri Lanka's agriculture sector in the face of climate change. Options include farm-level climate-responsive agronomic practices as well as institutional changes involving multiple food system actors.

EVIDENCE FOR ACTION:

Table 1 summarizes the main average yield changes by crop in irrigated systems. Projected changes should be regarded as indicative because climate impacts are quite heterogeneous due to the diverse agroecological settings of the country.

The maps of projected yield changes represent the component of yield change (future minus past) that depends on changes in climate variables only (without the effects of technological, economic or policy changes). Climate variables have been simulated using the global climate model MPI-ESM-MR – RCP 8.5.

Table 1. Average yield changes by crop in irrigated systems (according to MPI-ESM-MR – RCP 8.5)*

CROP	 **PROJECTED CLIMATE CHANGE IMPACTS ON YIELD** Period 2071–2100 **Legend to maps: change in yield** (tonnes/ha)		CLIMATE CHANGE ADAPTATION MEASURES TO AVOID THE WORST PROJECTED IMPACTS
	Maha season	Yala season	
RICE *(Oryza sativa)*			• Follow the recommendations based on data from the country's approximate 45 agro-meteorological stations • Ensure adequate drainage to avoid salinity build up • Start land preparation at the beginning of the rainy season • Use quality seed • Use varieties tolerant to drought, pests and diseases • Use drought-escaping varieties (early maturity at 2.5 months) • Use the parachute planting method instead of broadcasting manually • Use the alternate wetting and drying irrigation technique • Use laser land levelling technology • Follow the recommendations provided by extension advisors at the start of the season (*kanna meetings*) • Improve fertilizer management integrating manure/compost and targeted applications of inorganic fertilizer • Use crop insurance
MAIZE *(Zea mays)*			• Develop local hybrid varieties adapted to local conditions • Improve fertilizer management integrating organic mulch/manure/compost • Use crop insurance
GREEN GRAM *(Vigna radiata)*			• Use varieties adapted to high temperatures and drought • Develop high-yielding and pest- and disease-tolerant varieties • Use micro-irrigation • Improve fertilizer management integrating organic mulch/manure/compost • Use crop insurance
ONION *(Allium cepa var. cepa)*	Projections for onion production during the Maha season were not considered because they are limited to a small land area.		• Promote local seed production during Maha season • Explore bringing more land under onion production in the dry zone • Use solar-powered micro-irrigation • Improve fertilizer management integrating mulch/manure/compost • Provide storage facilities with appropriate temperature and humidity regulation mechanisms
POTATO *(Solanum tuberosum)*			• Use varieties adapted to local conditions • Promote G0 seed production through public–private partnerships • Encourage farmers to use G1 seeds • Use micro-irrigation • Improve fertilizer management integrating mulch/manure/compost • Promote use of storage facilities with appropriate temperature and humidity regulation mechanisms • Use crop insurance
CHILI *(Capsicum annuum)*			• Use locally developed hy-brid seeds • Encourage the private sec-tor to produce local hybrid seeds in non-conventional areas under protected cul-tivation • Promote the identification and development of varie-ties tolerant to heat stress • Use solar-powered micro-irrigation • Improve fertilizer man-agement integrating mulch/manure/compost • Promote communal drying facilities forming chili farmer federations • Use crop insurance

Source: UN. 2020. Map of the World [online]. [Cited 8 March 2021]. *http://www.fao.org/geonetwork/srv/en/metadata.show?id=12691*

INCREASING THE RESILIENCE OF THE AGRICULTURE SECTOR IN SRI LANKA REQUIRES COHERENT POLICIES

Policies play a decisive role in setting up a proper enabling environment that accelerates growth and sustains resilience of the agriculture sector in the face of climate change. Four factors are key:

Generation and management of baseline information

Generating input data for specific analyses is the first key step towards evidence-based solutions for optimized crop production.

- With about 37 percent of the national weather stations currently manually operated, the establishment of Automatic weather stations in all agroecological regions (with a higher density in the dry and intermediate zones) would allow the timely and efficient collection of weather data.
- The use of crop growth models allows to investigate the response of crop yields to climate variables at relevant spatial scales (district, agroecological region or agroclimatic zone) based on emerging priority issues. This is useful for:
  - guiding investments in the research sector, for example breeding priorities; and
  - identifying crop-specific agronomic adaptation measures by location, such as crop systems using species and varieties selected for stress escape (length of growing cycle/phenological stages), stress tolerance and stress avoidance (shifting planting date and adjusting nutrients and planting density to precipitation patterns), and conservation agriculture-based soil and crop residue management practices for carbon sequestration (climate change mitigation) and stress attenuation (optimized soil water storage, reduced evaporation, run-off and erosion).

STATISTICAL MODELLING TO ACCESS THE IMPACTS OF CLIMATE CHANGE

The FAO Modelling System for Agricultural Impacts of Climate Change (MOSAICC) uses statistical modelling to assess the effects of climate over large areas and a relatively wide range of agroecological conditions.

MOSAICC does not require the extensive input data and in situ calibration that other widely-used process-based models need. The approach is highly participatory, country driven and multidisciplinary. Inter-institutional exchanges and collaborations are fostered throughout the process, from data collection to analysis, synthesis and finally formulation of policy recommendations.

Process-based models can simulate the performance of specific varieties and practices at small scale, up to the farm level.

MOSAICC can be used together with process-based models to account for crop-specific response to climate.

For example, the Agricultural Production Systems Simulator (APSIM) process-based model has already been calibrated for some varieties of rice, maize and green gram and for the environmental conditions of several locations of Sri Lanka. Calibration of this model for the other crops will allow to identify specific varieties to be introduced/promoted as climate smart adaptation actions.

Another process-based model for climate change impact assessment already applied in Sri Lanka with rice is the Decision Support System for Agrotechnology Transfer (DSSAT).

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Inter-institutional and public–private collaboration

Climate impact assessments are multidisciplinary and information-intensive activities. They require active collaboration among all stakeholders working in agriculture and climate sciences.

- Thanks to the use of the MOSAICC approach, the project has fostered inter-institutional collaboration among the Department of Meteorology, the Natural Resources Management Centre of the Department of Agriculture, the Socio Economics and Planning Centre of the Department of Agriculture and the extension sector. The methodology of the study is available in a technical report.
- To increase farmers' access to sustainable mechanization, the project has supported the creation of a public–private scheme for the provision of affordable hire services in Puliyankulama. The collaboration includes the establishment of an agribusiness hub owned by the Department of Agriculture and managed by a farmer organization through a concession agreement. Both farmers and private service providers can participate in a specific training course in conservation agriculture to become members and benefit from the services offered by the hub.

Capacity development

Enhancing institutional capacity on climate and agricultural data generation and management is an effective way to increase the competitiveness of the national research sector and facilitate access to international funding opportunities earmarked for climate-responsive actions.

- In the context of the project, the collaboration between the research and development institutes and the extension branch of the Department of Agriculture has led to the development of a harmonized training curriculum aimed at guiding the optimization of crop production in areas vulnerable to climate change.
- For the sustainable development of the agriculture sector, it is important to involve all key stakeholders in the design and dissemination of this harmonized educational material and in its integration into both Department of Agriculture extension and farmer training organized by state and cooperation development actors.

Market access and profitability of farming activities

Creating traction for regenerative and productive agronomic practices requires this type of production to be linked to markets.

- The creation of the agribusiness hub at grassroots level enables farmers to easily access sustainable mechanization services, receive continuous assistance on conservation agriculture and implement optimized practices. The reduced farming time, increased yields and improved post-harvest handling, primary processing and transformation allow farmers to market surplus crops and increase revenue.
- Analysis of the results of demonstration plots and interviews with key informants show that when farmers growing rice in lowlands and maize in uplands adopt best practices, annual profits can triple (from about USD 952 to USD 3 710 after the first year), including: intercropping with high-value crops for which there is a high market demand (e.g. groundnuts); direct seeding (as opposed to broadcasting); use of no-till machinery and other soil conservation practices that reduce the need for water and fertilizers; and the replacement of manual labour with mechanized practices. Likewise, productivity improves: in optimal conditions, direct seeding can produce an increase in maize yields of up to 20 percent (also with intercropping); paddy yields can increase by up to 11 percent if broadcasting is replaced by the parachute method.

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