RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security

CGIAR CCAFS

Info Note

Climate change adaptation in agriculture: practices and technologies

Messages to the SBSTA 44 agriculture workshops

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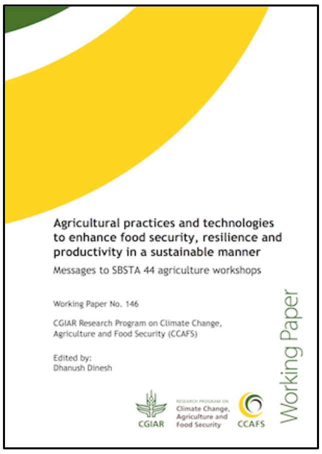
Key messages

- Many agricultural practices and technologies already provide proven benefits to farmers' food security, resilience and productivity.
- Indigenous knowledge provides the backbone of successful climate change adaptation in farming, livestock and fisheries.
- Agro-ecological zones and farming systems are extremely diverse. Thus interventions need to be targeted to specific contexts. Decision support to match practices and technologies with agro-ecological zones is a priority.
- Portfolios of practices and technologies are more likely to realize goals of food security, resilience and increased productivity. Trade-offs and synergies among these goals may exist and the focus should be on maximizing synergies.
- Bringing practices and technologies to scale is possible and underway. Strong mechanisms for finance, capacity enhancement and technology transfer are prerequisites for success.
- Engaging women in design and management of new technologies and practices will help close the gender gap in agriculture and deliver positive outcomes for the whole of society.
- Case studies demonstrate the potential for agricultural practices and technologies to achieve co-benefits for environmental health, and climate change mitigation.

In 2014 the United Nations Framework Convention on Climate Change (UNFCCC) Subsidiary Body for Scientific and Technological Advice (SBSTA), as part of its mandate to consider issues related to agriculture, decided to invite submissions from parties and observers, covering four topics, in 2015 and 2016. Of the two topics for consideration in 2016, one relates to 'identification and assessment of agricultural practices and technologies to enhance productivity in a sustainable manner, food security and resilience, considering the differences in agro-ecological zones and farming systems, such as different grassland and cropland practices and systems'.



In this info note we provide a brief overview of key practices and technologies. A twinned info note considers higher-level measures of adaptation in agriculture, such as policies and institutions. Both info notes are drawn from longer working papers, all freely available to download at https://cgspace.cgiar.org/handle/10568/71053

Many agricultural interventions, such as integrated soil fertility management, can deliver climate resilience and enhanced productivity. Photo: N. Palmer (CIAT).

Soil and land management

Soil and land management interventions focus on enhancing soil health. Proven approaches build on existing indigenous practices and knowledge to maximize benefits to climate change adaptation.

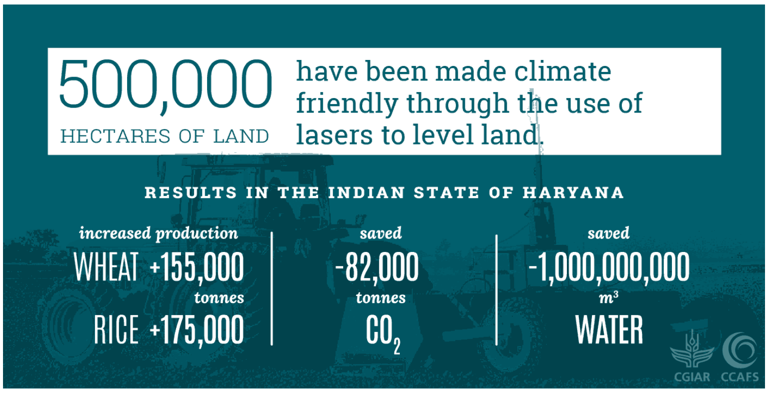
In the West African Sahel, a range of indigenous practices – ***contour stone bunds, half-moons, zaï*** – address regional challenges of rainfall runoff and erosion, while increasing organic matter within the region's soils.

Conservation agriculture covers nearly 157 million hectares – 11% of the world's arable land area. Highest adoption levels are in Latin America, particularly Brazil, Argentina and Paraguay. Conservation agriculture combines three practices: no-till, retention of crop residues in fields and regular fallow periods. It is particularly useful in regions where climates are projected to become drier, or extreme rainfall events more frequent.

Integrated soil fertility management combines the use of appropriate amounts of organic and inorganic fertilizers together with well-adapted, disease- and pest-resistant germplasm, and good agronomic practices. ISFM is widely promoted across Africa. For example, in Malawi, about 30,000 farmers, as well as several hundred farmer associations and agricultural extension workers, have been trained in ISFM technologies.

Site-specific nutrient management matches the supply of soil nutrients to context-specific needs of crops. For example, in India and Mexico, the Trimble GreenSeeker technology helps farmers calculate nutrient needs of crops. Addressing site-specific nutrient needs has increased yields by 10% in India, while also reducing greenhouse gas emissions by 47%, by optimizing fertilizer use.

Laser-assisted precision land levelling removes undulations in the soil surface using a tractor-towed laser-controlled device. The resulting flat and even surface, makes better use of water resources, increases cultivated area, reduces weeds and improves yields. It has been applied to over 500,000 hectares in India, saving 1 billion m^3 of water.

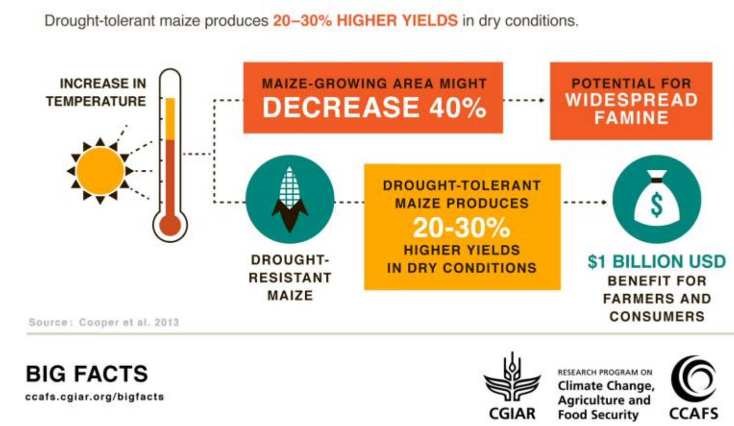


However, technical interventions need to be complemented with ***socio-ecological considerations***. Tools like the Land Degradation Surveillance Framework, which has been applied in Uganda, Kenya, and Tanzania, can help to ensure that soil health and new farming practices contribute effectively to better livelihoods.

Crop management

Crop-specific innovations complement other practices that aim to improve crop production under climate change, e.g. soil management, agroforestry, and water management. Crop-specific innovations include ***breeding*** of more resilient crop varieties, ***diversification*** and ***intensification***.

In sub-Saharan Africa, the Drought Tolerant Maize for Africa initiative has released 160 ***drought-tolerant*** maize varieties between 2007 and 2013. These generate yields 25-30% superior to those of currently available commercial maize varieties under both stress and optimal growing conditions. In Andhra Pradesh, India, early maturing, ***disease- and heat-resistant*** chickpea varieties have more than doubled yields (from 583 to 1,407 kg per ha).



Longer-term adaptation interventions include changes to crops cultivated. In the Peruvian Highlands, farmers who traditionally cultivate potato are expanding into organic quinoa, milk and cheese, trout, and vegetable production. This ***diversification*** is helping them improve farm incomes and reduce vulnerability to climate change.

In Burundi, Rwanda and Uganda, ***coffee-banana intercropping*** is proving to be effective in addressing increasing temperatures which affect coffee production. Growing the two crops together can increase incomes by over 50% compared to mono-cropping either crop alone.

In Viet Nam, over a million rice farmers have ***sustainably intensified*** rice production, by changing water and nutrient management. Inputs (fertilizers, seeds and water) have been reduced while yields have increased by 9-15% compared to conventional practices. Savings in input

costs improved farmer incomes by USD 95-260/ha, per crop and per season.

Livestock management

Improved or modified livestock management practices include ***improved grazing management***, use of ***improved pasture and agroforestry species***, better use of ***locally available feeds***, the judicious use of highly nutritious diet ***supplements and concentrates***, and ***breeding for heat-tolerance***. Appropriate ***manure management*** can also increase soil organic matter and water-holding properties, leading to increased productivity of both food and fodder crops. Better ***animal health management***, including surveillance and veterinary services, will improve animal performance and productivity.

Improving ***pasture and fodder*** offers a readily available way to increase livestock production. In parts of Latin America, *Brachiaria* grasses have been widely adopted with large economic benefits: animal productivity can be increased by 5-10 times compared with diets of native savanna vegetation. In Brazil, where about 99 Mha have been planted, annual benefits are about USD 4 billion. Similarly, growing tree fodder species, such as *Leucaena leucocephala*, on farms improves animals' diets and productivity.

Another important approach is ***cross-breeding***. It is estimated that to meet projected milk and meat demand in 2030 using local breeds would need 363 and 173 million bovines, respectively; with 29% adoption of crossbreeds, this could be reduced to 308 and 145 million, respectively. An added benefit is the mitigation potential of about 6 Mt CO_2 eq. In Nyando, Kenya, heat-, drought-, and disease- resistant crossbreeds of native sheep and goats are being introduced to increase resilience and productivity of farming households.

Forestry and agroforestry

In smallholder farming systems, trees and forests are often key to livelihoods. Increasing ***forest cover and agroforestry*** can build resilience and environmental health, including mitigation benefits.

In Niger, ***farmer-managed natural regeneration***, which builds on indigenous knowledge, has expanded tree cover (from dormant rootstock) to 5 million hectares. In India, a first of its kind national agroforestry policy has been adopted, which aims to enhance the productivity, incomes and livelihoods of smallholder farmers. In Chile, La Corporación Nacional Forestal (CONAF) has designed a national certification system to ***measure adaptation performance*** of forest ecosystems. In West and Central Africa, farmers are expanding ***agroforestry intercropping***, using cocoa alongside other trees, to deliver multiple benefits and more stable livelihoods.

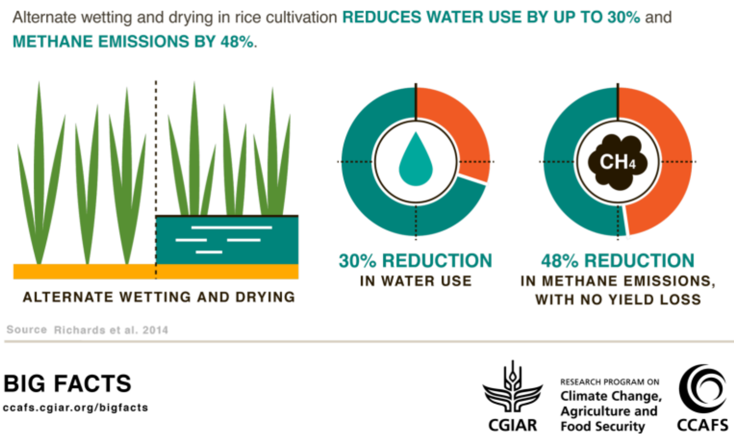
Agroforestry practices can help farmers diversify their crops and income, and enhance climate resilience. Photo: S. Kilungu (CCAFS)

Fisheries and aquaculture

Expansion and innovations in ***aquaculture*** offers cost-effective opportunities to provide sustainable sources of protein under climate change. For example, in Bangladesh, the use of field rings in rice fields for fish supplements household nutrition and provides an additional source of income. In China, ***multi-trophic fish farms*** combine complementary species to increase productivity through nutrient cycling. For capture fisheries, ***nearshore fish-aggregating devices*** have been deployed in the Solomon Islands, which improve household food security.

Water management

Agriculture is the largest user of the world's freshwater resources, using 70 % of the available supply. Improved water management can be achieved through ***capture and retention of rainfall***, and ***improved irrigation*** practices. Soil fertility and crop management innovations also improve water use efficiency.



In rice production, ***alternate wetting and drying*** can reduce water use by 30% and methane emissions by 48%. In Benin and Togo, ***low cost irrigation systems*** designed and developed by farmer groups involving bunds, drainage canals and irrigation infrastructure, have

increased rice yields by 3.5 to 4 tonnes per hectare. More than 3,000 farmers are involved, at 200 sites. Emerging ***water harvesting technologies*** include mechanized water harvesting systems in Syrian rangelands and small basins and semi-circular bunds in Jordan and Egypt. In Morocco, a system combining trees and shrubs with the use of contour ridges proved very successful in collecting runoff in areas with rainfall of 100–200 mm. In the Kurdistan region of Iraq, ***supplemental irrigation*** has been shown to increase wheat yields.

Energy management

Improving ***energy efficiency***, supply of ***renewable energy*** and ***access to modern energy services*** supports a sustainable future for agriculture under climate change. In the Solar Power As a Remunerative Crop (SPaRC) project in India, farmers generate solar energy for their own needs and also earn an additional source of income by selling the excess power back to the grid. In Indonesia, the BIRU (BIogas RUmah) program generates bio-energy from animal waste. By 2013, 11,000 bio-digesters had been installed.

Climate information services

Climate information services help farmers cope with climate variability. In Senegal, new weather forecasting and advisory services, which have been designed directly with farmers, now reach up to 7.4 million rural people. Learning from Senegal, a similar approach to climate information services is now being applied in four regions in Colombia. The Colombian initiative combines scientific and indigenous knowledge to provide ***agro-climatic information*** to more than 1,500 farmers, integrated with farm planning, choice of varieties, water harvesting, optimization of fertilizer use and flexible planting dates.

In India, the Integrated Agro-meteorological Advisory Service, one of the world's largest agrometeorological information programs, provides locally relevant services on ***weather forecasting***, associated ***agricultural advice***, and a ***phone-in help-desk*** for users. Meanwhile agricultural extension officers are delivering climate information to groups of farmers under the Participatory Integrated Climate Services for Agriculture project, which is being piloted in Zimbabwe and Tanzania and scaled out in Ghana, Tanzania, Malawi and Lesotho.

Crop and livestock insurance

Well-designed and targeted agricultural insurance can enable farmers to re-invest in inputs and technologies despite bad years. Index-based insurance in particular overcomes major obstacles to insuring poor smallholder farmers, such as high transaction costs and logistical challenges of verifying reported losses.

In India, 30 million farmers are covered under crop insurance schemes. In Africa, the largest ***index insurance*** program in which farmers pay a market premium is the Agriculture and Climate Risk Enterprise (ACRE) scheme. Currently operating in Kenya, Rwanda and Tanzania, it covers 800,000 farmers and is projected to reach 3 million farmers across ten countries in Eastern and Southern Africa by 2018. In Honduras, an index is being developed to pilot index insurance in the dry corridor with beans and maize crops. The R4 Rural Resilience Initiative reaches more than 32,000 farmers in Ethiopia, Senegal, Malawi, and Zambia. In Northern Kenya and Southern Ethiopia, index-based ***livestock insurance*** is available to nomadic pastoralists. Index-based ***flood insurance*** is an innovative approach now being tested in India and Bangladesh.

Index-based livestock insurance can help farmers overcome climate-induced losses, and encourage them to invest in improved practices and breeds. Photo: S. Kilungu (CCAFS)

Lessons from implementation

Experience shows that strong mechanisms for ***finance***, ***capacity development*** and ***technology transfer*** are prerequisites for success of these agricultural practices and technologies. For example, in the laser-assisted precision land levelling case, subsidy from the state Government of Haryana for purchase of capital equipment played a crucial role in increasing adoption. In Senegal, efforts to build capacity of national partners to communicate climate information paid rich dividends and led to rapid scale up of a pilot project to a national effort disseminating climate information to 7.4 million rural people. In the Drought Tolerant Maize for Africa project, technology transfer between CGIAR centres and national agricultural research systems, farmer organizations, non-governmental organizations and seed producers played a crucial role in ensuring benefits reached 30-40 million people in 13 African countries.

Climate change adaptation in agriculture: practices and technologies around the world

Data source: Richards et al. 2015

The geographic designation employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of CCAFS concerning the legal status of any country, territory, city or area or its authorities, or concerning the delimitation of its frontiers or boundaries.

There is a pressing need to facilitate ***sharing of best-fit practices*** among countries and farming communities, matching options to fine-scale variations in local circumstances. Many of the practices and technologies shared here are low-cost in nature, and are ripe for investment to reach scale. Decision support to match practices and technologies with agro-ecological zones is a priority. A variety of ***decision support*** tools are now available, as discussed in the twinned info note on adaptation measures.

Successful case studies of agricultural practices and technologies which enhance food security, resilience and productivity in a sustainable manner help build the case for investment in these practices and technologies. Case studies also identify ***best-bet investment opportunities*** and ***country readiness*** for implementation and scaling up, as covered in the twinned info note on adaptation measures. As countries seek international support for adaptation actions in the agricultural sector, these case studies can serve as resources to assess investment risks and benefits.

Engaging women in design and management of new technologies and practices can improve success of climate change adaptation projects. Photo: P. Vishwanathan (CCAFS).

Efforts to scale up these practices and technologies should strive to promote ***gender equality***. Closing the gender gap in access to resources and decision-making would result in a 20-30% increase in yields on farms managed by women. Engaging women in design and management of new technologies and practices will lead not only to more gender-sensitive innovations, but also to more positive outcomes for the whole of society. For example, the global Seeds for Needs project asks women to evaluate field trials of accessions for global gene banks. The idea is to capitalize on women's wide-ranging knowledge of agricultural suitability as well as the cultural and nutritional value of different crops and varieties.

There is enormous potential for agricultural practices and technologies to achieve ***co-benefits for environmental health*** and ***mitigation*** of greenhouse gas emissions. For example, site-specific nutrient management can improve farm household incomes and food security by saving on input costs, while also reducing emissions. Managing for multiple outcomes makes sense where emissions reductions are possible without compromising farm livelihoods, since agriculture is a major contributor to global greenhouse gas emissions.

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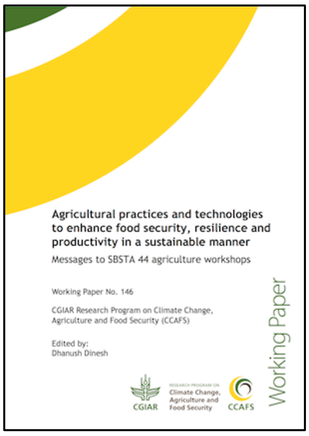
Further reading, with links to all referenced case studies and cited facts

Dinesh D, (Ed.). 2016. Agricultural practices and technologies to enhance food security, resilience and productivity in a sustainable manner: Messages to SBSTA 44 agriculture workshops. CCAFS Working Paper no. 146. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Available online at: http://hdl.handle.net/10568/71050



Related info note

Vermeulen SJ, Dinesh D. 2016. Measures for climate change adaptation in agriculture. Messages to the SBSTA 44 agriculture workshops. CCAFS Info Note. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Available online at: http://hdl.handle.net/10568/71052

This brief synthesizes knowledge within CGIAR on agricultural practices and technologies that enhance food security, resilience and productivity. This brief has been prepared for the benefit of parties and observers making submissions to the UNFCCC SBSTA 44 on issues related to agriculture.

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