



Using greenhouses allows farmers in East Africa to grow high-value crops such as tomatoes.

PERSPECTIVES

Legislating change

What should governments do to enhance sustainable agriculture and mitigate droughts?

THE GLOBAL IMPERATIVE

Drought affects us all

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In developing countries, drought can cripple communities. Its impact is often long-lasting, especially if smallholders have to sell off farming equipment in order to survive the loss of crop income. And in the developed world, drought in a major food-producing region can push up food prices worldwide.

Over the coming decades, climate change is expected to cause more frequent and more severe droughts (see 'The dry facts', page S2). Governments need to invest in research to make agriculture more resilient. Such strategies may include drought-adapted crop varieties, improved soil management techniques or greater use of irrigation (see 'Eastern Europe'). Some regions could require

major changes in farming and food systems (for example, a shift from growing maize to smaller grains).

Knowledge is essential to prepare and adapt for changing conditions. National climate risk assessments, which are important for the development of seasonal weather forecasts and adaptation strategies, require greater collaboration between meteorological and agricultural departments (see 'Australia'). The crucial function of conveying information to farming communities has led to innovative schemes to deliver forecasts via mobile devices (see 'West Africa').

Responses to drought may involve setting up funding reserves from which financial relief can be drawn by communities affected by severe weather events. These can be developed through public-private partnerships, as in India where almost 10 million farmers are covered by a weather-based crop-insurance scheme.

Other safety nets are also needed. These can involve cash and in-kind transfers, employment guarantee schemes, and capacity to deliver rapid humanitarian responses. For example, under the Ethiopian Productive Safety Net Programme, which covers 8 million people, water-harvesting infrastructure has been set up.

Given the scale of the suffering caused by the impact of drought, governments need pre-planned risk-reduction programmes, rather than just crisis management. In the coming months, the CGIAR research programme on Climate Change, Agriculture and Food Security will define an index to measure national commitment to climate-smart agriculture. The index will allow the public to track how governments across the world are managing the risks of climate change, and to hold them accountable.

V. ATAKOS (CCAFS)

EAST AFRICA

Invest in the dry lands

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More than two-thirds of East Africa is arid or semi-arid — the infertile soils are designated as low-potential, suitable only for grazing. But these low-potential regions are a frontier for agricultural expansion. A recent report by the International Livestock Research Institute shows that the demand for meat in East Africa is growing as its societies become more affluent. Nearly 90% of the meat consumed in this region is farmed on arid and semi-arid lands. And these lands hold further potential: innovations in greenhouse farming systems, implemented in urban and peri-urban settlements, mean that high-value crops — and not just livestock feed — can be grown in these areas.

Greenhouse farming is a revolutionary system, which, coupled with soil treatments, uses scarce water more efficiently and produces high yields. Greenhouses located near towns result in better access to local and export markets. This type of farming has the potential to create thousands of jobs for young agricultural workers.

For livestock farmers to raise output, cattle, camel and goat breeds need to be better adapted to heat stress and to tolerate a diet of low-quality herbage during droughts. For many years, the dairy sector has used artificial insemination to rapidly increase milk production. This technique must be used to develop livestock breeds, and governments need to speed up the research process.

Some governments are starting to invest. In Kenya, for example, greenhouse farmers now qualify for support from a US\$70-million youth development fund, and the

Boran and Sahiwal breeding programmes are starting to improve the indigenous zebu cattle. Governments across East Africa, in partnership with the private sector, need to prioritize research investment and rollout programmes, in addition to stimulating microfinance schemes, to make dry-land farming more productive and meet growing food demands.

EASTERN EUROPE

Implement good practice

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A recent study carried out jointly by the European Commission and member states estimates the cost of Europe's droughts over the past 30 years to have been at least €100 billion (US\$133 billion). Drought-risk management policies to improve preparedness and reduce impact should become a priority for governments — particularly for those in Eastern Europe, which is more vulnerable to drought than Western Europe.

Moldova has been hit particularly hard by droughts over the past decade. International donors responded with assistance, including distribution of seed, fertilizers, animal feed and food, but the real challenge is to ensure that countries such as Moldova are better prepared through more resilient farming systems.

According to a recent analysis by the Food and Agriculture Organization of the United Nations (FAO), Moldova is particularly vulnerable to the impact of drought because it lacks good agricultural practices. The analysis cited several examples of poor practice: use of seed varieties that are not adapted to droughts; lack of proper agronomic technologies to retain soil moisture; weakness of grazing methods and poor-quality pastures; inadequate use of effective silage methods to accumulate fodder for the winter; deficient storage systems that cause post-harvest losses; and poor maintenance of irrigation systems.

The FAO has proposed a strategy to tackle drought and other natural hazards likely to be exacerbated by climate change. In particular, the FAO is helping to strengthen Moldova's seed production sector by, among other measures, supporting the state commission and various seed producer associations. We are also holding a series of workshops to educate farmers and support

services about conservation agriculture and soil improvement technologies.

Crucial to all this is the will of the Moldovan government to make sustainable agriculture a priority. Many other Eastern European countries have similar agricultural problems, but not all of them take climate change and sustainability as seriously. The FAO proposals for Moldova could equally be applied in those countries.

AUSTRALIA

Better research planning

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Australia is the driest inhabited continent. Balancing agricultural water use with the needs of communities and the environment is acutely challenging. The Millennium Drought of 2001–09 harmed river systems, threatened water supplies for communities, and depleted the supply of irrigation water. Despite these consequences, spending on research into agricultural water use has remained static.

Australia spends about Aus\$1.9 billion (US\$1.7 billion) annually on agricultural research, with about 26% coming from 15 sector-based, levy-funded rural research and development corporations (RDCs). By funding a variety of discrete research providers, the RDCs have delivered new knowledge and practices for their sectors, but they have been less effective for cross-cutting issues such as drought and water use.

Since 2007, national research, development and extension (RD&E) strategies have been developed to make more efficient use of agricultural research funds, improving cooperation between research providers, and minimizing duplication. Yet despite the goodwill engendered by cooperation, implementing the strategies could prove problematic. The challenge lies in balancing and coordinating the work of distinct public and private organizations that have different purposes, cultures, priorities and expectations.

Instead of the sector-based planning used for developing RD&E strategies, a more holistic approach is needed. Several national committees of the Australian Academy of Sciences have developed decadal plans (go.nature.com/cgOep5).

The recently formed National Committee for Agriculture, Fisheries and Food

should launch a similar plan for agricultural research that includes drought and water use. This plan should assess the state of agricultural research in Australia, consider the problems and opportunities facing agriculture over the next 10–15 years, and outline potential research that could help address them. By taking a national overview of all sectors, the plan would give the comprehensive vision that is now lacking.

WEST AFRICA

Communication is key

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About 80% of West Africans live in rural populations that mainly depend on rain-fed, cereal-based subsistence agriculture. These areas are highly vulnerable to climate variability. The increasing frequency and severity of climate extremes — primarily drought — have led to food crises in the sub-Saharan Sahel region. Although existing technologies and practices can mitigate agricultural risk, farmers need access to accurate long- and short-term weather forecasts so they can utilize these measures more effectively.

One solution is localized seasonal climate forecasts for farmers. Partners from CCAFS in West Africa have recently tried such an approach in the Kaffrine district in central Senegal.

To help ease the transition from traditional forecast practices, we presented the new information to farmers alongside discussions about established methods. Farmers in Kaffrine were able to develop adaptive techniques from climate information and choose a good strategy for improving yield during dry and wet seasons.

Extending these trials across the Sahel will require investment in setting up multi-disciplinary groups to translate seasonal forecast information into tailored agrometeorological advice. CCAFS is working with the national meteorological office in Mali to pilot such a scheme for farmers in the Cinzana district. By documenting the effects and benefits of these measures, we should be able to convince policymakers to allocate funds to promote them and also attract donors and other stakeholders.

Governments could promote access to

agro-meteorological information by establishing partnerships with mobile-phone companies, as well as with rural radio and TV stations. This will allow the most relevant information to reach the maximum number of farmers at the right time, who can then make informed decisions about planting and other cropping activities.

LATIN AMERICA

Empower the farmers

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Large dams and irrigation schemes are seemingly obvious solutions in drought-prone regions, but they rarely improve agricultural productivity. That's because drought is not just a water supply issue: it is embedded in a broader social, political and economic context.

It is usually interventions on a smaller scale, tailored to local conditions, that achieve lasting results. The International Fund for Agricultural Development (IFAD) has supported many such schemes in Latin America. In the Sertão region of Brazil, for example, several projects have introduced innovative irrigation technologies. The region is home to 11% of Brazil's population but has only 5% of the country's water resources. One such scheme, managed by local farmers, built small underground dams and wells to store rainwater without flooding the most productive land. By pumping up the water for irrigation, families were able to grow more vegetables, improve their diets, and sell the surplus produce to generate income.

As outlined by Bruce Campbell above, developing sustainable agriculture in drought-affected areas also requires incentives and social safety nets to encourage farmers to be less risk-averse and more entrepreneurial. In Brazil, for example, poor rural people receive cash payments for sending their children to school. In the short term, these conditional cash transfers give smallholder farmers some security to experiment with new seed varieties and grow crops for the market, rather than just for domestic consumption. This scheme also guarantees an education for children, boosting their long-term opportunities of setting up a business or finding employment in other sectors.

Development efforts are most effective when farmers are empowered to find their own solutions. IFAD-funded projects in Peru introduced the practice of holding public competitions to assign development resources. These public competitions, set up and managed by the farming communities, allow local people to choose which services they want and need. Such socially inclusive mechanisms have been so successful that they are now part of Peru's government strategy to reduce rural poverty.

SOUTH ASIA

Enhance adaptation

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South Asia has achieved a large increase in food production over the past few decades: from 172 million tonnes in 1970 to more than 400 million tonnes in 2010. Despite this increased production, almost 42% of the world's poor, and nearly 40% of its malnourished women and children, live in the region. Improved food production is not sufficient to compensate for high population density, limited human capital, poor infrastructure, frequent extreme weather events and a widespread dependence on agriculture.

There are many technological, institutional and policy interventions that could improve resilience to climate change in South Asia, but implementation will require more proactive government support.

Measures to improve resilience that should be prioritized include conservation agriculture, reclamation of degraded land, scientific management of seed, soil and water resources, improved weather forecasts and services to farmers, and agricultural infrastructure. Adaptations made in these areas could also significantly contribute to reducing greenhouse gases.

Political and scientific management of land and water resources is also essential for sustainable agriculture. Reforming land ownership rights, alongside policies to encourage cooperative farming and making credit available, will encourage farmers to invest in their land. The South Asian Association for Regional Cooperation can assist in the administration of trans-boundary water sharing and pest control, as well as

helping to set up safety nets in the form of food banks.

Problems caused by the widespread poverty, poor governance, outdated institutions, and lack of human capital are limiting agricultural growth and will continue to hinder adaptation to climatic risks. Although scientific interventions are crucial, it is important to simultaneously address these socio-economic and political constraints.

UNITED STATES

Re-evaluate crop subsidies

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The extreme weather events associated with climate change present opportunities for the meaningful reform of agricultural policies. In the United States, antiquated federal policies subsidize the overproduction of a small number of crops — primarily maize, rice, soybean, wheat and cotton — and incentivize monoculture farms.

In 2012, the United States grew 39.4 million hectares of maize — the largest area of the crop planted since 1936. Maize monoculture degrades soil so it requires more inputs, particularly nitrogenous fertilizer. An excess of nitrogen, largely from agricultural fertilizer use, has caused hypoxia in the Gulf of Mexico and the degradation of Chesapeake Bay. Re-evaluating subsidy policies would go a long way towards promoting more environmentally sustainable agriculture.

Addressing the imbalance caused by such policies would lead to funding decisions that encourage crop diversity and improve soil health. Conservation and diversification are at the core of sustainable agriculture and can help mitigate increased pressures and risks from climate change and drought. Practices that integrate environmentally conscious techniques for managing soil, crops, livestock and water are critical to creating and sustaining a resilient agriculture that is also more carbon neutral.

Policies that favour large monoculture farms have given rise to environmental degradation and changed the fabric of US rural communities. As skilled farming jobs have disappeared, people have been forced to move to urban centres. By diverting limited government funds to agricultural research and promoting diversification and healthy soils, we can protect our farms, food, environment and rural communities. ■