



Achieving food security in the face of climate change

Summary for policy makers from the Commission on
Sustainable Agriculture and Climate Change

Commissioners:

Professor Sir John Beddington, Chair, United Kingdom

Dr Mohammed Asaduzzaman, Bangladesh

Dr Megan Clark, Australia

Dr Adrian Fernández, Mexico

Dr Marion Guillou, France

Professor Molly Jahn, United States

Professor Lin Erda, China

Professor Tekalign Mamo, Ethiopia

Dr Nguyen Van Bo, Viet Nam

Dr Carlos A Nobre, Brazil

Professor Robert Scholes, South Africa

Dr Rita Sharma, India

Professor Judi Wakhungu, Kenya

Commissioners

- Professor Sir John Beddington, Chair, United Kingdom
- Dr Mohammed Asaduzzaman, Bangladesh Institute of Development Studies, Bangladesh
- Dr Adrian Fernández, Metropolitan University, Mexico
- Dr Megan Clark, Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia
- Dr Marion Guillou, French National Institute for Agricultural Research (INRA), France
- Professor Molly Jahn, University of Madison-Wisconsin, United States
- Professor Lin Erda, Chinese Academy of Agricultural Sciences, China
- Professor Tekalign Mamo, Ministry of Agriculture, Ethiopia
- Dr Nguyen Van Bo, Viet Nam Academy of Agricultural Science, Viet Nam
- Dr Carlos A Nobre, Ministry of Science, Technology and Innovation, Brazil
- Professor Robert Scholes, Council for Scientific and Industrial Research (CSIR), South Africa
- Dr Rita Sharma, National Advisory Council, India
- Professor Judi Wakhungu, African Center for Technology Studies (ACTS), Kenya

Commission Secretariat

- Commission Coordinator: Dr Christine Negra
- Communications Manager: Ms Vanessa Meadu
- Events Coordinator: Ms Ratih Septivita
- Research Assistants: Ms Cecilia Schubert, Ms Helena Wright

Acknowledgments

- Mr Odd Arneson, Norwegian Agency for Development Cooperation (Norad)
- Dr Marie-Caroline Badjeck, WorldFish Centre
- Mr Paul Barnett, CSIRO
- Dr Ademola Braimoh, World Bank
- Dr Bruce Campbell, Consortium of International Agricultural Research (CGIAR) Research Program on Climate Change, Agriculture and Food Security (CCAFS)
- Mr Volli Carucci, World Food Programme (WFP)
- Ms Beatrice Darcy-Vrillon, INRA
- Professor Alex Evans, New York University
- Ms Rebecca Fisher-Lamb, United Kingdom Government Office for Science
- Professor Charles Godfray, Oxford University
- Mr Elwyn Grainger-Jones, International Fund for Agricultural Development (IFAD)
- Dr Herve Guyomard, INRA
- Dr Stefan Hajkovicz, CSIRO
- Dr Ulrich Hoffmann, United Nations Conference on Trade and Development (UNCTAD)
- Mr David Howlett, University of Leeds
- Dr Brian Keating, CSIRO
- Mr Danny Martinez, International Center for Tropical Agriculture (CIAT)
- Mr Musa Muwanga, National Organic Agricultural Movement of Uganda (NOGAMU)
- Dr Henry Neufeldt, World Agroforestry Centre (ICRAF)
- Mr Randall Purcell, WFP
- Mr Scott Ronchini, WFP
- Professor Cynthia Rosenzweig, Columbia University
- Professor Tim Searchinger, German Marshall Fund/Princeton University
- Ms Emmy Simmons, Meridian Institute AGree Initiative
- Dr Egizio Valceschini, INRA
- Dr Sonja Vermeulen, CCAFS
- Dr Paul West, University of Minnesota
- Dr Elizabeth Warham, United Kingdom Government Office for Science

Disclaimer

This report contains the findings of the Commission on Sustainable Agriculture and Climate Change. The findings represent the independent views of the authors and should not be interpreted as the views of their institutions or their funders, nor of the CGIAR or the Global Donor Platform for Rural Development.

Financial support

- CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)
- Global Donor Platform for Rural Development (GDPRD)

Published by

The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

Contact information

CCAFS Coordinating Unit, Department of Agriculture and Ecology, Faculty of Life Sciences, University of Copenhagen, Rolighedsvej 21, DK-1958 Frederiksberg C, Denmark
 Tel: +45 35331046
 Email: ccaafs@cgiar.org
 Online: www.ccaafs.cgiar.org

Correct citation

Beddington J, Asaduzzaman M, Fernandez A, Clark M, Guillou M, Jahn M, Erda L, Mamo T, Van Bo N, Nobre CA, Scholes R, Sharma R, Wakhungu J. 2011. Achieving food security in the face of climate change: Summary for policy makers from the Commission on Sustainable Agriculture and Climate Change. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark. Available online at: www.ccaafs.cgiar.org/commission.

Creative Commons License



This publication is licensed under a Creative Commons Attribution – NonCommercial-NoDerivs 3.0 Unported License.

This publication may be freely quoted and reproduced provided the source is acknowledged. No use of this publication may be made for resale or other commercial purposes.

© 2011 CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

Front cover photo

Sorghum at Sawla market in Ghana's Northern Region, by N Palmer (CIAT)

Production

Scriptoria Communications

To learn more, visit www.ccaafs.cgiar.org/commission

Achieving food security in the face of climate change

Summary for policy makers from the Commission on Sustainable Agriculture and Climate Change

Business as usual in our globally interconnected food system will not bring us food security and environmental sustainability. Several converging threats – from climate change, population growth and unsustainable use of resources – are steadily intensifying pressure on humanity and world governments to transform the way food is produced, distributed and consumed¹.

On a planet with sufficient food for all, a billion people go hungry². Another billion over-consume, increasing risks from chronic diseases³. The food system faces additional pressure as the global population grows, to around 9 billion by 2050⁴, and as diets shift towards higher consumption of calories, fats and animal products. Food insecurity afflicts communities throughout the world wherever poverty prevents assured access to food supplies. As well as causing widespread human suffering, food insecurity contributes to degradation and depletion of natural resources, migration to urban areas and across borders, and political and economic instability.

Inefficiencies in food supply chains have a negative impact on the environment, lower productivity and waste food. Current farming practices, including land clearing and inefficient use of fertilizers and organic residues, make agriculture a significant contributor to greenhouse gas emissions on the planet. From the farm gate to consumers, refrigeration and other supply chain activities are an additional major source of greenhouse gas emissions. As global demand for food, fodder and bioenergy crops grows, many agricultural systems are depleting soil fertility, biodiversity and water resources. In many regions there are large gaps between potential and actual crop yields. Every year, an estimated 12 million hectares of agricultural land, which could potentially produce 20 million tonnes of grain, are lost to land degradation, adding to the billions of hectares that are already degraded⁵. It is estimated that a third of food produced for human

consumption is lost or wasted across the global food system⁶. It is clear that our collective choices related to agriculture and food systems must be revisited.

Our climate is changing and, given the levels of greenhouse gases already in our atmosphere, will continue to do so. Extreme weather events, such as high temperatures, droughts and floods, are already more frequent and severe,

Global food prices have risen dramatically in the last few years and are forecast to rise further and become more volatile.

In 2007/8, food price rises shocked many policymakers from the belief that stable or declining food prices and assured supplies could be taken for granted. Before the price spike, poverty meant that 800 million people were hungry. Following the price spike, this number increased to a little over 1 billion people⁷ (a rise that significantly set back progress towards the UN Millennium Development Goal to halve the proportion of people suffering hunger between 1990 and 2015⁸). It is estimated that an additional 44 million people have since fallen into extreme poverty due to the rise in food prices since June 2010⁹. These events have drawn increased attention to the fact that a significant proportion of humanity remains chronically undernourished, even during periods of relatively normal prices and low volatility.

¹ This summary for policy makers is complemented by a detailed report of findings and recommendations, and background documents.

² Food and Agriculture Organization of the United Nations. 2010.

³ Foresight. 2007; WHO / FAO. 2003; Haslam and James. 2005.

⁴ United Nations Population Division. 2010.

⁵ UNCCD. 2011; Bai et al. 2008.

⁶ Gustavsson et al. 2011.

⁷ FAO. 2009.

⁸ HMG. 2010.

⁹ World Bank. 2011b.

and have dire social, economic and ecological consequences. Ever-higher average global temperatures are likely without dramatic changes in greenhouse gas emissions across a wide range of human activities. In the coming decades, global climate change will have an adverse overall effect on agricultural production and will bring us toward, and perhaps over, critical thresholds in many regions. Areas currently suffering from food insecurity are expected to experience disproportionately negative effects. To reduce the effect of climate change on food supplies, livelihoods and economies, we must greatly increase adaptive capacity in agriculture – both to long-term climatic trends and to increasing variability – as an urgent priority.

Table 1. Status of selected global parameters.

People in the world (2011) ¹⁰	7 billion
Undernourished people (2010) ¹¹	0.9 billion
Overweight people over age 20 (2008) ¹²	1.5 billion
People living on less than USD 1.25 per day (2005) ¹³	1.4 billion
People living in dryland areas (2007) ¹⁴	2 billion
People dependent on degrading land ¹⁵	1.5 billion
Losses due to climatological events (extreme temperature, drought, forest fire) (2010) ¹⁶	USD 7.5 billion
Area of agricultural land (2009) ¹⁷	4.9 billion hectares
Area of croplands, pasture and grazing lands devoted to raising animals ¹⁸	3.7 billion hectares
Annual growth in world agricultural production (1997-2007) ¹⁹	2.2%
Food produced for human consumption lost or wasted annually ²⁰	1.3 billion tonnes

The Commission on Sustainable Agriculture and Climate Change has reviewed the scientific evidence to identify a pathway to achieving food security in the context of climate change. Food systems must shift to better meet human needs and, in the long term, balance with planetary resources. This will demand major interventions, at local to global scales, to transform current patterns of food production, distribution and consumption. Investment, innovation, and deliberate effort to empower the world's most vulnerable populations will be required to construct a global food system that adapts to climate change and ensures food security while minimizing greenhouse gas emissions and sustaining our natural resource base. Greatly expanded investments in sustainable agriculture, including improving supporting infrastructure and restoring degraded ecosystems, are an essential component of long-term economic development. The sooner they are made, the greater the benefits will be.

Over the course of the 21st century, the world will need to produce significantly more food in order to deliver a basic, but adequate, diet to everyone. The amount of food required will be even greater if current trends in diets and the management of food systems continue. We need to make concurrent efforts to establish climate-resilient agricultural production systems, make efficient use of resources, develop low-waste supply chains, ensure adequate nutrition and encourage healthy eating choices. Together, these will constitute a sustainable food system. Intensification of food production must be accompanied by concerted action to reduce greenhouse gas emissions from agriculture to avoid further acceleration of climate change and avert threats to the long-term viability of global agriculture. Making these changes, although technically feasible, requires urgent, collective and substantially increased action internationally, nationally and locally.

As climate change amplifies the environmental and socioeconomic drivers of food insecurity, it is imperative that we prioritize where, how and when to act. The threats posed by climate change to food supplies and livelihoods are likely to be spatially variable. We will need to identify global hotspots where the threats are greatest and to develop specific, practical interventions to boost resilience in these areas. For example, some of the world's major food-producing regions lie in mega-deltas which are threatened by escalating rates of saltwater intrusion. In Africa, the pronounced gaps between actual and potential crop yields and shrinking per capita land base²¹ inhibit food security.

¹⁰ <http://www.un.org/en/development/desa/news/population/world-to-welcome-seven-billionth-citizen.html>

¹¹ FAO. 2010.

¹² World Health Organization. 2011.

¹³ World Bank: Poverty and Equity Data.

<http://povertydata.worldbank.org/poverty/home/>

¹⁴ UNCCD. 2011.

¹⁵ *Ibid.*

¹⁶ Munich RE NatCatSERVICE. 2010.

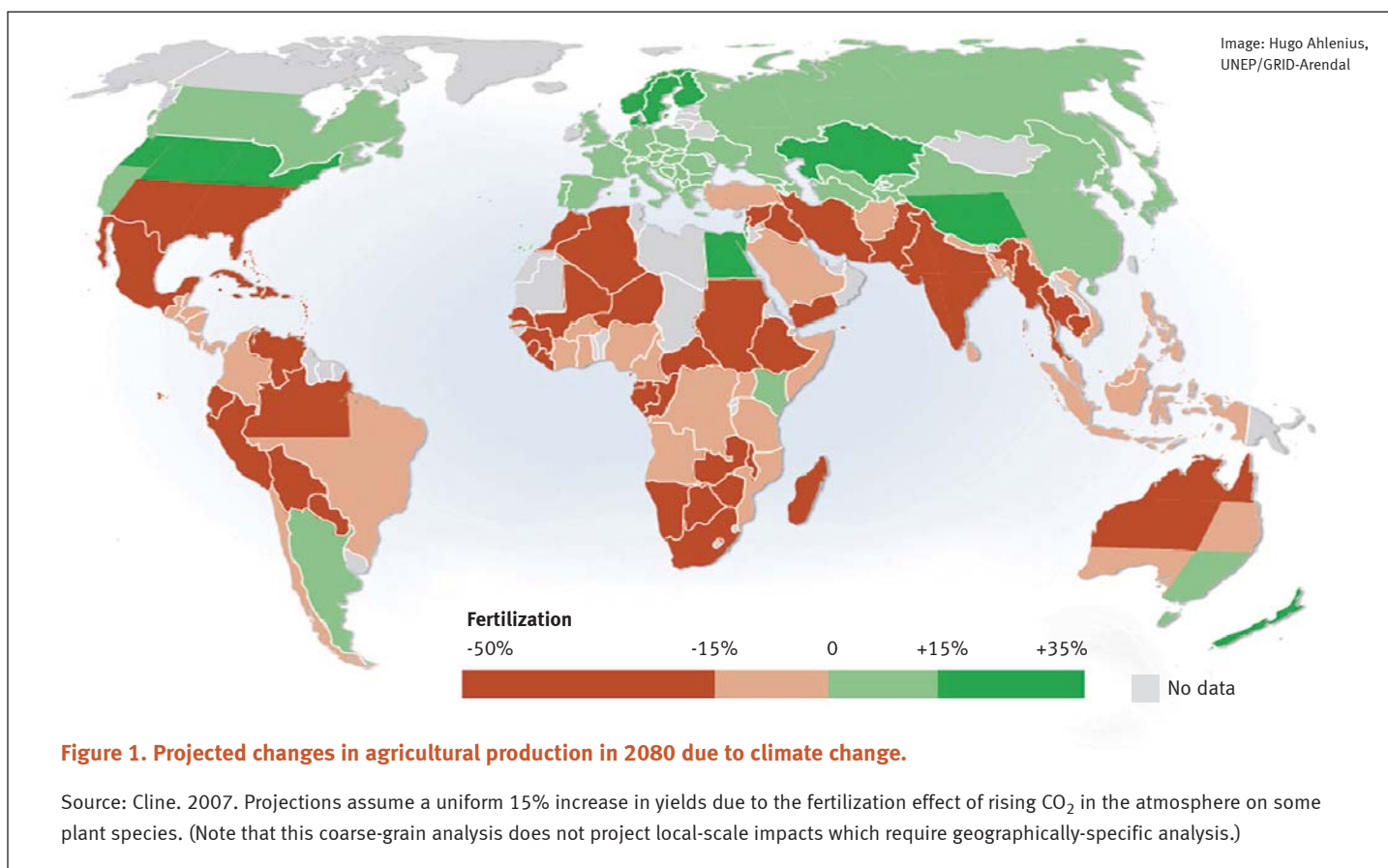
¹⁷ Foley et al. 2011.

¹⁸ *Ibid.*

¹⁹ Bruinsma. 2009.

²⁰ Gustavsson et al. 2011.

²¹ United Nations Population Division. 2010.



In Europe, North America and elsewhere, a combination of intensive agriculture, food storage practices, retail systems and eating habits generates high per capita greenhouse gas emissions and food waste. The environmental and human diversity of the planet forbids the imposition of one-size-fits-all solutions.

Humanitarian, environmental and global security concerns demand a global commitment to improve the lot of the large proportion of the human population that is currently food insecure or vulnerable to food insecurity. This requires that we must build resilience to climate shocks and food price volatility, halt land degradation, and boost productive assets and infrastructure. There are many entry points for action. Many policies and programmes provide ample evidence of multiple benefits for livelihoods and the environment, with meaningful participation at local and regional scales.

Many millions of people around the world depend on agriculture for basic subsistence. Efforts to reduce net greenhouse gas emissions from agriculture must not have perverse effects on the food security and livelihoods of these people. Techniques for restoring degraded areas and sequestering soil carbon to enhance future productivity should increase or stabilize food production. Where the path

to long-term sustainability means reducing productivity in the short term, economic incentives and transitional programmes will be required. Specific actions must be taken to assist those most vulnerable to long- and short-term increases in the price of food rather than relying on trickle-down economic effects. Appropriate targeting of a portfolio of interventions at key points of vulnerability, such as meeting the food and nutritional needs of mothers and young children, will have disproportionately positive payoffs in future productivity and development.



Traditional maize storage, Yunnan, China.
 Photo: E. Phipps (CIMMYT)



Figure 2. Regional examples of threats from climate change, population growth and unsustainable resource use.

²² National Academy of Sciences. 2010.

²³ Nelson et al. 2011.

²⁴ Cabinet Office. 2008.

²⁵ WRAP. 2008.

²⁶ FAO Country Profiles: France; Etilé. 2010; Reardon et al. 2003.

²⁷ World Bank. 2010a.

²⁸ Foresight. Migration and Global Environmental Change. 2011.

²⁹ Foley et al. 2011.

³⁰ FAO Country Profiles: China

³¹ World Bank. 2010a.

³² Laborte et al. 2011.

³³ Choudhury. 2006.

³⁴ Mittal. 2007.

³⁵ Prosser. 2011.

³⁶ FAO. 2011a.

³⁷ World Bank. 2010a.

³⁸ FAO. 2011b.

³⁹ FAO Country Profiles: South Africa

⁴⁰ World Bank. 2010b.

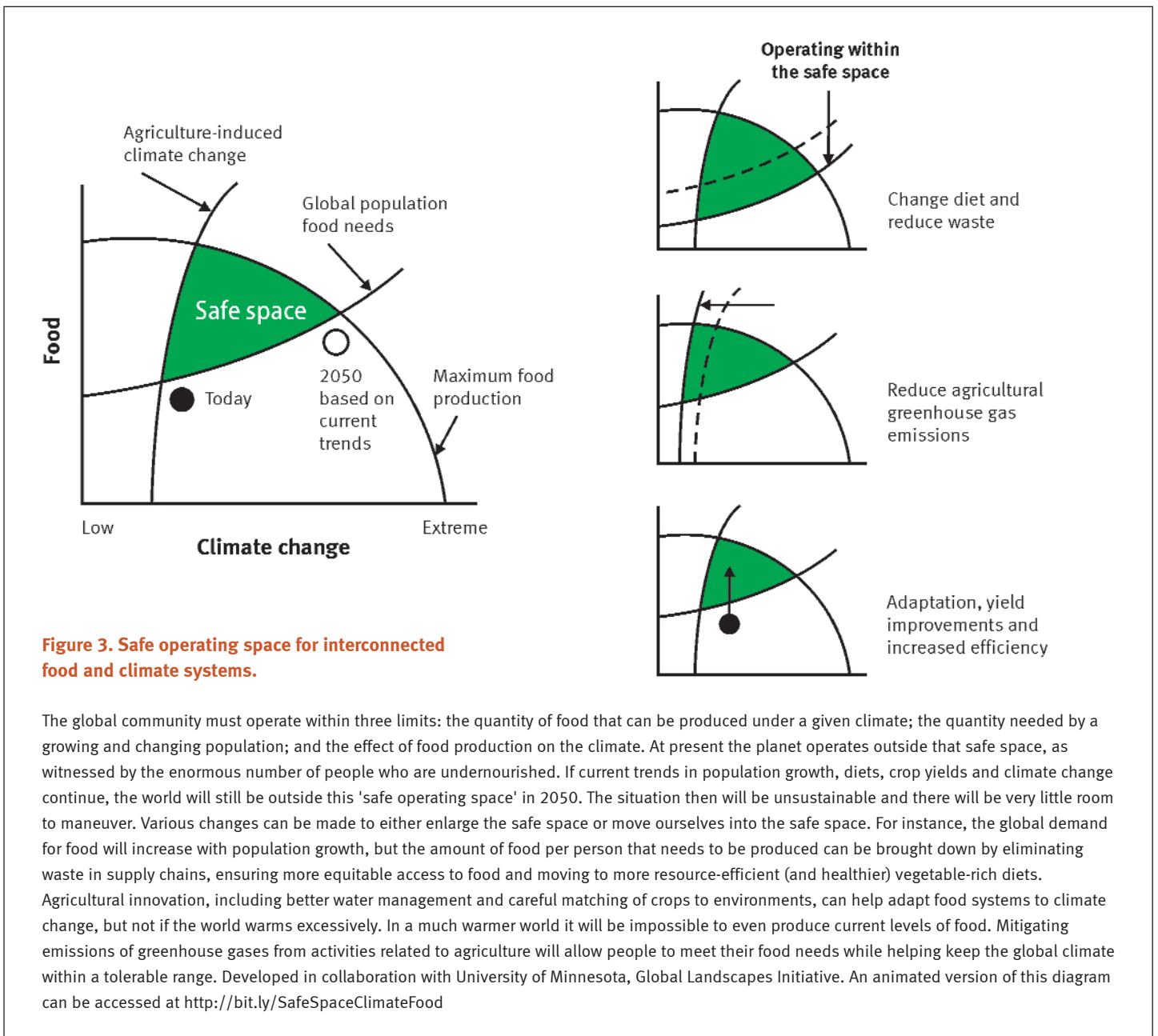
⁴¹ World Bank. 2010a.

⁴² FAOStat: Mexico

The multiple emergent challenges – food insecurity and undernutrition, climate change, increasing competition for energy and water, degradation of land and biodiversity – are connected in complex ways and demand an integrated management approach. Adaptive management and governance to improve nutritional security, economic prosperity and environmental outcomes will require a much better global system for integrating spatially explicit information about agriculture, ecosystem services, markets and human populations in real time. Existing and future investments in information and knowledge must be structured to identify limits, inform trade-offs and deliver practical guidance for a sustainable future, not simply to maximize single components of the food system. Such an

information system will give us a richer understanding of the dynamic systems we depend on and enable us to renew and broaden our efforts to secure a more sustainable and healthy food system for our own and future generations.

As a global community, we need to navigate toward a 'safe operating space' that provides adequate food and nutrition for everyone without crossing critical environmental thresholds. Plotting a course towards this space will require innovative technologies, institutions and policies, and will severely test our social, technological and agricultural ingenuity. In all circumstances, we will need governance at multiple levels that accommodates participation, learning and the ability to correct course. To be successful we will



need a robust, widely shared appreciation of agriculture as a multifunctional enterprise that delivers nutritious food, rural development, environmental services and cultural heritage, through and beyond the 21st century.

Without a global commitment to reducing greenhouse gas emissions from all sectors, including agriculture, no amount

of agricultural adaptation will be sufficient under the destabilized climate of the future. While change will have significant costs, the cost of remaining on the current path is already enormous and growing. Given the already intolerable conditions for many livelihoods and ecosystems, and the time lag between research and development and widespread application, we need to take urgent action.



Measuring greenhouse gas emissions from rice.

Photo: N. Palmer CIAT



Photo: P Casier (CCAFS)

Key messages and action points

The transition to a global food system that satisfies human needs, reduces its carbon footprint, adapts to climate change and is in balance with planetary resources requires concrete and coordinated actions, implemented at scale, simultaneously and with urgency. Based on robust scientific evidence, the Commission on Sustainable Agriculture and Climate Change has identified critical leverage points and high-priority policy actions.

The Commission proposes the following evidence-based actions to achieve food security in the face of climate change. By taking these steps we can deliver long-term benefits to communities in all countries.

1. Integrate food security and sustainable agriculture into global and national policies

- Establish a work programme on mitigation and adaptation in agriculture in accordance with the principles and provisions of the United Nations Framework Convention on Climate Change (UNFCCC), based on Article 2, as a first step to inclusion of agriculture in the mainstream of international climate change policy.
- Make sustainable, climate-friendly agriculture central to Green Growth⁴³ and the Rio+20 Earth Summit⁴⁴.

⁴³ Green Growth is a policy focus that emphasizes environmentally sustainable economic progress to foster low-carbon, socially inclusive development. www.greengrowth.org

⁴⁴ Rio+20, United Nations Conference on Sustainable Development, Rio de Janeiro, Brazil, June 4-6, 2012.

- Finance 'early action' to drive change in agricultural production systems towards increasing resilience to weather variability and shocks, while contributing significantly to mitigating climate change. This includes supporting national climate risk assessments, developing mitigation and adaptation strategies, and programme implementation.
- Develop common platforms at global, regional and national levels for coherent dialogue and policy action related to climate change, agriculture, crisis response and food security, at global, regional and national levels. These include fostering country-level coalitions for food security and building resilience, particularly in countries most vulnerable to climate shocks.

2. Significantly raise the level of global investment in sustainable agriculture and food systems in the next decade

- Implement and strengthen the existing G8 L'Aquila programmes and commitments to sustainable agriculture and food security, including long-term commitments for financial and technical assistance in food production and to empower smallholder farmers.
- Enable UNFCCC Fast Start⁴⁵ funding, major development banks and other global finance mechanisms to prioritize

⁴⁵ The Copenhagen Accord notes developed countries' commitment to providing developing countries with fast start finance for enhanced action on mitigation (including Reducing Emissions from Deforestation and Forest Degradation, REDD), adaptation, technology development and transfer and capacity building. www.faststartfinance.org/home



A pig farm in the United Kingdom.
Photo: K Robinson (Panos)

sustainable agriculture programmes that deliver food security, improved livelihoods, resilience to climate change and environmental co-benefits. Such programmes should emphasize improving infrastructure and land rehabilitation.

- Adjust national research and development budgets, and build integrated scientific capacity, to reflect the significance of sustainable agriculture in economic growth, poverty reduction and long-term environmental sustainability, and focus on key food security issues (for example, developing nutritious non-grain crops and reducing post-harvest losses).
- Increase knowledge of best practices and access to innovation by supporting revitalized extension services, technology transfer and communities of practice (for example, North-South, South-South, cross-commodity and farmer-to-farmer exchanges), with emphasis on low- to high-income countries and on women farmers.

3. Sustainably intensify agricultural production while reducing greenhouse gas emissions and other negative environmental impacts of agriculture

- Develop, facilitate and reward multi-benefit farming systems that enable more productive and resilient livelihoods and ecosystems, with emphasis on closing yield gaps and improving nutrition.
- Introduce strategies for minimizing ecosystem degradation and rehabilitating degraded environments, with emphasis on community-designed programmes.
- Empower marginalized food producers (particularly women) to increase productivity of a range of appropriate

crops by strengthening land and water rights, increasing access to markets, finance and insurance, and enhancing local capacity (for example through farmer and community-based organizations).

- Identify and modify subsidies (such as for water and electricity) that provide incentives for farmers to continue agricultural practices that deplete water supplies or destroy native ecosystems. Introduce compensation schemes that target the poor.
- Couple economic incentives for sustainable intensification of agriculture with strengthening governance of land tenure and land zoning to prevent further loss of forests, wetlands and grasslands.



Smallholder agroforestry in Kenya is an example of sustainable intensification.
Photo: N Palmer (CIAT)

4. Develop specific programmes and policies to assist populations and sectors that are most vulnerable to climate changes and food insecurity

- Develop funds that respond to climate shocks, such as 'index-linked funds' that provide rapid relief when extreme weather events affect communities, through public-private partnerships based on agreed principles.
- Moderate excessive food price fluctuations by sharing country information on production forecasts and stocks, strengthening market databases, promoting open and responsive trade systems, establishing early warning systems and allowing tax-free export and import for humanitarian assistance. This includes embedding safeguards related to import surges and trade distortions in trade agreements.
- Create and support safety nets and other programmes to help vulnerable populations in all countries become food secure (for example, cash and in-kind transfers,



Rushing to buy bread as wheat runs short and food prices rise in Mozambique.
Photo: Mann (ILRI)

employment guarantee schemes, programmes to build resilience, health and nutrition, delivery of education and seeds of quick growing foods in times of famine).

- Establish robust emergency food reserves and financing capacity that can deliver rapid humanitarian responses to vulnerable populations threatened by food crises.
- Create and support platforms for harmonizing and coordinating global donor programmes, policies and activities, paying particular attention to systematically integrating climate change risk management, adaptation and mitigation co-benefits, and improved local nutritional outcomes.

5. Reshape food access and consumption patterns to ensure basic nutritional needs are met and to foster healthy and sustainable eating patterns worldwide

- Address chronic undernutrition and hunger by harmonizing development policy and coordinating regional programmes to improve livelihoods and access to services among food-insecure rural and urban communities.
- Promote positive changes in the variety and quantity of diets through innovative education campaigns, which target young consumers especially, and through economic incentives that align the marketing practices of retailers and processors with public health and environmental goals.
- Promote and support a coherent set of evidence-based sustainability metrics and standards to monitor and evaluate food security, nutrition and health, practices and technologies across supply chains, agricultural productivity and efficiency, resource use and

environmental impacts, and food system costs and benefits. This should include providing consumers with clear labelling.

6. Reduce loss and waste in food systems, targeting infrastructure, farming practices, processing, distribution and household habits

- In all sustainable agriculture development programmes, include research and investment components focusing on reducing waste, from production to consumption, by improving harvest and postharvest management and food storage and transport.
- Develop integrated policies and programmes that reduce waste in food supply chains, such as economic innovation to enable low-income producers to store food during periods of excess supply and obligations for distributors to separate and reduce food waste.
- Promote dialogue and convene working partnerships across food supply chains to ensure that interventions to reduce waste are effective and efficient (for example, redirecting food waste to other purposes), and do not create perverse incentives.



Addressing nutrition and diet in development policies and education can help reduce food insecurity.

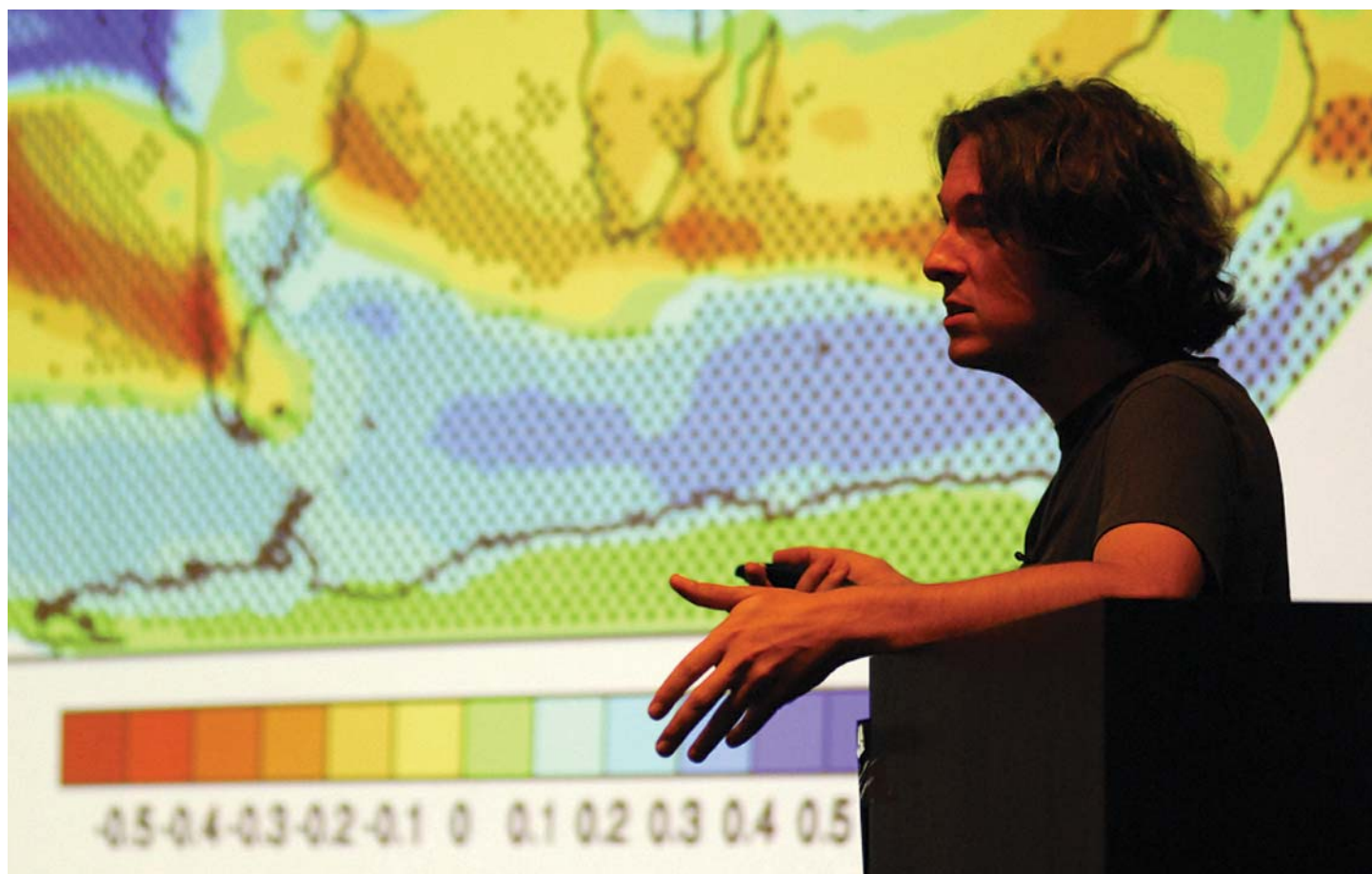
Photo: International Rice Research Institute (IRRI)

7. Create comprehensive, shared, integrated information systems that encompass human and ecological dimensions

- Sustain and increase investment in regular monitoring, on the ground and by public domain remote sensing networks, to track changes in land use, food production, climate, the environment, human health and well-being worldwide.

- Support improved transparency and access to information in global food markets and invest in interlinked information systems with common protocols that build on existing institutions.
- Develop, validate and implement spatially explicit data and decision-support systems that integrate biophysical and socioeconomic information and that enable policy makers to navigate trade-offs among agricultural intensification, nutritional security and environmental consequences.

Only by implementing real changes across the global food system will we be able to achieve food security and a stable climate for the long term. This will require a break from business as usual and a significant shared commitment by policy makers, investors, agricultural producers, consumers, food companies and researchers.



Policy makers need better tools and data for analysing options and trade-offs.

Photo: N Palmer (CIAT)

Real-world investment, innovation and action

Public and private sector leaders around the world are already taking action. This section highlights a diverse set of policies and programmes that are tackling food security in the context of climate change.

Australia: National initiatives and information services support adaptive agriculture

Real-time information and forecasting for rainfall, temperature, humidity and drought are critical to successful climate change adaptation and mitigation in agriculture. In Australia, these challenges need to be undertaken in the most variable climate of any inhabited continent. For example, the El Niño Southern Oscillation drives cycles of drought and flood that significantly affect the rural sector. Australian agriculture, including land clearing, accounts for at least 25% of the country's greenhouse gas emissions (similar to the global average), creating the combined imperative of reducing greenhouse gas emissions by 50-80% by 2050, while increasing food production by 30-80%. Australia's Carbon Farming Initiative is the world's first national legislation for land-based mitigation and rural income enhancement. To support adaptive agriculture and 'carbon farming' by Australian producers, the Bureau of Meteorology (BoM) provides Seasonal Climate Outlooks with detailed forecasts and risk assessments, including a 3-month prediction based on the Troup Southern Oscillation Index and a 6-month El Niño Southern Oscillation prediction⁴⁶. In addition, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the BoM provide longer-term climate projections to help farmers prepare for future changes. In some areas, such as southwest Australia, climate projections are already an important tool for farmers forced to change their farming practices in response to changing climatic conditions. The



Carbon-rich agricultural landscape, Tasmania, Australia.

Photo: M Castley, Private Forests Tasmania

⁴⁶ www.bom.gov.au/climate

initiatives are supported by Australia's Farming Future programme which provides information, funding, training and support to help farmers adapt to climate change, including grants targeted at women farmers and 'next generation' farmers⁴⁷.



Irrigation channel, Bangladesh.

Photo: International Rice Research Institute (IRRI)

Bangladesh: Investing in smallholders and food security

Despite tripling rice production over the past 40 years, food security in Bangladesh is challenged by population growth, climate change, scarce natural resources, vulnerability to price shocks, persistent poverty and malnutrition. Based on broad consultation, the 5-year Bangladesh Country Investment Plan (BCIP) sets out 12 priority investment programmes that, when implemented together, will improve food security and nutrition. The total cost will be USD 7.8 billion⁴⁸. Key elements include: (1) improving access to and tenure of land and water resources, (2) improving access to credit and other financial resources, (3) enabling private sector involvement, and (4) recognizing the key role of women in household food production. To measure progress against baselines, a set of target indicators were agreed, which included reducing the prevalence of Chronic Energy Deficiency among women from 32% in 2005 to 20% by 2015. With its focus on replication and scaling up successful innovations, the BCIP addresses the need for extension services, such as farmer field schools, to enable agricultural adaptation to climate change, as well as to build awareness of tools like the land and soil guide, Upazila Nirdeshika. The BCIP aims to more effectively target social safety net programmes that currently absorb 15% of the Bangladesh Government's annual budget (2.4% of gross domestic product), and particularly to ensure benefits reach women. The BCIP recognizes the need to improve farmers' access to markets, reduce pre- and postharvest losses, and to add value across whole food chains, including by working with the private sector in public-private partnerships.

⁴⁷ www.daff.gov.au/climatechange/australias-farming-future

⁴⁸ Government of the People's Republic of Bangladesh. 2011.

Brazil: Integrated approach to land use policy

National governments can stimulate sustainable food production by coordinating policies. In addition to successes in inclusive growth – a reduction in poverty from 20% of the population in 2004 to 7% in 2010 – Brazil has a set of complementary policies and programmes to reduce the environmental impact of agriculture. As the fifth highest greenhouse gas-emitting country in the world, 80% of Brazil's pledge under the Copenhagen Accord will be fulfilled by the agriculture and forestry sectors. These two sectors generate more than 70% of domestic emissions. To meet its target of reducing the rate of deforestation in the Amazon by 80% by 2015, Brazil has established ecological and economic zoning plans, as well as a satellite monitoring system to enable prompt action against illegal logging⁴⁹. Introduced in 2008, Brazil's National Climate Change Plan is credited with successfully reducing deforestation and making the shift to low-emission agriculture. Agroecological zoning laws for sugar cane and palm oil balance competing land uses and address multiple objectives in the agriculture, forest, water and energy sectors⁵⁰. Key policy documents, such as the National Plan, Sustainable Amazon Plan and National Water Resources Plan, prohibit cultivation of sugar cane in protected areas, the Amazon and Pantanal for example⁵¹. The Forest Code provides for maintaining forest cover on private property in rural areas. The Brazil Development Bank has also restructured its guidelines to make lending conditional on environmental protection measures which avoid deforestation, and land and water pollution.

China: Research, policies and pilot programmes promote agricultural adaptation and mitigation

In China, recent advances in agricultural productivity and poverty reduction have been built on a significant domestic agricultural research and development base. With roughly 10% annual increases since 2001, agricultural R&D spending equalled USD 1.8 billion in 2007 and shifted an estimated seven people out of poverty for every USD 1500 of investment⁵². National policies and pilot programmes also catalyse agricultural adaptation and mitigation⁵³. The Plan for the Construction of Protective Cultivation Projects will cover 2.7 million hectares in 2009-2015. In addition to enhancing soil resilience to drought, 1.7-2.5 billion cubic meters of irrigation water have been saved. By the end of 2009, 25.6% of Chinese grasslands had been closed to grazing, or had been fallowed or zoned for rotational grazing, while 1.6 million severely degraded hectares of grassland were reseeded⁵⁴. Strategies to improve rice yields while reducing greenhouse gas emissions have been promoted. These include encouraging farmers to grow low-emission and high-yield rice breeds, use intermittent irrigation methods and convert straw to a biomass feedstock for the

production of fuel, products and power. Subsidies for water-saving irrigation technologies, machinery and equipment, as well as for improving crop varieties and industrial systems, have been established. Under the Special Climate Change Fund, pilot projects to develop alternative water sources, adopt water-saving technology and adaptively manage irrigation and drainage have been launched in the Yellow, Huaihe and Haihe river basins, as well as in the Ningxia Hui Region. Successful strategies will be integrated into future national plans. National climate change targets for 2010, such as 15% non-fossil fuel sources for Chinese energy consumption and forest coverage of 40 million hectares, have been encouraged by subsidies, labelling and tax incentives.



A community in Ethiopia helps restore a watershed by planting trees.

Photo: Trees for the Future

Ethiopia: Complementary, predictable long-term response to food insecurity

Support to chronically food insecure populations can be designed to protect and create assets at the household and community level, as an alternative to annual emergency food appeals. In Ethiopia, the Productive Safety Net Program (PSNP) takes a development-oriented approach to food aid that creates an assured governmental safety net and greater predictability for smallholders⁵⁵. By combining international donor funding (over USD 1.27 billion over the last six years) with government supplied infrastructure, labour and inputs (USD 500,000 annually), the PSNP ensures food access, stimulates markets and rehabilitates natural resources⁵⁶. Chronically food insecure households with able-bodied adults receive transfers of cash and food for their participation in labour-intensive public works, while other households receive unconditional transfers. The public works initiatives improve soil quality, water supply, ecological condition, infrastructure and social services, as prioritised through a participatory watershed planning

⁴⁹ World Bank. 2011a.

⁵⁰ Meridian. 2011.

⁵¹ World Bank. 2011a.

⁵² Chen and Zhang. 2011.

⁵³ National Development and Reform Commission. 2009.

⁵⁴ Ibid.

⁵⁵ World Bank. 2010c.

⁵⁶ IFPRI. 2008.

approach . Now in its third phase and operational in 317 woredas (administrative districts), PSNP is reaching 7.7 million beneficiaries. The PSNP program is associated with a range of successes including graduation of approximately 1.3 million individuals from food insecurity, rehabilitation of 9 million hectares of land, growth in livestock holdings, better access to clean water, and increase in school attendance as well as enhancing the impact of other food security programs⁵⁷. Complementary programs address household asset building, community infrastructure development and resettlement. The World Food Program (WFP) and other partners have developed a unified stream of technical advice and a stakeholder platform provides oversight.

France: Public health messages promote healthy eating habits

Public policy can be used to change unhealthy eating habits. In France, concern about rising levels of childhood obesity and the influence of the fast food industry on consumption habits led the Government to target food advertising. In 2004, France passed public health legislation requiring advertisements for processed food and drink containing added sugar, salt or artificial sweeteners to include health information⁵⁸. Companies that did not include a public health message in advertisements were required to pay a levy of 1.5% of their advertising budget. The levies were channelled to the national institute for health prevention and education. A 2007 study confirmed the link between advertisements and children's eating habits, noting that 89% of all commercials during children's programmes were for products rich in sugar, fat or salt⁵⁹. The study also found that 57% of children did not notice the health messages – usually flashed as a thin band on the screen or as a notice displayed after the advertisement – in advertisements on television and in the cinema. In 2007, the legislation was amended to require health messages to emphasize eating fruits and vegetables, and avoid snacking and eating too many foods high in fat, sugar or salt.



Better food labels can promote positive changes in diets.

Photo: IJ Clark

⁵⁷ Ibid.

⁵⁸ Jolly. 2011.

⁵⁹ Que Choisir. 2007.



Rural women in India benefit from guaranteed national employment.

Photo: UNDP

India: National guaranteed employment bestows multiple benefits

Poverty alleviation programmes can also address environmental sustainability objectives, particularly when they involve locally appropriate, bottom-up planning. The Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), launched in 2006, now operates in every district in India. In 2010-2011, MGNREGA provided jobs for over 50 million rural households at a cost of USD 9.1 billion. MGNREGA entitles every adult to 100 days a year of minimum wage, unskilled manual employment on public works, such as water management, drought proofing, tree planting, land development and rural connectivity. Village-level government, the Gram Panchayat, proposes projects based on felt needs of local communities and MGNREGA priorities. Over 80% of the projects have contributed to rejuvenating the natural resource base in some way. MGNREGA jobs deliver local environmental services, such as recharging groundwater, enhancing soil fertility and increasing biomass which, in turn, contribute to climate change resilience and mitigation, as well as conserving biodiversity. The right to employment and flexible access to the scheme help small-scale farmers and landless rural households to manage risk. MGNREGA specifies that at least one-third of workers should be women. Flexible working hours that accommodate women's unpaid work and the mandatory presence of women in Gram Panchayat committees mean that women provide more than 50% of the MGNREGA workforce⁶⁰.

Kenya: Improving smallholders' market access and production efficiency

Poverty among smallholder dairy producers results, in part, from poor access to markets and degradation of grasslands. More efficient production and more opportunities to market their produce can boost smallholders' resilience and create sustainable livelihoods while helping to meet growing demand for food. The East Africa Dairy Development Project (EADD) is a regional industry

⁶⁰ Mahapatra. 2010.



Better systems for collecting and storing milk can help smallholder dairy farmers access markets and boost income.

Photo: Gates Foundation

development programme implemented in Kenya, Uganda and Rwanda by Heifer International and a consortium of partners that includes the International Livestock Research Institute, the World Agroforestry Centre, Heifer International, TechnoServe and Nestlé⁶¹. Funded by the Bill and Melinda Gates Foundation, the project enhances services and training to boost farm yields and the incomes of millions of smallholders in East Africa. The project, modelled on the 'hub' concept, increases access to markets and reduces postharvest losses. Twenty-seven collection hubs to store and chill milk are being developed. These will be managed by new business associations. Smallholders will receive training in business and production, such as improved breeding technologies and animal nutrition practices to improve the quality of milk.

Mexico: Index-based insurance spurs investment in sustainable agriculture

Extreme weather (for example, droughts, floods and heat waves) can not only trigger crises and cause hardship in farming families, but can also inhibit investment in agriculture. Farmers are reluctant to invest in their enterprises in the face of uncertainty and risk. Index-based insurance automatically pays out to farmers when the weather exceeds an established level. There is no need for insurers to make site visits⁶². Making sure farmers receive insurance payments quickly can minimize distress sales of assets. Index-based insurance also boosts risk tolerance among farmers, banks, microfinance lenders and agricultural industries. In Mexico, risk insurance products are well-developed, especially those targeting

smaller-scale farmers. In 2010, the public insurance agency, Aseguradora Nacional de la Agricultura y Ganadería (ANAGSA), provided traditional and index-based insurance covering more than 8 million hectares – half of the area sown with annual crops and mostly rainfed maize⁶³. Farmers who borrow land from the Government, known as ejidatarios, pay much lower premiums than other farmers. Only non-irrigated major crops are eligible⁶⁴. Index-based insurance to safeguard the livelihoods and assets of poor producers, such as that provided by ANAGSA, usually needs to be subsidised and requires special delivery channels. Schemes to help viable farm businesses manage risk are usually provided by the private sector⁶⁵.

Southern Africa: Land tenure reform to empower women farmers

Although women in low-income countries play a significant role in food production, they often do not have clear rights to land. This can inhibit their ability to access credit, improve their yields and economic status, or take up sustainable agricultural methods. Since 2009, the Women and Land Rights Project has been implemented by Action Aid in the five southern African countries of Malawi, Mozambique, South Africa, Zambia, and Zimbabwe⁶⁶. In South Africa, post-apartheid land reform policies and land-related programmes, such as the Settlement/Land Acquisition Grant and the Land Acquisition and Redistribution Programme, present an opportunity for women farmers to establish their rights to own, reside on and cultivate land. However, women encounter obstacles. For example, they may be barred from participating in local decision-making systems affecting land or there may be gender inequities concerning the rights of survivors to land. Several non-government organizations (NGOs), such as the Legal Resources Centre and the Association for Rural Advancement, provide legal assistance to advance women's land rights and challenge laws that disadvantage women. In Eastern Cape and KwaZulu Natal, NGOs have been specifically addressing land issues affecting women through education and leadership development.

United Kingdom: Reducing emissions and waste in food chains

Efforts to improve the environmental footprint of food systems can mobilize public-private partnerships. The Climate Change Act of 2008 commits the United Kingdom to an 80% economy-wide reduction in greenhouse gas emissions from 1990 levels by 2050. The agriculture industry's ambitious Greenhouse Gas Action Plan (GHGAP) aims to reduce annual emissions by 3 million tonnes CO₂-equivalent by 2018-2022 through strategic delivery of messages, technical advice and information to agricultural producers in all farming systems⁶⁷. GHGAP builds on existing initiatives (for example, the Dairy Roadmap) and brings together whole supply chains, to encourage adoption of farm practices that are more efficient and reduce greenhouse gas emissions while enabling cost

⁶¹ www.eadairy.wordpress.com

⁶² Barrett et al. 2007.

⁶³ Hazell et al. 1986.

⁶⁴ Fuchs and Wolff. 2011.

⁶⁵ Hess and Hazell. 2009.

⁶⁶ Kachika. 2009.

⁶⁷ GHG emissions - agriculture's action plan. www.nfuonline.com/ghgap/

savings per unit of production and enhancing landscapes and biodiversity. Another UK initiative, the Waste Resources and Action Programme (WRAP) works with businesses, individuals and communities to reduce food waste. Household food and drink waste represents £12 billion in lost value and 20 million tonnes of CO₂-equivalent in emissions each year⁶⁸. Research by WRAP focuses on ways to cut down the amount of food thrown away by consumers and covers consumer habits, attitudes and behaviours, appropriate ways of communicating to priority audiences and retail innovation. In partnership with WRAP, the grocery sector has made changes to make it easier for consumers to buy the right amount of food, and to optimize freshness and value, as well as to implement large-scale consumer-facing campaigns (for example, Love Food Hate Waste). As a result, 670 000 tonnes of food waste have been diverted from landfills, saving £600 million a year⁶⁹.

United States: Standard certification informs consumer choices

National governments play a key role in certifying and enforcing food standards and labelling to ensure that consumers receive accurate information about the way agricultural products are grown and processed, their nutritional value and their environmental impact. From 1990 to 2010, sales of organic products in the United States grew from USD 1 billion to nearly USD 27 billion⁷⁰. This made certification to verify the claims of organic producers essential. Organic labelling rules introduced by the United States Department of Agriculture (USDA) require that organic products, whether produced in the US or abroad, meet established standards. These standards include assurance that organic products are produced



A small scale farmer harvests organic greens, Virginia, USA.

Photo: L Cheung (USDA)

without antibiotics, pesticides, hormones or bioengineering, and that they adhere to criteria for soil and water conservation as well as animal welfare. Products must be certified as 95% or more organic to display the voluntary USDA organic sticker, or 70% or more organic to be labelled 'made with organic ingredients'⁷¹. Individuals or companies that sell products with organic labels but do not meet USDA standards can be fined up to USD 10 000 for each violation. Cumbersome certification processes can exclude small-scale organic farmers so USDA certification exempts producers with less than USD 5000 in organic sales (for example, farmers selling limited quantities at farmer's markets).

Viet Nam: Upscaling techniques to deliver higher yields and climate benefits

Agricultural sustainability hinges on development and uptake of farming techniques that simultaneously deliver robust yields and incomes, climate resilience and greenhouse gas mitigation. With a projected 12-14% decline in global rice production by 2050 due to climate change⁷², Integrated Crop Management (ICM) helps farmers to boost production while adapting to climatic changes and resource scarcity. Developed to benefit smallholder farmers, ICM reduces requirements for inputs and labour. In the ICM method, Alternative Wetting and Drying (AWD) and balanced fertilization on paddy fields lowers methane and nitrous dioxide compared to continuous flooding⁷³. There is less need for fertilizers and other inputs and so indirect greenhouse gas emissions are minimized. Yield increases are attributed, in part, to more vigorous root systems, and better resilience to biotic and abiotic stresses. In Viet Nam, the ICM programme began in 2002 and, by 2004, already engaged 103,000 farmers in 13 provinces (i.e. 15% of the Mekong Delta area with two rice crops per year). Compared to control sites, these farms saw higher grain yields and significantly reduced use of nitrogen fertilizer, seeds, water and pesticides, leading to considerably lower production costs and higher profits. A recent survey shows that Vietnamese farmers are implementing ICM on more than 1 million hectares. The System of Rice Intensification (SRI) has shown positive results in Viet Nam as an ICM alternative method. Oxfam-funded field trials, demonstrations and dissemination, have mobilized farmers to act as local extension agents, and helped to bring SRI to 21 provinces. A 2008 review found 11% higher average SRI yields, 16% lower urea fertiliser use, 45% less frequent pesticide application, 35% reduction in average irrigation expenses, and 50% increases in income⁷⁴.

⁷¹ USDA. 2011.

⁷² Nelson et al. 2009.

⁷³ Nguyen et al. 2007.

⁷⁴ Africare, Oxfam America, WWF-ICRISAT Project.

⁶⁸ WRAP. 2011. www.wrap.org.uk

⁶⁹ Ibid.

⁷⁰ Organic Trade Association. www.ota.com

References

- Africare, Oxfam America, WWF-ICRISAT Project. 2010. More Rice for People: More Water for the Planet, System of Rice Intensification (SRI). Hyderabad, India: WWF-ICRISAT Project.
- Bai ZG, Dent DL, Olsson L, Schaepman ME. 2008. Global assessment of land degradation and improvement identification by remote sensing. Wageningen: International Soil Reference and Information Centre (ISRIC).
- Barrett CB, Barnett BJ, Carter MR, Chantarat S, Hansen JW, Mude AG, Osgood D, Skees JR, Turvey CG, Ward MN. 2007. Poverty traps and climate risk: limitations and opportunities of index-based risk financing. IRI Technical Report No. 07-02. Columbia University: International Research Institute for Climate and Society.
- Bruinsma J. 2009. The resource outlook to 2050: by how much do land, water and crop yields need to increase by 2050? Expert Meeting on How to Feed the World in 2050. Rome, FAO.
- Cabinet Office. 2008. Food Matters: A strategy for the 21st century. London: Cabinet Office.
- Chen KZ, Zhang T. 2011. Foresight Project on Global Food and Farming Futures. Regional case study R2: agricultural R&D as an engine of productivity growth: China. www.bis.gov.uk/assets/bispartners/foresight/docs/food-and-farming/regional/11-591-r2-agricultural-r-and-d-productivity-growth-china.pdf. Conversion at interbank rates of 15 June 2007 at www.oanda.com.
- Choudhury M. L. 2006. Recent developments in reducing post-harvest losses in the Asia-Pacific region. In Reports of the APO Seminar on Reduction of Postharvest Losses of Fruit and Vegetables, October 2004 (ed. R. S. Rolle), pp. 5-11. Tokyo, Japan: FAO, Asian Productivity Organization (APO).
- Cline WR. 2007. Global Warming and Agriculture: Impact Estimates by Country. Washington DC, USA: Peterson Institute. <http://maps.grida.no/go/graphic/projected-agriculture-in-2080-due-to-climate-change>
- Etilé F. 2010. Food Consumption and Health. In J. Lusk, J. Roosen and J. Shogren (editors), Oxford Handbook of the Economics of Food and Agricultural Policy. Oxford, UK: Oxford University Press.
- FAO. 2011a. The State of the Food Insecurity in the World: How does international price volatility affect domestic economies and food security? Rome, Italy: Food and Agriculture Organization of the United Nations.
- FAO. 2011b. State of the World's Forests. Rome, Italy: Food and Agriculture Organization of the United Nations.
- FAO. 2010. The state of food insecurity in the world: addressing food insecurity in protracted crises. www.fao.org/docrep/013/i1683e/i1683e.pdf.
- FAO 2009. The State of Agricultural Commodity Markets. High food prices and the food crisis - experiences and lessons learned. Food and Agriculture Organization of the United Nations. Rome. March 2009.
- FAO Country Profiles. China: Food Safety and Security. <http://www.fao.org/countryprofiles/index.asp?lang=en&iso3=CHN&paia=2>
- FAO Country Profiles. France: Food Safety and Security. http://www.fao.org/fileadmin/templates/ess/documents/food_security_statistics/country_profiles/eng/France_E.pdf
- FAO Country Profiles. South Africa: Food Safety and Security. <http://www.fao.org/countryprofiles/index.asp?lang=en&iso3=ZAF&paia=2>
- FAO Stat. Mexico. <http://faostat.fao.org/site/666/default.aspx>
- Foley et al. 2011. Solutions for a cultivated planet. *Nature* 478, 337-342.
- Foresight. The Future of Food and Farming. 2011. Final Project Report. Futures. London, UK: Government Office for Science.
- Foresight. Migration and Global Environmental Change: Future Challenges and Opportunities. 2011. Final Project Report. Futures. London, UK: Government Office for Science.
- Foresight. Tackling Obesities: Future Choices. 2007. Project Report. London: UK: Government Office for Science. Department for Business, Innovation and Skills.
- Fuchs A, Wolff H. 2011. Concept and unintended consequences of weather index insurance: the case of Mexico. *American Journal of Agricultural Economics* 93(2): 505-511.
- Government of the People's Republic of Bangladesh. 2011. Bangladesh Country Investment Plan: a road map towards investment in agriculture, food security and nutrition. Updated Version June 2011. www.nfpcsp.org/agridrupal/sites/default/files/Bangladesh%20Food%20security%20CIP%202011%20Final.pdf
- Gustavsson et al. 2011. Global Food Losses and Food Waste. Rome, Italy: Food and Agriculture Organization of the United Nations. www.fao.org/fileadmin/user_upload/ags/publications/GFL_web.pdf.
- Haslam DW and James WPT. 2005. Obesity. *Lancet*, 366, 1197-1209.
- Hazell PBR, Pomerada C, Valdes A, eds. 1986. Crop Insurance for agricultural development: issues and experience. Washington DC: International Food Policy Research Institute.
- Hess U, Hazell P. 2009. Innovations in insuring the poor. Sustainability and scalability of index-based insurance for agriculture and rural livelihoods. 2020 Vision. Focus 17. Brief 5. Washington DC: International Food Policy Research Institute.
- HMG. 2010. The 2007/2008 Agricultural Price Spikes: Causes and Policy Implications. London: HM Government.
- IFAD. 2011. Rural Poverty Report: New realities, new challenges: new opportunities for tomorrow's generation. Rome, Italy: International Fund for Agricultural Development.
- IFPRI, 2008. Gilligan DO, Hoddinott J, Kumar NR, Taffesse AS. An Impact Evaluation of Ethiopia's Productive Safety Nets Program. International Food Policy Research Institute, 2033 K Street, NW, Washington, D.C. 20006. 74p.
- INRA / CIRAD. 2011. Agrimonde: Scenarios and Challenges for Feeding the World in 2050. Versailles, France: Editions Quae.
- International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD). 2009. Agriculture at a crossroads: A synthesis of the global and sub-global IAASTD reports, eds. B.D. McIntyre, H.R. Herren, J. Wakhungu, and R.T. Watson. Washington, D.C.: Island Press.
- Jolly R, 2011. Junk food, advertising and kids. Research Paper No. 9 2010-11. Parliament of Australia Parliamentary Library. www.aph.gov.au/library/pubs/rp/2010-11/11rp09.htm#_Toc282609530
- Kachika T. 2009. Women's land rights in Southern Africa. South Africa: Niza and ActionAid International. www.niza.nl/documenten/100129_womens_land_rights.pdf
- GHG emissions - agriculture's action plan. www.nfuonline.com/ghgap/
- Laborte AG, de Bie K, Smaling EMA, Moya PF, Boling AA, Van Ittersum MK. 2011. Rice yields and yield gaps in Southeast Asia: Past trends and future outlook. *Europ. J. Agronomy* 36 (2012) 9
- Lipper L, Mann W, Meybeck A, and Sessa R. 2010. "Climate-Smart" Agriculture: Policies, Practices and Financing for Food Security, Adaptation and Mitigation. Rome, Italy: UN Food and Agriculture Organization.
- Mahapatra R. 2010. MGNREGA: making way for women's empowerment. www.southasia.oneworld.net/fromthegrassroots/mgnrega-paving-way-for-women-empowerment
- Meridian. 2011. Addressing agriculture in climate change negotiations: a scoping report. Colorado and Washington DC: Meridian Institute.
- Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well-being. Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well-being: Synthesis. Washington, DC: Island Press.
- Mittal S. 2007. Strengthening backward and forward linkages in horticulture: some successful initiatives. *Agric. Econ. Res. Rev.* 20, 457-469.
- Munich RE Geo Risks Research NatCatSERVICE. Natural catastrophes worldwide 2010. http://www.munichre.com/en/reinsurance/business/non-life/georisks/natcatservice/annual_statistics.aspx
- National Academy of Sciences. 2010. Toward Sustainable Agricultural Systems in the 21st Century. Washington, DC: The National Academies Press.
- National Development and Reform Commission. 2009. China's policies and actions for addressing climate change -The Progress Report 2009. China: National Development and Reform Commission. www.ccchina.gov.cn/WebSite/CCChina/UpFile/File571.pdf
- Nelson GC, Rosegrant MW, Palazzo A, Gray I, Ingersoll C, Robertson R, Tokgoz S, Zhu T, Sulser TB, Ringler C, Msangi S, and You L. 2011. Climate change: Impact on Agriculture and Costs of Adaptation and Food Security, Farming, and Climate Change to 2050. Washington, DC: International Food Policy Research Institute.
- Nelson GC, Rosegrant MW, Koo J, Robertson R, Sulser T, Zhu T, Ringler C, Msangi S, Palazzo A, Batka M, Magalhaes M, Valmonte-Santos R, Ewing M, Lee D. 2009. Climate change: impact on agriculture and costs of adaptation. Washington DC: International Food Policy Research Institute.
- Nguyen VT, Nguyen QT, Nguyen VA. 2007. Influence of on farm water management to the methane emissions in the Red River Delta Area - Vietnam. Vietnam National Commission on Large Dams.
- Parry M, Evans A, Rosegrant MW, and Wheeler T. 2009. Climate Change and Hunger: Responding to the Challenge. Rome, Italy: World Food Program.
- Prosser IP (Ed.) 2011. Water: science and solutions for Australia. CSIRO Publishing, Australia. 178pp.
- Que Choisir. 2007. Obésité et publicités télévisées, quelles mesures de protection pour les enfants? Dossier. Paris: UFC-Que Choisir. www.quechoisir.org/alimentation/nutrition/etude-obesite-et-publicites-televees-queelles-mesures-de-protection-pour-les-enfants
- Reardon T, Timmer CP, Barrett CB & Berdegue J. 2003. The Rise in Supermarkets in Africa, Asia, and Latin America. *American Journal of Agricultural Economics* 85: 1140-46.
- Royal Society. 2009. Reaping the Benefits: Science and the Sustainable Intensification of Global Agriculture. London, UK: The Royal Society.
- The Hague Conference on Agriculture, Food Security and Climate Change. 2010. Chair's Summary.
- United Nations Convention to Combat Desertification. 2011. Desertification: A visual synthesis. Bonn, Germany: UNCCD Secretariat. www.unccd.int/knowledge/docs/Desertification-EN.pdf

- United Nations Population Division. 2010. World population prospects: the 2010 revision. New York: United Nations Department of Economic and Social Affairs United Nations Population Division.
http://esa.un.org/wpp/unpp/panel_population.htm
- USDA. 2011. What does the "Organic" label really mean? US Department of Agriculture (USDA) and the Food and Drug Administration (FDA). <http://usda-fda.com/articles/organic.htm>
- Vermeulen SJ, Aggarwal PK, Ainslie A, Angelone C, Campbell BM, Challinor AJ, Hansen J, Ingram JSI, Jarvis A, Kristjansson P, Lau C, Thornton PK and Wollenberg E. 2010. Agriculture, Food Security and Climate Change: Outlook for Knowledge, Tools and Action. CCAFS Report 3. Copenhagen, Denmark: CGIAR-ESSP Program on Climate Change, Agriculture and Food Security.
- WHO/ FAO. 2003. Diet, Nutrition and the Prevention of Chronic Diseases. Geneva: WHO.
- World Bank. 2011a. Climate-smart agriculture: increased productivity and food security, enhancing resilience and reduced carbon emissions for sustainable development, opportunities and challenges for a converging agenda: country examples. Washington DC: The World Bank.
- World Bank. 2011b. Food Price Watch.
http://siteresources.worldbank.org/INTPOVERTY/Resources/335642-1210859591030/FPW_April2011.pdf
- World Bank. 2010a The Hague Conference on Agriculture, Food Security and Climate Change Opportunities and Challenges for a Converging Agenda: Country Examples. Conference Edition.
- World Bank. 2010b. World Development Report, 2010: Development and Climate Change. Washington, DC: The World Bank.
- World Bank, 2010c. Designing and implementing a rural safety net in a low income setting: Lessons learned from Ethiopia's Productive Safety Net Program 2005-2009. Independent Evaluation Group of the World Bank's assistance to social safety net. 168p.
- World Bank. 2008. World Development Report, 2008: Development and Agriculture. Washington, DC: The World Bank.
- World Health Organization. 2011. Obesity and overweight. Fact sheet No. 311.
www.who.int/mediacentre/factsheets/fs311/en/
- Worldwatch Institute. 2011. State of the World: Innovations that Nourish the Planet. New York, NY USA: W.W. Norton & Company.
- WRAP 2008. The Food We Waste, Banbury, Waste and Resources Action Programme.



Photo: N. Palmer (CIAT).

Achieving food security in the face of climate change

Summary for policy makers

The Commission on Sustainable Agriculture and Climate Change was established by the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) with support from the Global Donor Platform for Rural Development (GDPRD) to produce a clear and authoritative set of policy recommendations. The Commission brings together senior natural and social scientists working in agriculture, climate, food and nutrition, economics, and natural resources in governmental, academic and civil society institutions in Australia, Brazil, Bangladesh, China, Ethiopia, France, Kenya, India, Mexico, South Africa, the United Kingdom, the United States and Vietnam. During 2011, the Commissioners undertook a synthesis of major assessment reports to clearly articulate scientific findings on the potential impact of climate change on agriculture and food security globally and regionally and to identify the most appropriate actions and pathways to achieve food security in the context of climate change.

Key Recommendations:

1. Integrate food security and sustainable agriculture into global and national policies
2. Significantly raise the level of global investment in sustainable agriculture and food systems in the next decade
3. Sustainably intensify agricultural production while reducing greenhouse gas emissions and other negative environmental impacts of agriculture
4. Target populations and sectors that are most vulnerable to climate change and food insecurity
5. Reshape food access and consumption patterns to ensure basic nutritional needs are met and to foster healthy and sustainable eating habits worldwide
6. Reduce loss and waste in food systems, particularly from infrastructure, farming practices, processing, distribution and household habits
7. Create comprehensive, shared, integrated information systems that encompass human and ecological dimensions

This summary for policy makers is complemented by a detailed report of findings and recommendations, and background documents.

For more information visit

www.ccafs.cgiar.org/commission