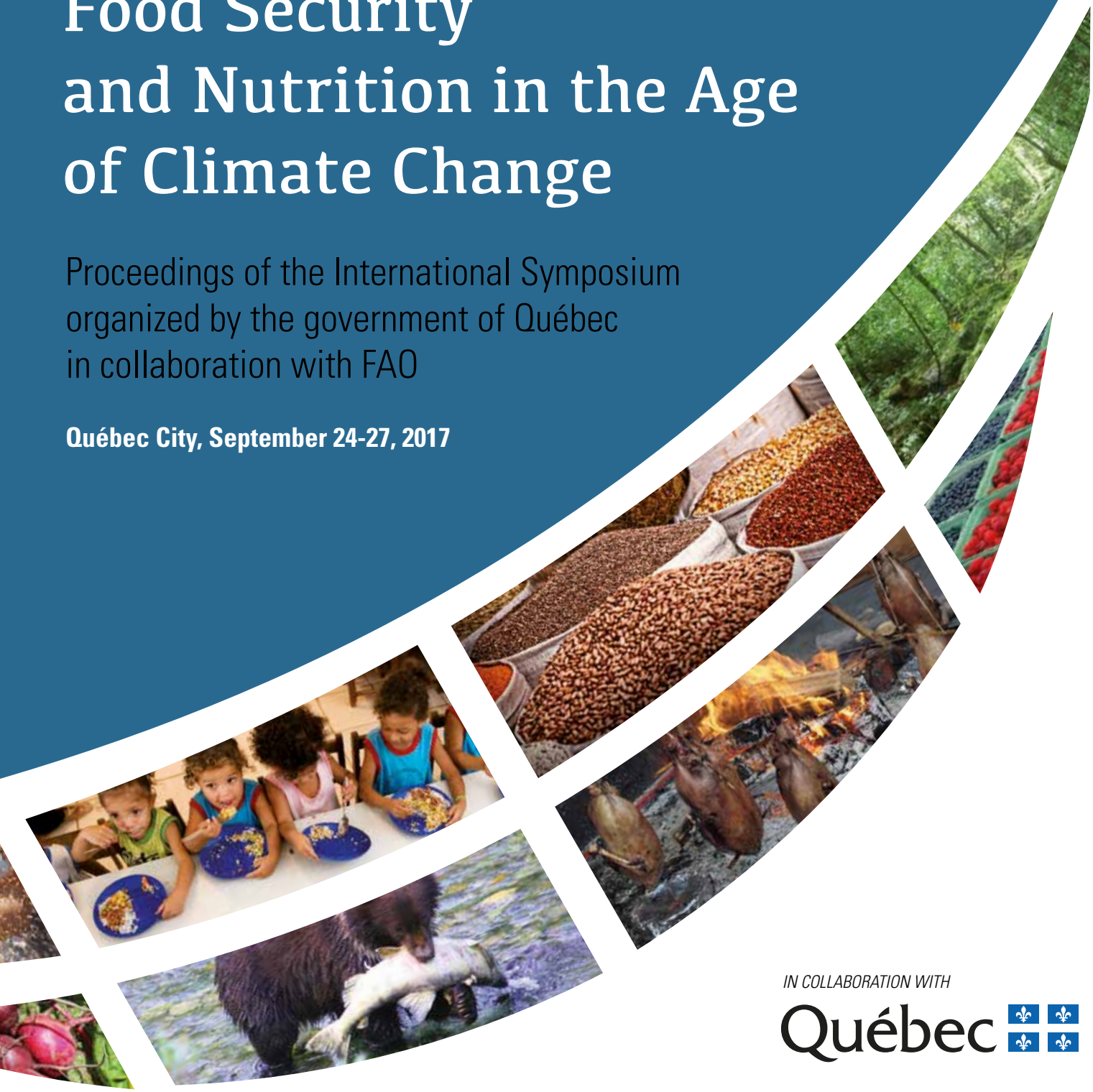
Food and Agriculture Organization
of the United Nations

Food Security and Nutrition in the Age of Climate Change

Proceedings of the International Symposium organized by the government of Québec in collaboration with FAO

Québec City, September 24-27, 2017



IN COLLABORATION WITH

Québec

Food Security and Nutrition in the Age of Climate Change

PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ORGANIZED BY THE GOVERNMENT OF QUÉBEC IN COLLABORATION WITH FAO

Québec City, September 24-27, 2017

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Executive summary

Thanks to the participation of 250 experts from all around the world, the International Symposium on Food Security and Nutrition in the Age of Climate Change (hereafter "Symposium") highlighted the importance of food and agricultural systems in the fight against climate change and presented concrete multi-sector solutions to address this global issue. As noted during the Opening Conference under the auspices of FAO, after steadily declining for over a decade, global hunger is on the rise again, while various forms of malnutrition coexist: two billion people suffer from micronutrient deficiencies; 815 million are in a state of caloric deficit; nearly one in four children suffers from chronic malnutrition; 52 million children suffer from acute malnutrition; and two billion adults are overweight. Climate change is already exacerbating this grim picture, which is why food security and food production will be a major focus of the Intergovernmental Panel on Climate Change's 6th Assessment Cycle. The Opening Conference thus set the tone for the four days of discussions that followed by providing an overview of the importance and complexity of the links between climate change, agricultural production (taken here to mean crops, livestock, forestry, fisheries, and aquaculture), food security, and nutrition. The Symposium placed special emphasis on the regional realities of West Africa and the Canadian North, as well as to the presence of young people and members of Indigenous and Northern communities directly affected by these issues.

The summaries of these four days of plenaries, interactive workshops, and special events have been grouped under seven major themes for this publication: 1) Climate change, food security and nutrition: the issues; (2) The agriculture sectors in the context of climate change; (3) Food systems in the face of climate change; (4) Natural resources: challenges and solutions; (5) Food security and nutrition in a changing North; (6) Summary of solutions; (7) Strengthening and adapting regional and international cooperation.

CLIMATE CHANGE, FOOD SECURITY AND NUTRITION: THE ISSUES

The effects of climate change on food security and nutrition

All regions of the world are experiencing, and will continue to experience, the effects of climate change with varying magnitude and consequences. Climate change is already affecting the four dimensions of food security (i.e., the physical availability of food, its economic and physical accessibility, its use, and the stability of these three dimensions over time), and its implications extend across all determinants of malnutrition. Moreover, from the outset, accounts presented at the Symposium revealed several analogies between situations that initially appear to be very different, and also underscored the essential lessons that can be learned from practices that have been adopted in different territories to mitigate climate change. For example, the food security and nutrition problems encountered by Small Island Developing States (SIDS) appeared in many ways comparable to those being experienced in the Canadian North.

Climate change, nutrition and health

Climate change exacerbates the multiple burdens of malnutrition as a result of its effects on food security, public hygiene, water supplies and quality, food safety, and maternal and child health care. The most vulnerable are, and will continue to be, the most affected: those who depend on natural resources, as well as women and children. Working on the barriers that limit access to a healthy and diversified diet thus involves not only considering the food system as a whole, but also the health, social protection, risk management, and agricultural extension systems. Strategies aimed at reducing climate change and its impacts exhibit synergies with interventions targeting improved food and human health. However, consistency in policies is needed.

Climate change, conflicts and food insecurity

Conflicts can increase the risks of food insecurity and malnutrition due to the damage they cause to agricultural land and food systems, crop and livestock looting, and the resulting loss of assets and revenue for local populations. The consequences of climate change, such as natural disasters and the disruption of ecosystems, hinder food production and food systems. Access to sufficient quantities of quality food is consequently hampered in several parts of the world. This can aggravate existing social tensions and sometimes even cause massive displacements of populations deprived of water and food, thereby increasing the risk of an open conflict. It is however important to note that because conflicts are characterized by their complexity and the multitude of causes that spark them, it is impossible to establish a linear causal relationship between climate change, food insecurity, and conflict.

THE AGRICULTURE SECTORS IN THE CONTEXT OF CLIMATE CHANGE

Focus on the agriculture sectors: combining climate change mitigation and adaptation

The agricultural sectors are the first to be affected by climate change. The resulting economic and social consequences are particularly discernable among the poorest households, the majority of which depend on agricultural activities. At the same time, the agricultural sectors themselves contribute to climate change and can thus be part of the solution by reducing their greenhouse gas emissions and increasing soil and biomass carbon sinks. In order to achieve this, producers must be positioned at the heart of the solutions, and their access to training, guidance, and investments must be facilitated. Implementing the Nationally Determined Contributions (NDCs) and establishing National Adaptation Plans (NAPs) constitute an opportunity for governments to take action for the mitigation of, and adaptation to, climate change.

Livestock farming: possible solutions

Climate change has multiple direct and indirect effects on animal production, while livestock farming represents an important agricultural sector for livelihoods, food security, and the nutritional status of rural households. As the sector significantly contributes to climate change, it also offers great potential for offering solutions in terms of both adapting to climate change and reducing the intensity of GHG emissions per kilogram of product. These solutions are generally well documented, but the barriers impeding their implementation, which often stem from a lack of human and financial resources, are complex and diverse. A systemic approach, rooted in specific contexts and based on a rigorous analysis of the environment, is essential.

Forests, climate change and food security: bridging the gap between agriculture and forestry

A paradigm shift is needed with respect to the role played by forests, forestry practices, and agricultural practices. Indeed, while agriculture is the main cause of deforestation, forests and trees are essential to food security. They provide diversified foods rich in micronutrients to populations that depend on them and constitute a significant source of income for the most vulnerable populations. They also supply the energy needed to cook food for a third of the world's population. Because of the multiple functions they perform, including among other ensuring soil fertility, carbon storage, water regulation (both quantity and quality) and helping to prevent erosion, forests and trees are indispensable for ecosystems and agricultural systems to function properly. Combining technical knowledge with innovations and traditional practices, facilitating financial support for local producers, and transferring knowledge to current and future generations are approaches that deserve special attention. Given that agroforestry strengthens resilience to climate change, it can also be seen as an example of an agricultural model that should be fostered to ensure food security in the future.

FOOD SYSTEMS IN THE FACE OF CLIMATE CHANGE

Food systems in the face of climate change

Food systems are many and varied. Like agriculture, they will have to reconcile adaptation and mitigation goals. In order for this to happen and to preserve the environment and ensure food and nutritional security for all, there needs to be a transition based on sustainable development principles. Diversified agroecology, whose benefits for productivity, the environment, and society are both simultaneous and mutually reinforcing, offers part of the solutions to the challenges at hand. Additional examples of existing means include production, conservation, and processing techniques that are consistent with an ever-growing demand for more sustainable production; legal instruments that ensure food diversity and security; and local and regional markets that are adapted to the diversity of food systems. Defined as a "set of agri-food supply chains that meet the criteria of sustainable development, located in a geographic area of regional size, and coordinated by territorial governance," territorialized food systems (TFSs), or local food systems, are inherently more resilient and provide greater food diversity. Their worldwide development, promotion, and protection have a key role to play in achieving greater food security.

The role of women in West Africa's food systems

In West Africa, women play a pivotal role in feeding their families and communities, as they engage in producing and processing food as well as in preparing meals. Food and nutrition security and resilience to climate change in agricultural sectors therefore depend largely on women. However, for cultural, religious, or other reasons, women do not always possess the necessary means to successfully carry out these tasks. For example, their access to land and financial resources is often limited. Consequently, it is important to focus efforts on the economic empowerment of women in order to strengthen their capacity to adapt their practices to the challenges posed by climate change. Similarly, it is essential to ensure the active participation of women in decision-making and in establishing agricultural sector policies and programs, whether at the local, national, or international level, so that their needs are taken into account and everyone can benefit from the positive impacts.

Feeding cities

Issues related to agriculture and food security are now no longer limited to rural areas. Cities also play a central role in the understanding and search for solutions to respond to the challenges linked to providing quality food in sufficient quantity while preserving the environment. There are numerous initiatives to foster the implementation of sustainable food systems, defined as territorial collaborative networks that integrate the stakeholders involved into the entire food life cycle in order to enhance a collectivity's environmental, economic, and social health. Urban and peri-urban agriculture, the purchase and consumption of local seasonal products by individuals and businesses, and the fight against waste are but a few examples. Implementing urban agricultural policies, enhancing infrastructure to facilitate a diversified supply, as well as improving the food offer in municipal facilities and popular businesses are other ways to ensure a better availability of quality food products in cities. These public decisions need to be rooted in a structured, forward-looking approach to ensure long-term benefits.

NATURAL RESOURCES: CHALLENGES AND SOLUTIONS

The preservation of natural resources and genetic material: a key element in the fight against climate change

Producing healthy and nutritious food in a sustainable way to meet the needs of a growing world population is one of the major challenges of our time. To achieve this, we must transition to diversified agroecological systems that allow for greater resilience

to climate change and the sustainable management of natural resources. Maintaining biodiversity for food and agriculture is indispensable for adapting to climate change. At the same time, climate change, the overexploitation of natural resources, and other change-inducing factors caused by human activities negatively impact biodiversity. Encouraging the conservation of genetic resources ex situ as well as in situ, especially on farms, is therefore essential. We must also recognize the contribution of indigenous genetic resources, ensure their protection, and put into practice traditional knowledge. Similarly, fostering territorial and local agricultural and food systems as a strategy to conserve genetic resources, and supporting the contribution of underutilized and neglected species can help ensure the maintenance of biological diversity.

Diversity as an adaptation and mitigation strategy

One of the key roles of biodiversity is to build resilience into agriculture, while contributing to climate change mitigation. By adopting certain practices, such as those associated with agroecology and regenerative agriculture, it is possible to mitigate environmental degradation, foster the maintenance of biodiversity, and thereby contribute to climate change adaptation and mitigation. Biodiversity plays a vital role in improving the resilience of agricultural sectors to climate change because it reduces vulnerability to changes and natural disasters. Moreover, biodiversity and the services that ecosystems provide help ensure nutritional diversity, increased productivity and adaptability, in addition to the long-term viability and profitability of food production. In this way, they can reduce the risks posed to food security and nutrition.

Water and food security in an era of climate change

While water resources are already scarce in some parts of the world, climate change is expected to increase pressure on existing resources in the years to come. Crop and livestock production, which involve particularly high water requirements, are especially at risk of being affected by rising temperatures, the greater frequency and length of droughts, and increasingly erratic precipitation. Irrigation is part of the solution, but it also contributes to the problem because it requires withdrawing large amounts of water. In view of these circumstances, some of the greatest challenges facing decision-makers involve the uncertainty surrounding the spatial-temporal impacts of climate change and the need to coordinate various levels of water governance. Adopting new water management techniques and climate-smart agriculture practices will help crop and livestock farmers adapt to the new conditions resulting from climate change while at the same time maintaining their production level. Areas that currently benefit from significant water resources, like Québec, must not be overlooked when implementing such initiatives.

FOOD SECURITY AND NUTRITION IN A CHANGING NORTH

Increasing food security resilience in a changing North

Indigenous and northern communities in Canada are facing major changes in their territories. These changes are endangering their traditional knowledge and food practices that are essential to their physical and psychological health. As the Canadian North is one of the first victims of the upheavals of climate change, these challenges come in addition to the need to increase the resilience of food systems in a context where "we can no longer predict." Since ecosystems play a crucial role in the Inuit diet, climate change makes it difficult to apply the traditional knowledge that is essential to hunting, fishing and gathering activities. In the context of climate change, the food security of the Inuit therefore requires continuous and sustainable access to the territory and biodiversity that ensure the vitality of their local food systems in the long term.

Innovative solutions to ensure food security and nutrition in the North

In an environment in constant change, it is essential to strengthen interchanges between ancestral knowledge, community knowledge, and scientific knowledge. As a result, collective solutions have emerged, such as community freezers and, more recently, community greenhouses. These social innovations seek to meet the requisite of being both grounded in traditional knowledge and local needs, while being flexible enough to foster the resilience of Inuit and Indigenous food economies. Technological innovations are also being implemented, such as geodesic domes, which create conditions favourable to producing fresh local products. In addition to these initiatives, best practices are shared for producing, preserving and preparing healthy foods, in collaboration with research institutions, schools, local governments, etc.

Summary of solutions

Food security, climate change, and malnutrition can no longer be addressed independently of one another. This was demonstrated over the Symposium's four days of discussions that broke down the barriers that traditionally compartmentalize the agricultural, environmental, and health sectors. A holistic analysis of the food and nutrition issue in the age of climate change is imperative and opens the way to concrete solutions. Special attention should also be given to representatives of Indigenous communities from here and beyond, North and South. A paradigm change is needed to ensure food security and nutrition in the age of climate change. It is important to return to solutions built on ancestral and local knowledge and tap into them. Conserving and utilizing indigenous genetic resources is essential to agricultural diversity, which continues to be the best defence against climate change. This diversity must also be found in food systems, notably through the inclusion of territorialized and sustainable food systems that ensure the implementation of such fundamental rights as the right to decent work, the right to an adequate standard of living, and the right to food, as well as the implementation of, and compliance with, environmental law.

Strengthen and adapt regional and international cooperation

Climate change is a global issue whose effects transcend borders. It therefore requires solutions at local and national levels, but also at regional and international levels. The 2030 Agenda for Sustainable Development, the Addis Ababa Action Agenda, and the Paris Agreement, which were all adopted in 2015, bear witness to the international community's commitment to take the measures needed to ensure low-carbon, resilient development in the face of climate change. The success of these measures depends on the collaboration of the various players involved, including states, regions, local communities, and organizations of all kinds. This collaboration can take the form of financial support, knowledge sharing, capacity building, etc. South-South cooperation particularly provides many opportunities to learn and benefit from experiences and solutions that have been found by others in similar contexts.

SECTION 1

Photo 1. Mickael is cooking bannick ©CC BY-SA 2.0/peupleloup

Photo 2. Municipality of Gros-Mécatina, village of La Tabatière. ©Société du Plan Nord

Photo 3. Railway. ©ArcelorMittal Exploitation minière Canada s.e.n.c

Photo 4. Opening speech by the Premier of Quebec, Philippe Couillard. ©Éric Labonté, MRIF

Welcome message from Philippe Couillard Premier of Québec

Today, more than 800 million people in the world still suffer from hunger and over two billion are victims of malnutrition. At the same time, agri-food systems produce about one fifth of global greenhouse gas emissions. This situation is extremely troubling and we all have a responsibility to act.

Guaranteeing food security for everyone and fighting climate change demand that we mobilize, engage in concerted reflection, and share our best practices. That is what the International Symposium on Food Security and Nutrition in the Age of Climate Change set out to do by bringing together researchers, elected officials, and members of civil society and international organizations to reflect on these questions together. In organizing this meeting in collaboration with the Food and Agriculture Organization of the United Nations (FAO), we wanted to reassert our desire to contribute to building a more sustainable, fairer, and safer world.

Governments of federated states have an important role to play in the fight against climate change. It is our firm conviction that in addressing this issue, we are providing ourselves with an opportunity to create a strong, innovative, and prosperous economy. That is why our government has taken several significant steps to encourage the electrification of transportation, support the use of renewable energy, and reduce greenhouse gas emissions. It is by taking these kinds of actions that we will succeed in improving the quality of life in Québec and beyond our borders.

I am proud that Québec is helping to find solutions and am convinced that these discussions will enable us to progress collectively toward global, sustainable, and smart agriculture.

Philippe Couillard, Premier of Québec

Message from José Graziano Da Silva FAO Director-General

Of all the UN's Sustainable Development Goals (SDGs), SDG 2 on ending hunger, achieving food security and improving nutrition is perhaps the most universal.

Globally, and in spite of considerable progress, almost all countries continue to contend with the multiple burdens of malnutrition: more than 800 million people are undernourished; more than two billion people suffer from micronutrient deficiencies; while in parallel 1.8 billion adults are overweight or obese. In fact, in many countries, households and even individuals, these various burdens of malnutrition coexist, hinting at just how complex the issue of malnutrition really is.

Climate change represents a substantial, transversal and complex additional challenge to this critical situation, and without urgent action millions more people will be at risk of hunger and malnutrition. Climate change already affects all four dimension of food security: availability of food; physical and economic access to food; utilization of food in terms of how it is used and assimilated by the human body; and stability of these three dimensions. In parallel, to achieve the objective of containing climate change under 2 degrees, greenhouse gas emissions need to be considerably reduced as soon as possible, which cannot be achieved without the contribution of food systems and land use.

A better understanding of the pathways linking climate change and nutrition is critical for developing interventions that ensure that the world's population has access to not only sufficient, but also safe and nutritious food. The implications of climate change indeed extend across all determinants of malnutrition, from underlying factors such as socioeconomic status and environmental conditions, to more direct determinants, such as food nutrient intake and disease. The later will be particularly affected through decreased quantity and access, decreased dietary diversity, and decreased food nutritional content. Climate change may affect not only people's capacity to produce crops, but also impair the nutritional content of those crops as well. Protecting nutrients in the food supply and increasing resilience to climate change beyond productivity requires for instance a focus on reducing post-harvest losses, enhanced storage, improved infrastructure (refrigeration, information systems) that can reduce losses of high nutrient perishable goods.

The most vulnerable are, and will be, hardest hit, especially those that are dependent on agriculture, fisheries, forestry and natural resources for their livelihoods, and women and children, who suffer the most significant burdens of poor nutrition.

As the world takes on the SDGs and the Paris Agreement, FAO advocates that poverty, hunger, malnutrition, and climate change are closely linked and best addressed together. There is a need to integrate measures to improve nutrition and climate change resilience. We can thus no longer look at food, livelihoods and the management of natural resources separately, and we need to transition towards food systems that are climate-smart and nutrition sensitive. We look forward to a greater focus of global attention and the strengthening of international cooperation on these crucial issues that will result from this International Symposium.

José Graziano da Silva, Director-General FAO

Photo 5. Collaborative exchange and dialogue session. ©Éric Labonté, MRIF

Introduction

The International Symposium on Food Security and Nutrition in the Age of Climate Change, organized by the Government of Québec, in collaboration with FAO, was held from September 24 to 27, 2017. The objective of this international meeting was to highlight the importance of food and agricultural systems in the fight against climate change, and to present concrete and multi-sectoral solutions to address this global issue.

Close to 250 experts and representatives of international organizations, civil society, private sector, and youth participated in the event at the Québec City Convention Centre. The four-day program included plenary sessions and interactive workshops where various topics directly or indirectly related to food security were discussed (health, biodiversity, forestry, urban agriculture, food waste, livestock breeding, women's empowerment, etc.). The regional reality of West Africa and Northern Canada, as well as the important role of young people, guided the discussions.

The Symposium also included activities focusing on specific problems and innovative solutions, such as a conference lunch on nutrition and climate change moderated by representatives of the three United Nations Rome-based Agencies (FAO, the World Food Programme, and the International Fund for Agricultural Development). In addition, there were two special events entitled "Feeding cities" and "Fork and Good Conscience: contributing to food security one chef at a time." Video presentations by Youba Sokona, Vice-Chair of the Intergovernmental Panel on Climate Change (IPCC), and Cristiana Pașca Palmer, Executive Secretary of the Secretariat of the Convention on Biological Diversity (CBD), were also screened.

The Symposium's logistics and material organization were in keeping with the event's themes. Accordingly, several eco-responsible measures were implemented to comply with the issues addressed. Special attention was given to the food served in order to tailor menus to the principles of healthy eco-friendly diets and minimize food waste. It was also decided early on that there would be no printing in conjunction with the event. An interactive mobile app containing all the useful information

to ensure that the event ran smoothly was made available to participants. The organizing committee also teamed up with a Québec stationary company to produce a cockade printed on special paper into which ready-to-plant basil seeds were inserted.

This Symposium strengthened the collaboration that has been developing for several years between Québec and FAO. The Government of Québec and FAO are both concerned about the challenge that climate change poses for the world's food and agricultural systems.

This publication compiles summaries of the presentations that were given and of the highly productive discussions that took place during the four-day event. Québec and FAO hope that the Symposium and this publication will facilitate the sharing of experiences and expertise and contribute to international thinking on this timely issue in order to foster the emergence of innovative and effective solutions and, at the same time, accelerate a transition toward smart and sustainable agri-food systems that take climate into account.

Food Security and Nutrition in the Age of Climate Change

Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.

The vulnerability of agricultural and food systems to climate variations will: intensify the risk of lower output in local and global agricultural production; increase food prices and their volatility; increase the possibility of resource-related conflict; have direct impacts on health; and increase food insecurity and malnutrition.

The agriculture and food systems have a role to play in the fight against climate change. Together, agriculture, forestry and land-use change are responsible for about one fifth of global greenhouse gas emissions. Moreover, according to FAO projections, global agricultural production will have to increase by 60 percent to meet the increased demand for food of a population of nine billion people in 2050. At the same time, about one third of the edible parts of food produced for human consumption is lost or wasted globally, which represents around 1.3 billion tons per year.

The agriculture sectors have the potential to reduce greenhouse gas emissions if concrete actions are taken to transform food and agriculture systems in order to improve the use of natural resources and their sustainability. Policies on climate change mitigation and adaptation, food security, nutrition, health, demography, the economy and natural resources need to be decompartmentalized to support a transition toward smart and sustainable food systems that take climate into account.

Symposium's committees

Scientific committee	
PARENT, Geneviève president	Professor, Faculty of Law, Legal Research Chair in Food Diversity and Security, Université Laval
MEYBECK, Alexandre vice-president	Senior Policy Officer on Agriculture, Environment and Climate Change, FAO
BEAUDOIN, André D.	Secretary General, Union des producteurs agricoles développement international (UPA-DI)
BERNOUX, Martial	Natural Resources Officer, FAO
BOURQUE, Alain	Executive Director, Ouranos Research Consortium
BOUTIN, Denis	Expert-advisor in Policy and Sustainable Development Analysis, Ministry of Agriculture, Fisheries and Food of Québec (MAPAQ)
CORTBAOUI, Patrick	Academic Associate & Program Director, McGill Institute for global food security
DEBAILLEUL, Guy	Professor in Rural Economy and Development, Université Laval
DUFOUR, Charlotte	Nutrition and food systems officer, FAO
EL ALTI, Jalila	Department head, "Studies and Planning", National Institute of Nutrition and Food Technology of Tunisia
GOSSELIN, Pierre	Coordinator of the Health Program, Ouranos Research Consortium
LEVASSEUR, Virginie	Consulting Services and Innovation Director, Société de cooperation pour le développement international (SOCODEVI)
NDOUR, Yacine Badiane	Senior Research Fellow and National Laboratory for Research on Plan Production Director, Senegalese Institute of Agricultural Research (ISRA)
OLIVIER, Alain	Professor, Phytology Department, Chair in International Development, Université Laval

Coordination committee	
ROYER, Vincent	Director, International Organisations and Global Issues Division, Ministry Of International Relations and La Francophonie of Québec (MRIF)
FRICK, Martin	Director, Climate and Environment Division (CBC), FAO
LÉVESQUE, Rachel	Special Advisor to the Coordination of the Symposium, International Organisations and Global Issues Division, MRIF, Québec
LAVAL, Elizabeth	Climate Change Specialist, CBC FAO
RENOSTO, Daniela	Multilateral Affairs Advisor in Italy and Holy See Relations, MRIF
NGUYEN, Mi.	Deputy Permanent Representative, Permanent Mission of Canada to FAO

Opening Conference under the auspices of the FAO

GLOBAL NUTRITION IN THE AGE OF CLIMATE CHANGE: TRANSFORMING CHALLENGES INTO OPPORTUNITIES

Charlotte Dufour, Nutrition and Food Systems Officer, FAO

World hunger has decreased considerably in recent years. Despite this progress, all of the world's countries are currently facing malnutrition in one form or another. Of the earth's seven billion people, two billion suffer from micronutrient deficiencies, 815 million have a caloric deficit, nearly one child in four suffers from chronic malnutrition and 52 million children are acutely malnourished (FAO et al., 2017). While undernutrition is not declining fast enough, overweight, obesity and the chronic diseases associated with them are skyrocketing everywhere: two billion adults (out of five billion) are overweight and one adult in 12 suffers from type 2 diabetes (IFPRI, 2016). These forms of malnutrition coexist and exert enormous pressure on household economies as well as on national and global economies.

This data conceals major regional disparities. Undernutrition - both acute and chronic - is concentrated primarily in Africa, Asia and Latin America, and is declining extremely slowly in countries most frequently affected by crises. Whether they stem from natural disasters or from conflicts, climatic and environmental factors are almost always an underlying cause of these crises and of the poverty, food insecurity and health problems that perpetuate undernutrition. Climate change and variability exacerbate these challenges and have a greater impact on the most vulnerable.

The relationship between climate change and nutrition is not a one-way street. Firstly, it appears that substantial food losses throughout the food chain account for 8 percent of anthropogenic greenhouse gas (GHG) emissions. Limiting food loss and waste is one of the key solutions for improving food security and nutrition as well as for reducing agriculture's contribution[1] to GHG emissions. Furthermore, diet types can also have an influence on climate change. In countries where income and urbanization are on the rise, diets tend to include more processed products (often high in vegetable oil and sugar) and animal products that contribute significantly to agricultural GHG emissions and the overweight epidemic that has been observed. The ways in which foods are consumed, preserved and transported are also a growing source of energy consumption.

Nevertheless, this sad commentary contains some good news: the solutions advocated for one of these challenges help to confront the other. Strategies for making agriculture "climate-smart" have much in common with strategies for making agriculture "nutrition-sensitive". And healthy diet principles are quite similar to sustainable food principles. But implementing them requires taking the entirety of our food system into account and restoring the well-being of humanity and our planet as its core element. It is therefore time to combine these two topics, which are the focal point of the 2030 Agenda, and there is an urgent need for us to act together

1 In FAO, agriculture is to be understood in its broad sense, covering crops and livestock production as well as forestry, fisheries and aquaculture.

CLIMATE CHANGE, AGRICULTURE AND FOOD SECURITY

Alexandre Meybeck, Senior Policy Officer on agriculture, environment and climate change, FAO

The links between climate change, agricultural production (understood here as covering crops, livestock, forestry, fisheries and aquaculture), food security and nutrition are significant and complex. The agricultural sectors are the first to be impacted by climate change, while they contribute to it, and can also help fight it by reducing their greenhouse gas emissions and increasing carbon sequestration in biomass and soils.

Climate change is dramatically altering the conditions in which agricultural activities are carried out. This is true both directly, by changing the physical characteristics of the environment (temperature, precipitation frequency, intensity and distribution, marine environment acidity, etc.), and indirectly, by changing ecosystems and relations between species, especially through its impacts on pollinators, parasites, weeds, diseases, etc. In tropical developing countries, negative consequences already weigh heavily on the livelihoods of households and vulnerable communities. Beyond 2030, the negative effects of climate change on agricultural yields will increase in all regions. According to a recent study, major crop yields will drop by 17 percent globally in 2050 compared to a scenario in which there is no climate change. Yet according to the FAO, agriculture must provide for a 50 percent rise in food production by 2050 due to population increases and dietary changes.

The impacts of climate change on agricultural sectors translate into economic and social consequences for households and countries dependent on agricultural production and also for consumers. Thus, climate change has repercussions on all aspects of food security - food availability, physical and economic accessibility, the utilisation of nutrients - as well as on the stability of these three aspects. These consequences are particularly severe for the poorest households, of which 70 percent depend on agricultural activity, and for the least advanced countries, where agricultural sectors account for an important share of the gross domestic product (GDP) and especially of employment.

At the same time, agricultural sectors currently account for one fifth of global greenhouse gas emissions, caused primarily by deforestation, methane emissions from livestock and rice, and the use of biological and synthetic fertilizers. Yet to achieve the objectives of the Paris Agreement and limit the rise in temperature to 2°C, planetary emissions must be considerably reduced.

How can the demand for agricultural production be reconciled with the mitigation of emissions? How can agriculture as well as land and forest use participate in global efforts without compromising food security? Solutions exist, such as improving the efficiency of production systems in order to reduce the intensity of emissions generated by the food sector, restricting deforestation and increasing carbon stocks in biomass and soils. Agricultural sectors must be radically transformed in order to adapt to climate change, contribute to its mitigation and sustainably ensure food security for everyone.

SECTION 2

Photo 6. Aurora borealis north of the 49th parallel. ©David Rouault

1. Climate change, food security and nutrition: the issues

1.1 IMPACTS OF CLIMATE CHANGE ON FOOD SECURITY AND NUTRITION

Agriculture in the IPCC's work

Youba Sokona, Vice-Chair, Intergovernmental Panel on Climate Change

The earliest assumptions about the greenhouse effect were formulated by scientist Jacques Fournier and date back to 1824. We however had to wait more than a century for the hypothesis of a climate change linked to greenhouse gases to be validated, in the 1940s, by the Canadian physicist Gilbert Plass. In 1988, the World Meteorological Organization and the United Nations Environment Programme created the Intergovernmental Panel on Climate Change (IPCC). As a scientific body and intergovernmental organization, the IPCC is mandated to review and assess the most recent scientific, technical and socio-economic information produced relevant to the understanding of climate change.

The very first IPCC assessment report, published in 1990, stressed that anthropogenic GHG emissions significantly increase the natural greenhouse effect and contribute to global warming. Subsequent reports published in 1995, 2001, 2007 and 2013 presented still more accurate and more alarming conclusions. The fifth and latest IPCC report indicates unequivocally that not only is the influence of humans on the climate system undeniable, but also that the increasingly high level of GHG emissions will lead to further warming and the alteration of all components of the climate system. This will intensify the effects that are already discernable on every continent and in the oceans. Inaction could be extremely costly for all of humanity.

It is in this global context that the crucial importance of the theme of this international Symposium should be understood. Food production and agriculture are key issues for the IPCC. Indeed, food availability, access and price come about as a result of a large number of interactive processes that have various connections with climate change as well as with responses to it. The strong linkages between food production, human health, and the economic outlook for rural communities mean that these areas should be

understood as one integrated entity, while the sustainability of resources and the integration of terrestrial and marine food production systems must be regarded as issues of paramount importance.

The fifth IPCC assessment report discusses the sensitivity of food production to climate variability. New data on extremes in a changing climate serve as a starting point for developing a better understanding of the current and future role of climate variability. Naturally, agriculture plays a major role in climate forcings, but also in the array of mitigation and adaptation options.

Food security and production will be central to the various reports of the IPCC's Sixth Assessment cycle. The reports are highly anticipated in order to inform the implementation of the Paris Agreement and the SDGs. Indeed, the theme of this Symposium will be widely covered in both the special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global GHG emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development and efforts to eradicate poverty, and the special report on climate change, desertification, land degradation, sustainable land management, food security, and GHG fluxes in terrestrial ecosystems.

Impacts of climate change on food security and nutrition

Hugo Melgar-Quinonez, Director, Institute for Global Food Security, McGill University - session chair

The impacts of climate change on our ecosystems are already visible throughout the world. Although it is expected that certain activities and populations will be more affected, and at a faster rate, than others, the fact remains that all regions of the world are undergoing and will continue to undergo the effects of these climatic upheavals with varying magnitude and consequences. Climate change causes chain reactions. These physicochemical changes are passed on to the ecosystems, agricultural systems, economy, and livelihoods of people who depend on agricultural sectors. As a result, they affect every dimension of food security and nutrition: the availability of food, physical and economic access to it, the utilization of food and the stability of these dimensions.

These impacts, which are already being felt and which are threatening food security, nutrition and health here and elsewhere, are evidence of the urgent need to take action.

Testimony from Small Island Developing States

Maria Helena Semedo, Deputy Director-General, FAO

Small Island Developing States (SIDS), which have very high costs due to insularity, are facing complex food security and nutrition challenges. Undernutrition, micronutrient deficiencies, and a high rate of obesity coexist in many SIDS. In fact, the seven countries most affected by obesity are located in the Pacific.

Moreover, extreme weather events such as cyclones and hurricanes, precipitation irregularity, droughts, rising sea level and coastal erosion are aggravating factors in SIDS, destroying the little capital that has been accumulated. Indeed, many people have very little arable land, and depend on small-scale farming, sea products and high-priced imports. Due to their limited surface area and isolation, SIDS are therefore especially threatened by such natural disasters as well as by climate change's impacts, which threaten traditional diets that are often healthier and further aggravate the risks of overweight, obesity, and associated diseases (diabetes, hypertension, etc.), triggering additional health costs.

To address these threats, we must improve the capacity to prevent climate change and adapt to its adverse effects, while strengthening resilience. In this context, the SIDS Accelerated Modalities of Action (S.A.M.O.A.) Pathway was adopted in 2014 during the United Nations Third International Conference on SIDS. This action plan deals with such issues as equitable economic growth, climate change, sustainable energy, natural disaster risk reduction, and the sustainable use of marine resources. Within the S.A.M.O.A. framework, the United Nations launched a new "Global Action Programme on Food Security and Nutrition in Small Island Developing States" in 2017. It is an important mechanism for enabling populations to gradually refocus on healthy lifestyles and diets. This action program includes three objectives:

Photo 7. Speech by Maria Helena Semedo, Deputy Director-General, Climate and Natural Resources, FAO. ©Éric Labonté, MRIF

- strengthening an institutional environment conducive to food security and nutrition, through a strong political commitment and governance that ensures the coordination of decisions;
- improving sustainability, resilience, and the contribution of food systems to good nutrition (e.g., promoting local food systems that foster balanced diets that combine land and sea products);
- the need to empower people and communities to improve their food situation in terms of both food security and nutritional issues.

As the 193 member States of the United Nations have unanimously committed to eliminating hunger by 2030, it is fundamental to take into account the specificities of SIDS in our analyses and decision making. At a time when a necessary paradigm change is taking place, innovative solutions, adapted to the specificities of insular states, are essential in order to address the need to reduce inequities and protect the planet and its natural land and marine resources, by changing non-sustainable modes of consumption and production.

Testimony on the impacts of climate change in the Arctic

Jean Lemire, Emissary for Climate Change, Northern and Arctic Affairs, government of Québec

While the notion of climate change has long remained restricted to the sciences, the concept has evolved over the years and is now associated with a much broader multidisciplinary sphere. Today, comprehending climate change can no longer be limited to a closed silo but must, more than ever, include food security, nutrition and public health issues. The Government of Québec intends to play a key role in this regard and views this international Symposium as the first step toward tangible collaboration with FAO.

A biologist by training, the new Envoy for climate change, northern and Arctic affairs shared his personal experience in the Arctic, gained during his numerous expeditions through the Northwest Passage aboard the Sedna IV. The schooner ventured repeatedly into the ice to document the effects of climate change in the Arctic, where warming has occurred the most rapidly in recent decades. In 2002, the Sedna IV became trapped in the ice and barely managed to escape. When it returned 13 years later to the same place during the same period, not a single patch of ice was visible on the horizon. Far from being an isolated circumstance, this observation of the region over several years is indicative of a disturbing phenomenon: the disappearance of the Arctic's old ice.

Climate change, food security and nutrition: linkages and implications

Sophia Murphy, Steering Committee of the High Level Panel of Experts on Food Security and Nutrition

The High Level Panel of Experts on Food Security and Nutrition (HLPE) was created as part of the reform of world food security governance and is the science-policy interface of the Committee on World Food Security (CFS)[2]. The CFS is the foremost intergovernmental platform on food security and nutrition. The HLPE's mission is primarily to provide evidence-based scientific analyses and policy recommendations at the request of the CFS. Its mission also includes identifying critical and emerging issues to assist CFS countries and stakeholders in targeting topics that call for immediate attention.

The 1996 World Food Summit adopted the following definition: "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life." This definition is based on four dimensions of food security: food availability, physical and economic access to food, utilization to reach a state of nutritional wellbeing, and the stability of these dimensions. These dimensions of food security are influenced by numerous factors – environmental, economic, social, political, etc. – that are in turn frequently impacted by climate change and its consequences, as well as by the policies implemented to address them.

Climate change was among the first topics for which the HLPE was requested to produce a report. A number of other reports deal with climate change, including the ones focussing on such matters as the use of natural resources (land, water), production systems (fisheries and aquaculture, agriculture, forestry), economic and social issues (price volatility, social protection) and specific policies (biofuel development). Based on the HLPE's reports and recommendations, the CFS adopts policy recommendations to facilitate the convergence of policies and actions by CFS member states and participating organizations (United Nations organizations, civil society, agronomic research, financial institutions, private sector and philanthropic foundations).

In its 2012 recommendations, the CFS "recognized that the adverse effects of climate change can pose serious threats to food security especially to small scale food producers' lives and livelihoods, and to the progressive realization of the right to food in the context of national food security," and invited the states "to integrate climate change concerns in food security policies and programmes and to increase resilience of vulnerable groups and food systems to climate change." It was also decided to submit the CFS's recommendations and the HLPE's report to the UNFCCC. This contributed to significant progress in taking food security and agriculture into account in the climate negotiations themselves.

Producing more and better with less within an agro-ecological framework: Efficiently harnessing our biological capital

Godfrey Nzamujo, Director, Songhai Center

A closer look at what we presently see as multiple crises (food security/poverty, difficult demographic transition/ youth unemployment and environmental changes), reveals that they are all connected - suggesting that we have before us a systemic problem that requires a holistic and broad-based approach. Unfortunately most of the solutions we have seen so far seem to be piecemeal and symptomatic therapies that hardly work. In the best cases, these solutions are simply Band-Aid endeavours. In most cases, they end up creating more problems. It is however refreshing to note that more and more people are now realizing that we have hit a point in history that calls for dynamics and orientations that are deeper and broader than any attempt we have seen so far. Today's challenges require a radical shift not just in our vision of the world or our mentality and how we think, but in every sphere of our lives - from the way we see ourselves and relate to each other; from our relationship with the environment to our intellectual, scientific, technical and business orientations; from our production systems to the ways we exchange and consume our products and services.

Business as usual is no longer a viable option. It should be new wine in a new wine skin; we need a new road map, a new compass.

2 The reports of the High Level Panel of Experts on Food Security and Nutrition are available at: http://www.fao.org/cfs/cfs-hlpe/rapports/en/. Also in French at: http://www.fao.org/cfs/cfs-hlpe/rapports/fr/.

The challenge before us now is how to appropriate and align ourselves with the emerging world view and create an enabling institutional framework that will enable us to unleash the production of a critical mass of a new human resource pool that is equipped with the right vision, values, technologies and operational capacities to help us navigate through this difficult and challenging period in our history. This, I think, will be the solid basis for developing a sustainable and productive agriculture in Africa.

A holistic world view and technologies aligned with it will therefore constitute the fundamental resources that we need to respond to the challenges of Poverty/food security, demographic transition/youth empowerment and the environmental crisis, all of which are the focus of the United Nations Sustainable Development Goals (UN SDG). The concept of sustainable development implies that we can increase our productivity, while protecting and enhancing our environment. Given our present situation, we have two inescapable lines of action:

- urgently increase the capacity of production of Africans through using leapfrogging technologies;
- re-design our production and development systems, based on our new understanding of nature and sustainability, to ensure that future generation's right to a healthy and productive environment is not compromised.

The Songhai initiative is a part of the search to develop processes and technologies that seek to harness the environmental capital of our planet to produce more and better quality food for a growing population, while protecting and enhancing our environmental capital. "When we change the way we grow our food, we change ourselves, we change our values, we change our society".

Impacts of climate change on access to various types of food in Nunavik

Annie Lamalice, Ph.D. candidate in food and cultural geography, Université de Montréal and Université de Montpellier (co-supervision program)

The Inuit food system and the socioecological systems on which it is based are at the crossroads of several crucial issues: environmental contamination, a rapid lifestyle transformation, and an increase in chronic diseases. Climate change accentuates the consequences of these cumulative effects while simultaneously casting a veil of uncertainty over the future development of the living environment of the Inuit, the wildlife and flora that for many centuries have provided all the resources needed for their survival. The accelerated transformation of Arctic ecosystems is reducing the ability of the Arctic's inhabitants to engage in livelihood activities that are essential to the culture, health and wellbeing of the Inuit. For example, warmer temperatures and the late formation of sea ice increase risks associated with travel over land and ice, thereby restricting access to hunting and fishing.

The rising temperatures, changing dynamics of sea ice, increase in extreme weather events and seasonal irregularities are all factors that affect the health and reduce the availability of certain animals that are essential to the livelihood of the Inuit, such as the caribou, Arctic char and seal. Climate change also threatens berry-picking activities. Indeed, it is anticipated that vegetation zones will be disrupted and that shrubs will colonize increasingly higher latitudes. A denser shrub cover, combined with longer and warmer growth periods, could be harmful to certain berry plants, particularly mountain cranberries and bog bilberries. In losing access to their territory and traditional foods, the Inuit are also being cut off from their knowledge and know-how, which have been developed and passed down through generations for centuries, and which have made it possible to optimize the use of resources available in the Arctic. In a rapidly changing environment, this traditional knowledge is becoming increasingly difficult to apply when planning safe travel or anticipating the availability of resources throughout the seasons.

Today, approximately 80 percent of the Inuit diet is composed of food purchased at supermarkets. This represents a radical

transformation when compared to the traditional diet that prevailed until a few decades ago. Nunavik's integration into the global food system means that the Inuit are also being impacted by the flaws inherent to it, including higher prices for agricultural commodities caused by extreme climate events in other regions of the world. In short, climate change in the Arctic, which is more pronounced than elsewhere in the world, is affecting the availability, accessibility and quality of key traditional food sources. This is a double punishment for Nunavik's inhabitants, who also pay up to 81 percent more than people in the southern part of the country to purchase food in the supermarket.

Climate change, traditional food & food security in Nunavik

Jimmy Johannes, Hunting, Fishing and Trapping Association, in collaboration with the Nunavik Regional Board of Health and Social Services

The Nunavik region is located in northern Québec. It is an immense territory with a population of 12 000, mainly Inuit. Harvesting, sharing and consuming traditional foods such as caribou, beluga, seal, fish, geese and berries are an important part of living. It contributes to nutrition, health and well-being. Because there are no road or rail links between the region and the southern part of the province of Québec, store-bought food and other goods are imported from the South by air and sealift. Consumer prices for food and

Photo 8. Speech by Jimmy Johannes, Secretary General of the Nunavik Regional Hunting, Fishing and Trapping Association (Nunavimmi Umajulivijiit Katujiqatigininga). ©Éric Labonté, MRIF

essential products are therefore high. For example, store-bought food costs are 81 percent higher in Nunavik than in Québec City (Robitaille et al, 2016).

Many families in Nunavik have difficulties accessing enough food. Nearly one person in four (24 percent) lacked food at home in the month prior to the health survey in 2004. Many reasons explain the high rate of food insecurity, including cost of food, cost of living and poverty. Climate change is also part of the problem. In a broad consultation in Nunavik called Parnasimautik, people mentioned that "impacts of climate change are increasingly threatening safe access to many traditional inland and marine harvesting areas." Decline in the caribou population is also a major issue in Nunavik these days. Caribou is an important food source for Nunavimmiut; it is one of the traditional foods that are the most eaten in the region. Many complex factors are linked to this decline, including climate change, changes in migration pattern and wildlife management practices.

To deal with those changes, Nunavik hunters are adapting their hunting techniques and wildlife management practices that they pass on to the younger generation. Monitoring and research on wildlife quality and availability is also part of the solutions to adapt to climate changes. The Nunavik Research Centre based in Kuujjuaq monitors wildlife diseases that affect both animal and human health. When hunters see abnormality in some species they hunt, they can send samples to the research centre for further investigations. The region is also starting to look at new ways to produce food locally. For instance, a small egg-production project was recently started in two communities. Those types of initiatives remain new and small-scale for now, but in the medium to long term, they aim to be part of key solutions to provide fresh and locally produced food to Nunavimmiut.

1.2 CLIMATE CHANGE, NUTRITION AND HEALTH

Climate change, nutrition and health

Pierre Gosselin, Coordinator of the Health Program, Ouranos Research Consortium - session chair

Despite significant progress, more than 800 million people are chronically undernourished; over two billion people suffer from micronutrient deficiencies; close to one child in four under five years of age suffers from stunting; and 3.4 million people die each year due to overweight and obesity.

Climate change is already amplifying these multiple burdens of malnutrition by its effects on food security, public hygiene, water quality and supplies, food safety, and maternal and child health care. Firstly, the effects of climate change on food availability, accessibility, and stability can cause major modifications in diet choices and balance, which in turn has repercussions on the health of households. Secondly, climate change is having a negative impact on nutrition because of its effects on health. Indeed, it can, for example, lead to an increase in water-borne, food-borne and vector-borne infectious diseases, which increase nutritional needs and reduce the absorption of nutrients. Lastly, climate change can also directly affect the health of agricultural workers, particularly because of intense heat waves and lack of drinking water. Consequently, the poorest and most vulnerable are and will continue to be the first affected.

Accessing and affording nutritious diets in the age of climate change

Lauren Landis, Director of Nutrition, World Food Programme

New efforts to understand to what extent climate change may influence people's ability to access a nutritious diet are essential. The World Food Programme (WFP) is beginning to model this by incorporating the projected effects of climate change on diets in an analytical tool, developed by WFP and partners, known as 'Fill the Nutrient Gap' (FNG).[3]

3 For more information on Fill the Nutrient Gap, please see: https://www.wfp.org/content/2017-fill-nutrient-gap?_ga=2.86790555.2011256344.1518424351-1082568425.1480515367

The FNG is a set of analyses and processes that support governments to understand the different context-specific barriers to adequate nutrient intake for vulnerable groups. Through affordability modelling using Cost of the Diet software (developed by Save the Children), the tool also reveals how existing national policies and programmes in various sectors can be leveraged or adjusted to increase access to nutritious foods and overcome the existing barriers. WFP started this work in 2015/16 with 3 pilot countries (El Salvador, Ghana & Madagascar) and reached 13 countries in 2017. By 2018, WFP aims to bring the total number of countries that have undertaken the FNG analysis to 22 in various regions of the world.

The new dimension of the FNG analysis is exploring a range of contexts to account for different climate change scenarios. For example, the modelling includes specifics for flood-prone regions, areas of drought, as well as for countries not currently impacted by climate-related shocks but that will likely suffer the gradual impact of climate change in the coming years.

To estimate the effect of climate change on the affordability of nutritious diets, the team uses changes in food prices and food expenditure, caused by an expected reduction in yields and in GDP as predicted by EU-funded 'HELIX' model, to account for possible impacts. Using different scenarios that assume three different levels of impact (conservative, medium and severe), the analysis will then demonstrate what climate adaptation and mitigation strategies are needed to ensure nutrition security, and, in turn, food security in the future. Cambodia is the first of the FNG countries to undergo this modelling, and results are expected in early 2018.

Building on pioneering climate data like this, WFP hopes this tool will help the nutrition community understand how much of a given population will struggle to access a nutritious diet if forecasted effects of climate change materialize. WFP sees this work as critical in contributing to global efforts to end all forms of malnutrition – in line with Sustainable Development Goal 2.2 - in the age of climate change.

Women can drive climate-smart and pro-nutrition agricultural transformation

Dominique Charron, director, Agriculture and environment program, International Development Research Center (IDRC)

To meet the UN's Agenda for Sustainable Development by 2030, agriculture must become not only more efficiently productive, it must become climate-smart and nutrition-smart to meet the diverse needs of a world population approaching 10 billion. Empowering women in developing regions of the world is key to this transformation, as they too frequently lack access to knowledge, services, and political power to lead this change.

Women are more vulnerable than men to shocks – natural, health or economic. They face additional obstacles and constraints when they are poor, live in degraded environments, or face new threats and an uncertain future due to rapidly changing climate, social and economic contexts. Women already bear the largest burden of undernutrition, and are at risk to do even more so with climate change.

To achieve SDG 2 in the context of climate change, women must be supported to become more resilient, and to empower themselves politically, socially and economically. In some of the poorest countries in the world, evidence shows that agricultural livelihoods are means by which women may change their condition and improve community nutrition and climate resilience at the same time. Whether cultivating indigenous vegetables in West Africa, integrating dryland legumes or grains in the drylands of Kenya, Ethiopia or India or marketing low-cost sustainable agricultural kits in Nepal, researchers have developed methods and strategies to improve women's incomes and family nutrition; and to support change in gender relations. Improved agricultural livelihoods are key to lasting empowerment, agricultural transformation, improved nutrition, and large scale positive change.

Putting people and land back at the center of our food system to combat malnutrition and climate change: What should be our response? What are the challenges?

Charlotte Dufour, Nutrition and Food Systems Officer, FAO

There are interesting synergies between strategies aimed at reducing climate change and its impacts, and response measures aimed at improving food and human health. Based on a conceptual framework stemming from the FAO's Toolkit on nutrition-sensitive agriculture and food systems,[4] the relevant "entry points" for promoting the consumption and production of healthy, nutritious, and environmentally friendly foods are as follows:

Several essential elements should be considered in the context of such an approach. It is important to work on the entire food system, since ad hoc interventions have limited impact. This requires a multi-stakeholder approach involving the private and public sectors. We must also recognize that food alone is not enough to ensure good nutrition. It is important to strengthen health systems, improve access to social protection, invest in water and sanitation, and adopt policies that protect the rights of women and children. Consistency across policies must therefore be achieved by incorporating nutrition and climate change management into farming and food policies and investments, as well as by integrating climate change into nutrition and food security policies, and ensuring that synergies exist with social protection policies.

Main Functions of the food system	Entry points for nutrition-sensitive and climate-smart responses
Consumer demand, food preparation and preferences	Nutritional education Income generation Social protection School feeding and nutrition Humanitarian food assistance Access to clean energy for cooking National food directives
Food trade and marketing	Trade policies Food marketing and advertising practices Labeling of food items Price control policies and consumption incentives
Food handling, storage and processing	Post-harvest handling, storage, and processing practices Food fortification Recyclable packaging
Food production	Diversification and sustainable intensification of production Biodiversity protection Selection of nutritive (bio-fortification) and resilient varieties in the face of climate variations Urban and peri-urban agriculture
Cross-cutting issues	Empowerment of women and gender issues Value chain approach Prevention and reduction of food loss and waste Food quality, health security, and hygiene

4 For more information on FAO's Toolkit on nutrition-sensitive agriculture and food systems, please see: http://www.fao.org/nutrition/policies-programmes/toolkit/en/.

Systems must also be strengthened. This not only applies to health systems, but also to agricultural extension, social protection, and risk management policies, so that unsustainable ad hoc interventions can be avoided. It is essential to improve risk management by enhancing disaster preparedness and integrating that management into agricultural and food policies as well as social protection policies. Rights-based approaches are also crucial if inequities are to be corrected.

Furthermore, it is important to be clear about the role of the various stakeholders. Indeed, the private sector must be the driving force of food systems, and sustainable change will only come about when the private sector has an interest in producing and selling healthy and environmentally friendly foods. Meanwhile, the public sector should create a favourable enabling environment as well as incentive policies to promote the production, marketing and consumption of healthy and diversified foods, produced in an environmentally acceptable way. Lastly, we must never forget our role as consumers and voters.

Summary of the discussions

Today, the interrelation between climate change, nutrition, and health is clearly perceptible in many parts of the world. In the Sahel, for example, experts report that droughts and rainfall changes are affecting the livestock breeding of nomads and, as a result, are impacting the availability of animal-derived products and the ability of nomads to trade with other communities. A participant from Haiti said that it is impossible to increase agricultural productivity in his country without focusing attention on resilience to hurricanes. Moreover, most of the accounts provided indicated that agricultural practices are inadequate to cope with the growing unpredictability of weather conditions.

A dominant theme of the discussions centred on the integration of approaches aimed at reducing the impact of climate change and improving the quality of food and human health in order to deal with these issues. Concerning production, promoting more diversified agricultural systems was encouraged because they increase the resilience of communities and yield a greater variety of foods. Other participants felt that solutions are too often considered to be the responsibility of farmers, even though they have fairly limited power. Integrating approaches to address climate change, food security, nutrition, and health must therefore be considered in terms of the entire food system. As participants noted, in a context where climate change affects the predictability of agricultural and fishery performance, national policies that establish resilient food systems and offer balanced risk sharing between producers and consumers should be adopted.

In this respect, food production should be incorporated into socio-economic initiatives, ranging from the implementation of systems that foster social protection, training, access to information, and strengthening ties between local producers and schools, to the internalization of environmental protection costs. Climate change is therefore forcing a paradigm shift on political stakeholders and a change of attitude in communities. This shift must go hand in hand with a reappraisal and fresh appreciation of the role of farmers, particularly in light of the rural exodus of young people. Placing more positive emphasis on traditional foods is also essential, since they are too often associated with a lower socio-economic status.

Lastly, as highlighted by the discussions, these approaches must be based on consultation, involvement, and the systematic empowerment of people in vulnerable situations, such as small-scale producers and Indigenous communities. In addition, programs implemented without adequately consulting the communities concerned can lead to inappropriate results. Therefore, the issue calls for integrating a more long-term vision that recognizes food security as a social project on which we must work together in solidarity in the face of the added challenge posed by climate change.

Conference lunch on Inter-Agency collaboration on nutrition in the age of climate change

The three United Nations agencies based in Rome – the FAO, WFP and IFAD – provide technical expertise and internationally recognized discussion forums that contribute to the advancement of policies and programs supporting food security, nutrition, and agriculture. In the age of climate change, these organizations recognize the importance of promoting nutrition-sensitive interventions. As a result, inter-agency collaboration on this matter has succeeded in creating synergies resulting in added value not only in Rome, but also in practice at the grassroots level. During the Symposium, Charlotte Dufour, Nutrition and Food Systems Officer, Lauren Landis, Director of Nutrition, WFP, and Marian Amaka Odenigbo, Senior Technical Specialist in nutrition at IFAD, spoke about how their respective agencies are integrating nutrition into their interventions, especially in a context of climate change, and heightening their collaboration on this important issue.

"The FAO's adoption of its Strategy on Climate Change in July 2017 and the fact that the Organization is stepping up its efforts to integrate nutrition into all its activities have created new opportunities to strengthen synergies between these two agendas. These are priority issues for the three Rome-based agencies and the FAO is working hand-in-hand with the WFP and IFAD, thereby bringing to this collaboration its normative work, expertise in capacity building, and assistance in the food and nutrition security governing process at the global, regional, and national levels."

Charlotte Dufour, Nutrition and Food Systems Officer, FAO

"WFP is pioneering new analysis to help understand how the effects of climate change will influence people's ability to access a nutritious diet. We see this as critical to support national decision-making, ensuring that adaptation and mitigation strategies enable governments and partners like the Rome-based UN agencies to maintain progress towards ending malnutrition".

Lauren Landis, Director of Nutritoin, WFP

"In IFAD, the interface between nutrition and climate change is being harnessed in projects as co-benefits of climate- resilient agriculture. We explore nutrition as one of the multiple dimensions of resilience of the poor households".

Marian Amaka Odenigbo, Senior Technical Specialist in nutrition, IFAD

Photo 9. A woman farmer harvesting beans. ©FAO/Ishara Kodikara

Photo 10. Collaborative exchange and dialogue session. ©Éric Labonté, MRIF

1.3
CLIMATE CHANGE AND FOOD INSECURITY: RISK OF CONFLICT

Climate change and food insecurity: risk of conflict

Anne Mottet, Livestock Development Officer, FAO - session chair

The study of conflict allows us to understand that its causes are never attributable to one factor only. On the contrary, evidence points to the complexity of the factors which drive conflicts' emergence. Several aspects of the relationship between food, hunger, peace and conflict have however been well explored and documented. We know that conflict has a strong adverse impact on hunger, food insecurity and malnutrition. Most conflicts mainly affect rural areas and their populations. This is particularly true for civil conflicts, which have tripled in recent years, and which are today the most common form of armed conflict, and increasingly prolonged. Such conflicts damage agriculture, disrupt food production and food systems, fuel the plundering of crops and livestock, and cause loss of assets and incomes. As a result, they are major drivers of food insecurity and malnutrition. In fact, one of the lasting effects of conflicts is their impact on nutrition, especially undernutrition during early childhood, with many of those affected suffering from lifelong physical and/or mental handicaps.

On the other side, there is evidence that sudden high food prices and lack of access to food have contributed to instability and civil strife – although this relationship must be nuanced, and taken in conjunction with other forms of grievance and discontent – while there are also indications that food security and improved rural livelihoods may contribute to the mitigation and prevention of conflicts and to securing sustainable peace.

The rapid progression of climate change and its consequences in terms of ecosystems' disruption, natural disasters or resource scarcity have serious socioeconomic implications which can lead to increased social tensions and political destabilization. There is growing evidence of a causal relationship between extreme weather events and the incidence of civil conflicts. This has proved to be valid for droughts and local violent conflicts in Somalia. A study led by Maystad and Ecker (2014) estimated that one standard deviation increase of the length and intensity of drought increases the likelihood of conflicts by 62 percent. The same study also suggests that drought-caused livestock price shocks are a main driver of local conflict.

The increased number of extreme climatic events may also cause major displacements of food- and water-deprived populations that migrate toward urban centres, thereby increasing the risk of conflict. In parallel, conflict also drives mobility: in 2014, every day conflicts and violence forced people to flee their homes and seek safety either internally or across borders. Fewer refugees (only 1 percent) have returned, less than at any point over the past 30 years. In the same year, children constituted 41 percent of the refugee population, the highest percentage in more than a decade. In other words, the impacts of climate change on resources, agriculture, health and livelihoods threaten to amplify the social and environmental pressures that are the sources of conflicts, and could therefore become major factors of destabilization and migration in this century.

As we take on the 2030 Agenda for Sustainable Development, which recognizes peace as a vital threshold condition for development, as well as a development outcome in its own right, understanding these complex linkages will be essential.

Climate disruptions and conflicts: a link that remains to be demonstrated

François Audet, Director, Canadian Research Institute on Humanitarian Crisis and Aid (OCCAH)

Contrary to general belief, the causal links between climate disruptions and conflicts have yet to be adequately demonstrated. A significant number of qualitative and quantitative studies that attempt to establish a connection between climate change and violent conflicts have come out in recent years. While this research makes it possible to delve deeper into the issue of security risks associated with climate-related hazards, the causal results remain ambiguous and are often misinterpreted (Detges, 2017). In fact, conflict studies reveal that the causes are never attributable to any single factor. On the contrary, the complexity of factors that explain the emergence of conflicts has been demonstrated. Environmental factors and, more specifically, climate-related hazards, may be directly or indirectly linked to conflicts. In some cases, they are factors that exacerbate existing tensions. In this context, it becomes urgent to clarify the state of knowledge and discuss the explanatory and causal factors between climate-related hazards and international insecurity, which generate humanitarian crises responsible for certain large-scale famines.

Anticipating food insecurity

Emmy Simmons, Senior Advisor, Global Food Security Project, Center for Strategic and International Studies

Sharp increases in global food prices in 2007/08 jolted global political leaders out of any complacency they might have had regarding the future of food and agriculture (Simmons, 2017). The global cereal price index of 2000 had nearly tripled by 2008. This rapid rise in food prices posed hardships for poor consumers. It also sparked political unrest that threatened and, in a few cases, toppled existing political regimes. Why was there so little anticipation of this "perfect storm" of food insecurity?

The world had made enormous progress in reducing the incidence of hunger and child mortality in recent decades (FAO et al., 2015; UN Inter-agency Group for Child Mortality Estimation, 2015). Agricultural production and trade in food and agricultural commodities had increased the availability of food for billions of people (FAO, 2017; Porkka et al., 2013). Rising incomes had enabled growing numbers of people to access diverse sources of food and to adopt eating habits far different from those of their parents (Kearney, 2010). But not all signals were positive. Greater access to dietary energy in both staple foods and in more high-fat and high-sugar foods was leading to an alarming increase in overweight and obesity around the world (Popkin et al., 2012). Diet-related non-communicable diseases were becoming major contributors to the global burden of disease (Global Panel on Agriculture and Food Systems for Nutrition, 2016). Persistent poverty meant that many did not yet have satisfactory access to food or healthcare services. Violent conflicts flared in all regions, displacing populations and placing harsh, negative impacts on food security. Natural disasters in Haiti and the Philippines demonstrated how quickly food insecurity can strike. And science began to show how changing climate conditions – higher temperatures, more extreme drought and flooding events – will constrain future growth in agricultural productivity and add greater volatility to agricultural markets (ccafs.cgiar.org and Ludi et al., 2007).

Anticipation of these potential food system disruptors – what I have called "recurring storms" – must now be an essential priority for action, even as we strive to accomplish the 2030 Sustainable Development Goals. As we have seen in the past decade, forward movements toward improving food security can stall or reverse with devastating impacts on food security. The impetus to increase public investment in agriculture sparked by the L'Aquila Food Security Initiative, for example, appears to be weakening (Anisimova, 2016).

Interdisciplinary analysis and foresight based on good evidence and sound science is essential to ensuring that short-term solutions are consistent with sustainable, long-term perspectives. Averting the inevitable recurring storms that will buffer efforts to increase food security will require attention to fragile states as well as countries committed to economic growth, investment in cities as well as agricultural

areas, and the development of policies that align immediate interventions supporting food security with the goal of a sustainable, healthy future (Springmann et al., 2016; FAO, 2017:136).

The migration and food security nexus in the context of climate change

Myriam Traore Chazalnoel, Associate Expert, Migration, Environment and Climate Change Division, International Organization for Migration

This presentation focuses on the linkages between food insecurity, risks of conflicts and migration in the context of climate change. On the one hand, there is growing evidence that some conflicts are exacerbated by climate change – this in turn might lead to situations of forced migration and severe adverse impacts on food security. One example is the ongoing Syrian conflict that has been linked by some researchers to the devastating impacts of drought on rural livelihoods before the eruption of the conflict. Yet these linkages are complex and climate change is very rarely evidenced to be the primary root cause of a conflict.

On the other hand, we also observe clear linkages between conflict, existing and subsequent food insecurity and forced migration of populations. Some of the countries affected by conflict, food insecurity and population displacement also experience severe climate change impacts. For instance, in the Lake Chad region, climate change impacts reduce livelihood opportunities and food security, whilst the region also faces an influx of refugees as well as internal migration, with the threat of terrorism as a backdrop.

However, existing evidence linking food, climate, conflict and migration is inconclusive. What we do know is that climate change is very often an amplifier of existing tensions and that in situation of fragility, this very often ties with issues of conflict and forced migration - in that respect there is a need to better understand how climate impacts might exacerbate the risks of conflict and of forced migration.

Currently the global policy debate is increasingly looking at how to manage migration occurring in the context of climate change. More precisely, two global policy processes offer opportunities to discuss climate migration and food security issues as a coherent nexus. On the climate policy side, the global climate negotiations under the United Nations Framework Convention on Climate Change (UNFCCC) have formally integrated discussions on climate migration and displacement, through the work of the so-called Taskforce on Displacement, whose creation was mandated by the Paris Climate Agreement in 2015. On the migration policy side, negotiations will take place throughout 2018 at the United Nations level to reach an international agreement called the global compact for safe, orderly and regular migration. Both these processes are entry points to bring the specific issues of climate migration, conflict and food insecurity to the global governance of climate migration.

In parallel to global action at the policy level, it is also critical to develop field programmes that take into account the specific challenges faced by states and populations in terms of managing migration flows linked to climate change as well as the expected impacts on food security. The International Organization for Migration (IOM) and specialized agencies like the Food and Agricultural Organization of the United Nations (FAO) have a track record of working together in various countries – but there is an urgent need to develop more specific programming targeting the climate-migration-conflict and food security nexus.

Summary of the discussions

The relationship between climate change, food insecurity and conflicts is usually presented as a vicious circle: climate change affects food security, leading to an instable context conducive to conflict, including population uprisings or displacements, which in turn can contribute to food insecurity and conflicts. As an example, one participant reported that desertification is intensifying in Cameroon and causing the gradual disappearance of pastures for livestock farming. As a result, the herds move to cultivated fields and, in doing so, damage crops and provoke conflicts with farmers. In addition, the populations follow the herds to more fertile lands, thereby causing rivalry over land use with previously established populations.

However, it is important to stress that the current state of knowledge makes it impossible to assert that climate change and the food insecurity it brings about lead to conflicts via a linear causal relationship. Rather, climate change is one of the factors that can exacerbate conflicts, and the vicious circle described above stems from multiple causes grounded in a specific context. Indeed, the overlay of various factors

such as tensions between different cultures, the economic, social and environmental vulnerability of communities, and failed modes of governance – to mention but a few examples – creates fertile ground for the outbreak of conflicts.

According to participants, the key to finding an adequate response is therefore to understand the local context. The discussions placed special emphasis on the importance of communicating with local stakeholders to elicit their perceptions of situations and their ideas regarding solutions to be implemented. One participant explained that in northern Cameroon, local populations are unable to access their fields because the area is occupied by Boko Haram. Given the situation, small-scale production techniques using burlap bags have been developed, thus enabling these displaced people to grow crops in front of their tents or huts and feed themselves despite the crisis. In contrast to food aid, this subsistence farming helps make them more autonomous. However, it is a "band-aid" solution.

Therefore, an integrated and multidisciplinary approach should simultaneously be fostered to support the transition to sustainable development and lasting stability. In this regard, the participants underlined the importance of giving priority to measures that focus on food security, especially by access to land and inputs and through job creation to generate income. Diversified public and private investments are also necessary to stimulate the national economy and jumpstart local production. It was also reiterated that special attention should be paid to young people in order to avoid a rural exodus, as well as to women, particularly to facilitate their access to inputs and microcredit.

Participants believe that research should continue in order to understand the specifics of local contexts while analyzing their interrelations at different levels (regional, national and global). Modeling was discussed as a way of making good state practices known and adapting global solutions to various local contexts. The importance of identifying indicators was also mentioned. These could provide a better understanding of the links between climate change, food security and the risk of conflicts, while also attempting to predict and prevent conflicts related to climate change or to a food insecurity situation.

2. The agriculture sectors in the context of climate change

2.1 FOCUS ON THE AGRICULTURE SECTORS: COMBINING CLIMATE CHANGE MITIGATION AND ADAPTATION

Focus on the agriculture sectors: combining climate change mitigation and adaptation

Guy Debailleul, Professor in Rural Economy and Development, Université Laval - session chair

The agricultural and forestry sectors are, and will continue to be, among the most affected by the impacts of climate change, with potentially significant implications for the country and the people who depend on these sectors for their economy and livelihood. This is especially the case for the least developed countries and most vulnerable populations. They also have a key role to play in the adaptation of ecosystems and territories, as their primary managers and users. The agricultural and forestry sectors are also a substantial source of greenhouse gas emissions, and could help mitigate climate change by reducing their own emissions and increasing the sequestration of carbon in biomass and soil, without compromising their contribution to food security and nutrition. Numerous examples in the agriculture and forestry sectors show that adaptation and mitigation can often be pursued simultaneously with, in addition, other important benefits in terms of sustainable development.

When discussing the need for agriculture to adapt, several questions arise. We must reflect on the manifestations of climate change that are already apparent. Given the diversity of challenges and opportunities that adapting agricultural production systems to climate change present, it is worth collecting the participants' insights in this regard.

Agriculture, especially certain agricultural activities, contributes substantially to greenhouse gas emissions. Consequently, do we need to radically call into question specific methods of production or breeding, or are we capable of significantly reducing this contributing factor to climate change without disrupting production systems? What are the approaches that seem the most promising to you for the future?

Over time, farmers have often demonstrated a great capacity to adapt to changes in their natural, economic and institutional environment. In the context of climate change, it is important to take advantage of that tremendous resilience and consider the best means for achieving this.

It is clear that great disparities in productivity exist among the world's various farming systems, making some of them less competitive in a global market. Since climate change could potentially exacerbate those disparities, it is important to explore the opportunity to review trade rules, assistance programs, and agricultural policies to reduce these imbalances.

National Adaptation Plans as core vehicle to deliver on adaptation priorities and achieve countries' Nationally Determined Contributions

Julia Wolf, Natural Resources Officer, Climate and Environment Division, FAO

In a world in which 75 percent of the food insecure rely on agriculture and natural resources for their livelihoods (FSIN, 2017) and are also the most vulnerable to the impacts of climate change, the need for the agriculture sectors to adapt to climate change is crucial to ensure food security and nutrition. Agriculture must rise to the challenge of the growing population of 9.2 billion while adapting to climate change in a sustainable manner. But adaptation of agriculture sectors to climate change is confronted to many challenges, such as the multiple natural hazards agriculture is exposed to (extreme weather events, increased and varied temperatures, less rainfall, drought, etc.) and also changes in the usual patterns, the shifting ranges of pests and diseases, having a direct negative impact on yields. A major barrier lies also in the significant knowledge gaps on the implication of climate change on agriculture, including adaptation options (such as the economic impacts of climate change, the costs and benefits of different adaptation options, etc.). Moreover, women account for 43 per cent of the global workforce in the agriculture sectors, and gender equality therefore represents another important challenge in adapting to climate change (FAO, 2011).

These challenges reflect the transformational change needed in agriculture. Many studies have shown how smallholder farming, sustainable practices promoting diversity and the efficient use of resources are key to address all these challenges. In order to promote, support and strengthen the development of these practices, it is key to ensure a good enabling environment, and therefore review existing public policies, to address adaptation, through its mainstreaming in countries' national planning and budgeting.

The adoption of the Paris Agreement has given a momentum for countries' engagement in a transformative change towards more resilient, more sustainable agricultural systems to ensure food security. The agriculture sectors are indeed the foremost priority for adaptation in the Nationally Determined Contributions (NDCs) (FAO, 2016). National Adaptation Plans (NAPs) are a core vehicle to deliver on adaptation priorities, to achieve countries' NDCs. The formulation and implementation of NAPs can promote policies to better adapt to climate change, bring together stakeholders from all sectors to promote integrated agriculture production systems of livestock, crop, forestry and fisheries. The UNDP-FAO Integrating Agriculture in National Adaptation Plans, the NAP-Ag programme,[5] aims to address these key climate change adaptation concerns related to the agriculture sectors in 11 developing countries' existing national planning and budgeting processes. This programme works on the basis of countries 'needs and priorities in adaptation options and seeks to support them to strengthen local technical skills to identify and adopt climate risk management strategies, adjust national and sectoral planning and budgeting processes to incorporate climate change risks, and support farmers to learn from and adopt best practices in climate change adaptation.

5 For more information on the program, please see: http://www.fao.org/in-action/naps/en/

Senegal in the face of climate change: adaptation mechanisms

Saliou Seye, Training Manager,
Réseau des organisations paysannes et pastorales du Sénégal

Context and manifestations of climate change

In Senegal, the agricultural sector employs much of the active population in various sectors, such as farming, livestock farming, fishing, and forestry. It is also among the sectors that are most sensitive to climate change. Climate change manifest itself in various ways, including highly irregular rainy seasons (decrease in rainfall, late rains) and the salinization of soil and groundwater, resulting in a reduction of arable land. These phenomena, combined with high demographic growth, will lead to problems affecting land availability. The reduction of usable freshwater sources for agriculture can be considered as one of the concrete manifestations of climate change in Senegal.

Challenges and opportunities

Climate change will unquestionably bring about a number of challenges that will require finding remedial solutions to its effects on several fronts, but it will also provide opportunities. The challenges to be addressed should focus on the producers themselves, by developing their ability to be resilient when they are confronted with change, through training and advice on better adapted techniques, sharing experiences among producers, and rural farming innovation. It will also be important to foster an environment that allows for production diversification and helps producers develop storage and conservation systems to meet market needs in terms of quantity and quality.

Various resilience approaches

Owing to their more or less traditional character, production systems in Senegal and in Africa in general produce few greenhouse gases. They are often based on family farm operations with, for most part, rain-fed crops and irrigation in some areas. The approach that seems appropriate in this context is to strengthen family farming, but also promote systems that enhance the knowledge of rural farmers and means of production, as well as local marketing channels. In addition, this approach will incorporate diversification as an adaptation measure and will also integrate the use of short-cycle varieties (e.g., black-eyed peas in Senegal).

Mobilization of experiences and adaptation capacities

Indeed, producers, consciously or unconsciously, develop systems to adapt to the constraints they face, including the consequences of climate change. This strong capacity can be mobilized by identifying and promoting rural farming innovations, sharing experiences and good practices among producers, building the awareness of decision makers to support local initiatives, and applying research in order to find tailored solutions.

Mechanisms for reducing disparities

Production systems in Senegal are characterized by high vulnerability due to climatic, means of production, and market factors. This situation is likely to worsen as a result of climate change, but also due to dynamics linked to the economic, social and political context. Measures should be taken to facilitate the access of producers to agricultural equipment and inputs, as well as to extension services and training. The disproportionate competition with respect to farming in the North also poses a competitiveness problem for our producers who receive few government subsidies. All these aspects will need to be reviewed to give producers the means necessary to adapt to climate change.

Québec's young farmers in the face of climate change

Michèle Lalancette, President, Fédération de la relève agricole du Québec

Ms. Lalancette began by stating: "We need to change the way we do things. For several years, considerable attention has been given to plants, but the soil is what we need to be concerned about, as the soil nourishes plants and makes it possible to achieve the desired yields."

Ms. Lalancette mentioned that there are excellent development opportunities for northern agriculture through the introduction of technological innovations. Moreover, young farmers are heavy users of new technologies, but our governments must provide additional support for adapting to these new technologies.

It is essential to encourage efforts to reduce the use of pesticides. Climate change will exert even more pressure on their use. We must therefore be concerned about this

situation and find alternative solutions. Producers are under constraints to deliver products based on a going price and they will be pressured to deliver products of the same quality in larger quantities. That is why we need to show our support for scientific research in order to provide sound, cost-effective solutions that can easily be applied at the farm level. Ms. Lalancette suggests making climate change a collective mobilization challenge and sparking a genuine desire among young people to mobilize with countries that want to take action now.

"It would be a mistake to wait until all countries mobilized before acting. We need to be daring and set the wheels in motion via a strong, highly motivated core!" Obviously, there have to be short- and medium-term benefits. In the longer term, the benefits will be the gains achieved for our industry and consumers.

Ms. Lalancette also discussed international treaties: agriculture should have the same prerogatives as the arts and culture so that it can be valued and protected. Failing that, the measures implemented to fight climate change should be taken into account in food commerce in order to ensure fair trade among producers in different countries.

Lastly, according to Ms. Lalancette, the key to success when it comes to climate change hinges on the information that is provided to producers. It must be circulated, and producers must be informed and supported. Above all, coercion must be avoided!

The resilience of Québec's farms

Marcel Groleau, President, Union des producteurs agricoles

Although agricultural producers are always on the lookout for opportunities that might arise, they are aware of the challenges posed by climate change. Their strong capacity to adapt is constantly being tested. "Adapting our farms is not so much a question of having access to technology, but rather of maintaining profitability in a sector that is continually changing".

According to Ouranos,6 the main climate changes expected between now and 2050 in Québec's agricultural zone are an increase in average temperatures and total annual precipitation, a prolonged growing season and frost free period, and more intense precipitation events.

In a globally warmer climate, opportunities might arise for Québec's producers, including the introduction of new cultivars, improved yields of several crops, and the reduction of certain costs associated with the northern climate. Québec remains well positioned geographically. However, like other parts of the world, the province will not escape the challenges posed by climate change. The challenge of water management is particularly important in Québec, both in terms of supply and quality. Consequently, a better understanding of climate change and its impacts on agriculture will strengthen the resilience of farmers in Québec and elsewhere, especially with regards to pest management, maintaining soil quality, and adapting livestock facilities.

In order to integrate sustainable changes, a link between researchers and producers must be established and maintained so as to focus research on real problems and viable solutions. Agriculture can be part of the solution and play a role in carbon sequestration and reducing greenhouse gas emissions (GHGs). Targeted investments (e.g., pits, methanization) and changes in practices (e.g., soil conservation techniques, nitrogen fertilization management, livestock feeding) must be accessible. Documenting the GHG emission externalities for agricultural commodities and establishing the value of the products accordingly would contribute to raising consumers' awareness, especially regarding the emissions associated with transporting commodities.

6 For more information on the Ouranos Consortium, please see: https://www.ouranos.ca/.

The best way to mobilize producers is to involve them in the quest for solutions. For this reason, we partner with the Agriclimat project, farms adapted for the future. This three-year project is led by the Conseil pour le développement de l'agriculture du Québec and funded by the Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques. Its aim is to document the impacts of climate change on agriculture in every region of Québec and have regional producers as well as agricultural and climate specialists develop adaptation plans. Implementing the adaptation plans will depend on the means to be developed to support them, with an eye to maintaining the largest number of farms and a maximum diversity of production.

Lastly, while each food system has its own economic, social, geographical, and climatic characteristics, it is important to review certain unfair rules that result in undue competition between farmers, wherever they are in the world. For several years, the UPA has been demanding the recognition of the agricultural exception in trade agreements. If nothing is done, climate change will exacerbate real problems that are widely decried by farmers all over the world.

2.2 LIVESTOCK FARMING: POSSIBLE SOLUTIONS

Livestock farming: possible solutions

Anne Mottet, Livestock Development Officer, FAO - session chair

Climate change has multiple direct and indirect effects on animal production. The most significant impacts regard productivity, animal health, and the quality and quantity of animal feed, including grazing. The increase in the variability of precipitation leads to drinking water shortages. It also influences grassland composition, pasture yield and forage quality. A rise in temperatures can create stress for animals, which is accompanied by various negative consequences: decrease in their feed intake and productivity, lower reproduction rates, reduced resistance to diseases and parasites, higher mortality rates. These changes also alter the distribution and spread of diseases and parasites affecting animals.

The livestock farming sector contributes significantly to climate change but shows strong potential to reduce emission intensity. More efficient production leads to increased production as well as to emission reduction resulting from a decrease in inputs. Therefore, the benefit is twofold: improved food security coupled with climate change mitigation.

Solutions exist, and lie primarily in better herd management and improved selection, breeding, health and feeding, as well as in better manure management. Improved grazing management can also promote carbon storage and improve animal diet. Additionally, livestock farming allows for better use of resources (land and biomass) and is often an adaptation solution for diversifying income or replacing crops when changes in precipitation make crop farming impossible.

Recapitalization of 5,000 family farms through goat breeding and milk production in regions devastated by Hurricane Matthew in Haiti

Michel Chancy, Professor-Researcher, Faculty of agricultural and environmental sciences, Quisqueya University

In Haiti, about 25 percent of families (50 percent of farming families) breed goats for meat production, which is considered one of the primary means that should be developed to improve the income and living conditions of extremely impoverished small farmers and combat food insecurity.

In November 2016, following hurricane Matthew's destruction of several departments in Haiti, a consortium of Haitian institutions and associations launched a recapitalization program. The objective was to allow farming families to re-establish a portion of the goat population that had been lost, and which represented their main source of savings. Adult goats were distributed to families as a payment-in-kind loan. A family that increased its herd in the first year could expect an annual income three to four times greater than the initial investment. In addition to distributing animals, the program supported the construction of animal pens and shelters and the creation of small forage plots.

Photo 11. A farmer feeding her sheep. ©Alex Webb/Magnum Photos for FAO

Cattle farming is also a major activity in the Haitian family farming economy. Support is provided for a network of mini dairies in order to give smallholder farmers better access to the milk market.

Focusing on social innovation to reduce GHGs while helping businesses perform better

Josée Chicoine, Strategic Advisor, Agri-Food Development, Coop Carbone

Today, many technological and behavioural changes are available to enable farm businesses to reduce GHGs and even seize opportunities linked to the carbon market and renewable energy development.

The obstacles to adopting certain practices that would result in reducing GHGs on farms are primarily economic, but they also stem from a natural resistance to change as well as from more systemic barriers. Indeed, barriers to implementing already known and accessible mitigation measures are often complex and diverse. These barriers can be difficult to remove at the business level or may require too much of an investment in time and money, which would jeopardize the profitability of the projects themselves.

Supporting businesses under the umbrella of structuring and collaborative projects can help remove systemic barriers, foster mobilization, and get people talking about the projects. This type of project facilitates the implementation of initiatives at the business level in order to unlock GHG emission reduction potential.

This will involve shared efforts aimed at reducing GHG emissions associated with livestock farming, focusing on such elements as enteric methane and manure management, which are significant sources of agricultural emissions.

An innovative approach to adapting the classic individual household economy analysis (IHEA) to the pastoral realities of the Sahel's fragile areas

Blamah Jalloh, Breeding Engineer in Niamey, Regional Technical Coordinator of the Billital Maroobe Network

As part of a project to support the design of social safety nets adapted to the realities of pastoral livestock farming (FISOREP), the Billital Maroobe Network (RBM) implemented a data collection and analysis mechanism. The mechanism used the Individual Household Economy Analysis (IHEA) approach and involved about 1,500 households. The food insecurity score is based on answers to nine questions dealing with a household's daily experiences with food insecurity, according to the method recommended by FANTA. This allowed to establish household profiles, define the survival threshold and viability conditions for these basic

Photo 12. Bringing home cattle at sunset to a small settlement in the desert. ©FAO

socioeconomic units, as well as their livelihood protection threshold.

By designing a database, the IHEA approach adapted to pastoral realities also made it possible to implement a mechanism to monitor and assess the effects and scope of medium- and long-term interventions on the living conditions of households benefitting from external support.

The main lessons learned from the study of the intervention areas are as follows:

- Several factors motivate the transhumance departure of households and determine their choice of host areas. Overall, in the area studied, pastoral and agropastoral households exhibited a negative growth rate for all species, ranging from –1 percent for cattle to –23 percent for camels. During the same period, the exploitation rate for all species was positive and was higher for small ruminants (+23 percent for sheep and +22 percent for goats). There are several reasons for this, the primary one being to support expenses related to transhumance and the family.
- Milk production is a source of income that enables households to meet basic needs. The average annual income per livestock farmer stemming from the sale of fresh milk and its derivatives is estimated at 1,192,381.29 CFA francs. This income is essentially higher from July to December.
- Lastly, many of the pastoral and agropastoral households studied (47.33 percent) are experiencing moderate to severe food insecurity. In all of the areas studied, with the exception of the region east of Burkina Faso, more than one fourth of households are experiencing food insecurity. Of these, 26.78 percent are experiencing severe food insecurity. The analysis of the results based on households shows that pastoral households suffer from the most severe food insecurity (40.2 percent of pastoral households compared to 22.90 percent of agropastoral households).

Summary of the discussions

As a source of calories and protein, and owing to its essential contribution to income, livestock farming represents an important agricultural sector for food security, but it also has a significant environmental impact. The livestock farming sector is often criticized and commonly associated with a tendency to overconsume meat in industrialized countries, a tendency that is also increasing in developing countries. Should we all become vegetarians? Can livestock farming offer solutions? These were the major issues discussed in this session.

Participants quickly agreed that vegetarianism was not necessarily the solution, especially among populations suffering from nutritional deficiencies. At the same time, discussions pointed out that raising public awareness

about the consequences that consuming too much meat can have, not only on the environment but also on health, would be part of a reasonable solution. From a production perspective, participants showed how livestock farming can complement crop production. They gave as examples the symbiotic systems in Vietnam that combine rice cultivation and fish farming, as well as agreements between farmers and pastoralists in Côte d'Ivoire whereby the residue of crops harvested to feed herds can be exchanged for herd excrement to fertilize the soil. These closed-circuit holistic approaches are one of the keys to livestock farming practices that are consistent with climate challenges. The entire livestock farming chain should be considered in this perspective, not only the methane emissions from cattle, but also the numerous innovative solutions for the recapture of carbon and its restoration in the soil through best agricultural practices.

The importance of moving away from a dichotomous way of thinking that pits livestock farming against the environment or even against health was also brought up repeatedly. A participant from Senegal stressed how health ministries are not included by other ministries in climate change discussions. As a result, environmental considerations are not reflected in food policies. A participant from Québec replied that economic considerations can sometimes break down barriers between these sectors. As an example, she cited a difference of opinion involving Québec's ministry of health and ministry of agriculture regarding the importance of increasing the consumption of fruits and vegetables in food recommendations. A policy agreement was reached following an economic study showing that such an increase could have a positive economic impact on these sectors of production. When applied to livestock farming, these types of analyses would make it possible to deal with the sector transversally, in addition to implementing adapted solutions at the local level.

2.3 FORESTS, CLIMATE CHANGE AND FOOD SECURITY: BRIDGING THE GAP BETWEEN AGRICULTURE AND FORESTRY

Forests, climate change and food security: bridging the gap between agriculture and forestry

Alain Olivier, Professor, Phytology Department, Chair in International Development, Université Laval - session chair

Agriculture and forestry are facing two major challenges: ensuring food security in the context of demographic growth and climate change, and contributing to reduce greenhouse gas emissions.

Agriculture is the principal cause of the deforestation currently taking place in the world (about 80 percent of deforestation), primarily in tropical and subtropical areas. This trend is compounded by climate change and land degradation, as well as by agricultural, forest and land policies that often lack coordination, especially in developing countries. At the same time, forests and trees are essential to food security. They directly provide a variety of micronutrient-rich foods to populations that depend on them, in particular Indigenous peoples. Forests and trees are an important source of income for the most vulnerable populations and a source of cooking energy for one third of the world's population. Moreover, they provide ecosystem services that are vital to agricultural production, particularly in terms of regulating water cycles and pollination at the local, national, and even regional levels.

For all these reasons, forests have a major role to play in the adaptation of agricultural systems and livelihoods, in addition to the contribution they make to climate change mitigation. Therefore, to achieve sustainable food security, it is essential to reconcile the two sectors in order to improve agricultural productivity while halting, or even reversing deforestation.

Forests and trees for food security and nutrition in a context of climate change: a way forward for integrated solutions

Vincent Gitz, Director, Research Program on Forests, Trees and Agroforestry, Consultative Group on International Agricultural Research

The presentation discussed the interactions between forests, trees, climate change and food security and nutrition (FSN). Forests and food security have often been considered antagonistic. Under this narrative, forests need to be cleared to enable expansion of agriculture. And the increasing performance of agriculture, as well as increased demand for food (and meat) generates even more incentives for deforestation. However, evidence calls for considering another narrative, by which forests and trees matter more than ever for agriculture and the world's food security in a context of climate change. This because of three main linkages between forests, food security and climate change:

- Climate change impacts forests and trees, in turn negatively affecting FSN.
- Forests and trees are key to adaptation of agriculture and landscapes to climate change, hence to food security in a changing climate.
- Forests and trees mitigate climate change (vital to preserve FSN in the medium/long term), by storing carbon or as source of bioenergy

While the third link is well known – for instance forests' carbon sinks have absorbed some 30 percent of CO2 emissions in the last 2 decades (Smith P. et al., 2014), the two others have so far been given less consideration. Forests and trees reduce environmental vulnerability and increase resilience of ecosystems, landscapes, farms and households, therefore are key to FSN. They perform a key role for biodiversity, ecological functions and ecosystem services, for the regulation of the terrestrial and atmospheric water cycle, for temperature regulation, to protect coastal areas against sea level rise, and as a protection against floods. At household level, for the estimated 1 to 1.6 billion "forest-dependent" people, including smallholder farmers, forests and trees can play an important safety net role in times of emergency, or of economic or climatic shocks – because of the capital they form, as a source of product diversification, and also because wild foods are key sources of dietary diversity (HLPE, 2017). With climate change increasing all categories of risks to which food systems and households are confronted (FAO, 2016), preserving these functions will be particularly important.

In a changing climate, maintaining forest ecosystems in a healthy state is therefore a straightforward action. But the next challenge is to optimize agriculture and forestry together, not one by one, and at different scales, towards an ecological and productive land-use integrated approach for adaptation and mitigation. Integration is key, as action in one domain can have impacts in another domain, such as the impact on food security of forest based mitigation policies.

Successful examples and solutions exist, including land-use policy and decision tools, coming from the latest research within the CGIAR Research Program on Forests, Trees and Agroforestry. This research also points to emerging issues and knowledge gaps.

There is a need to remove barriers between agriculture and forest policies for the sake of climate change and food security. This is as important for the success of adaptation policies, as for mitigation policies such as REDD+.

Agroforestry, food security and resilience in the Sahel

Diaminatou Sanogo, Researcher, Senegalese Institute for Agricultural Research

Agroforestry plays a central role in the resilience of ecosystems and communities in the Sahel. It provides an alternative to the forest-agriculture confrontation. Indeed, agroforestry improves: the capital base of poor households through regenerating or planting trees in fields; crop and livestock productivity; the multifunctionality of agricultural landscape by ensuring a balance between increased productivity and the sustainable management of natural resources; the provision of ecosystem services; the provision of timber forest products and non-timber forest products (NTFPs) allowing for the food, economic and ecological diversity of rural landscapes.

In Senegal, for example, the assisted natural regeneration (ANR) of two ligneous species, Guiera senegalensis and Combretum glutinosum, resulted in an increase in the millet yield by 41 percent and 64 percent, respectively (Camara

et al., 2017). Sanogo et al., (2013) have shown that only 3 percent of those who adopted ANR, compared to 14 percent of those who did not, fail to meet their annual food needs beyond four months. These authors have shown that this resilience is enhanced by the sale of NTFPs, which brings in an average income per season of 63.74 USD/adopter vs. 26.09 USD/non-adopter. An ex ante assessment of sustainable management plans and solutions for setting up an off-limits area of 20 hectares in Senegal's Arachidier Basin showed that exploiting 25 percent of wild fruit makes it possible to significantly increase surpluses resulting from the exploitation of the Simple Management Plan products, representing a 0.52 percent addition to the aggregate income as opposed to 0.37 percent (Sanogo et al., 2014).

Lastly, some of the findings of the agroforestry research conducted by the Senegalese Institute for Agricultural Research and its partners to strengthen the resilience of communities and ecosystems were presented. They focussed on the domestication of the Adansonia digitata (baobab), Tamarindus indica (tamarind) and Ziziphus mauritiana (jujube) forest fruit trees. The presentation recommended scaling the agroforestry research findings based on the Climate-smart village (CSV) Agricultural Research for Development (AR4D) model.

Trees at the service of intensive agriculture

Alain Cogliastro, Researcher, Montreal Botanical Garden, Associate Professor, Université de Montréal

Surveys indicate that major climate variabilities and the uncertainties they cause are among the climate change concerns of farmers (Bryant et al., 2007). Diversifying activities and sources of income is one of the solutions being considered for adapting to future changes. Agroforestry, which incorporates trees into crop production, takes this option into account. It also has strong potential for providing ecosystem services that are essential to current and future agricultural production issues.

The presentation included an overview of intensive agriculture in Québec which, as in most temperate countries, relies on a few major crops that extend over large areas. It also addressed the effect of intensive practices on biodiversity by emphasizing the rarefication of several species and the obvious concern regarding the protection of residual forest environments. Efforts aimed at increasing the forest canopy are being made, but at the same time, increasing agricultural production continues to be a goal. Agroforestry could reconcile these two objectives. The presentation also showed how, in a temperate climate with high levels of precipitation, the risk of soil degradation due to runoff can be mitigated by the presence of trees (Udawatta et al., 2011; Seobi et al., 2005). This effect is particularly important in light of the likely increase in extreme events caused by climate change.

Agroforestry combines ligneous and herbaceous species with distinct growth patterns. As a result, we can anticipate greater efficiency in the use of resources, increased primary production (Graves et al., 2007), and greater carbon sequestration (Bambrick et al., 2010; Peichl et al., 2006). Diversity, especially of soil organisms, also seems to be linked to the increased stability of biological systems (Rivest et al., 2013), a condition that makes it possible to sequester more carbon.

The financial profitability of agroforestry at the producer level is still uncertain and dependent on the calculation assumptions used. However, the overall economic profitability of agroforestry at the territorial level is well established because of the numerous public services provided (Alam et al., 2014). Agroforestry is currently still very discreet in the landscape, but its deployment seems realistic.

An analysis conducted by a working group from the Agroforestry Committee of the Québec Reference Center for Agriculture and Agri-food (Anel et al., 2017) concluded by making six recommendations to boost the deployment of agroforestry in Québec: (1) recognition by government authorities of agroforestry's potential and its integration into policies and programs; (2) increased knowledge transfer through a network of advisors, information tools, demonstration sites, and the integration of agroforestry into education intended for future farmers; (3) granting of financial support to producers via a program dedicated to agroforestry practices; (4) development of basic and applied knowledge; (5) development of plant materials adapted to agroforestry conditions; (6) establishment of a provincial working group on agroforestry consisting of representatives from the main institutions involved in agriculture, forestry,

the environment, and land use.

Implementing these recommendations has the potential to unite many local and regional players behind concrete projects that could bring about benefits adapted to various regional realities.

Summary of the discussions

Forests are shrinking due to agriculture, which is currently one of the main causes of deforestation in the world. Its consequences are often disastrous. A young researcher reported her experience in the Brazilian Amazon, where deforestation for agriculture is a major cause of soil erosion. A nutritionist pointed out the negative effects of deforestation on the food security and nutrition of First Nations, which depend on forests for their food, primarily through hunting and gathering, but also for generating income.

In the era of climate change, it is imperative to restore the rightful place of trees in agricultural systems. Indeed, the repercussions of climate change on forests threaten food security, but, as one participant noted, trees in themselves constitute a technology for adapting to climate change and mitigating its effects both in cities and in the countryside. Trees and forests are sources of food, income and energy, and provide essential ecosystem services in terms of regulating water cycles, pollination and soil fertility. The use of semi-forested areas in agricultural systems, for example, should be encouraged, since a lack of trees can cause water drainage and soil fertility problems. Furthermore, trees that are planted or retained sequester carbon and help mitigate climate change.

The participants therefore argued that agroforestry represents an alternative to the forest-agriculture clash when it comes to land use. A Senegalese participant stated that a number

Photo 13. Giant of Kauri Forest, Erromango Island, Vanuatu. ©FAO/Rudolf Hahn

of farmers in her country are already convinced of the benefits associated with integrating trees into farming. This is especially the case for women, who are already deriving economic benefits from the sale of non-ligneous forest products. The added value of fertilizer tree plantings was also demonstrated. However, it was explained that in Haiti the opposite is true: there appears to be minimal interest in investing in trees, since farmers rent land for only a few years at a time. As a result, the lack of land security is a hindrance to adopting agroforestry practices.

Participants also gave special consideration to the role played by political leaders. It was reported, for example, that to raise young people's awareness of the crucial function of trees, the Cameroonian government gives a tree to each student in some schools. The student is then responsible for the growth of its tree. However, discussions also pointed out that in most countries, government incentives focus instead on promoting the development of an agro-industrial model, including in regions where agroforestry was initially practiced by rural farmers.

It is therefore crucial to highlight the multiple ecological, socio-economic and cultural functions of agroforestry systems with regards to biodiversity, food security, and sustainable development. While the link between forests and carbon sequestration is now widely acknowledged, the relationship between forests and food is still poorly understood. The multidisciplinarity and decompartmentalization of agricultural, forest and land policies, the establishment of training programs for rural stakeholders, and the implementation of grant programs are central to a broader reconciliation of agricultural and forestry practices. As one participant noted, integrating trees and agriculture represents a paradigm shift that requires building bridges between disciplines, stakeholders and policies.

Photo 14. Collaborative exchange and dialogue session. ©Éric Labonté, MRIF

3. Food systems in the face of climate change

3.1 FOOD SYSTEMS IN THE CONTEXT OF CLIMATE CHANGE

Food systems in the context of climate change

Geneviève Parent, Professor, Faculty of Law, Legal Research Chair in Food Diversity and Security, Université Laval - session chair

Food systems will have to adapt to the transformations and risks brought about by climate change. They must also be able to help mitigate climate change. The modification of production zones, the need to ensure agricultural and food diversity, population migration, and sustainable supply stability are all among the challenges that food systems must address.

In addition, food production and consumption are a significant source of greenhouse gases, from primary production to processing and transport. Also keep in mind that consumption plays a key role in the direction production takes.

Food systems are many and varied. Like agriculture, they will have to reconcile adaptation and mitigation objectives, using various means to achieve this: production, conservation and processing techniques that are in line with an ever increasing demand for sustainable production, legal instruments that ensure food diversity and security, local and regional markets that are adapted to the diversity of food systems. Local networks of agricultural, agri-food, and service companies that pool local resources while taking sustainable development criteria into account can play an important role in facilitating the adaptation of systems and small producers.

Photo 15. Mountain Herdsboy in Mu Cang Chai - Yen Bai province. ©FAO/N Tuan Anh

Diversity of food systems and resilience to climate change

Jean-Louis Rastoin, Emeritus Professor, Montpellier SupAgro, Founder and Scientific Advisor of the UNESCO Chair on World Food Systems

There are hundreds of forms of food systems on our planet. They can be grouped into three meta-categories: the agro-industrial model, traditional systems, and intermediary forms. In the face of climate change and other major social, environmental and economic challenges, it is essential to organize the food transition according to the criteria of sustainable development, in order to ensure the food and nutritional security of the inhabitants of every country. A majority of scientific studies conclude today that strong negative externalities exist in the dominant food systems and that there is a need to design and build innovative systems based on the quality of the products and their territorial anchorage, the proximity and solidarity of the stakeholders and, as a result, redesigned technological trajectories, new behavioural patterns on the part of producers and consumers, as well as new organizational methods. In this perspective, the chain of knowledge (R & D, education, training), together with ethics and governance in the public and private spheres at the local, national and international levels, will play a key role.

Impacts of alternative investment strategies under alternative climate change regimes

Alex De Pinto, Researcher, Environment and Production Technology Division, International Food Policy Research Institute

Most business-as-usual scenarios for farming under changing climate regimes project increasing food shortages by 2050. Underdeveloped economic regions where food security is already problematic and populations are vulnerable to shocks are expected to suffer the worst consequences. Increases in temperatures and in the frequencies of extreme weather events are expected to undermine the technological and management improvements in crop and livestock productivity. Moreover, climate change is expected to have consequences on a wide range of other ecosystem services.

Uncertainties in climate change scenarios make it difficult to determine the precise impacts on future agricultural productivity. Warmer temperatures and longer growing seasons may increase agricultural productivity in some high-latitude regions but studies have consistently found that under the most severe scenarios of climate change, significant losses should be expected worldwide. No matter the severity, regional differences in crop production are expected to grow stronger through time, with the risk of widening the gap between the haves and have nots,

increases in prices and hunger amongst the poorer nations. Moreover, localized weather shocks and emerging pest and disease outbreaks are already compromising stability in crop production, highlighting the urgency for immediate and adaptable management responses.

Perhaps ironically, agricultural production contributes substantially to the problem with yearly greenhouse gas (GHG) emissions that range from 5.0 to 5.8 Gt CO2e, or about 11 percent of total anthropogenic GHG emissions, not including land use change (Smith et al., 2014). Combined with forestry and other land uses, anthropogenic land activities contribute about a quarter of annual GHG emissions, the equivalent of 10 to 12 Gt CO2e per year, three-fourths of which are estimated to originate in the developing world (Smith et al., 2014). Poor soil management and vast land conversions from tropical forests to poorly productive agricultural systems, for example, result in a large climate footprint. Smallholder farming systems contribute to 3.4 percent of the total global emissions.

After a brief review of the current knowledge of the effects of climate change on agricultural production, the benefits of a series of possible investments were explored with a particular focus on Climate-smart Agriculture. Recent analyses indicate that while "win-win" outcomes appear possible they are not automatic and for these to reach levels that contribute significantly to global food security challenges and emission abatement targets proper incentives and policies must be in place.

Legal fiction resulting in real environmental protection

Hugo A. Muñoz Ureña, Professor and Director, Institute of Legal Research, University of Costa Rica; Senior researcher, Legal Research Chair in Food Diversity and Security, Université Laval

Dividing reality into two categories

The foundations of law include a classification that distinguishes between people (subjects) and things (objects). However, what falls in one or the other of the categories has undergone changes over time, which could give us possible options for new legal protection of the environment.

Regarding subjects, it could be said that, in the past, not all human beings were considered people. Slavery, among other examples, highlights this situation. The law has also succeeded in adding abstract constructions to both categories. Through legal fiction, new subjects, to which moral or legal personalities were attributed, indisputably belong to the category of persons (corporations, cooperatives and even states). Also, "intangible" assets such as subjective rights or goods stemming from intellectual property currently belong to the category of things. The effect of this distinction is that subjects can exercise dominance over objects. This dominance can take various forms, but only persons can have rights and obligations. In the context of environmental protection, the ultimate goal is the well-being of persons ("anthropocentric" vision).

The emergence of innovative approaches

Innovative legal approaches, based on traditional cultures, have recently been given preference by some judges and lawmakers, especially in countries in the South. These approaches allow for recognizing the rights of things. Such a possibility had already been mentioned in the literature. Some judges have granted requests for the protection of animals (especially primates) through procedural remedies established to protect the fundamental rights of persons. Examples where legal personality (or certain rights) has been granted to rivers or to all of nature have recently been observed (New Zealand, India, and Colombia). One should also mention the vision of nature adopted by the new Bolivian and Ecuadorian constitutions.

These examples are based on legal fiction, like the one used to grant legal personality to legal entities. Significant impacts on environmental protection (including climate change) could emerge. New forms of land organization could develop, starting with watersheds considered as a kind of legal person. Subsequently, food production and organization of the local supply chains could also feel the effects of such a change: the rights of these new legal persons will need to be considered. Environmental "externalities" will be taken into account in the form of legal obligations to the environment. It is therefore important to closely monitor these developments.

Photo 16. Agriculture, the main option". ©FAO/Rubí López

Potential of diversified agro-ecological farming for sustainable and resilient food systems in the face of climate change

Émile Frison, Independent Consultant on agriculture, biodiversity and sustainable food systems and member of the International Panel of Experts on Sustainable Food Systems[7]

Today's food and farming systems have succeeded in supplying large volumes of foods to global markets, but are now generating negative outcomes on multiple fronts. Many of these problems can be linked specifically to 'industrial agriculture', i.e. the industrial-scale feedlots and uniform crop monocultures that dominate agricultural landscapes, and rely on chemical fertilizers and pesticides as a means of managing agro-ecosystems. This form of agriculture is associated with widespread degradation of land, water and ecosystems; high GHG emissions; biodiversity losses; persistent hunger and micro-nutrient deficiencies alongside the rapid rise of obesity and diet-related diseases; and livelihood stresses for farmers around the world.

In contrast to industrial agriculture, diversified agroecological farming can deliver simultaneous and mutually-reinforcing benefits for productivity, the environment and society. These alternative systems deliver strong and stable yields over time by building healthy ecosystems where different species interact in ways that improve soil fertility and water retention. They perform particularly strongly under environmental stress and deliver production increases in the places where additional food is most needed. These systems have major potential to keep carbon in the ground, increase resource efficiency and restore degraded land, turning agriculture from a major contributor to climate change to one of the key solutions. Diversified agriculture also holds the key to increasing dietary diversity at the local level, as well as reducing the multiple health risks from industrial agriculture (e.g. pesticide exposure, antibiotic resistance).

Recognizing the potential of diversified agroecological production systems, the presentation examined "what prevents the transition to these sustainable models of agriculture". Eight 'lock-ins' or key feedback loops that characterize modern food systems and keep industrial agriculture in place are: Path Dependency; Export Orientation; The expectation of cheap food; Compartmentalized thinking; Short-term thinking; 'Feed the world' narratives; Measures of success and Concentration of power.

Finally, a set of coherent steps that strengthen the emerging opportunities while simultaneously breaking the vicious cycles that keep industrial agriculture in place were suggested. Together, these steps must shift the center of gravity in food systems, allowing harmful dependencies to be cut, the agents of change to be empowered, and alliances to be forged in favor of change. These include: developing new indicators for sustainable food systems; shifting public support towards diversified agroecological production systems; supporting short supply chains & alternative retail infrastructures; using public procurement to support local agroecological production; strengthening movements that unify diverse constituencies around agroecology; mainstreaming agroecology and holistic food systems approaches into education and research agendas; and developing food planning processes and 'joined-up food policies' at multiple levels.

7 For more information, please see: http://www.ipes-food.org.

3.2
THE ROLE OF WOMEN IN WEST AFRICA'S FOOD SYSTEMS

The role of women in West Africa's food systems

Ndèye Yacine Badiane NDour, Senior Research Fellow and National Laboratory for Research on Plan Production Director, Senegalese Institute of Agricultural Research - session chair

In West Africa, women are entirely responsible for the family food sector. They play a major role in community food security. The traditional division of family-related and social responsibilities, which must increasingly deal with severe constraints imposed by the market economy, gives women a key role in food security. Men frequently provide the grains, and women manage to turn them into meals. Women more readily allocate land for home consumption purposes (vegetable gardens, food production, medicinal plants, etc.). They are involved in the entire value chain of farm products in the rural sector. They are generally in charge of subsistence farming for the family's food consumption, and of the processing, marketing and preparation of farm products. The entrepreneurship of women is an invaluable asset for food and nutritional security as well as for the resilience of West African communities.

The role of indigenous pastoralist women in the fight against food insecurity and malnutrition in the Sahel

Mariam Wallet Aboubakrine, Doctor, Tin-Hinan Association and United Nations Permanent Forum on Indigenous Issues

The Sahel is an extremely arid region where the effects of climate change have already had a palpable impact on its inhabitants. The later depend heavily on the climate for their existence and means of survival, which consists primarily of agriculture and livestock farming. Furthermore, in the case of nomadic pastoralist livestock farmers, women play a crucial role in adequately responding to this scourge in the community and even at the national, regional, and international levels.

These women are pillars in their communities, countries and regions owing to the traditional knowledge they possess and the sociocultural roles that are attributed to them. They are the ones who are responsible for producing, preparing and managing food for the family. They are able to recognize signs of nutritional deficiency. Consequently, they are the first-line care providers for their children and other members of the family or the community. They spend most of their budget on feeding their families. They are the first to detect the warning signs of an imminent food crisis. When these crises occur, they are key collaborators that all humanitarian workers in this field of activity must include in their response if it is to be successful.

Today, in a globalized and interconnected world, where actions that have a negative impact on climate in one region affect the entire planet, we are, to some extent, "all in the same boat." Pastoralist women are involved in the Global Indigenous Peoples' Movement, whether through United Nations mechanisms pertaining to Indigenous peoples, United Nations organizations, funds and programs, or the appeals of major global processes: the 2030 Agenda for Sustainable Development, the Paris Agreement on Climate Change, the Committee on World Food Security (CFS), the International Food Security and Nutrition Civil Society Mechanism (CSM), etc.

Given the role that women in general, and female West African pastoralists in particular, play in their communities, it is imperative that efforts to achieve Goal 2 (Zero Hunger) of the 2030 Agenda for Sustainable Development in the era of climate change rely upon them.

Lastly, there is an urgent need to strengthen the capacity of these women: empower them (economically and through their political participation), promote, revitalize and protect their traditional knowledge and know-how, so that this fundamental fringe element of our communities can contribute fully to fighting food insecurity and malnutrition and, more broadly, to achieving the Sustainable Development Goals.

Photo 17. Collaborative exchange and dialogue session. ©Éric Labonté, MRIF

Analyzing the role of women in the development of sustainable agriculture and resilient food systems in West Africa

Mariama Sonko, General Treasurer, Association of the young farmers of Casamance; National Coordinator, "We Are the Solution" movement in Senegal

An analysis of the role of women in the development of sustainable agriculture and resilient food systems in West Africa reveals that women are responsible for 67 percent of the hours spent working. Nevertheless, the status of women frequently deteriorates more than that of men, in both relative and absolute value. Women continue to earn less than men for the same work.

Reflecting on the empowerment of women to sustainably improve food security in West Africa

Meriem Houzir, Founder and Director of the AlliaDev Franco-Moroccan consulting firm

FAO highlighted the role of women in its report, The State of Food and Agriculture 2010-11: Women in Agriculture. The importance of economic empowerment in the agricultural sector was especially stressed in 2011 at the International Conference on Women's Empowerment in Ottawa, jointly organized by Canada and UN Women. In 2012, the 56th session of the Commission on the Status of Women focused primarily on the empowerment of rural women and their role in eradicating poverty and hunger, as well as in development, and in addressing current challenges. In their negotiations, the UNFCCC (United Nations Framework Convention on Climate Change) and UNCCD (United Nations Convention to Combat Desertification) also included statements on the important role played by rural and farming women.

If we are to be consistent with these international commitments, it is important to reflect on the opportunities and constraints associated with empowering women to sustainably improve food security in West Africa. How can we strengthen women's leadership in conjunction with their economic empowerment and promotion of the value chain, while striving to preserve the environment, biodiversity and, in particular, the need to develop sustainable agriculture that is resistant to climate change? How can women farmers develop their capacity to produce agro-ecological crops that are adapted to climate change? How can women farmers, at the forefront, develop and manage their own businesses and income-generating activities, in addition to sharing their know-how? What role can these women play in food sovereignty through the conservation and reproduction of local, indigenous seeds?

Summary of the discussions

Despite their predominant role in agriculture, African women have only minimal access to land and financial resources. This not only catalyzes the feminization of poverty but also makes women the primary victims of climate change and the most vulnerable to food insecurity. To reverse this situation, it is essential to stimulate the leadership of these custodians of traditional knowledge by empowering them economically. This requires, among other things, involving rural African women in the most lucrative links of value chains, where they are often absent or poorly positioned. However, where the role of women is concerned, several obstacles remain, especially with regard to satisfying family needs.

Among the solutions proposed, participants recommended that the "gender" component be included in policies, and that women be involved in drafting such policies. Experts in attendance noted certain legislative initiatives that have provided more empowerment for women, enabling them to participate fully in political and socioeconomic life. For example, in Senegal, a 25 percent quota is reserved for women in order to allow them to hold public service positions, while gender parity legislation also enables women to serve in the National Assembly. With respect to Mali, some fields near villages are automatically given to women so that they can farm independently and benefit from their income. Sub-regional policies (Economic Community of West African States) and continental policies (African Union) were also underscored for their contribution to women's capacity building.

However, discussions also pointed out that there is a significant difference between gender equality policies as they appear on paper and their concrete implementation. Indeed, in reality, women continue to face many difficulties that are often related to traditional practices. In this regard, participants mentioned that there is a gap between women's participation and their actual involvement. Examples were given of meetings where women are physically present but do not speak. It is therefore important for everyone to support gender equality, especially since there is sometimes the same degree of opposition from men and women to changing traditionally established roles. Access to education and awareness raising in schools were identified as important potential solutions. Several participants stressed the fact that women who are more educated have a better knowledge of their economic and inheritance rights. In addition, they are more efficient producers.

Lastly the participants agreed that the problem is not so much a lack of initiatives but rather the fact that initiatives are not valued. We must go further and bring about a change of attitude in order to establish a system where the role of women is valued and recognized, thereby making the true empowerment of women in West Africa's food systems possible.

3.3
FEEDING CITIES

Feeding cities

Florence Egal, Expert in food security and nutrition - session chair

Climate change on the one hand and food security and nutrition on the other are too often considered separately. Yet both of these issues are closely linked to food systems that have become dysfunctional, as determined by a production-driven development model that has failed to take environmental and social dimensions into account. The time has come to rebalance the situation, starting with demand, and to involve consumers and citizens in reorienting these systems.

Today, most of these consumers live in cities. It is essential to ensure the quality and safety of their food, but also to take into account the implications that their consumption patterns have for environmental management and jobs across all sectors concerned, especially regarding the surrounding region. Hence, foods that are sustainable, healthy and respectful of the environment and social justice need to be promoted.

Municipalities and regional authorities – in collaboration with local stakeholders – are therefore being urged to play a key role as catalyzers for a sustainable development that contributes to food security and better nutrition in the context of climate change.

Throughout the world, public procurement (particularly for school canteens), farmers markets, and the food service industry are critical levers for ensuring a healthier diet for people as well as for creating jobs. Initiatives are on the rise: restaurants are featuring local seasonal produce; school children are visiting farms and working in school gardens; and fighting waste has become a priority. In

Athens, community gardens have improved the ordinary diet of the poorest households and built social ties. In Barcelona and London, markets in the heart of the city have become vibrant centres for locals and tourists. In New York, social welfare programs distribute coupons that can only be used to purchase local fruit and vegetables. And everywhere, immigration, social insecurity, and the employment problems of young people – and of course women – are both a challenge and an opportunity. As a result, social and solidarity economy initiatives are emerging every day. But to what extent is such an approach realistic over time? Is it possible to simultaneously improve food availability, contribute to the territory's economic development, and manage the environment more sustainably?

The Institute for Sustainable Food Systems at Kwantlen Polytechnic University recently conducted prospective studies focusing on British Columbia's southwestern bioregion. The findings are promising. Assuming a 60 percent population increase by 2050, the study shows that by strategically reallocating crop and livestock production to meet local food demands and limit the negative impacts of agriculture on the environment, while at the same time expanding the land area under cultivation, it would be possible to increase the region's self-reliance from 40 percent, where it stands today, to 57 percent. Furthermore, the potential for local economic development would almost double. This type of research could be helpful to bordering municipal and rural authorities in assessing whether or not to consider a territorial reorientation of food systems.

The presentations of this session have delved further into three key aspects of local food systems: urban and peri-urban agriculture; the role of municipalities and local authorities in reorienting current food systems; and establishing food policy councils.

What types of urban agriculture should be adopted to feed and transform cities in the era of climate change?

Éric Duchemin, Scientific and Training Director, Urban Agriculture Laboratory, Associate Professor, Institute of Environmental Sciences, Université du Québec à Montréal

Environment and ecology issues are central to the latest urban planning utopias. There has been a proliferation of illustrations of urban scenes depicting the city, its activities and infrastructure in harmony with vegetation that has been integrated and adapted to urban or environmental conditions or needs. While environmental considerations used to be associated with hygienic principles, there are currently numerous urban greening initiatives and efforts to reintroduce nature into cities: rain gardens,[8] eco-grazing in parks by sheep or goats, green rooftops, biodiversity plans, and nurturing cities (villes nourricières).

Can cities be food self-sufficient? Are they going to break the ties that bind them to farming regions? To what extent does urban agriculture have the power to transform cities, architecture, urbanism and landscapes? As researchers or decision makers, we must consider how to operationalize these questions, and especially ask ourselves what social changes this would cause.

These considerations harbor the projects that cities should foster and the type of territorial solidarity that should be supported. To achieve this, guides, analysis grids, pilot projects, etc., should be developed and implemented so that government decisions can be grounded in a structured and forward-looking approach. This approach should include the economic, social and environmental parameters (including the impacts of climate change) surrounding the implementation of urban agricultural policies, and provide a framework for developing effective urban agriculture, especially urban farms.

8 Landscaping for the purpose of storing, infiltrating or slowing runoff from impervious surfaces, such as roofs, terraces, squares, lanes and sidewalks.

Cities and municipalities: agents of change for sustainable food systems

Vincent Galarneau, Advisor and Speaker for Vivre en Ville

Communities are increasingly recognizing the interest and importance of integrating food into the municipal agenda in order to improve the health and food security of their residents. Indeed, food and agricultural activities play a strategic role in the way cities function and can no longer be ignored when undertaking efforts to sustainably develop the territory.

The challenges that communities are facing in the context of climate change are many and interrelated, whether they concern the loss of agricultural land, inequalities in access to food, or food waste. To understand this complexity and identify levers for bringing about lasting changes in practices, a systemic and territorialized approach to food has become essential.

A sustainable food system is a network of territorial collaboration that integrates the actors involved into the entire food life cycle with the aim of increasing a community's environmental, economic and social health. It encompasses the actors, activities, and infrastructure involved in a population's food security (Vivre en Ville, 2017). Implementing sustainable food systems represents an opportunity to bring together public and private stakeholders from various sectors of activity around a unifying theme. It also makes it possible to act on several fronts, such as fighting poverty and food insecurity, adapting to climate change, promoting healthy lifestyle habits, and protecting the environment.

The strategic and cross-sectional role of food systems should incite communities to become involved in food governance. Strategies that enable more cities to become nurturing cities can be grouped into five categories: protecting and developing the productive territory; supporting businesses that engage in responsible practices; improving access to healthy food; increasing local demand; and optimizing the food life cycle (Vivre en Ville, 2014).

More specifically, municipalities can enhance their agricultural territory and remove barriers that impede the development of urban agriculture. To guarantee better access to healthy food, they can provide guidelines for the location of food infrastructure (grocery stores, community gardens, collective kitchens, etc.) to ensure that food sources can be accessed from living environments on foot, bicycle or via public transit, and facilitate their installation in neighbourhoods that are less well served. Together with public health services, merchants and organizations in the area, municipalities can work to improve the food supply at municipal installations and popular businesses, namely convenience stores.[9] Obviously, these are just a few examples of possible actions that could be taken by cities and municipalities.

In short, developing strong, consistent food policies based on the transparent and inclusive governance of local food systems is now within the reach of communities, regardless of their size. Will they succeed in appropriating this new tool?

A unique Montréal model to share: the Montréal Network of Food Partners and the Future Montréal Food Policy Council, CPA-Mtl

Ghalia Chahine, Coordinator, Système alimentaire montréalais - Montréal Food Policy Council

The Système alimentaire montréalais (SAM - Montréal Food System) is rooted in a rich history of food-related mobilization and commitment. Since 2011, it has been working to develop a holistic, systemic approach and vision regarding the access of all Greater Montréal citizens to healthy, varied, affordable food that is available nearby and consistent with sustainable development.

Under a development plan for a sustainable and equitable food system for the Montréal community (SAM, 2025) and two action plans (2014-2016 and 2017-2019), regional mobilization has resulted in nearly 50 pilot projects and cross-sectional mandates that bring together and rally Montréal's expertise as well as good practices from here and beyond.

The SAM pools together over 200 local, regional and national organizations, public institutions, businesses, experts and agencies, and is structured around the economic, social, and

9 Called dépanneurs in Québec, these are small grocery stores that are open outside the usual business days and hours of other stores.

environmental pillars of sustainable development.

It relies on multi-sectoral and inter-sectoral connections (coordination, mobilization, networking, representation); ensures the consistency and complementarity of local and regional initiatives and projects through guidance that is adapted to the issues, needs and capacities of stakeholders; and acts as a strategic regional lever for creating or renewing partnerships and collaboration involving grassroots participants, players, and experts.

Food issues are many, and the regional food system is extremely complex. Therefore, Montréal began by focusing on a definition and common, collective understanding of the dynamics, levels of intervention and components of each of the system's sectors: production, processing, distribution, consumption and post-consumption.

Next, knowledge and the recognition of the issues and assets formed the basis of a collective approach. The following observations were thus the starting point for regional mobilization: half of the adults in Montréal are overweight and one in three suffers from at least one chronic disease; 60 percent of Montrealers do not eat enough fruit and vegetables (less than 5/day); 43 percent of Montréal's population does not have access to fresh, healthy food within walking distance.

Through its approach, knowledge of the issues, and the partnership that has been established, Montréal is building on the region's assets: committed partners; productive urban and peri-urban spaces; status as the largest food processing centre in Québec (564/2,366 companies); more than 103,400 jobs in the wholesale, retail and food services industries; 40 percent of its public health, educational and municipal institutions have a specific food procurement policy.

Montréal has clearly joined a global movement by signing international agreements such as the Milan Urban Food Policy Pact[10] (160 signatory cities), as well as through national mobilization focusing on various food policies and strategies, and it stands out for its regional multi-partner and multi-sectoral action.

In 2017, Montréal will reach another major food milestone: the SAM will be transformed to become the first Food Policy Council of a Francophone metropolis. The Montréal Food Policy Council is the only one of its kind in Québec and America. It has the distinction of having come about as the result of a collective desire (civil society, institutions and the political sphere). It was conceived with the support of major public institutions, by regional, local and national organizations, through a co-creation and co-construction approach that made it possible to develop a common vision, four specific roles, and a shared mission.

10 http://www.milanurbanfoodpolicypact.org

4. Natural resources: issues and solutions

4.1 THE PRESERVATION OF NATURAL RESOURCES AND GENETIC MATERIAL: A KEY ELEMENT IN THE FIGHT AGAINST CLIMATE CHANGE

The future of agriculture depends on the variety of life on Earth

Cristiana Pasca-Palmer, Executive Secretary of the Secretariat of the Convention on Biological Diversity

The ecosystems of our planet produce our healthy and nourishing food, and biodiversity is the root of this bounty. Biodiversity is the origin of all crops and domesticated livestock, and human civilizations have, over millennia, adapted and developed local crop and animal varieties. The future of agriculture depends on the variety of life on Earth. This variety includes countless other species, such as microorganisms that contribute to ecological functions and services upon which agriculture depends, such as soil fertility, pollination and climate regulation.

Climate change, overexploitation of natural resources and other human-caused drivers of change, have all had a negative impact on biodiversity. And this loss of biodiversity is putting at risk our ability to adapt to changing conditions. To feed our growing world, we must transform our current unsustainable agricultural systems. We need to reduce food waste and food loss by both producers and consumers. We need to call for an integrated approach to increase productivity. We need to achieve sustainable use of biodiversity. To improve our health and our nutrition, as well as adapt to climate change, we need diversification. We need ecosystem services. We need both traditional knowledge and scientific knowledge. We need to promote biodiversity conservation.

In other words, we have a big challenge ahead of us: agricultural systems need to produce more nutritious food to meet rising global demand and adapt to changing, and often more difficult, environmental conditions. Under these circumstances, biodiversity and ecosystem services are key to ensuring nutritional diversity, increased productivity and adaptability, as well as to guarantee the long-term viability and profitability of food production. The nexus of biodiversity and agriculture is at the intersection between several global frameworks, including the Strategic Plan for Biodiversity 2011-2020, the 2030 Agenda on Sustainable Development and its Sustainable Development Goals, the Paris Agreement on climate change and the Strategic Framework 2010-2019 of FAO.

To conclude, tackling food security and biodiversity conservation should be seen as two mutually supportive

Photo 18. Cereals, beans, sorghum and other seeds at a stall in a market, Meru County, Kenya. ©FAO/Luis Tato

objectives. One of the essential roles of biodiversity is to integrate resilience into agriculture in order to reduce its vulnerability to natural disasters while at the same time, enabling agriculture to contribute to climate change mitigation and adaptation.

This International Symposium presents a unique opportunity for all stakeholders to discuss different issues related to the use of biodiversity for food and nutrition. This dialogue must continue, towards achieving agricultural systems that promote positive synergy in food production and the conservation of natural resources. But, to be effective, this integrated approach must be applied at all levels of policies and actions that help lead to the reduction of pressures on biodiversity and ecosystem services caused by current agricultural practices. This includes action by subnational and local governments.

The preservation of natural resources and genetic material: a key element in the fight against climate change

Linda Collette, Advisor, Legal Research Chair in Food Diversity and Security, Université Laval – session chair

Climate change is altering the conditions in which agricultural activities are practiced in various ways. Many of these changes are difficult if not impossible to predict. This makes it all the more imperative to shift to resilient production systems, as well as to the sustainable management of natural resources like water, and the sustainable management of biodiversity for food and agriculture. The latter includes crops, livestock, forest tree species, micro-organisms and invertebrates - in other words, thousands of species and their genetic variability - upon which sustainable, healthy and nutritive food production is based.

Since 1983, the FAO Commission on Genetic Resources for Food and Agriculture has been addressing issues related to plant genetic resources and, in 1995, the FAO Conference broadened the Commission's mandate to include all aspects of biological diversity that are linked to food and agriculture. In this permanent forum, governments examine and negotiate issues pertaining to biological diversity, such as climate change, food security and nutrition. The Commission reaches international consensus on policies to ensure the conservation and sustainable use of genetic resources for food and agriculture and the fair and equitable sharing of benefits stemming from their use. Since its inception, it has overseen assessments of the state of genetic resources and biodiversity for food and agriculture and has negotiated international instruments such as the International Treaty on Plant Genetic Resources for Food and Agriculture. It also works in close collaboration with the Convention on Biological Diversity on issues of common interest.

Diversity is becoming one of the cornerstones of an effective strategy for adapting to the impacts of climate change. The underlying foundation of that strategy is formed by the conservation and sustainable management of genetic resources for food and agriculture, including indigenous genetic resources along with the knowledge related to them, particularly traditional and indigenous knowledge. Whether it is done ex situ, through major genebanks or in situ, on farms, especially as concerns animal breeds and non-domestic agricultural biodiversity, the conservation of genetic resources is an indispensable prerequisite for allowing agriculture to continue to adapt to changing conditions.

Biodiversity, and more specifically genetic diversity, is declining at an alarming rate. In order to respond to the challenges of climate change, it is important to give thoughtful consideration to the sustainability of food systems, agricultural practices, as well as to conservation and resource management strategies.

In this context, the speakers highlighted the importance and complementarity of ex situ, in situ, and on-farm genetic resource conservation; the contribution of indigenous genetic resources along with the knowledge related to them, particularly traditional and indigenous knowledge; the importance of local agricultural systems as a strategy for conserving genetic resources, and the contribution of under-utilized or neglected species; and, lastly, the importance of a systemic approach, sustainable natural resource management and genetic diversity, with sustainable and resilient food systems.

Food security at stake: adapting to change requires genetic diversity in cultivated plants

Axel Diederichsen, Curator, Research Scientist, Plant Gene Resources of Canada, Agriculture and Agri-Food Canada

Agriculture has been with us for about 10,000 years. The major and drastic changes that occurred in wild plants and animals and turned them into cultivated plants and domestic animals happened in the dawn of agriculture. Domesticated plants provide us with food, clothing, and raw materials for many industries. In no other area does man have such intimate interaction with nature as in agriculture and breeding of plants or animals. It was only in the late 19th century when science started to recognize the enormous diversity that man himself had created. Charles Darwin recognized genetic principles that Nikolaj I. Vavilov elaborated and turned into an applied science for crop plant breeding.

However, human interventions have resulted in loss of natural habitats and plant diversity, and this process accelerated considerably after the industrial revolution. Industrialized farming systems are often based on reduced genetic diversity in crops and result in less diverse landscapes. Therefore, many countries established genebanks that are reservoirs of genetic diversity for cultivated plants and their wild relatives. Accelerating changes in climate demand a great flexibility in adapting to new growing conditions, diseases and pests. Only genetic diversity and creativity of man can ensure food security for future generations. In some cases indigenous knowledge and underutilized cultivated plant species may harbour solutions to pressing problems. Examples for Canada are the three sister crops maize, garden bean, and squash, but also rare crops such as Jerusalem artichoke.

The interdependencies among peoples, cultures, countries, regions and continents are very evident when it comes to food security based on access and utilization of crop plant diversity. For Canada, international cooperation on the global level (Food and Agricultural Organization of the United Nations), regional level (Mexico, Canada and the United States in the PROCINORTE Taskforce on Genetic Resources) or on the national level including Universities, plant breeders, farmers, gardeners and non-governmental organisations is critical. The ex situ conservation work of genebanks such as Plant Gene Resources of Canada[11] makes sense only in the context of other and complementary activities in research, breeding and in the on-farm sector. Genetic diversity is not an abstract idea: Every home garden represents a reservoir of relevance and contributes to enhanced conservation, utilization and understanding of the great cultural heritage of cultivated plant diversity mankind is depending on.

11 For more information on Plant Gene Resources of Canada, please see: http://pgrc.agr.gc.ca/.

The importance of local agriculture systems as a strategy for preserving genetic resources, increasing revenues and obtaining food security in an era of climate change - the example of Mexico

José Fernando De La Torre Sanchez, Researcher, Director of the National Genetic Resources Center, National Forestry, Crops and Livestock Research Institute

Mexico is a mega-diverse country (Sarukhán et al. 2009); it harbors 10 percent of the known biodiversity, in just 1.5 percent of the world's land mass, being also one of the richest countries for endemism (CONABIO and SEMARNAT. 2009). The Mesoamerican region, which includes Mexico, as well as Belize, Guatemala, Honduras, El Salvador, Nicaragua and Costa Rica, is one of the centers of origin and domestication of many crops (many of them of global use) and their wild relatives (Harlan 1971). Mexican plant diversity accounts for more than 25,000 species of vascular plants (Llorente-Bousquets and Ocegueda 2008), and it is estimated that 5,000 to 7,000 species, domesticated and wild, are utilized by humans in the Mesoamerican region (Casas et al. 2007). In México, 600 to 700 plant species are utilized, mostly by indigenous groups, practicing in situ management systems like systematic gathering and protection (Caballero et al. 1998). At least, 142 crop species have been domesticated in Mexico (Perales and Aguirre 2008); however, taking out the most commonly used species such as maize, beans, squash, pepper, tomato, potato, chayote, amaranth, avocado, vanilla, husk tomato, marigold, pineapple, cacao sweet potato, among others, most of them are cultivated at small scale and at least 30% of them are cultivated on less than 100 hectares.

These local alternative crops along with the most traditional ones such as maize, beans, squash, husk tomato and peppers, have developed in Local Agriculture Systems (LAS) with specific characteristics by region and with a deep relation with culture and traditional knowledge of farmers, especially indigenous peoples (Aragón and De La Torre, 2015). Besides being a true option to fight hunger, poverty and malnutrition in the rural population, LAS are also an option to make agriculture more resilient to the effects of climate change (Padulosi et al., 2013). Another remarkable characteristic of LAS is that by the amalgamation of conventional crops with a wide array of species of plants (more than 200 recorded), the diets become more balanced in energy and protein, plus outstanding sources of micro-nutrients, phytochemicals and other beneficial molecules that collectively provide a healthy diet (Gálvez and Peña, 2015).

LAS are known to be a good practice in rural environments, especially among indigenous groups; however, external factors like globalization, transculturation, large scale production, and migration to urban areas, have threatened the permanence of LAS and the genetic richness and traditional knowledge associated. The continuity of the LAS is in the hands of the small scale farmers, who still adhere to their traditional systems, passed from generation to generation. Their prevalence depends greatly on the support they can receive for the development of value chains of their products, and importantly the in situ and ex situ preservation of their genetic resources (Gálvez and Peña, 2015; Aragón and De La Torre, 2015). LAS in Mexico represent an opportunity to take out our Country from the regrettable paradox of being a Country with high malnourishment rates, but also one of the highest rates in the world of obesity.

Survival

Terrylynn Brant, seed keeper, Six Nations of Grand River, Ontario, Canada

Indigenous people are experts in sustainability. We have developed our seed keeping skills by working with our Mother Earth over countless generations.

We believe seeds have been given to our Haudenosaunee people as a sacred bond with our Creator, he only asks that we give thanks for them as they continue in their responsibilities. As the world looks to share this bond we trust you will do so as if you are one with creation.

Seed saving unifies practical knowledge of plants, celestial bodies, songs, prayers, ceremonies, and relationships. Western science has created monsters in our seeds. These seeds have forgotten how to follow through with their natural cycles of growing and providing sustenance for the people. It is time for the scientists of the world to return the lands to the indigenous farmers of the world. It is time to release the seeds so they too can continue in their natural state and cycle. Seedkeepers will continue to feed the

families of earth and must be allowed the freedom to do so.

Countries, corporations, and scientists can no longer create systems that attempt to control the food of the world's citizens. Honour the rights of the seeds, the earth and those who keep them by listening to their ways.

Under-utilized species could help fight malnutrition, food insecurity and climate change

Ndjido A. Kane, Researcher, Senegalese Institute of Agricultural Research

The so-called "under-utilized" species feed much of the world's population. To achieve development objectives, a profitable but sustainable exploitation of these species can significantly help increase agricultural productivity and improve the living conditions of vulnerable populations that derive nutrition from these species. Between now and 2050, how, as a result of indigenous knowledge and the latest biotechnological tools, can the biodiversity of these "neglected" species help: deal with the harmful effects of climate change; and (ii) improve nutrition and food security? Citing millet as an example, research results show that this cereal grain, grown mainly in Africa and Asia, is richer in calories and nutrients than rice or corn. The recent decoding of its genome revealed that, since its domestication approximately 4,800 years ago, millet has adapted well to aridity and heat. Its cultivation requires little or no external inputs and it is therefore a priority option in agro-ecological farming. Thus, millet was, is and will be a basic, nutritious and environmentally sustainable food for human and animal health.

Importance of a systemic approach, sustainable management of natural resources, and genetic diversity in agriculture as part of a strategy for adapting to climate change

Émile Frison, Independent Consultant on agriculture, biodiversity and sustainable food systems and member of the International Panel of Experts on Sustainable Food Systems

Sustainable and resilient food systems require greater genetic diversity. Sustainably producing healthy and nutritious food is one of the greatest challenges for the coming decades. It will necessitate a transition to diversified agro-ecological systems, as evidenced in the recent report by IPES-Food[12]. These systems not only provide greater resilience to climate change as well as more diversified and nutritious food, but they also allow for better natural resource management, such as a more effective and rational use of water – a resource that will be increasingly limiting in the future.

This transition requires effective access to genetic resources in order to meet the needs of genetic improvement programs but, more importantly, it is essential to ensure that farmers have access to an expanding diversity of species and locally adapted varieties to provide greater resilience to climate change. This means going beyond the conservation of genetic resources in genebanks and investing significantly in the in situ on-farm management of the diversity of a larger number of species and recognizing and supporting the essential role of farmers in the management and conservation of this diversity. Investments are also needed for the improvement of seed systems managed by farmers who supply more than 70 percent of the seeds used in the world. In addition, appropriate seed policies must be established – policies that do not simply focus on implementing commercial seed systems, but that also recognize the essential role of seed systems managed by farmers. These policies must allow for, and facilitate, the exchange of genetic resources of locally adapted varieties among farmers, even if they are not genetically pure lines. The policies must also acknowledge the role of farmers in the management of these systems.

12 For more information on IPES-Food, please see: http://www.ipes-food.org.

4.2
DIVERSITY AS AN ADAPTATION AND MITIGATION STRATEGY

Diversity as an adaptation and mitigation strategy

Monica Kobayashi, Consultant, agriculture and biodiversity, Secretariat of the Convention on Biological Diversity – session chair

Our planet's ecosystems produce healthy, nutritious foods. Biological diversity is the source of that abundance. The future of agriculture depends on the variety of life on Earth. This variety includes countless species, such as micro-organisms, which contribute to the functions and ecological services on which agriculture depends, including soil fertility, pollination, combating harmful organisms, regulating climate, and the water cycle.

Climate change, the over-exploitation of natural resources, and other factors of change caused by human activities have a negative impact on biodiversity, and this loss of biodiversity is threatening our ability to adapt to change. One of the key roles of biodiversity is to build resilience into agriculture in order to reduce its vulnerability to changes and natural disasters, while allowing agriculture to contribute to climate change mitigation and adaptation.

An important challenge awaits us: farming systems need to produce more nutritious foods to meet the growing global demand and adapt to environmental conditions that are changing and often becoming more difficult. In these circumstances, biodiversity and the services provided by ecosystems are essential for ensuring nutritional diversity, increased productivity and adaptability, and for guaranteeing food production's long-term viability and yield.

This type of optimal production includes ecological intensification patterns based on traditional knowledge and scientific research that are essential for improving crop resilience and sustainable practices, promoting crop diversification and in situ conservation, an increased appreciation of local varieties, the effective use of nutrients and resources, and introducing effective soil and water conservation measures.

Lastly, agriculture and food systems have an important role to play in supporting and conserving biodiversity, as well as in strengthening the sustainable use of natural resources.

The challenges of biodiversity in the face of climate change

Sylvie De Blois, Professor and Director, McGill University School of environment and member of the Québec Centre for biodiversity science

Biodiversity science seeks to identify gene, species, and ecosystem varieties and understand the causes and consequences of their spatial and temporal dynamics, including the consequences for agriculture. What do we know about biodiversity and its ability to respond to climate change? Can we reconcile biodiversity conservation and food production in the face of global warming?

Biodiversity is the result of millions of years of evolution during which species have adapted to changing environmental conditions, including extreme climates. Agriculture developed from the genetic diversity that emerged from this natural selection. Similarly, selection practices going back thousands of years preserve today's diversity of traditional varieties and, with them, their ability to adapt.

The distribution of biodiversity is influenced by climate, and a successive replacement of species can be observed as the climate changes. In southern Québec, global warming has accounted for a rise in temperature of approximately 2°C over the past 13,500 years and deciduous forests have replaced the tundra (Richard and Grondin, 2009). The first inhabitants exploited local biodiversity for their subsistence and adopted species that were from the south, such as corn, but that were selected for a cold climate (Arnason et al., 1981). Today, climatologists are talking about an average global warming of 1.5°C to 4.9°C over the course of this century, and possibly more in the north (IPCC, 2013). One can imagine the strong pressure on species in terms of adaptation or migration.

Biodiversity science also informs us about the functions and ecological services provided by biodiversity. The benefits that we derive directly or indirectly from these services depend on the ability to maintain species and ecosystems at the local and global levels. Diversity often means functional

Photo 19. Indigenous Terra Madre 2015. ©FAO

redundancy and complementarity as well as greater resilience and a greater ability to adapt. These benefits can apply both to natural ecosystems and agro-ecosystems.

Despite biodiversity's capacity to adapt, climate change poses a high risk to it. The speed and extent of the predicted changes are unmatched in the history of humanity. A higher incidence of extreme and often catastrophic events has been observed. Biodiversity has already been weakened by human activity. These risks also affect agro-ecosystems, which have become more homogenous and therefore more vulnerable.

Food production can benefit from biodiversity conservation as long as we recognize the importance of reconciling these two functions in the landscape. This presumes adopting practices that are in keeping with biodiversity preservation. For ecologists, the pressing challenges in the face of climate change are: 1) identifying the species and areas that are at risk. This approach is illustrated by a biodiversity study in Québec (Berteaux et al., 2014) and a study of traditional varieties in Guatemala (MacEwan, 2017); 2) identifying or creating climate refuges and migration corridors. The preservation of hedges or islands of vegetation in agricultural landscapes affords temperate microclimates for species, including those that provide services for agriculture. Green corridors will facilitate the migration of species seeking to expand their range (Roy and Blois, 2008; and Schmucki and Blois, 2009).

From the conservation of genetic resources to indigenous food security: the Three Sisters value chain project

Stéphane Gariépy, Knowledge and Technology Transfer Manager, Agriculture and Agri-Food Canada

Among Native Americans, the plant group composed of corn, squash (including pumpkins) and beans is called "the Three Sisters." Grouping these plants together makes their cultivation more resistant to diseases and requires less fertilizing. Combined, these plants contain complex carbohydrates, essential fatty acids and the eight essential amino acids. In the past, traditional foods were an important dietary component of Canada's indigenous peoples. This was the case for the Three Sisters, particularly among the Iroquoian-speaking peoples, including the Mohawks and Huron-Wendat. Despite the cultural, economic and health benefits of consuming traditional foods, many Indigenous people have added processed products to their diet over the years. These dietary changes, combined with other socio-economic factors, contribute to increased health problems, including diabetes and obesity. In collaboration with members of indigenous communities, scientists from Agriculture and Agri-Food Canada (AAFC) have undertaken to study and revisit the cultivation of the Three Sisters with a view to nutritional improvement and economic and community development.

AAFC researchers are developing procedures to enhance the production of these plants, for instance for food and nutraceutical applications. These include: the nixtamalization of corn (whose processed product enters into the composition of Native American foods), extracting the functional components of pumpkin, and processing beans into bio-products. The current project is based on applying the value chain concept to the production and processing of the Three Sisters. Its central objective is to boost the characteristics of the ancestral lines of corn, squash and beans, especially the level of bioactive components that have a beneficial effect on human health, as well as the functionality and attributes of derivative ingredients and food products. The feasibility of Three Sisters cultivation models that are at once sustainable, practical and culturally acceptable is also being studied. An important aspect of the project involves identifying and conserving ancestral varieties of the three types of plants and protecting the rights of indigenous peoples related to these varieties. These challenges are all the more significant since there are only a limited number of indigenous horticulturalists who still cultivate the Three Sisters, particularly in Québec.

In the context of climate change, it is becoming imperative to preserve a maximum amount of varieties in order to maintain the Three Sisters - an important element of the Native American heritage - for the benefit of indigenous peoples as well as for humanity. The data collected on ancestral lines will be used to identify ways to protect and preserve the genetic material. To this end, based on the collaboration and agreements that may be established with indigenous partners, seeds could be deposited in the Plant Gene Resources of Canada genebank, in parallel with traditional modes of conservation. Lastly, some acquired knowledge could lead to innovation in indigenous as well as biological and traditional cropping systems.

Biodiversity and food systems in the age of climate change

Monica Kobayashi, Consultant, agriculture and biodiversity, Secretariat of the Convention on Biological Diversity

The future of agriculture depends on biodiversity - the diversity of life on Earth. Agricultural biodiversity includes species and microorganisms that contribute to the ecological functions and services upon which productive and sustainable agriculture rests - soil fertility, pollination, pest control and water cycling.

Conserving and sustainably using biodiversity in agricultural settings can also contribute to meeting multiple Sustainable Development Goals, that relate to important issues such as poverty reduction, food security, nutrition, disaster risk reduction and biodiversity conservation.

Where do we stand today? Thirty-three per cent of our land is moderately to highly degraded, due to erosion, salinization, compaction, acidification and chemical pollution of soils. In addition, one third of all food produced for human consumption is either wasted or lost. Furthermore, it is estimated that food production will need to increase 70 per cent by 2050 to cope with population increases and changes in dietary patterns.

These are all very serious challenges. Addressing these will be difficult as they all need to be met in a world that will face uncertain consequences as a result of climate change.

Future food production, according to Global Biodiversity Outlook 4, accounts for 70 per cent of the projected loss of terrestrial biodiversity. However, we believe that meeting increasing food demands in a sustainable way is achievable. In particular, actions taken on restoring degraded land and ecosystem services in farming landscapes create synergies between biodiversity conservation and sustainable agriculture.

We also need to shift our consumption patterns towards more diversified diets that are beneficial for both human health and biodiversity conservation. Traditional plant-based foods have been abandoned in favour of diets rich in meat, dairy products, fat and sugar. We need to increase appreciation of indigenous and local varieties, increase their market share and value, and make people feel proud of their local food culture, especially the younger generations. Going forward, we need both traditional knowledge and scientific research related to food systems.

Reducing pressures on the ecosystems where agriculture is practiced will avoid negative impacts on biodiversity and give us greater capability to react to climate change, adapt crops and breeds to be resilient, to mitigate and to improve productivity, as well as enhance our health and nutrition.

More than twenty years ago, the Conference of Parties to the Convention on Biological Diversity established the Programme of Work on Agricultural Biodiversity, which includes three international initiatives on: pollinators, soil biodiversity, and food and nutrition. The Convention has two protocols relevant to agriculture: the Cartagena Protocol on Biosafety and the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization.

Agriculture depends on biodiversity in various ways and at multiple scales, and vice-versa. All things considered, food security and biodiversity conservation should be seen as two mutually supportive objectives.

Using regenerative agriculture and agro-ecological practices to leapfrog productivity, mitigate environmental degradation, create green jobs and build an inclusive and sustainable economy

Godfrey Nzamujo, Director, Songhai Center

We all recognize the fact that the advent of the present day conventional agriculture based on the intensive use of chemicals has increased global food production and the average per capita food consumption. In the process however, this practice has depleted and damaged the resources of many agro-ecosystem, jeopardizing future productivity and aggravated the environmental challenges (greenhouse gases, water pollution etc.) of our time. It is now evident that this system of production cannot meet the challenges of our time, especially in Africa. The Songhai system is a part of the search to develop processes and technologies that seek to harness the environmental capital of our planet to produce more and better quality food for a growing population, while protecting and enhancing our environmental capital.

The Songhai regenerative agriculture promotes the real "greening" of Agriculture, through an ecosystem approach that draws nature's contributions to crop and animal growth and performance, such as soil organic matter and soil micro-organisms, rainfall, pollination, bio-control, integrated pest management and Eco services (watershed and landscape).

The hitherto ignored and misunderstood colonies of tiny living organisms (effective/regenerative microorganisms) have now become some of the key elements in the development of authentic and regenerative agricultural technologies to unlock the potential of biological and environmental capital of Africa. Songhai is now developing processes that strive to harness the regenerative forces/elements in nature to develop an agriculture that enhances benevolent cycles and pathways. This Agriculture creates a pro-biotic environment that empowers the regenerative agents of nature. These agents - effective micro-organisms - are capable of creating "reverse entropy"- SYNTROPY- and the "super enabling" conditions and environments like enzymatic actions, appropriate pH conditions etc.

We are therefore relearning the way we practice agriculture, from the way we view the soil and its fertility, through the way

we maintain, nourish, and protect our plants and animals, to the way we condition and market them.

Effective micro-organisms are critical in the recycling and delivery of essential inputs in agriculture. The deployment of the new Agro-ecological system will become imperative when we realize that the availability of phosphorus will be problematic by the year 2030. We at Songhai have shown that if mycorrhizal fungus are deployed to recycle organic matter, they will not only produce critical elements like phosphorus, but they can deliver them more efficiently (up to 90 percent) to the root systems of plants, unlike the very inefficient (less than 20 percent) conventional system of phosphorus delivery.

It is therefore clear that this agriculture will no longer be primarily a bio-chemical interventionist approach, like conventional agriculture. Instead, it will be largely a biological process where our incredible environmental and biological capitals will not only be sustainably engaged and harnessed, but this system will enable different life cycles involved in agricultural production to operate in a systemic, synergetic and efficient manner.

This agriculture will be: multifunctional; it will produce food in sufficient quantities and with qualities that promote healthy living, healthy aging, and disease prevention; it will enhance the environment (soil life, food web, soil structure, etc); it will build sustainability and biodiversity.

The merits of a development strategy based on this type of agriculture are not only safe, affordable, high yield, high quality and sustainable; it also addresses employment and environmental problems in both rural and urban areas and builds a strong base for an inclusive and broad-based economy.

We believe that this type of agriculture could turn the rural sectors around to become productive, efficient and remunerative. The collateral effects of this broad based approach will constitute the leverage point and fertile ground for meaningful employment in the different sectors of the economy (primary, secondary and tertiary). This will eventually trigger a reversal of the massive rural exodus in the region. In other words, agro-ecological practices could become a pathway to a viable, broad-based and inclusive economy.

Summary of the discussions

Biodiversity protection is essential to achieving the sustainable development goals of the 2030 Agenda regarding agriculture and food. It is a climate change mitigation and adaptation strategy that must be fully deployed at the international, regional and local levels by integrating a plurality of actors and disciplines. In particular, the in situ and ex situ conservation of a diversity of species and varieties must be promoted at all levels to strengthen the world's food systems' resilience in light of the challenges of climate change, and to ensure the right to a healthy diet that is adapted to the food preferences of populations.

At the same time, in the era of climate change, biodiversity, which is already declining at an alarming rate, faces great risk, while the recognition and promotion of its essential role remain insufficient. Indeed, the participants expressed their concern about the fact that our food systems still continue to favour a so-called "industrial" agriculture that skews our perception of the risk, especially by creating environments that are "controlled" by chemical fertilizers and pesticides. The participants indicated their desire for a transition by the various stakeholders to diversified agro-ecological systems.

The discussions highlighted the wealth of knowledge that has already been gained and pointed out examples of solutions that have proved to be effective, ranging from the designation and creation of climate refuges and migration corridors to community seed banks. The "Three Sisters" project, which combines squash, corn and beans, was stressed as a successful example of preserving traditional seeds and adapting cultivation practices to environmental challenges and indigenous realities – demonstrating the potential that biodiversity has to offer.

Efforts should now focus on creating communication channels for disseminating these examples. Consumers need to be made aware of the benefits generated by the sustainable management of biodiversity for food and agriculture - including the socio-economic and adaption benefits in a context where making predictions is almost impossible. The venues for building awareness and making information more accessible should also be expanded towards the general public, in order to change the mindset of consumers who do not fully recognize the role that biodiversity plays. Purchasing power is still a key driving force behind food choices, which is why it is important to

Photo 20. Niger. ©FAO/Ibrahim Maman

make a variety of healthy local products more affordable. In this context, the vital role of policy makers was underscored.

Indeed, along with awareness-building efforts, support and concrete incentives must be provided to producers and consumers respectively. Establishing education programs on farmers' rights and implementing accompanying economic measures to support producers that promote biodiversity were mentioned. In this regard, a quantification of the benefits of ecosystem services using indicators adapted to local contexts would allow for informed decision making and actions.

According to the participants, the transition is already underway. Mindsets are changing and the number of initiatives in various sectors is increasing. As one participant pointed out, in some situations in Africa the transition to greater diversification as a solution for livestock farmers came about on its own, with the introduction of forage plants that are drought resistant and that stimulate soil microbiology. Consumer habits are also increasingly influenced by health-related concerns that have synergies with biodiversity conservation. In other words, while the exchanges stressed the urgency to act, they were also hopeful.

4.3
WATER AND FOOD SECURITY IN AN ERA OF CLIMATE CHANGE

Water and food security in an era of climate change

Alain Bourque, Executive Director, Ouranos Research Consortium - session chair

Water, whether from irrigation or rainfall, is an essential resource for agriculture. Agriculture and livestock farming are by far the largest water users. Water is also central to adequate diets, which are conducive to leading a healthy and active life. However, the impacts of climate change are already weighing heavily on this resource. Water supplies are threatened; droughts and floods are more frequent and are occurring at shorter intervals. This is in addition to the alarming phenomenon of melting glaciers. Therefore, as a resource, water cannot be disassociated from land and ecosystem issues. Even a province like Québec, despite its tens of thousands of rivers and over three million bodies of water which account for 3 percent of the planet's renewable freshwater reserves, is not immune. On the contrary, this great privilege calls for thought and action. Consequently, the conservation, sustainable management and development of water as a resource are crucial to food and nutritional security in the age of climate change.

Climate change and water management: public policy challenges and opportunities

Paule Halley, Chairholder, Canada Research Chair in Environmental Law and Professor, Faculty of Law, Université Laval

In Québec, as in many countries, the management of water and its various uses is governed by laws whose origins frequently go back in time and have diverse objectives (drinking water, irrigation, navigation, fishing, hydraulic power, etc.). These laws had in common the fact that they did not take climate change into account. In recent years, all levels of government have recognized climate change adaptation in their public policies, chiefly through water resource management, and have pledged to take action to integrate it.

Since then, strategic government planning has been adopted and amendments have been made to water rights to ensure better consideration of the anticipated risks and repercussions of climate change for civil security, agriculture, fisheries, energy production, transportation infrastructure, and municipalities. What stands out in the many initiatives undertaken is their scattered nature, which makes monitoring and assessing difficult. Indeed, the mere existence of legal and normative frameworks that support adaptation is insufficient if such frameworks are not implemented.

It is too early to take stock of initiatives since they are so recent. Nevertheless, some of the obstacles and difficulties that could impede their development and implementation have been identified.

One of the major difficulties for all levels of government concerns the spatial and temporal uncertainties of the effects of climate change on water resources (what impact, where and when?). These uncertainties act as deterrents to interventions by public authorities. It is recommended to deal with these uncertainties by adopting flexible adaptation pathways. These could be based, for instance, on developing strategies and action plans that should be periodically reviewed in order to integrate new knowledge and needs; on regulation flexibility, especially regarding administrative authorizations in order to be able to adapt the regulations to climate change; or even on so-called "no-regrets" measures, thus described since they are profitable and useful in their own right (such as the conservation of wetlands and water environments).

Coordinating the various levels of water governance is a major challenge. The key lies in understanding how the echelons interconnect (who does what?). As we know, the vulnerabilities that public policies aim to tackle vary from one place to another. With respect to water resources, their implementation should be territorialized. In light of this observation, local governments naturally come to mind as the primary agents of this public action. Yet they are, for the most part, unable to finance it. The other levels of government must therefore provide support, especially through contributions to international mechanisms as well as through taxes and fees based on the "polluter pays" and "user pays" principles at the national level.

Obviously, uncertainty about sharing the responsibilities associated with climate change, including water-related risks, is a concern that will continue to require attention.

A water and climate change action plan for food and nutrition security

Chandra Madramootoo, James McGill Professor, Bioresource Engineering Department, and Director of the Water Innovation Lab, McGill University

It is estimated that food production will at least have to double over the next 25 years to meet the food demands in several developing countries, particularly in Asia and Sub Saharan Africa. The ability of countries in these regions to meet these food requirements and to secure food supplies for a growing population is very much in doubt, considering the growing water scarcity and dwindling availability of fertile land for agriculture. There is continual encroachment on prime agricultural lands as a consequence of rapid urbanization, and new housing developments in peri-urban areas.

Water withdrawals for irrigation exceed 70 percent in several countries of Asia, Sub-Saharan Africa, and the Middle East and North Africa. There are approximately 300 million hectares of irrigated land worldwide, which represents about 20 percent of currently cultivated lands. Irrigated agriculture makes a significant contribution to food

security, as it produces about 40 percent of the world food supplies. However, the sustainability of irrigated agriculture is very much threatened by a changing climate. The IPCC has shown that temperatures will rise significantly in many parts of the world. In addition, precipitation will likely decrease in several parts of Latin America, the Middle East and North Africa, the southern cone of Africa, and the South Pacific. Increased frequency of heavy precipitation events are also likely to occur in several regions. Higher risks of flooding and droughts, and increased temperatures will inflict damage to cropped agriculture, and potentially lead to severe food shortages in many parts of the developing world.

As a consequence of these effects, new water management technologies will be required for both rainfed and dryland agriculture. These include water harvesting and soil moisture enhancements using techniques of conservation agriculture. Irrigation schemes, which typically tend to exhibit lower irrigation efficiencies (less than 60 percent), will need to introduce technologies such as drip and micro-irrigation, variable rate irrigation, and low-energy, low-pressure, application (LEPA) systems to conserve dwindling water supplies and increase water application efficiencies. Advanced soil-water and crop sensors, including the use of Unmanned Aerial Vehicles (UAVs), to predict crop water requirements will also lead to water savings and higher crop water productivity.

There will be increased emphasis on the development of Climate Smart Agriculture (CSA) practices, to reduce emissions of greenhouse gases, particularly, nitrous oxide, carbon dioxide, and methane. Agricultural systems will have to become more resilient to climatic shocks, and this will require the use of advanced genomics in crop breeding programs. In keeping with commitments made by countries as part of the Paris agreement, agricultural systems will need to have a lower carbon footprint.

What form of water management should be implemented to improve the food security of communities in the context of climate change?

Antoine Verville, Acting General Manager, Québec network of basin organizations

Water is an indispensable resource for food, firstly in terms of direct consumption, but also as an essential input for animal and plant production, and as a component in food processing. Until now in Québec, with respect to agriculture, water has been considered an abundant resource. In certain seasons, it was even deemed to be overabundant. As a result, agricultural land was drained to increase profitability. However, climate change has altered seasonal cycles and water regimes. On the one hand, this can increase the potential of agricultural yields, but on the other, it increases the chances of water stress, difficulties linked to drinking water supplies, flooding, soil erosion, and damage to infrastructure.

To address these issues related to hydroclimatic changes, Québec's watershed organizations and their partners are fostering an adaptation approach that combines using scientific knowledge (climate scenarios and risk assessment) with efforts to build the resilience capacities of communities. Additionally, the preferred approaches for supporting communities in their adaptation efforts include: collective adaptation approaches at the watershed level, the establishment of communities of practice (Répert'eau and Rés-Alliance), and the development of support tools such as a sustainable storm water management self-diagnostic test for municipalities.

The management of the Beaudet Reservoir, the main source of drinking water for the city of Victoriaville, provides a good illustration of this approach. The reservoir is experiencing a major silting problem that is linked to erosion in the middle farming portion of its watershed. While the watershed organization is working to find solutions for slowing the water flow in the mountainous area upstream of the watershed, a collective farming approach aimed at adopting better cultivation practices is being implemented in the middle portion. Furthermore, the city of Victoriaville has assumed community leadership under the Rés-Alliance in order to benefit from the contributions of an expanded community of practice.

With respect to water management in the context of climate change, four lessons can thus be learned from the experiences of Québec's watershed organizations. First, water management must be carried out at the natural water flow level, namely, the watershed. Next, a socio-ecosystem approach should be promoted. Third, it has been observed in the agricultural sector that growing importance is being given to storing water resources and groundwater. Moreover, from now on, water must be considered as a valuable resource and no longer as a problem. Its retention in the territory rather than its rapid evacuation should therefore be promoted. Lastly, efforts to build the adaptation and resilience capacities of farming communities should be increased in order to face the challenges of the future.

Summary of the discussions

The rich content of the presentations provided a broad range of data on the risks that climate change poses for water and the vulnerabilities linked to this resource. In addition, the discussion between the panelists and the audience made it possible to identify major considerations and potential innovative solutions. A frequently mentioned aspect was the fact that, although technical and technological solutions can contribute to reducing risks if they are properly used, the challenge is essentially a socioeconomic one, which involves seeking solutions supported by the socioeconomic sciences, such as developing long-term public policies. The policies must be adapted to the realities of communities, while individuals and civil society must take ownership of these issues. In short, there is great concern over the illusion that only technical solutions will enable us to address water-related challenges in the era of climate change.

Photo 21. Woodland caribou (boreal). ©Tourisme Québec

5. Food security and nutrition in a changing North

5.1 INCREASING THE RESILIENCE OF FOOD SYSTEMS IN A CHANGING NORTH

Increasing the resilience of food systems in a changing North

Robert Sauvé, President and Chief Executive Officer, Société du Plan Nord - session chair

While the impacts of climate change are evident everywhere in Canada, several studies show that they are more pronounced in northern Canada. Climate change adaptation is therefore a challenge that adds to the many food insecurity and nutrition issues that indigenous and northern communities are already facing. Commercial and non-commercial food supplies, traditional livelihoods, and hunting and fishing activities will all come under increasing pressure. It is important to take stock of these issues and reflect on possible adaptation solutions that could be implemented.

Inuit food security and climate change: rethinking territorial and biodiversity governance from a food sovereignty perspective

Sophie Thériault, Associate Professor, Faculty of Law, University of Ottawa

It is now widely recognized that food insecurity is a major issue for indigenous peoples living in the Canadian North, including the Inuit. Poverty, the high cost of food in northern communities, and the increased consumption of marketed foods instead of traditional foods with a higher nutritional value are among the many factors that result in food insecurity for the Inuit. Added to these factors are the current and anticipated effects of climate change on Inuit harvesting activities, as well as the harmful environmental impacts resulting from, or likely to result from, the intensification of industrial and mining activities.

This presentation was based on the position that the food security of the Inuit in the context of climate change is dependent on their continuous and sustainable access to the territory and to biodiversity to ensure the long-term

vitality of their local food systems. Hence climate change adaptation inevitably has implications for the governance of the territory and natural resources. In particular, governance should be rooted in traditional knowledge and local needs, in addition to being sufficiently flexible to foster the resilience of Inuit food economies. Drawing on the notion of food sovereignty, which, in the context that concerns us, advocates greater control of food production, distribution and consumption strategies by the indigenous peoples, the goal was to propose avenues for reflection and research on governance arrangements for the territory and biodiversity, likely to foster the adaptation of Inuit food economies to climate change.

Community driven solutions for increasing food security resilience in Nunatsiavut

K. McTavish, C. Furgal, S. Doody, R. Laing, IHACC Team; Presented by Kristeen McTavish, Food Security Coordinator, Nunatsiavut Government

Communities in Inuit regions of Canada face unique challenges in addressing food insecurity, such as extreme weather conditions which impact food transportation and changes in wildlife availability and accessibility which impact access to country food. In 2014 the Nunatsiavut Government partnered with Trent University, McGill University and the University of Guelph to conduct a large household survey in the 5 Nunatsiavut communities with the goal of producing community specific household food security prevalence. Select aggregated results from the Nunatsiavut Food Security Survey, as well as some community-specific results for all 5 Nunatsiavut communities are presented and discussed. Results from the 2014 Nunatsiavut Food Security Survey illustrate the importance of community level data in creating a community level understanding of food security.

Nunatsiavut communities are rapidly growing and changing, placing new pressures on development planning for sustainable, healthy communities. At the same time, climate change is having an increasingly pronounced impact in the region, affecting infrastructure, community services and the wellbeing of residents. It is expected that climate change and associated environmental changes will impact all dimensions of food security in Nunatsiavut. The impacts of climate change on the food system and on community and individual wellbeing are widespread, and include things like: making it more difficult for people to spend time on the land, to travel on the land, to spend time outside the community in all seasons, to go wooding, to hunt and fish and collect berries, and to visit cabins. These activities are central to the health and wellbeing of residents and to their ability to provide food for their families. Climate change is also impacting the transportation of market foods into the region, with increased anomalous weather events.

Addressing these impacts and the potentially harmful consequences they will have requires government policies and programming that encourage and facilitate the practice of land-based activities, among other things. Long-term planning is needed to sustainably fund and implement climate change adaptation strategies in Nunatsiavut, and should include programs within communities that help residents access the resources they need to safely engage with the land, that will encourage the practice of traditional skills, that teach youth and that incorporate traditional knowledge and values such as sharing. Some of the many innovative community-driven solutions that are being implemented in Nunatsiavut, such as innovative economic development programs, community freezer programs, youth oriented land-based programs are presented and discussed.

Poverty alleviation pathways: T'it'q'et, food security and climate change

Dean Billy, T'it'q'et First Nation community member, T'it'q'et Community (Amlec), British Columbia

In November 2008, the Assembly of First Nations established the Make Poverty History Expert Advisory Committee comprised of First Nation, metis and non-aboriginal academics from across Canada. The Committee prepared a report in 2009 titled 'The State of the First Nations Economy and the Struggle to Make Poverty History'. This report documented the extent to which First Nations families, individuals and communities are experiencing high levels of poverty and inequality in comparison to the rest of Canadian society.

The group prepared a five year research agenda on poverty issues and secured grant funding from the Canadian Institute

of Health Research and the Institute of Aboriginal Peoples Health for the purpose of designing and implementing a strategic plan to create a sustainable economic base, reduce poverty and improve the health and well-being of community members. Five First Nation communities across Canada were selected for a pilot basis: T'it'q'et, in British Columbia, Shubenacadie in Nova Scotia, Opiticiwan in Québec, Eabametoong in Northern Ontario, Misipawistik Cree Nation in Manitoba.

A Regional Advisory Committee was formed by T'it'q'et that addressed each of the following steps in the intervention process: undertaking a community-based research assessment and environmental scan to identify the salient characteristics, strengths, challenges and opportunities that the community exhibits with reference to achieving reduced levels of poverty and the development of a self-reliant economic base linked to improved community health and well-being. The assessment included an environmental scan of community infrastructure such as water, sewer, housing, educational and other resources, and the community's relationship to the surrounding region. Working with the community and in keeping with the community's vision of where it wants to go and the values that are important to it, the project contributed to the development of a strategic plan for reduced levels of poverty and the development of a self-reliant economic base linked to improved community health and well-being.

The Regional Advisory Committee recommended that T'it'q'et focus on food security and climate change. The goal of the food security project is to achieve self-sufficiency through localized agricultural training for community members as well as building the necessary infrastructure to support intermediate and long term food production in the community. Agricultural knowledge and practice is fading quickly in our community. Only a few families still grow their own gardens. T'it'q'et studied examples of management practices in the form of case studies that identified adaptation and mitigation strategies currently being implemented by various communities across Canada in an effort to alleviate the effects of climate change. These examples can be integrated into current and future community plans and strategies for the St'at'imc territory so as to strengthen their resilience to natural disturbances and climate change.

Summary of the discussions

Climate change is primarily affecting certain regions of the world, including the Canadian Arctic. Northern Canadian communities are therefore facing major transformations of their territories. These transformations endanger their traditional knowledge and food practices (hunting, fishing, gathering), which are essential to their physical and psychological health. The First Nations and Inuit food systems have undergone significant changes, going from a self-sufficient diet based on local natural resources to a diet that is either mixed or exclusively composed of imported products sold commercially. Lastly, climate change is exerting additional pressure on a set of social, economic and political factors, resulting in serious food insecurity and malnutrition.

To ensure the adaptation of northern food systems to new climate conditions, it is essential to strengthen the links between ancestral knowledge, intercommunity knowledge and scientific knowledge. As an example, experts mentioned the creation of artificial bridges to compensate for the disappearance of natural ice paths. This innovative initiative fosters the preservation of traditional practices. A participant from an Indigenous community also mentioned the example of hunters in Nunavut who were invited to hunt moose in Newfoundland where there is an overpopulation of the species. Participants discussed the topic of northern greenhouses at length. Although these structures provide potential solutions, they are a departure from the food traditions of northern communities. Experts and Indigenous community stakeholders nonetheless agreed that this adaptation strategy was preferable to importing processed industrial products sold at exorbitant prices. The participants concluded that it is essential to include exogenous initiatives for ensuring food security and a healthy diet, as long as they are developed in partnership with northern populations so that they will be culturally acceptable.

All in all, what emerged from the discussions is the fact that a food system adapted to the northern and Arctic context must be designed not only for, but also by the communities. It must therefore be based primarily on the traditional knowledge and activities that are central to their diet. Maintaining and improving conditions for accessing market products should be considered, but only as a second step since, although it is a food security factor, it does not guarantee a healthy diet. This better adapted food system would therefore be

favourable because it would contain its own resilience within itself: as it would be based on traditional knowledge, food cultures and the participation of local stakeholders, which are important factors for the adaptability of various innovations and their appropriation by the communities.

5.2 INNOVATIVE SOLUTIONS TO ENSURE FOOD SECURITY AND NUTRITION IN THE NORTH

Food in the Canadian North: understanding and addressing food security in Nunavik

Ellen Avard, Director, The Nunavik Research Centre, Makivik Corporation – session chair

Food, and the land where food comes from, is at the very heart of Inuit culture. In Nunavik, food is not only about sustenance, but also about lifestyle, family and tradition. Today, it is also about the creation of adaption strategies in a rapidly changing social and environmental context. Food security in Nunavik is a multidimensional issue that requires a multifaceted approach to both understand its complex history and address its current challenges.

The Nunavik Regional Working Group on Food Security brought together representatives from all the major organisations in Nunavik and, together, over the past three years, they have identified and targeted the four major areas that define food security in the region today. These four areas are: 1) country food; 2) local food production; 3) access to store-bought food; and 4) healthy lifestyle.

Aquaponics: a food production technology that meets environmental and social challenges

Benjamin Laramée, Chief Scientific Officer, Urban Food Ecosystems (ÉAU), President of AgroCité, and doctoral student in aquaponics at Université Laval; Emilie Nollet, Co-chairman, ÉAU

Concerns about protecting the environment are widely shared across the globe, particularly in the agri-food sector where consumers are increasingly concerned about the origin and quality of their food. To respond to this demand, producers are endeavouring to use cultivation technologies that are more sustainable and environmentally friendly. At the same time, the aquaculture industry is also trying to reduce its waste to comply with stringent environmental standards, but also to meet the demands of consumers who are giving growing importance to the origin of aquatic products. It is in this context that Urban Food Ecosystems Inc. (Écosystèmes Alimentaires Urbains - ÉAU), Université Laval (Vandenberg Laboratory) and AgroCité have a role to play.

ÉAU is a company concerned about environmental protection, climate change and the food insecurity of communities, including indigenous communities. ÉAU is working to develop innovative technologies for sustainable agriculture in various northern, rural and urban contexts. One of the technologies targeted by ÉAU to meet these challenges is aquaponics – a food production method that combines aquaculture and hydroponics. Aquaponics makes it possible to produce fish and plants with 80 percent less water than through traditional agriculture and without using fertilizers or pesticides, thanks to the symbioses between the different organisms, including bacterial and fungal microflora.

Aquaponics is therefore a food production method where the waste of aquatic organisms is converted into fertilizer for plants by the action of micro-organisms. In return, plants clean the water by capturing nutrients that are toxic to fish. This allows for recycling the same water at a rate of over 99 percent and saving it through better waste management. Aquaculture effluents promote the growth and yield of a wide range of plants in soilless cultivation. In addition, the microflora present in aquaculture effluents induces the process of phytoprotection in some plants in soilless cultivation. One of the greatest research challenges lies

in the fact that there is a limited amount of information available about the specific taxonomy of this microflora - microflora that requires several months before colonizing an aquaponics system.

Aquaponics is generating increasing interest because of the many advantages it has to offer in terms of sustainable development and public health, but its challenges are also gaining attention.

Tackling food insecurity in Canada's North

Monica Khaper, Sustainability Director, Growing North

The impact of climate change on agriculture is a significant issue that will affect different parts of Canada. In Canada's North it is seen that agriculture is not a possibility. For Growing North this is not true, we incorporate the three pillars of sustainability- environment, social, and economical in our project as one innovative solution to alleviate the high prevalence of food insecurity. The challenge of climate change on agriculture is an opportunity that Growing North sees to solve in a changing and developing North. From our first pilot project of implementing a geodesic dome which is able to withstand 7ft of direct snow per sqft, wind speeds of up to 130 MPH winds, and heat itself 30C warmer than outside conditions with 4 hours of sunlight, vertical hydroponic towers, and Able Smart Farm Management technology we see a potential to increase food security in Naujaat, Nunavut.

Growing North's primary focus is to decrease food insecurity within Northern Canadian communities by improving the accessibility of fresh and local produce. From engaging and collaborating with the local community, Growing North has implemented an innovative solution for the long term sustainability of the community to ensure food and nutritional security to apply across the North. Since food insecurity is a multi-faceted issue, we use a holistic approach to improve and increase the standard of living of Northern Canadians. Not only is food insecurity a target issue of the organization, but other systematic problems evidenced through Growing North's primary data collection are also tackled. Other issues such as food inaccessibility, health patterns among the population, low graduation rates, lack of employment opportunities are identified and a part of the system. We use the growing dome as an opportunity to ensure food security by offering an educational cooperative program for high school students, creating local economic opportunities, from hiring local Inuit community members to recognizing agriculture once again as a trade.

After 4 years of implementing the greenhouse dome, Growing North's project has taken the interest of other Northern communities such as Arviat, Kugaaruk, and Qikiqtarjuaq who are looking to implement our work into their communities. A socially innovative solution is needed to address food security in Canada's North which Growing North strives for and has succeeded in. A multi-pronged approach has been used to not only address the issue of food insecurity but the underlying socioeconomic problems.

Photo 22. Greenhouses in Kuujjuaq. ©Société du Plan Nord

Inuvik community greenhouse: promoting healthy communities through gardening

Emily Mann, Coordinator of the Inuvik Community Greenhouse, Northwest Territories

The Inuvik Community Greenhouse is located in the Northwest Territories in a town of 3,200 people, two hundred kilometres north of the Arctic Circle. Converted from a hockey arena into its present form as a community greenhouse in 1998, the greenhouse is now run by the Community Garden Society of Inuvik (CGSI). The greenhouse has over 100 community garden plots under its roof and in recent years the work of the CGSI has also extended into outdoor projects and surrounding communities. The CGSI empowers residents of the Beaufort Delta region with the tools and skills required to grow their own food. This includes educational internship programs, garden and food preservation workshops, and healthy cooking classes and demonstrations. Collaborations take place with local research institutions, youth groups, municipal and territorial governments, school groups, community counselling programs, and elders groups. In addition to the outreach and programming that occurs, the greenhouse also sells its fresh produce at an affordable rate, both through local markets and through a veggie box share program. The community greenhouse is a community landmark and provides a unique model for growing fresh produce in a northern climate.

6. Summary of solutions

The International Symposium on Food Security and Nutrition in the Age of Climate Change was a great success and the outcome was extremely positive. This is largely due to the wide diversity of speakers, the impressively assiduous participation of all attendees, the role given to young people, women, and members of communities directly affected by the issues addressed during the Symposium, the special attention paid to eco-responsibility and responsible food procurement, as well as the commitments that were made to continue these discussions to make agriculture part of the solution in the fight against climate change.

THE VOICES OF YOUNG PEOPLE

Geneviève Laroche

"What I derive from this Symposium is even more tangible proof that my initial convictions about the importance of integrating trees into farming systems make complete sense, whether we are talking about agroforestry systems or agro-ecological systems in a broader sense. Diversity is the key to the resilience of our agricultural and human systems in the face of climate change. But to begin this transition, particularly in our temperate systems, we need to unlock our minds, and that is the second thing I am taking away from this Symposium."

Cecile Dibor Mbaye

"One thing I retained from this Symposium is that we talk a lot about the role of women, but do not make a distinction between urban and rural women. Yet, they do not live the same realities, and do not have the same needs."

Morgane Leclercq

"I appreciated the reminder of the importance of research on species considered to be secondary or neglected, and the need to save seeds via ex situ strategies, in other words in gene banks, and in situ, meaning dynamic conservation on plots of land."

Brice Ulrich

"Young people were given a chance to express themselves throughout the event, which is really rare, and was a true learning opportunity to better understand and grasp climate-smart agriculture."

Solène D'Arexy

"This Symposium has shown the unanimous importance to adopt a participatory approach, in the sense that the solutions of tomorrow must come from international, national, regional and provincial, but also local fora, and with full participation of local communities to ensure the food security of tomorrow in our climate change context."

Photo 23. Message by Cecile Dibor Mbaye during the Synthesis of solutions. ©Éric Labonté, MRIF

Catherine Mercier

"One of the solutions to remember from this Symposium is the importance of focusing on small-scale farming and encouraging the production of diversified food crops instead of export monocrops."

Nnedimma Nnebe

"Women are at the frontline in this fight against climate change and for food security, and there is a great importance to look at grassroots movements and how you can incorporate women's innovations and knowledge about these realities and these changing climates into interventions."

Ibrahim Dan Bariah Mahamadou Kabirou

"One of the impressions I got in taking part in this Symposium was that young people are actively involved in this common climate and food issue. Some very good examples stand out in my mind, especially territorialized food systems here in Québec. They promote a whole array of integrated and structural food security solutions."

Sara Magdalena Pinera Torres

"There has been a dichotomy between nature and society. Instead of thinking how are we going to manage biodiversity, first we need to include ourselves into biodiversity. This change of mindset is necessary to become aware of the impact of our consumption patterns and to value the food that we have on our tables. To achieve this, transdiscipline might be the option. We need to work further with other disciplines that could help to integrate cultural values into these matters."

Nafissa Kaboré

"Personally, I was encouraged, motivated and inspired by the presentations of the Deputy Director-General of the Food and Agriculture Organization, Maria Helena Semedo, who urged us to move toward a sustainable food system in order to address malnutrition, especially among women and children who suffer greatly from anemia. I am therefore enthusiastic to be able to bring back a wealth of knowledge that will enable me to get girls like me involved in developing sustainable food systems and to participate in building awareness about climate change, which is a challenge for us."

MY PROJECT IN 180 SECONDS

In a world where information circulates at a frenetic pace, entrepreneurs who have designed innovative projects must be able to cut through the complexities with assurance in order to reach their audience easily and get their message across. That is the challenge that the Symposium's coordination committee issued to four innovative entrepreneurs. The challenge was based on the "My thesis in 180 seconds" concept of the Association francophone pour le savoir (Francophone Association for Knowledge). The young entrepreneurs had exactly 180 seconds to share their vision and passion.

Agro-Expert

Jean-Pierre Guensly

Jean-Pierre Guensly an agricultural engineer by training, founded Agro-Expert in 2008. The company specializes in the agricultural and environmental sectors and is currently coordinating an innovative project called "Strengthening food security and resilience in northeastern Haiti's sustainable agrosystems." The project aims to use drip irrigation techniques on 20 hectares supplied with 2000 photovoltaic watts of power to address a food insecurity problem affecting 150 families. The goal is to solve water scarcity and demographic pressure problems in the region by increasing plot productivity. The project intends to make production ecosystems more resilient in the face of climate change, while at the same time increasing the income of farmers. The expected outcomes include boosting production through the innovative use of irrigation technology, capacity-building, promoting academic research, implementing sustainable alternatives, and strengthening international cooperation.

NAVET

Abdoul Allahougam

NAVET is a livestock dairy farming project known as the "White Revolution in Chad." The project came about as the result of a clear desire to transform the dairy farming sector to make it more intensive in order to contribute significantly to the food and nutrition security of people in N'Djamena and major urban centres in Chad. NAVET is also a way to initiate real grassroots development. To achieve this, the project is introducing several innovative techniques to change the livestock farming system in Chad, especially by introducing forage crops via a drip irrigation system using solar pumps, a cow dung methanization device, and importing exotic cows to Chad. NAVET owns an experimental farm with over 100 cows selected from the best local breeds. The NAVET project's goal is to reach a production level of at least 1,000,000 L of milk per day by 2030.

NAVET wants to make rural women the "new modern farmers," who will thus become the "linchpin of the rural sector's development," by giving them the means to practice market gardening year round and grow forage crops to feed livestock. The modernization of cooking through the use of biomethane will help curb abusive tree cutting. NAVET wants to become a pioneer in the livestock dairy farming sector by implementing the "White Revolution in Chad" through its innovative, reliable approach that is mindful of the environment and people's quality of life.

Global Biotek

Gafffan Ayéwodé Amoussou

Established in 2012 in Togo, Global Biotek is a start-up specialized in agricultural biotechnology, including the use of micro-organisms that are of agro-ecological interest and all modern biological technologies that can enable agriculture in Africa to meet the needs of an ever-growing population in a context of climate change-related challenges and constraints.

For over two years now, Global Biotek has been developing the BIOTRI project, in collaboration with the 2iE Foundation. The purpose of BIOTRI products is to provide an effective alternative in terms of agricultural inputs that are respectful of the environment and the health of producers, and that are also affordable and improve agricultural yields in Africa. Access to farm inputs is a recurring problem in Africa and farmers often turn to the massive use of chemical fertilizers and pesticides. The goal of the BIOTRI project is therefore to produce pesticides and fertilizers as well as organic- and bio-based growth promoters that take into account environmental risks, climate change adaptation issues, and cost concerns related to agricultural inputs. This last point is crucial to reaching a large portion of African producers who have limited resources to invest.

The final objective is to enable farmers to have consistent harvests, which is a priority for them if they are to be self-sufficient, able to feed their families and the population, and provide consumers with healthy products, while using inputs that are not harmful to them or to their environment ì

Näak

William Walker

Mr. Walker is the co-founder of Näak, a company specialized in the manufacture of nutrition products that are innovative because they are made from the most eco-friendly source of protein on the planet: crickets.

Photo 24. Abdoul Allahougam, young Chadian engineer participting to My project in 180 seconds. ©Éric Labonté, MRIF

Currently, livestock farming is among the world's largest sources of pollution, accounting for more than 18 percent of greenhouse gas emissions. It is also one of the greatest consumers of water: It takes more than 2,500 gallons of water to produce one kilo of beef. In the coming years, the earth's population will exceed nine billion, which is why it is important to find alternative proteins. And one of the most promising alternatives is to integrate edible insects into our diets.

Crickets are a source of eco-friendly protein. They require 2,000 times less water than beef to produce the same amount of protein, while emitting 100 times fewer GHGs. Cricket is also a super food, containing twice as much protein as beef, more calcium than milk, and more iron than spinach. This form of protein has the potential to feed the entire planet.

The challenge now is making people understand the benefits of eating insects. Consequently, Näak decided to focus directly on a target audience that is highly informed about nutrition: ecologically-minded athletes. Hence the creation of Näak bars. The name is an acronym for Nutrition Aventureuse pour les Athlètes qui parcourent des Kilomètres (adventurous nutrition for athletes who cover long distances). These energy bars are highly nutritious, 100 percent natural, and eco-friendly. Since operations began a year ago, more than 50,000 bars have already been sold.

FORK AND GOOD CONSCIENCE

Liza Frulla, Chief Executive Officer, Institut de tourisme et d'hôtellerie du Québec

Increasingly large numbers of chefs in Québec and beyond are promoting responsible cuisine because they are aware that what they do has an impact on the environment as well as on their clientele. They are major players in the food system and their good practices are often a source of inspiration for our own culinary habits. The Symposium's coordination committee wanted to seize the opportunity provided by this event to mobilize great chefs from here and elsewhere. The heads of Québec's government offices abroad were mandated to ask a chef working in their territory the following question: "How can you reduce the ecological footprint of your culinary practices on a daily basis?" The answers were presented at the Symposium during the special event called "Fork and Good Conscience," moderated by the Honourable Liza Frulla, CEO of the Institut du tourisme et de l'hôtellerie du Québec (ITHQ), who made it a point to highlight the ingenious methods that some chefs have devised to avoid or reduce the waste that is all too often observed in kitchens. The following are among the answers received:

Jürgen Weingarten, Chef, Conti Restaurant, Munich

"Sustainable development has always played a very important role in my cuisine. I place great importance on sustainability, especially when it comes to selecting ingredients and I almost exclusively buy regional, seasonal products. I prefer products that are transported over short distances, so I buy freshwater fish from the Munich area and meat directly from livestock farmers, for instance. I never buy beef from overseas. As for fish, I make sure it bears the MSC (Marine Stewardship Council) seal and never buy fish caught by bottom trawling, which damages the seabed. One of the main criteria of my cuisine is product transparency: I know exactly where the products come from and I can personally convey that information to guests."

Pierre Lortie, Chef, Québec Government Office in Paris

"It is important for me to build relationships with players that I trust in the agri-food sector. I mostly use ingredients accredited by recognized organizations that certify their compliance regarding respect for the environment and animal welfare. Organic certification is a guarantee of expertise, quality, and origin. It's an asset on menus. I prefer buying products in bulk and avoid over-packaged items. I opt for certified fair trade products that take human values into account. I use less animal protein and more vegetable protein. I transform "ugly vegetables" by using them to their full potential: vegetable juices and water, dehydrated vegetables, marinades, fermented and powdered vegetables. We need to go back to the basics, respect the environment and the land, the way our ancestors did. Eat locally in Île-de-France. I like to use lesser known native ingredients. In urban areas, we have to maximize the space we have. I use the residence's balconies to grow our herbs, microgreens, edible flowers and sprouts, which are all highly perishable. That allows me to minimize losses because I can use the amount I need as I go along. It seems that eating insects is an upcoming trend. It's something to try…"

Anthony Myint, Co-Chef, The Perennial, Los Angeles

"Chefs can embrace their opportunity to lead a broad cultural shift to fight climate change. The food system is responsible for about half of all emissions, but farming can actually return atmospheric carbon to the soil. Chefs must learn about the impacts of different ingredients and farming practices. For example, feedlot beef is extraordinarily bad for the environment, accounting for one sixth of all emissions, and with four times the footprint of industrial chicken. But incredibly, beef raised as part of a carbon farming protocol utilizes the cows to return so much organic matter to the soil, that the meat can be carbon negative. Overall, what we eat can either further pollute our atmosphere and waterways, or be part of a revitalization of our soils that also cools the planet. Restaurants comprise about one tenth of America's work force and we can each make a delicious and meaningful impact."

Mark Sapienza, Executive Chef, Langham Hotel Boston

"We reduce our carbon foot print by purchasing a percentage of our products from local farms, fisherman and artisan food producers. The culinary team manages an urban cultivator to grow some of our own sprouts and herbs. He owns several apiaries to produce honey. The Food and Beverage team is committed to an extensive recycling program including separation of packaging materials, food waste for composting and waste oils. The hotel collects spent oyster shells used by the Massachusetts Oyster project to rebuild ecosystems in our local waterways. We have installed water and energy saving equipment throughout the hotel. In purchasing we try to reduce our grocery and sundry orders to once a week and make efforts to have perishable foods delivered only Monday through Fridays. We also provide training to our staff."

Vicky Ratnani, Chef, Inde

"The first step towards reducing the ecological footprint is by reducing the consumption of red meat such as beef and lamb and dairy products in my personal diet. I am also trying to promote vegetarian and vegan diet in the restaurant menu. Another important way is using locally produced ingredients and including seasonal fruits and vegetables in the daily diet. Supporting the local farmers is one of the main goals. It is also extremely important to reduce the food wastage and having a compost for all waste materials so that they are utilised efficiently. To sum it all up - Eating freshly cooked vegetables and increasing the amount of vegan and raw food in my diet, in the restaurant menu and in the cooking shows is my main goal."

Liza Frulla, CEO, ITHQ

"The Institut de tourisme et d'hôtellerie du Québec plays a leading role in sustainable development in Québec. In all its programs, whether they apply to cooking or management, it makes students aware of the importance of reducing their ecological footprint. As a result of its sorting process, it succeeded in recovering 75 percent of its residual materials in 2016-2017. The ITHQ is committed to preaching by example. Additionally, it gets its supplies from sources nearby or, more broadly, throughout Québec. Nearly 100 percent of the dairy products, eggs, pork and poultry the ITHQ buys come from regions in Québec, and it is proud to indicate the names of its local producers and suppliers on its menus. The ITHQ is also socially involved. Its students and staff actively participate in fundraising, particularly for "Chefs without Borders," and it sends 7,900 kg of food to the Maison du père homeless shelter each year."

A SYMPOSIUM THAT INSPIRES HOPE

Geneviève Parent, Professor, Faculty of Law, Legal Research Chair in Food Diversity and Security, Université Laval

The International Symposium on Food Security and Nutrition in the Age of Climate Change inspired hope in many respects.

Firstly, it inspired hope that it will be possible to break down the barriers that have traditionally separated the three major topics under consideration: 1) agriculture and food production; 2) environmental protection; and 3) nutrition and health. This Symposium has clearly shown that we can no longer allow ourselves to tackle one of the areas independently of the others and that strong food policies are needed to break down those barriers. Such policies were clearly called for on several occasions during the Symposium's workshops and plenaries, policies that must look beyond, and focus on "sustainable health," including the health of individuals as well as that of the environment and, as a result, demand the "sustainable quality" of food on agricultural, environmental, and nutritional levels.

One of the most effective ways to teach is by example and that is what we did during this Symposium. Each of the plenaries and workshops addressed these three dimensions and they did so in an interdisciplinary way. We can appreciate the seminal nature of this interaction and affirm that this approach is not only possible and effective, but also that it is necessary if we are to succeed in meeting the challenges of climate change.

The Symposium also generated hope through the presence of representatives from several Indigenous communities from here and beyond, North and South. This helped confirm to what extent we are all united by the need to adapt to the impacts of climate change and adopt behaviour and measures aimed at reducing our environmental footprint.

At the Symposium, we had the opportunity to hear several indigenous representatives confirm that, in order to confront this scourge, we must go back to ancestral and local knowledge, tap into it, and further develop it. We need to preserve and utilize indigenous genetic resources, since agricultural and food diversity is one of the best means of defence against climate change. We have come to understand that, to achieve this, we will most certainly have to change the views of those who continue to argue that productivity at all costs is the solution. Drawing on what the indigenous and Inuit speakers taught us over the past few days does not mean "going backward" but rather ensuring our common future.

This Symposium also generates hope for Francophone research. As a professor at Université Laval in Québec, the only Francophone province in Canada and North America, I feel it my duty to underscore the importance of the fact that such a large-scale international event was held almost exclusively in French. We were able to appreciate that Francophone research on food and nutrition security is alive and well. It needs forums such as this so that it can be expressed and shared for the benefit of everyone. Hence the importance for the Francophone research community of this productive collaboration between Québec and the FAO.

In addition to hope, this Symposium also provided lessons. Naturally, it is impossible to revisit everything that was said. Given the scope of the commentaries, we must take the time needed to properly assimilate and absorb these new insights resulting from the intersecting reflections of different disciplines and experiences. Nonetheless, it is important to consider two major observations that emerged from these three days of proceedings.

A few lessons to be learned from food insecurity challenges in the Canadian North

The first of these observations is that major food and nutrition insecurity problems caused by climate change exist in the Canadian North. These problems are both specific to these regions and comparable to what is prevalent in regions in the South in that they are just as dramatic and worrying. The different presentations that provided an overview of the situation in northern Canada in the age of climate change highlighted certain basic elements that are also applicable to other regions of the world.

On the one hand, it is clear from these various presentations that food is cultural and that climate change adaptation and mitigation solutions must take that fact into account. Hunter-gatherers in the Canadian North cannot be forced to become farmers. Nonetheless, it is their right to have access to varied and nutritious food. Therefore, we must meet the challenge with them and aim for empowerment while respecting lifestyles. In fact, the link between the physical and psychological health of communities and their "dietary" lifestyles was mentioned several times during the workshops and plenaries. It was demonstrated that climate change affects not only food but also the culture of identity. In our opinion, we must all learn from that and remember that food is part of our cultural identity.

On the other hand, the presentations focusing on the Canadian North also stressed the interrelation that exists between the three topics under consideration: agriculture, environment, and health. All these presentations underscored the fact that it is ineffectual to deal with these topics separately when addressing the challenges posed by climate change. Indeed, it is clearly apparent that several factors pertaining to food insecurity in northern Canada are also an impediment to adapting to climate change. A holistic analysis of the food and nutritional issue in the age of climate change is therefore essential.

The role of territorialized and sustainable food systems

The second major observation resulting from this Symposium is that we must give greater importance to territorialized and sustainable food systems in order to both face and adapt to the effects of climate change while at the same time improving food and nutritional security. Climate change, nutrition, and agricultural experts' views all point to this direction.

Food systems that are territorialized and sustainable make nature - which includes humans - their central focus. They are organized according to sustainable development principles. Additionally, these systems are more conducive to fostering the implementation of fundamental rights - civil, political, economic, sociocultural - including the right to decent work, the right to an adequate standard of living, the right to food, and environmental law.

As a result, these systems are best suited to provide a framework in which the status and rights of women are more fully recognized and protected. As was suggested during the Symposium, the role women play in achieving food security and the respect for their rights as farmers are essential elements in the fight against climate change.

At the close of this Symposium, there can be no doubt that, driven by the commitment of young people to become involved in finding effective solutions to the food and nutritional insecurity problem in the age of climate change, we will succeed in continuing the in-depth deliberation process that was launched in Québec City.

PERSPECTIVES AND SOLUTIONS

Alexandre Meybeck, Senior Policy Officer
on Agriculture, Environment
and Climate Change, FAO

This Symposium had a threefold objective for FAO: reiterating the importance of food security and nutrition and the threats posed by climate change; juxtaposing a variety of perspectives grounded in concrete realities; promoting the emergence of possible solutions. The Symposium was unquestionably a success in these three areas.

The 2008-9 food crisis was a reminder to us all that having food on our plates cannot be taken for granted. It requires productive, resilient agriculture that uses natural resources sustainably. It also requires value chains and the work of men and women. We must never forget that. It likewise presupposes making the necessary investments and transformations in all countries to ensure food security and good nutrition for everyone in a constantly and rapidly changing environment. Singular voices and striking examples are vital to make this message heard.

The Symposium produced a wealth of voices, examples, and solutions to share. I neither whish nor am able to provide a summary of the entire meeting but instead intend to focus on three aspects that I consider to be the most innovative and, as Geneviève Parent put it, that "inspire hope."

There is something inconceivable about climate change. How can we comprehend and admit that humans are disrupting nature to such an extent? Science and reason are insufficient for integrating this new reality into our daily lives. But we must be able to think this change objectively if we are to deal with it. Young people will have to do that, but it is in tradition that they will find the means to succeed. Indigenous cultures remind us that major upheavals are part of history and that they can and must be confronted. Change needs to be grounded on something on the ground, and also in the past and in tradition. Science reminds us about the major upheavals of the past, but cultures inform us as to how generations before us overcame them. That is perhaps what will allow us to better examine the current upheaval; many scientists talk about the Anthropocene.

The Far North provides us with another opportunity to consider, recognize, and confront climate change and its impacts on food security and nutrition. These territories are among the first and most severely impacted. For the ones in the South, the rise in temperature seems to be a positive factor, owing to the extreme cold there. But this example shows precisely how a change in natural conditions, whatever it is, can be traumatic for the balance between man and nature on which food security depends. Valuable lessons for all food systems facing climate change now and in the future can be learned from this.

Northern regions are experiencing major food security and nutrition problems. These problems are compounded by climate change. Traditional food systems are disrupted by social, political, and economic changes, and climate change adds to these adversities. Since ecosystems play a crucial role in the Inuit diet, climate chaos makes it difficult to apply traditional knowledge that is essential to hunting, fishing and gathering …as "we can no longer predict." This situation is highly specific to the territories and communities of the Far North, but extremely similar situations can also be found in territories and communities that are very far away and quite different. Maria Helena Semedo drew a parallel between communities in the Far North and the situation in Small Island Developing Countries (SIDS), which are subjected to serious food security and nutrition difficulties characterized by overweight, obesity, and the chronic diseases associated with them. These are also linked to constraints stemming from the isolation of SIDS and their dependence on imports. Climate change that further weakens traditional food sources threatens to aggravate their situation as well.

The testimonies that were shared all confirm the urgency to act in the face of the additional threat that climate change poses to food security and nutrition. And everyone provided, together with the descriptions of climate change's impacts, suggestions for concrete solutions, as well as for technical and social innovations based on traditional knowledge and a better understanding of how agroecosystems function. A number of salient points can be drawn, the first being the significance of collective approaches, territorial ties, and value chains. Emphasis was placed on such factors as the importance of processing, the key role of women and women's knowledge in food processing, and the issue of global, regional, and local markets. A multitude of ideas and achievements were discussed. Better use can be made of the extensive biodiversity of agroecosystems, from valorizing traditional resources, species that are too often neglected, such as the Jerusalem artichoke and millet, to better use of the soil's micro fauna. We can also develop systems to

observe changes in natural conditions, such as the Smart-Ice system, which measures ice thickness and provides the information to hunters in real time. Increased urbanization and the need to feed megacities and provide opportunities for diversification products make it mandatory to take the importance of processing and marketing into account. In this regard, the mobilization of stakeholders in the private sector is particularly encouraging as evidenced by such projects as Coop-Carbone. Similarly, examples provided by the food service industry have much to offer, both in and of themselves and with respect to mobilizing consumers.

There is, in all these initiatives, potential solutions to radically transform food systems; with the perspective of quality in terms of both nutrition and taste for consumers, but also good for the environment and for the stakeholders who earn their living from the food chains. A transformation rooted in culture, in the diversity of cultures.

Photo 25. Synthesis of solutions. ©Éric Labonté, MRIF

7. Strengthening and adapting regional and international cooperation

STRENGTHENING REGIONAL AND INTERNATIONAL COOPERATION

Julia Wolf, Natural Resources Officer,
FAO - session chair

In 2015, the international community made three historic commitments to address the most pressing challenges of the 21st Century. In September 2015, in adopting the 2030 Agenda for Sustainable Development, countries clearly articulated their high-level ambitions for a hunger-free, equitable and environmentally sustainable world. With the adoption of the Addis Ababa Action Agenda at the Third International Conference on Financing for Development, the international community also agreed on financial and non-financial means of achieving the 2030 Agenda. Finally, in December 2015, Parties to the United Nations Framework Convention on Climate Change adopted the landmark Paris Agreement on climate change, by which developed and developing countries committed to do their part to transition towards a climate-resilient and low-emissions future. As we look towards 2030, and as the world takes on these international commitments, we can no longer look at food, livelihoods and the management of natural resources separately: a more holistic approach is needed.

The movements and multiplication of climate variations and cross-border risks (animal diseases, parasites, invasive plants and animals) increase the need for regional and international approaches to risk management. The agricultural sectors (crops, livestock, forestry, fisheries and aquaculture) are and will be among the most impacted by climate change, with potentially significant consequences for the countries and populations that depend on these sectors for their economies and livelihoods, particularly the least developed countries and the most vulnerable populations. The ability to respond to climate change will thus require a paradigm shift towards more sustainable food systems. This change has a cost – a cost that poor farmers, pastoralists, fishers, foresters and indigenous communities, especially those living in developing countries – are unable to pay. In other words, climate change forces us to rethink our models of cooperation and solidarity.

In the context of climate change, it is essential to reinforce co-operation between the states of the same sub-region, the same continent as well as international co-operation

(both South-South and North-South). Countries in the South undoubtedly offer a myriad of development solutions – knowledge, experiences, good practices, innovative policies, etc. South-South cooperation is playing a greater role than ever before in the international development landscape, while triangular cooperation should provide increasing resources to facilitate its operationalization. There must also be co-operation between populations that are affected by the impacts of climate change, as well as among the structures and organizations that support these populations, i.e., producers' organizations, governmental and para-governmental public services and national, regional and even international public institutions. One must not forget that for many countries, learning how to access and effectively use climate funding is the first step in the long-term transition to climate-resilient development pathways.

This co-operation must be inclusive of both women and men, and it must reinvent itself to integrate the various dimensions of climate change into all of its programming. This co-operation must reinforce the ability of vulnerable populations to adapt to and mitigate climate change, as well as reinforce the ability of organizations and institutions to mainstream mitigation and adaptation measures into their activities.

INTERNATIONAL COOPERATION IN SUSTAINABLE DEVELOPMENT: "AN INTEGRAL APPROACH AND SHARED RESPONSIBILITY"

Gerardo Almaguer, Senior Director, Agricultural Finance and Food Security Division, Développement international Desjardins

Sustainable development is defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable development is based on a long-term vision that takes into account the inseparable nature of the environmental, social and economic dimensions of development activities (Government of Québec, 2017). These three dimensions or pillars must be considered by communities, companies and individuals.

Financing the fight against climate change is one of the most important aspects of global efforts to address the challenge of climate change. It is an essential catalyst for efforts being undertaken in developing countries to strengthen their resilience to climate change, limit their GHG emissions, and support their transition to sustainable development.

Currently, the financing needed to effectively fight against the impacts of climate change is considerable. The Intergovernmental Panel on Climate Change (IPCC) expects that, between now and 2030 alone, funding needs will be in the hundreds of billions of dollars (ADA, 2015).

As for the amount of funds that developing countries will require to adapt to climate change, most of the estimates range between 50 and 100 billion dollars per year.

To meet these funding needs, developed countries made it a goal in 2009 to mobilize 100 billion U.S. dollars per year by 2020 to support mitigation and adaptation activities in developing countries.

Microfinance institutions (MFIs) can act to address the problems caused by climate change. In addition to supporting economic development through their financial intermediation activities, MFIs, and particularly savings and credit cooperatives, have always had a social concern stemming from the development of their communities and the human well-being of their clients. Microfinance stakeholders (MFIs, investors, legislators) are now increasingly aware of climate change issues and are placing greater importance on them. MFIs can improve their environmental performance and combat the impacts of climate change. They have several options available for implementing mitigation and adaptation measures in their activities and those of their clients. Before taking steps to address environmental issues, MFI management teams must ensure that these interventions are in line with their missions and objectives as well as with their human and financial capacities. In all cases, MFIs must take their role into account and integrate the activities they undertake to fight climate change into their strategic planning.

There are four broad strategies (Realpe Carrillo et al., 2015) that MFIs can use to take action against climate change:

- Environmental and social responsibility policy;
- Reduction of the internal ecological footprint of MFIs;
- Management of the environmental and social risks of clients;
- Providing green finance products and services to clients.

REGIONAL COOPERATION AS PART OF CANADA'S NEW FEMINIST INTERNATIONAL AID POLICY: OPPORTUNITIES AND CHALLENGES

Amrane Boumghar, Head of the knowledge and Program Support section within the Food Security division, Global Affairs Canada

The new Canadian Feminist International Assistance Policy ("the Policy") is a significant shift in Canada's approach to development assistance. The Policy focuses on the empowerment of women and girls as a core element of addressing the root causes and the systemic barriers faced by the world's poorest and most vulnerable. The cross-cutting nature of agriculture and food systems provides a unique opportunity to help advance a significant portion of Canada's feminist Policy including environment and climate action.

The presentation focussed on how the new policy could be delivered through agricultural development and examined a variety of pathways aimed at strengthening agriculture and food system resilience - including systemic, adaptive and responsive strategies - at the technical, programmatic, organizational, partnership, and policy levels.

The presentation did also explore how Canada can most effectively support women's leadership and decision-making in agro-ecosystem approaches to climate change adaptation and mitigation through capacity building, ensure that developing countries' governments policies, programmes, services, and regulations address the particular challenges faced by women and girls and support the employment and business opportunities for women in the green economy.

STRENGTHEN AND ADAPT REGIONAL AND INTERNATIONAL COOPERATION - THE WORLD BANK

Mary Kathryn Hollifield, Advisor in Agriculture, World Bank

The Bank's Vision for the Global Food System is to: feed every person, every day, in every country with a safe, nutritious and affordable diet; supporting jobs and income gains in the food system to meet poverty reduction targets; and improving sustainability and health outcomes. The World Bank Group Climate Change Action Plan[13] (the Plan, April 2016) demonstrates how the Bank will scale up climate action, integrate climate change across its operations, and work more closely with others. The Plan focuses on helping to shape national investment plans and policies and leveraging the private sector. It reconfirms the WBG's commitment to increase the climate-related share of its portfolio from 21 to 28 percent by 2020 in response to client demand, with financing (including leveraged co-financing) of potentially $29 billion per year by 2020. The Plan also highlights broader Bank action:

Support transformative policies and institutions

The WBG will support countries in translating their NDCs into climate policies and investment plans into actions, and in mainstreaming climate considerations into policies and budgets. The Bank is also bringing climate into growth and poverty analytics and into World Bank Group Country Partnership Frameworks.

Leverage Resources

The IFC will crowd in private sector finance by significantly scaling up its own investment. The WBG will work with regulators, create green banking champions, provide climate credit lines, and promote continued growth and development of the green bond market. It will scale up financial leverage in operations for resilience and mitigation through improving the preparation, structuring, and aggregation of projects; de-risking private investments; and scaling up support for a climate-smart focus in project preparation facilities. The WBG will also focus on enhancing the effectiveness of, and helping countries gain access to, concessional climate finance.

13 For more information on the World Bank Group Climate Change Action Plan, please see: https://www.openknowledge.worldbank.org/handle/10986/24451.

Scale-up climate action

The Bank is supporting the development of climate-smart profiles and investment plans for at least 40 countries by 2020, and climate smart agriculture (productivity, resilience and reduced emissions). Examples include: better water-use efficiency in China on 44,000 hectares of farmland and new technologies, improving soil conditions, boosting production of rice by 12 percent and maize by 9 percent, and increasing incomes for 29,000 plus farmers' cooperatives; 1,165 small and medium agribusiness in Mexico have adopted environmentally sustainable energy technologies, reducing C02 emissions by 3,388,670 tons; 500,000 farmers and agro-pastoralists in 44 communes in Niger have received improved, drought-tolerant seeds, more efficient irrigation, and expanded use of agroforestry and conservation agriculture techniques.

Align internal process; Work with others

The WBG is working with others to benefit from what they do best, and ensure synergies across actors, strengthening alignment and cooperation with Multilateral Agencies and Development Banks and bilaterals on strategies and work programs; working on mainstreaming principles and reporting with MDBs and the international development finance agencies; strengthening collaboration with leading think tanks, research groups, NGOs, and business alliance groups. The WBG will also align internal processes, metrics, and incentives to support Plan implementation.

THE INTERNATIONAL AGRICULTURAL ALLIANCE: A TRAJECTORY FOR THE CAPACITY BUILDING OF AGRICULTURAL PRODUCERS AND THEIR ORGANIZATIONS

Richard Lacasse, President of the International Agricultural Alliance and Executive Director of the Société de coopération pour le développement international

The three organizations that form the International Agricultural Alliance (AAI), namely the Centre for International Studies and Cooperation (CECI), the Société de coopération pour le développement international (SOCODEVI), and the Union des producteurs agricoles Développement international (UPA DI), combined, have over 100 years of experience in international cooperation.

These organizations provide expertise in agricultural development, food security and sector development to individuals and rural households, co-operatives, producers and agricultural producer organizations as well as to government authorities.

Climate change is exacerbating the problematic situations that populations living in developing countries were already experiencing (food and nutrition insecurity, poverty, the sometimes abusive and uncoordinated exploitation of natural resources, etc.). The acceleration of the impacts of climate change prompts and compels us to place even more emphasis on building the resilience of the people we support by more specifically targeting solutions to reduce or eliminate the vulnerability of rural households and organizations. Some segments of the population are extremely vulnerable, especially women, girls and marginalized groups. Many rural households are in a state of poverty and therefore have few resources to predict climate change, mitigate its impacts or adapt to them.

To increase the adaptation capacity of agricultural producers and boost the resilience of these populations, our approaches and interventions cover several aspects, including: a) sustainably intensifying while at the same time diversifying current production systems, particularly by introducing crops or varieties adapted to climate change (tolerance, resistance, high yields, etc.); (b) supporting

training and the professionalization of the agricultural activities of households, especially where young people are concerned; (c) improving access to markets (to increase profits); (d) supporting the implementation of innovative techniques adapted to the environment, ranging from agricultural production to packaging and the sale of value-added products; (e) supporting the social and economic empowerment of women and girls; (f) supporting and professionalizing cooperatives and producer organizations to sustainably improve the living conditions of their members.

To assist producers and their organizations in this new era of climate change, increased collaboration among stakeholders is essential. We need to focus on local organizations that have a sound knowledge of their realities and challenges and possible actions to address them. We should also focus on new and innovative partnerships with research and development structures as well as with specialized private companies and non-governmental organizations (NGOs) that provide new solutions and support for implementing effective strategies to increase resilience. An example of note is the effort underway in Senegal, where new multi-stakeholder collaboration is being established between the FAO, the Ministère des Relations internationales et de la Francophonie (MRIF) and international cooperation agencies. This collaboration is specific to communities of practice and enables them to share a variety of expertise and experiences.

Photo 26. Parliamentary reception at the National Assembly of Quebec to taste the products of the National Assembly's garden. ©Éric Labonté, MRIF

SECTION 3

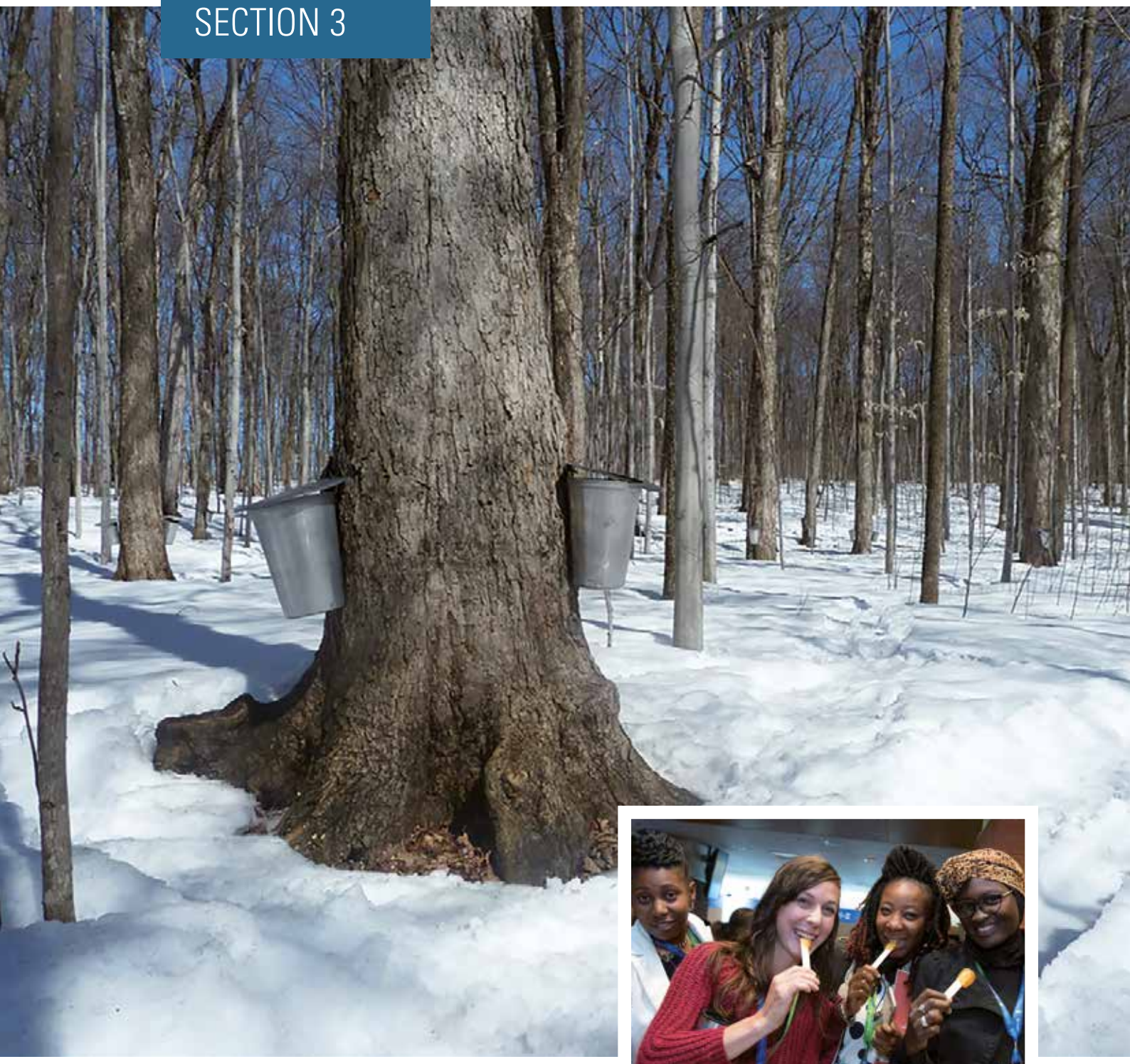

Photo 27. Maple syrup production. © CC BY-NC-ND 2.07 Maxim off

Photo 28. Thematic break, maple syrup on snow. ©Éric Labonté, MRIF

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(Benjamin Laramée)

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Appendix 1

LIST OF RAPPORTEURS

The summaries of the interactive workshops were made possible thanks to the diligent note-taking of the following volunteer-rapporteurs:

Raphaëlle Bach	Université Laval
Ève Boileau	Groupe Conseil Carbone
Denis Boutin	Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec
Anh Bui	Université McGill
Audrey Auclair	Université Laval
Catherine Eva Ruest Bélanger	Université Laval
Marie-Ève Buist	Université Laval
Xavier Bédard Cadieux	Ministère des Relations internationales et de la Francophonie du Québec
Jeanne Camirand	Ministère du Développement durable, de l'Environnent et de la Lutte contre les changements climatiques du Québec
Jonathan Charlebois	Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques du Québec
Solène D'Arexy	Université Laval
Catherine David-Bélanger	Université Laval
Baba Diarra	Ministère des Relations internationales et de la Francophonie du Québec
Arielle Hudon Fortier	Ministère des Relations internationales et de la Francophonie du Québec
Tom Ignacchiti	Université Laval
Geneviève Laroche	Université Laval
Morgane Leclercq	Université Laval
Julien Malard	Université McGill
Catherine Mercier	Université Laval
Riadh Mestiri	Université Laval
Marylinn Morin	Ministère des Relations internationales et de la Francophonie du Québec
Isabel Alvarez Murillo	Université McGill
Nnedimma Nnebe	Université McGill
Isabelle Marie Proulx	bénévole
Catherine Richard	Université Laval
Émilie Rochette	Ministère de la Santé et des Services sociaux du Québec
Marie Tanchon	Université Laval
Julie Veillette	Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques du Québec

Appendix 2

BIOGRAPHIES OF THE SPEAKERS

ALMAGUER, Gerardo. Senior Director, Agricultural Finance and Food Security Division, Développement international Desjardins

Gerardo Almaguer has been Senior Director, Agricultural Finance and Food Security at Développement international Desjardins (DID) since December 2016, where, as a member of the Steering Committee, he takes part in defining directions, strategic and operational planning and institutional decision making for the organization. He also coordinates the implementation of technical assistance projects entrusted to DID to support the agricultural finance and food security sector. Throughout his career, he has developed extensive expertise in project management and in the deployment and management of local financial institutions in different countries. He has also acquired considerable knowledge of all aspects of operating these institutions as well as a thorough understanding of savings and credit mechanisms. He has also contributed to the development and dissemination of training programs for both employees and executives of local financial institutions supported by DID.

ARDO KANE, Ndjido, Researcher, Institut sénégalais de recherche

Dr Ndjido A. Kane is a geneticist and plant molecular biologist working to preserve and exploit the genetic diversity of cereals in prevision of climate change and growing population's needs. Currently, Dr Kane uses recent sequencing (NGS and GBS) approaches to identify SNPs in genes of interest tightly linked to important agronomic traits (drought, salinity, nutritional quality, etc.) and to study crop transcriptome in order to contribute significantly to our understanding of the global genetics of crop adaptation and performance in dry environments. Dr Kane also explores adaptation during the past 40 years and mitigation options in response to climate forecasts to help close gaps of knowledge about how climate conditions are becoming more extreme and will affect agriculture productivity in Africa.

AUDET, François. Director, Canadian Research Institute on Humanitarian Crisis and Aid

François Audet is Professor at the School of Management at Université du Québec à Montréal and Scientific Director of the Canadian Research Institute on Humanitarian Crisis and Aid (OCCAH). He holds a Ph.D. in public administration from ENAP for his research on the decision-making process of humanitarian organizations with regard to local capacity building. He was previously a visiting scholar at the Program on Humanitarian Policy and Conflict Research at Harvard University. Prior to entering academia, François Audet worked for over 15 years in humanitarian aid. He was previously the head of the Regional Delegation of East Africa and the Indian Ocean for the Canadian Red Cross and served as Program Director for CARE Canada. He worked for several years in Latin America and Southeast Asia on behalf of the Canadian Centre for International Study and Cooperation (CECI), where he served as chief of humanitarian aid projects. He has participated in over a hundred humanitarian and technical support missions in Haiti, Colombia, the Horn of Africa and the Sahel region.

AVARD, Ellen. Director, The Nunavik Research Centre, Makivik Corporation, and Member of the Nunavik Regional Working Group on Food Security

Ellen Avard has an academic background in environmental studies and geographical sciences with a focus on northern community development and food security. She was appointed Director of the Nunavik Research Centre (NRC) in 2014. The Nunavik Research Centre is an Inuit body that was created in 1978 to monitor and collect land-use and ecological data in the Nunavik region. The NRC is located in Kuujjuaq, the administrative capital of Nunavik, and operates as a semi-autonomous unit within the Resource Development Department of Makivik Corporation. Today, the majority of the work carried out by staff involves scientific research on wildlife (i.e., country food) and the natural environment. The NRC also administers projects and programs that directly respond to the needs of Inuit in all 14 Nunavik communities as well as in neighbouring regions. The NRC engages in numerous collaborative research projects and regularly partners with other research institutions, universities and all levels of government in order to address issues that are of direct relevance to Nunavimmiut.

BADIANE NDOUR, Ndèye Yacine. Senior Research Fellow, Senegalese Institute of Agricultural Research

Ndèye Yacine Badiane Ndour is a Specialist in agroecology and climate change adaptations; Senior Research Fellow at the Senegalese Institute of Agricultural Research; Director of the National Research Laboratory on Plant Production; Co-Director of the International Joint Laboratory on Ecological Intensification of Cultivated Soil in West Africa (LMI IESOL); Member of the National Climate Change Committee of Senegal.

BILLY, Dean. T'it'q'et First Nation community member, T'it'q'et Community (Amlec), British Columbia

Dean Billy is a member of the T'it'q'et First Nation, part of the St'at'imc Nation. He lives in Lillooet, British Columbia, Canada, and holds a bachelor's degree in anthropology with a minor in archaeology from Simon Fraser University. He served his community for five terms as an elected councillor from 2000 to 2014.

BOUMGHAR, Amrane. Deputy Director, Knowledge and Program Support, Food Security Division, Global Affairs Canada

Amrane Boumghar is the Deputy Director of the Knowledge and Program Support section of the Food Security division at Global Affairs Canada. In his previous position as sector lead at Agriculture and Agri-Food Canada, he was responsible for a number of Agriculture sub-sectors in Canada and Québec and managed the Traceability team and the Value Chain Roundtables Secretariat. He has also held senior advisory positions in sector strategy design and value chain development at the International Trade Centre (UNCTAD-WTO) in Geneva and covered several countries in Africa, Asia and the Pacific regions. Before joining the government in 2015, Mr. Boumghar held project and program management positions in agribusiness and private sector development with Deloitte Emerging Markets.

BOURQUE, Alain. Executive Director, Ouranos Research Consortium

Alain Bourque holds a Master's in atmospheric science from Université du Québec à Montréal (UQAM). He was a meteorologist/climatologist with Environment and Climate Change Canada from 1989 to 2001 where he worked on the Saguenay flood of 1996, the ice storm of 1998 and on climate services. At Ouranos since its creation in 2001, Mr. Bourque has implemented the Vulnerabilities, Impacts and Adaptation program which includes more than 200 projects. Since 2013, he has served as Executive Director. During his career, he has completed many regional, national and international scientific summaries and contributes regularly to media stories and policy discussions about climate change and adaptation.

BRANT, Terrylynn. Seedkeeper, Six Nations of the Grand River

Terrylynn "Sera:sera" Brant, of the Mohawk Nation Turtle Clan in Grand River Territory in Canada is a traditional Seedkeeper, meaning one who ensures family seed lineages continue for generations of "coming faces," in keeping with the spirit and ceremony of the Haudenosaunee people. She is a lifelong gardener who was gifted with the spirit of her plant relations from a young age and was encouraged by the land's first sustainable experts, those who learned and continue to learn from Mother Earth.

CHAHINE, Ghalia. Coordinator of the Système alimentaire montréalais

Ghalia Chahine is a specialist in urban and metropolitan territorial dynamics as well as in peri-urban agriculture in Montréal. Between 2011 and 2018, she coordinated the drafting of the first plan to develop a sustainable and equitable food system for the Montréal community (SAM 2025) and two SAM Action Plans. She is currently responsible for regional mobilization support and converting the SAM into the first Montréal Food Policy Council (CPA-Mtl). In addition to her CPA-Mtl duties, Ms. Chahine is pursuing a doctorate at the Université de Montréal and serves as a consultant and strategic advisor (support, activity leadership, territorial mediation) to municipal bodies on dossiers involving upgrading and redeveloping agricultural territories.

CHANCY, Michel. Professor-Researcher, Faculty of agricultural and environmental sciences, Quisqueya University

Michel Chancy (veterinarian and graduate of the National Autonomous University of Mexico, 1986) is Professor and Researcher at the Faculty of Agricultural and Environmental Science at Quisqueya University in Haiti. He was born in Haiti and raised in Canada. In 1986, he returned to Haiti, which at the time had only four veterinarians. He has been the Secretary of State for Animal Production (2008–2016) and Director and a founding member of the farming NGO Veterimed (1991–2008). He has also been a member of the Presidential Commission on Competitiveness in the Haitian economy (2009–2011) and the Presidential Commission for the Fight against Hunger and Nutrition (2012–2013). In 2005, Veterimed's Lèt agogo project received the prize for the best innovative social project from the Economic Commission for Latin America and the Kellogg Foundation (Chile, 2005). Other distinctions include: Officer of the Order of Agricultural Merit (France, 2017), Commander of the Order of Rio Branco (Brazil, 2012), and the Latin Trade BRAVO Humanitarian Leader of the Year award (United States, 2016).

CHARRON, Dominique. Director, Agriculture and Environment Program, International Development Research Center

As Director of IDRC's Agriculture and Environment program, Dominique Charron oversees research that seeks innovative, evidence-based solutions to help people face the world's toughest development and environmental challenges: poor agricultural productivity, food insecurity and malnutrition, chronic and infectious diseases, and risks to lives and livelihoods from a changing climate. In this role, she pursues the tradition of research excellence of the International Development Research Center (IDRC), promoting the active involvement of stakeholders in the research process, including affected communities, and the integration of research outcomes into policy decisions that help improve the lives of all members of society. Dr. Charron joined IDRC in 2006 as Program Leader of the Ecosystems and Human Health program. Previously, she developed and managed research programs on climate change and infectious diseases at the Public Health Agency of Canada. She has conducted research in Canada, including in the Arctic, and in the Caribbean. Dr. Charron has taught epidemiology and ecosystem health at the graduate and undergraduate levels at several Canadian universities. She holds a Ph.D. in epidemiology and a Doctor of Veterinary Medicine from the University of Guelph.

CHICOINE, Josée. Strategic Advisor, Agri-Food Development, Coop Carbone

Josée Chicoine works to establish and implement Coop Carbone's development strategy in the agri-food sector through collaborative capacity-building projects. An agronomist by training, she holds a master's degree in animal nutrition. For 15 years, she held the position of Agri environmental Director of La Coop fédérée, the largest agri-food enterprise in Québec. At La Coop fédérée, she coordinated the agri-environmental offer for all affiliated cooperatives and managed several strategic projects, among them projects focused on greenhouse gases in dairy production, sustainable management of agricultural businesses and the study of biomethanization projects. She also coordinated La Coop fédérée's sustainable development process.

COGLIASTRO, Alain. Researcher, Montreal Botanical Garden, Associate Professor, Université de Montréal

Alain Cogliastro is a researcher at the Montréal Botanical Garden, a member of the Institut de recherche en biologie végétale, an adjunct professor at Université de Montréal and an associate researcher at the Centre for Forest Research. He has a doctorate in forest ecology from Université de Montréal.

COLLETTE, Linda. Advisor, Legal Research Chair in Food Diversity and Security, Université Laval

Linda Collette has a bachelor's degree in ecology, a master's degree in environmental sciences and a master's degree in project management as well as a diploma in administration. She has more than 35 years of experience in positions of increasing responsibility at operational, technical and policy levels in the field of sustainable development and has worked in Québec, in Canada and in developing countries as well as at the international level. She worked at the FAO for 17 years, collaborating with local, national and international partners to promote sustainable agriculture and sustainable management of biodiversity, including agricultural biodiversity. Her last position at the FAO was Secretary of the Commission on Genetic Resources for Food and Agriculture, where she positioned genetic resources on the climate change agenda as well as on the food security and nutrition agenda. Ms. Collette is currently Advisor to the Legal Research Chair in Food Diversity and Security at Université Laval in Québec, Canada.

COUILLARD, Philippe. Premier, Gouvernement du Québec

For the 31st Premier of Québec, Philippe Couillard, climate change and its impact on people are one of the most important transformations of the 21st century, since they affect all spheres of activity. Beyond the many policies implemented by the Gouvernement du Québec to provide support to, among other things, the electrification of transportation, the development of renewable energy and the reduction of Québec companies' greenhouse gas emissions through the carbon market, energy efficiency programs and the Green Fund, the Premier secures Québec's constant presence on the international stage to create partnerships and contribute to international reflection on the fight against climate change. In the context of the world's agri-food systems being directly impacted by climate, the Premier has set up programs to support French-speaking countries that are the most vulnerable to the effects of climate change: the Programme de coopération climatique internationale and the Initiative jeunesse de lutte contre les changements climatiques. This International Symposium on Food Security and Nutrition in the Age of Climate Change, organized by the Gouvernement du Québec in collaboration with the Food and Agriculture Organization of the United Nations, is in line with the Premier's vision of anticipating change rather than simply submitting to it.

DE BLOIS, Sylvie. Professor and Director of the School of Environment, McGill University

Sylvie de Blois received a Ph.D. in biology from Université de Montréal in 2001. She is an Associate Professor at McGill University and Director of the McGill School of Environment, an interdisciplinary teaching and research unit. Her area of expertise is plant and landscape ecology. She has been an invited scientist at CSIRO in Australia and at the École des Mines engineering school in France. She is a member of the Québec Center for Biodiversity Science and a scientific advisor for AgreenSkills, a European Union programme aimed at supporting excellence in agricultural and environmental research. She has co-directed the CC-Bio project on the impact of climate change on Québec biodiversity and the CC-PEQ project on climate change and biological invasion. She is the co-author of Changements climatiques et biodiversité du Québec : vers un nouveau patrimoine naturel, an award-winning book on the impact of climate change on Québec biodiversity.

DE LA TORRE SANCHEZ, José Fernando. Researcher, Director of the National Genetic Resources Center, National Forestry, Crops and Livestock Research Institute of Mexico

José Fernando De La Torre Sánchez got his DVM and MSc. Degrees at the National Autonomous University of Mexico, and received his PhD in Biomedical Sciences at the Colorado State University in USA. From 1982 to date he has worked as a Researcher at the National Forestry, Crops and Livestock Research Institute of Mexico (INIFAP), where he has been doing research on reproductive physiology in farm animals, in vitro production of mammalian embryos, gamete and embryo cryopreservation and lately on genetic resources conservation. He also has been teaching undergraduate and graduate students at the University of Guadalajara, since 2004. From March, 2009, he led the establishment and set in operation of the National Genetic Resources Center of Mexico (CNRG), belonging to INIFAP, and from May, 2011, when the Center started its operations, he is the Director of the CNRG-INIFAP.

DE PINTO, Alessandro. Researcher, Environment and Production Technology Division, International Food Policy Research Institute

Alessandro (Alex) De Pinto is an environmental and natural resource economist with 25 years of experience working in economically depressed areas. Dr. De Pinto has a Ph.D. in agricultural and consumer economics from the University of Illinois at Urbana-Champaign, and has diverse international experience working with GIS-based socioeconomic and environmental modeling, empirical applications of dynamic behavioral models, and discrete-choice modeling techniques in Latin America, South Asia and sub-Saharan Africa. His research focuses on agricultural risk management, resilience and low-emission development strategies, and he has developed a series of modeling techniques that make it possible to simulate location-specific effects of policy changes and the subsequent effects on the economy and the environment.

DEBAILLEUL, Guy. Professor in Rural Economy and Development, Université Laval

Agricultural engineer, graduate of the Paris Institute of Political Studies and holding a Ph.D. in Agricultural Development Economics, Guy Debailleul was a full professor in the Department of Agroalimentary Economics and Consumer Sciences at Université Laval in Québec City before retiring. He is still an associate professor in this department. He began his research career at the National Institute of Agronomic Research (INRA) in Paris before joining the Faculty of Agricultural and Food Sciences at Université Laval. His research focuses on the transformations of agriculture in both developed and developing countries. He analyzed more specifically the role of agricultural and agri-environmental policies in these transformations. He recently became interested in the different dimensions of food security.

DIEDERICHSEN, Axel. Curator and Research Scientist, Plant Gene Resources of Canada

Axel Diederichsen has worked as curator and research scientist at national and regional genebanks in Germany, Sweden and Canada. His main interest is to improve the conservation and utilization of cultivated plant diversity. He assessed and described the genetic diversity of species of cultivated plants such as wheat, oat, flax, pulses and spice plants in order to understand their evolution and the potential their diversity has for food security. He engages with farmers, plant breeders, researchers, genebank colleagues and non-governmental organizations in many countries. He is Curator and Research Scientist for Plant Gene Resources of Canada, the Canadian national genebank, located in Saskatoon, Saskatchewan. He is working actively with the Food and Agriculture Organization of the United Nations on behalf of Canada on plant genetic resources and chairs the NORGEN Taskforce on Genetic Resources that coordinates activities among Mexico, the United States and Canada.

DUCHEMIN, Éric. Scientific and Training Director, Urban Agriculture Laboratory, Associate Professor, Institute of Environmental Sciences, Université du Québec à Montréal

Scientific and Training Director at the Urban Agriculture Lab (AU/LAB), for over 10 years Éric Duchemin has been conducting interdisciplinary research on urban agriculture issues, from kitchen gardens to rooftop urban farms to municipal public policy on food. An internationally recognized specialist, he also facilitates training courses and participates in committees and research and urban agriculture projects abroad, particularly in France, Belgium, Brazil and the United States. He is also the coordinator of the Carrefour de recherche, d'expertise et de transfert sur l'agriculture urbaine du Québec (CRETAU), funded by the Ministère de l'Agriculture, des Pêcheries et de l'Alimentation of Québec. He is co-founder of the Urban Agriculture Summer School, which has been held in Montréal since 2009. Since 2001, he has been an associate professor at the Institute of Environmental Sciences at Université du Québec à Montréal.

DUCLOS, Jean-Yves. Minister of Families, Children and Social Development

Jean-Yves Duclos was Director of the Department of Economics and a tenured professor at l'Université Laval. As a well-published author, conference speaker, and renowned economics expert, he was often asked to comment on current events in Québec and Canada. In addition to his professorial duties, Jean-Yves held and co-founded the Industrial Alliance Research Chair on the Economics of Demographic Change, was President-elect of the Canadian Economics Association, and was a member of the Institut sur le vieillissement et la participation sociale des aînés. He was also Vice-President and Fellow of the Centre interuniversitaire de recherche en analyse des organisations, Senior Fellow of the Fondation pour les études et les recherches sur le développement international and Fellow-in-Residence at the C.D. Howe Institute. Lastly, Jean-Yves is co-founder of the Poverty and Economic Policy Research Network (Partnership for Economic Policy, PEP). Jean-Yves earned a Bachelor of Arts in Economics (First-Class Honours) from the University of Alberta, and his master's and doctoral degrees in Economics from the London School of Economics and Political Science. He has been rewarded for relentless hard work with prestigious grants, the Société canadienne de science économique's prix Marcel Dagenais, and the Harry Johnson Award for best paper published in the Canadian Journal of Economics. In 2014, Jean-Yves was elected a Fellow of the Royal Society of Canada, the highest accolade bestowed on Canadian researchers.

DUFOUR, Charlotte. Nutrition and food systems officer, FAO

Charlotte Dufour specializes in the linkages between agriculture, food systems and nutrition. She has been working with FAO as a nutrition expert since 2005. She first worked as nutrition advisor to the Ministry of Agriculture, Irrigation and Livestock in Afghanistan from 2005 to 2008, before joining FAO headquarters in 2010 to promote agriculture and nutrition linkages in sub-Saharan Africa and internationally. She has coordinated the publication of several manuals and training resources on nutrition-sensitive food systems. She has also worked with Action Against Hunger in Afghanistan and Ethiopia (2000 to 2002) and Groupe Urgence – Réhabilitation - Développement. She holds a bachelor's degree in human sciences from Oxford University and a master's in public health nutrition from the London School of Hygiene and Tropical Medicine.

EGAL, Florence. Expert in food security and nutrition, sustainable diets and local food systems

Florence Egal started her career in the field as a public health doctor in developing countries. She joined FAO in 1990 where she worked for more than 20 years on food security, nutrition and livelihoods, including urban-rural linkages and the promotion of local food. Since her retirement in 2013, she has been dedicated to promoting sustainable food and food systems in the context of climate change.

FRISON, Émile. Independent Consultant on agriculture, biodiversity and sustainable food systems and member of the International Panel of Experts on Sustainable Food Systems

Dr. Frison is a Belgian national who has dedicated his career to international agricultural research and development. He worked in Nigeria and Mauritania for six years on agricultural research and development. In 2003, he became Director General of Bioversity International and developed a strategy entitled "Diversity for Well-being" focusing on how agricultural biodiversity contributes to the nutritional quality of diets and to the sustainability, resilience and productivity of smallholder agriculture. He was member and Vice-Chair of the Board of Directors of EcoAgriculture Partners (2006-2016) and Extraordinary Professor at the Université catholique de Louvain, Belgium (2007-2009). He is currently Chair of the International Sustainable Food Systems and Diets Scientific Committee of the Daniel and Nina Carasso Foundation. In 2015, he joined the International Panel of Experts on Sustainable Food Systems (IPES-Food). Dr. Frison is author or co-author of over 175 scientific and technical publications.

FRULLA, Liza. CP, C.M.O.Q Chief Executive Officer, Institut de tourisme et d'hôtellerie du Québec

Backed by experience in marketing, media and politics, Liza Frulla enthusiastically shares her passion for public affairs and media, as well as her knowledge of the political processes. Her life has been a series of firsts: the first female sports journalist in the history of electronic media in Québec; the first female marketing director of a major Canadian brewery (Labatt Brewing Company); the first woman to hold the position of executive director of CKAC, the largest French-language radio station in Canada at the time, and the first person (and woman) to hold the positions of Minister of Culture and Communications in the National Assembly and Minister of Canadian Heritage in Ottawa, making her the only person in Canada to have officially had cultural responsibilities at both the provincial and federal levels. She led the charge to create the first cultural policy in Québec, the Conseil des arts et des lettres du Québec and the Société de développement des entreprises culturelles. On the international stage, she was one of the fiercest advocates of the UNESCO Convention on the Protection and Promotion of the Diversity of Cultural Expressions. Under her leadership, Canada was the first country to sign this international convention in December 2005. She has been Executive Director of the Institut de tourisme et d'hôtellerie du Québec since August 2015. Ms. Frulla was named a Member of the Order of Canada on July 1, 2017, for her cultural achievements, an Officer of the Ordre national du Québec in 2016, a Compagne of the Ordre des Arts et des Lettres du Québec in 2015 and an Officer of the Ordre de la Pléiade in 1995

GALARNEAU, Vincent. Advisor and Speaker for Vivre en Ville, a public interest organization for sustainable land-use planning

Vincent Galarneau is an advisor and speaker for Vivre en Ville, a public interest organization concerned with sustainable land use (Québec). He holds a bachelor's degree in environmental science and a master's degree in anthropology from Université Laval. For several years, he coordinated the implementation of community gardens, helped agri-food businesses with their marketing and participated in several action-research projects. More recently, he has been interested in setting up local food systems in the cities and regions of Québec. Vincent is the primary author of Villes nourricières : mettre l'alimentation au cœur des collectivités, a reference book for Vivre en Ville published in 2015. He is an active member of several regional and national working groups, including the Table québécoise sur la saine alimentation (TQSA) and the Réseau d'agriculture urbaine de Québec (RAUQ).

GARIÉPY, Stéphane. Knowledge and Technology Transfer Manager, Agriculture and Agri-Food Canada

Stéphane Gariépy is a science and technology manager for Agriculture and Agri-Food Canada (the Canadian department responsible for agriculture) in Québec, Canada. Mr. Gariépy has a bachelor's degree in agricultural engineering from Université Laval (Québec, Canada) and a master's degree in environmental sciences from the Institut national de la recherche scientifique (Québec, Canada). His interests and activities focus on the exploration of approaches and projects to increase the efficiency of knowledge and technology transfer from scientists to farmers and agronomists. Since 2012, he has worked with Indigenous and non-Indigenous colleagues and collaborators on projects to increase awareness of Indigenous agriculture and to establish new agricultural and agri-food activities in First Nations communities.

GITZ, Vincent. Director, Research Program on Forests, Trees and Agroforestry, Consultative Group on International Agricultural Research

Vincent Gitz is the Director of the research program on Forests, Trees and Agroforestry (FTA) of the Consultative Group on International Agricultural Research's (CGIAR). An engineering graduate of École Polytechnique (1994) in France, he holds a PhD from AgroParisTech on land use and global climate policies that was awarded the Le Monde award for academic research. He specializes in natural resource management and development economics. Vincent has done research for CIRED and CIRAD, policy making, and worked at the interface between the two. He served as sustainable development and research advisor to the French minister of agriculture and fisheries Michel Barnier, and as assistant director for food policy in the French ministry of agriculture. Between 2010 and 2015, he was coordinator of the High Level Panel of Experts on Food Security and Nutrition (HLPE), the science-policy interface of the United Nations Committee on World Food Security (CFS).

GOSSELIN, Pierre. Coordinator of the Health Program, Ouranos Research Consortium

Since 2004, Dr. Gosselin has coordinated the health program at Ouranos, the Québec consortium on regional climatology and adaptation to climate change. From 2007 to 2017, he also led the health component of the government of Québec's action plan on climate change. A graduate in medicine and environmental health, for the past 20 years he has been leading the World Health Organization's Collaborating Centre for Environmental Health Sciences at the CHU de Québec – Université Laval and conducting projects around the world. He is a medical consultant at the Institut national de santé publique du Québec, clinical professor at Université Laval and associate professor at the National Institute of Scientific Research. In this capacity, he has collaborated on numerous research projects and published about a hundred papers and scientific reports on climate change and health in the last 15 years.

GROLEAU, Marcel. President, Union des producteurs agricoles

Marcel Groleau is a dairy producer in Thetford Mines and has been the President General of the Union des producteurs agricoles (UPA) since December 2011. He has been active in the agricultural union movement for more than 20 years and served as President of Les Producteurs de lait du Québec from 2004 to 2011 after serving as Vice-President for four years. He also served on the Union's executive board from 2005 to 2009. He was part of the Dairy Farmers of Canada's Executive from 2004 to 2011 and has chaired, among others, Valacta (2006–2011), Semex Alliance (2002–2003) and the Canadian Dairy Network (1998–1999). Marcel Groleau's involvement in the agricultural sector far exceeds his presidency at the UPA. He is also President of such organizations as UPA Développement international, the Food Sovereignty Coalition and G05, the Coalition for a Fair Farming Model, Supply Management. He is Second Vice-President of the Canadian Federation of Agriculture and Interim President of Solidarité rurale du Québec. He has taken part in numerous missions abroad to follow up on bilateral and multilateral trade agreement negotiations, including those of the WTO. The farm "Ferme D.M. Groleau", which he co-owns with his brother Denis, has 250 hectares of land and 225 heads of purebred Holstein cattle. In 2000, the Groleau brothers received the Cérès award for excellence from Salon de l'agriculture for their outstanding qualities as managers. Marcel Groleau has received several awards over the years, including Person of the Year from the Chambre de commerce de la région de l'Amiante (2000) and at the Gala Zénith in his region (2012). In 2013, he received the Honoris Causa award at the Gala Cérès held during the Salon de l'agriculture in Saint-Hyacinthe.

HALLEY, Paule. Chairholder, Canada Research Chair in Environmental Law and Professor, Faculty of Law, Université Laval

Paule Halley, LL.D., LL.M., LL.B., is a professor in the Faculty of Law at Université Laval, where she has taught environmental law since 1994. She has been the chairholder of the Canada Research Chair in Environmental Law since 2002 and a member of the Barreau du Québec since 1998. Dr. Halley is the author of numerous articles and books on environmental law and sustainable development, and she is active in several organizations, including the Kativik Environmental Advisory Committee (Nunavik), the Institut de la Francophonie pour le développement durable and the Hydro-Québec Institute for the Environment, Development, and Society. Her work and accomplishments have been recognized by the ACFAS Michel-Jurdant Award for environmental sciences (2015), the Prix scientifique de la Francophonie from the science council of the Agence universitaire de la Francophonie (2005) and the prize for the best monograph from the Fondation du Barreau du Québec (2003) for her work Le droit pénal de l'environnement.

HOLLIFIELD, Mary Kathryn. Conseillère en agriculture, Banque mondiale

Mary Kathryne Hollifield is currently serving as Adviser in Agriculture Glocal Practice (GP). She joined the Bank in 1997 and has worked in Operations Policy and Country Services (OPCS), Africa, and East Asia. She is an Economist with MA from the University of Alberta with focus on agriculture and natural resources and started her career with the Government of Canada.

HOUZIR, Meriem. Founder and Director of the consulting firm AlliaDev

Founder and Director of the Franco-Moroccan consulting firm AlliaDev, Meriem Houzir is an engineer and ecologist with a Ph.D. in land use planning and sustainable development. For the last 15 years, she has worked as a consultant in Morocco, Africa and other Francophone spaces within public institutions at the national level (ministries and government corporations), the local level (territorial authorities) and with NGOs and international organizations and agencies of the United Nations (UNDP, UNEP, IFDD, GIZ, ESCWA, etc.). Meriem developed her expertise through study-consultation missions, project management assistance/support, training, evaluation of public policy and development programs, and the organization of high-level meetings/debates. She also has a great deal of experience in supporting decentralization processes and territorial authorities as well as local governance. Meriem has participated in United Nations conferences on sustainable development and climate change (Rio+20 in 2012 and COP21 in 2015). In anticipation of COP22, which took place in November 2016, she started "Initiatives Climat Afrique Francophone," which recognizes projects fighting climate change that are led by non-state actors (civil society, female and green entrepreneurs, and territorial authorities). The website (www.initiativesclimat.org) brings together over 170 initiatives from 21 countries, and 30 African nominees and winners were invited to participate in COP22, where an awards ceremony featuring international personalities was held. The 2017 edition of this project will include South South cooperation projects and initiatives to facilitate expertise transfer and shared and collaborative capacity building among African actors. An awards ceremony will be held at COP23. Meriem believes that it is time to put people at the centre of sustainable development concerns, and that a local approach, decentralized cooperation and capacity building for local actors can catalyze an ecological transition and the fight against climate change in Africa.

JALLOH, Blamah. Breeding Engineer in Niamey, Project Manager of the Billital Maroobe Network

Based in Niger, Blamah Jalloh is the Regional Technical Coordinator of the Billital Maroobe Network of livestock farmers and pastoral farmers in West Africa. This has provided him with an opportunity to gain an integrated sub-regional vision of pastoral problems and emerging issues as well as the challenges affecting pastoral mobility in West Africa. Having worked with pastoral organizations for over ten years, he has proven experience in pastoral organization support and management in keeping with pastoral logic and a holistic approach, as well as an integrated vision of agricultural production systems. In addition, he has a strong track record in dealing with issues pertaining to pastoral vulnerability. His sound knowledge of sub-regional institutional issues is combined with a full understanding of sub-regional integration institutions (ECOWAS, UEMOA [West African Economic and Monetary Union], CILSS [Permanent Interstate Committee for Drought Control in the Sahel], ALG).

JOHANNES, Jimmy. Hunting, Fishing and Trapping Association, in collaboration with the Nunavik Regional Board of Health and Social Services

Jimmy Johannes is the Secretary General of the Nunavik Regional Hunting, Fishing and Trapping Association (Nunavimmi Umajulivijiit Katujiqatigininga), Québec, Canada, since 1999. As such, he represents Inuit hunters and defends their rights at all levels of government, and in particular Fisheries and Oceans Canada. He has been a member of the Nunavik Regional Food Security Working Group since 2015, a consultant to the Polar Bear Management Plan for Québec and a permanent member of the Circumpolar Biodiversity Monitoring Program.

KHAPER, Monica. Sustainability Director, Growing North

Monica Khaper has a background in environment and urban sustainability with a specialization in food security. She has experience in a variety of fields, including transportation and environmental planning. She has worked with non-profit organizations and volunteered her time to rooftop gardens across Toronto. Monica's passions include food security from an environmental perspective, sustainable cities, biophilic design, urban planning, and more. Her role as Sustainability Director with Growing North allows her to engage with Indigenous communities in Canada, work with agrotechnology, and explore renewable energy options in northern communities.

KOBAYASHI, Monica. Consultant on biodiversity and sustainable development, Secretariat of the Convention on Biological Diversity

Monica Kobayashi is a consultant on biodiversity and sustainable development. She currently works on the Programme of Work on Agricultural Biodiversity of the Convention on Biological Diversity (CBD) in supporting Parties on the integration of biodiversity into agricultural practices, not only to promote conservation and the sustainable use of natural resources, but also to increase resilience, productivity, food security and nutrition. She has been working on the review of the International Pollinators Initiative and also in different projects in partnership with FAO, such as the series of technical guidance on Mainstreaming Ecosystem Services and Biodiversity into Agricultural Production and Management in East Africa and in the Pacific Islands. She holds a Master of Business Administration degree from HEC Montréal and a master's degree in Environment and Sustainable Development from the Université de Montréal.

LACASSE, Richard. President of the International Agricultural Alliance and Executive Director of the Société de coopération pour le développement international

Mr. Richard Lacasse is the Executive Director of Société de coopération pour le développement international (SOCODEVI) since May 2013. Mr. Lacasse joined SOCODEVI in 1989 and has been in the recent years the International Program Director and Latin America Director. Mr. Lacasse has developed during all these years a sound expertise in planning, coordination, management and implementation of cooperation and development programs to support sustainable economic development in local communities in Latin America and Africa, particularly through the development of cooperatives and associative businesses. Mr. Lacasse holds a Master degree (M. Adm.) in Management and Governance of Cooperatives from Sherbrooke University in Canada and a B.A. in Political Science and Journalism from the Université Laval. Mr. Lacasse is member of the Advisory Board of the Research and Teaching Institute for Cooperatives at Sherbrooke University (IRECUS).

LALANCETTE, Michèle. President, Fédération de la relève agricole du Québec

Michèle Lalancette gained her agricultural experience on her family's dairy farm. She plans to take over the business in the coming years: the transfer is currently underway and she is working on implementing protocols to have the herd certified as organic. In addition to studying natural sciences at Alma College, she completed a training in Agricultural Business Management and Operation at the ITA (agri-food technology institute) in Saint-Hyacinthe. Following her training, Michèle worked with several agricultural companies at the technical service level, especially with the Nutrinor cooperative and subsequently as an agri-environmental technician at the Club Conseil Pro-Vert in Jonquière. She was an administrator at the Regional Centre of Young Farmers (CRJA) from 2007 to 2016, including six years as president, and administrator of the regional federation of the

UPA (agricultural producers union) of the Saguenay-Lac-Saint-Jean region. Since March 2016, she has served as president of the Federation of Young Farmers of Québec (FRAQ), an organization affiliated with the UPA that brings together close to 1,700 enthusiastic young people who want to earn their living from agriculture. Several challenges will need to be addressed in the next few years. Land grabbing as well as easy access to financing and farm transfers are priority issues for Michèle, who envisions agriculture as strong, profitable, local, and in harmony with the environment, with a focus on developing agricultural entrepreneurship.

LAMALICE, Annie. Ph.D. Candidate in food and cultural geography, specializing in issues related to food security and food sovereignty in Nunavik, Université de Montréal and Université de Montpellier (co-supervision program)

Annie Lamalice holds a master's degree in geography from Université du Québec à Montréal. Under the direction of Juan-Luis Klein, she wrote her thesis on the socio-environmental impacts of open-pit mining projects on women in Latin America. She is now a co-supervised doctoral candidate in geography with the Center for Evolutionary and Functional Ecology (CEFE-CNRS) in Montpellier and Université de Montréal. Her thesis focuses on food sovereignty within the Inuit communities of Kuujjuaq and Kangiqsujuaq. Based on a participatory action-research approach, she supports the development of northern agriculture projects as well as reflection on the multiple issues that hinder access to nutritious, sustainable and culturally acceptable food in Nunavik.

LANDIS, Lauren. Director of Nutrition, World Food Programme

Lauren Landis began her career in relief and development in 1985, working for the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) in Geneva. She then took on assignments in Washington and in Africa working as a Disaster Operations Specialist and as an Emergency Operations Coordinator for the U.S. Office of Foreign Disaster Assistance within USAID. In 1993, Ms. Landis turned her efforts to the NGO sector and held several positions, including serving as the Director of Humanitarian Response as well as the Director of the Food Security Unit at Save the Children. Ms. Landis returned to the U.S. Government in 2002 as Director of USAID's Office of Food for Peace. In 2006, she transitioned to the U.S. Department of State, where she served as the Senior Representative on Sudan. In 2009, Ms. Landis joined the United Nations World Food Programme (WFP) as Chief of Staff, and in 2011 she became Director of the WFP Geneva Office. From 2013-2016, Ms. Landis served as the WFP Country Representative and Director in Chad. In mid-2016, she returned to Rome, Italy to take up her current role as WFP's Director of Nutrition.

LARAMÉE, Benjamin. Chief Scientific Officer, Urban Food Ecosystems

Benjamin Laramée is a doctoral student in aquaponics at Université Laval, President of AgroCité and Chief Scientific Officer of Urban Food Ecosystems (ÉAU). During his master's studies, his research focused on the intensive farming of percids—a family of fish that includes walleye and perch—in recirculation systems. He is currently pursuing doctoral studies focusing on the role of the microbacterial flora on plants grown in aquaponic systems. Through his research, engagement and work, Benjamin seeks to optimize the efficiency of food production in urban settings through aquaponics. He places great importance on reducing the environmental impact of this kind of production. He takes inspiration from his observations of nature, where, he notes, the concept of waste does not exist - the waste of one species becomes the resources of another.

LEMIRE, Jean. Emissary for Climate Change, Northern and Arctic Affairs, Government of Québec

A renowned biologist and scientific communicator, Jean Lemire has conducted research on climate change and biodiversity that have launched major scientific missions. In 2001, he transformed a large oceanographic sailboat into a scientific research platform and production studio, which led him to travel the oceans to raise awareness about major environmental issues. After his missions to the Arctic (2002) and the Antarctic (2005-2006), he undertook with his team the "1000 jours pour la planète" TV series in 2012, a three-year world tour to discuss the state of global biodiversity, in collaboration with the secretariat of the UN Convention on Biological Diversity. He also designs, in association with the Sedna Foundation, many educational programs which have become references in the academic field over the years. Jean Lemire was appointed as emissary for climate change, northern and arctic issues by the Government of Québec in September 2017, becoming the first emissary in the history of Québec diplomacy.

MADRAMOOTOO, Chandra. James McGill Professor, Bioresource Engineering Department, Faculty of Agricultural and Environmental Sciences, McGill University

Chandra Madramootoo is a James McGill Professor in the Department of Bioresource Engineering at McGill University, and Director of the McGill Water Innovation Lab. Mr. Madramootoo's areas of expertise are water management, irrigation and food security. He is also a Visiting Professor and Visiting Scholar in Water and Food Security at the Massachusetts Institute of Technology (MIT). He served as Dean of the Faculty of Agricultural and Environmental Sciences from 2005 to 2015 and was the Founding Director of the Brace Centre for Water Resources Management at McGill. He created the McGill Institute for Global Food Security, as well as programs in integrated water management, food safety, food security, and innovation and entrepreneurship in the Faculty of Agricultural and Environmental Sciences. Professor Madramootoo has published over 230 book chapters and refereed journal papers. He has delivered over 200 conference presentations and has been invited to deliver some 160 keynote presentations at national and international conferences and symposia. He has supervised the thesis research work of over 100 graduate students.

MANN, Emily, Inuvik Community Greenhouse Coordinator

Emily Mann is the Coordinator of the Inuvik Community Greenhouse, in the Northwest Territories, Canada. Her work focuses on education, community outreach, membership coordination, plant orders and local food sales. She keeps the plants happy and healthy and organizes vegetable harvests for markets and the greenhouse's vegetable box share program. Emily recently completed her Masters' degree in agriculture and food security through the University of Waterloo. She has spent the last few years studying and working with various environmental and food security groups across Canada, France, and New Zealand.

MCTAVISH, Kristeen. Food Security Coordinator, Nunatsiavut Government

Kristeen McTavish is the Regional Food Security Coordinator for the Department of Health and Social Development of the Nunatsiavut Government, a self-governing Inuit regional government in the province of Newfoundland and Labrador. In this position, she is responsible for coordinating the Nunatsiavut Government's response to food insecurity within the region and working collaboratively with all departments to plan for long-term sustainable improvements in food security. Her work includes addressing key determinants of food security through a wide range of initiatives, programs, and policies involving community, provincial, national, university, private and non-profit partners, and creating and implementing a Nunatsiavut Food Security Strategy.

MELGAR-QUINONEZ, Hugo. Director, Institute for Global Food Security, University McGill

Dr Melgar-Quiñonez is the Director of the Institute for Global Food Security and the Margaret A. Gilliam Faculty Scholar in Food Security with an appointment in the McGill School of Dietetics and Human Nutrition. With a degree in Medicine (1992) and a doctoral degree in Sciences (1996) from the Friedrich Schiller University in Germany, he moved to McGill in September of 2012, after 9 years of work as a professor in the Department of Nutrition at the Ohio State University (2003-2012). Previously he worked in public health, nutrition and food security research at the University of California in Davis (1998-2003) and at the Mexican Institute of Public Health (1996-1998). Dr Melgar-Quiñonez has been a food security advisor to several countries in Latin America. He has conducted food security research in 20 countries in Africa, Asia and the Americas, and maintains a strong collaboration with FAO as a researcher in the project Voices of the Hungry which incorporates 150 countries.

MEYBECK, Alexandre. Senior Policy Officer on Agriculture, Environment and Climate Change to the Assistant Director General in charge of the Agriculture and Consumer Protection Department, FAO

Alexandre Meybeck is Senior Adviser on Agriculture, Environment and Climate Change to the Assistant Director General in charge of the Agriculture and Consumer Protection Department of FAO. He coordinates the FAO-UNEP Sustainable Food Systems Programme. He has worked extensively on issues related to sustainability, food security and nutrition at both national and international levels, and is the author of numerous publications on climate change and agriculture, sustainable food systems and sustainable diets. Prior to joining FAO, he served in the French Ministry of Agriculture as Head of the Environment and Rural Areas Unit and Head of the Environmental Strategies and Climate Change Unit, in which capacity he coordinated the preparation of the French adaptation plan for agriculture, forestry and fisheries.

MOTTET, Anne. Livestock Development Officer, FAO

Anne Mottet is a Livestock Development Officer with FAO. She is an agronomist and holds a Ph.D. in agronomy from the Toulouse INRA Centre as well as a master's in agricultural economics. She has 15 years of experience in the livestock sector. She has worked on and published about market analysis of animal products, policy assessments in agriculture and rural development, strategic consulting to the livestock sector and support for livestock and environmental policies, including global and regional assessments of natural resource use efficiency, climate change and ecosystem services.

MUÑOZ UREÑA, Hugo A. Professor and Director, Institute of Legal Research, University of Costa Rica; Senior researcher, Legal Research Chair in Food Diversity and Security, Université Laval

Hugo A. Muñoz Ureña is a full professor in the Faculty of Law and Director of the Law Research Institute of the University of Costa Rica. He is a senior researcher at the Legal Research Chair in Food Diversity and Security at Université Laval in Québec. He holds a Ph.D. in law from Université de Nantes (France), where he wrote a thesis on transparency and consumer information in European food law. He drafted a bill on the right to food and food security that was presented to the Legislative Assembly of Costa Rica in 2016. His work is focused on agri-food law, consumer law, the international food trade and, more recently, the legal aspects of food security.

MURPHY, Sophia. Steering Committee of the High Level Panel of Experts on Food Security and Nutrition

Sophia Murphy has 25 years of professional experience in international trade, food security and rural development. Her research, writing and advocacy work has focused on international trade law, the agricultural polices of OECD countries, rural development in the Global South, the right to food, and concentrated economic market power in agri-food markets. Sophia is a PhD candidate at the Institute for Resources, Environment and Sustainability at the University of British Columbia, and a Trudeau and Vanier scholar. She is serving her second term as one of the 15 members of the High Level Panel of Experts to the UN Committee on World Food Security. She is also Chair of the ActionAid USA board of directors. She has published dozens of articles and has extensive media experience. She holds an undergraduate degree from Oxford University and a master's (with distinction) from the London School of Economics.

NOLLET, Émilie. Co-founder and co-CEO, Écosystème alimentaires urbains

Emilie Nollet is the co-founder and co-CEO of Écosystème alimentaires urbains (EAU) where she is responsible for the administration and the social mandate of the organization. Emilie has participated in COP23 in Bonn and, as a part of her PhD focusing on entrepreneurship, sustainable food sources and food justice, she was invited to take part in the Research Consortium on the Fight against Poverty of the FRQSC. In 2016, Emilie was awarded the Entrepreneur of the Year award from the Women's Y in Montreal. She has also given many talks at schools concerning the importance of social entrepreneurship and green technologies.

NZAMUJO, Godfrey. Director, Songhai Center

Father Godfrey Nzamujo, O.P., was born in Kano, Nigeria in 1949. He has a B.A. in Modern Philosophy and Mathematics, an M.A. in Theology (creation-centered/evolution option) and a Ph.D. in Economic Philosophy. He also holds a Graduate Certificate in Systems Engineering as well as an M.S. in Electrical Engineering from Loyola Marymount University in Los Angeles, California, a Ph.D. in Electrical Engineering and Computer Service from the University of California, Irvine, and a Ph.D. in Management Science from the International Institute for Advanced Studies. Father Nzamujo has been the Director of the Songhai Centre in Benin since 1984. He has also been a Research Fellow/Professor at the University of California, Irvine, Associate Pastor at St. Nicholas Catholic Church in Laguna Hills, California, and Assistant Professor of Engineering at Loyola Marymount University, Los Angeles, California. His current research and development interests include: sustainable agriculture in the tropics and the corresponding institutional framework, renewable energy (biogas, biofuels and rural energy development), and microbiology and soil fertilization (Bacillus laterosporus and Rhizobium genus, moisture, temperature, microbiological environments and nutritive elements in integrated soil fertility management, energy pathways in water bodies, nutrient mining, energy sinks in urban and peri-urban wastewater, etc.). Father Nzamujo has received many honours and awards including membership in the U.N. Independent Commission on "Africa and the Challenges for the Third Millennium," the Africa Prize for Leadership for the Sustainable End of Hunger (co-recipient with President Rawlings of Ghana), the Jesuit Honors Award and the Engineering Honors Award (California). He was made a Grand Officer of the National Order of Benin by the Grand Chancellery of Benin and received the FAO's 70th-anniversary Commemorative Medal. He was also honoured with the "Rebranding Africa Award 2016 - Lifetime Achievement" prize at the Rebranding Africa Forum in Brussels.

ODENIGBO, Marian Amaka. Senior Technical Specialist, Nutrition, International Fund of Agricultural Development

Marian Amaka Odenigbo is a registered nutritionist and Senior Technical Specialist, Nutrition, at the International Fund of Agricultural Development (IFAD). She implemented a regional approach to mainstreaming nutrition in IFAD agriculture and rural development investments, led and supported projects on nutrition-sensitive interventions in Africa, and contributed to knowledge product development and advocacy for nutrition-sensitive agriculture. Prior to joining IFAD, she was a research associate and visiting scholar at McGill University in Canada, where she managed the nutrition component of a multinational rice post-harvest project funded by the Canadian International Development Agency to enhance food security in sub-Saharan Africa. Her Ph.D. from the University of Nigeria, in Nsukka, focused on community health and nutrition, food consumption patterns, nutritional value assessment and glycemic indices of traditional foods. In Nigeria, she explored locally neglected and underutilized foods to manage diabetes mellitus and other metabolic diseases. Her experience as a senior lecturer at the Michael Okpara University of Agriculture Umudike in Nigeria involved lecturing, research, and supervision of both undergraduate and post-graduate students as well as authoring over 30 international and national scientific publications.

OLIVIER, Alain. Professor, Phytology Department, Chair in International Development, Université Laval

Alain Oliver has a bachelor's degree in agronomy and a Ph.D. in plant biology. He has been a professor of agroforestry in the Faculty of Agriculture and Food Sciences at Université Laval since 1995. His research is primarily focused on the integration of trees in agricultural settings ranging from tropical regions like the Sahel to Québec. Since 2004, he has been Director of the Groupe interdisciplinaire de recherche en agroforesterie (GIRAF). He has held the Chair in International Development at Université Laval since 2011.

PARENT, Geneviève. Professor, Faculty of Law, Legal Research Chair in Food Diversity and Security, Université Laval

Geneviève Parent is a full professor in the Faculty of Law at the Université Laval, where she holds the Legal Research Chair in Food Diversity and Security. Her areas of interest include food security and national and international agri-food law. Her research over the last 20 years has focused on promoting food diversity through the development of national and international legal instruments, studying the impact of international law on Canadian and Québec agri-food legislation, and achieving a greater coherence between international economic law and other dimensions of law to promote sustainable global food security. She has published numerous scientific papers and is frequently invited to speak at national and international meetings on food security issues. She was appointed to the Agricultural Review Tribunal in August 2017.

PAȘCA PALMER, Christina. Executive Secretary, Secretariat of the Convention on Biological Diversity

Cristiana Pasca Palmer was appointed to the position of Executive Secretary of the Secretariat of the Convention on Biological Diversity by the Secretary-General of the United Nations. She assumed her responsibilities on March 17, 2017. Before her appointment, Dr. Pașca Palmer served as Romania's Minister for Environment, Waters and Forests from November 2015 to January 2017, and headed the Romanian delegation to the 2015 Paris Climate Conference, where she signed the agreement on behalf of Romania. She also headed the Romanian delegation to the 2016 Marrakech Climate Change Conference and the 2016 United Nations Conference on Biodiversity in Cancun. Born in 1968, Dr. Pașca Palmer holds a Ph.D. in international relations, with a specialization in development economics, international business management, and environmental sustainability from the Fletcher School of Law and Diplomacy in the United States. She also holds a master's degree in public administration

from Harvard University's John F. Kennedy School of Public Administration and a master of science in systems ecology and natural capital management from the University of Bucharest. In addition to Romanian, her native language, Dr. Pașca Palmer is proficient in Spanish and French.

RASTOIN, Jean-Louis. Emeritus Professor, Montpellier SupAgro, Founder and Scientific Advisor of the UNESCO Chair on World Food Systems

Jean-Louis Rastoin is an agronomy engineer who has a doctorate of economics and is associated with universities in management sciences. He is a professor emeritus at Montpellier SupAgro and the founder and scientific advisor of the UNESCO Chair in World Food Systems. He co-founded and was formerly director of the CIHEAM-IAMM/CIRAD/INRA/SupAgro Joint Research Unit "Markets, Organizations, Institutions and Strategies of Actors" (MOISA) and leads the editorial committee of the journal Systèmes alimentaires / Food Systems published by Éditions Garnier in Paris. He is an associate expert of the think tank Ipemed and a member of the Académie d'Agriculture de France. His teaching and research focus on food systems, agri-food markets, forecasting and business strategies. Most recent book published: Rastoin J.-L., Ferault C., dir., 2017, La sécurité alimentaire mondiale : État des lieux et prospectives, L'Harmattan, Paris.

SANOGO, Diaminatou. Researcher, Senegalese Institute for Agricultural Research

Dr. Diaminatou Sanogo is a senior researcher at the Senegalese Institute of Agricultural Research (ISRA). She is currently the Director of the National Center for Forest Research of ISRA and the focal person of the World Agroforestry Centre (ICRAF) in Senegal. She represents her institute on the National Climate Change Committee (COMNACC) and is a member of the technical committee of the Green Climate Fund (GCF) in Senegal. She has always been interested in the issue of adoption as well as participatory action research to promote sustainable community ownership of technologies. She developed a Climate-Smart Village model in Kaffrine, Senegal, which has been well documented in several publications.

SAUVÉ, Robert. President and Chief Executive Officer, The Société du Plan Nord (Canada)

Robert Sauvé has been President and CEO of the Société du Plan Nord since April 1, 2015. Prior to that, in May 2014, he was Associate Secretary General responsible for the Secrétariat au Plan Nord. Mr. Sauvé has held a number of senior positions in Québec public service, for which he has worked since 1987. His career as a public manager has been marked, among other things, by his thorough knowledge of the territory and its regions. He was Associate Secretary General of Aboriginal Affairs, Deputy Minister at the Ministère des Régions and Associate Deputy Minister of Regional and Municipal Affairs. From 2009 to 2012, he was Deputy Minister at the Ministère des Ressources naturelles et de la Faune and responsible for the Plan Nord. From August 2012 to October 2012, he was Associate Secretary General at the Bureau de transition du Plan Nord. From October 2012 to May 2014, he served as Associate Secretary General responsible for the Secrétariat des comités ministériels. Robert Sauvé was born in Beauharnois and holds a bachelor's degree in architecture from Université de Montréal and a master's degree in urban and regional planning from Oxford Polytechnic in England. He also pursued doctoral-level studies in land planning and regional development at Université de Montréal.

SEMEDO, Maria Helena. Deputy Director-General, Climate and Natural Resources, FAO

Maria Helena Semedo, a leading expert in global development issues, has worked in public service for over thirty years. Currently serving as Deputy Director-General for FAO, Ms Semedo is an economist and politician from Cape Verde. A strong advocate on the importance of food security, nutrition and sustainable agriculture as the key to tackling the root causes of hunger and poverty, Ms Semedo helps give voice to the most vulnerable people and communities around the world, especially the rural poor and women. Before taking up her current duties in 2013, Ms Semedo gained valuable experience and insight in Africa, first as FAO Representative in Niger, then as Deputy Regional Representative for Africa and Subregional Coordinator for West Africa. Ms Semedo started her career in 1984 as an economist for the Cape Verde Ministry of Planning and Cooperation and later at the Bank of Cape Verde. Two years after becoming Secretary of State for Fisheries, in 1993 she was appointed Minister for Fisheries, Agriculture and Rural Affairs – the first ever women Minister in Cape Verde. After serving as Minister for Tourism, Transportation and Marine Affairs from 1995-1998, she became Member of Parliament, a position she held until 2003. During this time she also represented her country in many international organizations.

SEYE, Saliou. Training Manager, Réseau des Organisations Paysannes et Pastorales du Sénégal

Saliou Seye has an engineering background and 16 years of experience, in training, advisory support to producers and rural development in general in Senegal. He worked for 6 years as an agricultural advisor at the Agence nationale de Conseil Agricole et Rural of Senegal and 7 years training producers at a national training centre and an agricultural high school. He is currently the head of training for the 35,000-member Réseau des Organisations Paysannes et Pastorales du Sénégal, and is in charge of identifying needs and implementing training actions. The organization's mission is to make sustainable and collaborative contributions to the development of viable rural and financial cooperatives offering efficient services that are tailored to the needs of Senegalese populations.

SIMMONS, Emmy. Senior Advisor, Global Food Security Project, Center for Strategic and International Studies

Emmy Simmons is currently an independent consultant on international development issues, with a focus on food, agriculture, and Africa. She serves as a non-resident senior advisor to the Center for Strategic and International Studies' Global Food Security Project, as a member of the Global Panel on Agriculture and Food Systems for Nutrition, and on the board of SNV USA. She is a member of the advisory committee for the CGIAR Research Program Agriculture for Nutrition and Health (A4NH). She has recently served as the co-chair of AGree, an initiative that brings together a diverse group of interests to transform U.S. food and agriculture policy in order to meet the challenges of the future. She has also served on the boards of several organizations engaged in international agriculture and global development. She completed a career of nearly 30 years with the U.S. Agency for International Development (USAID) in 2005, having served since 2002 as the Assistant Administrator for Economic Growth, Agriculture, and Trade, a presidentially appointed, Senate-confirmed position. Prior to joining USAID, she worked in the Ministry of Planning and Economic Affairs in Monrovia, Liberia and taught and conducted research at Ahmadu Bello University in Zaria, Nigeria. She began her international career as a Peace Corps volunteer in the Philippines from 1962 to 1964. She holds an M.S. in agricultural economics from Cornell University and a B.A. from the University of Wisconsin-Milwaukee.

SOKONA, Youba. Vice-Chair, Intergovernmental Panel on Climate Change

Dr. Youba Sokona is currently the Special Advisor on Sustainable Development of the South Centre. With over 35 years of experience in the fields of energy, climate change, the environment and sustainable development, he is an internationally recognized player on these issues. Reflecting his status, Dr. Sokona was elected Vice-Chair of the Intergovernmental Panel on Climate Change (IPCC) in October 2015. Previously, Dr. Sokona was Co-Chair of the IPCC Working Group III on climate change mitigation for the IPCC's Fifth Assessment Report, after serving as one of the main authors of the previous report. Dr. Sokona has also demonstrated his leadership and organizational management skills in such roles as Coordinator of the United Nations Economic Commission for Africa's African Climate Policy Centre (ACPC) and Executive Secretary of the Sahara and Sahel Observatory (OSS). As a Special Advisor to the African Energy Leaders Group, he is affiliated with numerous boards, scientific committees, universities and organizations. He is an Honorary Professor at the University College London (UCL). Dr. Youba Sokona is a global figure with deep technical and scientific knowledge, extensive sustainable development policy experience and an unreserved personal commitment to the development of Africa. He has published several books and articles about energy and climate, environmental and development changes focusing on Africa.

SONKO, Mariama. General Treasurer, Association of the young farmers of Casamance; National Coordinator, "We Are the Solution" movement in Senegal

Mariama Sonko has been a member of the Association des jeunes agriculteurs de Casamance (AJAC LUKKAL) since 1995, when she first became involved as an organizer. Today, she is the General Treasurer of AJAC. She has been defending the knowledge and practices of local farmers at the international level since she started getting involved in community associations in 1990. She has contributed to numerous studies on peace in Casamance, in southern Senegal. She joined the movement "Nous sommes la solution" (we are the solution) in 2011 and is now the Coordinator in Senegal. She advocates for better governance of genetic property rights.

THÉRIAULT, Sophie. Professor in the Faculty of Law, University of Ottawa

Sophie Thériault is Associate Professor in the Faculty of Law, Civil Law Section, of the University of Ottawa, and a member of the Barreau du Québec (2003). Professor Theriault holds a doctoral degree from Université Laval (LL.D. 2009), for which she earned a scholarship from the Pierre Elliott Trudeau Foundation. She has been a visiting scholar at the University of Washington in Seattle (2004–2005) and at the University of Victoria (2005–2007). She also served as a law clerk to the Honourable Louis LeBel at the Supreme Court of Canada in 2002–2003. Professor Thériault's research focuses on Indigenous peoples' rights in the context of natural resources extraction; Indigenous environmental governance; environmental justice and environmental rights; and food security and sovereignty for Indigenous peoples.

TRAORE CHAZALNOEL, Mariam. Associate Expert, Migration, Environment and Climate Change Division International Organization for Migration

Mariam is a Thematic Specialist in Migration, Environment and Climate Change at the UN Migration Agency (IOM) in New York. In this capacity, she manages IOM's work in relation to global climate negotiations and oversees the organization of training for policy-makers and other events addressing migration in a changing climate. She also speaks regularly around the world at events related to climate migration and displacement. Mariam is the editor of the IOM Outlook on Migration, Environment and Climate Change (2014) as well as the author of various articles on climate migration. Since 2008, Mariam has worked with IOM in various capacities in Geneva, Bamako and New York.

VERVILLE, Antoine. Acting General Manager of the Québec network of basin organizations

Antoine Verville is General Manager of the Québec network of basin organizations (ROBVQ), where he has been contributing to the implementation of the integrated water resource management for almost 10 years, in collaboration with the 40 basin organizations. He initiated the Rés-Alliance, a community of practice about adaptation to hydroclimatic changes. From 2013 to 2016, he co-led the Community-University Research Alliance on Coastal Communities Challenges facing climate change (CCC-CURA). As a research professional at the Université du Québec à Rimouski in 2015, he contributed to the analysis of the anticipated effects of hydrocarbons development in Anticosti and of the community's adaptation and resilience capacities. He has served as an advisor to the North American Network of Basin Organizations since its foundation in 2009 where he led the development of several international collaborations about integrated water management, such as with France and Mexico.

WALLET ABOUBAKRINE, Mariam. Doctor, Tin-Hinan Association and United Nations Permanent Forum on Indigenous Issues

Mariam Wallet Aboubakrine is a general practitioner by training. She did her residency in three health care systems of different levels in Mali, Algeria and Switzerland. Gaps and inequalities in health care within and between countries led her to humanitarian work, a field in which she completed a Masters in the world's humanitarian capital, Geneva. Mariam is also very committed to the rights of indigenous peoples, hence her election, in 2014, as an expert member of the United Nations Permanent Forum on Indigenous Issues, which she currently chairs.

WOLF, Julia. Natural Resources Officer, Climate and Environment Division, FAO

Julia Wolf is an agricultural economist and has been working for FAO, UNDP and the German Government for over 15 years. Currently, she is the Programme Coordinator of "Integrating Agriculture in National Adaptation Plans (NAP-Ag) Programme", a collaborative effort with UNDP to support the agriculture sectors (including fisheries and forestry) of Least Developed and Developing Countries to integrate their priorities into the NAP processes (www.fao.org/in-action/naps). She also supports FAO in engaging in the UNFCCC climate processes and with key partners.

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