IMPACT OF CLIMATE CHANGE AND BIOENERGY ON NUTRITION

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1. Summary

Background: Unacceptably Slow Progress against Hunger and Malnutrition

Food security has *deteriorated* since 1995 and reductions in child malnutrition are proceeding too slowly to meet the Millennium Development Goal (MDG) target for halving hunger by 2015. Three major challenges threaten to drastically complicate efforts to overcome food insecurity and malnutrition: climate change, the growing use of food crops as a source of fuel and soaring food prices.

Food security has four dimensions: food availability, access to food, stability of supply and access and safe and healthy food utilization. It is a key factor in good nutrition, along with health, sanitation and care practices. Globally, one billion people are currently without access to safe water and over 2 billion lack adequate sanitation facilities.

Present global food supplies are more than adequate to provide everyone with all the needed *calories*, if the food were equally distributed. But over 820 million people in developing countries have calorie-deficient diets; over 60 percent live in Sub-Saharan Africa and South Asia.

Even if a person consumes enough calories, this does not guarantee adequate intake of essential micronutrients – vitamins, minerals and trace elements. Micronutrient malnutrition ("hidden hunger") `has serious public health consequences. For example, over one billion people consume diets deficient in iron. Iron deficiency is responsible for roughly half of the global prevalence of anaemia. Iron deficiency anaemia causes 20 percent of global maternal mortality, can impair children's health and development and reduce adult work performance. Vitamin A deficiency disorders affect 40 million people causing blindness and contributing to infections and death.

One in three developing-country children under the age of five – 178 million children – suffers stunting due to chronic undernutrition and poor quality diets. Eighty percent of them live in just 20 African and Asian countries. Stunting is associated with higher rates of illness and death, reduced cognitive ability and school performance in children and lower adult productivity and lifetime earnings. Chronic malnutrition during the first two years of life usually results in irreversible harm.

At each stage in the lifecycle, malnutrition has consequences for each successive stage and/or the next generation. Malnourished mothers are more likely to have low birthweight babies, that face higher mortality and disease rates, impaired mental and physical development and increased risk of adult chronic diseases. Stunted children living with inadequate food, health and care become stunted adolescents; the girls among them too often grow up as the next generation of malnourished mothers.

HIV/AIDS interacts negatively with malnutrition. Poor nutrition can accelerate the spread of HIV, both by increasing people's vulnerability to the virus and by increasing the risk of infection following exposure. In turn, HIV infection can lead to nutritional deficiencies

through decreased food intake and malabsorption, which hasten the onset of AIDS. The disease impairs the immune system and so can lead to additional infections.

In 2008, the United Nations is appealing for humanitarian assistance for over 100 million people in two dozen countries affected by conflict and political and economic breakdown. Displaced people are susceptible to malnutrition because they frequently depend on food aid that may for a variety of reasons be inadequate in both quantity and quality. The number of natural disasters has increased, due to more frequent extreme weather events. Aid donors routinely fail to provide all of the resources requested through UN humanitarian appeals.

Causations and Linkages: Conceptual and Analytical Frameworks

The costs of inaction are considerable, so efforts to accelerate progress against malnutrition in all its forms should have a high place on the global policy agenda. Inadequate dietary intake and disease are the immediate causes of malnutrition. Inadequate food consumption heightens vulnerability to infectious diseases, which, in turn, can keep the body from absorbing adequate food. These immediate causes stem from insufficient access to safe and wholesome food, poor maternal and child rearing practices and inadequate access to clean drinking water, safe sanitation and health services. Ultimately, these factors are embedded in the larger political, economic, social and cultural environment. Food insecurity, ill health and sub-optimal caring practices are all closely related to poverty. Poor people generally consume fewer than 2,100 calories per day. Lower-income households experience significantly higher rates of preschooler stunting and illness and worse caring practices than better-off families. Taken together, chronic and acute child malnutrition, low birthweights, suboptimal breastfeeding and micronutrient deficiencies lead to the deaths of 3.6 million mothers and preschool children each year, accounting for 35 percent of all preschooler deaths and 11 percent of the global disease burden. Difficult pregnancies and illnesses due to malnutrition cost developing countries $30 billion annually. Lost productivity and income resulting from early deaths, poor school performance, disability and absenteeism raise the yearly total into the hundreds of billions of dollars. Malnutrition also reflects and contributes to inequity, disproportionately affecting poor, marginalized and extremely vulnerable groups. While the policies and programmes needed to address malnutrition will require substantial resources, the costs of *not* tackling malnutrition are considerable. Furthermore, food insecurity and malnutrition infringe on the human right to adequate food.

Future Challenges and Major Issues and Risks

In addition to climate change and rising bioenergy demand, the following factors will constrain efforts to reduce malnutrition in the coming years:

- demographic forces;
- widespread land degradation and scarcity of fresh water resources, resulting from both bad management practices, inappropriate land uses for a certain land class and impacts from climate change and extreme climate variations;
- structural shifts in the food and agricultural system;
- transboundary movement of diseases;
- environmental and energy pressures.

World population will increase by 37 percent, to 9.2 billion people by 2050. Anticipated economic growth of 6 percent per year in developing countries during the next few years and rapid urbanization will also lead to increases in demand and structural shifts in diets.

Productivity growth in cereals, the main staple food crops, declined dramatically in the 1990s and continues to decline for maize. A major reason is underinvestment in agriculture by aid donors and developing-country governments.

The global food system has a dualistic structure. The vast majority of farms (85 percent) remain operations of less than two hectares. But the 0.5 percent of farms that exceed 100 hectares capture a disproportionate share of global farm income, enjoy privileged access to policy makers and, particularly in developed countries, receive generous subsidies. Outside of farming, buying power is increasingly concentrated in the hands of supermarkets and other powerful corporate actors. Preferences of affluent consumers in high- and middle-income countries are shaping global food and agricultural systems, offering smallholders opportunities and niche markets. However, they may face difficulties in being able to produce up to the standards of the buying agents.

Agricultural intensification, rapid growth in international trade and more frequent international travel offer opportunities to bolster rural livelihoods. However, there are also substantial risks from the spread of plant and plant pests, animal diseases and invasive species across international borders and climate change will heighten these risks.

Efforts to intensify agricultural production have helped boost food output, but some agricultural practices have taken a severe toll on the natural resource base. In the absence of a yield-boosting technological breakthrough, increases in food production will have to come from area expansion. That would require cultivation of fragile or marginal land and destruction of forests and wildlife habitat, causing biodiversity loss and increased greenhouse gas (GHG) emissions. Food and agricultural production faces growing competition for water from home and industrial use.

By April 2008, crude petroleum prices reached an all-time high of US$120 per barrel and helped to raise demand for biofuels. This means increased costs for fertilizer, operating farm machinery and transportation of both inputs and output.

Climate Change, Food Security and Nutrition

The large and expanding populations in developing countries derive their livelihoods from agriculture and will, therefore, be especially vulnerable to climate change. Climate change and variability will have significant impacts on food security and malnutrition. They will lead to more intense and longer droughts and the frequency of heavy precipitation events has increased over most land areas. It is very likely that heat waves and heavy precipitation events will continue to become more frequent and that future tropical cyclones will become more intense. Droughts and water scarcity diminish dietary diversity and reduce overall food consumption and this may lead to malnutrition. The risk of flooding may increase, from both sea-level rise and increased heavy precipitation in coastal areas. This is likely to result in an increase in the number of people exposed to diarrhoeal and other infectious diseases, thus lowering their capacity to utilise food effectively. During the course of the 21st century, water

supplies stored in glaciers and snow cover are projected to decline, reducing water availability in regions that are home to one-sixth of the world's population.

Deforestation, agriculture and livestock production systems further accelerate climate change. The expansion of livestock and biofuel sectors has a major role in deforestation and land degradation. Vulnerability to adverse effects from climate change differs by region, ecosystem, population group and gender. The most vulnerable people will suffer earliest and most, so climate change should be addressed in a way that is fair and just and adherent to the human rights principles of non-discrimination and equality. The regions likely to be adversely affected are those already most vulnerable to food insecurity and malnutrition, notably Sub-Saharan Africa. In seasonally dry and tropical regions, crop productivity is projected to decrease with even small local temperature increases. In Africa, by 2020, 75-250 million people will be exposed to increased water stress due to climate change. In much of Africa, agricultural production and access to food are projected to be severely compromised.

Projected climate-change related exposures are likely to affect the health status of millions of people, particularly those with low adaptive capacity, through:

- increased deaths, disease and injury due to heat-waves, floods, storms, fires and droughts;
- increases in malnutrition;
- increased frequency of cardio-respiratory diseases;
- altered spatial distribution of some infectious-disease vectors; and
- increased burden of diarrhoeal diseases.

Due to the very large number of people that may be affected, malnutrition, linked to extreme climatic events, may be one of the most important consequences of climate change. Populations at greater risk of food insecurity include smallholder and subsistence farmers, pastoralists, traditional societies, indigenous people, coastal populations and artisanal fisherfolk. Men and women are affected differently in all phases of climate-related extreme weather. Many of the world's poorest people are rural women in developing countries who depend on subsistence agriculture to feed their families. Climate change could add to water and food insecurity and increase these women's work levels.

Impacts on Food and Water Security and Nutrition

There are many pathways through which climate change and variability may impact food and water security and nutrition:

- increased frequency of extreme climatic events;
- sea-level rise and flooding of coastal lands, leading to salination and or contamination of water and agricultural lands;
- impacts of temperature increase and water scarcity on plant or animal physiology;
- beneficial effects to crop production through CO_2 "fertilization";
- influence on plant and livestock diseases and pest species and livestock diseases;
- damage to forestry, livestock, fisheries and aquaculture; and
- impaired sustainability: socio-economic, political/armed conflict and demographic impacts.

Multiple socio-economic and environmental stresses, such as globalization, limited availability of water resources, loss of biodiversity, the HIV/AIDS pandemic and conflicts, are further increasing sensitivity to climate change and reducing agricultural resilience.

Climate change is likely to exacerbate the declining reliability of irrigation water supplies leading to increased competition for water. Water scarcity may lead to multiple adverse health outcomes, including waterborne diseases, exposure to chemicals, vector-borne diseases associated with water-storage systems and malnutrition. Drought and water scarcity can have negative effects on nutrition and the HIV/AIDS epidemic may further amplify these effects.

Children in poor rural and urban slum areas are at high risk of diarrhoeal disease mortality and morbidity. Childhood mortality due to diarrhoea in low-income countries, especially in sub-Saharan Africa, remains high and child malnutrition is projected to persist in regions of low-income countries.

Impacts on Food Security

Climate change will affect all four dimensions of food security. Agricultural output in developing countries is expected to decline by 10-20 percent by 2080. Globally, the potential for food production is projected to grow with increases in local average temperature over a range of 1-3°C, but above this it is projected to decrease. In seasonally dry and tropical regions, even slight warming (1-2ºC) reduces yield. Temperature increases of more than 3°C may cause food prices to increase by up to 40 percent. Temperature increases are leading to changes in the distribution of marine fisheries. Increases in atmospheric CO_2 are raising ocean acidity. Rising seawater temperature is associated with increased densities of *Vibrio* spp in shellfish, which is a major cause of diarrhoea.

Changes in the patterns of extreme weather events will affect the stability of, as well as access to, food supplies. Increasing frequency of crop loss due to these extreme events may overcome positive effects of moderate temperature increases. For forests, elevated risks of fires, insect outbreaks and wind damage are projected. Food insecurity and loss of livelihoods would be further exacerbated by the loss of cultivated land and nursery areas for fisheries through inundation and coastal erosion in low-lying areas.

Climate-related animal and plant pests and diseases and alien invasive aquatic species will reduce food availability, influence production system stability and reduce food access through reduction of income from animal production, lower crop yields, lessened forest productivity and changes in aquatic populations, as well as increased costs of control.

Climate change may affect health outcomes and food utilization with additional malnutrition consequences. For example, populations in water-scarce regions are likely to face decreased water availability. Flooding, increased precipitation and higher temperatures are likely to increase the incidence of infectious and diarrhoeal diseases. Climate change is projected to increase the burden of diarrhoeal diseases in low-income regions by approximately 2-5 percent by 2020. In the long term, in some areas the geographical range of malaria will contract due to the lack of the necessary humidity and water for mosquito breeding, but elsewhere, it will expand and the transmission season may be changed. It is estimated that in Africa, climate change will increase the number of person-months of exposure to malaria by 16-28 percent by 2100 which will affect food availability, access and utilization.

Climate Change and Sustainable Development

Sustainable development can reduce vulnerability to climate change by enhancing adaptive capacity and increasing resilience. For example, sustainable intensification of livestock production can reduce GHG emissions and other negative environmental impacts. On the other hand, climate change can slow the pace of progress towards sustainable development, either directly through increased exposure to adverse impact or indirectly through erosion of the capacity to adapt.

Social Impacts of Climate Change

Smallholder and subsistence farming households in the dryland tropics are particularly vulnerable to increasing frequency and severity of droughts. These may lead to a higher likelihood of crop failure; increased diseases and mortality of livestock, indebtedness, out-migration and dependency on food relief; and impacts on human development indicators such as health, nutrition and education. Drought and the consequent loss of livelihoods are also a major trigger for population movements, particularly rural to urban migration. Population displacement to urban slums can lead to increases in diarrhoeal and other communicable diseases and poor nutritional status. The United Nations projects that up to 50 million people will flee environmental deterioration by 2020, possibly leading to food and water emergencies, ill health and malnutrition and increased likelihood of conflict.

Adaptation and Mitigation Strategies

Adaptation strategies to climate change for food security could be autonomous or planned. Many autonomous adaptation options are extensions or intensifications of existing risk-management or production-enhancement activities. There has been little evaluation of how effective and widely adopted these may actually be, given the complex nature of agriculture decision-making, the diversity of responses within regions and the possible interactions between different adaptation options and economic, institutional, human and environmental health and cultural barriers to change. Many options for policy-based planned adaptation to climate change have been identified for agriculture, forests and fisheries. These can involve developing infrastructure or building the capacity to adapt in the broader user community and institutions. Policy-based adaptations will interact with, depend on, or perhaps even be just a subset of policies on natural resource management, human and animal health, governance and human rights.

Agriculture, land use and waste account for 35 percent of GHG emissions. At the same time, agricultural practices can make a significant contribution at low cost to increasing soil carbon sinks and GHG emission reductions. Reduced deforestation, more sustainable forest management and adoption of agroforestry (integration of tree and crop cultivation) have particularly good potential to capture significant amounts of carbon and other GHGs and, at the same time, contribute to poverty reduction. Agroforestry helps maintain soil health through nitrogen fixation and provides fodder, fruit, timber, fuel, medicines and resins. This can help improve nutrition in cultivator households through higher incomes and more diverse diets. Improved waste management can enhance public health. However, not all the land can be in agroforestry, thus it is important to consider also the appropriate land-water management practices for a particular soil type and agro-ecosystems to reduce GHGs.

Nutrition and Bioenergy

Rising petrol prices have made new biofuels, such as ethanol and biodiesel, an attractive alternative energy source. Technological development has recently made them more cost-effective and energy-efficient, but biofuels offer only a very small gain in energy efficiency and their production minimally reduces GHG emissions. Research is underway to develop cellulosic biofuels from low value non-food crops, such as grasses or wood, but these are more difficult to process than starch or sugar crops and it is not clear that their production will expand significantly in the near future.

Biofuel production can have negative impacts on nutrition through increased GHG emissions that may result from burning forests to clear land for crop cultivation, as well as through direct effects on health and sanitation and reduced food availability and associated price effects.
Growth of the biofuel sector may lead to water shortages and contamination. Use of sugarcane as a feedstock is particularly water-intensive. Water scarcity in developing countries is a cause of concern for agricultural productivity, health and sanitation. Poorly managed input use in energy crop cultivation could pollute drinking water, adversely affecting human and animal health. Increasing prices are leading to the diversion of food and feed crops to biofuel production. This can reduce food availability and may consign food and feed production to less productive land, reducing yields.

In relation to such effects, the International Food Policy Research Institute (IFPRI) estimates that rising bioenergy demand accounted for 30 percent of the increase in weighted average grain prices between 2000 and 2007. The impact was 39 percent of the real increase in maize prices.

A rise in the food bill for households that are net buyers of food may lead to the substitution of starchy staples for micronutrient-rich animal source foods, legumes, processed foods, fruits and vegetables and to a reduction in the average number of meals and the amount of food consumed and therefore to reduced micronutrient intakes among poor people. Extremely poor people will experience decreased calorie consumption. IFPRI projects that in 2020, if biofuel development proceeds at or exceeds its current pace, calorie availability will decline and child malnutrition will increase substantially, particularly in Sub-Saharan Africa.

Appropriate policies can make bioenergy development more pro-poor and environmentally sustainable. Poor farmers might be able to grow energy crops on degraded or marginal land not suitable for food production. Further investment is needed in developing technologies to convert cellulose to energy, which could provide smallholders with a market for crop residues. Biofuel production is labour-intensive, offering new job opportunities. Organizing groups of smallholders through contract farming schemes to grow and market biomass would be more pro-poor than plantation production. Technologies, institutional arrangements and bioenergy crop choice are important to determining impacts on poverty and the environment. Outgrower schemes could allow for technology spillovers to food crops, meaning additional growth and poverty reduction benefits, as well as increased food availability. There may be barriers to female farmers taking advantage of opportunities, as they have less access than men to land, water, credit, inputs and services.

Policies and Programmes for Improving Nutrition

The ultimate causes of food insecurity and undernutrition are social, economic, cultural and political. Therefore, it is essential that efforts to achieve food security and good nutrition address these causes.

At the regional and national level, developing countries have issued national policies and plans of action on nutrition, but these often do not prioritize nutrition actions, assure adequate budgetary allocations, or incorporate appropriate specific actions to address the problems identified. Accelerated progress against food insecurity and malnutrition requires that governments put appropriate policy responses much higher on their agendas, with adequate resources provided. Brazil's Zero Hunger (*Fome Zero*) program shows the tremendous difference it makes when governments make food security and nutrition high priorities. Donors must provide technical and financial support. The potential impacts of climate change and bioenergy demand increase the urgency of action. Harmonised, large-scale, multi-component programmes are required to make a difference and should include the following steps:

- create an enabling environment to promote peace, eradicate poverty and remove gender inequality;
- promote a fair and market-oriented world trade system;
- increase investments in human resources, sustainable food production systems and rural development;
- implement policies to improve physical and economic access by all to sufficient, nutritionally adequate and safe food and its effective utilization;
- focus on participatory and sustainable agriculture;
- use a "nutrition lens" to direct multi-sectoral actions to improve household food security; improve food quality and safety; prevent, control and manage infectious diseases and micronutrient deficiencies; promote appropriate diets, including breast-feeding and healthy lifestyles; provide care for the vulnerable, including people living with HIV/AIDS; introduce productive safety nets; and provide direct assistance;
- prevent and prepare for emergencies; and
- build anti-hunger alliances.

Governance Issues

A number of governance issues have a considerable bearing on food security and nutrition. Both food security and nutrition are multi-sectoral issues, but developing country governments are composed of sectoral ministries that frequently view budgetary allocation as a zero-sum game. Nor do senior policy-makers always recognize the costs of undernutrition. Many developing countries lack adequate human resources. A fragmented and incoherent international nutrition system complicates these problems.

Resources for nutrition are inadequate. Annual donor funding runs at less than US$300 million, compared to US$2.2 billion for HIV/AIDS and several billion dollars in food aid. In real terms, aid to agriculture is about half the level of 25 years ago. Governments of low-income countries devote 19 percent of their budgets to military expenditures, compared to less than 5 percent for agriculture. Military expenditures account for 2.6 percent of GDP in low-income countries, compared to one percent for public health. There are some indications that priorities are changing. The African Union seeks to boost agriculture to 10 percent of member

budgets and bring agricultural growth to six percent per year. The World Bank is putting renewed stress on both nutrition and agriculture.

There is an urgent need to reform the global humanitarian response, for example by moving towards a more insurance-oriented approach that guarantees a rapid response.

A Revitalised Twin Track Approach

At the International Conference on Financing for Development held in 2002, FAO, the International Fund for Agricultural Development (IFAD) and the World Food Programme (WFP) agreed upon a "twin-track approach" for combating hunger and poverty: strengthening the productivity and incomes of hungry and poor people, targeting the rural areas; and direct and immediate access to food by hungry people and social safety nets. The latter include food transfers, conditional and unconditional cash transfers and public work programmes and may be targeted or universal.

Introducing improved water management, use of green manures, agroforestry and other low-cost, simple technologies not only enhances the productivity and incomes of small farmers, but also their role as stewards of natural resources. Investing in rural infrastructure can reduce the lethal impact of water-borne illnesses, improve access to health care, prevent thousands of needless child and maternal deaths and open links to markets where farmers can sell surplus produce and acquire fertilizer and other inputs at reasonable prices. Measures to provide direct access to food for the neediest families such as feeding programmes for mothers and infants target the hub of the vicious cycle of hunger and malnutrition that undermines maternal health, stunts children's physical and cognitive growth, impairs school performance and impedes progress towards gender equality and the empowerment of women.

High food prices exacerbate food insecurity and create social tensions, but high agricultural commodity prices also present a potential opportunity for reversing the decline in public investment in agriculture. More food needs to be produced where it is urgently needed to contain the impact of soaring prices on poor consumers and simultaneously boost productivity and expand production to create more income and employment opportunities for rural poor people. Smallholder farmers need to have proper access to resources, infrastructure and services. This will allow them to increase their supply response to higher prices. Agricultural research needs to enhance its focus on mitigation of and adaptation to climate change and on pro-poor biofuel development. Increased agricultural productivity can increase food availability, rural employment and access to food by reducing prices. Agricultural growth will stimulate growth in other sectors. Appropriate policies and institutions, such as organization and collective action, can help facilitate smallholder participation in value chains on a fair basis. Agricultural and rural development strategies must recognize the important roles that women play in food security and nutrition and take into account the need for sustainable natural resource management.

FAO needs to retain its focus on a twin-track approach. This now needs to be made more explicit to ensure that policies and programmes are put into effect to boost supply, not only by the larger commercial farmers but also targeted to smallholders, while at the same time designing social protection and safety nets that protect the vulnerable and direct nutrition interventions.

Direct Nutrition Interventions

Good nutrition makes an essential contribution to the fight against poverty. It protects and promotes health; reduces mortality, especially among mothers and children; encourages and enables children to attend and benefit from school; and enhances productivity and incomes in adulthood. The increased participation of poor and vulnerable people and of women in the development process that may arise from effective community nutrition programmes will likely lead to more effective demands for improved services and to better use of existing resources.

With regard to preschooler malnutrition, the crucial "window of opportunity" is from conception through the first 18-24 months of a child's life. Effective interventions targeting infants and young children include improving food consumption and nutrient intakes through improved complementary feeding and dietary diversity, breastfeeding promotion, salt iodisation, vitamin A and zinc supplementation, vitamin A fortification, hand-washing and hygiene interventions and treatment of severe acute malnutrition. Interventions should not neglect other age groups, other family members, or low-income childless households who may equally be in need of support. The care of adolescent girls and pregnant women is vital for protecting their own health and that of their future children.

A new approach to tackling micronutrient malnutrition is through "biofortification," which involves developing micronutrient-dense crop varieties. Breeding efforts also aim to develop varieties with agronomically desirable traits. Biofortification may be more sustainable than supplementation or fortification, as it has lower recurrent costs.

For those living with the disease, better nutrition can postpone HIV/AIDS-related illnesses, such as diarrhoea, pneumonia and tuberculosis. Nutrition policies can provide incentives for improving diets, for strengthening the nutrition focus of health services and for ensuring nutritionally balanced food aid as a safety net.

Educating Girls

IFPRI research has shown that improvements in girls' education had the biggest impact on reducing child malnutrition in developing countries during 1970-95, but at present, 100 million primary school-aged children are not enrolled and 57 percent of these children are girls. School meals and food-for-education programs can help achieve full enrolments, educational gender equality and improved food security.

Priorities and Approaches for Responding to Threats to Nutrition from Climate Change and Biofuel Demand

A combination of adaptation and mitigation measures, sustainable development and research to enhance both adaptation and mitigation can diminish the threats to nutrition from climate change. On average, cereal cropping system adaptations such as changing varieties and planting times enable avoidance of a 10-15 percent reduction in yield corresponding to a 1 to 2°C local temperature increase. The benefits of adaptation tend to increase with the degree of climate change up to a 3°C temperature increase, at which point adaptive capacity in low latitudes is exceeded. Changes in policies and institutions will be needed to facilitate adaptation. Adaptation measures should be integrated with development strategies and programmes. The development of adaptation strategies should consider that adaptation

capacity depends on geographical situation, economic development, natural resources, social context, institutions, governance and technology. With regard to mitigation, financial incentives can help promote improved land management, maintenance of soil carbon content and efficient use of fertilizers and irrigation. This could encourage synergy with sustainable development and reducing vulnerability. It can also help improve the health environment. Incentives to improved waste management, as well as stronger regulation, would improve the sanitary environment. Sustainable development can reduce vulnerability to climate change by enhancing adaptive capacity and increasing resilience. Sustainable development should promote adaptive and mitigation strategies.

Agriculture, food and nutrition issues need to be placed onto national and international climate change agendas, in order to devise effective and pro-poor policies. The expiration of the Kyoto Protocol in 2012 offers an opportunity to bring these issues to the table. FAO and other international organizations should assist countries to assess capacity building needs. Adopting a human rights' perspective when tackling the challenge of climate change puts people at the centre of attention of decision-making. Sustaining and protecting the environment against degradation will be enhanced through the protection and promotion of human rights. At the same time, human rights cannot be fully realized without securing ecosystem services.

Biofuel production in developing countries should be carefully designed, so as not to crowd out other development investments. Policies should ensure that smallholders, including women farmers, have access to resources so that they can participate in biofuel production on a fair basis. Policies need to examine and regulate the environmental consequences of biofuel development. Increased investment in agricultural productivity will help developing countries increase their own food production and be able to engage in the biofuel market. Global cooperation is needed on R&D to bring technologies on line that will allow production of biofuels from non-food crops. Developed-country governments should remove trade barriers to developing-country biofuel exports and, along with international organizations such as FAO and the international financial institutions, provide financial and technical assistance to pro-poor, sustainable biofuel projects in developing countries. Developing-country governments need to conduct food security and nutrition impact assessments before launching biofuel projects.

2. Introduction

Purpose of Paper

Despite a dozen years of solemn pledges by global leaders to take action to drastically decrease world hunger – promises made at the World Food Summit in 1996, the Millennium Summit of 2000 and high-level follow-up meetings held during the course of the present decade – food security in the world has *deteriorated* since 1995. This has contributed to the unacceptably slow pace of cutting the prevalence of malnutrition: between 1990 and 2005, the prevalence of child underweight in the developing world only fell from 30 to 23 percent. At that rate, it will not be possible to meet the Millennium Development Goal (MDG) target of halving the underweight prevalence between 1990 and 2015.

Against this very disappointing background, three major challenges have arisen that threaten to drastically complicate efforts to overcome food insecurity and malnutrition: climate change, the growing use of food crops as a source of fuel (bioenergy) and soaring food prices. As a result of climate change, agricultural production and the availability of and access to food are likely to decline drastically in Sub-Saharan Africa and South Asia. That will increase the risk of hunger and malnutrition in the two regions that are home to three of every five undernourished people. Furthermore, climate change is expected to increase undernutrition through its effects on illnesses, such as diarrhoea and other infectious diseases. The expected increases in the frequency and intensity of droughts and floods and their potential impact on crops and cattle losses are especially worrisome. Drier weather may reduce the transmission of malaria in some places in Sub-Saharan Africa, while in others, the geographical range will expand and the transmission season may be changed (Metz *et al.*, 2007).

For its part, rising bioenergy demand is likely to affect nutrition through a number of pathways. First, production of staple food crops, particularly maize, for biofuel markets can have a negative impact on the availability of grain for direct consumption as food and for use as feed for livestock to produce meat and milk. As demand for biofuels is likely to remain high and to be met with food crops for the foreseeable future, this may lead to the clearing of biodiversity-rich land for cultivation, including tropical forests and wetlands. Burning of forests will mean additional emissions of the greenhouse gases (GHGs) that cause global warming. Intensified production of energy crops such as sugarcane, as well as increased cereal production to meet competing demand for food, feed, fibre and fuel, may mean excessive or poorly managed use of water and farm chemicals, causing illnesses and deterioration in environmental health, with negative implications for nutrition.

In addition, bioenergy demand is a significant driver of recent dramatic increases in food prices; according to an analysis by IFPRI, it accounted for 30 percent of the escalation in global cereal prices between 2000 and 2007 and for nearly 40 percent of the increase in the real global price of maize (Rosegrant, 2008). Increased food prices are likely to result in calorie deficits, but even more importantly, they will probably cause micronutrient malnutrition, as low-income people may reduce their consumption of micronutrient-rich foods (such as animal products, fruit and vegetables) in an effort to maintain consumption of increasingly expensive staples. Jean Ziegler, the former Special Rapporteur on the Right to Food of the UN Human Rights Council, has gone so far as to call the growing use of food crops to produce biofuels “a crime against humanity” (Ferrett, 2007).

Nevertheless, strong bioenergy demand also offers opportunities to smallholder farmers. If the right policies are in place, they may be able to boost their incomes and take advantage of technological spillovers to improve food crop production alongside their energy crops. This has positive implications for both food availability and access, key inputs for good nutrition.

A human rights-based approach – a conceptual framework that is normatively based on international human rights standards and operationally directed to promoting and protecting human rights – can provide the tools for balancing many factors, reaching easier consensus and conducting a more effective and complete analysis, as well as a more authoritative basis for advocacy and for claims on resources. The human rights framework also offers the opportunity of embracing environmental concerns more explicitly and is thus highly relevant to assessing the challenges of climate change and bioenergy for nutrition.

To explore these issues in greater depth, the Food and Agriculture Organization of the United Nations (FAO) has organized a special event on Climate Change and Bioenergy: Implications for Nutrition, Food Safety and Human Health, to be held during the High-Level Conference on World Food Security: The Challenges of Climate Change and Bioenergy, on 5 June 2008 in Rome. This paper is one of three background documents prepared for this side event. It was jointly written by teams from FAO and the International Food Policy Research Institute (IFPRI). The paper examines the consequences of climate change and rising bioenergy demand for sustainable development, food security and nutrition throughout the lifecycle.

Concept and Content

The paper begins by laying out the current state of global food insecurity and malnutrition, including magnitude, trends and future projections. The causes, consequences and costs of food insecurity and malnutrition are explored. Malnutrition is clearly a severe impediment to sustainable development and human security as it slows down economic growth and the achievement of equity. The paper briefly lays out a number of factors besides climate change, bioenergy and rising prices that will likely contribute to malnutrition in the future.

The paper then explores the implications of climate change and rising bioenergy demand for nutrition. Agricultural activities contribute to climate change, but can also play an important role in adaptation and mitigation strategies, as well as in boosting food availability.

Next, the paper examines the direct nutrition effects of rising bioenergy demand, as well as its contribution to rising food prices. It also discusses potential strategies for cultivation of bioenergy crops that can contribute to poverty reduction, food security and sustainable natural resource management.

A chapter on policy implications provides a number of options for improving food security and nutrition, as well as for addressing the links between climate change and bioenergy demand on the one hand and nutrition on the other. The paper concludes with recommendations.