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Review Paper

Changing Dimensions of Food Security in a Globalized World: A Review of the Perspectives for Environment, Economy and Health

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Abstract

With the change of time, income growth, globalization, urbanization, high energy prices, shifting diets and climate change are transforming food consumption, production and markets. The global food crisis is affecting the structures of the human society severely and pushing millions of people into poverty and malnutrition. Recent increases in the prices of the main agricultural commodities have increased the number of hunger affected people from 850 million to 963 million all over the world. Additionally, climate change is making the platform of food insecurity more strong. Increased rainfall amounts and intensities are leading to greater rates of soil erosion, whereas increasing problem of drought in some areas affects agricultural productivity tremendously. Rising sea levels are threatening coastal aquifers and adjoining groundwater systems, which in turn, is affecting the irrigation systems and food security. In Africa and Latin America many rain fed crops are near their maximum temperature tolerance, so that yields are likely to fall sharply for even small climate changes; falls in agricultural productivity of up to 30% over the 21st century are projected. Sea level rise in the Nile delta can change the water quality, can affect many freshwater fishes, can increase the salinity of the groundwater and also can inundate the fertile agricultural lands. The water from the melting Himalayas annually supports the production of over 514 million tonnes of cereals, equivalent to nearly 55.5% of Asia's cereal production and 25% of the world production today. Melting of glaciers in Himalayas can highly reduce the agricultural productivity of India. Additionally, new biotechnological methods have been recently used to improve the quality and quantity of foods in our globalized world to meet the demands exponentially increasing world population. Genetically modified organisms are produced by specific changes introduced into their DNA by genetic engineering techniques. There is a growing concern that introducing foreign genes into edible plants may have an unexpected and negative impact on human health. By inserting genes from organisms which have never been eaten as food, new proteins with unexpected functions are introduced into the human and animal food chains. The new varieties of genetically modified seeds can increase the price of seeds, which can raise the question of affordability of the poor farmers of the developing countries. The technology can execute a devastating effect on the economy and food security of the farmers in developing world and can eventually destroy the locally adapted, inexpensive traditional crop varieties. Understanding food systems in modern socio-cultural context is essential for designing sustainable food production and marketing for adequate human consumption.

Keywords: Food security, climate change, development, globalization, genetically modified foods.

Introduction

Human beings gradually have modified his immediate environment which gives him physical sustenance and affords him the opportunity for intellectual, moral, social and spiritual growth. During last two centuries, the civilized societies have tremendously used energy, raw materials, marginalized people and transport commodities over huge distances and generated enormous amount of wastes-mostly hazardous, culminating in the destruction of the equilibrium of the environment. Development has increased consumerism in a small section of the society, but as expected, it has degraded and depleted natural resources.

With the change of time, income growth, globalization, urbanization, high energy prices, shifting diets and climate change are transforming food consumption, production and markets. The overall issue of food and health is very broad, covering all aspects of food safety including pesticides, veterinary drug issues (e.g. antibiotics, hormones), transgenic plants and various contaminants like heavy metals or mycotoxins. The global food crisis is affecting the structures of the human society severely and pushing millions of people into poverty and malnutrition. The inequitable distribution of food, land, and other productive resources is the main controlling factors for poverty, hunger and malnutrition. About 925 million people do not have sufficient food in our globalized and civilized world and 98% of these live in the developing countries[1]. 65% of the world's hungry live in India, China, Democratic Republic of Congo, Bangladesh, Indonesia, Pakistan, and Ethiopia[1]. Women account for about 60% of

global hunger. Malnutrition and hunger-related diseases are responsible for the death of about 7 million children per year[1]. The undernourishment associated with missing macronutrients or micronutrients in poor-quality diets is even more widespread than the undernourishment indicated by underweight alone, in both the developed and developing world[2]. Millions of people are also suffering from one or more vitamin and mineral deficiencies. These results in shorter life-spans, frequent illnesses, or reduced physical and mental abilities[2]. More than three-quarters of poor people in developing countries live in rural areas, and most of them depend directly or indirectly on agriculture for their livelihoods. It is ironical that most of the people affected by food insecurity live in rural areas where food is produced. The so-called 'green revolution' that introduced technological packages, based on industrial production methods in high potential areas, increased national food production but failed to reach the hungry and even exacerbated hunger at local levels. Paradoxically, only 43% of the cereal produced all over the world is available for human consumption; the rest is lost because of harvest and post-harvest distribution and use of cereal for animal feed[3]. The current world food crisis is actually the result of the combined effects of competition for cropland from the growth in biofuels, low cereal stocks, high oil prices, speculation in food markets and extreme weather events.

Food security is defined as 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.[1] Food security is a complex sustainable development issue and highly linked with social and health perspectives, economic development and environment. Hence food security is the product of many variables including physical factors such as climate, soil type and water availability; economic factors like GDP, export and import policies, distribution systems; environmental factors like pollution, biodiversity and population dynamics. The status of food security of a country needs to be assessed at three levels: i. Availability of food at national level on sustainable basis, which depends on level and growth of food production, or adequate capacity to import food. ii. Physical and economic access of all households to food. Physical access requires efficient marketing, transport, and storage system to carry the food within an easy reach or at a reasonable distance from human settlements. Economic access of every household to food depends on its purchasing power and prices of food at which it is available. iii. The utilization of available food by individuals, which depends on intra-family allocation of food, and maintenance of reasonable level of health of all individuals to consume and absorb required level of food. Social factors like education, primary healthcare, gender bias, and role of women in household decisions affect food security at the individual and family level.

Food Economy, Security and Health

Recent increases in the prices of the main agricultural commodities have increased the number of hunger affected people from 850 million to 963 million all over the world[4]. Between September 2007 and March 2008 the price of wheat, corn, rice and other cereals increased in an average of 41% on the international market[3]. The FAO index of food prices rose by 9% in 2006, 23% in 2007 and surged by 54% in 2008.[5] The sudden increase in food prices in 2006-2007 was largely unanticipated, and it has impacted the water and food sectors severely[6]. The current and continuing food crisis may lead to increased inflation by 5–10% (26–32% in some countries including Vietnam and the Kyrgyz Republic) and can reduce GDP by 0.5–1.0% in some developing countries.[7] It was caused by a variety of factors including "rising demand, shifting diets, droughts, increased cost of agricultural inputs, and policies that encourage use of agricultural land and output for bioenergy production"[8]. The price increases highlighted the connections between food systems in different places, e.g. drought in Australia and demand for meat in Asia, biofuel policy in the US and Latin America, and between the local food movement in Europe and export farmers in Africa[7]. This has resulted in an increased burden on the poor, who already spend one half to three quarters of their income on food. Major food producing countries have restricted exports of food to keep costs down domestically, which has raised international food prices even more. While increased food prices will naturally push the governments to invest more in agricultural productivity, this will certainly take years to offset the current high food prices[8]. Undoubtedly, the main driver relating to food security is the demographic pressure; in order to feed 9 billion people by 2050, food production has to increase. Increasing population pressure are pushing the society towards the consumption of more resources and eventually will lead to reduced food security, increased water use, more pollution of the natural resources and ecosystem degradation.

Driving forces behind soaring food prices are many and complex, with both supply-side and demand-side factors playing a part. Long-term structural trends and underlying growth in demand for food have coincided with short-term cyclical or temporary factors affecting food supply. The rapid rise in petroleum prices exerted an upward pressure on food prices as fertilizer prices nearly tripled and transport costs doubled during 2006-08. The price hikes has reduced the affordability of poor people and has inhibited the ability of the third world countries to supply food for their populations. In underdeveloped poor societies, where male offspring are more highly valued than female, girls and boys are subject to different feeding practices and food intakes. Changes in food economy can aggravate this problem in future[5].

Aquaculture, freshwater and marine fisheries supply about 10% of the total calorie intake of world populations[7]. The fisheries of the world have declined since 1980s because of habitat damage, pollution, and climate change. Eutrophication is a major threat to freshwater and coastal marine fisheries, the sources of which are the agricultural runoff and sewage disposal. It significantly affects the undernourished coastal population, who generally survive on marine resources[4]. For many people, particularly in

India, wetlands are considered as the main source for their livelihood. Local people use food products from the wetland bioresources which can satisfy the nutritional requirement of those poor people. Destruction of wetlands for construction purposes can deprive those people from accessing the natural reservoir of water and food resources[9].

In India, changes in the economy have been made with the liberalization, privatization and globalization of almost every aspect. While this process began in 1991 in sectors like power, it has gradually expanded in the water sector in recent times. To solve the problem of global water crisis, one of the possible solutions that has been proposed and has been implemented is privatization of water, which in effect leads to treatment of water as a commodity. The ideological choice of treating water as an economic good or a 'cashable resource' is based on the assertion that market is the principal mechanism to regulate the flow of goods. Increase in water consumption will be satisfied through the market dynamics often at the cost of the poor who cannot afford the increased water tariffs. Privatization can also favour bulk water exports, which will have disastrous ecological and environmental consequences. Many crops and vegetables need huge amount of water for their growth and production. For example, in India, production of 1 kg. of Basmati rice requires 4200 liters of water, for long duration coarse rice it is 2500 liters and for wheat the amount is 700 liters[10]. Water pricing and privatization will inevitably increase the price of the major crops and vegetables all around the world, which, in turn, can adversely affect the food security issues. While government management of water resources is partly responsible for the water crisis we face today, privatization will at best compound the problem.

Globally, economic growth in emerging and developing countries will continue to lead to changing dietary patterns, with staple foods of vegetable origin being replaced by proteins of animal origin. These changing patterns can increase demand for crops used as animal feedstock disproportionately. The demand for ready-to-cook and ready-to-eat foods is increasing in urban areas, particularly in metropolitan cities. These foods do not always have the same nutritional value as fresh or home-made food, and have a higher environmental footprint (energy consumption for manufacturing, pollution and depletion of resources etc.)[4]. The increasing growth and power of international food corporations are affecting the opportunities of small agricultural producers in developing countries. While new opportunities are being created, the majority of the local farmers are not able to utilize them because of the stringent safety and quality standards of food retailers. The economy of the corporate food supply chain has grown steadily over the past years. Besides, trade and urbanization affect consumer preferences. The rapid diversification of the urban diet cannot be met by the traditional food supply chain in the hinterland of many developing countries. Consequently, importing food to satisfy the changing food demand could be relatively easier and less costly than acquiring the same food from domestic sources. In Asia traditional rice-eating societies are consuming increasing quantities of wheat in the form of bread, cakes, pastry and other products[11]. Countries that traditionally imported rice for meeting food shortfalls may now be shifting towards increasing levels of wheat imports[12]. This trend is also evident in the import of other temperate products like vegetables, milk and dairy products and temperate fruit. Poor connections between urban and rural areas hinder price transmissions towards local markets and gradually increasing the gap between urban demand and rural production.

Climate change, water resources and food security

In the past few decades scientists have assembled considerable amount of database which speak in favour of the causes and projected impacts of the growing concern of climate change.United Nations Framework Convention on Climate Change defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods." Without urgent and concerted actions, it will damage fragile ecosystems, impede development efforts, increase risks to public health, frustrate poverty alleviation programs, and force large-scale migration from water or food-scarce regions[13]. On the other hand, global warming is the increase in the average measured temperature of the earth's near-surface air and oceans since the mid-20th century, and its projected continuation. The effects of climate change including sea-level rise, inundation, seawater intrusion into freshwater lenses, floods, droughts, soil salinization and decline in water supply can adversely affect agricultural systems and food security. While natural and human factors influence the climate, it is the human footprint which is contributing to climate change through increasing emissions of greenhouse gases and declining capacity to sequester them.

A warmer climate will accelerate the hydrological cycle and can subsequently alter the intensity and timing of rainfall. Warm air can hold more moisture and can increase evaporation of surface moisture, which in turn can intensify rainfall and snowfall events. So, intensity of flood will also increase. On the other hand, higher temperature can also increase higher evaporation and plant transpiration rates and hence, more drying up of soils. This will entail higher losses of soil moisture and groundwater recharge and greater exposure to desertification and soil erosion. All these will have negative impacts on the integrity of groundwater recharge systems. If there is deficiency of moisture in the soil, solar radiation will increase the temperature, which could contribute to longer and more severe droughts[14]. In a number of studies, it has been proved that global warming and decline in rainfall may reduce net recharge and can affect groundwater levels[13]. Decrease in winter precipitation would reduce the total seasonal precipitation being received during December–February, and can impose greater water stress. Intense rain for few days will result increased frequency of floods and the monsoon rain would also be lost as direct run-off, thus can decrease the groundwater recharging potential[15].

Increased rainfall amounts and intensities will lead to greater rates of soil erosion. Rising sea levels will threaten coastal aquifers. Many of India's coastal aquifers are already experiencing salinity ingress including Saurashtra coast in Gujarat and Minjur aquifer in Tamil Nadu. Increasing frequency and intensity of droughts in the catchment area will lead to more serious and frequent salt-water intrusion in the estuary and thus can deteriorate surface and groundwater quality[16,17]. Some scientists suggest that climate change may alter the physical characteristics of aquifers themselves. Higher CO_2 concentrations in the atmosphere may change carbonate dissolution and can promote the formation of crust, which in turn may negatively affect infiltration properties of topsoil. All these changes will ultimately affect agricultural productivity and food production systems.

The changes in temperature do not produce linear responses with increasing temperature because the biological response to temperature is nonlinear, therefore, as the temperature increases these effects will be larger. Additionally, elevated CO_2 can partially close plant stomata and can subsequently decrease conductance, and can reduce loss of water vapor from leaves to the atmosphere[18]. Reviews of the effects of elevated CO_2 on stomatal conductance from chamber-based studies have reported that, on average, a doubling of CO_2 (from about 340 to 680 ppm) reduces stomatal conductance about 34 percent[19]. In general, atmospheric warming can accelerate plant metabolism and developmental processes, leading to earlier onset of spring green-up, and lengthening of the growing season in rangelands[20]. The effects of warming are also likely to be seen as changes in the timing of phenological events such as flowering and fruiting. Plant nitrogen and crude protein concentrations can also get reduced in CO_2-enriched atmospheres. This reduction in crude protein in turn can reduce forage quality.

Crop productivity is projected to increase slightly at mid to high latitudes for local mean temperature increase of up to 1-3°C depending on the crop, and then decrease beyond that in some regions[13]. At lower latitudes, especially seasonally dry and tropical regions, crop productivity is projected to decrease for even small local temperature increases (1-2°C), which would increase the risk of hunger. The poorest countries would suffer most, with reductions in crop yields in most tropical and sub-tropical regions due to decreased water availability, and new or changed insect pest incidence. In Africa and Latin America many rain fed crops are near their maximum temperature tolerance, so that yields are likely to fall sharply for even small climate changes; falls in agricultural productivity of up to 30% over the 21st century are projected. Production of rice, maize and wheat in the past few decades has declined in many parts of Asia due to water shortage, increasing frequency of El Niño and reduction in the number of rainy days. All of these factors are related with climate change[13]. In a study at the International Rice Research Institute, the yield of rice was observed to decrease by 10% for every 1°C increase in growing-season minimum temperature[21]. The combined influence of fertilization effect and the accompanying thermal stress and water scarcity in some regions under the projected climate change scenarios, rice production in Asia could decline by 3.8% by the end of the 21st Century[13]. In Bangladesh, production of rice and wheat might drop by 8% and 32% respectively, by the year 2050[22]. About 1ºC temperature rise would shorten the reproductive phase of wheat by 6%, grain filling duration by 5% and would reduce grain yield and harvest index proportionately[23]. Net primary productivity of grassland in colder regions of Asia is projected to decline and shift northward due to climate change. The limited herbaceous production, heat stress from higher temperature and poor water intake due to declining rainfall could lead to reduced milk yields and increased incidence of diseases in animals[13].

Sea level rise due to global warming could also displace many shore-based populations; it is estimated that a sea level rise of just 200 mm could create 740,000 homeless people in Nigeria[13]. Many small islands have poorly developed infrastructure and limited resources, and often small island populations are dependent on marine resources to meet their protein needs. Sea level rise in the Nile delta can change the water quality, can affect many freshwater fishes, can increase the salinity of the groundwater and also can inundate the fertile agricultural lands.

During the twentieth century, majority of the Himalayan glaciers have shown recession in their frontal parts, besides thinning of the ice mass as revealed by mass balance and secular movement studies undertaken by Geological Survey of India[24]. The water from the melting Himalayas annually supports the production of over 514 million tonnes of cereals, equivalent to nearly 55.5% of Asia's cereal production and 25% of the world production today. A reduction of, for example, 10–30% due to increased flood damage to irrigated lands combined with reduced water flow and seasonal drought, would thus lower world cereal production of 3,000 million tonnes (by 2050) by 1.7–5%, even if it can be assumed that no other yield increases in this period (in such cases the losses would be larger)[4].

Between 2000 and 2050, even with no climate change, the price of rice would rise by 62%, maize by 63%, soybean by 72%, and wheat by 39%. The climate change can increase additional price for these edible crops – a total of 32-37% for rice, 52-55% for maize, 94-111% for wheat, and 11-14% for soybeans[25]. The results also show that if CO_2 fertilization is effective in farmers'fields, these future prices are 10 percent smaller. Similarly, the meat prices are 33% higher by 2050 without climate change and 60% higher with climate change and no CO_2 fertilization of crops[25]. Similarly, the per capita calorie availability would be lower under climate change compared to no climate change scenario in 2050. For example, the number of malnourished children in South Asia would decline from 76 million in 2000 to 52 million without climate change in 2050. With climate change the number of malnourished children would be 59 million in 2050[25].

Future climate change is expected to have considerable impacts on natural resource systems, which, in turn, can lead to instability and conflict, often followed by displacement of people and changes in occupancy and migration patterns[26]. The production losses due to climate change will drastically increase the problem of poverty, food insecurity and malnutrition in several developing countries in Asia[27].

Sustainable adaptation strategies for mitigating the effects of climate change on agricultural system and food security has to be implemented urgently for the survival of the human civilization. Some possible measures which should be taken are as follows: i. Use of more heat/drought-tolerant crop varieties in areas under water stress. ii. Use of more disease and pest tolerant crop varieties. iii. Introduce higher yielding, earlier maturing crop varieties in cold regions. iv. Altered application of nutrients/fertilizer and pesticides. v. Breeding livestock for greater tolerance and productivity. vi. Improve pasture and grazing management including improved grasslands and pastures. vii. Increase plant coverage per hectare. viii. Improve crossbreeds of high productivity crops and livestock. ix. Improve irrigation systems and their efficiency. x. Improve information exchange system on new technologies at national as well as regional and international level. xi. Reimplementation of traditional water management systems like rainwater harvesting.

Adaptation and mitigation practices require extensive high quality data and information on climate, and on agricultural, environmental and social systems affected by climate, with a view to carrying out realistic vulnerability assessments and looking towards the near future.

Genetically modified food and health security

New biotechnological methods have been recently used to improve the quality and quantity of foods in our globalized world to meet the demands exponentially increasing world population. Most of our food crops have been developed using traditional genetic modification techniques through plant breeding[28]. In modern society, recombinant DNA technology help the scientists to transfer desirable traits more rapidly, predictably and precisely than the previous conventional methods. Since the mid-1990's, genetic modification techniques has flourished rapidly that can help to boost agricultural productivity, but the technology is not fully understood by many of the consumers till date[29]. Genetically modified organisms are produced by specific changes introduced into their DNA by genetic engineering techniques. The edible and economically important plants have been modified in the laboratory to enhance desired traits such as increased resistance to herbicides or improved nutritional content in their physiological processes[30]. Researchers are focusing on traits like allowing crops to cope with water stress, temperature variation, salinity etc[29]. These advances have the potential to improve both the resilience of crops (to climate change and land degradation) and their sustainability. Herbicide resistant cotton, vitamin rich rice, pest resistant potatoes, infection free fish- all are the examples of increasing outputs and consumption by means of genetic remodeling[31].

There is a growing concern that introducing foreign genes into edible plants may have an unexpected and negative impact on human health. By inserting genes from organisms which have never been eaten as food, new proteins with unexpected functions are introduced into the human and animal food chains. The process of inserting the gene can damage the plant's own DNA. The foreign gene can integrate right in the middle of another gene and can cause it to lose its function. Additionally, the tissue culture stages cause numerous changes to the rest of the plant's DNA. A gene can behave in different ways in different locations, depending on the regulatory elements it ends up next to. As genetic engineers cannot control where the genes take its position in the plant DNA and do not know the effects of the different locations, unpredicted effects can easily occur[31]. A harmless protein in one organism can become harmful if inserted into another organism, even if its sequence of amino acids remains completely identical. The reason behind it is the molecular mechanism called post-translation modification where, depending on the plant species and the type of cell, different sugars, lipids or other molecules attach to the protein and modify its function[32].

Biotechnology has the potential to lower food prices and environmental impact of agriculture but a number of real and perceived risks to the environment and human health still exist. There is a growing concern that introducing foreign genes into food plants may have an unexpected and negative impact on human health. By inserting genes from organisms which have never been eaten as food, new proteins with unexpected functions are introduced into the human and animal food chains. The safety testing of GM foods is based on the concept of 'substantial equivalence'. This is the idea that "if a GM food can be shown to be 'substantially' the same as a non GM food then it is considered to be safe"[33]. It was developed because of the difficulties and cost of conducting traditional safety tests (like those used for new drugs) on GM foods. But it has been severely criticized by some scientists because it is not clear what level of similarity can make the GM and non-GM food substantially equivalent.

One example of genetically modified plant is the StarLink corn which was engineered to produce Bt (a protein synthesized by the soil bacterium *Bacillus thuringiensis*) that is an effective Lepidopteran insect controlling agent[31]. The U.S. Centre for Disease Control and Prevention recorded 51 reports of severe human illness including allergic reactions because of the consumption of StarLink corn. However, EPA studies revealed that the extent of risk was not so significant, but they also admitted that Bt protein has the capacity for causing moderate allergies[28].

Many GM crops contain genes which provide resistance to commonly used antibiotics such as ampicillin. There is concern that these genes could be passed from food to bacteria in the

guts of humans and animals. Researchers recently used a model of a human gut to study the effects of GM food after ingestion in human body. The prediction showed that 6% of the genes from GM tomatoes would survive digestion in the gut and considered that the genes could survive for long enough time for bacteria to pick them up[31]. Besides, the process of growing plant cells into GM plants may create huge number of mutations throughout the genome which can have their multiple interacting effects. Experiments revealed that GM potatoes engineered to produce their own insecticides can induce precancerous cell growth in the digestive tracts of rats and can inhibit the development of their brains, kidneys, livers and testicles and can also damage the immune system[31]. Numerous studies have revealed that unintended changes in nutrient content, increase in the concentrations of toxins and allergens and undesired gene activation can occur by using GM foods[30]. Viral genes that are generally inserted into some disease resistant crops generally produce viral proteins which may suppress the immune system of human body against viral infections, particularly in the gut region. The gut microorganisms can produce large amounts of potentially harmful proteins if the viral genes can get entry inside these organisms[31]. GM material may even pass into the unborn fetus through the placenta or integrate into adult sex cells and has the capacity to alter the genetic constitution of the future generations[31]. For the safety assessment of these modified varieties, researches should be carried out at different locations and in diverse environmental and climatological conditions in order to assess the chances of alteration of other metabolic pathways in these plants. These possible changes can adversely affect the composition of the food plants, and in turn, can be detrimental to human health.

Additionally, the new varieties of genetically modified seeds can increase the price of seeds, which can raise the question of affordability of the poor farmers of the developing countries. Genetically modified crops can increase marginalization of small farmers due to intellectual property rights and other restrictive practices associated with seed certification[33]. The terminator technology (methods for restricting the use of genetically modified plants by causing second generation seeds to be sterile) is increasing the dependency of the farmers on the multinational companies. It has particularly troubling implications for the developing world where seed saving is more widely practiced. The technology can execute a devastating effect on the economy and food security of the farmers in developing world and can eventually destroy the locally adapted, inexpensive traditional crop varieties[34]. The companies can create artificial demand for the new seeds and can disrupt the age-old cycle of agricultural practice for mere profit, which can make situation ethically problematic. These new technologies have triggered many questions regarding bioethics, human rights and food security, and most of them remain unanswered.

Conclusion

Several areas should be better understood, tested and implemented by the officials before nutrition can fully serve in the frontline as a promoter of economic, social, and cultural development. Transparency in nutrition data should be maintained in all records for the betterment of health and food security. Both individuals and groups must have the opportunities to claim their legal human rights related to the right to adequate food from the relevant duty holders and administrators, in both government and private sectors. Furthermore they must have the right to complain to appropriate institutions about violations of the rights that are essential for their food security and nutritional well-being. Ultimately, food sovereignty should be maintained for establishing sustainable food security. This is the right of each nation and its people to maintain and develop its own capacity and freedom to produce people's basic food, whilst respecting environmental, social and cultural diversity.

The right to food is a perfect example of the indivisibility, interdependence, and interconnectedness of economic and social rights. A rights-based approach for ensuring food security is advantageous on many levels. It supports the human rights law of nondiscrimination and equality; it supports a number of other basic human rights, such as the right to the highest attainable standard of health; and it significantly enhances human dignity and democracy. But fulfilling one’s need for food in the biological sense is different from fulfilling one’s right to food. If people have no chance to influence what and how they were being fed, if they are provided with prepackaged rations or capsules, their right to adequate food will not be fulfilled, even if they get all the nutrients necessary for their bodies. Human rights are mainly about upholding human dignity, not about meeting the basic physiological needs. Understanding food systems in modern socio-cultural context may be essential for designing sustainable food production and marketing for adequate human consumption.

References

1. Boelee E., Ecosystems for water and food security, Nairobi: United Nations Environment Programme, International Water Management Institute, Colombo **(2011)**
2. World Health Organization, Global Database on Child Growth and Malnutrition, Retrived from: http://www.who.int/nutgrowthdb **(2003)**
3. UNESCO, World Water Assessment Programme. The United Nations World Water Development Report 3: Water in a changing world, Retrieved from: http://www.unesco.org/water/wwap/wwdr/wwdr3/pdf/WWDR3_Water_in_a_Changing_World.pdf **(2009)**
4. United Nations Environment Programme, The Environmental Food Crisis: The Environment's Role in Averting Future Food Crises, Retrieved from: http://www.grida.no/publications/rr/food-crisis/ **(2009)**

5. FAO, The state of food and agriculture 2008, FAO, Rome. Retrieved from: http://www.fao.org/docrep/ 011/ i0100e/ i0100e00.htm **(2008)**

6. Von Braun J, The world food situation. new driving forces and required actions, International Food Policy Research Institute, Washington DC **(2007)**

7. Nellemann, C., MacDevette M., Manders T., Eickhout B., Svihus B., Prins A.G. and Kaltenborn B.P. (Eds), The environmental food crisis – The environment's role in averting future food crises, A UNEP rapid response assessment, United Nations Environment Programme, GRID-Arendal **(2009)**

8. WWA (World Water Assessment Programme of the United Nations), Water in a changing world (WWDR3), 3rd United Nations World Water Development Report, UNESCO Publishing, Paris; Earthscan, London, Retrieveed from: http://www.unesco.org/water/wwap/wwdr/wwdr3/ **(2009)**

9. Ghosh D., Ecology and traditional wetland practices, Worldview press, Kolkata **(2005)**

10. Shiva V. and Jalees K., The Impact of the River Linking Project, Navdanya, New Delhi, India **(2003)**

11. Pingali P. and Rosegrant M.W., Supplying Wheat for Asia's Increasingly Westernized Diets, *Am. J. Agricul*., **80(5)**, 954-959 **(1998)**

12. Pingali P., Westernization of Asian Diets and the transformation of food systems: Implications for research and policy, ESA Working Paper No. 04-17. FAO, Rome **(2004)**

13. IPCC, Climate Change 2007: Impacts, adaptation and vulnerability, Cambridge University Press, Cambridge, UK **(2007)**

14. Trenberth K.E., Fasullo J. and Smith L., Trend and variability in column-integrated atmosphere water vapor, *Clim. Dynam*., **24**, 741-758 **(2005)**

15. Mall R.K., Gupta A. and Singh R., Water resources and climate change: An Indian perspective, *Curr. Sci.,* **90(12)**, 1610-1626 **(2006)**

16. Xu C.X., China National Offshore and Coastal Wetlands Conservation Action Plan, China Ocean Press, Beijing **(2003)**

17. Thanh T.D., Saito Y. and Huy D.V., Regimes of human and climate impacts on coastal changes in Vietnam, *Reg. Environ. Change*, **4**, 49-62 **(2004)**

18. Medlyn B.E., Barton C.V.M., Broadmeadow M.S.J., Ceulemans R., De Angelis P., Forstreuter P., Freeman M., Jackson S.B., Kellomaki S., Laitat E., Rey A., Roberntz P., Sigurdsson B.D., Strassemeyer J., Wang K., Curtis P.S. and Jarvis P.G., Stomatal conductance of forest species after long-term exposure to elevated CO_2 concentration: a synthesis, New Phytol., **149**, 247-264 **(2001)**

19. Kimball B.A. and Idso S.B., Increasing atmospheric CO_2: Effects on crop yield, water use, and climate, *Agr. Water Manage*, **7**, 55-72 **(1983)**

20. Badeck F.W., Bondeau A., Bottcher K., Doktor D., Lucht W., Schaber J. and Sitch S., Responses of spring phenology to climate change, *New Phytol*., **162**, 295-309 **(2004)**

21. Peng S., Huang J. and Sheehy J.E., Rice yields decline with higher night temperature from global warming, *P. Natl. Acad. Sci*. USA, **101**, 9971-9975 **(2004)**

22. Faisal I.M. and Parveen S., Food security in the face of climate change, population growth and resource constraints: implications for Bangladesh, *Environ. Manage*., **34**, 487-498 **(2004)**

23. Lawlor D.W. and Mitchell R.A.C., Crop ecosystem responses to climatic change: Wheat, In: K. R. Reddy and H. F. Hodges (Eds.) Climate Change and Global Crop Productivity, CAB International, New York **(2000)**

24. Pandey A.C., Ghosh S. and Nathawat M.S., Evaluating patterns of temporal glacier changes in Greater Himalayan Range, Jammu & Kashmir, India, *Geocarto Int*., **26**, 321-338 **(2011)**

25. Backlund P., Janetos A. and Schimel A., The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity, Climate Change Science Program U.S.A. **(2009)**

26. Barnett J., Security and climate change, *Global Environ. Chang*., **13**, 7-17 **(2003)**

27. Wang X., Chen F. and Dong Z., The relative role of climatic and human factors in desertification in semiarid China, *Global Environ. Chang*., **16**, 48-57 **(2006)**

28. Winter C.K., Safety of genetically engineered food, Agricultural Biotechnology in California series, Division of Agriculture and Natural Resources, University of California, Publication 8180 **(2006)**

29. Ekici K. and Sancak Y.C., A perspective on genetically modified food crops, *African J. Agr. Res*., **6(7)**, 1639-1642 **(2010)**

30. Ho M.W., *Genetic* engineering: Dream or nightmare? The brave new world of bad science and big business, Third World Network, Malaysia **(2007)**

31. Smith J.M., Genetic Roulette: the documented health risks of genetically engineered foods, SAGE and Other India press, India **(2009)**

32. Prescott V.E., Campbell P.M., Moore A., Mattes J., Rothenberg M.E., Foster P.S., Higgins T.J. and Hogan S.P., Transgenic expression of bean alpha-amylase inhibitor in peas results in altered structure and immunogenicity, *J. Agr. food chem.*, **53**, 9023–9030 **(2005)**

33. Kuiper H.A., Kleter G.A., Noteborn H.P.J.M. and Kok E.J., Assessment of the food safety issues related to genetically modified foods, *Plant J.*, **27(6)**, 503-528 **(2001)**

34. Yusuf M., Ethical issues in the use of the terminator seed technology, *Afr. J. Agr. Res*., **9(52)**, 8901-8904 **(2010)**