Rice: Water, Food Security and Climate Change in Nepal

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Abstract: Rice is the staple food for more than 50% of the world's population, and more than 90% rice is produced and consumed in Asian countries (IRRI.org). In Nepal, both the national economy and food security depend on rice production. Theoretically, about 5,000 liters of water are required to produce one kilogram of paddy (IRRI.org). Now, water is becoming a scarce resource in the world because of global warming. Extreme weather and erratic rainfall are becoming common phenomena. One degree Celsius increase in nighttime temperature decreases rice production by 10% (IRRI.org). Food security, nutrition security, profitability and sustainability are the major issues. Stress-tolerant rice varieties (i.e., from the stress of flood, drought, heat, cold, pests, soil fertility degradation, etc.) and crop management technologies are generated by research. Irrigated rice is the major contributor of methane gas emissions. Thus, direct seeded rice helps to reduce methane emissions. Resource conservation technologies/ conservation agriculture are some of the ways for reducing methane emissions and encouraging carbon sequestration. World rice scientists are engaged in C4 Rice Project and, if successful, 50% more rice production will be possible with less water and fertilizer.

Key words: Rice, stresses, food security, climate change, Nepal

Background

Rice (*Oryza sativa L.)* is a primary source of food for more than half of the world population and more than 90% production and consumption of rice are in Asia (IRRI website). Rice is the number one cereal crops in Nepal. Nepal's economy is directly related to rice production. Not only is rice a key source of food, it is also a major employer and source of income for the poor. As per the preliminary estimate of Fiscal Year 2010/11, the rice crop is grown in 1.496 million hectares with the production of 4.460 million metric tons and the productivity is 2.981 t/ha (MoAC 2010/11). Nepal is considered as one of the origins of rice. British Broadcasting Corporation (BBC) had reported that rice was cultivated since 15,000 years back. In Nepal rice is cultivated in the highest altitude (about 3,000m) of the world, that is in Haatsinja Village of Jumla district.

The global demand for rice is booming. To keep up with this demand, rice production must increase by about 70% by 2050 (IRRI website). At the same time, too much or too little water, extreme temperatures, and poor soils are threatening rice production. Developing better rice varieties that stand up against environmental and soil stresses can help Asian and African rice farmers and their families-thrive. For example, the world's food grains were 631 million tons only prior to Green Revolution, but now it is around 2,300 million tons.

Water

One hectare of rice plants uses at least 8 million liters of water during its life (Vergara 1979). Now, water is a scarce resource/commodity in the world. In South Asia, it is estimated that, by 2025, 12 million hectares of irrigated rice may suffer from severe water shortage, seriously affecting the region's food security and social stability. Preliminary estimate in India says by 2030 the water availability as well as food grain's productivity will decrease by 30% respectively. It is said 'Third World War' will be for fresh water. The Newsweek magazine on 29 January 2007 issue had reported as a foot note that in the last 30 years the world's water supply has halved. What will happen thirty years from now? Therefore, water-saving technologies; i.e., wise-use of water (drip, sprinkler, rain water harvesting, etc.), more crops per drop, resource conservation technology (RCT) like zero-till, alternate wetting and drying (AWD), direct seeded rice (DSR) technologies, integrated watershed management, need to be followed. Glaciers are melting because of global warming reducing water storage and supply. Extreme weather and erratic rainfall are the common phenomena.

Food Security

There are less possibilities of bringing more lands into agricultural production. Therefore, we have to increase the productivity by knowledge and science-based farming. The promising technologies generated by agriculture research play the pivotal roles. The modern varieties can express their yield potentiality only when recommended packages are practiced. Quality seeds alone can contribute 15-20% yield. Paddy seeds selection can be done by following the specific gravity principle as practiced by 100% of Japanese farmers. Early paddy and Boro (winter) rice can be used for increasing rice yield by utilizing higher intensity of solar radiation, which is the free gift of nature. Rice yields can also be increased by using plant growth regulators like Gibberelic acid GA3, Kinetin etc. (Basnet 1984). However, we should not forget the environmentally-friendly and sustainability issues while increasing the productivity and production (Basnet 2010a). It is said 'Grow paddy with soil fertility, wheat with fertilizers' and also said 'Healthy seedlings are responsible at least for half of the yields'. These sayings carry great meanings in rice production from scientific point of views too.

When we review the past 23 years, the edible food deficit was for 14 years and surplus was for nine years only in Nepal (MoAC 1987/88-2010/11). Generally, three to five hundred thousand metric tons food grains are surplus in Terai annually. At present, out of 75 districts, 32 Hills and 6 Terai districts are food deficit. The surplus food of 1,10,000 metric tons was recorded for FY 2010/11. But there were food deficit by 3,30,000 and 1,33,000

metric tons during the FY 2009/10 and 2008/09 (MoAC 2010/11) respectively. The contribution of rice in total food grains is more than 50%. Rice contributed about 23% in agricultural gross domestic product (AGDP).

Most commonly, due to tradition and preference, rice is milled, yielding white rice. While this process reduces cooking time and increases storage life, it also removes a large percentage of many nutrients including protein, fiber, fat, iron and B vitamins. People in a number of countries parboil rice grains to preserve the nutrients naturally present in rice. Brown rice is better from the nutritional as well as food security point of view. Fortification (iron, zinc) techniques can be used to add essential vitamins and minerals to the grain. Rice production is facing serious constraints including a declining rate of growth in yields, depletion of natural resources, crop diversification, conversion of food to fuel (bio-diesel), urbanization, climate change, labor shortages, gender-based conflicts, institutional limitations, skyrocketed food prices, reduced investment in research and development and environmental pollution (Basnet 2010b), etc. Food system encompasses activities related to production, processing, distribution, preparation and consumption of food and the outcomes of these activities that contribute to food security, such as food availability, food access (including affordability, allocation and preferences) and food use (including nutritional value, social value and food safety). When living standard increases then people rely more and more on livestock products rather than depending on cereals only. This also has created problem on food security because to produce one kilogram meat of beef, pig and poultry, it required eight, five and two kilograms of food grains respectively (IRRI interview with Hargrove 2010).

It is strongly suggested that every country must have 'A high-level national food security mission' with concrete plan of action with fixed priorities, assured budgetary allocation, involvement of field-hardened agriculturists with proven track-records, so as to cope with burning problem of food grains in the nation/ world. India has banned the export of wheat and non-basmati rice since 2007 and 2008 respectively. There was global food crisis during 2007/08. Later on global financial crisis eclipsed the global food crisis. Therefore, food self-sufficiency is the urgent demand of present time. Food grains cannot be produced overnight. We need to have a clear cut mission and vision for making the country self-reliant in food grains. If we are serious and committed we can reach the targeted goal easily. Because it is easy to increase the productivity and production of food grains from the lowest-levels especially in the developing countries.

World rice scientists are engaged in C4 Rice Project (Using sun to end hunger, feeding the world with C4 rice), if successful, 50% more rice production will be possible with less water and fertilizer (IRRI website). The C4 rice project is about using cutting edge science to discover the genes that will supercharge photosynthesis, boost food production and improve the lives of billions of poor people in the developing world. The C4 consortium is a group of multidisciplinary scientists from advanced institutions around the world.

Climate Change

It is said that if the temperature rises by 1.5 to 2.5 degree Celsius in India by 2030, there will be danger of 50% loss of biodiversity and around 25% loss of botanical plants. With increase in temperature, there will be 50% decrease in wheat areas in South Asia after 50 years. The study revealed that at present with the increase of 1 to 2 degree Celsius in Mid-hill condition of Kathmandu, Nepal; there is no effect in rice and wheat production but the production of wheat in warmer area Terai will be affected significantly.

Bill-Melinda Gates Foundation (BMGF) is helping IRRI for the project entitled Stress-tolerant Rice for Africa and South Asia (STRASA), which comprises countries like Bangladesh, India, Nepal and Pakistan. Through this project, Sub1 gene has been identified, which when transferred to rice, then rice plants even after about 2 weeks of submergence will not die. This is a great contribution for the country like Bangladesh where every year flood is the recurrent problem. Sub1 gene incorporated rice varieties named Swarna Sub1 and Sambhamahsuri Sub1 are popular in above mentioned four countries. Nepal also has released three drought-tolerant rice varieties named Sukhadhan-1, Sukhadhan-2 and Sukhadhan-3. Newly released rice varieties for mid-hills called Khumal-10 and Khumal-13 can be transplanted late by about one-month or so without yield sacrifice. Because, these days the rainfall is late by about one-month. Rice varieties like Bindeswori, Janaki, Radha-4 are drought-tolerant. The rice seedlings raised in dry seedbeds can tolerate more drought as compared to wet bed seedlings.

Climate change will further challenge rice production. The IRRI recognizes the trend of increasing global temperatures and foresees that overall climate change will have a negative impact on rice production. An International Food Policy Research Institute (IFPRI) study forecasts a 15% decrease in irrigated rice yields in developing countries and a 12% increase in rice prices as a result of climate change by 2050. IRRI is helping farmers prepare for climate change such as by breeding climate-change-ready rice varieties that have improved tolerance to submergence, salt, iron, drought and cold. IRRI is also working to minimize emission of methane from rice production, to help curb climate change.

The International Rice Genebank, the largest collection of rice genetic diversity (approximately 1,15,000 out of 1,40,000) in the world is housed at IRRI and helps us conserve and share rice genetic diversity to tackle the challenges of climate change. Nepal has collected 2,964 rice accessions from about 70 districts including four wild rices. The global seed vault at Svalbard in Norway is now functioning as the world's genebank.

Climate change threatens water, agriculture, food security and climate change is also a threat/ risk multiplier. Knowledge of today is not enough and science must advance quickly toward new frontiers, in search of greater understanding and more powerful solutions. The Intergovernmental Panel on Climate Change (IPCC) estimates that 31% of total emissions in 2004 came from agriculture and forestry. This clearly needs to be addressed in mitigation strategies. The rising temperatures are already

having measurable impacts, on glaciers and ice caps, sea levels and rainfall patterns, and these impacts will also increase over the next decades. Many believe that a rise of two degrees Celsius is the threshold beyond which impacts are likely to be severe, and dangerous to environmental systems. Mitigation measures are obviously critical to contain the damage and changing agricultural and land use practices have a major role to play.

Irrigated wheat yields in 2050 will be reduced by around 30% and irrigated rice yields by 15% in developing countries. Climate change will increase prices in 2050 by 90% for wheat, 12% for rice and 35% for maize, on top of already higher prices. The impacts of climate change are not uniform throughout the world.

Climate change poses an additional problem on the world's agricultural and natural resource systems that must already cope with a growing food demand in many countries. As a significant source of greenhouse gases (GHGs) and potential sink for atmospheric carbon, agriculture and rice production systems can also help mitigate climate change. The impacts that climate change will have on rice production will play a key role in determining food security in large parts of the world. Especially in Asia, where rice is the staple food of, negative effects on yields and availability of rice will directly translate into major food shortages. For example, sea level rise causing flooding and salinity intrusion may affect Asia's mega-deltas (Ganges-Brahmaputra in Bangladesh; Irrawady in Myanmar; and Mekong and Red River in Vietnam) limiting future production. This in turn, along with other climate change impacts will affect domestic rice markets and international trade as well. Moreover, rice is also grown in rainfed lowland regions that are prone to drought and flood. In these areas, production risks will increase under aggravating climatic extremes. Rice yields will also be negatively affected by higher night-time temperatures (a decline of 10% for every 1 Degree Celsius temperature increase). Alternatively, rice production is a source of GHG (methane) due to flooding of paddies. Like other cropping systems, rice fields also emit nitrous oxide due to soil and fertilizer nitrogen.

Conclusion

Food security, nutrition security, profitability and sustainability are must. The future of agriculture depends on the decisions we make now. Moreover, environmentally-friendly technologies every possible effort to develop early warning system, forecasting modeling of climate change to respond negative effects of climate change and also to increase resilience in agriculture and other sectors as well as to adapt capacity development measures. Climate change, agriculture, and food security pose increasingly urgent challenges, investing in climate-smart agriculture in developing countries must be at the forefront of today's climate change regime for the survival of future generations. Agro-biodiversity (indigenous seeds and breeds) is the insurance for food security. More investment on agricultural research and development is the demand of the time.

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