Session 3: Food Security and Sustainable Crop Production

Sustainability and Security in Rice Agriculture

Bas Bouman
International Rice Research Institute, Los Baños, The Philippines

Rice is eaten by about 3 billion people and is the most common staple food of the largest number of people on Earth. More than 90% of the world's rice is produced and consumed in Asia where two-third's of the world's poor reside – some 75% of them living in rural areas. Recently, Africa and the Middle East have become large importers of rice. In the fifty years following the Green Revolution, average rice yields have increased from 1.5 to 4.2 t ha-1 and the supply of rice has kept pace with population growth. As a consequence, the world-market price of rice steadily declined from around $1000 to $250 a metric ton in the early to mid-2000s. Currently, 600-650 million tonnes rough (unhusked) rice are produced annually from some 150 million ha (harvested area). About 133 million ha are so-called lowland rice fields that have saturated soils with ponded water during crop growth. Of these, 79 million ha are equipped with irrigation facilities and provide 75% of the world's rice production. Irrigated rice receives 34-43% of the total world's irrigation water, or about 24-30% of the entire world's developed fresh water resources. Rice environments also provide unique but as yet poorly understood ecosystem services, such as regulation of water and preservation of aquatic and terrestrial biodiversity.

The high yields have contributed to poverty alleviation among rice farmers while the supply of large amounts of low-cost rice increased food security and helped alleviate poverty of net rice consumers (small farmers, landless laborers, urban poor). However, the decades of sufficient and cheap food resulted in complacency in the agricultural sector. As investments in research and development dwindled, the growth in productivity has slowed in many countries in Asia. As more rice got consumed than produced, rice stocks declined and prices of rice spiked at $800 t-1 in the food crisis of early 2008. The high cost of rice and other basic goods pushed large numbers of net rice consumers back into poverty. Poverty remains in rural irrigated and rainfed rice growing areas and is increasing in urban areas. To meet the dual challenge of producing enough food and alleviating poverty, more rice needs to be produced at a low unit cost so that producers can be ensured of reasonable profits, poor consumers can have the benefit of low prices, and the environment and ecosystem services can be safeguarded. All this needs to be achieved as the productive capacity of rice environments is being threatened by increasing water scarcity, droughts, salinity, uncontrolled flooding, and climate change.

Because many stresses on rice production are related to water, increasing water productivity is especially important. Approximately 25 million ha of rainfed rice are frequently affected by drought, and 9–12 million ha by salinity, and 15–20 million ha of irrigated rice are projected to suffer some degree of water scarcity over the next 25 years. This increasing water scarcity is expected to further shift rice production to more water-abundant delta areas and to lead to crop diversification and more aerobic soil conditions. Water-saving technologies based on the system of Alternate Wetting and Drying (AWD), can help farmers reduce combined losses from percolation, drainage, and evaporation by 15%–20% without reducing yields. In AWD, irrigation water is applied to flood the field a certain number of days after the disappearance of ponded water. Hence, the field is alternately flooded and non-flooded. The number of days of non-flooded soil between irrigations can vary from 1 day to more than 10 days. With increasing number of days between irrigation, water savings increase but yields start to decline. However, the amount of water saved is relatively larger than the yield loss and water productivity increases. The efficiency of irrigation systems can be increased by the conjunctive use of surface and groundwater and the reuse of percolation and drainage water. An emerging production system is aerobic rice, in which especially developed varieties are grown in flat, well-drained, non-puddled, and non-saturated soils. Systems of aerobic rice occur in Brazil (some 250,000 ha) and in the North China Plain (some 80,000 ha). In experiments in the Philippines and northern China, water inputs in aerobic rice systems were 30-50% less than in flooded systems, with yields that were 20-30% lower, with a maximum of about 5.5 t ha-1. Irrigation is applied through flash-flooding, furrow irrigation (or raised beds), or sprinklers. Unlike irrigated lowland rice, irrigation is not used to flood the soil but to just bring the soil water content in the root zone up to field capacity. We still need to improve our understanding of the effects of increasingly aerobic field conditions on the environment, ecosystem services, and the sustainability of rice growing.

Bas Bouman
Head. Crop and Environmental Sciences Division Leader Program
"Sustaining productivity in intensive rice-based systems" (IRRI), The Philippines

Academic Degrees

1991 Agriculture and Environmental Sciences, Wageningen Agricultural University, The Netherlands

1987 MSc., Agricultural engineering, Wageningen Agricultural University, The Netherlands

Field of Study

Agriculture and Environmental Sciences