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Production of the Rice for the Fulfillment of Food

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Abstract

Rain-fed lowland rice is grown in river deltas and coastal areas of South Asia, parts of Southeast Asia, and essentially all of Africa, where the fields are bundled and flooded with rainwater for at least a part of the cropping season. In this system, the major method of rice establishment is transplanting, but direct wet or dry seeding is also practiced.

Keywords: River deltas; Salinity; South asia; Dry seeding; Rice establishment; Production

Introduction

Globally, world's rice is produced from 52 million ha of rain-fed lowlands. Abiotic stresses, such as drought and uncontrolled flooding ranging from short-duration flash floods to deep water submergence with water for a few months, prevail due to highly uncertain rainfall and salinity [1]. Water is deep and is supplied by rivers, lakes, or tides in river mouth deltas. Water depth may exceed in some parts of Bangladesh, as well as in the Mekong, Kariba Dam, and Niger deltas. Deep water or floating rice is established by broadcasting rice seed in ploughed fields and is normally grown unbundled, in regions where the water level rises quickly after the beginning of the monsoon [2]. Traditional long tiller and few sprout varieties are cultivated. The rice plants elongate and float as the floodwater advances; thus, it is named as floating rice. Due to the risk involved in growing rice in these most difficult environments, farmers tend to use fertilizers rarely and avoid using improved rice varieties. Thus the rice productivity in rain-fed lowland areas is very low. In Rain-fed upland rice production system the rice is grown under high rainfall. Rain-fed upland rice production system is often used by subsistence farmers in Asia, Africa, and Central America. It can be found in environments ranging from low-lying valley bottoms to steep sloping lands with high runoff. The rice in this system is established by broadcasting or dibbling in dry soil prior to the onset of monsoon or during the rainy season. The aerobic condition prevails in the soil throughout the rice cropping season. Traditionally, one rice crop is grown annually with minimal input application. Of rice produced in million ha, rain-fed uplands account for global total rice production [3]. Two-third of rain-fed upland rice is in Asia.

Discussion

In the rice belt of Africa, upland areas of central and western part represent African area under rice cultivation and employ region's rice farmers. The ecosystem is extremely diverse, including fields that are level, gently rolling, or steep, at altitudes and with rainfall ranging annually. Soils range from highly fertile to highly weathered, infertile, and acidic, but only total upland rice grows where soils are fertile and the growing season is long [4]. The productivity of upland rain-fed rice is low because of many biotic, abiotic, and social constraints and the use of the local varieties by farmers that fail to respond to improved management practices. The major constraints of this system are drought, problem soils, and pests. In aerobic rice systems, the rice plant is established by direct seeding in non-puddled, non-flooded fields and managed intensively as an upland crop. Aerobic rice systems can reduce water requirements for rice production relative to conventionally transplanted systems, by reducing percolation, seepage, and evaporation losses, while maintaining yields at an acceptable level. There were efforts in the 1980s to develop and popularize the irrigated upland rice or aerobic rice production in Brazil using sprinkler irrigation systems. In northern China, aerobic rice production is being practiced currently at a limited scale in freely drained fields, as a response to water shortage. The areas planted with aerobic rice varieties were estimated to be in China and in Brazil. In India, the aerobic rice system adoption has been initiated in states like Karnataka [5]. The major methods of rice establishment in the world are transplanting and direct seeding. Thus, based on the method of rice establishment, the rice production systems may be categorized as transplanted rice production systems and direct-seeded rice production systems. Direct-seeded rice production systems may be further categorized as dry-seeded rice production system, wet-seeded rice production system, and water-seeded rice production system. Rice is commonly grown by transplanting seedlings into the puddled soil in lowlands of Asia and Africa. Transplanting of rice is done manually or by machine. The manual transplanting method involves growing of seedlings in a nursery and replanting old rice seedlings to puddled soils. The rice seedling nursery may be raised on wet bed or dry bed or dapog or mat or modified mat methods depending on the locality, soil type, rice ecosystem, and the resource availability. In several Asian countries, the labour-intensive trans-planted rice production systems are being practiced until now, where even the labour supply is abundant due to the population growth [6]. For machine transplanting the rice seedlings are grown in trays or in mat-type nursery in which a thin layer of sol mixed with farm yard manure or compost is placed on a polythene sheet and rice seedlings are raised. Mats of rice seedlings from the trays or mat-type nursery are used for machine transplanting. In Asia, machine transplants are now being used to establish rice crops in China, Japan, Korea, and Taiwan. In India, farmers started using it in states like Karnataka and Andhra Pradesh. However, higher quantities of water are consumed in TPR in order to accomplish the processes such as paddling, surface evaporation, and percolation. This production system is labour, water, and energy intensive and is becoming less profitable as these resources are becoming increasingly scarce. It also deteriorates the physical properties of soil, adversely affects the

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performance of succeeding upland crops, and contributes to methane emissions. However, TPR continues to dominate under certain environmental and socioeconomic conditions of the world. Several studies have shown that productivity of TPR and DSR rice will be similar in a given environment provided that they are cultivated using best management practices. Traditionally under rain-fed TPR areas, need of ponded water for customary practice of paddling delays rice transplanting by few weeks resulting in reduced yields. The puddled TPR production systems need a large quantity of water and labour, which are becoming scarce and costly, in addition to the drudgery to transplanting women and children. The profit margins were also reduced due to increasing water and labour cost for TPR [7]. The drum seeded and the crop of wet-seeded rice sown by using the drum seeded irrigated areas of many developing countries in Asia. However, compared to TPR, lower yield was reported with wet-and dry-DSR production systems due to uneven or poor crop establishment; inadequate weed control; higher spikelet sterility than in puddled transplanting; higher crop lodging, especially in wet seeding and broadcasting; and micronutrient deficiencies. Higher rice productivity was reported when these constraints were alleviated. The performance of different types of DSR production systems varied with countries depending on the cultural practices used the environment, and their interaction. Among DSR production systems, line/drill seeding and wet-DSR were reported to yield higher. However, dry-DSR was found to be more resistant to drought with longer survival under drought period and may increase yield stability of rain-fed rice than the wet-DSR and transplanted rice systems. The yield of dry-DSR and TPR systems was similar when irrigation was scheduled daily [8]. In China, a meta-analysis revealed that the rice grain yield decreased in rice–rice cropping system and increased in rice-upland cropping system due to the adoption of zero tillage, when compared to conventional tillage. The responses of rice grain yield to zero tillage did not differ with rice establishment method, rice cultivar type, zero tillage adoption duration, and management of crop residues. High cost of production and diminishing resources have led to a greater focus on improving the overall eco-efficiencies of agricultural systems for achieving optimal agricultural outputs using less land, water, nutrients, energy, labour, and capital inputs in rice production systems. Irrigated lowland rice is typically grown under flooded conditions, and at the field level, it utilizes up to two to three times more water than other major food crops, due to the unproductive water flows, in the form of seepage and percolation to drains, creeks, or groundwater. This can amount all water inputs to rice [9]. The water input for a typical puddled TPR per season was estimated to vary depending on the growing season, climatic conditions, soil type, and hydrological conditions, as a typical value in most cases. The overexploitation of groundwater to meet the high water requirement of TPR and water scarcity has become a major threat to the sustainability of rice production. The per capita availability of water is expected to decline over the next few years in several countries of Asia, and by 2025, rice lands will suffer some degree of water scarcity. Hence, increasing water use efficiency in rice production systems is essential. In addition to the consumption of large amount of irrigation water and labour, the process of paddling results in subsurface compaction [10]. The increasing shortage of water resources has led to the development and adoption of aerobic rice system, which saves water input and increases water productivity by reducing water use during land preparation and limiting seepage, percolation, and evaporation. In an aerobic rice system, the crop can be dry direct-seeded or transplanted and soils are kept aerobic through the major part of the growing season. Supplemental irrigation is applied when needed. Aerobic rice cultivars are adapted to aerobic soils and have higher yield potential than traditional upland cultivars. Grain yields can be reached in aerobic rice system. The micronutrient deficiencies such as Zn and Fe in aerobic rice are of major concern. Aerobic rice could considerably improve eco-efficiency in rice-based systems where water, labour, and energy are becoming increasingly scarce, and hence it is gaining importance in South Asia as an alternative to the conventional transplanted flooded rice system. Dry-DSR production system helps to save irrigation water, especially in fine-textured soils. Dry-DSR with intermittent irrigation offers potential water savings at the field level due to reduced evaporation losses, intermittent irrigation, and avoidance of paddling. In dry-DSR and TPR production systems, significant irrigation water input decline was recorded with irrigation compared to daily irrigation. Novel irrigation water-saving technologies such as alternate wetting and drying can also help many rice farmers around the world to cope with water scarcity. In AWD, irrigation is given at intervals for heavy soils and lighter soils. Prior to next irrigation, the soil dries naturally after the water disappearance from soil surface and the water quantity applied at each of the irrigation.

Conclusion

Thus, the introduction of aerobic periods during the growing season and altering soil chemistry and flooding practices results in reduced water use and reduced global warming potential of greenhouse gas fluxes. A saving in water and increase in rice yield with the additional advantages of energy saving, nutrient use efficiencies, and controlling vectors of malaria and Japanese encephalitis were reported with the use of AWD. The irrigation lowered the irrigation water use of dry-DSR, with AWD, as compared to the respective transplanted rice system.

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Conflict of Interest

None

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