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Aerobic Rice: A Water Saving Approach for Rice Production

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Aerobic rice is grown in well-drained, non-puddled and non-saturated soils without ponded water. It is rice growing in aerobic soil, with the use of external inputs such as supplementary irrigation, fertilizers & aiming at high yields. Main driving force behind aerobic rice is economic water use. Aerobic rice is better remedy for future climate change under drought condition with lesser green house gas (GHG) emission.

Introduction

Food and water are two of the most important necessities for survival, but with an increasing demand for food and a looming water crisis, a shortage of both may be on the horizon unless innovative technologies are developed. Water, especially, is becoming a fast precious commodity, as more and more people continue using water for the household, industry, and agriculture. Scientists are now taking on the challenging task of developing rice production systems that can cope with water scarcity. More than 75% of the rice production comes from 79 million ha of irrigated lowland. Over 17 million ha of Asia's irrigated rice may experience "physical water scarcity" and 22 million ha may experience "economic water scarcity" by 2025 (Tuong and Bouman 2003). In Asia, upland rice is aerobically grown with minimal inputs & it is usually planted as a low yielding subsistence crop in the adverse upland conditions. With predictions that many Asian countries will have severe water problems by 2025, aerobic rice gives hope to farmers who do not have access to enough water to grow flooded lowland rice. Aerobic rice is a production system where rice is grown in well-drained, non-puddled, and non-saturated soils. Water requirements can be lowered by reducing water losses due to seepage, percolation, and evaporation. Promising technologies include saturated soil culture and intermittent irrigation during the growing period. However, these technologies still use prolonged periods of flooding, so water losses remain high.

Irrigated rice has very low water-use efficiency as it consumes 3000–5000 liters of water to produce 1 kg of rice (Barker et al. 1998). The traditional rice production system not only leads to wastage but also causes environmental degradation and reduces fertilizer use efficiency. Along with high water requirement, the traditional system of transplanted rice production in puddled soil on long run leads to destruction

of soil aggregates and reduction in macro pore volumes, and to a large, increase in micro pore space which subsequently reduce the yields of post rice crops. Aerobic rice cultivation will curb methane production and saves water without affecting the productivity. It is the time to save water from the irrigated system of rice cultivation by adopting the aerobic rice cultivation.

Aerobic Rice

Aerobic rice is a new type of rice that is aerobic-soil-adapted and input-responsive. It grows well in non-puddled and non-saturated soils with water content of 70% to 100% of water-holding capacity throughout a growing season. Aerobic rice is specifically developed rice, combining drought tolerance of upland rice and yield potential of lowland rice. Therefore, aerobic rice is "improved upland rice" in terms of yield potential, and "improved lowland rice" in terms of drought tolerance. Aerobic rice varieties have the ability to maintain rapid growth in soils with moisture content at or below field capacity, and can produce yields of 4-6 t/ha with a moderate application of fertilizers under such soil water conditions (Parthasarathi et al. 2012). Aerobic rice can save as much as 50% of irrigation water in comparison with lowland rice (Huaqi et al. 2003). Aerobic rice is a paddy crop grown in well-drained, non-puddled & non-saturated soils without ponded water. It is growing rice in aerobic soil, with the use of external inputs such as supplementary irrigation, fertilizers & aiming at high yields. Main driving force behind aerobic rice is economic water use. A fundamental approach to reduce water inputs in rice is growing like an irrigated upland crop, such as wheat or maize. Aerobic rice varieties developed for the purpose, produce yield as much as irrigated puddled rice varieties which are traditionally grown in rice paddies. Yields were on par with irrigated puddled rice with an average of 5.5- 6 t ha^{-1} with 60 percent less water use (Parthasarathi et al. 2012). Due to unsaturated conditions, there is possibility that aerobic rice emits lesser methane gas into the atmosphere thus keeping the environment safe besides water saving.

Difference between Aerobic Rice and Upland Rice

Upland rice is grown in rainfed and naturally well-drained soils that are usually on sloping land with erosion problems, drought-prone, and poor in physical and chemical properties. Upland rice varieties are low-yielding but drought- and low-fertility-tolerant, thus giving low but stable yields under the adverse environmental conditions of uplands. However, high levels of fertilizer application and supplemental irrigation to upland rice lead to lodging and thus reduce yield.

Aerobic rice is targeted at more favorable environments where land is flat or terraced, and soil can be frequently brought to water field capacity by rainfall or supplemental irrigation, or where land is sloping but frequent rainfall can keep soils moist throughout the growing season. Aerobic rice can be a replacement of lowland rice wherever available water is insufficient for lowland rice but sufficient for aerobic rice.

Both aerobic and upland rice are adapted to aerobic soil conditions, but aerobic rice varieties are more input-responsive and higher yielding than traditional upland ones.

Cultural Practices for Aerobic Cultivation

Seed bed preparation: Minimum Tillage is enough for aerobic rice cultivation. Dry direct seeding ensures that fields are well harrowed and leveled. Field should be thoroughly prepared by using disc plough, cultivator and rotavator.

Seed rate and sowing method: Sowing can be done either by using manual seeding or drum seeder. Seed rate should be 40-45 kg/ha with the spacing of 20 x 10cm (50 hills/m^2).

Varieties suitable for aerobic rice: Apo, Pyari, Sahabhagi dhan, Annada - grain yield- 4.5-5.0 t/ha.

Weed control: Pre emergence herbicide application pendimethalin/oxadiazon or Post emergence herbicide (bispyribac sodium) and manual weeding recommended.

Nutrient management: 120:50:50 kg ha^{-1} NPK to obtain a yield of 4-6 t ha^{-1}. First split can best be given at 10-12 days after emergence, second split at active tillering (AT) and third split fertilizer application at panicle initiation (PI) stage.

Irrigation: Irrigation can be given through flooding up to just enough to bring the soil water content in root zone up to field capacity (FC). Light irrigation (30 mm) after sowing may be needed to promote emergence. Irrigation needed when soil water tension at 20 cm depth is more than 20 kPa (or leaves start to roll). Amount of each irrigation application should be sufficient to bring the topsoil of 20 cm to field capacity. The optimum soil water condition would be maintained around field capacity (30-40 kPa" or 0.3-04 bar soil moisture potential) across the growth stages. Apply irrigation upon visible symptom of developing hair cracks on surface soil, or initiation of tip rolling of first top leaves. Irrigation, applied at this stage attaining the condition of saturated soil moisture regime. Usually, scheduling irrigation at 5-7 days interval may supplement the optimum water requirement in aerobic rice. The different planting systems on rice crop showing clear evidence on reduction in total water use in aerobic rice cultivation than the other irrigated and upland condition which are using more water. But aerobic cultivation recorded a maximum yield with very minimum level of water for its growth with a moderate drought tolerant capacity.

Table 1. Water requirement comparison between lowland flooded rice and aerobic rice

Particulars	Seasonal water requirement (mm)	
	Lowland flooded rice	**Aerobic rice**
Land preparation	150–300	100
Evaporation	200	100
Transpiration	400	400
Seepage and percolation	500-1500	335
Application loss (at 60% efficiency)	-	335
Total seasonal water requirement	1650-3000	935

Source: Tuong and Bouman 2003.

By reducing water use during land preparation and limiting seepage, percolation, and evaporation, aerobic rice recorded about 51% lower total water use with 32-88% higher water productivity, expressed as gram of grain per kilogram of water, than flooded rice (Bouman et al., 2005). As land preparation, puddling, transplanting, and irrigation activities require maximum percentage of total labour, exclusion of these practices in arobic rice no doubt saves major portion of labor too.

Conclusion

The concept of aerobic rice holds promise for farmers in water-short irrigated rice environments where water availability at the farm level is too low or where water is too expensive to grow flooded lowland rice. Aerobic rice technology is better remedy for future climate change under drought condition with lesser green house gas (GHG) emission. Selection of good aerobic rice variety with desired physiological attributes along with good cultural practices and weed free environment would give better performance. However, yield penalty or yield stability parameter of aerobic rice is one which has to be considered by the farmers before its adoption.

References

Bouman BAM, Peng S, Castaneda AR and Visperas RM. 2005. Yield and water use of irrigated tropical aerobic rice systems. *Agricultural Water Management* **74**:87-105.

Tuong TP and Bouman BAM. 2003. Rice production in water-scarce environments, *In*: Proc. Water Productivity Workshop, 12-14 November 2001, Colombo, Sri Lanka. International Water Management Institute, Colombo, Sri Lanka.

Huaqi W, Bouman BAM, Zhao D, Changgu W and Moya PF. 2003. Aerobic rice in northern China: Opportunities and challenges. In ‘‘Water-Wise Rice Production’’ (B. A. M. Bouman, H. Hengsdijk, B. Hardy, P. S. Bindraban, T. P. Tuong, and J. K. Ladha, Eds.). pp. 207–222. Proceedings of a Thematic Workshop on Water-Wise Rice Production, 8–11 April 2002 at IRRI Headquarters in Los Ban˜ os, Philippines. International Rice Research Institute, Los Ban˜ os, Philippines.

Parthasarathi T, Vanitha K, Lakshamanakumar P and Kalaiyarasi D. 2012. Aerobic rice-mitigating water stress for the future climate change. *International Journal of Agronomy and Plant Production.* **3**(7): 241-254.