Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.7238

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **6 (6):** 1326-1329 (2018)

Review Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Innovative Water Saving Technologies to Improve Rice Production

"Let's count every drop of water"

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Received: 7.10.2018 | Revised: 13.11.2018 | Accepted: 20.11.2018

ABSTRACT

Rice is one of the three leading food crops in the world. It is semi-aquatic crop, requires ample water to grow. For producing one kg rice, it requires 3000 to 5000 liters of water, which is much higher than requirement of wheat and maize. Climate change and water scarcity threatens the sustainability of irrigated rice cultivation. Increasing global population actuate scientists to explore various techniques for increasing crop productivity. In this situation, rice scientists are focused on different water saving technologies to get more yields with less water.

Key words: *Rice, Water scarcity, Aerobic Rice, SRI, Hydrogel.*

INTRODUCTION

Rice is one of the three leading food crops in the world. It contributes 21% of global human per capita energy and 15% of per capita protein[1]. It is semi-aquatic crop in nature and requires ample water to grow. For producing one kg of rice, it requires 3000 to 5000 liters of water, which is much higher than requirement of wheat and maize[2]. Generally rice fields are kept flooded for long period of time which enhances seepage, percolation, transpiration and evaporation. Climate change has adverse affects on crop production. It is expected that nearly half of global population may face water scarcity by 2030 due to climate change and unpredictable rainfall. Increasing fresh water crisis threatens the sustainability of irrigated rice cultivation in most of the rice producing countries. It is expected that 15 million ha irrigated rice areas of Asia may experience 'Physical water scarcity" and 22 million ha may face "Economic water scarcity"[3]. Around 15–20 million hectares of irrigated rice area are projected to suffer some degree of water scarcity in the next 25 years, particularly the wet-season irrigated rice regions of China, India and Pakistan[4]. To meet increasing global food demand, there is need to improve rice production and productivity. Different strategies to enhance rice production in water scarcity conditions are discussed in the present study.

WATER SAVING TECHNOLOGIES

I. Aerobic Rice Cultivation

It is a water saving technology developed by International Rice Research Institute (IRRI) to produce more yield using less water.

Cite this article: Dey, S., Innovative Water Saving Technologies to Improve Rice Production *"Let's count every drop of water", Int. J. Pure App. Biosci.* **6(6):** 1326-1329 (2018). doi: http://dx.doi.org/10.18782/2320-7051.7238

In this method, rice used to cultivate in non-puddled, non-flooded fields like upland crop with sufficient inputs and supplementary irrigation when rainfall is scarce[5]. Cultivars suitable for aerobic rice cultivation should be responsive to high inputs and tolerate occasional flooding[6,7].

Features-

- Grow in non-puddled and non-flooded fields like upland crop
- Have longer roots than conventional varieties which help better water absorption and facilitates better air circulation
- Water requirement is only 50-70% of the water required for irrigated rice production
- Responsive to high inputs

Benefits -

- ✓ **Saves Water**: No standing water
- ✓ **Saves labour** : Puddling, leveling, raising nursery & transplanting are not required
- ✓ **Eco-friendly**: Low methane emission
- ✓ **Cost effective**: Less incidence of diseases and pests
- ✓ **Saves seeds**: Well ventilated plants in wider spaced rows
- ✓ **Improves soil health**: Inter or mixed cropping with pulses, vegetables, oilseeds are possible

II. System of Rice Intensification (SRI):

It is an innovation in rice production systems which increase productivity of the land, labor, water and capital. The system of rice intensification (SRI) started in Madagascar in the 1980's through participatory on small farms research by practitioners[8].

Features:

- Transplant very young seedlings, at the 2 leaf- stage (preferably 8-12 days old)
- Careful transplanting of single seedlings; One plant per hill transplanting helps to avoid root competition
- Transplant at wider spacing to promote better root and canopy growth
- Follow square grid pattern (at least 25 x 25 cm distances between rows and hills)
- Less use of chemicals (fertilizer, pesticide, insecticide and herbicide)
- Use less water by following wet-dry cycle of soil moisture
- Use organic manures: for improving soil structure, nutrient and water holding capacity

Impacts:

- Increase paddy yield usually by 20-50%
- Reduce required seeds for transplanting by 60-80%; require less amount of seeds (5–7 kg ha^{-1})
- Reduce use of chemical fertilizers and agrichemicals; sustains soil health
- Reduce irrigation water by 25-50%
- Reduce production costs usually by 10-20%

Now this concept is also applying to other crops like wheat, maize, sugarcane, rapeseed mustard, sesame, pulses etc.

III. Alternate Wetting and Drying (AWD)

AWD is another water saving and methane mitigation technology developed by International Rice Research Institute[4]. In this technology, fields are alternately flooded and dried. The number of days of drying the soil can vary from 1 day to more than 10 days, depending on the type of soil and the cultivar.

In this method a 'field water tube' ('pani pipe') is used to monitor the water depth on the field. After irrigation, the water depth will gradually decrease. When the water level has dropped to about 15 cm below the soil surface, irrigation should be applied to re-flood the field to a depth of about 5 cm. The field should be kept submerged, topping up to a depth of 5 cm from one week before to a week after flowering as needed. After flowering during grain filling and ripening, the water level can be allowed to drop again to 15 cm below the soil surface before re-irrigation[9].

Benefits

- Save water about 38% without affecting rice production[10]
- Increase water productivity by 16.9% compared with continuously flood irrigation[11]
- Eco-friendly; reduces methane (CH4) emissions
- increase grain yield by enhancing grain-filling rate, root growth and remobilization of carbon reserves from vegetative tissues to grains[12,13,14].

Fig: Alternate Wetting and Drying technology (Source: Rice Knowledge bank, IRRI[9])
(**1**. Field water tube made up of PVC; **2**. A field tube in flooded field; **3**.Water at 15 cm below the soil surface: Time to irrigate the field again)

IV. Natural Hydrogel Technology:

Hydrogels can absorb water by osmosis and store significant amounts of water in the soil. They can improve the water holding properties of soils, reduce the need for irrigation, and improve soil permeability, reduce erosion and leaching, and also improve seed germination and plant growth. Natural gums like tragacanth (Goond Katira), sterculia (Goond Karaya) and xantham have water absorption capacity about 100 times of their dry weight. They are locally available, derived from plants, nontoxic and even edible. Most important aspect is that they are also cost-effective. Seed coated with Goond Katira hydrogel can allow farmers to delay the first irrigation by two weeks in summer crops. Using this technology, around 40% irrigation, nitrogen fertilizers and cultivation costs can be save without any yield penalty[15].

CONCLUSION

Rice is one of the most important staple food crops in the world. It is semi-aquatic in nature and single biggest user of fresh water. Increasing water scarcity becomes a big challenge for lowland rice cultivation. To improve rice production and productivity there is need to adopt the above mentioned innovative strategies at commercial scale. Technologies like SRI and Aerobic rice cultivation are already in practice in different parts of the world. For getting more benefits from these techniques, Breeders need to develop suitable high yielding varieties.

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