



ENHANCING WATER USE EFFICIENCY AND PRODUCTIVITY OF RICE CROP USING MODERN FARMING METHODS IN PUNJAB, PAKISTAN, A BRIEF REVIEW

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ABSTRACT

Rice is the major staple food for billions of people worldwide. It has the social and economic impacts on people lives. Water scarcity is one of the major challenges to rice production and ultimately food security globally. For food security, it is important to explore efficient rice production technology that uses less water. Therefore, in the modern agriculture focus has been shifted towards development of water saving technologies. These methods include direct seeding, alternate wetting and drying, aerobic rice systems, use of mulches etc. These techniques reduce the water requirements and can enhance water use efficiency (W.U.E) of rice. However, yield may be compromised with these techniques, but research has been carried out to reduce yield losses and water use. Biotechnology and breeding approaches are being used to develop rice varieties with drought tolerance, improved water use efficiency etc. Development and adoption of these technologies will shift the rice production from anaerobic to completely or partially aerobic systems. These techniques may reduce the water losses. In Pakistan farmers are willing to adopt new technologies; however, there is a need of dissemination and demonstration to adopt these technologies at farmer level to enhance crop productivity and water use efficiency. Innovative research approaches are required to fill the gaps in technological innovations and adoption.

Key word: Water Use Efficiency; Rice Seeding Methods; Water Scarcity, Irrigation.

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INTRODUCTION

Rice is the major staple crop of Pakistan after Wheat and major export crop after Cotton. It accounts for 3.1% in the value added in agriculture and 0.6% in GDP (GOP, 2018). About 60% of rice is exported to Asia, Africa and Europe. Basmati rice is popular for its natural aroma and it also has the grain elongation character while cooking. Its demand is increasing worldwide. Basmati rice from Pakistan is earning three times more price in international markets compared to coarse rice cultivars (Mahajan *et al.*, 2018). It has a great contribution in revenue generation and has a key role in export earnings for Pakistan. Punjab and Sindh provinces of Pakistan are main rice crop producers, contributes 50% and 38% respectively (GOP, 2017). In Pakistan rice production is around 2562kg/ha, that is only 60 percent of potential yield of rice (GOP, 2018-19). Rice production is mainly limited by water availability for irrigation.

Global climate change leading to the extreme inconsistency in the weather, increasing the average temperature, more severe droughts and decline in water availability. These factors in addition to the increasing population are making the food security situation more worse (Cheeseman, 2016). Pakistan's food security is linked with the availability of water. In recent decades food security has been improved due to increase in production as result of increased in acreage. The unsustainable use of water stressing the groundwater aquifers. Therefore we have to manage the water use in agriculture properly and efficiently (Kirby *et al.*, 2017).

Rice crop accounts for 24 to 30% of fresh water and 34 to 43% irrigation water consumption all over the world. Water inputs for season ranges between 660-5280mm in puddled system depending on growing and environmental conditions (Mann *et al.*, 2016). In Asia about 50% of water is used for irrigation of

rice crop. Consumptive use of rice is around 8cm but supplied water quantity is very higher and ranges between 13-18cm (Rehman *et al.*, 2017). Water scarcity can be classified into two types, economic and physical scarcity. Economical scarcity is the scarcity when investments are not available to meet the current growing demand due to the various constraints. While physical scarcity is when water availability is insufficient to meet demands. In Asia a large portion suffers from economic or physical water scarcity. In future, Pakistan will face the water scarcity for irrigation due to decline in availability and increased demand of water (GOP, 2018-19). As 90% of rice is produced and consumed in Asia, therefore, this scarcity is going to affect the rice production severely in Asia. Water scarcity is becoming the biggest problem for rice production.

Current rice cultivation practices: In Pakistan rice is grown usually by transplanting seedlings in puddled soils having standing water during the growth period. To rely on standing water during the growing period results in in poor water use efficiency (W.U.E). Seepage and percolation also contribute to increase the water losses. By conventional rice production, 2500 liters of water is used for producing 1kg of rice (Bouman, 2009). Majority of farmers use puddling system regardless of water availability for irrigation. Extensive research is required for clear demarcation of challenges and development of water saving techniques for targeted sites.

Water scarcity: Total cultivated area of Pakistan is around 22mha, and 14.7mha or 68% is irrigated primarily by Indus Basin Irrigation System (IBIS). It provides 54 million-acre feet water to farms and almost 48 million-acre feet water is supplemented with the help of tube wells. But there is still shortage of 22.7 million-acre feet that is projected to become double in 2020s. The country is recently suffering with a serious water deficit while resources on surface as well as

underground are shrinking swiftly. This is an alarming situation of irrigated agriculture as well as for food security at national level.

Rice production in Pakistan is totally irrigated and consumes the 30% of available fresh water resources. It is need of time to adopt alternative methods to increase water use efficiency, for rice production that require low amount of water. In Punjab province, due to canal water shortage tube wells are installed for supplemental irrigation that is causing depletion to groundwater resources. In Sindh, canal water is sufficient in many upper areas, but lower areas are facing serious problem of water scarcity.

Suitable water management strategies: In Pakistan, due to water scarcity area under rice crop is decreasing due to practice of conventional methods like puddling, flooding and transplanting. To overcome and minimize the problem, Pakistan Agricultural Research Council (PARC) collaborated with the International Rice Research Institute (IRRI) in a project entitled "Development and Dissemination of Water Saving Rice Production Technologies in South Asia". Over conventional practices anaerobic and aerobic technologies saved 25% and 20% water respectively. This technology was disseminated to two districts of Punjab i.e., Hafizabad and Mandi-Bahaudin (Mann *et al.*, 2016).

Water scarcity is emerging as a major threat for sustainable rice production all over the globe. There is need to find ways to produce rice with less water requirements. Therefore, Research is mainly focused on "Developing water saving technology systems for rice crop". Recently, several techniques have been developed for efficient water use in rice production. These technologies include "Dry Direct Seeding (DDS)", "Wet Direct seeding (WDS)" and "Alternates Wetting and Drying (AWD)" etc. These technologies can be used effectively to save 15-25% of water without affecting the yield and scaled up in Punjab and Sindh provinces by Pakistan Agricultural Research Council (PARC) (Rehman *et al.*, 2015).

Dry direct seeding (DDS) -aerobic rice: It refers to a rice cultivation system that consists of growing rice in levelled field without puddled conditions. In this system, throughout the season standing water is not mandatory. This method is primarily used for upland and lowland rain-fed areas. But, due to water saving potential as compared to conventional methods it has become popular in irrigated areas as well. This technique is now in practice at Kala Shah Kaku and Dokri. This technique greatly reduces the water losses through seepage, percolation and evaporation.

Methane emission under anaerobic or puddled condition is also a serious concern in rice production. This emission is contributing to rise in atmospheric methane and ultimately in climate change. In this regard, aerobic cultivation can help to reduce methane emission as well as water saving without compromising production.

Wet direct seeding (WDS): It refers to the seeding of pre-germinated seeds into or on the surface of puddled rice field. This technique has less water saving potential than dry direct seeding because more water is required to flood the field for puddling.

Alternate wetting and drying (AWD): The amount of irrigation water required for puddled paddy production on lowlands can be potentially lessened by minimizing the

standing water depth and allowing drying the soil surface before the next application of irrigation water. This practice of irrigation withholding is known as alternative wetting and drying.

Mulching: Mulch can increase water retention and improve the water efficiency and productivity. This technique can be used to reduce water use and losses. It can serve as water saving technique for rice production. Mulching can reduce water losses about 18-27% as compared to the conventional rice production. It can reduce the numbers of sterile spikelets, and grain quality in rice (Jabran *et al.*, 2015).

Rice breeding for water saving: Breeding of rice varieties can be done to improve the water use efficiency and improve water saving in rice production. For water saving, system breeding is not so much common in past. But now there is a need to develop varieties with water saving traits, water deficit tolerance and high yielding. In china different varieties have been developed and cultivated in northern parts are facing water scarcity. Similarly, in IRRI and Brazil breeding for water saving traits was initiated and developed varieties are sown in Indonesia and Philippines.

Impacts of different water saving technologies: To address the issue of declining water availability on large scale adoption of water saving techniques can make the rice production and cultivation sustainable. To slow down the groundwater depletion, these techniques can serve effectively by reducing the irrigation frequency and amount of water. Furthermore, these techniques will improve the environmental sustainability in rice producing areas. However, these techniques might compromise the yield as well but with effective and proper management this issue can be managed (Jabran *et al.*, 2015).

Farmer's view on aerobic rice culture and future perspectives: Conventional rice system is threatened by water, labor and land in Pakistan. Water and resource use efficiencies can be enhanced by adopting aerobic rice production systems. For this purpose, farmer's view is vital component to determine factors for adoption. A study was conducted In Punjab, the results were surprising because more than 50% of farmers had never heard about the aerobic rice culture (Awan *et al.*, 2015). Majority of farmers were open for experimenting the aerobic rice systems because of less input requirement and ease of operation by direct sowing etc. However, there are some serious limitation including non-availability of fine basmati rice, weed problems etc. Aerobic system is a good alternative to conventional rice production. Research and farmer awareness can reduce the risks in aerobic farming by filling the technological gaps (Awan *et al.*, 2015).

CONCLUSION

Water scarcity is an emerging threat for agriculture production especially for rice production in Pakistan as well as in other parts of the world due to the shortage of canal water and depletion of groundwater resources. Water saving production systems for rice is inevitable in rice production regions. Therefore, we must introduce and adopt the water saving rice production technologies and practices to reduce the water losses and reliance on water as well. In past few years, significant progress has been made in testing and evaluation of aerobic and other water saving techniques in

rice production. Technology dissemination and demonstration in the targeted areas can help in adopting the new techniques at farmer level to save water use and improve the rice water use efficiency.

CONFLICT OF INTEREST:

The author has no conflict of interest.

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