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Climate Change Implications for Rice Cultivation

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Authors' contributions

This work was carried out in collaboration among all authors. Authors PD and CKP designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author UD managed the analyses of the study. Author CKP managed the literature searches. All authors read and approved the final manuscript.

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Opinion Article

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ABSTRACT

The inter-linkage between climate change and agriculture are multidimensional and complex. Crop response to climate change depends on the location specific baseline climate and soil condition thus; no consensus has emerged so far on how rice production will be affected by climate change impact in India. SRI methods have been implemented for more robust and healthy plants and the larger and deeper root systems. Climate change might have some adverse impacts on rice production that has been reflected in several literatures. As per Prof. M.S. Swaminathan, there will be a decline in Asian rice production due to climate change impact. International Rice Research Institute (IRRI) has indicated one-degree increase in temperature could cause a reduction of 10 percent in rice yield. Climate directly influences the physiological processes of rice plant's growth, development and grain formation. Indirectly, climate influences the incidence of crop pests, diseases and hence, and grain yields. A skilful seasonal prediction will likely become significantly essential to provide the necessary information to guide agriculture management to mitigate the compounding impacts of soil moisture variability and temperature stress in rice cultivation.

Keywords: Climate change; agriculture; SRI methods; rice production.

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1. INTRODUCTION

The inter-linkage between climate change and agriculture are multidimensional and complex. Crop response to climate change depends on the location specific baseline climate and soil condition thus, no consensus has emerged so far on how rice production will be affected by climate change impact in India [1]. Although some authors are in a strong view that climate change will have negative impacts on rice production [2-6]. The role of climate is becoming increasingly important due to anthropogenic climate change, which could drastically change local environments; damage yields [7]. As per Prof. M.S. Swaminathan there will be a decline of Asian rice production due to climate change. International Rice Research Institute (IRRI) has indicated that a one degree increase in temperature could cause rice yield to drop by 10 percent. Some climatic conditions and their biophysical impact on the agricultural environment or rice cultivation that can reduce rice crop yield are:

1. Erratic rainfall conditions.
2. Temperature rise leading to increased soil evaporation & evapotranspiration from plants.
3. Soil moisture stress.
4. Extreme weather events like cyclones and typhoons.
5. Heat waves.
6. Increased weed, insect pest and disease challenges through temperature and humidity rise.
7. Soil erosion and loss of soil organic matter due to extended dry spells and increased frequency of heavy rainfall events.

2. SYSTEM OF RICE INTENSIFICATION (SRI) POTENTIAL TO REDUCE NEGATIVE IMPACTS OF CLIMATE CHANGE

The SRI offers multiple benefits against the background of the various climate change implication for agriculture. The following two elements of SRI are of particular relevance for reducing externalities of modern rice cultivation in the perspective of climate change.

A. SRI has a low requirement for surface irrigation and groundwater supplies. SRI demands the reduced use of chemical fertilisers and pesticides coupled with the higher input of organic manures. These practices reduce the risk of groundwater contamination and enhance soil quality, including water retention capacity of the soil. In addition, SRI helps to increase the resilience of rice cultivation system to various climate-related risks. This is mainly a result of the more robust and healthy plants and the larger and deeper root systems that evolved under SRI methods.
B. Through the deeper root system, SRI plants are better prepared to survive short periods of water stress associated with drought conditions, dry spells and irrigation water shortage.
C. SRI plants are more resistant against various pests and disease. The incidence of sheath Blight and infestation of brown plant hopper is reported to be low in SRI cultivation.
D. SRI rice is less vulnerable to severe weather events like heavy rainfall and strong wind due to a stronger root system.
E. Maturation period of varieties under SRI is shorter than conventional practice. Harvesting earlier reduces the frequency of losses due to bad weather, pests or disease which often come at the end of growing season and are expected to occur more frequently with climate change.

Increase in yield and productivity gains offered by SRI, as well as a reduced dependency on external inputs if farmers replace chemical fertilisers and pesticides with in situ produced organic input, will improve farmers overall livelihood situation [8,9]. All in all, SRI combines a number of features that make it highly valuable with regard to reducing the vulnerability of the agricultural system to climate change. The benefits are in terms of:

1. Reducing pressure on vulnerable ecological systems.
2. Enhancing the resilience of the rice cultivation system.
3. Improving farmers overall livelihood situation and
4. Building adaptive capacity of farmers as the key human resource in the agricultural system.

3. SRI POTENTIAL FOR CONTROLLING TO CLIMATE CHANGE MITIGATION

Agriculture has been shown to produce a significant effect on climate change, primarily through production and release of greenhouse gases such as carbon dioxide, methane and nitrous oxide. Rice production is considered to the main cause of rising methane emissions from the agriculture sector during the past century [10,11]. A study of greenhouse gases emission from irrigated rice in India revealed that total methane emission in Kharif season ranged from 24.5 to 37.2 kg/ ha.

SRI has therefore often been subject to discussion on how a change in agriculture practice can contribute to climate change mitigation. Under the conventional methods of rice, cultivation methane is emitted by bacteria that thrive in flooded rice fields which decomposes manures, fertilisers and other organic matter in the oxygen-free environment [12,13]. The gas is emitted through the plants or directly into the atmosphere. Thus, by avoiding the flooded conditions on rice fields, SRI can help bring down methane emission from rice cultivation.

SRI contributes to mitigation of climate change through a lever also. Through requiring a precise dosage of irrigation water, it helps reduce energy consumption for operation of water pumps. And therefore has a potential to mitigate carbon emission from burning of fossils fuels for power generation.

Finally, another factor of mitigation of greenhouse gases emission through SRI is the reduced need for application of chemical fertilisers. Production of chemical fertiliser is associated with significant energy and process related greenhouse gases emissions which outweigh the respective greenhouse gases footprint of organic fertilisers.

4. CONCLUSION

The SRI offers multiple benefits for reducing vulnerable of agricultural system and livelihoods to climate variability and change. It helps to reduce pressure on the vulnerable ecological system by reducing irrigation water requirement and need of pesticide inputs and chemical fertilisers. SRI enhances the resilience of rice cultivation system against climate risk. The regional relationships between climate variability and production/yield in combination with both the regional long-term mean production/yield and seasonal climate forecasts might help to mitigate future impacts. Therefore, skilful seasonal predictions can provide useful information regarding agriculture management to mitigate the climate-induced effects on rice production as well as yield.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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