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Rice Yield Gaps in India and Strategies to Narrow the Gaps

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Abstract

Rice is the staple food crop of India. The productivity of rice in India is comparatively low (2.4 tha^{-1})and ought to be raised to ensure sufficient production to meet the needs of the growing population. There are few 'yield gaps in rice and closing the same could improve the productivity and efficiency of rice production. The paper discusses various concepts related to the yield gaps in rice and strategies to address such gaps. It is suggested that there should be institutional and policy support to farmers which is crucial for ensuring agricultural input supplies, farm credit and minimum support price in a holistic approach for a sustainable increase in rice production and for narrowing the yield gaps in rice.

1. Introduction

Rice is one of the most consumed foods on earth, a staple food for more than 3.5 billion people worldwide and for about half of the world's population. In India, 50% of its population depends on this grain for sustenance. India is the world's second-largest producer of rice and the largest exporter of rice in the world (Heitzman, 1996). Rice provides up to 60% of the daily energy requirement and a substantial part of the protein intake, and therefore is crucial for nutritional security (Nirmala, 2016).

Rice production in the world in the year 2022 is 515.3 million metric tons (USDA, 2022). The food grain production in India during 2021–2022 is 314.51 million tons and the production of paddy during the year is 129.66 million tons (Indiastat, 2021–2022).

Despite these achievements, the productivity of rice in India is comparatively low (2.4 t ha^{-1}) and ought to be raised to ensure sufficient production to meet the needs of the growing population. It was predicted that the rice-cropped area in our country will decline by 6–7 million hectares by 2050 (FAO, 2020). And at the same time consumer demand also increases due to ever increasing population, thus rice production should be increased by 1.5% per year over the next four decades to ensure the self- sufficiency (Nayak,

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2022). Thus, there is a huge 'yield gap' and closing these gaps could improve not only the productivity but also the efficiency of rice production.

The term 'yield gap' has been commonly used to refer to the difference between the average farmers' yields and an estimate of a reference yield or potential yield at a specific area in a given time (Gomez, 1977; Nirmala, 2009). Maximum attainable yield is the yield of experimental or on-farm plots with no physical, biological and economic constraints and with known management practices at a given time and in a given ecology. Potential yield can be defined and measured in a variety of ways such as using crop growth models (Bhanusree, 2022), maximum yield trials and other research experiments or best yields from farmers' fields. Farm level yield is the average farmer's yield in a given area at a given time in a given ecology.

2. Methodology/Concepts of Yield Gap

Yield gap has two components; where the first component is yield gap I, it is the difference between model yield and the field demonstration yield or research station yield, which cannot be narrowed or not exploitable, because it is mainly governed by the factors that are non-transferable such as environmental conditions. The second component is yield gap II, it is the difference between the field demonstration yield or research station yield and the actual average farmers' yield (Lobell, 2009), which is mainly due to differences in management practices or farmer's inefficiency level, which is manageable and can be bridged.

As average crop yields are critical drivers of food prices, crop land expansion; and food security, yield gaps should be better quantified and understood (Chaudhary, 2000). Along with yield gaps yield gap indices like Index of Yield Gap (IYG), Index of Realized Potential Yield (IRPY), Index of Realized Potential Farm Yield (IRPFY) should also be studied (Nirmala, 2014). These are discussed briefly below.

2.1. Total Yield Gap

Potential Yield (Y_p)–Actual Yield/District average yield (Y_a)

Where, Y_p is the yield realized through model

Y_a is the yield realized on farmer's field

2.2. Yield Gap I

Potential yield (Y_p) – Potential farm yield (Y_d),

Where, Y_p is the yield realized through model

Y_d is the yield realized at research station

2.3. Yield Gap II

Potential farm yield (Y_d) – Actual yield/District average yield (Y_a)

Where, Y_d is the yield realized at research station

Y_a is the yield realized on farmer's field.

2.4. Index of Yield Gap (IYG)

It is the ratio of difference between potential yield (Y_p) and the district average yield (Y_a) to the potential yield, expressed in %. That is

$$IYG=((Y_p-Y_a)/Y_p)\times100$$

2.5. Index of Realized Potential Yield (IRPY)

It is the ratio of the district average yield (Y_a) to the potential yield (Y_p), expressed in %.

$$IRPY=(Y_a/Y_p)\times100$$

2.6. Index of Realized Potential Farm Yield (IRPFY)

It is the ratio of the district average yield (Y_a) to the potential farm yield (Y_d) expressed in %.

$$IRPFY=(Y_a/Y_d)\times100$$

3. Strategies to Bridge the Yield Gaps

Even though many efforts are being made to boost the yields by developing new high yielding and disease resistant varieties, there is more pressing need to reduce the yield gaps (Nirmala, 2016), which can be considered as a local solution to global problem.

3.1. Promotion of Integrated Crop Management

Yield gaps caused by biological constraints can be effectively addressed through the integrated crop management (ICM) practices.

3.2. Adequate Input and Credit Supplies

Input play an important role in the productivity of crops and minimizing yield gaps. Farmers need adequate amounts of quality inputs like seed, fertilizers and also some credit at the right time to obtain good yields.

3.3. Research and Extension Support

The researcher should understand farmers constraints and should develop the location specific integrated technological packages to narrow the gaps and at the same time the extension support should be extended by effective trainings, demonstrations, field visits, monitoring, etc.,

3.4. Policy Support

New public policies can narrow the yield gap to an extent

by solving the socio-economic constraints faced by the farmers.

4. Conclusion

Bridging the yield gap requires integrated and holistic approaches. Mechanization, improved package of practices and management of pests and diseases will help in narrowing the yield gaps. For this purpose, institutional and policy support is crucial for ensuring agricultural input supplies, farm credit, and minimum support price in a holistic approach. Even with the existing technologies it is possible to increase the production by closing the yield gaps. This will help in ensuring food and nutritional security in the future.

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