Assessing area, production and return with rice varieties of NRRI, Cuttack

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ABSTRACT

The ICAR-National Rice Research Institute (NRRI), Cuttack in Odisha develops varieties and agro-technologies for enhancing and sustaining rice production. The Institute so far has released 133 high-yielding varieties of rice for various ecosystems. Some of the varieties have been very popular among the farmers and even became ruling varieties in some states. However, there are no reports on the area covered by NRRI varieties and its impact on incremental gain in farm income. In the present study, area covered by NRRI varieties in the country during 2017-18 was estimated based on the amount of quality seeds provided to the farmers through various ways: breeder seed indent to the DAC; breeder seed and truthfully-labeled seed supplied by the NRRI farm; participatory seed production by NRRI; seed distributed in various programmes and projects of the Institute; front-line demonstrations and on-farm testing; seed of NRRI varieties supplied by the private entrepreneurs and disseminated from farmers to farmers etc. A validation exercise was conducted to cross-check the estimated areas under NRRI varieties. The analysis showed that currently NRRI varieties cover about 8.0 million ha (Mha) i.e., 18% of rice area of the country. West Bengal has the largest area of 2.26 Mha, followed by Odisha with 2.18 Mha. Total production of rice with NRRI varieties is 27.80 million tons (Mt) with the value of Rs.48,643 crores per annum. Further, incremental production and income with NRRI varieties considering 5% more than the existing popular varieties is estimated to be 1.39 Mt and Rs.2,432 crores per annum, respectively. Over the years, indents of breeder seed (BS) of NRRI varieties have increased considerably indicating growing popularities of NRRI varieties among the farmers in different states.

Key words: NRRI rice varieties, breeder seed, rice area

INTRODUCTION

Rice is the staple food for more than 2/3rd of Indian population. The country grows rice in 43 million ha area with production of 112 million tons of milled rice and productivity of 2.6 t ha^{-1} (Pathak et al., 2018b). The crop is grown in highly diverse conditions ranging from hills to coasts. Primarily a kharif crop, it is cultivated round the year in one or the other parts of the country. Area under rice has remained almost unchanged over the years, but production has increased more than five times (Fig. 1). With this, India has not only achieved self-sufficiency in rice but also produces surplus for export.

The ICAR-NRRI, Cuttack is country's premier Institute for rice research. The Institute so far has released 133 high-yielding varieties of rice for various ecosystems. The first high yielding variety (HYV) of NRRI Padma was released in 1968. Subsequently, several HYVs with higher yield potential and resistant to biotic and abiotic stresses have been developed and released. About 13% of the rice varieties released in the country have been released by NRRI. Currently, 55 NRRI varieties out of 250 in the country *i.e.*, 20% are indented for breeder seed production through Department of Agriculture and Cooperation (DAC), Ministry of Agriculture and Farmers' Welfare, Government of India. Some of the varieties of NRRI have been popular among the farmers and even became ruling or preferred varieties in some states *i.e.*, Pooja
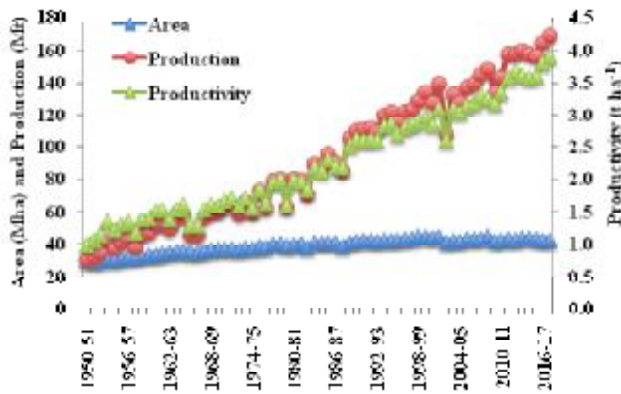
Fig. 1. Area, production and yield of rice in India over the years.

in Odisha, Naveen in Assam, Shatabdi in West Bengal and Savitri in Tamil Nadu. However, the coverage of NRRI varieties and its contribution to overall income gains in India are not reported so far. The objectives of the present study were to estimate the area covered by the NRRI varieties and assess the production and income gains due to the spread of NRRI varieties in different states of the country.

MATERIALS AND METHODS

Estimation of area under NRRI varieties

Area under specific varieties of a crop is conventionally calculated using various methods such as (1) distribution of breeder seed (BS) as indented to Department of Agriculture and Cooperation, Ministry of Agriculture and Farmers' Welfare, Govvernment of India; (2) sale of certified seed (CS) by the agriculture department of various states; (3) sample survey; (4) expert estimation; and (5) community survey (Pathak et al., 2018a). Every method however, has its own advantages and disadvantages and also various levels of assumptions. In the current analysis, efforts were made to quantify the amount of quality seeds of NRRI varieties provided to the farmers through various ways and estimated the area in different states under NRRI varieties. In the analysis, it was identified that the seeds of released varieties of NRRI reaches to the farmers through the following ways: breeder seed indent to the Department of Agriculture and Cooperation, Ministry of Agriculture and Farmers' Welfare, Govvernment of India; breeder seed and truthfully-labeled seed (TLS) sold by NRRI

Farm; participatory seed production; seed distributed in various programmes and research projects such as Mera Gaon Mera Gaurav (MGMG), Bringing Green Revolution in Eastern Region (BGREI), Farmer's FIRST and Tribal Sub-Plan (TSP) of the Institute; front-line demonstrations and on-farm testing; seed multiplied and supplied by private entrepreneurs and seed disseminated from farmers to farmers. Considering all the modes of distribution of seeds of NRRI varieties to the farmers, the following methods were used to estimate the area under NRRI varieties in different states of the country.

Method I

It was assumed that the area covered by NRRI varieties are proportional to the BS indent of NRRI varieties to the BS indent of all the rice varieties submitted at DAC, Government of India. The following equation was used to calculate area under NRRI varieties.

Area (Mha) = BSI for NRRI varieties (kg) / Total BSI of all varieties (kg) × Area under rice (Mha) × Area under HYVs (%) / 100   ....Eq. 1

Where, BSI, breeder seed indent; HYVs, high yielding varieties; 100, conversion factor.

Method II

In this method, 1 kg of BS was considered to produce 60 kg of foundation seed (FS), which in turn produces another 60 kg of CS. About 50 kg of CS or truthfully labeled seed (TLS) is recommended to grow nursery for transplanting 1 ha area. Thus, area covered by NRRI varieties was calculated using the following equation.

Area (Mha) =[{BSI of NRRI varieties (kg) x60x60} + TLS (kg)] /50/10^6 ...Eq. 2

Where, BSI, breeder seed indent; TLS, truthfully labeled seed; 50 and 10^6, conversion factors.

Method III

It was assumed that the area covered by NRRI varieties is proportional to the sale of CS and TLS of NRRI varieties to the sale of CS and TLS of all the rice varieties in a state. The following equation was used to calculate area under NRRI varieties.

Area (Mha) = Sale of CS and TLS of NRRI

varieties (kg) / Total sale of CS and TLS (kg) × Area under rice (Mha) × Area under HYVs (%) / 100

$$\text{........ Eq. 3}$$

Where CS, certified seed; TLS, truthfully labeled seed; HYVs, high yielding varieties; 100, conversion factor.

Method IV

In this method, it was considered that 50 kg of CS or TLS is required to plant 1 ha of area. An adjustment was made to consider the adoption of the varieties from farmers to farmers taking the seed replacement ratio (SRR) of state as a proxy. Area covered by a variety was thus calculated using the following equation.

Area (Mha) = Sale of CS and TLS of NRRI varieties (kg) / 50 / 10^6 x 100 /SRR   …….Eq.4

Where, CS, certified seed; TLS, truthfully labeled seed; SRR, seed replacement ratio; 50, 100 and 10^6, conversion factors.

Method V

As all the above methods have some assumptions and uncertainties, this method estimated the area under NRRI varieties taking the average area of all the above four methods.

Data on BSI for all rice varieties and NRRI varieties were collected from DAC (2018) and sales of CS data were obtained from State Government Departments. Data on supply of BS and TLS for NRRI varieties during 2017-18 were collected from the Farm Section, ICAR-NRRI, Cuttack, Odisha.

Validation of the estimated area under NRRI varieties

A validation exercise was conducted during July-August, 2018 to cross-check the estimated areas derived through different methods adopted in this study. The District Agriculture Officers of Odisha (30 officers) and West Bengal were requested to provide the data on coverage of NRRI varieties in their respective districts as these two states showed the largest area covered by NRRI varieties. Additionally, an expert consultation was also organized to corroborate the results obtained using different methods.

Estimation of increase in production and income

with NRRI varieties

Production and gross return with NRRI rice varieties

Production of rice of NRRI varieties was calculated using the following equation.

Production of rice from NRRI varieties (Mt) = Area of NRRI varieties (Mha) / Total area (Mha) × Total production (Mt)   ………………Eq. 5

Gross return with NRRI varieties was calculated using the following equation.

Gross return from NRRI rice varieties (Rs. crore) = Production of rice from NRRI varieties (Mt) ×MSP (Rs. t^{-1}) / 10   ………….. Eq. 6

Where, MSP, minimum support price; 10, conversion factor.

Incremental gains in production and return with NRRI varieties

Incremental gain in production due to adoption of NRRI varieties were calculated considering 5% incremental gain, because a new variety is released only when a minimum yield advantage is more than 5% than the local check variety. Thus, the incremental gain in production of NRRI varieties was calculated using the following equation.
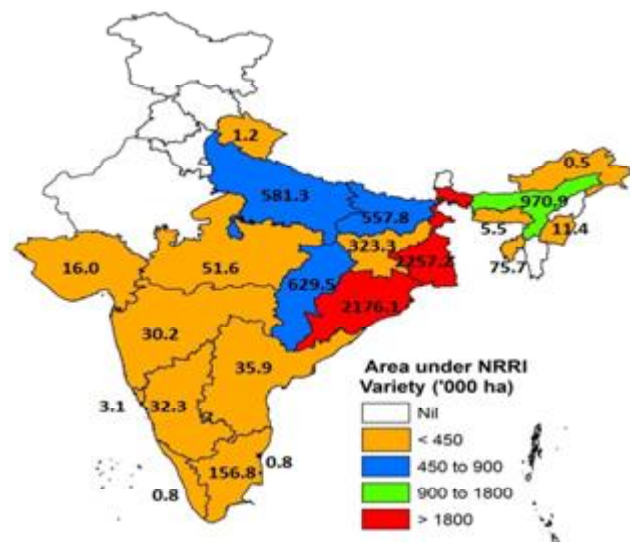

Fig. 2. Area covered by NRRI varieties in different states of the country.

Gain in production of NRRI varieties (Mt) = Area of NRRI varieties (Mha) / Total area (Mha) × Total production (Mt) × 5/100   ……........Eq. 7

The incremental production was multiplied with the minimum support price (Rs.17, 500 t^{-1}) to get additional return over other popular varieties. Incremental gain in return with NRRI varieties was calculated using the following equation.

Gain in income of NRRI varieties (Rs. crore) = Gain in production of NRRI varieties (Mt) × MSP (Rs. t^{-1}) / 10   ……………..Eq. 8

Where, MSP, minimum support price; 10, conversion factor.

RESULTS AND DISCUSSION

Area under NRRI varieties

In terms of breeder seed indent, NRRI varieties accounted for 27% of total indent in DAC (467.3 t) for the year 2017-18. Accordingly, NRRI varieties are presumed to cover 27% of area covered by the HYVs of rice in various states of the country. Thus, as per method I, NRRI varieties covered 10.05 Mha *i.e.*, 23% of total rice area in the country. Also, during 2017-18, ICAR-NRRI has supplied 126 t BS and 140 t TLS through direct farm sale or through various research

projects. Therefore, area estimated based on supply of seeds from NRRI (Method II) showed that 9.12 Mha is covered by NRRI varieties. Area covered by NRRI varieties estimated by method III *i.e.*, sale of CS and TLS was 5.73 Mha. As per method IV, in which it considered that 50 kg of CS or TLS is required to plant 1 ha of area and an adjustment was made to consider SRR of state, the area under NRRI varieties were estimated to be 6.77 Mha. Finally, the rationalized area, as calculated by averaging the area estimated by different methods was 7.92 Mha *i.e.*, 18% of total rice area in the country.

The NRRI varieties are popular in all the states of eastern India (Fig. 2). It has considerable presence in the southern states also. The West Bengal state has the largest area under NRRI varieties (Table 1). About 2.26 Mha of rice area (41% of state) is covered by NRRI varieties namely Shatabdi, Swarna Sub1, Sahbhagi Dhan and Khitish (Fig. 2). Next to West Bengal, Odisha has 2.18 Mha (57% of state) rice area under NRRI varieties. The varieties namely Pooja, Naveen, Swarna-Sub 1 and Sahbhagi Dhan are predominantly grown in Odisha. Also, the adoption of NRRI varieties is as high as 39.3% in the state of Assam and 27.3% in Tripura. The average adoption of NRRI varieties in the states of Bihar, Jharkhand and
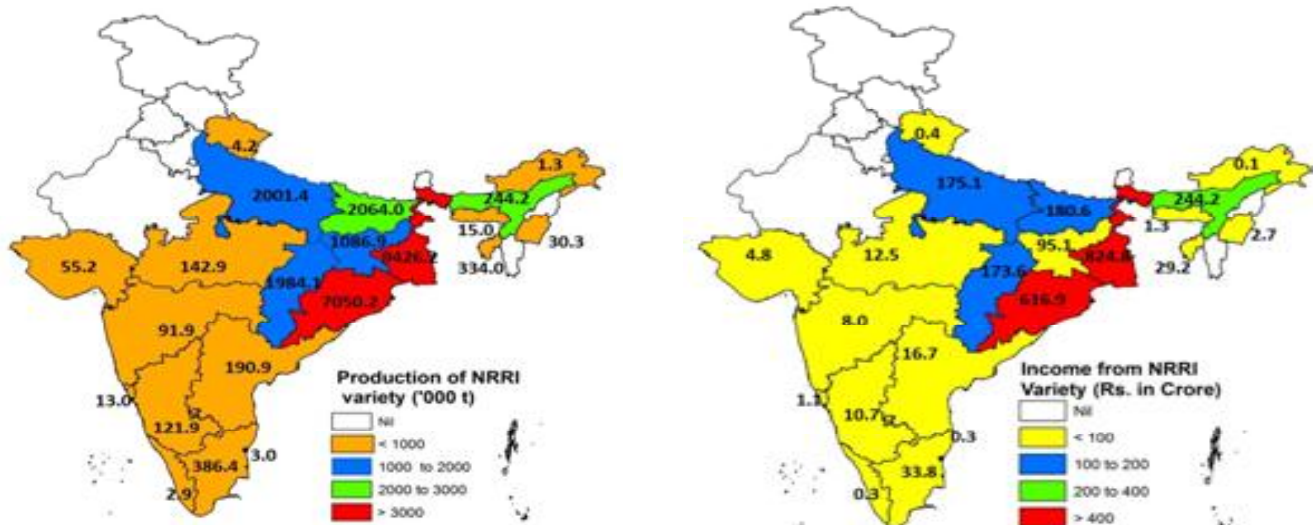
(a) Production ('000 t)   (b) Income (Rs. Crore)

Fig. 3. Production and income with NRRI varieties in different states of the country.

Chhattisgarh is more than 15% with a national average of 18%.

Gains in production and income with NRRI varieties

Total production of rice with NRRI varieties in the country is estimated to be 27.80 Mt with the production value of Rs. 48,643.7 crores per annum (Fig. 3). West Bengal has the highest production of 9.43 Mt of the NRRI varieties followed by Odisha (7.05 Mt), Assam (2.79 Mt) and Bihar (2.06 Mt). Also, incremental production and income with NRRI varieties *i.e.*, 5% more than the high yielding local check is 1.39 Mt and Rs. 2,432 crores per annum, respectively. It is reported that the significant impacts of the NRRI technologies adopted by farmers are due to higher production at a lower cost of investment (Mondal et al., 2012) and higher income.

CONCLUSION

Adoption of NRRI varieties by the farmers has resulted in increasing and stabilizing rice production as well as economic upliftment of the farming community. The methodology developed in the present study would be useful in assessing area under various crop varieties and other agro-technologies and evaluating the impacts of technologies on production and income of farmers. It will also help in guiding seed subsidies for different varieties, increasing the seed replacement ratio and redesigning of varietal development programmes.

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