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Enhancing rice and wheat production by bridging yield gap in western Uttar Pradesh of India

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Abstract

Food security of India depends on rice and wheat crops. The study was conducted in Agra region of western Uttar Pradesh to assess yield gap at farmers' field. Etah district was purposively selected because of large area under the rice-wheat crop system. Out of the 15 blocks in Etah, Sakeet was selected having 176 villages of which 10 villages with maximum area under rice-wheat system were selected. From the selected villages, 120 farmers were selected through proportionate random sampling from small (up to 2.00 hectares), medium (above 2.00–4.00 hectares) and large (more than 4.00 hectares) farmers. There is a yield gap on all the farms. The yield gap-II was more than the yield gap-I. The major constraints responsible for yield gap were late sowing/transplanting, higher prices of seed, non-availability of fertilizer at sowing time, lack of funds with farmers and infestation of pest and disease. There is further scope to increase productivity on the farms by managing the constraints. Providing quality inputs to the farmers at right time in sufficient quantity can help in reducing yield gap.

Keywords: Wheat bridging yield gap, constraints and productivity

Introduction

Rice and wheat are the major cereal crops in India contributing significantly to the nation's food and nutritional security. These two crops together account for more than 60 per cent of area and 77.20 per cent of total food grain production in the country (Final estimate of 2011-12, Govt of India). Since cereals continue to be an important source of carbohydrates and protein, the contribution of rice and wheat to the daily calorie intake of people is significant. Nasurudeen *et al.* (2006) reported that more than 66 per cent of the calorie and protein intake of rural Indians were obtained from the cereals consumption. The same was about 56 per cent among urban population. The combined share of these two commodities reported over 90 per cent of total quantity consumption of cereals in rural India (CSO, 2010). However, decadal growth in the production of these two crops has decelerated. Growth in rice production declined from 3.62 per cent (1980-81 to 1989-90) to 1.72 (2001-02 to 2011-12) whereas, in wheat it reduced from 3.57 per cent to 2.37 per cent for the same period (Economic Survey, 2011-12).

India has the largest area under rice and wheat in the world but in the case of production it is next only to China. The country has made tremendous progress in wheat production since the introduction of semi-dwarf high yielding verities so called green revolution technology. It produced a historic record output of 94.88 million tons from an area of 29.86 million hectare. Among wheat growing states, Uttar Pradesh, Punjab, Haryana, Rajasthan, Madhya Pradesh and Bihar together contributed 90.47 per cent of total production (Anonymous, 2012). In the case of rice, India produced 105.31 million tons in an area of 44.01 million hectare (Final estimates 2011-12).

Uttar Pradesh, principally an agrarian state went rapid strides in rice-wheat production and its contribution in ensuring food security to its increasing population is commendable. The state produced 14.03 million tons of rice in an area of 5.95 million hectare with a productivity figure of 2358 kg ha^{-1}. In the case of wheat, the figures correspond to 30.29 mt in 9.73 mha with a productivity of 3113 kg ha^{-1} (4^{th} Advance Estimates, 2011-12).

Etah, the principal rice-wheat belt in Western Uttar Pradesh grows rice and wheat respectively in an area of 27072 hectare and 136560 hectare. Average production in Etah was estimated at 69358 tons and 442318 tons respectively for rice and wheat with the corresponding productivity figures of 2562 kg ha^{-1} and 3239 kg ha^{-1} (Directorate of Economics and Statistics, 2011-12). Among different crops being cultivated in this region, rice ranks fourth among Kharif crops and wheat tops the list in Rabi crops.

The main constraints faced by the farmers generally focus three issues viz. yield gap between research farm and farmer's field, technological constraints and socio-economic constraints. Analysing these aspects will help to understand the real situations in rice and wheat production, and immensely useful to frame policies for overcoming the constraints and enhancing rice and wheat production. Literature reports that there are considerable variations in productivity, constraints and opportunities in the rice-wheat system. The entire rice-wheat system in the country may be grouped into regions of high and low productivity. The high productivity region majority

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of north India is primarily characterized by fertile land, high level of input use, mechanized farming and assured irrigation through utilization of ground water. On the other hand, low productivity region pertains to eastern Indian states and is characterized by inadequate irrigation, low level of input use, traditional practices, frequent flooding and other weather-induced risks and availability of ground water. The traditional cultural cultivation practices are also harmful for rice-wheat cropping system (Rizwana and Lyaqet, 2011).Considerable attention is being paid

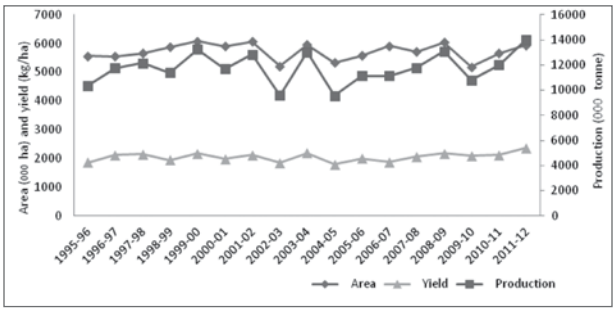

Fig 1. Trend of area, production and yield of rice in UP

to abiotic constraints like soil fertility, water management and tillage but less on the biotic obstacles particularly the soil-borne pathogens. Rice–wheat system has started showing good progress, thus the critical analysis of this system is a pre- requisite for any attempt to strengthen and sustain productivity of these crops. The constraints analysis will help in identifying the thrust areas to concentrate in future action. It also requires a different technological, infrastructural and policy support from the northern India. While some studies have analysed the performance of Rice -wheat system in the northern India (IRRI, 1990; Hobbs *et al*., 1992, Chaudhary and Harrington, 1993; Harrigton *et al*., 1993; Roy and Dutta, 2000), systematic studies focusing on the Western Uttar Pradesh are relatively few. Therefore, the present study has examined the yield gap and production constraints of rice and wheat in the western UP.

Materials and methods

The present study was confined to Agra region of Western Uttar Pradesh. Agra Mandal (Region) comprises of six districts viz., Agra, Etah, Aligarh, Mainpuri, Firozabad and Mathura (Now Etah district comes under Aligarh region). Out of these districts, Etah was selected purposively since it covers the major area under rice-wheat crop system. Out of the 15 blocks in Etah, Sakeet was selected because it has major area under the rice- wheat system with assured irrigation by canal as well as tubewell. Out of 176 villages in Sakeet, 10 villages with maximum area under rice-wheat system were selected. The selected villages are: Angadpur, Sabalpur, Nekpur, Kambapur, Sakatpur, Bavali, Ashpur, Chhachhena, Puraon and Nagla Bhatmai. From the selected villages, 120 farmers were randomly selected adopting the proportionate sampling technique comprising categories of small (up to 2.00 hectares), medium (above 2.00–4.00 hectares) and large (more than 4.00 hectares). Thus 80, 25 and 15 farmers were selected randomly in case of small, medium and large farm size groups respectively. The present study was based on primary as well as secondary data. The primary data were collected for the year 2008-09 by personal interview method through well-structured and pre-tested interview schedule.

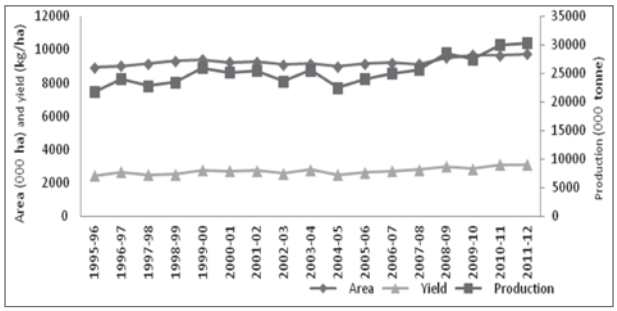

Fig 2. Trend of area, production and yield of Wheat in UP

Estimation of yield gap: Yield gap can be defined as the difference between potential yield, which is maximum attainable yield at research station under optimal conditions and actual yield obtained by farmers. This total yield gap can be divided into two parts, viz., yield gap I and yield gap II (Singh, 2011). Bhattacharya (2011) analysed, whether genetic yield of wheat has reached and, if not, discussed the reasons for the yield gap. He estimated yield gap I (difference between potential yield and national average yield), yield gap II (difference between potential yield and state average yield) and yield gap III (difference between potential yield and on-farm yield). The results indicated that wheat registered 28.22 per cent yield gap I in India and 57.01 per cent yield Gap II and 0.98 per cent yield gap III in Uttar Pradesh. Non availability of high yielding quality seeds and uncertain rainfall were identified as the reasons for yield gap. Aggarwal *et al.* (2008) used 'Infocrop' to calculate the potential yield of crops apart from plant breeders field and FLDs report. They found that wheat had a yield gap of 70kg/ha. Sarungham and Prasad (2011) analysed the yield gap in rice and found that environmental factors played a major role in non-exploitation of potential yield. Difference in farmers' management practices, infrastructural facilities and planning at macro level influenced the yield gap. Singh (2010) estimated the yield gap and identified the constraints in rice production. Farmers perceived that lack of credit facilities, inadequate availability of good varieties and inadequate fertilizer application were the major constraints in attaining poor yield.

Yield gap I: This gap refers to the difference between research station yields and potential farm yields obtained

at demonstration plots in a particular region. This gap is caused by differences in climate, soil and other physical environmental factors, which are difficult to manage or estimate at demonstration farmers' fields.

Yield gap II : This gap reflects a series of biophysical and socio-economic constraints and it is the difference between yield obtained at the nearest demonstration plot and average yield obtained at farmers' fields in a particular region. This gap is of prime concern in the present study. The yield gaps were estimated as follows:

Yield gap I $= \{(Y_R - Y_D)/ Y_R\} \times 100$

Yield gap II $= \{(Y_D - Y_F/Y_D\} \times 100$

where, Y_R is the research station yield (KVK Avagarh, Etah), Y_D is the demonstration plot yield at farms (conducted by KVK Avagarh, Etah), Y_F is the actual farm yield.

Ranking of constraints: The constraints were ranked on the basis of response given by the respondents on a particular constraint.

Results and discussion

Yield gap analysis in wheat: The yield gap in case of wheat crop was worked out by using the formula discussed in the methodology and the results are presented in Table 1.

Table 1. Yield gap in various conditions of wheat production

Particular	Yield (q ha^{-1})
Experimental station (R)	57.50
Demonstration yield (D)	51.28
Actual yield at farmer's field (F)	37.74
Yield gap I	6.22 (10.82 %)
Yield gap II	13.74 (26.40 %)

Source: Krishi Vigyan Kendra, Avagarh, District Etah, Uttar Pradesh

The yield gap (I) has been estimated by the difference in yield between experimental farms and demonstration farms which denotes that there was a yield gap of 6.22 q ha^{-1} being about 10.82 percent. The yield gap II was 13.74 q ha^{-1} (26.40 %) calculated on the basis of difference in yield between demonstration farms and actual yield on the farmers' field. It shows a wide gap in yield on farmer's field which should be minimized by adopting improved high yielding varieties coupled with optimum use of fertilizers, judicial use of irrigation water and other package of practices.

Yield gap analysis in rice: The yield of rice at different levels is shown in Table 2. Farmers in the study area followed the recommended technology on demonstration plots at KVK Avagarh, district Etah farm. The average yield on demonstration plot was 55.28 q ha^{-1}. On the other hand, the average yield at farmers' field stood at 44.70 q ha^{-1}. The average yield gap I and average yield gap II were estimated at 8.22 q ha^{-1} (12.94 %) and 10.58 q ha^{-1} (19.14 %) respectively. Thus the yield gap II was more than the yield gap I indicating the non-adoption of improved technologies at farmer's field but carried out successfully at research farms.

Table 2. Yield gap in various conditions of rice production

Particular	Yield (q ha^{-1})
Experimental station (R)	63.50
Demonstration yield (D)	55.28
Actual yield at farmer's field (F)	44.70
Yield gap I	8.22 (12.94 %)
Yield gap II	10.58 (19.14 %)

Source: Krishi Vigyan Kendra, Avagarh, Etah

The yield gap is attributed to different factors: biophysical, socio-economic, characteristics and technical factors as well as climatic factors. The most important reason for existing yield gap among different farms might be due to non adoption of improved farm practices and integrated pest management. The other important factors which affect the yield levels are largely beyond the control of farmers like climate, irrigation, biophysical and other uncertain happenings. The productivity and sustainability of rice wheat system is threatened as yields of both rice and wheat are either stagnant or decreasing and total factor productivity is declining for the following reasons: 1) inefficiencies in the current production system; 2) increasing shortage of resources, especially water and labor; 3) changing climate; and 4) socio-economic changes (such as urbanization, labor migration, preference of non agricultural work, rapid economic growth led to increased labor requirement in non agricultural sectors) (Ladha *et al.,* 2003). Several yield-reducing and yield limiting factors, together with delayed planting of wheat and transplanting of rice; energy, labor, and other input shortages; resistance of the weed *Phalaris minor* to Isoproturon; and crop residue burning have contributed to the stagnating or declining production, productivity and sustainability of this system (Gupta *et al.,* 2002).

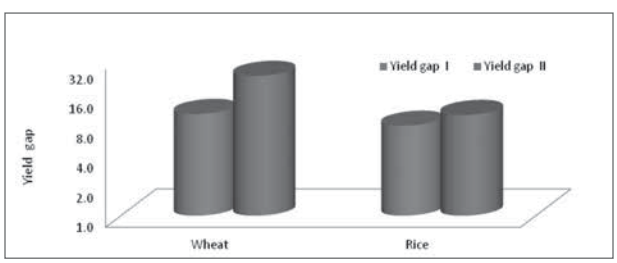

Fig 3. Yield gaps in per cent for rice and wheat production

Constraint analysis under rice-wheat cropping system: This section presents the constraints faced by the farmers in rice-wheat production and they are discussed under two broad categories *viz.*, technical constraints and socio-economic constraints.

Socio-economic constraints under rice-wheat cropping system: The socio-economic constraints were analyzed and presented (Table 3.) The study identifies eleven major socio-economic problems being faced by farmers.

Table 3. Socio-economic constraints under rice-wheat cropping system

Constraint	Frequency	Per cent	Rank
High prices of HYV seeds	111	92.50	I
Non availability of chemical & fertilizer	107	89.17	II
High prices of chemical and fertilizer	88	73.33	III
Low prices of produce	79	65.83	IV
Non availability of institutional credit in time	73	60.83	V
Sufficient Institutional credit not available	71	59.17	VI
Poor quality of seeds	65	54.17	VII
Poor quality of fertilizer and chemical	63	52.50	VIII
Irregular supply of canal water	55	45.83	IX
Non availability of labour at peak hours	42	35.00	X
Miscellaneous	38	31.67	XI

Analysis of socio-economic constraints adopting the rank-based quotient indicated that higher prices of HYV seeds was the most serious constraint followed by non-availability of chemical and fertilizer at sowing time and high price of inputs. The rice-wheat rotation was more capital intensive due to higher cost of cultivation. There is a need for institutional finance mainly to small farmers at cheapest rate.

Over all the composition of socio-economic constraints resulted in low crop productivity. The productivity and sustainability of rice wheat system is threatened by socio-economic changes (Ladha *et al.* 2003).

Technical constraints analysis in rice-wheat cropping system: The results of analysis on technical constraints under rice-wheat cropping system are presented in Tables 4.

Table 4. Technical constraints analysis in rice-wheat cropping system

Constraint	Frequency	Per cent	Rank
Late sowing/ transplanting	111	92.50	I
Weed problems	96	80.00	II
Disease	91	75.83	III
Nutrient deficiency	86	71.67	IV
Lack of proper varieties	72	60.00	V
Rodents	65	54.17	VI
Plant protection constraints	62	51.67	VII
Pests	55	45.83	VIII
Lack of irrigation at proper time	53	44.17	IX
Post harvest technology	45	37.50	X
Other constraints	42	35.00	XI

Apart from the socio-economic constraints, technical constraints also play an important role in widening yield gap at farmers' field. Eleven technical constraints were identified and these constraints were arranged according to their seriousness as perceived by the farmers. The major technical constraint in rice-wheat cropping system was late sowing/ transplanting followed by weed infestation. Disease (blast, stem rot diseases, Karnal bunt) incidence was perceived as the next most serious constraint and reported by 75.83 per cent of the respondents. Nutrient deficiency and lack of proper varieties were ranked at subsequent positions with 71.67 and 60.0 per cent, respectively. Inefficiencient production system is limiting productivity and sustainability (Ladha *et al.*, 2003).

Conclusions and policy implications: There is a yield gap on all the farms, the second yield gap was more than the first yield gap. Therefore, there is scope to increase further productivity on the farms. The yield gap can be minimized by making the inputs available to the farmers in sufficient quantity, good quality and at right time. The major constraints responsible for yield gap were late sowing/ transplanting, higher prices of high yielding variety seed, non-availability of fertilizer at sowing time, lack of funds with farmers and infestation of pest and disease. By managing these constraints, the productivity can be increased and ultimately the production will increase. The use of chemical & fertilizers has direct impact on the production. Measures need to be taken to provide such inputs to the farmers in time and solve the socio economic problems to enhance wheat and rice productivity.

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