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RESEARCH ARTICLE :

Yield gap analysis in maize production in Karimnagar district Telangana

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SUMMARY : The term "yield gap" refers to "the difference between actual yields and potential yield,". The purpose of the study was to investigate the key factors limiting maize productivity in Karimnagar district of Telangana in order to develop strategies to reduce the yield gaps. So, for the present studymaize hybrid KNMH-131 was purposively. Purposive sampling technique was employed for collecting primary data from a sample of 30 progressive farmers and 30 normal farmers, so the total sample becomes 60 for the study. Thus, collected primary data was analysed with the help of yield gap analysis tables and production function analysis. The study revealed that the yield gap–I was observed to be -1.21 per cent and yield gap –II and yield gap-III were 3.97 and 23.13 per cent, respectively. Various yield gap indices in maize were worked out and the same are presented in Table 2. Various yield gap indices were worked out to know the untapped potential of maize in the farmers' fields. The index of yield gap in maize was 21.92 per cent, the index of realized potential yield gap of normal farmers in maize was 78.07 per cent. The indices of realized potential farm yield presented in table indicated that the farmers, in general, were successful in exploiting the potential farm yield of normal farmers of maize to the extent of only 77.14 per cent. The analysis indicated the existence of a considerable percentage of untapped potential farm yields in maize.The production function analysis showed negative production elasticities for total labour (-0.083) and plant protection chemicals cost (-0.1499) which clearly indicates the excess usage of these inputs for progressive farmers. For the normal farmers plant protection chemicals cost and experience in farming resulted in negative results which indicates that the farmers need to know the current information on newly introduced pests and diseases and they have to take initiative measures for controlling the same.

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BACKGROUND AND OBJECTIVES

Karimnagar district in Northern Telangana Zone of Telangana state has a typical composition having a large share of its area under highly diversified agricultural crops, higher growth in agriculture assumes great importance and is a matter of concern for policy planners and research scholars in recent times. Maize was one of the major crops grown in Karimnagar district of Telangana in an area of 8416 ha in *Rabi*, 2016-

17. Any new technology developed at research stations is tested amply through verification trials and demonstrations before it is released to the farmers' fields for adoption. Even then the crop raised and realized by the farmers on their farms tends to be considerably lower than those recorded at the research stations. Wide variations are also witnessed in the yields realized under different agro-climatic conditions. This showed the existence of a considerable untapped yield potential. The factors for such yield differences are many and their contributions are varied. Hence, the analysis of yield gaps is of great relevance and significance today. The yield gap analysis is a potent research technique that has been introduced during 1970s. Developed by the International Rice Research Institute (IRRI), it is extensively used to measure and analyze determinants of the yield gaps. The concept of yield gap provides the information base in this regard. The findings of such research have many implications for policy formulation, aimed at alleviating the constraints causing the yield gaps (Gavali *et al.*, 2011; Kalamkar, 2004; Nagaraj, 2002 and Rajagopalan, 1986). Yield gaps can be conceptually divided into three components; Gap-I and Gap-II, Gap-III. It is the difference between potential yield (Y_p) and potential farm yield (Y_d). Yield gap-I is hypothesized to be caused by either the environmental differences between experiment station and farmers' fields or by non-transferable technology.YG-II is the difference between potential farm yield (Y_d) and progressive farmers yield (Y_{pf}). It is hypothesized to be caused by agronomic factors like management and soil constraints; stem from the non-supervision of essential production inputs that prevent farmers from using the recommended technology. YG-IIIis the difference between potential farm yield (Y_d) and the actual farm yield (Y_a). It is hypothesized to be caused by biological and socio-economic constraints; biological constraints stem from the non-application of essential production inputs and the socio-economic constraints from the social or economic conditions that prevent farmers from using the recommended technology.

Maize ranks third position next to wheat and rice in the world with respect to area, while its productivity surpasses all other cereal crops. In USA more than 90 per cent of the people use the maize oil for consumption purpose. It is also used more in bakery products. In addition, it is used as an important feed and fodder for animals. Nearly, 500 products of maize have been listed in USA. Maize is a rich source of starch (60-80%), proteins (8-12%), fat (3-5%) and minerals (1-2%).

The area under maize cultivation in the period has increased at a CAGR of 1.11 per cent from 85000 hectare in 1979-80 to 100000 hectare in 2015-16, leading to a production of 381000 tons which has grown at a CAGR of 2.99 per cent over the years from 12000 tons and the productivity of maize has increased at a CAGR of 2.58 per cent.

RESOURCES AND METHODS

Purposive sampling technique was used to collect the primary data from 30 progressive farmers and 30 normal farmers in Karimnagar district who cultivated the maize hybrid KNMH-131 for the season *Rabi*, 2018-19.

Yield gap analysis:

The tabular analysis was extensively used in the study both independently and in conjunction with other tests. To estimate the magnitude of yield gaps in the selected crops and the input use gaps between the demonstration plot and the farmers field, simple tabular analysis was used. For better understanding and meaningful comparisons, percentages and appropriate indices to yield gaps were computed. The following important concepts were used in the present study.

Potential yield (Y_P):

Potential yield refers to that which is obtained in the experiment station. The yield is considered to be the absolute maximum production of the crop possible in the given environment, which is attained by the best available methods and with the maximum inputs in trials on the experiment station in a given season.

Potential farm yield (Y_d):

Potential farm yield is the yield obtained on the demonstration plots on the farmers' fields in the study area. The conditions on demonstration plots closely approximate the conditions on the cultivators' fields with respect to infrastructural facilities and environmental conditions.

Progressive farmers yield (Y_{pf}):

The yield obtained by the progressive farmers in the natural environmental conditions was considered as progressive farmers yield and this yiels was closely

related to actual farmers yield in the study area.

Actual yield (Y_a):

Actual yield refers to the yield realized by the farmers on their farms under their management practices.

Total yield gap (TYG):

It is the difference between the potential yield (Y_p) and actual farm yield (Y_a). This total yield gap comprises of yield gap-I and yield gap-II.

$$TYG = Y_p - Y_a \quad .....(1)$$

Yield gap-I (YG-I):

It is the difference between potential yield (Y_p) and potential farm yield (Y_d).

Yield gap-I is hypothesized to be caused by either the environmental differences between experiment station and farmers' fields or by non-transferable technology.

$$YG\text{-}I = Y_p - Y_d \quad .....(2)$$

Yield gap-II (YG-II):

It is the difference between potential farm yield (Y_d) and progressive farmers yield (Y_{pf}).

$$YG\text{-}II = Y_d - Y_{pf} \quad .....(3)$$

It is hypothesized to be caused by agronomic factors like management and soil constraints; stem from the non-supervision of essential production inputs that prevent farmers from using the recommended technology.

Yield gap-III (YG-III):

It is the difference between potential farm yield (Y_d) and the actual farm yield (Y_a).

$$YG\text{-}III = Y_d - Y_a \quad .....(4)$$

It is hypothesized to be caused by biological and socio-economic constraints; biological constraints stem from the non-application of essential production inputs and the socio-economic constraints from the social or economic conditions that prevent farmers from using the recommended technology.

Index of yield gap (IYG):

It is the ratio of the difference between the potential yield (Y_p) and the actual yield (Y_a) to the potential yield (Y_p), expressed in percentage.

$$IYG = [(Y_p - Y_a)/ Y_p] \times 100 \quad .....(5)$$

Index of realized potential yield (IRPY):

It is the ratio of the actual yield (Y_a) to the potential yield (Y_p), expressed in percentage.

$$IRPY = [Y_a / Y_p] \times 100 \quad .....(6)$$

Index of realized potential farm yield (IRPFY):

It is the ratio of the actual yield (Y_a) to the potential farm yield (Y_d), expressed in percentage.

$$IRPFY = [Y_a / Y_d] \times 100 \quad .....(7)$$

Production function analysis:

It was used to work out the resource productivity and returns to scale. Cobb – Douglas production function has been chosen for its flexibility and suitability. It is a power function and log linear. The function is of the form:

$$Y = Ax_1^{b1}.X_2^{b2}.X_3^{b3}.X_4^{b4}.X_5^{b5}.X_6^{b6}.\mu$$

where,

Y = Dependent variable

$x_1, x_2 \ldots\ldots x_n$ = The independent variable inputs selected for the study

$b_1, b_2 \ldots\ldots b_n$ = Regression co-efficients of the input factors ($x_1, x_2 \ldots\ldots x_n$).

μ = Error term and

a = Constant

The function in the double logarithmic form would be.

$$\log Y = \log a + b_1 \log x_1 + b_2 \log x_2 + \ldots\ldots + b_n \log x_n + \log u$$

Specification of the variables selected

$$Y = a x_1^{b_1}.x_2^{b_2}.x_3^{b_3}.x_4^{b_4}.x_5^{b_5}.x_6^{b_6}.x_7^{b_7}.\mu$$

Y = Gross income in rupees

x_1 = Total labour expenses in rupees

x_2 = Seed expenses in rupees

x_3 = Fertilizers expenses in rupees

x_4 = Plant protection chemicals expenses in rupees

x_5 = Experience in farming in years

x_6 = Percentage area irrigated.

Thus, in all six independent variables and one dependent variable were selected for fitting the Cobb-Douglas production function to test the productivity of the selected resources.

The function was fitted by means of least square estimates (OLS) and its significance was tested by working out analysis of variance and estimation of standard error. Finally, after calculating 't' value, it was tested for its significance at 5 per cent, 10 per cent and 1 per cent levels of probability.

OBSERVATIONS AND ANALYSIS

It was observed from the Table 1 that, yield gap - I was -1.21 per cent which indicates that the potential farm yield (7000 kg/ha) was more when compared with potential yield (6916 kg/ha) which may be due to environmental or non-controllable factors like soil health conditions. The experiments were conducted on very small plots under ideal conditions of land, soil moisture and assured input supply and the technical expertise available in research stations was of a high order. These factors helped in attaining considerable productivity at the research stations. The farmers of demonstration fields have good knowledge on all the practices and they were under the supervision of scientists of DAATTCs. These farmers in anticipation of realizing better yields applied more fertilizers and realized more yields than research station to an extent of 84 kg/ha.

The estimated yield gap - II observed to be 3.97 per cent and this may be due to agronomic factors like better crop management and soil characteristics of sampled farmers. These progressive farmers have considerably good amount of knowledge on crop management practices which helped them in realizing the better yields and the yield gap was less *i.e.*, 3.97 per cent only which may be overcome by little modifications in the production aspects like timely management.

The estimated yield gap – III was observed to be 23.13 per cent which is mainly due to the social or economic conditions that prevent farmers from using the recommended technology. Thus, a remarkable difference in the productivity of maize under different situations was observed. This was matter of great concern to extension functionaries involved in transferring new technology from research stations to the farmers' fields. This gap was attributed mainly to the biological and socio-economic constraints operating on the farmers' fields. The biological constraints related to the non-adoption of the recommended technology or non-application of the essential inputs at the recommended level. The analysis of input gap between demonstration plots and farmers' fields revealed that the level of inputs used on demonstration plots was higher than on farmers' fields. This reinforced the conviction that yield gap-III was basically attributed to the farmers inability to apply the essential inputs to the required extent in the correct time was the major contributing factor to the yield gap between farmers field and demonstration plot.

Some of the management practices also might have contributed to the existence of yield gap-III. The farmers inability to take up the recommended management practices due to labour and financial constraints with a stipulated time could cause a noticeable decline in output. Therefore, yield gap-III could be termed as resource-cum-management-cum-extension gap.

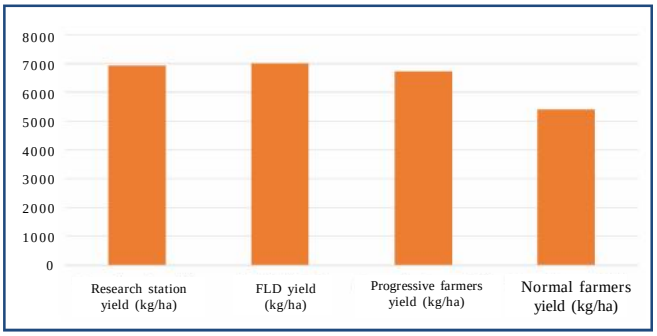

Fig. 1: Realized and estimated yields under different situations

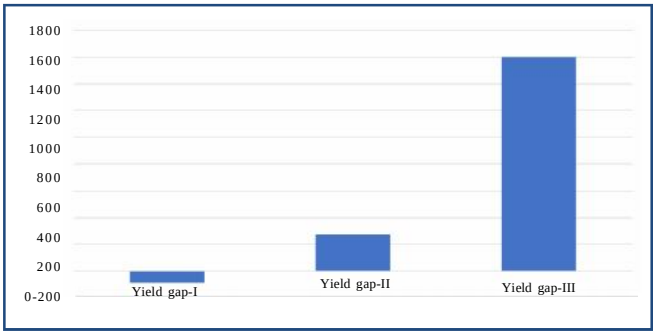

Fig. 2: Estimated yield gaps in maize

Estimated yield gap indices in maize:

Various yield gap indices in maize were worked out and the same are presented in Table 2. The index of yield gap was defined as the ratio of difference between the potential yield and the actual yield to the potential yield expressed in percentage. This ratio indicated the extent of unrealized yield potential. The data presented

Table 1: Different yield gaps of maize

Sr. No.	Research station yield (kg/ha)	FLD yield (kg/ha)	Yield gap – I (kg/ha)	Progressive farmers yield (kg/ha)	Yield gap – II (kg/ha)	Normal farmers yield (kg/ha)	Yield gap – III (kg/ha)
1.	6916	7000	-84 (-1.21%)	6725	275 (3.97%)	5400	1600 (23.13%)

Figures in the parenthesis indicate percentage to the potential farm yield

in the Table 2 indicated that the index of yield gap in maize was 21.92 per cent.

The index of realized potential yield was defined as the ratio of actual yield to the potential yield expressed in terms of percentage. The data presented in the table indicated that the index of realized potential yield gap in maize was 78.07 per cent.

The estimated index of realized potential farm yield was defined as the ratio of actual yield to potential farm yield expressed in terms of percentage. The indices of realized potential farm yield presented in table indicated that the farmers, in general, were successful in exploiting the potential farm yield of maize to the extent of only 77.14 per cent. The analysis indicated the existence of a considerable percentage of untapped potential farm yields in maize.

The primary emphasis was given to yield gap-III (represented by the difference between actual yield and potential farm yield) because this alone was expected to be amendable to policy influence. Physical and environmental factors responsible for yield gap-I were obviously difficult to change through policy measures.

From the results it was worth that only about 78 per cent of potential yield in maize was being exploited, leaving around 22 per cent of the potential yield untapped. This meant that the maize output could be increased by 22 per cent with effective transfer of the existing technology in maize crop to the farmers' fields.

The farmers were not in a position to exploit the maximum yield potential because of two reasons. One was environmental conditions under which the potential yield was determined were different from those prevailing on the farmers field and the second was, the difficulties in duplicating certain aspects of technology on the farmers' fields. However, it is realistic to compare the potential farm yield with the actual yield. The present study revealed that the farmers, in general, had succeeded in exploiting about 77.1 per cent of the potential farm yield. This revealed that the possibility of increasing maize output. If the technology know how available to the farmers were adopted properly and timely.

As indicated in the Table 3, the output elasticity co-efficient for progressive farmers indicated that total labour cost and plant protection chemicals cost was negatively significant which indicates that farmers were using more labour and insecticides and pesticides than recommended practices which had negative impact on yield. Whereas, seed cost, fertilizers cost, experience in farming and percentage area irrigated were positively significant to the total yield. The above results were in conformity to

Table 2 : Indices of yield gaps

Sr. No.	Yield gap indices	Percentage
1.	Index of yield gap (IYG)	21.92%
2.	Index of realized potential yield (IRPY) of progressive farmers	97.23%
3.	Index of realized potential yield (IRPY) of normal farmers	78.07%
4.	Index of realized potential farm yield (IRPFY) of progressive l farmers	96.07%
5.	Index of realized potential farm yield (IRPFY) of normal farmers	77.14%

Table 3 : Resource use efficiency in maize production at farmers level

Particulars	Regression co-efficients - Progressive farmers	Regression co-efficients - Progressive farmers normal farmers
No. of farmers	30	30
Intercept	7.6809	7.8751
Total labour cost	-0.083 (0.04504) ***	0.2058 (0.0868) *
Seed cost	0 .3125 (0.0305) *	-0.0673 (0.0881) NS
Fertilizer cost	0.1548 (0.0192) *	0.339753 (0.0634) *
PPC cost	-0.1499 (0.0161) *	-0.09243 (0.0521) ***
Experience in farming	0.1579 (0.01701) *	-0.12841 (0.0756) ***
% area irrigated	0.2872 (0.0609) *	-0.05528 (0.0796) NS
R^2	0.88	0.74

Figures in the parenthesis indicate the standard error of regression co-efficients
Note: *, ** and *** indicate significance of values at P=0.01, 0.05 and 0.1, respectively NS= Non-significant

Gaddi *et al*. (2002) revealed that short fall of labour was the greater portion of yield gap. Non-availability of labour and non-application of chemical fertilizers at the recommended level were the major constraints in cotton production.

Total labour cost and fertilizer cost were significant, and they have positive impact on the total yield to the normal farmers. Whereas plant protection chemicals cost (-0.09243) and experience in farming (-0.12841) were negatively significant which indicates that farmers applied more of chemicals resulted in negative returns and experience in farming also revealed negative results which clearly indicates that the farmers need to know the current information on newly introduced pests and diseases and they have to take initiative measures for controlling the same.

However, to reduce these yield gaps it is suggested that government and farmers should focus on yield gap – III by improving agronomic practices and increasing the input supply.

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