*Agricultural Economics Research Review*
Vol. 24 July-December 2011 pp 339-343

*Research Note*

# Yield Gap Analysis of Jowar in Maharashtra§

**A.V. Gavali, T.B. Deokate*, R.B. Choudhari and B.H. Kamble**

Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednager - 413 722, Maharashtra

**Abstract**

Jowar is the main cereal crop in Maharashtra occupying 4.176 M ha area out of which *rabi* jowar occupied maximum area of 3.112 M ha during the year 2009-10. The gradual growth in use of technology in agriculture has resulted in increased crop productivity. The actual yields obtained are considerably lower than those recorded in the demonstration plots and research stations/farms. Therefore, there is a need to know the different yield gaps between the farmers' fields and the demonstration plots. The study has suggested that to bridge this gap the use of recommended levels of input is most essential. The farmers should be motivated through visits to progressive farmers and organizations of field demonstrations, seminars and other communication means to use the recommended levels of inputs and improved variety of seeds to enhance the productivity of jowar in the state.

**Key words:** Yield gap, Jowar, Maharashtra

**JEL Classification:** Q12, Q16

## Introduction

The commonly grown cereals in state of Maharashtra are jowar (*kharif* and *rabi*), paddy, wheat, bajra and maize. Jowar is the main cereal crop in the state occupying 4.176 million hectares area out of which *rabi* jowar occupied maximum area of 3.112 M ha during the year 2009-10. Although growth in use of technology in agriculture has resulted in increased crop productivity, even then the actual yields obtained are considerably lower than those recorded in the demonstration plots and research stations/farms. Therefore, there is need to know the different yield gaps between the farmers' fields and the demonstration plots. To analyse the fact empirically the present study on yield gap analysis of jowar has been undertaken in different regions of the state with following specific objectives :

- To examine the input use and output levels of jowar in Maharashtra,
- To estimate the gap in the levels of inputs-use and output of jowar, and
- To identify the factors contributing to yield gap.

## Data and Methodology

The study is based on the primary data collected during the year 2009-10 from 237 farm families (*kharif* jowar: 118 and *rabi* jowar:119) selected under the Comprehensive Scheme for Studying the Cost of Cultivation of Principal Crops from Western Maharashtra, Marathwada and Vidarbha regions of the state.The differentials between the recommended and actual use levels of important inputs like seed, manure and fertilizers have been estimated. The two yield gaps have been calculated on the basis of per hectare potential yield, potential farm yield and actual yield obtained using simple statistical tools.

To estimate the direct and indirect contribution of input gaps ($X_i$s) to yield gap (Y), a path co-efficient

* Author for correspondence,
Email: drdeokatempkv@rediffmail.com

§ This paper is part of the Comprehensive Scheme undertaken during 2009-10

analysis was carried out. A path co-efficient is the ratio of standard deviation of the effect (Y) due to a given cause ($X_i$) to the total standard deviation of the effect or it is a standardized partial regression co-efficient. In the present analysis six variables, viz. the total yield gap (potential yield-actual yield) [dependent variable (Y)], the difference in the per hectare use of seeds (kg), manures (q), nitrogen (kg), phosphorus (kg) and potash (kg) between the farmers field and recommended levels [independent variables ($X_i$s)] were used. The path co-efficient for each selected crop was calculated at overall level by solving the following generalized equation expressing the basic relationship between the correlation co-efficient ($r_{ji}$) and the path co-efficient ($P_{yi}$).

The generalized formula may be written as

$$r_{yi} = r_{1i}P_{y1} + r_{2i}P_{y2} + r_{3i}P_{y3} + \ldots\ldots + r_{ni}P_{yn} \quad \ldots(1)$$

where,

i = ( 1 to 5) is the correlated cause and 'y' is the effect

$$P_{yi} = b_i \frac{\sigma_i}{\sigma_y} \quad \ldots(2)$$

These direct and indirect effects of independent variable included in path analysis were obtained by constructing correlation coefficient ($r_{ji}$) matrix, flow chart of the direct and indirect effects and $R^2$ per cent matrices.

## Results and Discussion

### Resource-use

The average per hectare resources used and yield obtained for *kharif* and *rabi* jowar in different regions of the state are depicted in Table 1.

***Kharif* Jowar —** The use of human as well as bullock labour was a observed to be maximum in the Vidharbha region, followed by Marathwada region and Western Maharashtra. The use of machine labour was maximum (9.62 hours/ ha.) in Western Maharashtra region and the lowest in Marathwada region (6.41 hours/ ha). The use of seed ranged from 9.47 kg/ha in Western Maharashtra to 10.83 kg/ha in Vidharbha region with an average of 10.13 kg seed /ha at the state level. The use of manures was maximum (2.68 q/ha) in the Vidharbha region; it was 5.35 q/ha at the state level. The productivity (19.69 q/ha) was observed highest in Vidharbha region, followed by Western Maharashtra and Marathwada regions. The average productivity at the state level was worked out to be 17.31q/ha.

***Rabi* Jowar —** The use of human, bullock and machine labour was maximum in Marathwada region, followed by Western Maharashtra and Vidharbha regions. The use of manures was not observed the *rabi* jowar, except a negligible amount in Western Maharashtra. The productivity was observed highest in Marathwada region, followed by Western Maharashtra and

**Table 1. Resource-use pattern of *kharif* and *rabi* jowar in Maharashtra**

(per ha)

| Region | Human labour (human-days) | Bullock labour (pair-days) | Machine labour (hours) | Seed (kg) | Manure (q) | N (kg) | P (kg) | K (kg) | Productivity (q) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | ***Kharif* jowar** | | | | | |
| Western Maharashtra | 62.41 | 5.34 | 9.62 | 9.47 | 9.66 | 63.13 | 30.99 | 8.92 | 18.54 |
| Marathwada | 74.58 | 11.39 | 6.41 | 10.70 | 4.92 | 49.59 | 42.31 | 13.66 | 13.38 |
| Vidarbha | 81.89 | 13.71 | 9.61 | 10.83 | 2.68 | 67.87 | 32.59 | 3.30 | 19.69 |
| Maharashtra | 74.08 | 10.62 | 8.57 | 10.41 | 5.35 | 60.59 | 35.32 | 8.24 | 17.31 |
| | | | | ***Rabi* jowar** | | | | | |
| Western Maharashtra | 70.38 | 6.20 | 5.35 | 11.15 | 0.09 | 27.56 | 16.97 | 3.03 | 9.78 |
| Marathwada | 71.67 | 6.99 | 7.37 | 11.98 | 0.00 | 8.96 | 12.74 | 5.05 | 11.86 |
| Vidarbha | 54.25 | 0.25 | 1.00 | 10.83 | 0.00 | 0.00 | 0.00 | 0.00 | 4.00 |
| Maharashtra | 70.89 | 6.54 | 5.13 | 11.47 | 0.05 | 18.34 | 14.79 | 3.99 | 10.74 |

**Table 2. Input use gap of *kharif* jowar and *rabi* jowar in Maharashtra**

| Crop | Regions | Seed (kg) | Manure (q) | Fertilizers | | |
|---|---|---|---|---|---|---|
| | | | | N (kg) | P (kg) | K (kg) |
| *Kharif* jowar | Western Maharashtra | 0.53 | 22.84 | 36.87 | 19.01 | 41.08 |
| | Per cent | 5.30 | 70.28 | 36.87 | 38.02 | 82.16 |
| | Marathwada | -3.20 | 22.58 | 30.41 | -2.31 | 26.34 |
| | Per cent | -42.67 | 82.11 | 38.01 | -5.78 | 65.85 |
| | Vidarbha | -2.08 | 34.82 | 12.13 | 7.41 | 36.70 |
| | Per cent | -23.77 | 92.85 | 15.16 | 18.53 | 91.75 |
| Rabi *jowar* | Western Maharashtra | -1.15 | 32.41 | 32.44 | 13.03 | 0.00 |
| | Per cent | -11.50 | 99.72 | 54.07 | 43.43 | 0.00 |
| | Marathwada | -1.98 | 27.50 | 71.04 | 27.26 | 34.95 |
| | Per cent | -19.80 | 100 | 88.80 | 68.15 | 87.38 |
| | Vidarbha | -2.08 | 37.50 | 80.00 | 40.00 | 40.00 |
| | Per cent | 23.77 | 100 | 100 | 100 | 100 |

*Note:* Minus sign indicates excessive use of inputs

Vidharbha regions with an average of 10.74 q /ha at the state level.

## Input-Use Gap

The gap between recommended and actual use levels of major inputs) for *kharif* and *rabi* jowar in different regions of the state is depicted in Table 2.

***Kharif* Jowar —** There was an excess use of seed in Marathwada and Vidharbha regions, while there was 5.30 per cent use gap in Western Maharashtra. The excess use was due to lower rate of germination and hard soils. In the case of manure, the gap in recommended and actual use levels was maximum in Vidharbha (92.85%), followed by Marathwada (82.11 %) and Western Maharashtra (70.28 %) regions. The gap in nitrogen-use ranged from 15.16 per cent (Vidharbha) to 38.01 per cent (Marathwada). The gap in use of phosphorus ranged from 18.53 per cent in Vidharbha to 38.02 per cent in Western Maharashtra, while its excessive use (5.78 %) was observed in Marathwada region. The use of potash ranged from 65.85 per cent in Marathwada to to 91.75 per cent in Vidharbha region.

***Rabi* Jowar —** In *rabi* jowar, excessive use of seed was observed in all the three region. In the case of manures, the gap in recommended and actual use levels was very high in the entire regions, 100 per cent in Marathwada and Vidharbha regions and 99.72 per cent in Western Maharashtra. The gap in nitrogen-use was observed 54.07 per cent in Western Maharashtra and 88.80 per cent in Marathwada region. The gap in phosphorus-use was 43.43 per cent in Western Maharashtra and 68.15 per cent in Marathwada. The use of potash is not recommended for Western Maharashtra, but farmers had used it and for Marathwada region gap of 87.38 per cent was observed.

## Yield Gaps

The information on yield performance of jowar in the three selected regions of the state is presented in Table 3.

In the case of *kharif* jowar, the total yield gap was noticed maximum in Marathwada (65.70 %), followed by Western Maharashtra (58.8 %) and Vidarbha (50.80 %). The per hectare yield gap-I for *kharif* jowar was maximum in Vidarbha region (43.80 %), while yield gap-II was maximum in Marathwada region (26 %).

The total yield difference in *rabi* jowar was observed to be 63.59 per cent at the state level comparing yield gap-I of 50.17 per cent and yield gap-II of 13.42 per cent. The regionwise analysis shows that the gap in yield was highest in Vidharbha (86.70 %), followed by Western Maharashtra (75.30 %) and Marathwada (37.60 %). Among the regions, the yield gap-I and yield gap-II were maximum in Vidarbha (60.00 %) and (26.70 %).

**Table 3. Estimated yield gap in *kharif* jowar and *rabi* jowar in Maharashtra**

| Regions | *Kharif* jowar | | | | | | *Rabi* jowar | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Potential yield | Farm yield | Actual yield | Yield gap-I | Yield gap-II | Total yield gap | Potential yield | Farm yield | Actual yield | Yield gap-I | Yield gap-II | Total yield gap |
| Western Maharashtra | 45.00 | 27.5 | 18.54 | 17.50 (38.89) | 8.96 (19.91) | 26.46 (58.50) | 39.55 | 18.10 | 9.78 | 21.45 (54.24) | 8.32 (21.04) | 29.77 (75.27) |
| Marathwada | 39.00 | 23.5 | 13.38 | 15.50 (39.74) | 10.12 (25.94) | 25.62 (65.70) | 19.00 | 16.50 | 11.86 | 2.50 (13.16) | 4.46 (24.42) | 7.14 (37.58) |
| Vidarbha | 40.00 | 22.50 | 19.69 | 17.50 (43.75) | 2.81 (7.03) | 20.31 (50.80) | 30.00 | 12.00 | 4.00 | 18.00 (60.00) | 8.00 (26.67) | 26.00 (86.67) |
| Maharashtra | 41.33 | 24.50 | 17.31 | 16.83 (40.72) | 7.19 (17.40) | 24.02 (58.12) | 29.50 | 14.70 | 10.74 | 14.80 (50.17) | 3.96 (13.42) | 18.76 (63.60) |

*Note:* Figures within the parentheses indicate percentages to the total

**Table 4. Direct and indirect effects of input use on yield gap of *kharif* and *rabi* jowar**

| Particulars | *Kharif* jowar | | | *Rabi* jowar | | |
|---|---|---|---|---|---|---|
| | Effect | | | Effect | | |
| | Direct | Indirect | Overall | Direct | Indirect | Overall |
| Seed | -0.2568 | -0.0287 | -0.2855 | -0.0275 | 0.1537 | 0.1263 |
| Manure | 0.0223 | -0.0426 | -0.0203 | 0.3192 | 0.0596 | 0.3788 |
| Nitrogne | 0.3882 | -0.0544 | 0.3338 | 0.1461 | -0.2326 | -0.0864 |
| Phosphorus | -0.1144 | 0.0529 | -0.0615 | -0.0218 | 0.1943 | 0.1724 |
| Potash | -0.2253 | 0.0041 | -0.2212 | -0.2690 | -0.0495 | -0.3185 |
| Residual effect | | 0.7394 | | | 0.8133 | |

## Path Co-efficient Analysis

The direct and indirect effects measured both in terms of input-use gaps and percentages are presented in Table 4. The yield gap was the result of gap in quantity of inputs used and composite variable that included all other factors affecting yield gap. These may be due to the change in climatic conditions and various cultural and crop management practices. The unexplained residual variance not accounted by five explanatory variables under condition worked out to be 0.73 per cent for *kharif* jowar and 0.81 per cent for *rabi* jowar. The results from correlation coefficient between the yield gap and input-use gap revealed that the sum of total effect of selected variables showed the consolidated total effect of seed, manure and N, P, and K fertilizer ingredients. The overall total effect in the case of *rabi* jowar was highest, viz. 0.27, of which 53.95 per cent was direct effect and 46.05 per cent was indirect effect the all inputs.

## Conclusions

The study has revealed that in *kharif* jowar there existed a yield gap of 58.12 per cent at the state level of which 40.72 per cent was yield gap-I and 17.40 per cent was yield gap-II (potential farm yield — actual farm yield).The maximum total yield gap (65.69 %) has been noticed in Marathwada, followed by Western Maharashtra and Vidarbha regions. The per hectare yield gap-I for *kharif* jowar has been observed maximum in the Vidarbha region, while yield gap-II is maximum in the Marathwada region (26 %).

The total yield difference in *rabi* jowar has been observed to be 63.59 per cent at the state level of which per hectare yield gap-I is 50.17 per cent and yield gap-II is 13.42 per cent. The regionwise analysis has shown that the highest gap in yield is in Vidharbha, followed by Western Maharashtra and Marathwada regions. Among the regions, the yield gap-I and yield gap-II were maximum in Vidarbha (60.00 %) and (26.70 %), respectively.

The coefficient of path analysis has shown that the total effect of seed, manure and N, P, K fertilizers on yield gap for *rabi* jowar is highest (0.2726) and positive at the state level.

The study has suggested that to bridge this gap the use of recommended levels of input is most essential. The farmers should be motivated through visits to progressive farmers and farmer's rallies, seminars and other communication means to use recommended levels of inputs and improved variety of seeds in order to enhance the productivity of jowar in the state.

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Received: May 2011; Accepted: June 2011