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Determinants of productivity of mustard in gird agro-climatic region of Madhya Pradesh: A micro level analysis

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Abstract
The productivity of mustard was found to be 1538 kg/ha in Madhya Pradesh whereas, it was 1705 kg per hectare in the region it was highest in Sheopur (2175 kg/ha) followed by Morena (2090 kg/ha), Guna (1989 kg/ha), Gwalior (1583 kg/ha), Ashok Nagar (1507 kg/ha), Bhind (1477 kg/ha) and Shivpuri (1029 kg/ha) in the year 2021-22. The total gap in yield was found to be 3.38 q/ha (19.30%) in cultivation of mustard and the size of farm increase it was found to be decreases from 20.74 (small) to 14.69% (large) percent. There were found many facts which influenced yield of mustard and if all things remain constant and at the present level of technological adoption an increase of ₹ 1.00 on fertilizers, seed, seed treatment, human labour and machine labour, irrigation and PPC be able to increase of 0.125, 0.05, 1.54 and 1.354, 0.138 q/ha yield of mustard in the area under study, if all things remain constant.

Keywords: Determinants, productivity, mustard

Introduction
Oilseed crops occupy a remarkable place in the Indian economy, next to food grains. Rapeseed-mustard is an important oilseed grown in the world after soybean (*Glycine max*) and palm (*Elaeis guineensis* Jacq.) oil. The rapeseed-mustard was found to be grown in 36.65 mha of area and produced 72.42 million ton of production at 1974 kg/ha of productivity in the world (2017-18). Globally, India accounts for 19.8% of the total acreage and 9.7% of production of rapeseed & mustard (Shivran *et al*. 2020) [4]. India has to resort to import of edible oils, due to the gap between availability and actual consumption of edible oils. Rapeseed-mustard is the major source of income of farmers even to the marginal and small farmers in rain-fed areas (Jatav *et al.,* 2020) [1]. Mustard occupying more than 80% of the total rapeseed-mustard cultivated area of the country. Madhya Pradesh, Rajasthan, Gujarat, Maharashtra, Karnataka and Andhra Pradesh are plays significant role in production of mustard. Northern Madhya Pradesh comprising Morena, Bhind, Gwalior, Sheopur and Datia districts contributing more than 80% share in the production of mustard in the state (Kirar *et al.,* 2018) [2]. The mustard was found to be cultivated in 675.079 -thousand-hectare area whereas, Gird agro-climatic region occupied highest area (73.87%) under mustard in Madhya Pradesh during the year, 2021-22. The productivity of mustard was found to be 1538 kg/ha in Madhya Pradesh whereas, it was 1705 kg per hectare in the region it was highest in Sheopur (2175 kg/ha) followed by Morena (2090 kg/ha), Guna (1989 kg/ha), Gwalior (1583 kg/ha), Ashok Nagar (1507 kg/ha), Bhind (1477 kg/ha) and Shivpuri (1029 kg/ha) in the year 2021-22.

The Yield refers to the production per unit area. The yield gap was attributable to the inability of the farmer to apply recommended level of inputs at their field. The yield gap is the difference between the potential and average farm yield of any crop. The adoption of agricultural technologies differs from farmer to farmer, referring to both mental acceptance and also the use of improved recommended package of practices in field. This can be achieved by using high yielding verities and recommended package of practices of crop cultivation management practices (Sharma *et al.,* 2022) [5]. Assessing, the yield gaps can help to understand productivity variability and its potential, with input use efficiency. It may also indicate appropriate pathways for improving agricultural efficiencies and farm income (Niranjan *et al*., 2019) [3].

Yield gap is always a matter of prime concern for researcher and developmental stakeholders to ensure real potential of crop harvested at the cultivator's field. Keeping all these matter in mind the present study has been carried out to analyse yield gap across size of farms and find out determinants of productivity of mustard in Gird Agro-Climatic Region of Madhya Pradesh.

Material and Methods

Gird agro-Climatic Region of Madhya Pradesh have been taken into consideration for the study. The Gird agro-climatic region comprises seven districts namely Sheopur, Morena, Bhind, Gwalior, Shivpuri, Guna and Ashoknagar. Out of seven districts, Bhind district was selected on basis of maximum area of Mustard**.** There are six blocks/tehsil in Bhind district namely Bhind, Ater, Mehgaon, Gouhad, Roun and Lahar, out of which four blocks were selected having maximum area under mustard. A list of all the villages in each selected block was prepared and one village was selected randomly for the study. Further, a list of all the mustard growers with their size of farms were prepared and classified into small (< 2 ha), medium (2-5ha) and large (> 5ha) size of farms and 10% of mustard growers were selected through proportionate random sampling method for the study. Therefore 121, 79 and 40 mustard growers were selected from small, medium and large category for the study, constituting total size of sample was of 240 Mustard grower from 4 villages, 4 blocks of Bhind district in Gird Agro-climatic Region of Madhya Pradesh.

The present data were collected through personal interaction by pretested interview schedule and hence to the study year 2021-22. Tabulation and analysis of data were carried out to drown conclusion. The yield gaps of mustard were analysed through following equations.

Yield gap-I: It is the difference between the potential farm yield (Yp) &the highest farm yield (Yh) this yield gap exist due to difference in soil & climatic condition and non-transfer of recommended technologies to the farmer's field

$$\text{Yield Gap} - \text{I} = \frac{\text{Yp} - \text{Yh}}{\text{Yp}} \times 100$$

Yield gap-II: It is the different between the highest farm yield (Yh) & average farm yield (Ya). Yield gap- II, denotes about socio-economic and technological constraints exist in the area.

$$\text{Yield Gap} - \text{II} = \frac{\text{Yh} - \text{Ya}}{\text{Yh}} \times 100$$

Yield gap- III: It is the difference between the potential farm yield (Yp) & the average farm yield (Ya). Yield gap-III exists due to difference in soil climate condition, non-transfer of recommended technologies in cultivation of crops and various socio-economic constraints exist in the area.

$$\text{Yield Gap} - \text{III} = \frac{\text{Yp} - \text{Ya}}{\text{Yp}} \times 100$$

Where:
Yp= Potential farm yield,
Yh= Highest farm yield
Ya= Average farm yield

The Determinants of yield of mustard was analyse through following multivariate regression model

$$Y= a+b_1X_1+b_2X_2+b_3X_3+b_4X_4+b_5X_5+b_6X_6+b_7X_7+E$$

Where,
Y= Productivity of mustard (kg/ha)
X_1= Seed Value (₹ /ha)
X_2= Seed treatment (₹ /kg)
X_3= Fertilizers (₹ /ha)
X_4= No. of Irrigation (₹ /ha)
X_5= Plant protection chemical (₹ /ha)
X_6= Hours of Human labour (₹ /ha)
X_7= Hours of Machinery (₹ /hr)
$b_1$to b_7 = regression coefficient of X_1, X_2……X_7
E= Error term

Results and Discussions

The yield gap and factors affecting productivity of mustard in gird agro-climatic region of Madhya Pradesh were analyzed for the study.

Yield Gap

The difference/gap of yield between potential yield & highest yield, highest yield & average yield and potential yield & average yield was analysed and presented in table 1. The potential yield of mustard (17.50 q/ha) was found to be more followed by highest 15.82 q/ha and average farmer yield (14.12 q/ha) of mustard. The Yield Gap-I between potential yield & highest was found to be reported 1.68 q/ha (9.59%) in cultivation of mustard. As per size of farm increase yield gap -I was found to be decreases from 10.69 (small) to 5.83% (large) size of farm.

Table 1: Yield Gap analysis of Mustard across size of farm (q ha^{-1})

S. No.	Particulars	Small	Medium	Large	Overall
1	Potential yield	17.50	17.50	17.50	17.50
2	Highest yield	15.63	15.78	16.48	15.82
3	Average yield	13.87	14.10	14.93	14.12
4	Yield Gap-I (1-2)	1.87 (10.69)	1.72 (9.83)	1.02 (5.83)	1.68 (9.59)
5	Yield Gap-II (2-3)	1.76 (11.26)	1.68 (10.65)	1.55 (9.41)	1.70 (10.74)
6	Yield Gap-III (1-3)	3.63 (20.74)	3.4 (19.43)	2.57 (14.69)	3.38 (19.30)

Figure in parenthesis show percent yield gap

The Yield Gap-II between maximum & average yield was found to be reported 1.70 q/ha (10.74%) in cultivation of mustard and as size of farm increase yield gap -II was found to be decreases from 11.26 (small) to 9.41% (large) size of farm. The Yield Gap-III between potential & average yield was found to be reported 3.38 q/ha (19.30%) in cultivation of mustard. As the size of farm increase yield gap -III was found to be declines from 20.74 small to 14.69% large size of farm (Fig.1).

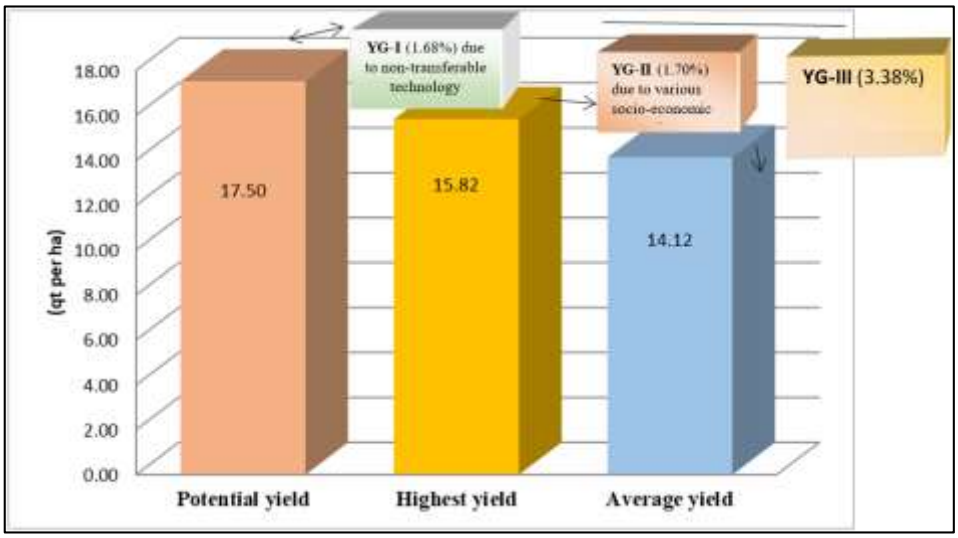

Fig 1: Yield Gap in Mustard production across size of farm

Determinants of productivity of Mustard

The yield of mustard was found to be determined by seed value (X_1), seed treatment (X_2), Fertilizers (X_3), irrigation (X_4), Plant protection chemical (X_5), Human labour (X_6) and machine labours (X_7). A multiple regression model was used to analysed factor affecting the productivity of mustard in the area under study (Table 2). It was observed from data that expenditure on fertilizers, human labour and machine labour found to be gave positively and response to producers of mustard highly significant. while expenditure on seed, seed treatment and plant chemical were found to be gave positive and significant response over productivity of mustard. This indicates that if all things remain constant and with the present level of technological adoption an increase of ₹ 1.00 on fertilizers, seed, seed treatment, human labour and machine labour, irrigation and PPC be able to increase of 0.125, 0.05, 1.54 and 1.354, 0.138 q/ha yield of mustard in the area under study.

Table 2: Determinants of productivity of Mustard of overall

Particulars	Regression (b- value)	P-value
Seed value (X_1)	0.046**	0.05
Seed treatment (X_2)	0.051**	0.05
Fertilizers(X_3)	0.125***	0.01
Irrigation(X_4)	0.046*	0.06
PPC(X_5)	0.054*	0.08
Human labour(X_6)	1.354***	0.00
Machine labour(X_7))	0.138***	0.00
Coefficient of multi regression (R^2)	0.98	

***, **, * denotes Significant at 1, 5 and 10 percent productivity level respectively.

The multiple regression model was found to be good fit as it explained 98.00 percent (R^2 0.98) of productivity of Mustard determinants by these known independent variables and rest i.e., only 2.0 percent was the contribution of unknown variables which were not taken into consideration in this regression model (Table *2*).

Hence, it can be concluded that a total yield gap of 3.38 q/ha (Yield Gap-III) in cultivation of mustard in which the yield gap of 1.68 q/ha (Yield Gap-I) was due to non-transfer of extension technology in farmers field and 1.70 q/ha (Yield Gap-II) was found due to various socio-economic constraints presented in the adoption of production technique of mustard in the area under study.

If all things remain constant and with the present level of technological adoption an increase of ₹ 1.00 on fertilizers, seed, seed treatment, human labour and machine labour, irrigation and PPC be able to increase of 0.125, 0.05, 1.54 and 1.354, 0.138 q/ha yield of mustard in the area under study.

Therefore, it can be suggested that efforts should be made to transfer recommended package of practices of mustard in farmers field with good quality high yielding & latest variety of mustard and timely supply of inputs fertilizers. The knowledge recommended quantity of seed treatment materials, weedicides, insecticides, fertilizers and irrigation should also be made available to mustard growers in time. Demonstration of newly released variety and package of practices of mustard should be demonstrated in farmers' field.

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