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Feasibility and Growth Dynamics of Mustard Farming in Uttar Pradesh and Bundelkhand Region of U.P. India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Bundelkhand is a region of central India lying in Uttar Pradesh and Madhya Pradesh. It is one of the least socio-economically developed regions of the country mainly due to regular incidence of drought and erratic rainfall. Mustard is one of the most important oilseed crop of rabi season for Bundelkhand region on the basis of area under the crop. With the limited resources, there has been a noticeable change in the area, production and productivity of mustard. Apart from edible oil, it also has industrial use in producing items like varnishes, soaps, paints, hydrogenated oil, perfumery, lubricants, etc. The study is an attempt to examine the pattern of growth, instability, cost and return of production of mustard crops at state (Uttar Pradesh) and regional (Bundelkhand region of Uttar Pradesh) level. Study is based on secondary data obtained from various published sources.

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Compound Annual Growth Rate, coefficient of variation, Commission for Agricultural Costs & Prices (CACP) cost concept and returns were used as analytical tools to assess the financial suitability and performance of the crop in both the Uttar Pradesh and Bundelkhand region. It was observed that the growth in area (2.94%) and production (4.36%) of mustard crop in Bundelkhand region was increasing at a higher rate as that of Uttar Pradesh. Higher net return was earned by the farmer growing mustard in Uttar Pradesh than the farmer of Bundelkhand region.

Keywords: Coefficient of variation; CACP; mustard; instability; Bundelkhand; rural income.

1. INTRODUCTION

Bundelkhand is a geographical and cultural region, divided between the states of Uttar Pradesh and Madhya Pradesh. The area is spread over 7 districts of Uttar Pradesh and 6 districts of Madhya Pradesh. Bundelkhand region of Uttar Pradesh comprises of seven districts namely Chitrakoot, Banda, Jhansi, Jalaun, Hamirpur, Mahoba, and Lalitpur. Agriculture is the predominant occupation in the region [1]. Bundelkhand is one of the least socio-economically developed regions in India. Large part of population is dependent on agriculture and livestock for their livelihood. There is a high incidence of poverty (30-55% in different districts), low literacy rate (57% overall, 43% in women) and highly vulnerable women and landless people [2,3]. Mean annual rainfall in the region is 750 mm and unevenly distributed throughout the year [4,5,6]. The wet season (called kharif) between July and September has 85% of the annual rainfall and the remaining 15% is distributed throughout the remaining nine months [7]. Since crop production, livestock rearing and seasonal out-migration provide more than 90% of the rural income in Bundelkhand region [8], the effect of recurrent drought on this region is palpably devastating. Increasing demands on natural resources and harsh and worsening bio-physical conditions, combined with more frequent drought caused by climate change, further exacerbate the region's vulnerability. Thus, the need for inclusive growth comes in the picture of economic and social development of the region [9].

Rapeseed-mustard (*Brassica* species) is the third most important oilseed crop after soybean and groundnut, contributing nearly 20-25% of the total oilseed production in the country [10]. India ranks third among rapeseed mustard producing countries producing about 11% of the total world's production. Also, it is the third largest producer of rapeseed mustard oil in the world [11]. Rajasthan is the leading rapeseed mustard producing State in India while the Uttar Pradesh ranked at the second ranked. Rajasthan and Uttar Pradesh together account for over 50% of the total rapeseed mustard production [12].

Mustard is one of the most important crop of rabi season for Bundelkhand region on the basis of area under the crop. With the limited resources, there has been a noticeable change in the area, production and productivity of mustard. Seven districts of Bundelkhand region of Uttar Pradesh produce greater proportion of mustard of Uttar Pradesh. Hamirpur has the most cultivated area (16062 ha.) and followed by Jalaun (11371 ha.). Mustard production was highest in Jalaun (19441 MT) followed by Hamirpur (17217 MT) among seven districts of Bundelkhand region or Uttar Pradesh. In terms of yield, Jalaun (1231 Kg per Ha) ranks first, Hamirpur (1007 Kg per Ha) as second and Banda (1000 Kg per Ha) is third (Fig. 1) [13].

Mustard oil an important oilseed crop and a major component of the food basket. Apart from food, it is also the major source of employment in India [14,15]. Mustard is a major Rabi oilseed crops of India. Its seeds are known by different names in different places for example: sarson, rai or raya, toria or lahi. While sarson and lahi are generally termed as rapeseed, rai or raya or laha is termed as mustard [16]. They occupy an important position next to groundnut both in area and production. It fulfills the nutrient requirement of major portion of population in the state of Madhya Pradesh, Bihar, Orissa, Uttar Pradesh, Punjab, Rajasthan, West Bengal and Assam [17]. The seeds and oils are used as a condiment in the preparation of pickles and for giving flavours to curries and vegetables. The oil cake is most commonly used as a cattle feed. The leaves of young plants are used a green vegetable [18]. The use of mustard oil for industrial purposes is quiet restricted because of its relatively high cost. Oilseeds provide easily available and highly nutritious food to human beings and animals. Oilseeds consist of high quality proteins which are beneficial to human health and wellbeing. Oils extracted from

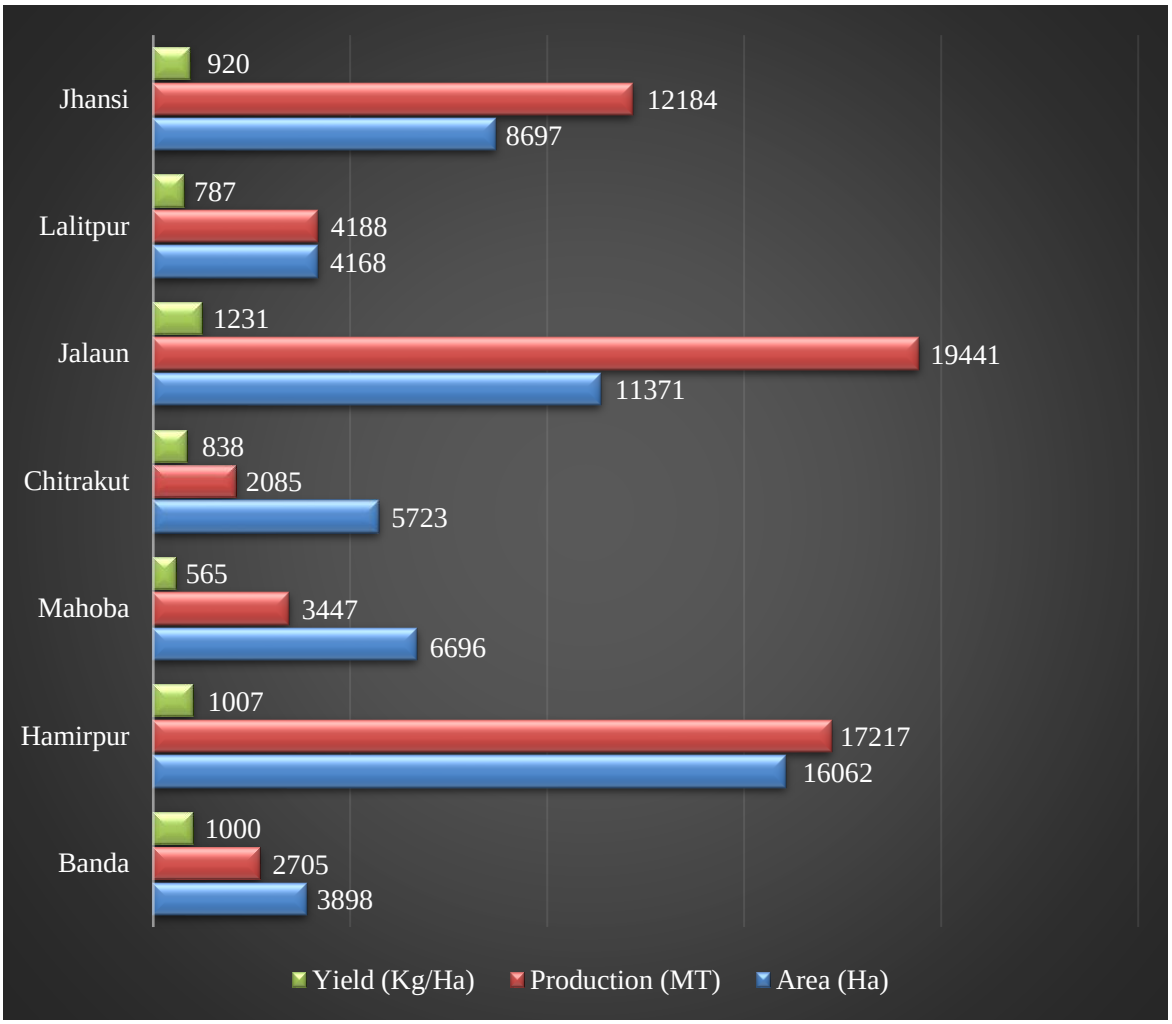

Fig. 1. Area, production and yield of mustard in seven districts of Bundelkhand (U. P.)

oilseeds are consumed as edible oil and the rest are used as raw materials for manufacturing large number of items like varnishes, soaps, paints, hydrogenated oil, perfumery, lubricants, etc. Mustard also acts as a very important flora for honeybees for nectar and pollen collection in Bundelkhand region [19].

Considering the importance and uses of the crop in the region, present study was undertaken to analyze and compare the growth and instability in area, production and productivity of mustard crop in Bundelkhand region and Uttar Pradesh. To get a better view of financial feasibility of the crop for a farmer under current package of practices, cost of cultivation and returns was worked out for whole of Uttar Pradesh.

2. MATERIALS AND METHODS

The study was based on secondary data obtained from different sources viz., Food and Agriculture Organization, Directorate of Economics and Statistics, Department of Economics and Statistics, Government of Uttar Pradesh. Time series data of area, production and productivity from 1981-82 to 2019-20 (Overall study period) was used. It was further divided into three sub periods viz., First (1981-82 to 1993-94), Second (1994-95 to 2006- 07) and Third (2007-08 to 2019- 20). Plot level summary data was used to estimate the costs and returns in mustard cultivation.

Compound annual growth rate was used to analyze and compare the trends in area, production and productivity of mustard crop among Bundelkhand region and Uttar Pradesh using time series data. Coefficient of variation was calculated to measure and compare the instability in area, production and productivity of mustard crop in Bundelkhand region and Uttar Pradesh. To estimate the costs and returns of

mustard crop, cost concepts recommended by Commission on Agricultural Costs and Prices was used. Benefit cost analysis was used to determine the returns per unit cost.

3. RESULTS AND DISCUSSION

3.1 Growth Analysis

Growth in area, production and productivity of mustard crop was analyzed. It was found that area under mustard in Uttar Pradesh was increasing from 1981 to 2020 at the rate of 0.73% per annum. During the same period, production was increasing at the rate of 2.49% per annum while productivity also increased with positive growth rate of 1.75% (Table 1).

A decline in area was observed in Uttar Pradesh during second sub period at a rate of 2.76% per annum. Although productivity of mustard crop was increasing at the rate of 1.27% per annum but the decline in area was much greater than the increase in productivity. Net effect was the decrease in production in second sub period (Table 1).

It was evident from the result that area and productivity showed a positive growth in first (1981 to 1994) and third sub period (2007 to 2020). Since, area and productivity were increasing with increasing rate, hence, production also showed a positive growth during the same study periods (9.99% and 3.05%) (Table 1).

In Bundelkhand region, area, production and productivity was increasing in the overall study period (1981 to 2020) at the rate of 2.94%, 4.36% and 1.38% per annum, respectively. However, area was decreasing in second sub period. But, the increase in productivity (1.92%) was sufficiently high to support the increase in production (Table 2).

A positive growth was observed in first (1981 to 1994) and third sub period (2007 to 2020) in area (3.04% and 7.81%) and productivity (2.73% and 2.39%). This resulted in increase in production at an increasing rate (5.85% and 10.38%) during first and third sub period (Table 2).

From Table 1 and Table 2, it can be seen that during 1981 to 2020, area and production of mustard crop in Bundelkhand region was increasing at a higher rate as compared to that of Uttar Pradesh. This is also due to the fact that mustard is a major oilseed crop of Bundelkhand region due to its agro-climatic conditions. Although, mustard is also one of the main oilseed crops of Uttar Pradesh but its agro climatic conditions is favorable for a large variety of crops for the same season.

3.2 Instability Analysis

Instability in area, production and productivity of mustard crop was analysed using Coefficient of Variation (CV). In Uttar Pradesh, variation in area was highest in first sub period (24%) followed by second (15%) and third (9%) sub period (Table 3).

In case of production in Uttar Pradesh, high variability was observed in first (40%) sub period followed by third (23%) and second (20%) sub period. Similar trend was observed in productivity where first (19%) sub period saw high fluctuation as compared to third (15%) and second (14%) sub period (Table 3).

Table 1. Growth rate of area, production and productivity under mustard crop in Uttar Pradesh

Particulars	Sub periods of study			Overall study period
	First	Second	Third	
Area	5.85	-2.76	1.78	0.73
Production	9.99	-1.53	3.05	2.49
Productivity	3.91	1.27	1.23	1.75

Table 2. Growth rate of area, production and productivity under mustard crop in Bundelkhand region

Particulars	Sub periods of study			Overall study period
	First	Second	Third	
Area	3.04	-1.75	7.81	2.94
Production	5.85	0.12	10.38	4.36
Productivity	2.73	1.92	2.39	1.38

Table 3. Instability in area, production and productivity of mustard in Uttar Pradesh

Particulars	Sub periods of study			Overall study period
	First	Second	Third	
Area	24	15	9	17.3
Production	40	20	23	33.6
Productivity	19	14	15	23.6

Table 4 shows the variation in area, production and productivity of mustard crop in Bundelkhand region. Significantly high variability was observed in production (78%) and area (47.3%) during the overall study period (1981 to 2020).

Among the sub periods, highest fluctuation in production was observed in third (53.4%) and first (43.2%) sub period. Similarly, variability was high in productivity in first (30.8%) sub period followed by third (29.4%) and second (20.8%) sub period.

Instability analysis showed that the variation in area, production and productivity in Bundelkhand region of Uttar Pradesh was much higher as compared to that of Uttar Pradesh. It might be attributed due to the agro-climatic situation of the Bundelkhand region where there is erratic rainfall, high temperature, long dry spells, variation in temperature, etc.

3.3 Costs and Returns in the Cultivation of Mustard Crop in Uttar Pradesh

3.3.1 Cost of cultivation

As per the cost concept suggested by Commission for Agricultural Costs & Prices, Cost A1, A2, B1, B2, C1, C2 and C3 was calculated. In Uttar Pradesh, Cost of cultivation (Cost C3) was estimated to be Rs. 51,695 per hectare. Cost A1 which includes the cost of inputs directly involved in the mustard cultivation was Rs. 24,419.82 per hectare. Cost B1 was Rs. 26,576.42; Cost B2 was estimated to be Rs. 41,973.27. Similarly, Cost C1 was calculated to be Rs. 31598.61. Cost A1 and Cost A2 are not equal because, farming was done on leased in land by the farmers in the Uttar Pradesh (Table 5).

In Bundelkhand region, cost of cultivation (Cost C3) amounted to Rs. 51,304.37 per hectare. Cost A1, A2, B1, B2, C1 and C2 were Rs. 22,737.94, Rs. 23,719.81, Rs. 24,665.69, Rs. 39,746.35, Rs. 31,559.67 and Rs. 46,640.33 per hectare respectively (Table 6). A minor difference was observed in the cost of cultivation of mustard between Bundelkhand region and Uttar Pradesh.

3.3.2 Returns per hectare

In Uttar Pradesh, return obtained by selling the main product and by product in the market was estimated to be Rs. 50,629.36 per hectare and Rs. 3,113.69 per hectare, respectively. Gross return obtained from the mustard crop was Rs. 53,743.05 per hectare. Cost of cultivation

Table 4. Instability in area, production and productivity under mustard crop in Bundelkhand region

Particulars	Sub periods of study			Overall study period
	First	Second	Third	
Area	30.8	20.8	29.4	47.3
Production	43.2	26.8	53.4	78
Productivity	17	17.9	33	30.5

Table 5. Cost of cultivation of mustard in Uttar Pradesh

S. No.	Particulars	Amount (Rs./ha)
1	Cost A1	24,419.82
2	Cost A2	26,003.74
3	Cost B1	26,576.42
4	Cost B2	41,973.27
5	Cost C1	31,598.61
6	Cost C2	46,995.46
7	Cost C3	51,695.00

Table 6. Cost of cultivation of mustard in Bundelkhand region

S. No.	Particulars	Amount (Rs./ha)
1	Cost A1	22,737.94
2	Cost A2	23,719.81
3	Cost B1	24,665.69
4	Cost B2	39,746.35
5	Cost C1	31,559.67
6	Cost C2	46,640.33
7	Cost C3	51,304.37

Table 7. Per hectare returns in mustard crop cultivation in Uttar Pradesh

S. No.	Items	Amount (Rs./ha)
1	Gross return from:	
(i)	Main product	50,629.36
(ii)	By product	3,113.69
	Total return	53,743.05
2	Cost of cultivation	51,695.00
3	Net return	2,048.05

was estimated to be Rs. 51,695.00 per hectare. Net return obtained was Rs. 2,048.05 per hectare (Table 7).

In Bundelkahnd region, return obtained by selling main product and by product was Rs. 51,148.04 and Rs. 2,197.89 per hectare. Net return was Rs. 2,041.56 per hectare (Table 8).

From Table 7 and 8, it can be noted that although there is very slight difference in the cost of cultivation between Uttar Pradesh and Bundelkhand region, but the difference between their respective net returns is more.

3.3.3 Item wise breakup of cost of cultivation

Break up of total cost or Cost C3 for Uttar Pradesh has been shown in Table 9. Total cost is divided into two major groups viz., Operational cost and Fixed cost. Operational cost are the variable costs because they change with the level of production.

It can be seen from Table 8 that the major contribution in total cost is of rental value of owned land (29.78%) (Fig. 1). Human labour has the next major contribution (19.74%) in the total cost indicating that agricultural operations in mustard cultivation involves significant amount of labour. Machine labour is the third highest cost amounting to Rs. 6,459.99 per hectare. Depreciation accounts to 11.42% of total cost. Lower cost of animal labour indicates the shift of farmers from animal to machinery for performing agricultural operations. Cost of seed, fertilizer, manure, insecticide and irrigation was Rs. 973.59 per hectare, Rs. 2,637.23 per hectare, Rs. 53.68 per hectare, Rs. 51.52 per hectare and 2,304.69 per hectare, respectively (Table 9).

In case of Bundelkhand region, similar results were found. Rental value of owned land (20.39%) had highest contribution in total cost followed by human labour (21.36%) (Fig. 2). Animal labour was not used by the farmers instead machinery was used. Total operational cost was Rs. 22,993.25 per hectare and total fixed cost was Rs. 23,647.08 per hectare. Managerial cost was Rs. 4,664.03 per hectare (Table 10).

Table 8. Per hectare returns in mustard crop cultivation in Bundelkhand region

S. No.	Items	Amount (Rs./ha)
1	Gross return from:	
(i)	Main product	51,148.04
(ii)	By product	2,197.89
	Total return	53,345.92
2	Cost of cultivation	51,304.37
3	Net return	2041.56

Table 9. Item wise breakup of cost of cultivation of mustard in Uttar Pradesh

	Particulars		Rs./ha
	Human Labour	Family	5,022.19
		Attached	49.91
		Causal	5,137.01
		Total	10,209.11
	Animal labour	Hired	4.61
		Owned	106.17
		Total	110.78
	Machine Labour	Hired	4,595.29
		Owned	1,864.7
		Total	6,459.99
	Seed		973.59
	Fertilizer & Manures	Fertilizer	2,637.23
		Manure	53.68
		Total	2,690.91
	Insecticides		51.52
	Irrigation Charges		2,304.69
	Miscellaneous expenditure		2.3
	Interest on Working Capital		712.59
1	**Total Operational Cost**		**23,515.48**
	Rental Value of Owned Land		15,396.85
	Rent Paid for Leased-in-Land		1,583.92
	Land Revenue, Taxes, Cess		19.25
	Depreciation On Implements & Farm Building		5,907.28
	Interest on Fixed Capital		572.68
2	**Total Fixed Costs**		**23,479.98**
3	**Managerial Cost (according to CACP)**		**4,699.54**
4	**Cost of cultivation (1+2+3)**		**51,695.00**

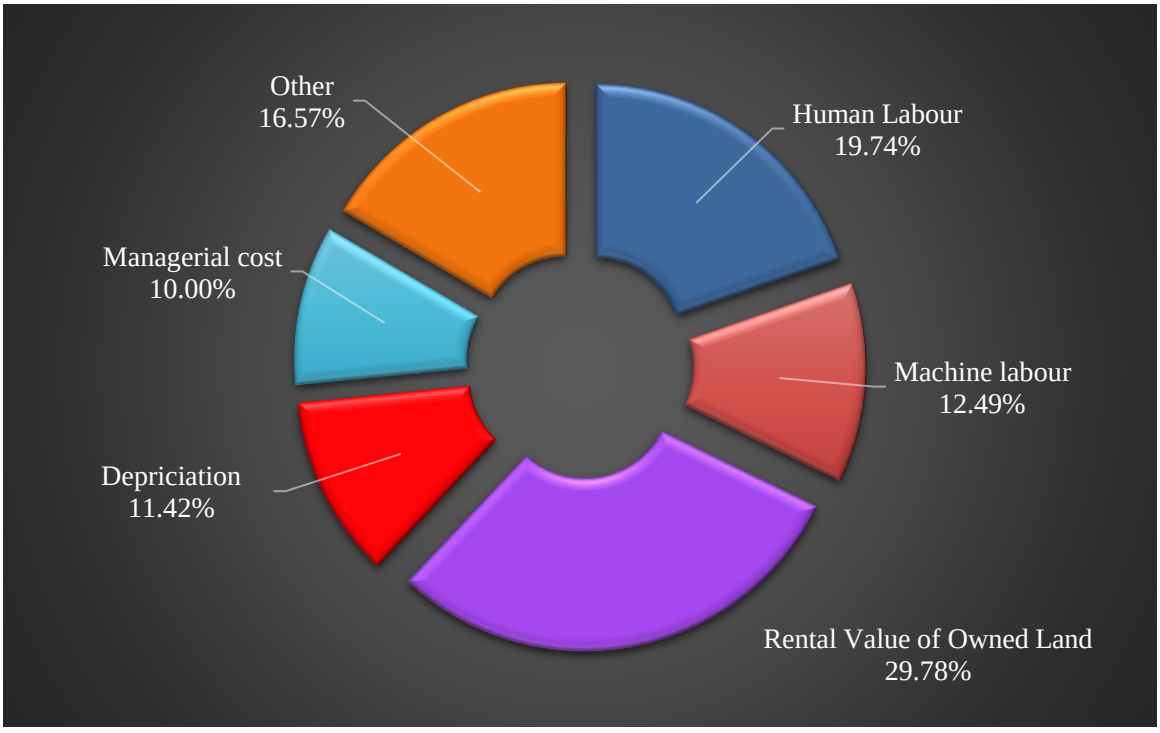

Fig. 2. Major constituents of cost of cultivation of mustard in Uttar Pradesh

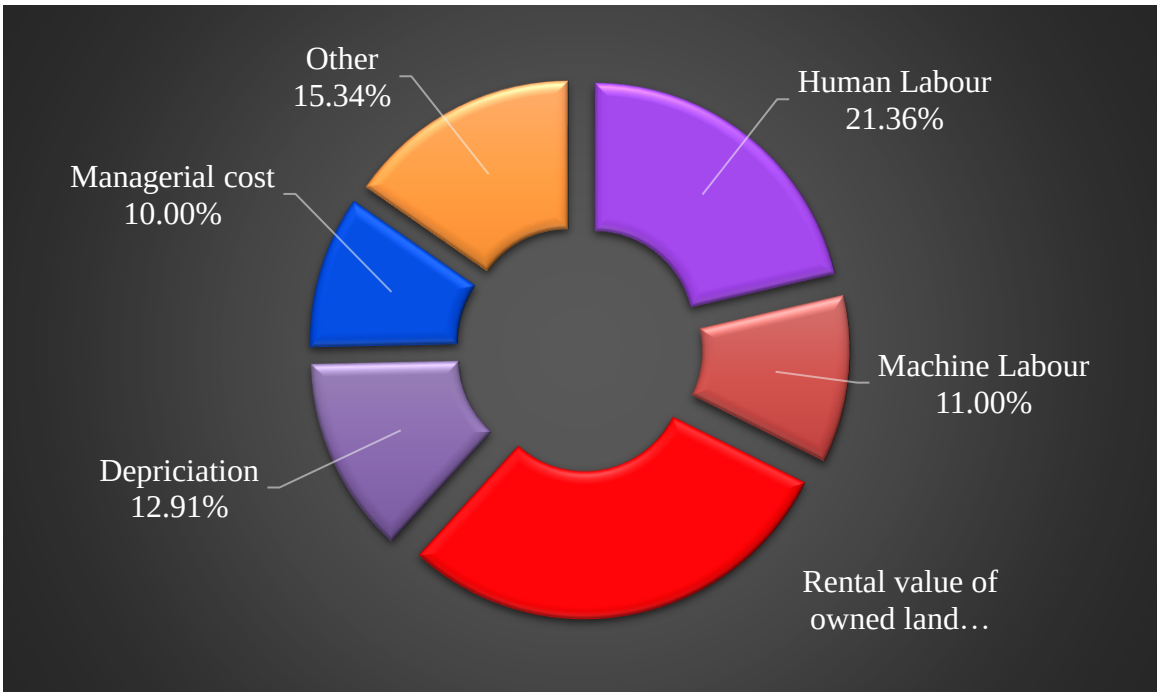

Fig. 3. Major constituents of cost of cultivation of mustard in Bundelkhand region

Table 10. Item wise breakup of cost of cultivation of mustard in Bundelkhand

	Particulars		**Rs./Ha**
	Human Labour	Family	6893.97
		Attached	0.00
		Causal	4063.44
		Total	10957.42
	Animal labour	Hired	0.00
		Owned	0.00
		Total	0.00
	Machine Labour	Hired	4211.93
		Owned	1429.51
		Total	5641.44
	Seed		838.37
	Fertilizer &Manures	Fertilizer	2716.16
		Manure	0.00
		Total	2716.16
	Insecticides		0.00
	Irrigation Charges		2281.59
	Miscellaneous expenditure		33.99
	Interest on Working Capital		524.28
1	**Total Operational Cost**		**22993.25**
	Rental Value of Owned Land		15080.66
	Rent Paid for Leased-in-Land		981.87
	Land Revenue, Taxes, Cess		12.83
	Depreciation On Implements & Farm Building		6625.83
	Interest on Fixed Capital		945.88
2	**Total Fixed Costs**		**23647.08**
3	Managerial Cost (according to CACP)		4664.03
4	**Cost of cultivation (1+2+3)**		**51,304.36**

3.4 Benefit Cost Ratio

Results of Benefit cost ratio estimation reveals that cultivation of mustard in the both the regions gave similar returns per unit of cost.

Table 11. Benefit cost ratio of Mustard cultivation

S. No.	Area	B C ratio
1	Uttar Pradesh	1.04
2	Bundelkhand region	1.04

4. CONCLUSION

Rapeseed-mustard (Brassica species) is an important oilseed crop contributing nearly 20-25% of the total oilseed production in the country. Uttar Pradesh is the second highest mustard producing state in India. major portion of mustard production of Uttar Pradesh comes from Bundelkhand region. Area and production of mustard crop was increasing in Bundelkhand region at a higher rate as compared to that of Uttar Pradesh whereas growth rate pf productivity for both the regions are almost same. Fluctuation in area, production and productivity in Bundelkhand region of Uttar Pradesh was much higher as compared to that of Uttar Pradesh during the study period. Net return from the mustard cultivation was Rs. 2,408.05 per hectare (Uttar Pradesh) and Rs. 2041.56 per hectare (Bundelkhand region). Cost of cultivation for Uttar Pradesh and Bundelkhand region was Rs. 51,695 per hectare and Rs. 51,304.36 per hectare, respectively. Major proportion in cost of cultivation was of rental value of owned land, human labour and Machine labour.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

None of the generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image converting softwares have been used during writing or editing of manuscripts by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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