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Instability and Sustainability Analysis of Mustard in Bhind (Madhya Pradesh) and Relationship with Factors of Production on Productivity

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ABSTRACT

The oilseed crops play a crucial role in Indian agricultural economy. The oil content varies from 37 to 49 percent. Oil is utilized for human consumption, seeds as spices and cake as a cattle feed and manure. Mustard is also an important oilseed crop containing over 40 percent oil on a dry weight basis. Madhya Pradesh (MP) is the fourth major mustard producing the state in India followed by Gujarat and West Bengal, with a share of nearly 11 percent of the country's total mustard production. In present study sustainable growth in the area, production and yield of mustard during the period under investigation for whole Madhya Pradesh. While Madhya Pradesh is found sustainable in the area, production and productivity as compared to Bhind district, which is a witness that Bhind district is having more fluctuation in the area, production and productivity of mustard during the study under investigation. Hence, in recent years a concept of sustainable agriculture is developed in order to ensure that the agro-eco-systems are stabilized and sustained crop yields are assured on a long term basis.

Keywords

Factors of production, instability, regression, sustainability.

JEL Codes

C43, C81, C51, C52, O13, Q56.

INTRODUCTION

Historically mustard is one of the earliest domesticated crop plants by man. Seeds of mustard were found from the channel - Daro of Harrapan civilization. Indian mustard (*Brassica juncea*) is predominantly cultivated in the states of Rajasthan, Uttar Pradesh, Haryana, Madhya Pradesh, and Gujarat which contribute 81.5 percent area and 87.5 percent production (2001-02 to 2005-06) (AICRPRM, 2007). Its cultivation is also being extended to non-traditional areas of Southern States like Karnataka, Tamil Nadu, and Andhra Pradesh. Madhya Pradesh (MP) is the fourth major mustard producing a state in India followed by Gujarat and West Bengal, with a share of nearly 11 percent of the country's total mustard production. The cultivation of brown sarson which once dominated the entire rapeseed-mustard growing region is now shadowed by Indian mustard. Mustard seeds are a particularly good source of the mineral selenium, providing almost 15 percent of the daily value for adults as recommended by the Food and Nutrition Board of the Institutes of Medicine. Sahu, & Mishra (2014) studied instability and forecasting the production of maize in India. Mishra *et al.* (2015) attempted the study of wheat sustainability and forecasting in India.

MATERIAL AND METHODS

The present study deals with the methodological details adopted for the fulfilment of the objectives of the present study. The nature and source of data collection of the methodology for examining descriptive statistics, trend and growth, instability, and sustainability yield index of the data analysis for the study are dealt in detail under following heads. Descriptive Statistics are used to

present quantitative descriptions in a manageable form. In a research study, we may have lots of measures. Or one may measure a large number of people on any measure. Descriptive statistics help us to simplify large amounts of data in a sensible way. Each descriptive statistic reduces lots of data into a simpler summary.

Correlation Coefficient

To measure the degree of linear association ship we shall use Karl Pearson's correlation coefficients. Correlation coefficient measures the degree of closeness of the linear association ship between any two variables and is given as

$$r_{xy} = \frac{Cov(x,y)}{s_x . s_y}$$

Regression

Regression is the measure of the average relationship between two or more variables in terms of the original units of the data. If two variables are correlated, unknown value of one of the variables can be estimated by using the known value of the other variable. Estimated value may not be equal to the actually observed value, but it will be close to the actual value. In a wider usage, regression is the theory of estimation of the unknown value of a variable with the help of known values of the variables.

$$(y - \bar{y}) = b_{yx}(x - \bar{x})$$

Here, the constants b_{xy} and b_{yx} are the regression coefficients. They are:

$$b_{xy} = \frac{r\sigma_x}{\sigma_y} = \frac{n\sum xy - (\sum x)(\sum y)}{n\sum y^2 - (\sum y)^2} or b_{xy} = \frac{Cov(x,y)}{Var(y)}$$

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Instability

For measuring the instability in area, production and yield the index given by Cuddy & Della (1978) and used by Larson *et al.* (2004):

$$CV_t = (CV)x\sqrt{1 + R^2}$$

$Cv_t = (CV)$ where,

$$C.V. = \frac{\sigma}{\bar{X}} \times 100$$

Where σ = Standard Deviation

$\bar{X} = Mean$

R^2 = coefficient of determination of the linear trend model of the variable concerned.

CVt = CV around trend

The more general option is to use ordinary CV value but in presence of trend, ordinary CV fails to explain the inherent trend component in a time series properly (Hasan *et al.*, 2008). So, Cuddy & Della (1978) method is assumed to be superior to ordinary CV. In present study period has divided into two periods, Period-1 (2005-2010), and Period-II (2011-2016)

Importance of Sustainability in Agriculture

Production of major crops in a sustainable manner is the need of the hour. Sustainability can be defined only by the boundaries of a system's framework, that is, after the specification of what is to be sustained. Choosing the boundary is difficult because agricultural systems operate at multiple levels: soil-plant system, cropping system or farming system, agro-ecosystem and so on to higher regional, national, and global levels (Lynam, 1994).

Sustainability Index (SI)

(1) Singh *et al.* (1990) have given the following measures of sustainability. Sustainability Index (S1) $\frac{\bar{y} - s}{y_{max}}$

where is the average yield of a treatment, s is the standard deviation of yields over the years and y_{max} is the maximum yield of a treatment in any year. Higher the value of the index, higher is the sustainability status

(2) Sahu *et al.* (2005) $SI = \frac{Y_{max\,a} - \bar{Y}}{\bar{Y}}$

sustainability index value closer to zero is the most desirable value.

(3) Pal & Sahu (2007) $SI = \frac{s_i}{\bar{y}_i} . \frac{1}{s_{max}}$

lower the value of the sustainability index higher is the sustainability.

RESULTS AND DISCUSSION

The effect of the expansion of area in Bhind is clearly visible (Table 1) in the production scenario of mustard. With a mere 136.50 thousand tonnes of production, it has reached to 341 thousand tonnes during the year 2016.A simple growth rate of -3.11 percent is registered during the period. Platykurticnature of production indicates that there has been a continuous force on enhancing production of these crops during the period. So the effect of area decreased.

Increased production of would not have been possible without a substantial increasing per ha yield of the crop,but here decreasing area and production effect clearly visible in productivity. Starting with only 932 kg of wheat per ha, it has reached to 1707 during the year 2016 thereby registering the simple result of -1.56 percent (Table 1). Thus the joint effect of expansion area and production has resulted in a brighter picture of mustard production scenario in Bhind. So the reason behind this decline in area and production may be farmer's adopted others crops taken place or environmental factor effect.

Correlation between Climatological and Productivity of Mustard

At the time of setting the objective for the present study, we assumed that the factors (rainfall, maximum and minimum temperature) are supposed to have a great role in the productivity of mustard. In this section, attempts have been made to work out the degree of linear

association ship and the linear relationship among these parameters for rice crop. Correlation, regression analysis is taken up to find out the extent and actual linear relationship of productivity on these parameters. Mustard in Bhind producing including whole Madhya Pradesh (Table 2) it is found that productivity yield is significant. There was the negative significant effect of rainfall, the average minimum temperature on mustard productivity.

In order to find out the relationship of yield with above factors, multiple linear regression equations are fitted. The most important factors affecting crop productivity is identified by using linear regression analysis (Table 3). A significant positive coefficient of maximum temperature on the productivity of mustard in Bhind and Madhya Pradesh is noticed. A temperature would lead to an increase in productivity of mustard crop by 49 and 69 kg/ha. So by seeing the correlation between maximum temperature and productivity matching the results of regression.

Instability of Mustard

Variability in agricultural production consists of variability in area and yield and their interactions. Variation in the area under a crop occurs mainly in response to distribution, timeliness, and variations in rainfall and other climatic factors, expected prices and availability of crop-specific inputs. Demand for food tends to grow in proportion to changes in population and

Table 1. Performance of mustard in Bhind and Madhya Pradesh (2005-2016)

Particular	Area	Production	Yield	Maximum temperature	Minimum temperature	Rainfall
Bhind						
Mean	169.83	222.55	1314.08	45.17	35.42	722.88
Standard Error	10.80	18.00	80.23	0.67	1.13	60.52
Kurtosis	5.88	-0.08	-1.38	-1.31	8.16	3.52
Skewness	2.11	0.47	0.26	0.43	2.67	1.56
Minimum	130.00	136.50	932.00	42.00	32.00	447.00
Maximum	274.20	341.00	1707.00	49.00	47.00	1261.90
SGR (percent)	-0.39	-3.11	-1.56	0.52	-0.64	1.95
Madhya Pradesh						
Mean	758.70	865.18	1129.00	31.66	20.17	969.95
Standard Error	22.74	60.77	49.06	0.29	0.26	32.37
Kurtosis	1.42	0.86	1.15	-1.68	-1.38	0.28
Skewness	-0.81	0.88	1.36	-0.09	-0.02	-0.88
Minimum	579.20	536.80	927.00	30.23	18.70	733.50
Maximum	872.00	1275.00	1480.00	33.05	21.54	1101.70
SGR (percent)	0.85	5.56	4.55	0.84	-1.12	-3.08

Table 2. Correlation of factors related with the productivity of mustard in Bhind and Madhya Pradesh

Particulars	Yield	Maximum temperature	Minimum temperature	Rainfall
Bhind				
Yield	1			
Maximum temperature	0.119*	1.000		
Minimum temperature	-0.290	0.450	1.000	
Rainfall	-0.017	0.265	-0.203	1
Madhya Pradesh				
Yield	1.000			
Maximum temperature	0.532*	1.000		
Minimum temperature	-0.459	-0.857	1.000	
Rainfall	-0.467	-0.598	0.495	1

Table 3. Regression analysis of factor affecting the productivity of mustard in Bhind and Madhya Pradesh

Term	Coefficients	Standard error	t-value	p-value
Bhind				
Constant	611	1708	0.36	0.730
Maximum temperature	49.7	46.1	1.08	0.312
Minimum temperature	-37.2	27.0	-1.38	0.205
Rainfall	-0.31	0.467	-0.66	0.526
Madhya Pradesh				
Constant	-715	5656	-0.13	0.903
Maximum temperature	69	115	0.60	0.564
Minimum temperature	-4.02	106	-0.05	0.963
Rainfall	-0.29	0.468	-0.64	0.541

income; yet, food supply can be very unstable. Production instability leads to market and food price volatility, and this volatility causes wide swings in consumer prices and producer incomes. All these factors also affect the variations in yield. The main concern in the strategy for agricultural development in India has been agricultural growth with stability as a way to meet the increasing demand for food.

Plant protection measures, chemicals, fertilizers, and mechanizationFurther, the yield is also affected by the outbreak of diseases, pests, and other natural.After seeing the per performance and trend, it is important to study the instability of crop in a different period. So for this period has divided into two periods as mentioned in material and method section. For Bhind in mustard in area and production, Period-I found more instability as compare to Period-II and whole period (Table 4). But in case of productivity in Period-II found variability. For whole Madhya Pradesh story is quite different in the area. In Period-II instability is more as compare to Period-I and whole period in the area, production, and productivity.

In present study period has divided into two periods.

(1) Period-1 (2005-2010)

(2) Period-II (2011-2016)

Sustainability of Mustard

Crop yields remaining stagnant, pesticides polluting the eco-systems, increasing the cost of fertilizers, reducing soil fertility, an imbalance in host-parasite and predator - parasite relationships have pushed agriculture into the dangerous mode. Scientists have looked back into the technologies evolved and used to increase the crop yields. Long-term projections have indicated that agriculture is pushing itself towards stagnation with severe damage to ecosystems.

Sustainability in productivities of mustard in Bhind and Madhya Pradesh has been measured with the help of sustainability indices as described in material and method section and has been presented in Table 5. So from table Whole Madhya Pradesh is found sustainable in the area, production and productivity as compared to Bhind district, which is the witness that Bhind district is having

Table 4. Instability in the area, production, and yield of mustard in Bhind and Madhya Pradesh

Particular	Area	Production	Yield
Period-I (Bhind)			
R^2	0.28	0.19	0.79
CV	26.05	29.87	18.69
CV_t	22.15	24.13	4.02
Period-II (Bhind)			
R^2	0.88	0.41	0.23
CV	14.66	28.24	24.31
CV_t	1.77	21.69	18.75
Whole Period (Bhind)			
R^2	0.39	0.63	0.70
CV	10.38	24.33	15.05
CV_t	8.10	14.88	8.19
Period-I (Madhya Pradesh)			
R^2	0.67	0.70	0.88
CV	7.50	23.22	16.04
CV_t	4.33	12.63	5.65
Period-II (Madhya Pradesh)			
R^2	0.22	0.18	0.21
CV	22.03	28.02	28.02
CV_t	19.45	25.38	24.92
Whole Period (Madhya Pradesh)			
R^2	0.39	0.63	0.70
CV	10.38	24.33	15.05
CV_t	8.10	14.88	8.19

Table 5. Sustainability measurement

	Area	Production	Yield
Bhind			
SI-1	169.69	222.36	1313.92
SI-2	273.20	340.00	1706.00
SI-3	61.22	77.88	58.78
Madhya Pradesh			
SI-1	758.61	865.01	1128.89
SI-2	871.00	1274.00	1479.00
SI-3	0.003	0.003	0.003

more fluctuation in the area, production and productivity of mustard during the study under investigation.

CONCLUSIONS

There has been sustainable growth in area, production, and yield of mustard during the period under investigation for whole Madhya Pradesh. Increased production of would not have been possible without a substantial increasing per ha yield of the crop, but here decreasing area and production effect clearly visible in productivity. In Bhind with only 932 kg of Mustard per ha, it has reached to 1707 during the year 2016 thereby registering the simple result of -1.56percent. In case of the area during the Period-I experienced the highest degree of instability in Bhind. In case of production Madhya Pradesh showing higher instability in Period-II. While Madhya Pradesh is found sustainable in the area, production and productivity as compared to Bhind district, which is a witness that Bhind district is having more fluctuation in the area, production and productivity of mustard during the study under investigation.

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