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Trend and Sustainability of Soybean Production in Madhya Pradesh

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ABSTRACT

Time series data covering the period of 1979-80 to 2010-11 was used for the study. Among the linear and non- linear models the cubic trend model is found to adequately delineate trends in area, production and productivity of soybean. From the growth rate analysis it is clearly visible that the area, production and productivity are positive in nature. Productivity of soybean over a period of 1979-80 to 2010-11 shows the sustainability.

Key words *Sustainability, Soybean, Production, Madhya Pradesh*

The soybean (*Glycine max*) is a species of legume native to East Asia, widely grown for its edible bean which has numerous uses. The plant is classed as an oilseed rather than a pulse by the UN Food and Agriculture Organization (FAO). The protein and oil content of soybean is 40 % and 20 % respectively. Soybean recognizing as the 'golden bean' or the 'miracle bean', the western world provided a massive push to its growth during the early part of the century. The USA now has over 50 percent of total soybean area in the world producing over 50 percent of the world soybean (S. Bisaliah, 2002). In India which is predominantly vegetarian society, fats and protein of vegetable origin acquire special significance. Since soybean is both an oilseed and a pulse crop. India's share in the world's total area under soybean is about one percent at present.

MATERIALS AND METHOD

Data related to area, production and yield of soybean in Madhya Pradesh since from 1979-80 to 2010-11 were collected from Anonymous. (2012). The whole period was divided into two period's viz., period- I from 1979-80 to 1994-95 and period- II from 1995-96 to 2010-11 to compare in area,production and yield between the two periods. In order to examine the nature of change, sustainability and trend in area, production and yield of soybean in Madhya Pradesh, various statistical measures such as mean, SGR,CGR and parametric, non-parametric models were worked out.Descriptive statistics

To examine the nature of each series these have been subjected to get various statistics. Descriptive statistics are typically distinguished from inferential statistics. With descriptive statistics one simply describes what is or what the data shows. With inferential statistics, one tries reach conclusions that extend beyond the immediate data alone. Statistical tools used to describe the above series are minimum, maximum, average, standard error, skewness, kurtosis.

Compound growth rate (CGR) = (Anti logb-1)*100

$$\text{Relative change (RC\%)} = \frac{Y_n - Y_0}{Y_0} * 100$$

Y_n= Current year and Y_0= Base year

Parametric trend models

To get an overall movement of the time series data, trend equations are fitted. In this exercise different idea about the models like polynomial, exponential, linear, compound etc are used for this purpose. The following linear-nonlinear models have been considered in the present investigations.

List of linear-nonlinear models

S. No.	Name of the Model	Model form
I.	Linear:	$Z_t = a + bt + e_t$
II.	Quadratic:	$Z_t = a + bt + ct^2 + e_t$
III.	Cubic:	$Z_t = a + bt + ct^2 + dt^3 + e_t$
IV.	Logarthmic:	$Z_t = a + b \ln(t) + e_t$
V.	Exponential:	$Z_t = a [Exp (bt)] + e_t$
VI.	Hyperbolic:	$Z_t = a + (b/t) + e_t$
VII.	Power:	$Z_t = a t^b + e_t$
VIII.	Compound:	$Z_t = a b^t + e_t$
IX	Gompertz:	$Z_t = a [exp(-exp(b-ct))] + e_t$

Sustainability Index

(1) Singh *et. al.* (1990) has given the following measures of sustainability. Sustainability Index

Table 1. *Per se* performance of soybean production in Madhya Pradesh during 1979-80 to 2010-11

	Area	Production	Productivity
Mean	3069.95	2963.70	888.73
Standard Error	307.29	351.51	33.13
Median	3632.10	3152.80	870.47
Kurtosis	-1.47	-1.19	-1.00
Skewness	-0.34	0.10	-0.11
Range	5252.60	6434.70	639.61
Minimum	307.30	235.10	560.02
Maximum	5559.90	6669.80	1199.63
SGR	38.81	83.72	3.35
CGR	8.45	10.95	2.30

Table 2. Sustainability analysis of soybean productivity

Methods	Period 1 (1979-80 to 1994-95)	Period II (1995-96 to 2010-11)	Period III Whole Period 1979-80 to 2010-11
Singh *et al*	0.364	0.410	0.343
Sahu *et al*	1.232	1.052	**1.309**
Pal and Sahu	0.001	0.001	0.001

Table 3. Trends in area, production and productivity of soybean in Madhya Pradesh during 1979-80 to 2010-11

Soyabean	Equation	Model Summary		Parameter Estimates						
		R Square	F	df1	df2	Sig.	Constant	b1	b2	b3
Area	Cubic	0.961	229.469	3	28	0	-96.148	148.948	7.188	-0.214
Production	Cubic	0.89	75.737	3	28	0	-506.109	246.834	-2.976	0.053
Yield	Cubic	0.549	11.361	3	28	0	560.121	44.634	-2.244	0.045

(SI) = $\frac{\overline{y} - s}{y_{max}}$, where $\overline{y}$ 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.

$$SI = \frac{Y_{max} - \overline{Y}}{\overline{Y}} \quad SI = \frac{Y_{max} - \overline{Y}}{\overline{Y}}$$

(2) Sahu *et.al* (2005) a sustainability index value closer to zero is the most desirable value.

(3) Pal and Sahu (2007) $SI = \frac{s_i}{\overline{y}_i} \cdot \frac{1}{s_{max}}$ lower the value of the sustainability index higher is the sustainability.

RESULT AND DISCUSSION

From the table 1, indicates the average area, production and productivity of soyabean in Madhya Pradesh is 3069.95 ha, 2963.7 MT and 888.73 kg per hectare respectively in the period of 1979-80 to 2010-11. Negative skewness in area and productivity indicates that the recently increased in its value but the production shows the positive skewness. Growth rate of area, production and productivity in Madhya Pradesh shows positive in nature. Sustainability in yield of soybean in period 1, period 2 and whole period of Madhya Pradesh measured with the help of sustainability indices and presented in the table 2. From the table 2 it is clearly visible that the as per the singh et al the period 2 shows the sustainable yield, as per the Sahu et al the whole period shows the highest sustainable yield. But as per the Pal and sahu, the period 1 and period 2 and whole period shows the sustainable

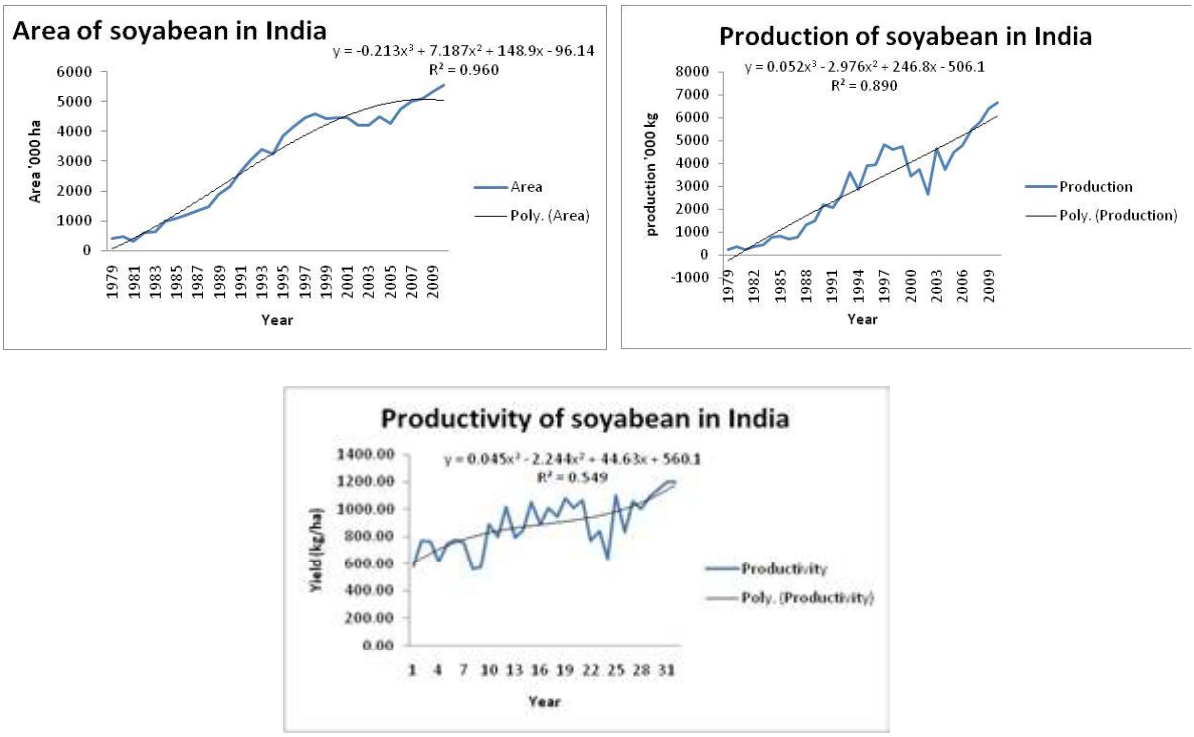

Fig. 1. Observed and expected trends of soybean in Madhya Pradesh

productivity. From these we can infer that soybean yield in Madhya Pradesh is maintain its sustainable level over the period of time. To work out the trends in area, production and yield of soybean in Madhya Pradesh different parametric models like linear, logarithmic, quadratic, cubic, compound, growth and exponential models were attempted to among the competitive models. The best model was selected on the basis of the maximum R2 value, significance of the model and its coefficient (Table 3). In most of the cases, the non-linear patterns are revealed (Fig.1). In all cases cubic model is found to be best, the coefficients of cubic time factor are negative in nature and thereby indicating the tendencies of the series to decline in recent past.

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