STUDY OF PRODUCTION OF MAJOR FOOD GRAIN CROPS IN MADHYA PRADESH AND THEIR YIELD SUSTAINABILITY

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ABSTRACT : Food crops like wheat, rice, maize play important roles in solving food and nutritional security problem. In the realm of food crops in the world, wheat (*Triticum* spp.) occupies the number one position. India is one of the principal wheat producing and consuming countries in the world. Its importance in Indian agriculture is second to rice only. World population particularly the population of developing world is increasing at an alarming rate. To feed these ever increasing human populations remains a challenging task to the planners of the individual countries and also the world bodies. The planners should know the likely population behaviour of the countries under changing scenario. During present study under investigation thus, from the study of area, production and productivity of rice, wheat and maize it is seen that there has been improvement in all the fronts in Madhya Pradesh. Wheat was found more sustainability as compare to rice and wheat.

Key words : *Parametric model, Sustainability yield index and production.*

INTRODUCTION

Agriculture plays a vital role in India's economy. Over 58% of the rural households depend on agriculture as their principal means of livelihood. Agriculture, along with fisheries and forestry, is one of the largest contributors to the Gross domestic product (GDP). As per estimates by the Central statistics office (CSO), the share of agriculture and allied sectors (including agriculture, livestock, forestry and fishery) was 16.1% of the Gross value added (GVA) during 2014-2015 at 2011-12 prices. During Q1 FY2016, agriculture and allied sectors grew 1.9% year-on-year and contributed 14.2% of GVA. Food crops like wheat, rice, maize play important roles in solving food and nutritional security problem. Rice is one of the major food crops of India. More than 33% of cropland is used for the cultivation of rice. Rice and wheat are India's pre-dominant staple food crops. Rice is grown across the nation under extensively varied condition of climate and eco-geography. At present, India is the second largest wheat producer in the world. Maize is the 3rd major crop in India, contributing about 19 million tonnes to Indian food grain basket, so thestability in production is important for food security. Vishawajith *et al.* (2016) studied the trend of sugarcane production in India and their major production states whereas Mishra *et al.* (2015) studied the sustainability of yield in major states in India.

MATERIAL AND METHODS

First we select the three crop, rice, wheat and maize in Madhya Pradesh. After the selecting these crops the next task was to select the statistical tools to meet the above objective. The data collected from published sources and various issues of agriculture at glances on area, production, yield of rice in Madhya Pradesh from 1979-2010. However, keeping parity with the objective of the study best possible common period of information are used in this study. Since independence, India has passed through different stages of agricultural production, such the whole period under study is divided into two periods *viz.*, period-I from 1979-1980 to 1994-1995 (pre WTO), period-II from 1995-96 to 2010-11 (post WTO).

Descriptive statistics : Descriptive statistics were used to describe the basic features of the data in present study. They provide simple summaries about the sample and the measures. Together with simple graphics analysis, they form the basis of virtually every quantitative analysis of data. Descriptive statistics are typically distinguished from inferential statistics. With descriptive statistics we are simply describing what is or what the data shows. Statistical tools used to describe the above series are minimum, maximum, average, standard error, skewness, kurtosis. Simple growth rates have been calculated using the following formula :

$$SGR\% = \frac{(Y_t - Y_o) \cdot 100}{Y_{o_n})}$$

where, Y_t and Y_0 are the values of the last year and the first year of the series; n is the number of years.

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 the purpose.

Different trend models used :

Polynomial model	$Y_t = b_0 + b_1 t + b_2 t^2 + b_2 t^3 + \ldots\ldots\ldots + b_k t^k$
Linear model	$Yt = b_0 + b_1 t$
Quadratic model	$Yt = b_0 + b_1 t + b_2 t^2$
Cubic model	$Yt = b_0 + b_1 t + b_2 t^2 + b_2 t^3$
Compound model	$Yt = b_0$
Exponential model	$Y = ab^t$
Logarithmic model	$Yt = b_0 + b_1 \ln(t)$
Growth model	$Y_t = e^{b0 + b1 \ln(t)}$

Sustainability index (SI) :

1. Singh *et al.* (1990). has given the following measures of sustainability. Sustainability index (SI) = $\bar{Y}$-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. According to measure higher value of the index shows higher sustainability status.

2. Sahu *et al.* (2005). According to measure lower value of the index shows higher sustainability status.

3. Pal and Sahu (2007). $SI = S_i / Y_i - 1 / S_{max}$ According to measure lower value of the index shows higher sustainability status.

RESULTS AND DISCUSSION

Rice is the most important cereal food crop of India as well as for Madhya Pradesh. It plays vital role in the national food grain supply. From the Table.1, one can find that in Madhya Pradesh, since 1979 the area under rice has increased from 1445.70 thousand hectare to 5479.50 thousand hectare, registering a growth of almost 25.52%. Average area under rice being 3652.65 thousand hectare For Madhya Pradesh, from a mere 982 thousand tons of production it has reached to 6463 thousand tonnes during the year 2010. A negative growth rate is registered during the period. Madhya Pradesh increased production of rice would not have been possible without a substantial increase in per ha yield of the crop. Starting with only 382 kg of rice per ha, it has reached to 1208 kg/ha during the year. Thus, the joint effect of expansion in area and yield have resulted in a brighter picture of rice production scenario in Madhya Pradesh.

Table. 1 Summary statistics.

	Area	Production	Productivity
Rice			
Mean	3916.15	3652.65	914.33
Standard error	296.73	330.93	32.90
Minimum	1445.70	982.10	382.68
Maximum	5479.80	6463.00	1208.17
SGR (%)	-2.07	-0.09	5.90
CGR (%)	-3.35	-0.09	3.37
Wheat			
Mean	3833.11	5744.33	1472.97
Standard error	73.62	302.38	55.85
Minimum	3085.20	2154.60	698.37
Maximum	4661.50	8685.20	1966.84
SGR	1.27	7.94	4.74
CGR	1.07	4.03	2.93
Maize			
Mean	852.63	1115.56	1300.23
Standard error	6.50	53.00	55.81
Minimum	750.80	540.60	720.03
Maximum	909.50	1866.20	2051.90
SGR	0.33	2.950	2.37
CGR	0.32	2.10	1.78

Since 1979, the area under wheat has increased from 3085 thousand hectare to 4661 thousand hectare registering a growth of almost 1.27%. The average area under wheat being 3916 million hectare. The effect of expansion of area is clearly visible in the production scenario of wheat. For Madhya Pradesh, with a mere 2154 thousand tonnes of production it has reached to 8685 thousand tonnes during the year 2010. A simple growth rate of 7.94% is registered during the period.
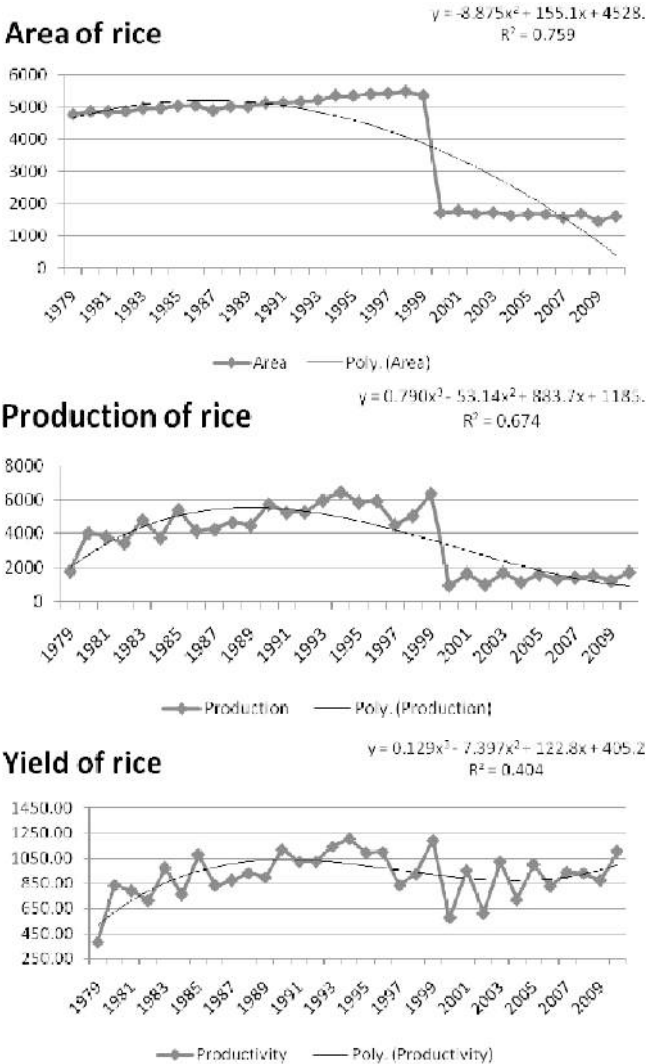

Fig. 1a Observed and expected trends of area, production and yield of rice in Madhya Pradesh.
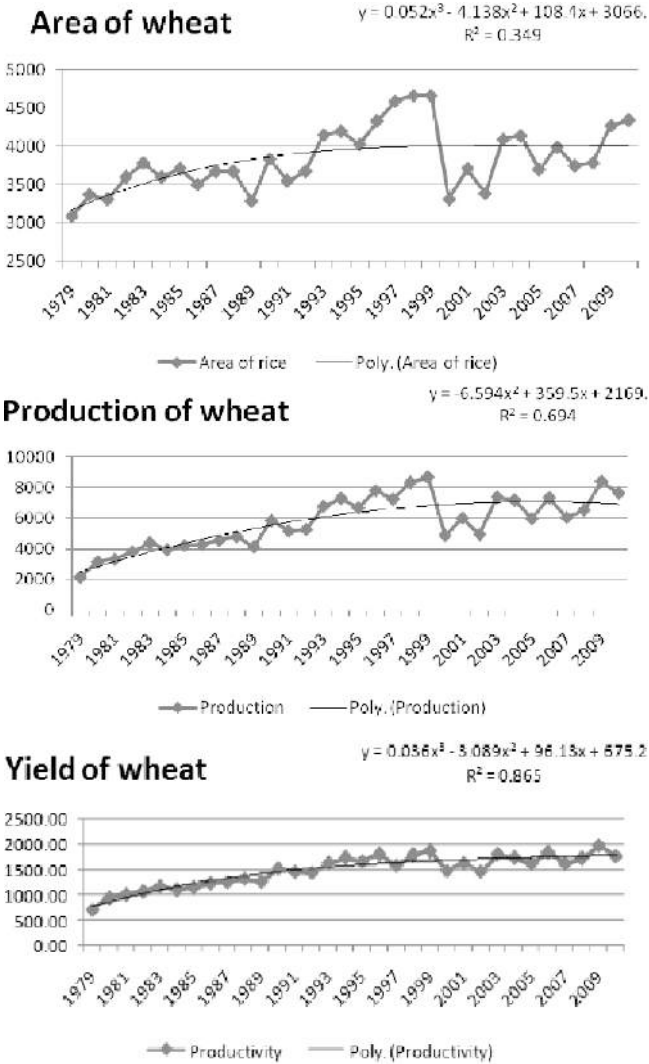

Fig. 1b Observed and expected trends of area, production and yield of wheat in Madhya Pradesh.

Table. 2 Model summary and parameter estimates of parametric trend models.

States	Model	R^2	F	Significance	Intercept	b_1	b_2	b_3
				Rice				
A	Cubic	0.78	33.03	0.00	3782.59	407.30	-27.68	0.38
P	Cubic	0.67	19.34	0.00	1185.32	883.74	-53.14	0.79
Y	Cubic	0.40	6.34	0.00	405.22	122.88	-7.40	0.13
				Wheat				
A	Cubic	0.350	5.024	0.007	3066.753	108.459	-4.138	0.052
P	Quadratic	0.695	33.004	0.000	2169.434	359.541	-6.594	
Y	Cubic	0.866	60.080	0.000	675.284	96.133	-3.089	0.036
				Maize				
A	Cubic	0.706	22.412	0.000	740.536	19.881	-0.880	0.011
P	Cubic	0.420	6.750	0.001	669.787	31.593	1.185	-0.057
Y	Cubic	0.374	5.587	0.004	897.342	18.711	1.999	-0.071

One of the possible ways under limited scope for expansion in area under the crop due to various reason is to boost the per hectare yield of the crop. Madhya Pradesh has increased its productivity by almost three fold; from a mere 698 kg/ha to 1966 kg/ha during the period under study. Thus, from the study of area, production and productivity of wheat it is seen that there has been improvement in all the fronts in Madhya Pradesh.

Maize is the 3rd major crop in India, contributing about 19 million tonnes to Indian food grain basket, so the stability in production is important for food security (Sahu and Mishra,2014). Since 1979 the production under maize 2.10% with an average yield of 1300 kg/ha.Overall picture of Madhya Pradesh shows that starting with only 720 of wheat per hectare; it has reached to 2051 kg/ha during the year 2010 thereby registering simple growth of 1.78%.

Knowing the above overall performance, path of movement of the series was traced through parametric trends models. To workout the trends in area, production and yield different parametric model like polynomial, logarithmic, quadratic, cubic, compound, growth, and exponential model were attempted. From Table.2, it is clearly understood that except the production of rice, wheat and maize in Madhya Pradesh cubic model well fitted comparison to other parametric model.

From Table.3 it is clearly visible that wheat shown highest sustainability in yield as compare to rice and maize according to sustainability measure SI-1 and SI-2. On the other measures-3 (Pal and Sahu,2007)All the three crops showing equal sustainability. In case of rice Period 1 is showing higher sustainability as compare to period 2. But in wheat and maize showing higher sustainability in period 2 as compare to period 1.
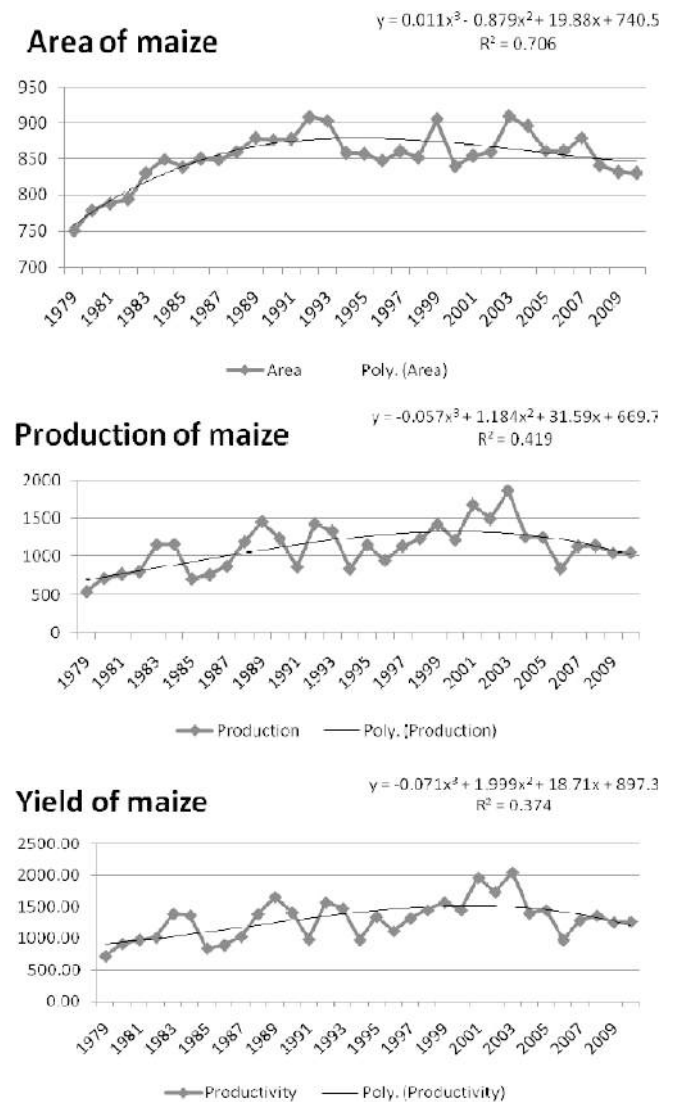

Fig. 1c Observed and expected trends of area, production and yield of maize in Madhya Pradesh.

Table. 3 Sustainability yield index.

	Method	Period-1	Period -2	Whole Period
		Rice		
SI-1	Singh *et al.*	0.408	0.362	0.356
SI-2	Sahu *et al.*	0.906	1.235	1.244
SI-3	Pal and Sahu	0.001	0.001	0.001
		Wheat		
SI-1	Singh *et al.*	0.561	0.762	0.566
SI-2	Sahu *et al.*	0.398	0.204	0.393
SI-3	Pal and Sahu	0.001	0.000	0.001
		Maize		
SI-1	Singh *et al.*	0.501	0.563	0.482
SI-2	Sahu *et al.*	0.492	0.428	0.578
SI-3	Pal and Sahu	0.001	0.001	0.001

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