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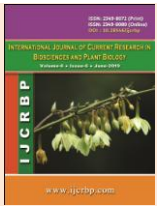

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Performance and determinants of maize production in India

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ABSTRACT

The present study has examined the growth, instability and determinants of maize production in India from the period 1980-81 to 2015-16. Compound Annual Growth Rate, Cudda-Della Valle method and Regression analysis were used in the study. The results revealed that significant higher growth rates in area, production and productivity of maize are found during post-WTO in the states of Andhra Pradesh, Madhya Pradesh, Maharashtra, Tamil Nadu and India as a whole. Tamil Nadu is the only state among the selected ones to show high instability in production during both pre and post WTO periods, whereas, Maharashtra indicated the presence of high instability in production during pre WTO period. The variable irrigated area is found as a key factor in increasing maize production in Tamil Nadu. Rainfall is one among the limiting factors in maize production, which led to low productivity due to prolonged dry spells. Therefore, there is a need to explore the possibilities i.e., educating the farmers to use high quality seed or drought mitigation strategies to provide technical know-how and other support to the farmers in order to increase maize productivity.

Introduction

Food grain production covers 65 per cent of the cropped area in India. The demand for the food grains in India is continuously increasing due to steady population growth. After rice and wheat, maize is emerging as the third most important crop in India. Maize is popularly known as Queen of Cereals; also called corn is one of the most important cereal crops of the world. It is the only cereal crop which can be grown in various seasons, having wider adaptability to different climatic conditions. It occupies an important place in consumer food basket all over the world. In 2015-16, maize has been cultivated on an area of 180.7 million ha globally in about 160 countries and contributed 38.4 per cent (972.4 million MT) to the global cereal production (United States Department Agency). The major countries producing maize are United States, China, Brazil, European Union, Argentina, Ukraine, India and Mexico. In India, maize was grown in area of 8.81 million hectares (4.90% of World) with a production of 22.57 million MT (2.30% of World) during the year 2015-16 (Ministry of Agriculture and Farmers' Welfare of India). The leading producer state of maize is Karnataka with 3.3 million MT (14.7% of India), followed by Madhya Pradesh, Bihar, Tamil Nadu, Maharashtra, Uttar Pradesh. The poultry industry alone accounts for 44 per cent of the country's total maize consumption.

In India, more than 70 per cent of maize area is rain-fed. The maize yield per hectare (25.6 Qt/ha) is still lower as against the world average of about 53.8 Qt/ha (USDA, 2015-16). Farmers are not able to earn more due to low productivity as well as low production. Increasing productivity and thereby reducing costs will greatly enhance the competitiveness of maize both globally as well as in the domestic market. Therefore, the performance of maize in terms of growth in area, production and productivity needs to be studied.

Materials and methods

Methodology

The proposed study is based on secondary data. The data was collected from various published reports, journals, official record of government and Ministry of Agriculture and Farmers' Welfare. Time-series data on maize production was collected for the period from 1980-81 to 2015-16.

To estimate the growth in area, production and productivity of maize in India and other selected states, exponential growth function has been fitted. To achieve this, the growth in time-series data of area, production and productivity of maize have been estimated for pre and post WTO periods as well as for overall period. The periods are specified as follows.

1. Pre WTO period (period I) from 1980-81 to 1994-95.

2. Post WTO period (period II) from 1995-96 to 2015-16.

3. Overall period from 1980-81 to 2015-16.

The pre and post WTO criteria has been considered to estimate whether WTO formation has had any impact on production of maize, since it is one of the major cereals produced in India.

Compound Annual Growth Rate (CAGR)

Compound annual growth rates are worked out in order to examine the tendency of variables to increase, decrease or remain stagnant over a period of time. In the present study, compound annual growth rates of area, production and productivity of maize in major maize producing states and for the country as a whole have been estimated by using the exponential growth function of the following form,

$Y_t = a\, e^{bt}$

Where,
Y_t = Dependent variable i.e. for which growth has been estimated
a = Intercept
b = Regression coefficient
t = Years i.e. (1, 2, ..., n)

To estimate the instability in area, production and productivity of Maize, Cudda-Della Valle method has been used. Instability index is a simple analytical tool to find out the fluctuations in any given time series data. Cudda-Della Valle method is employed to measure the instability in the time series. Cudda-Della Valle method is used as it corrects the coefficient of variation if data are scattered around the negative or positive trend line, over estimation can be avoided. The Cudda-Della Valle (CDI) Index is given as follows,

$$I_x = CV \sqrt{(1 - \bar{R}^2)}$$

Where,
CV = Coefficient of variation $(\sigma / \bar{X})$*100
$\bar{R}^2$ = Adjusted coefficient of multiple determination

The selection rule of instability index is that implied in the preceding paragraph:

1. If the regression equations of both linear and log-linear form are significant at the 1 per cent level: choose instability measure of equation whose $\bar{R}^2$ is higher.

2. If $\bar{R}^2$ is significant at the 1 per cent level for one equation but is not significant for the other, choose the instability measure corresponding to the 'significant' equation.

3. If the $\bar{R}^2$ is not significant at 1 per cent level of significance and $\bar{R}^2$ <0, then Coefficient of Variation (CV) is chosen to measure instability index.

The present study divides the CDI value into three categories, which represent the different range of instability (Sihmar, 2014).

The ranges of instability are as follows:

1. Low instability = between 0 to 15
2. Medium instability = greater than 15 and lower than 30
3. High instability = greater than 30

Determinants of maize production from India

The multiple regression of log-linear form is used for assessing the factors determining maize production in India and other selected states. The present study involved quantitative analysis of the variables by adopting the method of ordinary least square (OLS) econometric technique. Before dealing with a time series, the first and foremost step is to check whether the underlying time series is stationary or not. Augmented Dickey-Fuller test is used for testing stationarity of the variables. If the variables are found to be stationary at unit root, then OLS estimation is employed.

To identify the determinants of maize production from India

The time series data regarding maize production and the factors determining are collected for the period from 1996-97 to 2015-16, as the continuous time series data available for this period only. Maize production is regressed with area under maize cultivation, irrigated area under maize, annual rainfall, quality seed consumption, fertilizer usage, animal labour, human labour and MSP, which is represented as follows:

$$\ln Y_t = b_0+b_1 \ln A_t+b_2 \ln I_t+b_3 \ln R_t+b_4 \ln S_t+b_5 \ln F_t+b_6 \ln N_t+b_7 \ln H_t+b_8 \ln M_t+\mu$$

Where,

Y_t refers to maize production in thousand tonnes i.e. 1996-97 to 2015-16;

A_t is the area of maize cultivation in thousand hectare;

I_t is the area covered by irrigation in thousand hectare;

R_t is the yearly average rainfall of the country in millimetre;

S_t is the country's quality seed consumption of maize in tonnes;

F_t is the fertilizer used in kg per hectare;

N_t is the animal labour used per hectare in pair hours;

H_t is the human labour used per hectare in man hours;

M_t is MSP of Maize in India in Rs/Qt;

μ is the error term.

The continuous time series data on consumption of quality seeds of maize by farmers is not available for selected states but it is available for the country as a whole. Therefore, the consumption of quality seed variable has been excluded from determinants of maize production for the selected states and included in country's determinants. For Tamil Nadu, the series data has considered from 2004-05 due to non-availability of data for few variables selected.

Results and discussion

Compound annual growth rates in area, production and productivity of maize

The results of growth rates in area, production and productivity of maize in major maize producing states as well as India for the given periods are presented in Table 1 and discussed below.

In comparison of pre and post WTO period, the significant higher positive growth rates in area, production and productivity of maize have been found during post-WTO period in states of Andhra Pradesh, Madhya Pradesh, Maharashtra, Tamil Nadu and India as a whole. In Bihar and Karnataka, the growth rates of production and productivity are positively significant in pre-WTO period, while in post-WTO period significant higher growth rate is found to be in area. The area in Uttar Pradesh has observed negative growth in both the periods and production and productivity recorded significant higher positive growth rates in pre-WTO period. The above findings are in line with Ranjana et al. (2017) and Yogesh (2017).

Table 1. Compound annual growth rates in area, production and productivity of maize in India and other selected states.

States	Description	Pre-WTO	Post-WTO	Overall
Andhra Pradesh + Telangana	Area	-0.35^{NS}	5.54***	3.99***
	Production	2.21^{NS}	8.34***	7.5***
	Productivity	2.58*	2.65***	3.38***
Bihar + Jharkhand	Area	-0.71^{NS}	1.71***	0.76***
	Production	4.06***	3.27***	3.43***
	Productivity	4.82***	1.53***	2.65***
Karnataka	Area	6.51***	6.67***	7.43***
	Production	8.16***	6.75***	7.81***
	Productivity	1.54***	0.072^{NS}	0.36*
Madhya Pradesh + Chhattisgarh	Area	0.93***	1.75***	0.83***
	Production	2.97*	2.52***	2.26***
	Productivity	2.05^{NS}	1.32*	1.45***
Maharashtra	Area	7.60***	8.59***	8.77***
	Production	6.80**	11.94***	10.92***
	Productivity	-0.72^{NS}	3.08***	1.98***
Tamil Nadu	Area	5.89***	11.18***	9.86***
	Production	4.31**	20.88***	13.66***
	Productivity	-1.78^{NS}	8.71***	3.38***
Uttar Pradesh + Uttaranchal	Area	-0.66**	-1.88***	-1.45***
	Production	2.87**	-0.63^{NS}	0.21^{NS}
	Productivity	3.55***	1.28**	1.68***
India	Area	0.18^{NS}	2.30***	1.46***
	Production	2.49***	4.95***	3.95***
	Productivity	2.51***	2.59***	2.45***

***, ** and * indicate significance at 1, 5 and 10 per cent probability level; NS – Non-significant, respectively.

Overall, the area, production and the productivity of maize in India grew significantly at 1.46, 3.95 and 2.45 per cent per annum, respectively. All the major maize producing states registered significant growth rates in area, production and productivity except Uttar Pradesh, where it is observed negative growth in area and production remained stagnant. It is to be noted that productivity of Uttar Pradesh has been significant at 1.68 per cent per annum. The growth rates of Tamil Nadu remained positively significant with 9.86, 13.66 and 3.38 per cent per annum in area, production and productivity of maize, respectively.

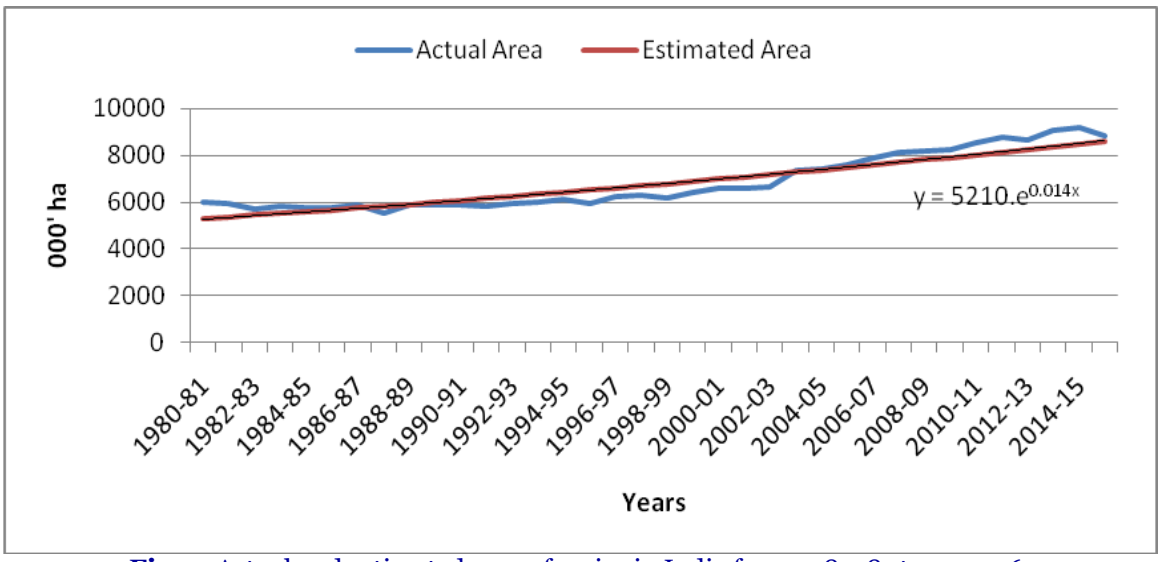

Fig. 1: Actual and estimated area of maize in India from 1980-81 to 2015-16.

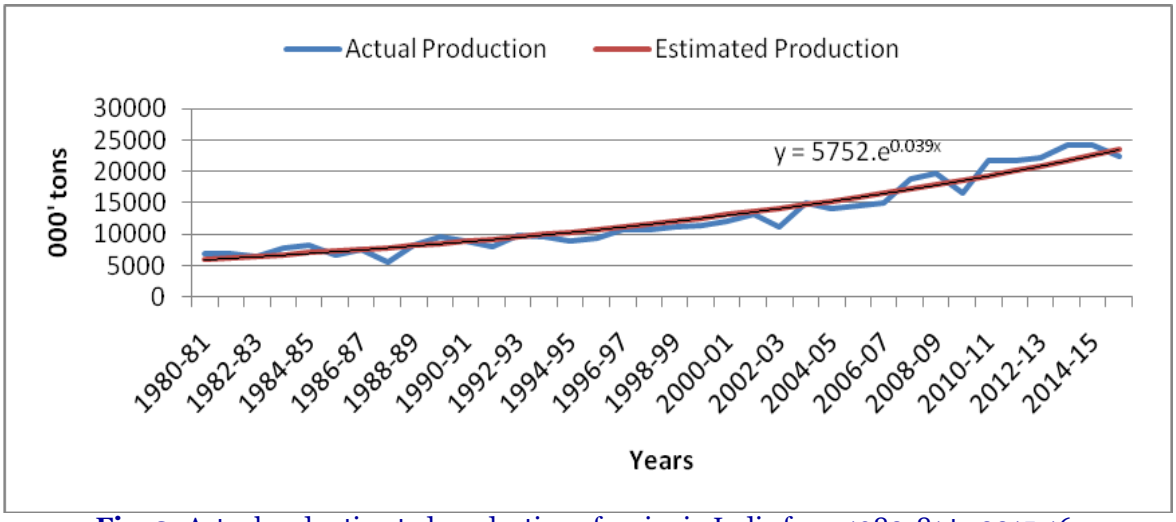

Fig. 2: Actual and estimated production of maize in India from 1980-81 to 2015-16.

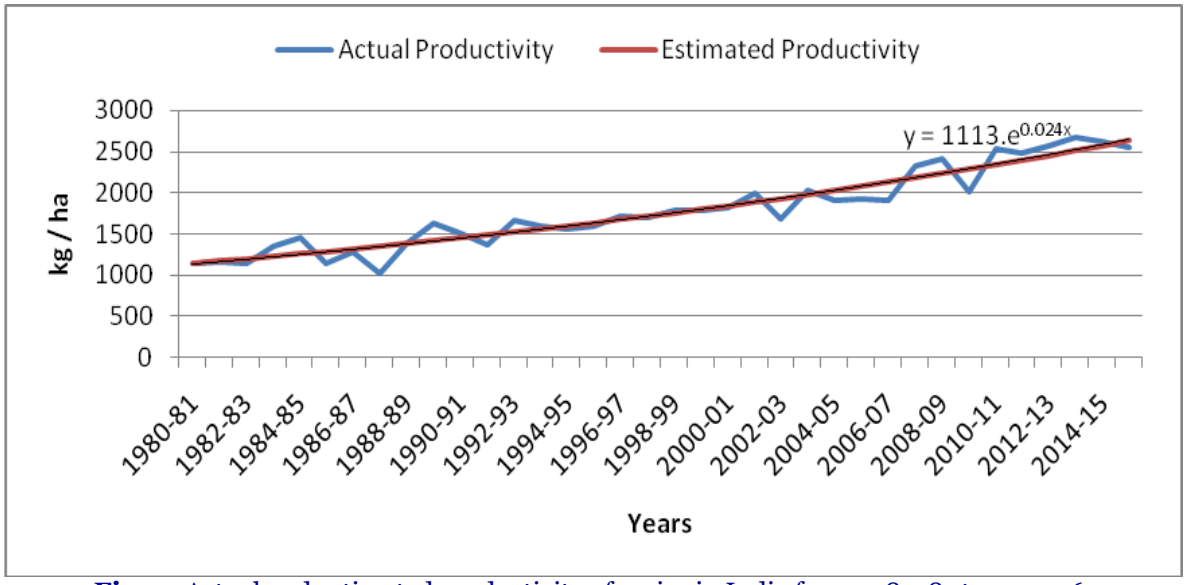

Fig. 3: Actual and estimated productivity of maize in India from 1980-81 to 2015-16.

Instability indices in area, production and productivity of maize

The results of instability indices in area, production and productivity of maize in major maize producing states as well as India for the given periods are presented in Table 2 and discussed below.

Table 2 with respect to area indicates that all the major maize producing states and India as a whole except Andhra Pradesh and Tamil Nadu, all the major maize producing states are showing low instability during the overall period, which varies in the range of 2.33 to 14.77. The state Tamil Nadu remained to be in the category of medium instability during pre as well as post WTO periods. If we consider India as a whole, the area under maize remained in the category of low instability in both pre WTO and post WTO period. It clearly shows area under maize is not fluctuating much over a time period at country level whereas, some extent of fluctuation can be seen at different states level. None of the major states found exhibiting high instability in any of the period with respect to area under maize.

High instability has been observed in maize production in Tamil Nadu during both pre and post WTO periods as well as for entire study period. The results further reveal that all along the study period Bihar and India as a whole remained

in low instability category for production, whereas, Andhra Pradesh, Karnataka, Madhya Pradesh and Uttar Pradesh fall in the category of medium instability. When it comes to Maharashtra, which was in the category of high instability during pre WTO period comes under medium instability with large decline in trend in post WTO period but remained to be in high instability category during overall period.

The table further reveals that during entire study period, it is seen that there is even distribution of states under low and medium instability categories, except Tamil Nadu which shows high instability with respect to productivity of maize. Although Karnataka, Bihar and Maharashtra are showing increase in instability indices from pre WTO period to post WTO period, they are remaining in their respective categories as they were in earlier period. But India as a whole falls in low instability category with decrease in magnitude over a period of time.

Table 2. Instability indices in area, production and productivity of maize for selected states and India.

States	Description	Period I	Period II	Overall Period
Andhra Pradesh + Telangana	Area	4.87 (L)	12.49 (L)	18.12 (M)
	Production	24.06 (M)	21.56 (M)	25.19 (M)
	Productivity	22.71 (M)	14.13 (L)	15.94 (M)
Bihar + Jharkhand	Area	11.42 (L)	4.69 (L)	10.00 (L)
	Production	12.07 (L)	14.17 (L)	12.68 (L)
	Productivity	10.62 (L)	11.55 (L)	11.73 (L)
Karnataka	Area	6.08 (L)	10.47 (L)	9.98 (L)
	Production	12.81 (L)	19.27 (M)	16.66 (M)
	Productivity	8.21 (L)	13.17 (L)	12.45 (L)
Madhya Pradesh + Chhattisgarh	Area	2.21 (L)	9.87 (L)	9.13 (L)
	Production	26.50 (M)	25.32 (M)	24.17 (M)
	Productivity	23.42 (M)	20.35 (M)	19.51 (M)
Maharashtra	Area	25.71(M)	10.98 (L)	14.77 (L)
	Production	46.09 (H)	23.87 (M)	30.25 (H)
	Productivity	17.64 (M)	19.55 (M)	21.24(M)
Tamil Nadu	Area	19.17 (M)	15.37 (M)	21.40 (M)
	Production	30.01 (H)	38.28 (H)	49.63 (H)
	Productivity	24.94 (M)	36.95 (H)	46.29 (H)
Uttar Pradesh + Uttaranchal	Area	4.69 (L)	5.51 (L)	5.13 (L)
	Production	22.06 (M)	15.22 (M)	18.05 (M)
	Productivity	22.58 (M)	13.89 (L)	14.10 (L)
India	Area	2.33 (L)	2.71 (L)	6.28 (L)
	Production	12.08 (L)	7.78 (L)	12.12 (L)
	Productivity	10.62 (L)	6.73 (L)	8.43 (L)

L-Low Instability, M-Medium Instability, H-High Instability.

Table 3. Determinants of maize production in India.

Variable	At level Coefficient	Standard Error	At difference Coefficient	Standard Error
Constant	-12.47*	1.96		
Area sown	0.42^{NS}	0.29	0.53*	0.29
Irrigated area	0.22*	0.11	0.22*	0.11
Rainfall	0.22***	0.06	0.23***	0.05
Quality seed	0.45***	0.14	0.47***	0.10
Fertilizer	-0.35***	0.09	-0.37***	0.06
Human labour	1.54***	0.36	1.55***	0.24
Animal labour	0.10*	0.05	0.12***	0.04
MSP	0.27***	0.06	0.24***	0.03
R^2	0.99		0.97	
DW Stat	2.30		1.95	

***, ** and * indicate significance at 1, 5 and 10 per cent probability level; NS – Non-significant, respectively

Table 4. Determinants of maize production in the selected states.

Selected States	Particulars	Constant	Area	Irrigation	Rainfall	Fertilizer	Animal labour	Human labour	MSP	R^2	DW Stat
Andhra Pradesh + Telangana	At level	2.07 (1.74)	0.53*** (0.14)	0.80*** (0.09)	0.13 (0.24)	-0.03 (0.19)	-0.13 (0.87)	-0.07 (0.13)	-0.30** (0.11)	0.99	2.38
	At difference		0.47** (0.17)	0.74*** (0.14)	0.39 (0.25)	0.12 (0.24)	-0.06 (0.08)	-0.14 (0.19)	-0.20 (0.18)	0.95	1.98
Bihar + Jharkhand	At level	-10.07** (3.91)	2.39*** (0.49)	-1.27** (0.53)	-0.26 (0.17)	0.34** (0.15)	0.09 (0.65)	0.86** (0.30)	0.54*** (0.12)	0.927	1.91
	At difference		2.56*** (0.53)	-2.08*** (0.63)	-0.25 (0.17)	0.39** (0.16)	0.01 (0.07)	0.69** (0.31)	0.47* (0.24)	0.71	2.17
Karnataka	At level	-3.71 (5.00)	1.05 (0.60)	0.26 (0.53)	0.59 (0.49)	0.32 (0.29)	-0.05 (0.34)	-0.13 (0.47)	-0.28 (0.28)	0.96	1.99
	At difference		1.09 (0.71)	0.37 (0.63)	0.50 (0.29)	0.20 (0.29)	0.03 (0.28)	0.07 (0.63)	-0.35 (0.49)	0.78	2.15
Madhya Pradesh + Chhattisgarh	At level	-25.18*** (5.62)	2.64*** (0.46)	-0.89*** (0.25)	0.67*** (0.20)	0.18 (0.13)	-0.24 (0.23)	1.25** (0.49)	0.81*** (0.25)	0.89	1.93
	At difference		1.88** (0.64)	-0.52* (0.30)	0.48** (0.20)	0.12 (0.12)	-0.14 (0.20)	0.87* (0.45)	0.80** (0.34)	0.61	1.83
Maharashtra	At level	-6.74 (6.00)	1.69 (1.42)	-0.84 (1.49)	0.75* (0.40)	-0.44 (0.37)	-0.12 (0.42)	-0.06 (0.67)	0.66 (0.64)	0.95	1.95
	At difference		1.39** (0.57)	-0.76 (0.76)	0.73** (0.30)	-0.55** (0.22)	-0.21 (0.24)	0.07 (0.41)	0.61 (0.55)	0.69	2.36
Tamil Nadu	At level	25.79** (8.00)	-6.54 ** (2.36)	5.23** (1.50)	-0.99* (0.45)	-1.62 (1.48)	0.07 (0.06)	0.38 (0.06)	0.88 (0.77)	0.97	2.39
	At difference		-5.13** (2.32)	4.47** (1.46)	-1.01* (0.38)	0.52 (1.41)	0.06 (0.09)	0.02 (1.64)	-0.17 (1.27)	0.88	1.81
Uttar Pradesh + Uttarakhand	At level	-14.56*** (4.09)	1.48*** (0.50)	1.04** (0.45)	0.05 (0.13)	0.11 (0.16)	-0.01 (0.05)	0.50 (0.05)	0.28 (0.17)	0.72	2.06
	At difference		1.47*** (0.44)	1.14** (0.48)	-0.06 (0.12)	0.29 (0.14)	0.06 (0.06)	0.52* (0.25)	0.12 (0.32)	0.79	1.99

***, ** and * indicate significance at 1, 5 and 10 per cent probability level; NS – Non-significant, respectively.

Determinants of maize production

Determinants of maize production in India

The results of factors affecting the maize production in India for the period from 1996-97 to 2015-16 are represented in Table 3. The variable area sown has found non-significant at level and other selected variables were significantly affecting the maize production in India. At difference, the variables rainfall, quality seed consumption, fertilizer used, human and animal labour used and MSP are found highly significant at 1 per cent level of significance whereas, area sown and irrigation is significant at 10 per cent level of significance. The selected variables had positive association with maize production except fertilizer used having negative relationship. Similar kind of results was obtained by Mech (2017).

Determinants of maize production in selected states

The Table 4 represents the factors affecting the maize production in selected states for the period from 1996-97 to 2015-16. The results showed that the variables area sown and irrigated area are having positive relationship with the maize production and found significant in states of Andhra Pradesh and Uttar Pradesh. In Bihar, the variables area sown, irrigated area, fertilized used, human labour and MSP had found significant in affecting its production, but the irrigated area with negative relationship. None of the selected variables are noticed significant in affecting maize production of Karnataka. On the other hand, the maize production of Madhya Pradesh was positively and significantly affected by the variables area sown, rainfall, human labour and MSP, whereas irrigation is having negative association and significant. In case of Maharashtra, Rainfall had played major role in determining maize production along with area sown. The variable irrigated area is found key factor in increasing maize production of Tamil Nadu, whereas area sown and rainfall had noticed significant with negative association.

Conclusion

The significant higher growth rates in area, production and productivity of maize are found during post-WTO in the states of Andhra Pradesh, Madhya Pradesh, Maharashtra, Tamil Nadu and India as a whole. In the overall period, the area, production and productivity of maize in India grew significantly at the rate of 1.46, 3.95 and 2.45 per cent per annum, respectively. The instability indices are low for area, production and productivity of maize in India during the pre as well as post WTO period showing that there is not much fluctuation over time periods. Tamil Nadu is the only state among the selected ones to show high instability in production during both pre and post WTO periods, whereas, Maharashtra indicated the presence of high instability in production during pre WTO period. The variable irrigated area is found as a key factor in increasing maize production in Tamil Nadu. All the possible factors are found to be affecting the maize production positively in India except fertilizers which has negative relationship.

The major part of maize area in India is rain fed. Rainfall is one among the limiting factors in maize production, which led to low productivity due to prolonged dry spells. Therefore, there is a need to explore the possibilities i.e. educating the farmers to use high quality seed or drought mitigation strategies to provide technical know-how and other support to the farmers in order to increase maize productivity.

Conflict of interest statement

Authors declare that they have no conflict of interest.

References

Available:https://www.indiastat.com/agriculture-data/2/agricultural_production/225/maize/17199 /stats.aspx

Mech, A., 2017. An analysis of growth, instability and determinants and rice production in Assam. Indian J. Agric. Res. 51(4), 355-359.

Ministry of Agriculture and Farmers' Welfare of India, 2017. Season-wise area, production and productivity of Maize in India (Accessed on 22nd December 2017).

Ranjana, A., Thakar, K. P., Burak, S. S., Arti, A., 2017. Production and export performance of Indian groundnut. Int. J. Agric. Sci. 9(4), 3724-3727.

Sihmar, R., 2014. Growth and instability in agricultural production in Haryana: A district level analysis. Int. J. Scient. Res. Publ. 4(7), 1-12.

United States Department of Agriculture. 2016. Maize Outlook. Foreign Agricultural Service.

Yogesh, H. C., 2017. An economic analysis of production and export of Flue Cured Virginia (FCV) tobacco in India. M.Sc. Thesis, Govind Ballabh Pant Agricultural University, Pantnagar, India.

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