

Research Paper

Future Outlook of Maize Sector in Pakistan: A 2030 Perspective

Nabeel Hussain¹, Chetna², Pradeep Mishra^{3*}, Yashpal Singh Raghav⁴, Rajani Gautam⁵ and Supriya⁶

¹Department of Agricultural Economics and Management, China Agricultural University, Beijing, China

²Department of Mathematics & Statistics, CCSHAU, Hisar, Haryana, India

³College of Agriculture, Rewa, Jawaharlal Nehru Krishi Vishwavidyalaya, Madhya Pradesh, India

⁴Department of Mathematics, Faculty of Science, Jazan University, KSA.

⁵Pandit S.N. Shukla University, Shahdol, Madhya Pradesh, India

⁶Department of Agricultural Economics, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, India

*Corresponding author: pradeepjnkvv@gmail.com (ORCID ID: 0000-0003-4430-886X)

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ABSTRACT

The objective of this study is to measure compound growth and predict future area, production and yield of maize in Punjab province and entire Pakistan using time series data collected from various government reports for the period of 1981-2019. Area, production and yield under maize crop showed positive compound growth in Punjab province and Pakistan as a whole. However, the above indicators were higher for Punjab province than entire Pakistan. Forecasting of maize crop in Pakistan and Punjab province indicated that the area, production and yield will increase by 2030. As Punjab province is a leading contributor of maize production, the increase in area, production and yield will significantly impact the overall economy and livelihoods of the people. This calls for standard maize growing policy and comprehensive actions by government to provide subsidies on inputs availability and to conserve water.

HIGHLIGHTS

- Area, production and yield of maize increased in Punjab Province and Pakistan during 2019 over 1981 and the rate of increase was higher for the province than entire Pakistan.

Keywords: Maize, Time series, Compound growth, Forecasting, Pakistan

Agriculture plays an indispensable role in the overall economic growth of Pakistan and it is the second largest sector of the national economy and possesses a share of about 19.2% in the overall Gross Domestic Product (GDP) (GoP, 2021). It provides employment to about 38.5% of the total labour force (GoP, 2021). However, approximately 65-70% of the total population lives in rural areas and hangs on with agricultural sector for their living (GoP, 2021). This sector plays an essential role in providing employment, food security and poverty alleviation. Agricultural sector in Pakistan can be

uplifted by increasing agricultural productivity that requires adoption of new approaches and modern technology.

In Pakistan, maize crop is cultivated for food, animal feed and fodder purposes. It ranks second in terms of production after wheat crop; however, it ranks third in terms of cultivated area after wheat and rice crops (GoP, 2021). Maize crop adds a value

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of about 3.4% to the agriculture sector and 0.6% to the overall country's GDP (GoP, 2021). In 2020-21, maize is cultivated on about 6.41% of the total cultivated area and accounts for about 19.16% of the major cereal crops production (GoP, 2021). Its production has increased by 7.4% due to an increase in area and availability of improved seed variety. Maize crop is mainly produced in Punjab and Khyber Pakhtukhwa provinces of Pakistan (Tariq and Iqbal, 2010). In the recent past, maize has become a major competitor for rice and cotton crops in Punjab province of Pakistan owing to shortage of irrigation water, issue of seed varieties, price instability and inadequate availability of inputs. During 2018-19, in Punjab province, maize is cultivated in an area of about 899.7 thousand hectares and accounts for a production of about 5915.5 thousand tonnes (GoP, 2019). The average yield of Punjab is about 8 thousand kg per hectare that is much higher as compared to Khyber Pakhtunkhwa province (about 1.92 thousand kg per hectare). The yield of maize crop increases gradually each year by introducing new varieties, however, lack of credit facilities, non-availability of sufficient inputs, imperfect labour market, and high prices of input endowment adversely affects the crop yield (Ali *et al.* 2019). Pakistan has a lower production record of maize in the world, of about 7.24 million tonnes, whereas, United States of America is the largest maize producing country in the world with a production of about 347.05 million tonnes followed by China (260.95 million tonnes), Brazil (101.14 million tonnes), Argentina (56.86 million tonnes), Ukraine (35.88 million tonnes), Indonesia (30.69 million tonnes), India (27.71 million tonnes), Mexico (27.23 million tonnes), Russia (14.28 million tonnes), Canada (13.40 million tonnes), South Africa (11.27 million tonnes), Nigeria (11.00 million tonnes), and Philippines (7.98 million tonnes) (FAO, 2019).

Although, the maize yield in Pakistan has increased three times during the last two decades, per hectare yield is still far behind as compared to the rest of the world. Thus, production of hybrid seeds domestically on a larger scale is the only alternative to cover the gap. Pakistan is a food insecure country, and wheat being the first major cereal crop remained short of demand during the past several years (Koondhar *et al.* 2018). However, maize is a major staple crop for the food insecure

countries and can be used as a food for human beings to heighten food security. Hence under the present food insecurity scenario, there is a dire need to increase the production of hybrid seeds so that can be easily available to the farmers to improve the average yield per hectare. Maize yield in Pakistan, however, is below a potential variable.

In the past, several research studies have been carried out to forecast production of different crops in Pakistan. For example, Amin *et al.* (2014) forecasted wheat production; Abid *et al.* (2018) forecasted area and production of potato crop; Ahmad *et al.* (2017) forecasted area, production and yield of major crops; and Mehmood *et al.* (2019) forecasted sugarcane production in Pakistan. However, less research was conducted to forecast maize production in Pakistan, such as, Tahir and Habib (2013) forecasted maize area and production and Abid *et al.* (2014) forecasted maize area and production in Khyber Pakhtunkhwa province of Pakistan. In the recent past, no research is carried out to forecast maize area, production and yield in Punjab province and Pakistan, hence, this research study was planned to forecast area, production and yield of maize crop in Punjab province and entire Pakistan.

This study emphasizes to estimate time series analysis of the maize area, production and yield in Punjab province and Pakistan. Furthermore, the study entails forecasting maize area, production and yield to visualize future trends in Punjab province and Pakistan. Forecasting is an important tool to decision making and scheduling future prediction more effectively, so it is assumed that forecasting will be helpful in planning maize production policy for forthcoming years.

MATERIALS AND METHODS

Punjab is the leading maize producing province of the country; hence the present study was mainly focused on Punjab province and Pakistan. The study was based on time series data on maize area, production and yield in Punjab province and entire Pakistan, retrieved from Pakistan Bureau of Statistics.

Compound growth rate

Compound growth rate is used to measure the mean growth rate over a specified period of time longer

than one year and was applied by Mehmood *et al.* (2019) to calculate the compound growth of cotton crop in Pakistan; used by Ikuemonisan *et al.* (2020) to measure trends, instability and decomposition analysis of cassava production in Nigeria; and Ayele *et al.* (2021) to study trend, instability and decomposition analysis of coffee production in Ethiopia. In the present study, the compound growth rate (Ali *et al.* 2017; Yadav *et al.* 2022 & Ashraf *et al.* 2018) was calculated by setting 2018 as base year by employing the following formula:

$$Z_t = Z_0(1+r)^t \quad \dots(1)$$

Where, Z_t presents area, production and yield in year t . Z_0 indicates area, production and yield during base year, whereas, r is the compound growth rate (Ali *et al.* 2017 & Ashraf *et al.* 2018). So,

$$\text{CGR} = \left(\frac{\text{Last_year}}{\text{First_year}} \right)^{1/\text{No. of years}} - 1 \quad \dots(2)$$

Forecasting

The area, production and yield of maize crop for the next 11 years were forecasted on the basis of compound growth rate by keeping 2017 as the base year. However, various factors such as adulterated inputs, unapproved varieties, climatic variability, and non-adoption of improved practices, production risks, and market fluctuations that affect the productivity were kept constant. The forecasting equation is given as follows:

$$Z_{t+1} = Z_t + (Z_t * r) / 100 \quad \dots(3)$$

Where, Z_t indicates base year (i.e. 2017) and r is calculated compound growth rate.

RESULTS AND DISCUSSION

The compound growth rate as delineated in Table 1 indicates that area, production and yield exhibited positive growth in Punjab province and Pakistan. The positive behavior of area under maize is pertinent to shifting of majority of maize growers towards cultivation of maize crop. Growers increase area and production of maize crop because of better hybrid varieties being available from private companies, active involvement of multinationals

(Tariq and Iqbal, 2010) and better economic returns (GoP, 2022). Similarly, availability of improved high yield seed varieties and favorable weather conditions plays a prominent role in increasing production of maize crop (GoP, 2022). Therefore, area, production and yield of maize crop in Punjab province show a much higher positive growth rate because of the increase in the use of maize grain in poultry industry (Tariq and Iqbal, 2010).

Table 1: Compound growth rate of maize in Punjab province and Pakistan

	Punjab	Pakistan
Area	2.72%	1.69%
Production	7.31%	5.43%
Yield	4.47%	3.67%

Table 2 depicts area, production and yield and, year wise percentage change in area production and yield of maize crop in Punjab province and entire Pakistan. Area, production and yield of maize crop show both positive and negative percentage change from 1981-82 to 2018-19 in Punjab province. The average maize area sown in Punjab during the period was about 462.3 thousand hectares with minimum and maximum values of about 311.3 thousand hectares and 899.7 thousand hectares, respectively. The average production and average yield is about 1712.1 thousand tons and 3054.5 kg/ha, respectively. Hence, this indicates that Punjab is the leading province in terms of area, production and yield of maize crop in Pakistan that can play an active role in meeting the raising demand of poultry industry. Table 2 further shows that there is a positive as well negative change in the growth rate of area, production and yield in the entire Pakistan also. The mean area sown by maize growers is about 964.3 thousand hectares with a minimum value of about 725.8 thousand hectares and maximum value of about 1373.9 thousand hectares. The mean production of maize crop is about 2512.7 thousand tons, with a minimum value of 916.2 thousand tons and maximum value of about 6826.4. The minimum and maximum quantities of yield are about 1225.5 kg/ha and 4969 kg/ha, and mean yield is about 2425.5 kg/ha.

Table 3 illustrates the forecasted maize area, production and yield in Punjab province by 2030. According to the 2030 forecast, area under maize cultivation may increase up to 10618.38 thousand

Table 2: Year wise distribution of maize area, production and yield in Punjab and Pakistan

Year	Punjab						Pakistan					
	Area		Production		Yield		Area		Production		Yield	
	'000 ha	% change	'000 tons	% change	kg/ha	% change	'000 ha	% change	'000 tons	% change	kg/ha	% change
1981-82	325		405.3		1247.1		725.8		916.2		1262.3	
1982-83	337.3	3.8	450.1	11.1	1334.4	7	789.8	8.8	1005.4	9.7	1273	0.8
1983-84	336.3	-0.3	450	0	1338.1	0.3	798	1	1013.5	0.8	1270.1	-0.2
1984-85	342.1	1.7	460	2.2	1344.6	0.5	808.8	1.4	1027.6	1.4	1270.5	0
1985-86	338.7	-1	415	-9.8	1225.3	-8.9	804	-0.6	1009.4	-1.8	1255.5	-1.2
1986-87	346.1	2.2	453.3	9.2	1309.7	6.9	816.2	1.5	1111.2	10.1	1361.4	8.4
1987-88	336.7	-2.7	404.8	-10.7	1202.3	-8.2	853.9	4.6	1126.9	1.4	1319.7	-3.1
1988-89	345.5	2.6	455.3	12.5	1317.8	9.6	865.8	1.4	1204.1	6.9	1390.7	5.4
1989-90	345.2	-0.1	455	-0.1	1318.1	0	862.9	-0.3	1179.3	-2.1	1366.7	-1.7
1990-91	319.7	-7.4	425	-6.6	1329.4	0.9	845.2	-2.1	1184.5	0.4	1401.4	2.5
1991-92	311.3	-2.6	415.3	-2.3	1334.1	0.4	847.5	0.3	1203.1	1.6	1419.6	1.3
1992-93	323.4	3.9	401.9	-3.2	1242.7	-6.8	867.5	2.4	1183.6	-1.6	1364.4	-3.9
1993-94	337.3	4.3	437.4	8.8	1296.8	4.3	878.5	1.3	1213	2.5	1380.8	1.2
1994-95	345.1	2.3	460.5	5.3	1334.4	2.9	889.5	1.3	1318.1	8.7	1481.8	7.3
1995-96	334.1	-3.2	450.8	-2.1	1349.3	1.1	880.8	-1	1283.4	-2.6	1457.1	-1.7
1996-97	325.4	-2.6	450.2	-0.1	1383.5	2.5	871.1	-1.1	1259.4	-1.9	1445.8	-0.8
1997-98	321.7	-1.1	427.9	-5	1330.1	-3.9	868.6	-0.3	1251.2	-0.7	1440.5	-0.4
1998-99	413.9	28.7	828.2	93.5	2001	50.4	962.2	10.8	1664.9	33.1	1730.3	20.1
1999-00	411.4	-0.6	817.2	-1.3	1986.4	-0.7	961.7	-0.1	1652	-0.8	1717.8	-0.7
2000-01	397.4	-3.4	748.5	-8.4	1883.5	-5.2	944.1	-1.8	1643.3	-0.5	1740.6	1.3
2001-02	392.6	-1.2	741.9	-0.9	1889.7	0.3	941.6	-0.3	1664.4	1.3	1767.6	1.6
2002-03	419.5	6.9	882.9	19	2104.6	11.4	935.5	-0.6	1737.1	4.4	1856.9	5
2003-04	427.5	1.9	1019.8	15.5	2385.5	13.3	947.1	1.2	1897.4	9.2	2003.4	7.9
2004-05	475	11.1	1934.6	89.7	4072.8	70.7	981.8	3.7	2797	47.4	2848.8	42.2
2005-06	540.8	13.9	2319.4	19.9	4288.8	5.3	1042	6.1	3109.6	11.2	2984.3	4.8
2006-07	492.5	-8.9	2161.9	-6.8	4389.6	2.4	1016.9	-2.4	3088.4	-0.7	3037.1	1.8
2007-08	534.5	8.5	2694	24.6	5040.2	14.8	1051.7	3.4	3604.7	16.7	3427.5	12.9
2008-09	534.4	0	2627.2	-2.5	4916.2	-2.5	1052	0	3593	-0.3	3415.4	-0.4
2009-10	504.9	-5.5	2501.5	-4.8	4954	0.8	935.1	-11.1	3261.5	-9.2	3488	2.1
2010-11	543.6	7.7	2959.1	18.3	5444	9.9	974.3	4.2	3706.9	13.7	3805	9.1
2011-12	603.9	11.1	3441.7	16.3	5699	4.7	1087.3	11.6	4338.3	17	3990	4.9
2012-13	587.7	-2.7	3353.1	-2.6	5705	0.1	1059.5	-2.6	4220.1	-2.7	3983	-0.2
2013-14	689.3	17.3	4020.8	19.9	5833	2.2	1168.5	10.3	4944.2	17.2	4231	6.2
2014-15	672.8	-2.4	4019.9	0	5975	2.4	1142.5	-2.2	4936.8	-0.1	4321	2.1
2015-16	716.1	6.4	4391.2	9.2	6132	2.6	1191.2	4.3	5270.9	6.8	4425	2.4
2016-17	868.2	21.2	5237.1	19.3	6032	-1.6	1348.4	13.2	6134.2	16.4	4549	2.8
2017-18	770.3	-11.3	5028	-4	6527	8.2	1250.8	-7.2	5901.6	-3.8	4718	3.7
2018-19	899.7	16.8	5915.5	17.7	6575	0.7	1373.9	9.8	6826.4	15.7	4969	5.3
Mean	462.3		1712.1		3054.5		964.3		2512.7		2425.5	
SD	162.2		1656.3		2029.1		153.2		1722.9		1268.4	
Min	311.3		401.9		1202.3		725.8		916.2		1255.5	
Max	899.7		5915.5		6575		1373.9		6826.4		4969	

hectares, production may rise up to 11310.57 thousand tons, and yield may increase up to 7329.20 kg/ha. However, area has lower future growth rate as compared to future production growth rate. Further, the increase of maize production in Punjab province could boost up the national economy as Punjab is the major maize producing province. In addition, livelihoods of the maize growers will gain sustainability.

Table 3: Forecasted area, production and yield of maize in the Punjab Province

Year	Area (000 ha)	Production (000 Tons)	Yield (kg/ha)
2019	6124.42	6991.61	4930.29
2020	6438.60	7304.13	5111.23
2021	6768.90	7630.63	5298.82
2022	7116.14	7971.71	5493.28
2023	7481.20	8328.05	5694.89
2024	7864.99	8700.31	5903.89
2025	8268.46	9089.22	6120.56
2026	8692.63	9495.51	6345.18
2027	9138.57	9919.95	6578.05
2028	9607.38	10363.38	6819.47
2029	10100.23	10826.62	7069.74
2030	10618.38	11310.57	7329.20

Table 4 presents forecasted maize area, production and yield in Pakistan from year 2019 to 2030, which shows that with each passing year, area under maize cultivation will increase from about 766.21 thousand hectares in 2019 to about 981.85 thousand hectares in 2030, while production will also rise to about 1453.16 thousand tons in year 2030. Maize yield is also expected to rise up to 11382.26 kg/ha in 2030. It is important to say that forecasted production growth rate of maize crop is higher than forecasted area growth rate in Pakistan. Furthermore, an ascent of maize area, production and yield is necessary to meet its demand in the country.

Table 4: Forecasted area, production and yield of maize in Pakistan

Year	Area ('000 ha)	Production ('000 Tons)	Yield (kg/ha)
2019	766.21	1243.04	5385.44
2020	783.68	1260.81	5764.58
2021	801.54	1278.84	6170.41
2022	819.82	1297.13	6604.80
2023	838.51	1315.68	7069.78

2024	857.63	1334.49	7567.49
2025	877.18	1353.58	8100.24
2026	897.18	1372.93	8670.50
2027	917.64	1392.56	9280.90
2028	938.56	1412.48	9934.28
2029	959.96	1432.68	10633.65
2030	981.85	1453.16	11382.26

Positive increase in future production can be possible by the availability of high yielding varieties, timely availability of inputs and proper use of inputs for maize crop in Pakistan (Tahir and Habib, 2013).

CONCLUSION

Estimation of compound growth rate of maize area, production and yield was positive in Pakistan as well as in Punjab province. Furthermore, maize area, production and yield are forecasted and observed to increase in Punjab province and the entire Pakistan in the coming years. This increase in maize crop could play a major role in the boost up of livelihood of the maize growers and the economy as a whole. Maize is an important food and feed crop of Pakistan and it is required to increase production to meet domestic need. This study exhorts the government to support maize policy and take preliminary action to subsidize inputs and conserve water for sustained utilization of water. Furthermore, there is a dire need to strengthen role of extension service providers, increase capacity building of farmers and improve efficiency of marketing system.

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