



Research Article

A Trend Analysis: Forecasting Growth Performance of Production and Export of Chilli in Pakistan

Mehar Ul Nissa Rais^{1*}, Tahmina Mangan¹, Jam Ghulam Murtaza Sahito¹ and Naeem Ahmed Qureshi²

¹Department of Agricultural Economics Sindh Agriculture University Tandojam, Pakistan; ²Department of statistics Sindh Agriculture University Tandojam, Pakistan.

Abstract | Chilli is an economically very important and valuable crop of Pakistan, which is consumed domestically and exported throughout the world. The present research was carried out to examine province wise production, export growth performance and forecasting of chilli in Pakistan. Annual time series data of 38 years (1981-2018) of chilli production and export was employed for this study. Overall, chilli production of the Pakistan exhibited a positive growth of 1 percent over the time; however, in Pakistan negative growth was recorded during 2001-02 and 2011-12, these losses can be attributed to major floods, diseases attack, poor management practices and shortage of high yielding varieties. Sindh is major producer of chilli with 85 percent contribution in chilli production of Pakistan. Sindh and Balochistan provinces depicted a positive growth of 0.016 percent and 0.035 percent, respectively. Growth performance of Punjab and Khyber Pakhtunkhwa provinces portrayed negative growth rate -0.044 percent and -0.006 percent, respectively. Forecasting model indicates R^2 value of 0.45 percent, which is a positive sign of increase in production and export in the next 10-18 years. Based on findings, there is a need to organize the training programs to increase the awareness among the chilli growers to increase chilli production and quality for increase export share in the world market.

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***Correspondence** | Mehar Ul Nissa Rais, Department of Agricultural Economics Sindh Agriculture University Tandojam, Pakistan; **Email:** meharris123@gmail.com

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Introduction

Chilli (*Capsicum annum* L.) is one of the essential vegetable crops, which is cultivated almost all around the world and cultivated over an area of 1.856 million hectares with a production of 4.626 million tons (Mondal *et al.*, 2012). Nutritionally it is a rich source of vitamin A, C, E, P and contains medicinal properties (Choudhary *et al.*, 2009). The major chilli producing countries are India, Myanmar, Bangladesh, Pakistan, Thailand, Vietnam, Romania, China, Nigeria and Mexico (Russel and Paterson, 2007). Asian countries are the largest producer of chilli in the world

(GOP, 2019). In Pakistan chilli was cultivated on an area of 157.9 thousand acres with a production of 142.9 thousand tonnes in year 2017-18 (GOP, 2018). Sindh province contributes about 85 percent in overall chilli production in Pakistan (GOP, 2018). Overall chilli production of Pakistan portrays a decreasing trend, the productivity had fallen 5.54 percent in year 2007 to 3.2 percent in year 2017 (Hussain and Abid, 2011). However, the production of chilli was 172.8 thousand tons that decreased to 126.2 thousand tons in year 2016-17 (GOP, 2017). Similarly, the recent trends of chilli production in Sindh dropped in year 2009-10. Not only in production but there are also problems

with export of chilli from Pakistan. Data reveals the amount of chilli exported from Pakistan declined from 3.585 thousand tons in year 2009-10 to 3.268 thousand tons in year 2017-18 (GOP, 2018). Like other horticultural products in Pakistan, chilli suffers from low productivity, low quality, high wastage and low exports (Parveen *et al.*, 2018). Though, farmers have very less access to modern farming production practices and techniques (Channa *et al.*, 2020). Many factors influenced the production of chilli crop including environmental factors, insect pests, diseases, shortage of water, soil fertility and shortage high yielding varieties which caused heavy losses of chilli crop (Muhammad *et al.*, 2017). Pakistan has not yet been able to capture a fair share in the world chilli export market (Ali *et al.*, 2018). Previous studies have ignored the province wise assessment of the trends and growth chilli production and export in the Pakistan. Thus, the present study aims to evaluate the status and growth performance of Pakistan's chilli production, export fluctuations and the actual reasons of low productivity and growth. Furthermore, an analysis of forecasting was use to predict the future chilli production for next eighteen years. The research will be helpful to agricultural policy makers and government officials to improve policy with reference chilli production and export.

Materials and Methods

For this study, annual data of chilli production for the years 1981-2017 was retrieved from Agricultural statistics of Pakistan (GOP, 2018) and chilli export data from 2002 to 2017 from Pakistan Economic Survey (GOP, 2018). The data was analyzed to assess the growth performance of chilli production in four provinces and export of Pakistan. For calculation of growth performance, we used annual growth rates and compound growth rates, the formulas of AGR and CGR are as under were applied:

Annual growth rate (AGR)

$$g_z = \left(\frac{Z_T - Z_0}{Z_0} \right) \quad (1)$$

Where;

g_z = Annual growth rate; Z_T = Current value of variable; Z_0 = Previous value of the variable.

Compound annual growth rate (CAGR)

$$G_z = \left(\frac{Z_T}{Z_0} \right)^{1/T} - 1 \quad \dots \dots (1)$$

Where;

G_z = Average annual growth rate; X_0 = Initial value of variable; X_T = Final value of variable; 0 = Base year; T = Final year.

Forecasting method

Forecasting is a technique that uses historical data as inputs to make informed estimates that are predictive in determining the direction of future trends (Adil *et al.*, 2004). Data used in this study are annual chilli production in Pakistan from 1981-2017 published in Agricultural Market Information System (GOP, 2018). Before analysis the data was transformed in natural log:

$$y_t = \ln(C_t) \quad \dots (1)$$

Where;

C_t is quantity of chilli produced in a year.

Given the conditional expected value $E[C_{t+1} | C_t]$ and the variance and if we assumed the error term is normally distributed, the expected value and variance of C_{t+1} are formulated as:

$$E[C_{t+1} | C_t] = e^{E[Y_t + 1 | y_t] + \partial^2 / 2} \quad \dots (2)$$

$$\partial_C^2 = e^{2E[Y_t + 1 | y_t] + \partial^2} (e^{\partial^2} - 1) \quad \dots (3)$$

Results and Discussion

Chilli productivity of Pakistan

In this section the findings of the study are presented. Figure 1 depicted that Sindh province has the highest productivity with average 970.80 kilogram per acre as compare to other provinces of Pakistan in year 2009-2018. The second higher producer of chilli was Punjab province with 576.8 kilogram followed by Balochistan with 509.60 kilogram and Khyber Pakhtunkhwa with 438.8 kilogram. Chilli crop can thrive well under warm weather in a sandy loam type soil with a pH range of 5.5 to 8.5 (Khokhar, 2018). Uddin *et al.* (2003) reported that soils of Sindh provinces are rich in nutrients and required pH range that is needed for cultivation of chillies. It is main reason of higher productivity of chillies in sindh as compare to other provinces. Cultivation of high yielding varieties plays a significant role in enhancing chilli production. Best chilli varieties are Longi (Dundi cut), Talhari, Gothki, Tatapuri, Narwala and Qaisar in Pakistan, among all these Sanam, Ghotki, Longi, Talhari, and Kunri-1 are

mostly growing in Sindh. This is also an important factor for better chilli production in Sindh.

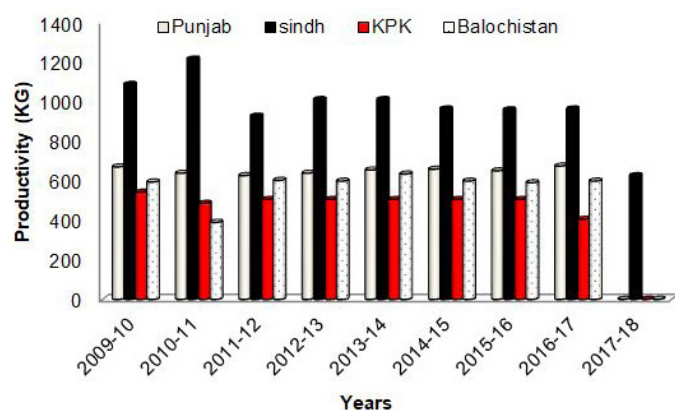


Figure 1: Province wise Chilli productivity of Pakistan.

Growth rate of chilli production

Table 1 indicated the results of Pakistan's chilli production performance. The negative annual growth rate -0.025 was observed during the year 2004, this decline is due to a number of factors including poor quality seed, mal-cultural practices and aflatoxin (Shah *et al.*, 2009). The growth in chilli production was 0.016 observed in year 2016, because crop suffered low productivity, low quality, high wastage, poor post-harvest management in chilli crop (Saima, 2019). Similarly, annual growth rate of chillies in Sindh provinces was decreased from 2.446 to -0.002 during the period 2012-13 and 2016-17, it was due to shortage of water that scorched chilli crop in the Khairpur, Hydreabad, Sanghar and Umerkot districts of the Sindh province (DAWN, 2018). Same trend was observed in Punjab Province where chilli production faced negative annual growth rate of -0.188 in 1981-82 and -0.032 in 2015-16, due to the attack of whitefly which causes virus infestation in chilli plant and whole crop was damaged rapidly in major chilli growing areas of Punjab (Muhammad *et al.*, 2017). Khyber Pakhtunkhwa with -0.006 and Balochistan 0.035 also showed a negative and significant reduction in chilli growth respectively during the period of study. The main reasons for the low chilli yield were the non-adoptability of the high yielding varieties coupled with poor farm management practice in Pakistan (Kaur, 2016). Zahoor and Arocha, (2014) reported that about 10-12 percent of the production is wasted due to poor post-harvest handling.

Forecasting of chilli production

Data presented in Table 2 shows that production of chilli will increase in future with slight variation and the estimated production of chilli will between

145.778 and 172.708 thousand tons for next eighteen years. It is the insufficient volume of chilli production for future consumption and export. Marri (2009) forecasted about the future production trend of different vegetables for next fourteen years; he stated that the growth of chillies production will be with similar pace of population growth.

Table 1: Annual production growth rates of Chilli crop in Pakistan.

Year	Sindh	Punjab	KP	Balochistan	Pakistan
1981-82	-0.007	-0.188	-0.167	0.000	-0.060
1982-83	-0.017	0.184	0.400	0.222	0.040
1983-84	-0.167	0.166	0.000	0.045	-0.066
1984-85	0.024	-0.067	0.000	0.174	-0.005
1985-86	0.013	-0.012	-0.143	0.778	0.025
1986-87	0.003	-0.223	0.000	0.104	-0.065
1987-88	-0.097	-0.093	-0.500	0.094	-0.088
1988-89	-0.133	-0.103	0.000	-0.034	-0.117
1989-90	0.876	0.423	0.000	0.036	0.687
1990-91	-0.262	-0.031	0.000	0.017	-0.196
1991-92	0.688	-0.199	0.000	0.136	0.410
1992-93	-0.585	-0.063	0.333	0.075	-0.471
1993-94	1.450	-0.014	0.000	-0.208	0.879
1994-95	-0.413	0.015	0.000	0.088	-0.329
1995-96	0.585	0.058	0.000	0.032	0.431
1996-97	0.033	0.095	0.000	-0.203	0.032
1997-98	0.022	-0.087	0.000	-0.039	0.001
1998-99	0.014	-0.241	0.000	0.020	-0.026
1999-00	-0.184	0.102	0.000	-0.360	-0.155
2000-01	0.638	0.011	0.000	-0.188	0.513
2001-02	-0.499	-0.274	0.000	0.077	-0.466
2002-03	0.103	-0.111	0.000	-0.286	0.060
2003-04	-0.027	-0.100	0.000	0.500	-0.025
2004-05	-0.055	-0.204	1.000	0.133	-0.061
2005-06	0.400	0.081	0.250	0.118	0.358
2006-07	-0.480	-0.140	-0.300	0.105	-0.434
2007-08	0.841	0.013	0.143	-0.286	0.671
2008-09	0.653	0.062	-0.125	1.067	0.617
2009-10	0.003	0.035	0.143	0.016	0.006
2010-11	-0.084	-0.101	-0.250	-0.206	-0.090
2011-12	-0.762	0.063	-0.167	0.480	-0.685
2012-13	2.446	0.129	0.000	-0.027	1.721
2013-14	-0.002	-0.063	0.000	0.000	-0.006
2014-15	-0.045	0.044	0.000	-0.139	-0.044
2015-16	0.022	-0.032	0.000	-0.016	0.016
2016-17	-0.002	0.110	-0.200	0.016	0.005
Compound growth rate	0.016	-0.044	-0.006	0.035	0.010

*Author's calculations, *Data collected from Agricultural Statistics, Pakistan.

Table 2: Eighteen years forecasting of Chilli production in Pakistan.

Years	Sindh	Punjab	KP	Balochistan	Pakistan
2017-18	130.146	4.468	0.395	6.641	145.778
2018-19	132.166	4.270	0.393	6.873	147.239
2019-20	134.216	4.080	0.390	7.113	148.715
2020-21	136.299	3.900	0.388	7.362	150.205
2021-22	138.413	3.727	0.385	7.619	151.711
2022-23	140.561	3.562	0.383	7.886	153.231
2023-24	142.742	3.404	0.381	8.161	154.767
2024-25	144.957	3.253	0.378	8.446	156.318
2025-26	147.206	3.109	0.376	8.742	157.884
2026-27	149.490	2.971	0.374	9.047	159.466
2027-28	151.809	2.840	0.371	9.363	161.064
2028-29	154.165	2.714	0.369	9.691	162.678
2029-30	156.557	2.594	0.367	10.029	164.309
2030-31	158.986	2.479	0.364	10.380	165.955
2031-32	161.453	2.369	0.362	10.743	167.618
2032-33	163.958	2.264	0.360	11.118	169.298
2033-34	166.502	2.164	0.358	11.507	170.995
2034-35	169.085	2.068	0.356	11.909	172.708

*Authors calculations, * Data collected from Agricultural Statistics, Pakistan.

Growth rate of chilli export

Growth of chilli export has gone through fluctuations from 2002-03 to 2017-18 (Table 3). As data show that amount of chillies exported was declined from 3.585 thousand tons in year 2009-10 to 3.268 thousand tons in year 2017-18 (AMIS, 2018). The results depict that annual growth rate of export negative -0.081 in 2003-04 and -0.40 in 2017-18. Pakistan is going through recession to compete the global market for chilli export faced major hindrances are higher price compared to other exporting countries, secondly lower chilli quality (Muhammad *et al.*, 2017). Chilli export of the Country can be strengthened by strictly following the quality improvement laws (GOP, 2017). Aflatoxin and chemical residues are two major constraints in the export of chillies to Europe, Japan and the US as buyers expect a high degree of hygiene and sanitation in processing and preparing chillies for export (Saima, 2019). The farmers are using low yielding varieties, they do not have access to modern farming practices and techniques (Russell and Paterson, 2007). The policies and situations need to be very supportive, fair and peaceful for trade, Pakistan's major neighbor international markets are India and Afghanistan, if agriculture commodities will not export on suitable time, ultimately farmers will not get returns of their

products (FAO, 2018).

Table 3: Pakistan's yearly Chilli export growth rates from (2002-03 to 2017-18).

Year	Chilli export (Million US\$)	Growth rate
2002-03	120.334	-----
2003-04	110.548	-0.08132
2004-05	96.287	-0.12900
2005-06	238.198	1.47383
2006-07	260.301	0.09279
2007-08	114.404	-0.56049
2008-09	124.642	0.08949
2009-10	415.326	2.33215
2010-11	212.094	-0.48933
2011-12	108.102	-0.49031
2012-13	945.06	7.74230
2013-14	304.40	-0.67790
2014-15	487.816	0.60255
2015-16	643.702	0.31956
2016-17	914.252	0.42030
2017-18	542.732	-0.40636
Average growth rate		1.09872

*Author's calculations, Data collected from Pakistan Economic survey.

Figure 2 depicts the linear forecast trend of chilli export for the next ten years from 2018-19 to 2027-28, the trend value indicates that export volume may increase to more than Rs. 25000/= till 2027-28. The R^2 value of 0.45 indicates that the future trend of export volume has a good relationship.

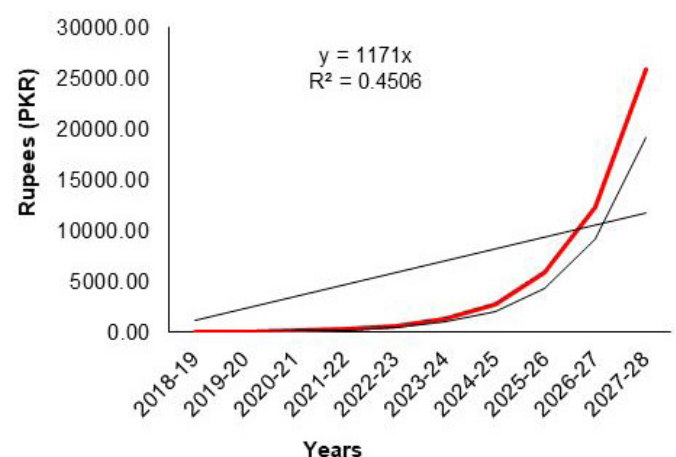


Figure 2: Ten years forecasting of Chilli export of Pakistan.

Conclusions and Recommendations

It is concluded from the present study that there are many major factors contributing in low chilli growth and productivity. It includes shortage of irrigation

water, lack of technical assistance, deficiency of nutrients in the soil, cultivation of low yielding varieties, heavy attack of insect pests, severity of aflatoxin diseases in Pakistan. Findings indicated that there is less acreage and production in Punjab and other provinces as compared to Sindh, it may be due to environmental conditions that do not suit the current chilli varieties.

Chilli export dropped (-0.40636) in year 2017-18. It is due to high contamination of disease in chilli crop, heavy price fluctuation and law and order situation at border (LOC) between Pakistan, India and Afghanistan. Forecasting model showed that positive sign of increase in production and export in the next 10-18 years. Chilli production and export could be enhancing more if the policy maker and stakeholders help the chilli farming community.

Based on the comprehensive growth performance analysis of chilli production and export, the following policy guidelines are suggested for the development of chilli production and export in Pakistan;

- Producers and growers can not only be encouraged to grow more chilli, but also increase the exportable volume of the product; they can be technically and financially supported by the federal or provincial government.
- Foreign trade missions can be considered for international market share and their need to increase chilli exports from Pakistan.
- Exporters should be encouraged to set up a supply centers in Pakistan with modern technology and well-designed centers to purchase the chilli from the producers and process it according to the needs of international buyers/importers.

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Novelty Statement

The findings of the study may have a significant impact on the policies formulation about chilli export and also can be accomplished by improving chilli production efficiency in Pakistan.

Author's Contribution

Current manuscript is the part of the Ph.D thesis the initial idea, data collection, methodology and write up was contributed by first author Ms. Mehar Ul Nissa Rais and major supervisor Prof. Dr. Tahmina Mangan while results and suggestions and proofreading was contributed to both authors Dr. Jam Ghulam Mur-taza Sahito and Dr. Naeem Ahmed Qureshi.

Conflict of interest

The authors have declared no conflict of interest.

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