ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of
DEVELOPMENT RESEARCH

International Journal of Development Research
Vol. 06, Issue, 11, pp.10301-10307, November, 2016

Full Length Research Article

TRENDS, GROWTH RATE SCENARIO AND INSTABILITY IN AREA, PRODUCTION AND PRODUCTIVITY OF MANGO FRUIT IN PUNJAB AND SINDH PROVINCES OF PAKISTAN

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ARTICLE INFO

Article History:
Received 11th August, 2016
Received in revised form
16th September, 2016
Accepted 19th October, 2016
Published online 30th November, 2016

Key Words:

Mango,
Growth,
Instability,
Horticulture,
Fungicides.

ABSTRACT

This study was undertaken with a view to analyze trend, growth rate scenario and instability of mango fruit in two different periods of Punjab and Sindh provinces of Pakistan. Period I (1970-71 to 1991-92) and Period II (1992-93 to 2013-14). The study reveals that in period I of Sindh, the increase in production growth was due to increase in its area and productivity growth both but in Punjab it was only due to increase in area growth because the productivity growth was negative. It means that the mango farmers of Sindh in period I are utilizing new farm technologies mainly because of profitability in growing mango fruit due to good qualities of trees, favourable price incentives, good irrigation facilities and climatic conditions. The study also concludes that the growth of production of mango increased in period II compared to period I in both the provinces. The study also reveals that the productivity growth of mango in Sindh recorded negative and significant growth, while in Punjab though the productivity growth become positive but statistically insignificant in period II compared to period I. The decline in productivity growth in period II compared to period I was mainly due to drought and floods from 2000 onwards, and non-availability of roads from mango garden to markets. The magnitude of instability in mango production declined in period II compared to period I. The synchronized movements in area and productivity both were responsible for low instability in mango production in period II. The study also reveals that in mango fruit, instability in production is lower than instability in productivity in period II, which indicated the importance of productivity instability.

INTRODUCTION

The horticulture sector, proved to be the engine of growth in agriculture for improving the productivity per hectare, improving the economic well being of the farming community, source of generating employment and the entrepreneurs involved in agriculture and horticulture and thereby enhancing exports and capable of earning foreign exchange. Fruits have become an integral part of human diet as they provide vitamins and minerals, the important constituents for human health (Mumzuroglu, et al., 2003). Among these fruits mango (Mangifera indica L), "King of Fruits", has been established as an emerging tropical crop in the world as well as in Pakistan. It is a delicious fruit being grown in more than 100 countries of the world. Total world production of Mango was 42140 thousand tonnes in 2012 (FAOSTAT) with developing countries accounting for about 98 percent of total production (Table 1 and Figure 1). Pakistan is the 5th (after India, China, Thailand and Indonesia) largest mango producer with production of about 1.6 million tonnes per year, contributing a share of more than 5 percent in total world production of Mango. As far as productivity tonnes/hectare is concerned Pakistan ranks 2nd (10.00 tonnes/hectare) after Brazil (16.04 tonnes/hectare). Scope still exist to increase the productivity and percent share of world Mango production with Pakistan itself through its planned based vision and monitored ways of activities.

Mangoes are very low in saturated fat, cholesterol and sodium. They are also an excellent source of dietary fiber and vitamin B6, as well as a good source of vitamin A and C. Mangoes are rich in minerals like potassium, magnesium and copper. Mango is the second largest fruit grown after citrus in Pakistan. It occupies 22 percent of the total area under all fruits (GoP, 2013-14). Table 2 indicates that of a total area of 171.3 thousand hectares under mango in the country, 62.6 percent is in Punjab and 36.8 is in Sindh province. Similarly Punjab and Sindh provinces contributes 75.5 and 24.3 percentage respectively in Pakistan's total production of fruits.

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The major growing districts in Punjab province are Multan, Rahimyar Khan, Muzaffargarh and Khanewal. In the province of Sindh it is mainly grown in Mirpurkhas, Sanghar, Tando Allahyar, Hyderabad and Naushehro Feroze. The four districts of Punjab contributes 85.6 percent of area while the five districts of Sindh has a contribution of 85.3 percent. The climate of Sindh gets warmer about one month earlier than the Punjab which has given the province the privilege to grow early varieties of mango. Harvesting begins in Sindh in late May and in Punjab it finishes in late August.

Table 1. Area, Production, Productivity and Share of Mango in Major World Countries: 2012

Name of Country	Area ('000' Hectares)	Production ('000' Tonnes)	Productivity (Tonnes/Hectare)	Percentage Share in Production
India	2143	13501	6.30	41.08
China	445	3752	8.43	11.41
Thailand	285	1800	6.31	5.47
Indonesia	266	1680	6.31	5.11
Pakistan	165	1650	10.00	5.02
Mexico	273	1413	5.17	4.29
Brazil	84	1348	16.04	4.10
Philippines	172	1003	5.83	3.05
Bangladesh	129	889	6.89	2.70
Nigeria	138	812	5.88	2.47
Others	580	5015	8.64	15.26
Total	4680	32863	7.02	100.00

Source: F.A.O. United Nation.

Significance of the Study

Mango is one of the country's major income earner but the exported quantity is very small. We know that Pakistan has a deficit in its trade, so by increasing the production of mango, export can be increased and Pakistan can earn a lot of foreign exchange which can be used to reduce trade deficit. Punjab and Sindh provinces have enormous potential for boosting mango production. Mango production also determines the progress of industry because most of the industries depends not on its production only but also on its raw materials. Strengthening the mango industry would have a major impact on the economies of Punjab and Sindh. Job creation, income generation, and employment opportunities or women are all positive benefits of a robust and expanding Pakistani mango industry. Thus, if mango fruit performs well, both the level and composition of trade favour mango industry growth. The converse is weak if mango fruit is weak. A sound data and its growth and instability analysis on area, production and productivity of mango will be a very good tool for the planners and policy makers in horticulture to take up planned investment in a systematic way for sustainable development of Pakistan horticulture.

History and Origin of Mango

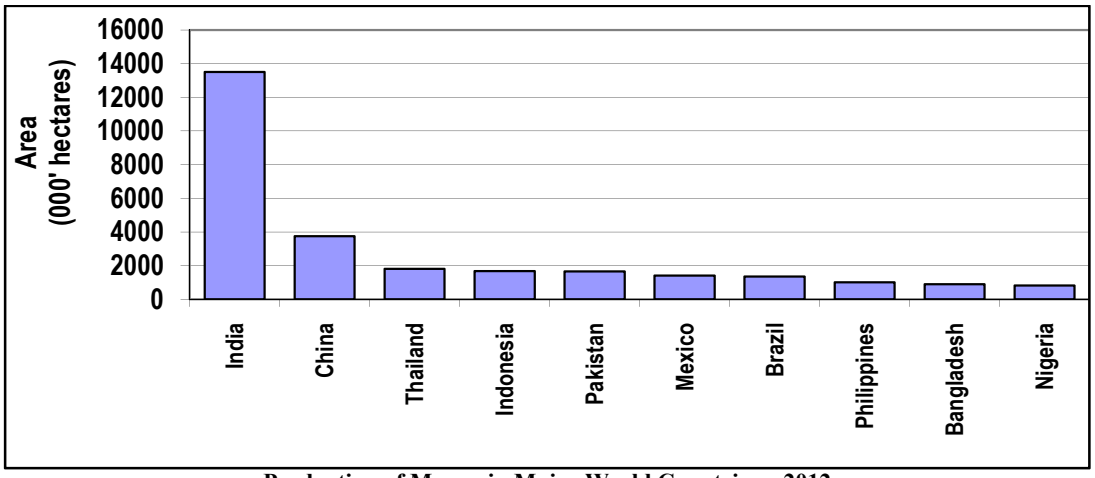
Mango has been cultivated for thousands of years in India (Mukherjee 1953, Kostermans and Bompard 1993). It is referred to in Sanskrit literature as Amra and has been under cultivation for over 4000 years. It appears, however, that Hsiiantsang (632-645) was the first person to bring mango to the notice of people outside India. During the rule of the Mughal emperors in India, this fruit occupied an important place in horticulture. Akbar the Great planted an orchard of 100,000 mango trees. Mango cultivation is found in many countries of Southeast Asia – the Philippines, Indonesia, Thailand, Burma, Malaysia and Sri Lanka. Introduction of the mango to East and West Africa and subsequently to Brazil occurred in the sixteenth century. In Mexico its cultivation started in nineteenth century, while in Florida it started in 1833. Mango is considered to be the native of Indo-Pakistan sub-content and eastern Asia.

Mango Varieties

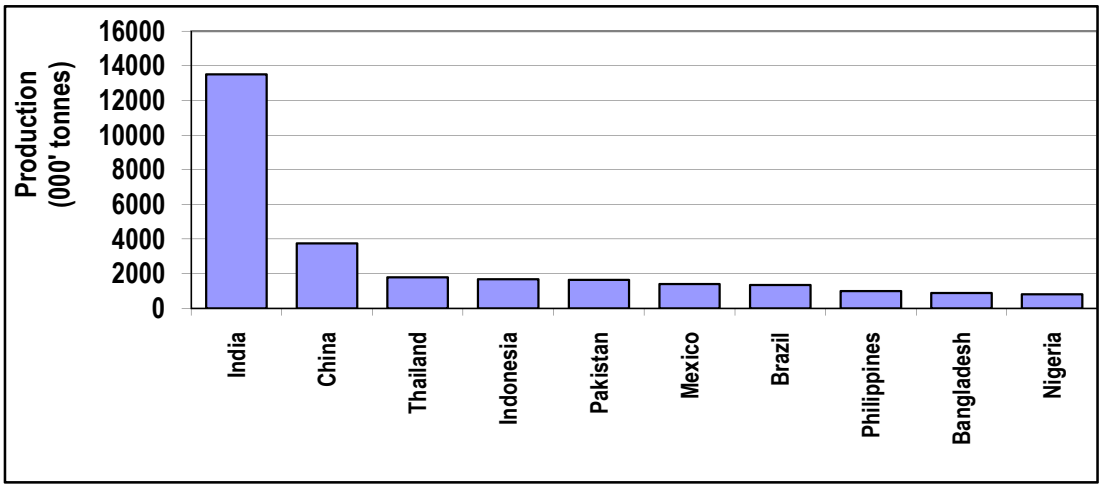
Mango is mainly produced in Punjab and Sindh. The important mango cultivars are:

Anwar Ratol, Chaunsa, Sindhri, Langra, Bangapali, Dashehari, Alphonso, Neelam, Siroli, Gulab Khas, Fajri, and Malda. Sindhri is the best variety grown in Sindh while in Punjab Chaunsa dominates. Instability/variability is one of the important decision parameters in development dynamics and more so in the context of agricultural production. An analysis of fluctuations in crop/fruit output, apart from growth, is of importance for understanding the nature of food security and income stability. Wide fluctuations in crop/fruit output not only affect prices and bring about sharp fluctuation in them but also result in wide variations in disposable income of the farmers. The magnitude of fluctuations depends on the nature of fruit production technology, its sensitivity to weather, economic environment, availability of material inputs and many other factors. High growth in production accompanied by low level of instability for any crop is desired for sustainable development of agriculture. There is a growing concern that rapid technological change in agriculture has increased variability in crop production. Several studies conducted in different countries analyzed the instability in cereal production responding this concern. Until now no empirical studies have been able to settle the debate. Some studies show that production instability has increased due to the expansion of modern technology while some other studies showed that production instability has decreased with the expansion of modern technology. A link between growth in agricultural production and instability was first addressed by Sen (1967).

He concluded that variability in production increases due to expansion of cultivation to the marginal land and the increased use of purchased inputs. Hazell (1982 and 1989), observed that production variability in world cereal and Indian food grains production increased due to the adoption of modern technology. Mehra (1981) also argues that instability in India's total food grain production has increased due to the widespread adoption of the improved seed-fertilizer intensive technologies since the mid 1960's. Wasim (1999), in his study concludes that the improvement in productivity in most of the crops of Sindh during phase II was higher as compared to the improvement in crops during phase III. Similar arguments are also put forward by Rao (1975), Ray (1983), Parthasarathy (1984), Barker, Gabler and Winckelmann (1981), Mitra (1990) and Griffin (1988). Carlson (1985) examined the causes of rice yield variability using panel data from 13 Asian countries. He concluded that the coefficients of variation of both rice yields and total production decreased significantly with higher adoption of modern varieties and irrigation development. Singh and Byerlee (1990), based on 57 wheat producing countries of the world, showed that relative variability in wheat yield declined over time and expansion of modern wheat varieties have positive contribution to the decrease in variability in wheat yield. Deb, Mandal and Day (1991), based



Production of Mango in Major World Countries – 2012



Productivity of Mango in Major World Countries – 2012

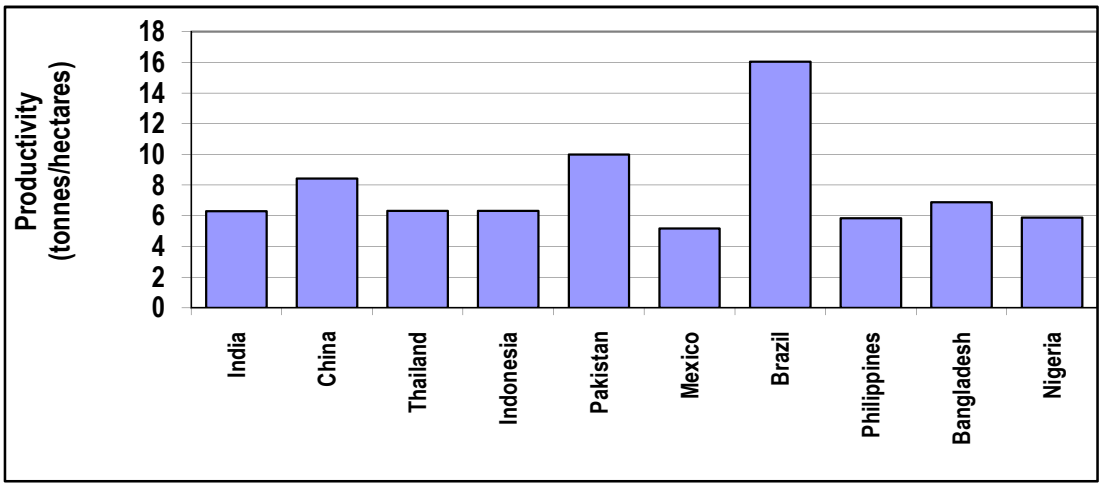


Figure 1. Area of Mango in Major World Countries – 2012

Table 2. Major Growing Districts and Percentage of Area and Production of Mango Fruit Crop of Punjab and Sindh Provinces in Pakistan's Total Area and Production of Fruits, 20313-14

Province	Percentage Area	Percentage Production	Percentage of Area Contribution of major districts of Punjab and Sindh in Descending order			
Punjab	62.6	75.5	Multan	(28.5%)	Rahim Yar Khan	(25.5%)
			Muzaffar Garh	(17.4%)	Khanewal	(14.2%)
Sindh	36.8	24.3	Mirpur Khas	(23.4%)	Hyderabad	(18.4%)
			N.Feroze	(16.0%)	Sanghar	(14.2%)
			Tando Allah Yar	(13.3%)		

Source:Crop Area and Production (by districts) 2013-14, Government of Pakistan.

on secondary data from Bangladesh for the period 1947-48 to 1986-87 analyzed production variability for six crops for two periods-modern technology period (1968-69 to 1986-87) and pre-modern technology period (1947-48 to 1967-68). They found that both the absolute and relative variability in production reduced during the modern technology period as compared to the pre-modern technology period. In Pakistan no study is available relating to growth and variability of mango. Examination of the issues stated above is expected to throw light on the nature of variability in mango production, following from this, on how far the current measures as economical and better water usage, farmer education through extension services, producing varieties consistent with the taste and demand of foreign markets, grading and certainty of delivery and development and dissemination of new technologies like trickle irrigation system, high yielding, drought and disease resistance varieties of mango could be said to be instrumental in bringing about increase in area and productivity.

The present study is undertaken with a view to analyze trend, growth and variability, of mango fruit in two different period of Punjab and Sindh. The study has the following specific objectives:

a) To discuss the trends in average area, production and productivity.
b) To examine the period wise growth rates of area, production and productivity.
c) To estimate the period-wise level of variability/ instability in major fruit crops area, production and productivity.
d) To suggest strategies to enhance mango production.
e) To present concluding remarks and recommendation.

Data Source

To fulfill the objectives of the present study, secondary data were collected from published source of Pakistan government viz. Agricultural Statistics of Pakistan from 1970-71 to 2013-14. The analysis of growth rate scenario and instability in mango fruit area, production and productivity is done for two different periods, Period I (1970-71 to 1991-92), and period II (1992-93 to 2013-14). Since the agricultural technology in improving day by day therefore in order to see the recent trend we have divided it into two periods.

Methodology

The compound growth rates of area, production and productivity of mango fruit was worked out by fitting a semi log trend equation (1).

$$Y = e^{a+bt} \quad or \; Ln(Y) = a + bt$$

where,

Y = dependent variables like area, production and productivity in the year '*t*' for which growth rate is estimated.
a = constant coefficient
b = slope coefficient, measures the relative change in *Y* for a given absolute change in the value of explanatory variable 't'. If we multiply the relative change in *Y* by 100, we will get percentage change or growth rate in *Y* for an absolute change in variable '*t*'.
t = time element which takes the value of 1, 2, 3, ……n.
Ln = natural logarithm.

The measurement of instability in time series data requires an explicit assumption of what constitutes the acceptable and unacceptable components. A systematic component which can be predicted does not constitute instability and hence, it should be eliminated from the data. The remaining unpredictable component represents the variability. There are a number of techniques available to measure the index of instability. Such techniques are found in Mac-Bean (1966), Weber and Sievers (1985), Massel (1970), Singh and Byerlee (1990) and Cuddy-Della Valle (1978). In this study the instability in area, production and productivity of mango fruit is measured in relative terms by the Cuddy-Della Valle Index which is used in recent years by a number of researchers as a measure of variability in time series data. The simple coefficient of variation over estimates the level of variability in time-series data characterized by long-term trends whereas the Cuddy-Della. Valle index corrects the coefficient of variation.

The instability index IX, is given by the expression:

$$IX = CV\,(1-r^2)^{1/2} \qquad (2)$$

where

CV = coefficient of variation (in percent)
R^2 = coefficient of determination from a time-trend regression adjusted by the number of degrees of freedom.

It may mentioned here that some authors have estimated the CV around trend as the standard error of regression divided by mean, after estimating in both ways from the same set of data. Singh and Byerlee (1990) found that the results are almost identical whichever method is used. Since both methods provide same results, we decided to estimate instability index using Cuddy Della Valle index.

Trends in Average Area, Production and Productivity of Mango Fruit in Two Different Periods

Punjab

During Period I, the average mango area was 35136 hectares (Table 3 and Figure 2). In period II, the area of mango increased by 111.76 percent. The average production of mango increased by 126.16 percent in period II as compared to period I. Similarly the average productivity increased by 6.90 percent in period II as compared to period I.

Sindh

The average mango area which was 35000 hectares (Table 3 and Figure 2) in period I increased by 33.71 percent in period II and reached to 46800 hectares. The average production of mango which was 262000 tones during period I, reached to 329200 tonnes in period II. This increase was by 25.65 percent. Average productivity tonnes/hectares decreased by (–6.67 percent) in period II as compared to period I. The major factor which caused decline in production and productivity of mango in Sindh was drought and floods from 2000 onward and unfavorable price and climatic conditions.

Table 3. Percentage Change in Area, Production and Productivity of Mango Fruit in Punjab and Sindh, 1970-71 to 2013-14

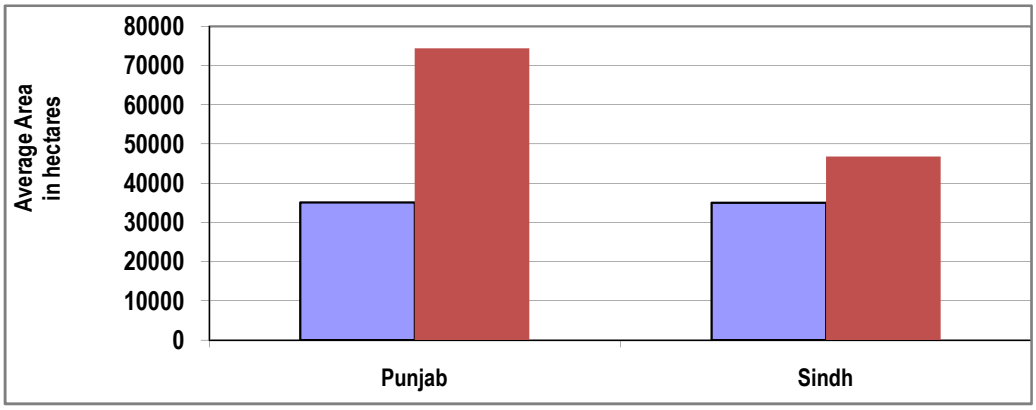
Province	Average Area (hectares)		Percentage Change in Area	Average Production (tonnes)		Percentage Change in Production	Average Productivity (tones/hectare)		Percentage Change in Productivity
	Period I	Period II	Period II over I	Period I	Period II	Period II over I	Period I	Period II	Period II over I
Punjab	35136	74404	111.76	408736	924381	126.16	11.6	12.4	6.90
Sindh	35000	46800	33.71	262000	329200	25.65	7.5	7.0	–6.67

Source: Agricultural Statistics of Pakistan (various issues), Government of Pakistan.
Note: Period I (1970-71 to 1991-92); Period II (1992-93 to 2013-14).

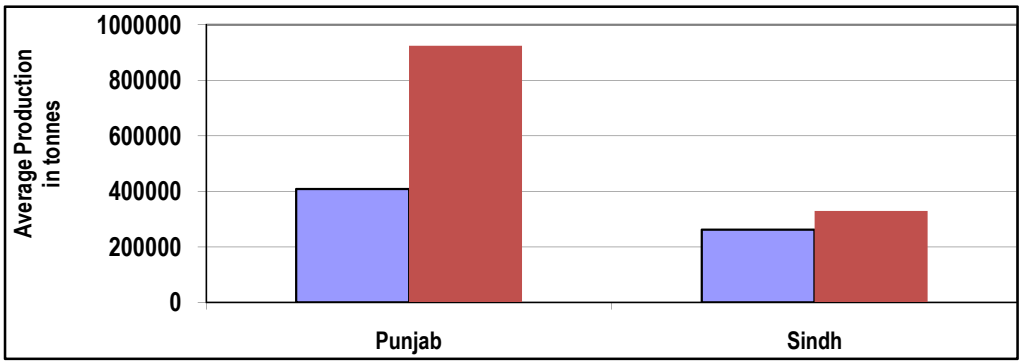
Table 4. Period-Wise Compound Growth Rates of Area, Production and Productivity of Mango Fruit in Punjab and Sindh, 1970-71 to 2013-14

Province	Period I (1970-71 to 1991-92)			Period II (1992-93 to 2013-14)		
	Area	Production	Productivity	Area	Production	Productivity
Punjab	3.97	2.46	–1.52	5.74	5.78	0.03
	(8.86)*	(5.63)*	(5.84)*	(0.006)^{ns}	(9.25)*	(0.20)^{ns}
Sindh	0.52	1.10	0.57	2.54	1.84	–0.70
	(6.52)*	(5.96)*	(3.70)*	(37.37)*	(15.73)*	(5.16)*

Note: *, significant at 1 percent level.
^{ns}, not significant/insignificant.



Average Production of Mango Fruit in Period I and II of Punjab and Sindh



Average Productivity of Mango Fruit in Period I and II of Punjab and Sindh

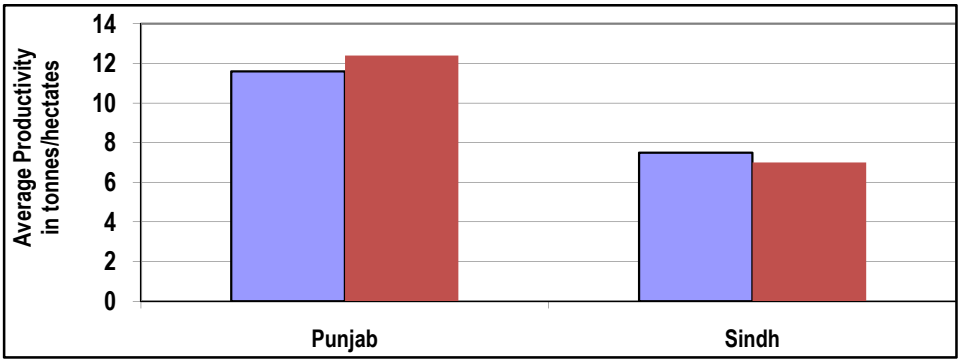


Figure 2. Average Area of Mango Fruit in Period I and II of Punjab and Sindh

Table 5. Period-Wise Instability in Area, Production, Productivity of Mango Fruit in Punjab and Sindh, 1970-71 to 2013-14

Province	Period I (1970-71 to 1991-92)			Period II (1992-93 to 2013-14)		
	Area	Production	Productivity	Area	Production	Productivity
Punjab	0.92	0.70	0.98	0.97	0.61	0.94
Sindh	0.20	0.30	0.89	0.04	0.08	0.69

Table 6. Period-Wise Growth and Instability in the Production of Mango Fruit in Punjab and Sindh

Province	Period I (1970-71 to 1991-92)		Period II (1992-93 to 2013-14)	
	Growth (%)	Instability	Growth (%)	Instability
Punjab	2.46*	0.70	5.78*	0.61
Sindh	1.10*	0.30	1.84*	0.08

Note: Taken from Tables 4 and 5.
*, significant at percent level

RESULTS AND DISCUSSION

Growth Rates in Mango Production

Period I (1970-71 to 1991-92)

Mango growth rate of Punjab and Sindh are presented in Table 4. Mango production growth rate recorded 2.46 percent growth in Punjab. This increase in production growth rate was mainly due to increase in its area growth rate only because the productivity growth rate was negative. The negative productivity growth was mainly due to water shortage and non-availability of HYVS. In Sindh the production growth rate increased by 1.10 percent. This increase in production was due to increase in both, area and productivity growth. It means that in this period in Sindh the mango growers were utilizing new farm technologies, HVs, favourable climatic condition, balanced fertilization, timely use of fungicides and good irrigation facilities.

Period II (1992-93 to 2013-14)

Table 4 indicates that the production growth rate of mango in Punjab increased in period II compared to period I. Area and productivity growth being insignificant. The production growth rate of mango in Sindh increased in period II compared to period I. This increase in production growth was mainly due to increase in its area growth rather than productivity growth. It means that though the productivity growth rate of Punjab improves in period II compared to period I but statistically insignificant. Though the area and production growth rate of Sindh increased in period II compared to period I but the productivity growth rate become negative. The main reasons for decline in mango productivity growth rate in Punjab and Sindh in period II are shortage of water, mango mealy bug, mango hopper, floods, shortage of fertilizer, sudden death and lack of pruning etc. This called or effective implementation of technology transfer and demonstration of technologies at field with the motivation of price bonanza. There is a need to increase the area and production of mango in Sindh through subsidized inputs including new farm technologies and higher prices.

Comparison of Productivity between Punjab and Sindh

From the area and production data of Punjab and especially Sindh, it was observed that there has been stagnation and fluctuation over a period of time called for effective implementation of transfer of technology and Demonstration of Technologies at Field with the motivation of profit to the farmers and agripreneurs. The productivity tonnes/hectare of Punjab is higher than Sindh. Similarly from Table 3, it can be seen that the productivity tonnes/hectare of Sindh is negative and much lower than Punjab. In 1970's we were the second largest producer of mango in the world while now our position have dropped upto 5th level (Table 1). The declining production of mango is a matter of great concern and has been caused by a complex of problems. The main responsible factors which affect the productivity of mango are shortage of water, insect/pest diseases like mangomealy bug, mango hopper, fruit fly, sudden death, poor management practices like intercropping and lack of pruning and plant protection measures.

Instability in Mango Fruit Production

For sustainable production, the level of instability in mango fruit production is very important. We have estimated the relative instability in mango fruit production in Table 5. In period I, the production of mango in Punjab recorded the highest degree of instability and that of Sindh the lowest. As the fluctuations in production are the compound result of fluctuations in fruit acreage and fruit productivity, area and productivity both contributed towards fluctuations in mango in Punjab in period I and II both. Mango fluctuation in production in Sindh in period II was mainly due to fluctuation in its area. The magnitude of instability in mango production declined in period II relative to period I.

The synchronized movements in area and productivity both were responsible for low instability in mango production in period II of Punjab and Sindh. In order to have a better understanding of growth and instability in mango fruit production we have presented Table 6. In period I mango fruit has low growth rate in production with high instability as compared to period II in Punjab and Sindh. The province of Sindh has low growth and instability as compared to Punjab province. In period II the mango production growth rate not only increased (due to the utilization of new farm technologies) but there instability has also declined in Punjab and Sindh provinces. Changes in production growth rate which cause instability can be due to a number of factors which include erratic availability of irrigation water, behavior of the prices of competing crops and timely availability of agricultural inputs. These are true for period II. A moderate and significant growth in production accompanied by low level of instability for mango fruit (Sindh in period I and II) is desired for sustainable development of agriculture as compared to high growth in production and high level of instability (Punjab in period II).

Conclusion and Recommendation

This study was undertaken with a view to analyze trend, growth rate scenario and instability of mango fruit in two different periods of Punjab and Sindh provinces of Pakistan. The study reveals that in period I of Sindh, the increase in production growth was due to increase in its area and productivity growth both but in Punjab it was only due to increase in area growth because the productivity growth was negative. It means that the mango farmers of Sindh in period I are utilizing new farm technologies mainly because of profitability in growing mango fruit due to good qualities of trees, favourable price incentives, good irrigation facilities and climatic conditions. The study also concludes that the growth of production of mango increased in period II compared to period I in both the provinces. The study also reveals that the productivity growth of mango in Sindh recorded negative and significant growth, while in Punjab though the productivity growth become positive but statistically insignificant in period II compared to period I. The decline in productivity growth in period II compared to period I was mainly due to drought and floods from 2000 onwards, and non-availability of roads from mango garden to markets. The magnitude of instability in mango production declined in period II relative to period I. the synchronized movements in area and productivity both were responsible for low instability in mango production in period II. The study also reveals that in mango fruit instability in production is lower than instability in productivity in period II, which indicated the importance of productivity instability.

In order to improve the growth in production and productivity with stability some of the important steps required are:

a) The result of the study indicates that in period II compared to period I, the productivity growth decreased. Therefore in order to increase its productivity more, its production growth rate is required to be increase more. The growth rate of production can be increased through favourable price incentive, proper and timely use o the fungicides, balanced fertilization on the basis of soil test, availability of ground water, post harvest technology to minimize the losses, farmers education through extension services, high density planting and better utilization of skilled labor and technical knowledge.
b) The study also confirms relatively high instability in mango producton in both the periods of Punjab. The instability can be declined through controlling the price of mango fruit and its competing crops, timely availability of agricultural inputs and better water usage.

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