



Research Article

TO STUDY GROWTH RATE OF AREA, PRODUCTION AND PRODUCTIVITY OF PINEAPPLE IN MANIPUR

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Abstract: Pineapple is one of the largely grown fruits in the North Eastern States of India. However, the demand of pineapple from Manipur is higher than the other states since it has a very distinctive taste and flavour as compared to the other states' varieties. The present study was conducted with a view to analyze the growth in area, production and productivity of pineapple in Manipur. The growth in the area, production and productivity of pineapple in Manipur was estimated using the compound growth rate and percentage change in this study. The necessary secondary data were collected for a period of 12 years from 2005-06 to 2016-2017. The compound growth rate indicates positive and significant growth in volume of pineapple in the state. The area, production and productivity were observed in the selected districts, so as the growth rate with respect to state as a whole is positive which registered a positive growth rate of nearly 1.26 percent in area, 2.43 percent in production and 1.16 percent in productivity of pineapple respectively. The high growth rate in area and production is because of the increase in the area under pineapple cultivation.

Keywords: Growth rate, Pineapple, Productivity, Compound Growth Rate, Manipur

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Introduction

India has made quite progress in agriculture since independence in terms of growth in area, output and yields under many crops. According to Pandey and Kumar (1999) there has been growing importance of fruit and vegetables in the agricultural economy of India, their production and marketing deserve the focused attention of all the stakeholders. India is the world's second largest producer of fruits (57.73 million tonnes) with its projected value touching 98mt by the year 2020-2021, whereas for vegetables, it is 129mt, each contributing 10.0 percent and 13.3 percent, respectively to the total world production. Pineapple (*Ananas comosus*) (Linn.) Merr., is one of the commercially important fruit-crops of the world and especially in India. It is the third most important tropical fruit in the world after banana. Pineapple is found in most parts of the country and is also one of the largely grown fruits in the North Eastern States of India. Its share in the country's total pineapple production is substantial and Manipur is one of the major contributors in this regard. The pineapple grown and cultivated in Manipur is higher in demand as compared to the other states due to its distinctive taste and flavour. In North-East India, Manipur is one of the leading pineapples producing States owing to its salubrious climate and soil type [1]. It has an average temperature of 20-36°C and receives excellent sunshine during summer and winter season. Among the fruits produced in Manipur, pineapple records the largest production. The prevailing wide agro climatic conditions of Manipur make it possible to cultivate pineapple throughout the year. Its share in the country's total pineapple production is substantial and Manipur is one of the major contributors. Economically, the fruit has become the backbone of a sizeable section of farmers who have been cultivating it as their major source of income. The present study aims at examining the growth rate in area, production and productivity of pineapple in the state [2-6].

Materials and Methods

The study on growth in area, production and productivity of pineapple was

purposely taken up in Manipur state of India. The secondary data on area, production and productivity were used to analyze the trends. The data on area, production and productivity of pineapple was available from 2005-06 onwards. Hence the analysis was covered for the period from 2005-06 to 2016-17. Data used for the study was collected from The Directorate of Horticulture and Soil Conservation, Government of Manipur, Imphal [7,8].

The growth rates with respect to area, production and productivity under pineapple was estimated using the compound annual growth rate and percentage change by fitting the following equation in the time series data area, production and yield.

$$Y_t = (Y_0 (1+r))^t \quad (1)$$

Taking log on both sides, we will get

$$\begin{aligned} \ln Y_t &= \ln Y_0 + t \ln (1+r) \\ \ln Y_t &= a + b^t \end{aligned} \quad (2)$$

Where,

$a = \ln Y_0$

$b = \ln (1+r)$

Y_t = area/production/productivity

Y_0 = Constant

t = Time period in years and

b = Regression coefficient

Finally, the compound growth rate in area, production and productivity were work out by using the formula

$$\% \text{ Compound Growth Rate, } r = (\text{Anti log } b - 1) \times 100 \quad (3)$$

The significance of the estimated compound growth rates was tested with the help of student's t test.

Percentage change in yield is given by:

$$\% \text{ change in yield} = (\text{current year yield} - \text{previous year yield}) \div \text{previous year yield}$$

Table-1 Area, production and productivity of pineapple in Manipur from (2005-06 to 2016-17)

Year	Area ('000 ha)	Percent change in area over years	Production ('000 tonnes)	Percent change in production over years	Productivity (tonnes/ha)	Percent change in productivity over years
2005-06	11872	-	97516	-	8.21	-
2006-07	11986	0.96	100682	3.24	8.4	2.31
2007-08	12048	0.51	102614	1.91	8.52	1.42
2008-09	12048	0	109519	6.72	9.09	6.69
2009-10	12048	0	71710	-34.52	5.95	-34.54
2010-11	12120	6.57	110598	54.22	9.13	53.44
2011-12	12595	3.91	116573	5.4	9.26	1.42
2012-13	13068	3.75	124148	6.49	9.5	2.59
2013-14	13700	4.83	136317	9.8	9.95	4.73
2014-15	14296	4.35	142794	4.75	9.99	0.4
2015-16	13654	-4.49	128361	-10.1	9.4	-5.9
2016-17	13631	-0.16	127033	-1.03	9.32	-0.85
CGR	1.26		2.43**		1.16	
SD	865.54		19567.3		1.08	
CV	6.79		17.17		12.16	

*Significant at 1 percent level of profitability, ** Significant at 5 percent level of profitability, figures in parentheses are the t value CGR (Compound Growth Rate)

Table-2 Area, Production and Productivity of Pineapple in Imphal east district of Manipur (2005-06 to 2016-17)

Year	Area ('000ha)	Percent change in area over year	Production ('000tonnes)	Percent change in production over year	Productivity (t/ha)	Percent change in productivity over years
2005-06	1025	-	8405	-	8.2	-
2006-07	1030	0.48	8652	2.93	8.4	2.43
2007-08	1035	0.48	8901	2.87	8.6	2.38
2008-09	1035	0	9305	4.53	8.99	4.53
2009-10	1035	0	1164	-87.49	1.12	-87.54
2010-11	1045	0.96	9501	716.23	9.09	711.6
2011-12	1145	9.56	10015	5.4	8.74	-3.85
2012-13	1202	4.97	11419	14.01	9.5	8.69
2013-14	1262	4.99	12557	9.96	9.95	4.73
2014-15	1440	14.1	17950	42.94	12.46	25.17
2015-16	1125	-21.87	14018	-21.9	12.46	0
2016-17	1254	11.46	15630	11.49	12.46	0
CGR	1.85		5.8		3.88*	
SD	131.15		4256.15		3.02	
CV	11.54		40.05		32.91	

*Significant at 1 percent level of probability, **Significant at 5 percent level of probability, Figure in parentheses are t values of CGR.

Table-3 Area, Production and Productivity of Pineapple in Churachandpur district of Manipur (2005-06 to 2016-17)

Year	Area (ha)	Percent change in area over year	Production (mt)	Percent change in production over year	Productivity (t/ha)	Percent change in productivity over year
2005-06	1865	0	16785	0	9	0
2006-07	1889	1.28	15868	-5.46	8.4	-6.66
2007-08	1904	0.79	16374	3.18	8.59	2.26
2008-09	1904	0	17326	5.81	9.9	15.25
2009-10	1904	0	11352	-34.47	5.96	-39.79
2010-11	1932	1.47	17575	54.81	9.09	52.51
2011-12	2008	3.93	19879	13.1	9.89	8.8
2012-13	2108	4.98	20026	0.73	9.5	-3.94
2013-14	2206	4.64	21950	9.6	9.95	4.73
2014-15	2275	3.12	26298	19.8	11.55	16.08
2015-16	2250	-1.09	22500	-14.44	10	-13.41
2016-17	2280	1.33	22500	0	9.87	-1.3
CGR	1.84		2.7		0.84*	
SD	168.02		3968.16		1.34	
CV	8.22		20.85		14.36	

*Significant at 1 percent level of profitability, ** Significant at 5 percent level of profitability, Figures in parentheses are the t value CGR (Compound Growth Rate)

Dispersion

Absolute variation in area, production and productivity was measured through standard deviation and relative variation through co-efficient of variation, each of area, production and productivity of pineapple by using the following formula:

Standard Deviation

$$S.D. = \sqrt{\frac{\sum x^2}{N}}$$

Where,

$$X = (X_1 - X)$$

N = No. of observation

Coefficient of variation (C.V.)

$$C.V. = \sigma/X \times 100 \text{ or}$$

$$C.V. = SD/Mean \times 100$$

Where,

σ = standard deviation

X = mean of sample

Results and Discussion

Growth rate of area, production and productivity of pineapple in Manipur state

In this section an effort has been made to compile the growth rate of area, production and productivity statistics of pineapple in Manipur for the particular period 2005-06 to 2016-17.

By using these data, the compound growth rates (CGR) and percent change in area, production and productivity of pineapple in Manipur state and the data pertaining it was accessed from the secondary source for a period of twelve years *i.e.*, 2005-06 to 2016-17. The area, production and productivity of pineapple in Manipur from 2005-06 to 2016-17 have been depicted in the [Table-1]. During 2005-06 as seen in [Table-1], the area under pineapple was 11872 thousand hectare, in 2006-07, they are increased to 11986 thousand hectare *i.e.*, 0.96 percent and again it further increased to 12048 thousand hectare (0.51 percent) for the year 2007-08 and the area remained unchanged for the year 2008-09 and 2009-10 *i.e.*, 12048 thousand hectare. In 2010-11, the area extended to 12120 thousand hectares *i.e.*, 6.57 percent. In 2011-12 the area was increased by 3.91 percent over the previous year and the area increased to 13068 thousand hectare (3.75 percent) in 2012-13. Further in 2013-14 the area increased by 4.83 percent *i.e.*, 13700 thousand hectare and in 2014-15 the area increased to 14296 thousand hectares (4.35 percent). In 2015-16 the area under pineapple declined to 13654 thousand hectares (-4.49 percent). Finally, in 2016-17 the area decreased again to 13631 thousand hectare *i.e.*, -0.16 percent. As shown in the [Table-1] over the years, the area, production and productivity was increased and then decreased from 2005-2017. In 2009-10, the area remained the same which is 12048 thousand hectares as in previous two year *i.e.*, 2007-08 and 2008-09. The production of pineapple in Manipur in 2005-06 is seen as 97516mt, in 2006-07 it increased to 100682mt. *i.e.*, 3.24 percent and it increased marginally to 102614mt. (1.91 percent) in 2007-08. Further the production increased by 6.72 percent *i.e.*, 109519mt. in 2008-09 due to adoption of plant protection measures. Where as in 2009-10, the production decreased rapidly to 71710mt (-34.52 percent) and later covered by 54.22 percent 110598mt. in the subsequent year 2010-11. The production rose further again to 116573mt. (5.40 percent) in 2011-12 and it was 124148mt. *i.e.*, 6.49 percent in 2012-13. Again in 2013-14, the production increased by 9.80 percent *i.e.*, 136317mt. And in 2014-15 the production level increased comparatively to 142794mt. (4.75 percent) over previous year. In 2015-16, the production slightly declined to 128361 thousand hectare (-10.10 percent). Whereas during the year 2016-17 the production decreased by -1.03 percent *i.e.*, 127033 thousand hectare over the previous year. The productivity of pineapple in Manipur in 2005-06 is seen 8.21 t/ha which increased to 8.40 t/ha (2.31 percent) in the year 2006-07. The productivity remained stable at 8.52 t/ha *i.e.*, 1.42 percent in 2007-08 and increased by 6.69 percent *i.e.*, 9.09t/ha in 2008-09 whereas in 2009-10, the productivity decreased rapidly by -34.54 percent *i.e.*, 5.95 t/ha and then recovered to 9.13 t/ha (53.44 percent) in 2010-11. In 2011-12, the productivity increased to 9.26 t/ha (1.42 percent) and by 2.59 percent 9.50 t/ha in 2012-13. Further the productivity increased to 9.95 t/ha (4.73 percent) in 2013-14. In 2014-15, the productivity increased by 0.40 percent *i.e.*, 9.99 t/ha over the previous year. In 2015-16 the productivity declined to 9.40 t/ha *i.e.*, (-5.90 percent). Finally, in 2016-17, the productivity decreased to 9.32 t/ha *i.e.*, (-0.85 percent) over the previous year. The productivity of pineapple was minimum *i.e.*, 5.95 t/ha in 2009-10 and maximum was 9.99 t/ha in 2014-15. The compound growth rates for area, production and productivity were 1.26 percent, 2.43 percent and 1.16 percent respectively. The growth rate in area was the major source of production growth. After that high yielding varieties introduced in the state which then contributed to production. The area and production were found to be stable from 2005 to 2017, whereas there was a variation in the production over the years. Productivity was having positive sign which indicates, farmer can take up this crop in better way. In nut shell we can say that the farmer can adopt this crop as a commercial basis as it provides positive sign with area, production and productivity.

Trends in area, production and productivity of pineapple in Imphal east district of Manipur

In this section, an attempt has been made to analyze the compound growth rates (CGR) in area, production and productivity of pineapple in Imphal east for twelve years (2005-06 to 2016-17) and to know about the growth rate over a period of time. The area, production and productivity of pineapple in Imphal east are shown in [Table-2]. The area under pineapple in 2005-06 is seen as 1025 thousand hectare where as in 2006-07, the area increased by 0.48 percent *i.e.*, 1030

thousand hectare. Similarly, in 2007-08, the area increased to 1035 thousand hectare (0.48 percent) and it remained constant at 1035 thousand hectare in the subsequent year *i.e.*, 2008-09 and 2009-10 respectively. Further in 2010-11, the area increased to 1045 thousand hectare (0.96 percent). Similarly, in 2011-12 the area was increased by 9.56 percent *i.e.*, 1145 thousand hectare. In 2012-13 the area increased to 1202 thousand hectares (4.97 percent). Further in 2013-14, the area increased to 1262 thousand hectare (4.99 percent) over the previous year. In 2014-15 the area extended to 1440 thousand hectare (14.10 percent), in 2015-16 the area decreased to 1125 thousand hectare *i.e.*, -21.87 percent over the previous year. Finally in 2016-17, the increased to 1254 thousand hectare (11.46 percent). The production of pineapple fruit in Imphal east district of Manipur in 2005-06 was 8405mt. In 2006-07 it increased to 8652mt (2.93 percent) and in 2007-08, the production was 8901mt *i.e.*, 2.87 percent and increased by 4.53 percent *i.e.*, 9305mt in 2008-09 over the previous year. The production slightly decreased to 1164mt (-87.49 percent) in the subsequent year due to climatic conditions. Whereas during the year 2010-11, the production slightly increased by 716.23 percent 9501mt over the previous year. In 2011-12 the production increased to 10015mt (5.40 percent) and in 2012-13 it increased to 11419mt (14.01 percent). Further in 2013-14 the production increased to 12557mt (9.96 percent) and increased by 42.94 percent 17950mt in 2014-15. Whereas in 2015-16, the production decreased to 14018mt (-21.90 percent) and inter covered to 15630mt (11.49 percent) in 2016-17. The productivity of pineapple in Imphal east and district of Manipur in 2005-06 was 8.2 t/ha. In 2006-07, the productivity was 8.4 t/ha (2.43 percent) and in 2007-08, it was 8.6t/h (2.38 percent). The productivity further increased to 8.99t/ha (4.53 percent) in 2008-09 and declined to 1.12t/ha (-87.54 percent) in 2009-10. In the year 2010-11, the productivity increased to 9.09 t/ha (711.60 percent) respectively and in 2011-12, it decreased to 8.74 t/ha (-3.85 percent) over the previous year. In 2012-13 the productivity further increased by 9.5 t/ha (8.69 percent) and increased to 9.95 t/ha (4.73 percent) in 2013-14. Further in 2014-15, the productivity increased to 12.46 t/ha (25.17 percent) over the previous year and it remained stable to 12.46 t/ha in the subsequent year and also in 2016-17. The compound growth rates for area, production and productivity in Imphal east were 1.85 percent, 5.80 percent and 3.88 percent respectively.

Trends in area, production and productivity of pineapple in Churchandpur district of Manipur

The area, production and productivity of pineapple in Churchandpur are shown in [Table-3]. The area under pineapple in 2005-06 is seen as 1865 thousand hectare whereas in 2006-07, the area increased to 1889 thousand hectare (1.28 percent). Similarly, in 2007-08, the area increased to 1904 thousand hectare (0.79 percent) and it remained constant at 1904 thousand hectare in the subsequent year and 2009-10. Further in 2010-11, the area increased to 1932 thousand hectares (1.47 percent). Similarly, in 2011-12 the area increased to 2008 thousand hectare (3.93 percent). In 2012-13, the area increased to 2108 thousand hectare (4.98 percent) and increased to 2206 thousand hectare (4.64 percent) in 2013-14. Further in 2014-15 the area increased to 2275 thousand hectare (3.12 percent). And in the year 2015-16, area decreased to 2250 thousand hectares (-1.09 percent). Finally, in 2016-17 the area increased to 2280 thousand hectares (1.33 percent). The production of pineapple fruit in Churchandpur district of Manipur in 2005-06 was 16785mt and in 2006-07 it decreased to 15868mt (-5.46 percent). In 2007-08, the production increased to 16374mt (3.18 percent) and in 2008-09, increased to 17326mt (5.81 percent) over the previous year. The production slightly decreased to 11352mt (-34.47 percent) in the subsequent year due to climatic conditions. And in the year 2010-11, the production slightly increased to 17575mt (54.81 percent) over the previous year. In 2011-12 the production increased rapidly to 19897mt (13.10 percent) and in 2012-13 it increased to 20026mt (0.73 percent). Further in 2013-14, the production increased to 21950mt (9.60 percent). In the year 2014-15 the production increased to 26298mt (19.80 percent). Whereas in 2015-16, the production decreased to 22500mt (-14.44 percent) over the previous year and it remained stable to 22500mt in the subsequent year. The productivity of pineapple in Churchandpur district of Manipur in 2005-06 is seen 9t/ha which decreased to 8.40 t/ha (-6.66 percent) in 2006-07 and 8.59 t/ha (2.26 percent) in

the year 2007-08, where in 2008-09, the productivity increased to 9.90 t/ha (15.25 percent). In 2009-10 the productivity declined to 5.96 t/ha (-39.79 percent) and in the year 2010-11, the productivity increased to 9.09 t/ha (52.51 percent) over the previous year. In 2011-12, the productivity increased to 9.89 t/ha (8.80 percent) and decreased to 9.5 t/ha (-3.94 percent) in 2012-13. The productivity increased to 9.95 t/ha (4.73 percent) in 2013-14. Whereas in 2014-15, the productivity increased to 11.55 t/ha (16.08 percent). The productivity decreased to 11.55 t/ha (-13.41 percent) in 2015-16 over previous year and decreased to 9.87 t/ha (-1.3 percent) in 2016-17. The compound growth rates for area, production and productivity in Churhandpur district were 1.84 percent, 2.70 percent and 0.84 percent respectively.

Table-4 Compound growth rates of area, production and productivity of pineapple

S	Particulars	Compound Growth Rate(CGR)		
		Area	Production	Productivity
1	Imphal East	1.85	5.8	3.88
2	Churchandpur	1.84	2.7	0.84
3	Manipur	1.26	2.43	1.16

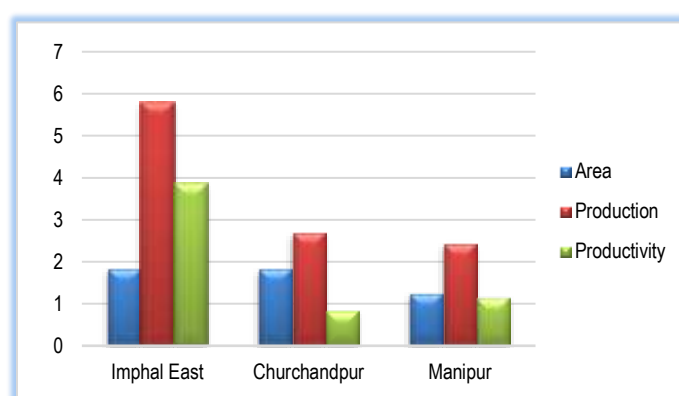


Fig-1 Compound Growth Rate of Area, Production and Productivity of Pineapple in Manipur

Conclusion

It is seen from [Table-4], that positive and significant growth in area production and productivity were observed in the selected districts, so as the growth rate with respect to state as a whole is positive. However, growth rates in area production and productivity of pineapple in case of Imphal East district were found to be highest. The corresponding figures were 1.85 percent, 5.80 percent and 3.88 percent respectively. Whereas, Churchandpur district registered a growth rate of 1.84 percent in case of area, 2.70 percent in production and 0.84 percent in case of productivity. On the contrary, a lower growth rate was observed in case of state as a whole, which registered a positive growth rate of area (1.26 percent), production (2.43 percent) and productivity (1.16 percent) of pineapple. A highly positive and significant growth in area and production of pineapple crop was observed in Imphal East and Churchandpur district. The high growth rate in area and production is because of the increase in the area under pineapple cultivation. This clearly indicates the increasing popularity of pineapple crop in the study area, especially in Imphal East district. Further it could be seen from the table that the growth rate for state as a whole was indicated the positive growth rate in area, production and productivity.

Application of research: The study of growth rate aims to better understand the regulation of pineapple growth which can future improve the productivity of pineapple as a whole.

Research Category: Agriculture, Economics

Abbreviations: CGR-Compound Growth Rate, SD-Standard Deviation, CV-Coefficient of Variation.

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Author Contributions: All authors equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: The Directorate of Horticulture and Soil Conservation, Government of Manipur, Imphal

Cultivar / Variety / Breed name: Pineapple (*Ananas comosus*) (Linn.) Merr.),

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

Ethical Committee Approval Number: Nil

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