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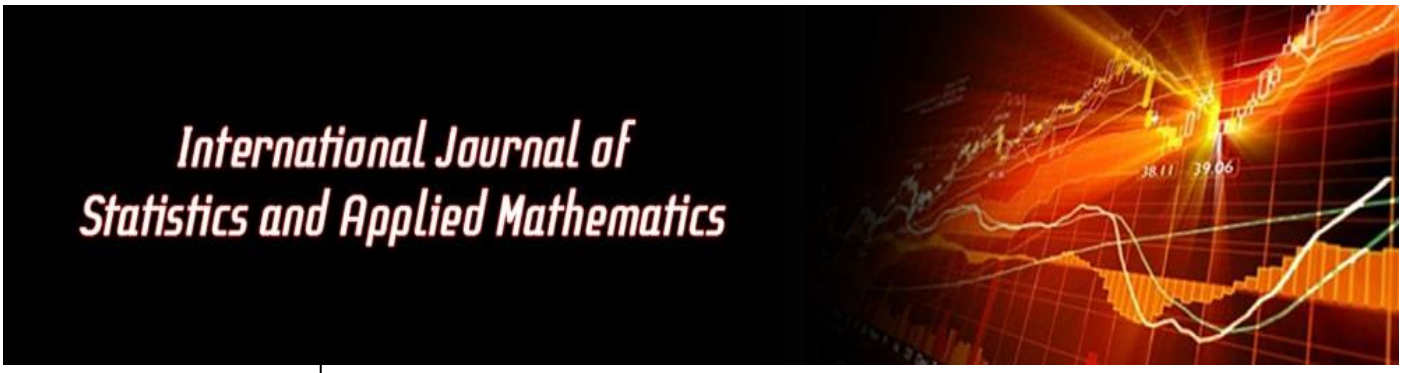

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Status of pineapple in Manipur State: An analysis of trend, instability and decomposition of area, production and productivity

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Abstract
The study aimed to understand the growth, instability, and contribution of both area and yield on pineapple production in Manipur State. Using secondary data spanning 21 years (2000-01 to 2020-21), the study focused on Manipur State, a leading pineapple producer in North-East India due to its favorable climate and soil. Pineapple stands out as the most abundant fruit in Manipur State. To measure the growth of pineapple production, the compound annual growth rate was employed, the Coppock's instability index measured instability, and decomposition analysis studied the contributions of area and yield to production. The findings indicated an overall positive trend with favorable annual growth rates in both area and production. Imphal-West and Ukhrul districts played significant roles in this growth. Throughout the 2000-2021 period, the area exhibited an instability of 11.18, with production instability at 12.99. Notably, the area's influence (67.41 percent) outweighed the yield effect in driving pineapple production in Manipur State.

Keywords: Pineapple, area, production, yield, interaction, instability

Introduction
Pineapple (*Ananas comosu*) belongs to the family Bromeliaceae and is a pan-tropical plant. It is one of the most significant commercial fruits in the entire globe. In addition to being a strong source of vitamins A and B, it also contains substantial amounts of calcium, magnesium, potassium, iron, and vitamin C. It provides a source of the digestive enzyme bromelain as well. Thailand, Costa Rica, Brazil, Philippines, Indonesia, India, Nigeria, China, Mexico, Colombia, and the United States are the world's top producers of pineapple. Assam, West Bengal, Karnataka, Meghalaya, Manipur, Arunachal Pradesh, Kerala, and Bihar are the major pineapple-producing states in India. In India, there was 106 thousand hectares of pineapple planted overall in 2021–2022, yielding 1799 thousand MT. (NHB, GOI, 2023)
Manipur is one of the top states in producing pineapple in North-East India because of its favorable temperature and soil. Pineapple output is the highest among the fruits grown in Manipur. It may be grown all year round in Manipur due to the state's diverse agro-climatic conditions. Manipur has access to pineapples for about eight months of the year. The State experiences good year-round sunshine with typical temperatures between 20 and 36 Degrees Celsius. It is being cultivated in all nine the districts of Manipur State. Senapati is the major producing district followed by Thoubal and Churachandpur districts. The main varieties grown in Manipur are Kew and Queen. According to the Directorate of Horticulture and Soil Conservation, Govt. of Manipur, during the year 2020-21, 12119 hectares of land was under pineapple cultivation in Manipur with a production of 147612 MT of pineapple fruits, in a research study compared the results from compound growth rate, exponential smoothing, and ARIMA models on pineapple production in Manipur. According to the results, the independent variable on Manipur's pineapple production accounted for 83.2 %, 75.4 %, and 85.2 % of the total variation, for the compound growth rate model, exponential smoothing model, and autoregressive integrated moving average model of production respectively.

Singh *et al.* conducted a study in 2015, focusing on the patterns of pineapple cultivation in Manipur. They used secondary data spanning from 2001 to 2011 for their analysis. The results of their investigation revealed positive instability indices. The productivity (5.19 per cent) of pineapple has the highest degree of instability followed by production (4.84 per cent) and area (0.76 per cent).

Objectives

The objective of present study was to analyze and understand the pineapple production and its future potential in Manipur State. The specific objectives of the study were;

1. To assess the growth in area and production of Pineapple in Manipur State
2. To analyze the instability in area, production and yield of Pineapple
3. To identify the potential for pineapple cultivation in Manipur

Methodology

For the study, time series data on area, production, and productivity of Pineapple were considered for the years from 2000-01 to 2020-21. The Directorate of Horticulture and Soil Conservation of Manipur provided secondary data. To normalize the study, the study period has been split into two phases. Compound growth rates, an instability indicator, and a decomposition model were used to analyze the pineapple production, area, and productivity.

Analytical framework

Estimation of growth rates

The two most used methods for measuring the growth rate in production are compound growth rate (CGR) and linear growth rate (LGR). Comparisons of growth rates between periods are constrained by the fundamental properties of the LGR. It is not necessary to exclude seasonal and cyclical variations in LGR calculation, and the metric does not take time series data's compound effects into consideration (Ayele *et al*. 2021) [1]. So, adopting the CGR to compare the growth rates of pineapple production, harvested areas, and productivity appears more suitable. The CGR function is calculated by fitting a semi-log trend equation using the following formula:

$$Y = ab^t e \quad (1)$$

The CGR was obtained by transforming Equation (1) to logarithmic form as below:

$$lnY = lna + t(lnb) + e \quad (2)$$

where, Y is the area (ha)/production (t)/ productivity (t/ha), t is the period in the year, a is the constant, b= (1+r) is the slope coefficient that measures the instantaneous relative change in Y for a given absolute difference in the value of an explanatory variable, r is the growth rate, ln is the natural logarithm, and e is the error term.

By multiplying the relative change in Y by 100, the percentage change or growth rate in Y for an absolute change in variable 't' was obtained. The instantaneous growth rate is also measured by the slope coefficient 'b'. Therefore, the CGR was then estimated using the following equation:

$$CGR = (\text{antilog } b - 1)^* 100 \quad (3)$$

Instability analysis

Agricultural instability in harvested regions, production, and productivity can be measured using various techniques. The coefficient of variation (CV), Cuddy-Della Valle Index (CDVI), and Coppock's Instability Index (CII) are three often employed techniques. Equations 4, 5, and 6 are used to calculate Coppock's Instability Index:

$$\text{Coppock's instability Index} = (antilog \sqrt{logV} - 1)*100 \quad (4)$$

$$logV = \frac{1}{N-1} \sum[logX_{t+1} - logX_t - M]^2 \quad (5)$$

$$M = \frac{1}{N-1} \sum[logX_{t+1} - logX_t] \quad (6)$$

Where,

1. X_t is the time series variable under consideration (production/area/yield) for the i-th year (i=1,2,3……N)
2. Log values of X_t are obtained for each year, and the first differences of logarithmic are computed.
3. The mean value of the first differences of the logarithm is denoted by M (6)
4. The value of Var.log is obtained by substituting the values of first differences and M in Equation (5) above, and finally, the instability index (CII) is obtained by substituting the value of Var.log in Equation (4).

According to this interpretation, a high CII number indicates a high instability value. Based on CII values, the districts were categorized as having low (15%), medium (15–20%), and high instability (>20%).

Decomposition analysis

Physically speaking, any change in a crop's yield is basically influenced by the harvested area under the crop and its average productivity. The relative contribution of harvested area, productivity, and their interactions with overall pineapple production has been calculated using the decomposition analysis approach. Using decomposition analysis, Kalidas *et al*., 2020, calculated the impact of the area and yield on the production of coconuts in Tamil Nadu. Decomposition analysis has been done as given below:

$$P=A0\ (Yn-Y0) + Y0\ (An-A0) + \Delta A \Delta Y \quad (7)$$

Where,

P= change in Production, A0= Area in the base year, An= Area in the current year, Y0= Yield in the base year, Yn= Yield in the current year, ΔA= change in area (An- A0), ΔY= Change in yield (Yn-Y0)

Results and Discussions

The secondary data presented below was utilized to calculate the growth rate, instability index and in decomposition analysis.

Trends in harvested area and production

The compound growth rate equation was used to analyze the growth of pineapple cultivation in Manipur. Data on the area and production of pineapples were gathered over a span of 21 years, from 2000 to 2021. This data was further divided into two distinct periods: period I, which covers the years 2000-01 to 2009-10, and period II, which spans from 2010-11 to 2020-21. After conducting the analysis, the findings have been presented in Table 2.

Table 1: Area and production of pineapple in Manipur

Year	Area (Ha)	Production (MT)	Yield
2000-01	10020	69145	6.90
2001-02	10080	69432	6.88
2002-03	10332	75580	7.31
2003-04	10652	79889	7.49
2004-05	11872	95427	8.03
2005-06	11872	97516	8.21
2006-07	11986	100682	8.39
2007-08	12048	102614	8.51
2008-09	12048	109519	9.09
2009-10	12048	71710	5.95
2010-11	12120	110598	9.12
2011-12	12595	116576	9.25
2012-13	13068	124146	9.50
2013-14	13700	136315	9.95
2014-15	14271	136746	9.58
2015-16	13663	128510	9.40
2016-17	13631	127033	9.31
2017-18	14157	134106	9.47
2018-19	13994	131638	9.40
2019-20	14048	166483	11.85
2020-21	12119	147612	12.18

(***Source***: Dept. Horticulture, GoM, 2022)

Table 2: Compound Growth Rates (%) of Pineapple Area and Production

District	Period I (2000-01 To 2009-10)		Period Ii (2010-11 To 2020-21)		Overall Period (2000-01 To 2020-21)	
Growth %	A	P	A	P	A	P
Imphal- West	15.52	19.29	1.14	4.87	6.66	10.71
Imphal- East	6.69	-0.11	3.78	8.12	4.24	8.58
Bishnupur	3.23	4.66	-1.19	-6.31	1.48	-2.05
Thoubal	2.33	3.50	-4.98	-1.40	-1.25	1.56
Chandel	2.42	5.25	-7.40	-6.55	-1.58	1.36
Ukhrul	2.81	8.33	12.00	20.07	6.74	13.50
Senapati	1.08	1.73	1.58	4.14	1.44	4.20
Tamenglong	1.00	3.01	2.63	-0.52	2.19	0.23
Churachandpur	1.00	2.22	2.33	4.52	1.86	4.26
Manipur	2.47	3.55	0.6	2.70	1.58	3.89

In the year 2000-01, pineapple cultivation in Manipur covered a total area of 10,020 hectares, and by 2020-21, this had expanded to 12,119 hectares. During period I, the Imphal-East district saw a substantial increase in the area of pineapple cultivation, growing at a rate of 6.69 percent. However, there was a decline in the production growth rate during this period, with a decrease of - 0.11 percent. This drop in production growth may be attributed to a significant portion of the pineapple plants being in their initial first and second years of cultivation, as pineapple production typically increases after the second year. Overall, the growth rate of area for pineapple cultivation in the region was 2.47 percent, with a corresponding production growth rate of 3.55 percent during the first Period.

During period II, there was a notably lower growth rate in the area dedicated to pineapple cultivation (0.6 percent) with a production rate of 2.70 percent. These figures represented a decline when compared to the growth rates observed in period I. The districts of Bishnupur, Thoubal, Chandel, and Tamenglong experienced a substantial decrease in both the area and production. This decline might be attributed to a reduction in pineapple cultivation in these districts, possibly due to a shift towards other crops like orange and passion fruit. In contrast, the Ukhrul district showed the higher growth rate in both the area and production of pineapples during this period. Manipur government did not implement any promotional schemes which led to a decline in the area. A similar pattern was also seen in production, which peaked in period I at 3.55 percent and declined to 2.70 percent in period II. Overall the pineapple area in Manipur indicated a positive growth rate of 1.58 percent in the region. Among the districts, Ukhrul district lead with a higher growth rate of 6.74 percent, followed by Imphal-West at 6.66 percent, and Imphal East at 4.24 percent. In terms of production, the annual production was increasing at a rate of 3.89 percent per year. Notably, only Bishnupur district had experienced a reduction in production, with a decline of -2.05 percent, despite an increase in cultivated area.

Instability in Pineapple Area, Production and Yield

The index for the harvested area, production, and yield of Manipur pineapple in the three study periods, i.e., Period I (2000-01 to 2009-10), Period II (2010-11 to 2020-21), and Overall Period (2000-01 to 2020-21), is presented in Table 3. The variation in pineapple area, production, and yield have been observed such that instability is captured. Coppock's instability index analysis was used to measure the instability.

In the first period, Manipur State as a whole experienced a 10.84 instability index in the region where pineapples were cultivated, and the production instability was measured at 11.96. Among the districts, Imphal-west, Imphal east, and Bishnupur had the highest instability indices in area, with values of 16.26, 12.50, and 11.14, respectively. In contrast, Churachandpur and Tamenglong districts exhibited the lowest levels of instability in area, which could be attributed to the fact that these districts were key pineapple production areas in Manipur.

During the second decade, the area instability index had reduced, standing at 10.62, in contrast to the first decade. In period II, districts such as Ukhrul (19.23), Tamenglong (18.40), and Bishnupur (18.99) exhibited elevated production instability. On the other hand, Senapati (11.63) and Churachandpur (11.67) reported the lowest levels of production instability among all the districts involved in pineapple production.

Table 3: Instability in of Area, production and yield of Pineapple

District	Period I (2000-01 To 2009-10)			Period Ii (2010-11 To 2020-21)			Overall Period (2000-01 To 2020-21)		
Index	A	P	Y	A	P	Y	A	P	Y
Imphal- West	16.26	18.37	11.50	12.18	13.56	11.58	16.34	20.42	12.82
Imphal- East	12.50	19.05	18.59	11.54	13.19	11.68	13.19	20.08	16.90
Bishnupur	11.14	12.55	11.65	13.01	18.99	21.96	12.46	16.36	18.28
Thoubal	10.82	11.33	10.54	12.33	11.33	11.47	11.81	11.70	12.04
Chandel	10.84	12.62	11.86	13.70	13.90	11.10	12.65	13.60	12.54
Ukhrul	11.02	12.94	11.79	14.80	19.23	13.99	15.47	22.78	15.22
Senapati	10.36	11.54	11.37	10.89	11.63	10.91	11.07	13.23	12.13
Tamenglong	10.32	12.03	11.83	10.97	18.40	18.67	11.49	15.66	16.03
Churachandpur	10.33	11.67	11.45	10.95	11.67	10.94	11.29	13.24	11.93
Manipur	10.84	11.96	11.35	10.62	11.16	11.05	11.18	12.99	11.87

According to Coppock's Instability Index, the area instability for the entire period from 2000 to 2021 was greater at 11.18 compared to both Periods I and II. Additionally, the production instability index was calculated to be 12.99. Notably, Imphal-west stood out with the highest area instability at 16.34, possibly owing to urbanization in the district and changes in people's livelihoods. On a positive note, Churachandpur district registered the lowest area instability index at 11.29, which was encouraging for pineapple farmers to continue their production efforts.

Table 4: Classification of Districts Based on the instability index

Periods	Particulars	Low (<15%)	Medium (15 – 20)%	High (>20%)
Period I	Area	All districts except Imphal west	Imphal west	-
	Production	All districts except Imphal East and West	Imphal East and Imphal West	-
	Yield	All districts except Imphal east	Imphal east	-
Period II	Area	All districts	-	-
	Production	Imphal East & Imphal West, Thoubal, Chandel, Senapati, and Churachandpur	Bishnupur, Ukhrul and tamenglong	-
	Yield	All districts except Bishnupur & Tamenglong	Tamenglong	Bishnupur
Overall period	Area	All districts except Imphal West & Ukhrul	Imphal West & Ukhrul	-
	Production	Thoubal, Chandel, Senapati and Churachandpur	Bishnupur & Tamenglong	Imphal East & West, Ukhrul
	Yield	Imphal West, Thoubal, Chandel, Senapati, Churachandpur	Imphal East, Bishnupur, Ukhrul, Tamenglong	

The Table 4 categorizes districts in Manipur based on their level of instability in pineapple cultivation during the three different periods considered for the study. In Period I, most districts had low area, production, and yield instability, except for Imphal West, which showed medium area instability. In Period II, all districts exhibited low area instability, with few districts like Imphal East and West, Thoubal, Chandel, Senapati, and Churachandpur having low production instability, while Bishnupur, Ukhrul, and Tamenglong were in the medium category.

The overall period analysis revealed that most districts had low area instability, with Imphal West and Ukhrul in the medium category. In production instability, some districts remained low, including Thoubal, Chandel, Senapati, and Churachandpur, while Bishnupur and Tamenglong fell into the medium category, and Imphal East, West, and Ukhrul experienced high instability. This table highlighted the varying degrees of instability in pineapple cultivation across different districts and time frames in the Manipur State.

Decomposition of production variability

Decomposition analysis was employed to examine how the factors of area, yield and their interactions contributed to the fluctuation in pineapple production. The analysis involved breaking down the variability in production into its individual components for two distinct time periods, and the outcomes of the decomposition analysis are presented in Table 5.

Table 5: Decomposition of production variability in pineapple

District	Period I: (2000-01 To 2009-10)			Period Ii: (2010-11 To 2020-21)			Overall Period: (2000-01 To 2020-21)		
Effect %	A	Y	Interaction	A	Y	Interaction	A	Y	Interaction
Imphal- West	6.09	11.83	82.06	142.02	-11.24	-30.77	22.63	39.28	38.07
Imphal- East	115.82	68.60	-84.42	34.90	18.60	46.49	26.52	38.84	34.63
Bishnupur	-116.51	-30.37	246.88	-58.13	26.71	131.42	440.58	-139.33	-201.25
Thoubal	14.13	2.52	83.33	-1145.8	340.30	905.49	185.25	-31.12	-54.12
Chandel	-32.66	-6.96	139.63	-16.20	8.95	107.25	-695.12	315.12	480
Ukhrul	58.62	14.06	27.30	12.97	33.67	53.35	14.51	50.91	34.57
Senapati	166.45	15.15	-81.61	82.45	4.09	13.44	73.79	10.80	15.40
Tamenglong	-214.81	-16.61	331.42	33.15	13.10	53.73	47.85	24.43	27.71
Churachandpur	260.09	26.15	-186.25	61.45	28.72	9.82	59.38	17.54	23.07
Manipur	-370.59	-75.00	545.59	100.03	-0.024	-0.008	67.41	14.12	18.45

In initial period, several districts experienced a dominant contribution from the interaction effect, which indicated that the combined impact of both area and yield was significant in affecting production. For instance, in Imphal-West, the

interaction effect accounted for a substantial 82.06 percent, while the area and yield effects played smaller roles, with 6.09 percent and 11.83 percent, respectively. A similar trend was observed in districts like Chandel (139.63 percent) and Tamenglong (331.42 percent). Churachandpur district's area effect (260.09 percent) was the highest during this period. Overall, during Period I, the interaction effect (545.59 percent) significantly contributed to production variability.

In Period II, the pattern of the interaction effect dominating the production variability continued in several districts. Chandel exhibited a pronounced interaction effect (107.25 percent), mitigating the negative area and yield effects. In Imphal-West, the interaction effect had a substantial negative impact (-30.77 percent), counterbalancing the positive area (142.02 percent) and negative yield (-11.24 percent) effects. The overall result for Period II highlighted that the area effect (100.03 percent) remained the most significant factor in influencing the production fluctuation.

During overall period, the districts consistently relied on the area effect as the major contributor to production variability. Notably, districts such as Bishnupur, Thoubal, and Senapati heavily depended on the area effect, with of 440.48, 185.25, and 73.79 percent respectively to offset the negative factors. Throughout the overall period in Manipur, the area effect constituted 67.41 percent of the production variability, whereas the yield and interaction effects had smaller impacts, accounting for 14.12 percent and 18.45 percent, respectively.

Conclusion

In order to determine the trend in growth of area and production, the study conducted an empirical analysis of pineapple production performance and productivity variability in Manipur State for the past two decades, from 2000–2001 to 2020–21. The results from the study will allow the State government to frame appropriate policies to maintain or increase production and decrease production variability.

Pineapple cultivation in Manipur State exhibited a overall positive trend with positive annual growth rates in area and production. Imphal-West and Ukhrul districts have been prominent contributors to this growth. However, the sector experienced varying degrees of instability across the districts and periods, with Imphal-East, Bishnupur, and Tamenglong demonstrating higher levels of instability, especially in production. Decomposition analysis highlighted the crucial role of the area effect in influencing production, suggesting that expanding cultivation area could significantly enhance pineapple production in the State of Manipur. To ensure sustainable growth, efforts should also be directed toward addressing instability in specific districts, for improving yield, and promoting best agricultural practices.

To promote sustainable pineapple production in Manipur State, it is essential to introduce effective measures such as insurance and forward contracts to mitigate the risks associated with this sector. Given the recent plateauing of pineapple productivity in the state, there is a pressing need to focus on the development of disease-resistant, pest-resistant, and high-yielding pineapple varieties, as well as the adoption of appropriate fertilization practices.

References

1. Ayele A, Worku M, Bekele Y. Trend, instability and decomposition analysis of coffee production in Ethiopia (1993–2019). Heliyon, 2021, 7(9).
2. Darlong PN. Growth and variability of pineapple production in Tripura, a North Eastern State in India. Intenational Journal of Multidisciplinary Educational Research; c2022.
3. Devi CG, Devi SL. Estimation of Pineapple Production In Manipur-A Statistical Approach. ANGRAU, 2022, 128.
4. Ikuemonisan ES, Mafimisebi TE, Ajibefun I, Adenegan K. Cassava production in Nigeria: trends, instability and decomposition analysis (1970–2018). Heliyon, 2020, 6(10).
5. Jainuddin SM, Suhasini K, Lavanya T. Determinants of growth and instability of groundnut production in Karnataka: evidence from Hazel's Decomposition Model. Economic Affairs. 2019;64(3):649-661.
6. Kalidas K, Mahendran K, Akila K. Growth, instability and decomposition analysis of coconut in India and Tamil Nadu, Western Tamil Nadu, India: a time series comparative approach. Journal of Economics, Management and Trade. 2020;26(3):59-66.
7. Krishan B, Chanchal A. Agricultural growth and instability in western Himalayan region: An analysis of Himachal Pradesh, India. Journal of Agriculture and Life Sciences. 2014;1(1):21-27.
8. Nayak A, Lokesha H, Gracy CP, Geetha KN. Instability and decomposition analysis of sesamum crop production in Karnataka and India. International Journal of Agriculture, Environment and Biotechnology. 2021:14(3):349-355.
9. Pant DK, Singh V, Mourya OP. Growth and Instability Analysis of Potato Cultivation in Pithoragarh District of Uttarakhand. Int. J. Curr. Microbiol. App. Sci. 2020;Special Issue-11:1035-1044.
10. Shafeer KB, Karunakaran KR, Reddy MA, Kumar KRB. Trend and Instability Index Analysis in Paddy Crop Area, Productivity and Production across District in Andhra Pradesh, India. Asian Journal of Agricultural Extension, Economics & Sociology. 2021;39(11):69-78.
11. Singh NA, Singh R, Feroze SM, Singh RJ, Rani PMN. Growth and instability of pineapple production in Manipur, India. Indian Journal of Agricultural Research. 2016;50(1):88-91.
12. Umar SM, Suhasini K, Jainuddin SM, Makama SA. Sources of growth and instability in cassava production in Nigeria: An evidence from Hazell's Decomposition Model. SKUAST Journal of Research. 2019;21(1):86-95.
13. Wasnik SB, Suryawanshi SN, Pandey S. Economics of growth performance, instability and decomposition analysis of tobacco in India. Economic Affairs. 2022;67(2):87-94.