Scholarly Research Journal for Interdisciplinary Studies,
Online ISSN 2278-8808, SJIF 2021 = 7.380, www.srjis.com
PEER REVIEWED & REFEREED JOURNAL, JAN-FEB, 2022, VOL- 9/69

GROWTH DYNAMICS AND PRODUCTION INSTABILITY OF MAIZE IN COOCH BEHAR: AN EMPIRICAL STUDY

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Paper Received On: 21 FEB 2022
Peer Reviewed On: 28 FEB 2022
Published On: 1 MAR 2022

Abstract

Instability is an inherent characteristic of agriculture influenced by various unpredictable factors and it refers to the unpredictable fluctuations in crop yields, production volumes, and cultivated areas over time. Maize is an important staple food crop not only in India but across the world. In India, maize is the third most important food crop after rice and wheat. It plays a vital role in the agricultural economy and is used for various purposes, including human consumption, animal feed, and industrial processing. Maize has greater potential than rice and wheat to provide gainful employment and contribute to the goal of doubling farmers' incomes. This study attempt to analysis the growth and instability of maize production in Cooch Behar district terms of area, production, and productivity will be examined and to measure the Compound annual growth rate of maize production.

Keywords: *Maize Production, Instability, Compound annual growth, crop yield.*

INTRODUCTION:

Agriculture is the backbone of the Indian economy, with the majority of the population directly or indirectly dependent on the agricultural sector. A significant portion of these individuals are small and marginal farmers, who rely heavily on agriculture for their livelihoods. Instability in farming is a major challenge for farmers, as it makes agricultural production unpredictable and risky. Instability in agricultural production creates challenges, leading to food insecurity, income volatility for farmers, and disruptions in global and local markets especially in developing countries, where agriculture is a primary source of livelihood ensuring food security and improving rural livelihoods. The word "maize" comes from the Taino language spoken in the Caribbean Islands (Hossain, Bhat, Muthusamy, Jha, 2016). Maize is Known as the "queen of cereals" for its high genetic potential (ICAR), maize provides significant nutritional value, offering 365 kcal per 100 g, with approximately 72% carbohydrates, 10% protein, and 4% fat. It is also rich in fiber, vitamin B, and essential minerals. Maize has become an important industrial crop worldwide, with 83% of its production being utilized in the feed, starch, and

biofuel industries. Currently, around 1,147.7 million metric tons of maize are produced globally by more than 170 countries, covering an area of 193.7 million hectares, with an average productivity of 5.75 tons per hectare (FAOSTAT, 2020). Globally 61 % of Maize is used for animal feeding and 22% is used for industrial used where only 17% is used as food. The consumption pattern of maize in India shows that the largest portion, approximately 47%, is used for poultry feed. About 13% of maize is allocated for livestock feed and another 13% for direct food consumption. Industrial purposes account for 12% of maize usage, with 14% going to the starch industry. Processed food products utilize 7%, while 6% of the maize production is designated for export and other purposes. The remarkable growth has aligned in Maize production with the rapid growth in poultry and allied industries in India, maize has demonstrated the highest compound annual growth rate in terms of area, production, and productivity among cereals over the past two decades. India ranks 4th in the world in terms of maize-growing area and 7th in maize production, accounting for approximately 4% of the global maize cultivation area and 2% of total world production. The study examines the production growth and instability in Maize cultivation using the Cuddy-Della Valle Instability Index and annual compound growth rates of Cooch Behar district of West Bengal, a region where the crop plays a pivotal role in both agricultural output and rural livelihoods.

OBJECTIVE OF THE STUDY:

- To analyze the growth trend of maize production in Cooch Behar district over a period, examining changes in area, yield, and production levels.
- To assess the level of instability in maize production by studying year-to-year fluctuations in area, yield, and total output, identifying the factors contributing to such instability.

DATA AND METHODOLOGY:

The study is based on the secondary data collected from Directorate of Economics and Statistics, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India. District wise information on the area, production, and yield of the crops was obtained from the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India. The compound growth rate was estimated using the following exponential model which is widely used in agricultural economics to study trends in crop production, yield, or area under cultivation. It helps in understanding how fast a variable is growing over time and is particularly useful in long-term

planning and forecasting. The data on the area, production, and yield of maize production in West Bengal has been collected for the period from 2009-2010 to 2019-2020.

$Y = ab^t$

Log Y = log a + t logb

CGR(r) = [Antilog (log b) -1] × 100

where, CGR = Compound growth rate

t = time in the year

Y= area/production/productivity

a and b = Regression parameters

In this study the Cuddy-Della Valle Index is used to measure the instability of potato yields, production, or area under cultivation over time. The Cuddy-Della Valle Index (CDVI) is a statistical measure used to quantify the instability or variability of a time series, particularly in agricultural production data. It is an adjusted version of the Coefficient of Variation (CV) that accounts for the presence of trends in the data. While the Coefficient of Variation measures the relative variability of data by expressing the standard deviation as a percentage of the mean, it does not consider any underlying trends in the data, which can lead to an overestimation of instability

The Cuddy-Della Valle Index is calculated as:

$CDVI=CV\times\sqrt{(1-R^2)}$

Where:

CV is the Coefficient of Variation, calculated as:

CV = (Standard Deviation)/Mean ×100

$R^2$is the coefficient of determination from a linear regression model fitted to the time series data, representing the proportion of the variance in the dependent variable that is predictable from the independent variable (usually time).

R^2 (Coefficient of Determination): This value indicates how well the linear regression model explains the variability in the data. If there is a strong trend, R^2 will be high, indicating that much of the variability is due to the trend rather than random fluctuations.

RESULT AND DISCUSSION:

This table illustrates the significant variation in maize production across different seasons, with Rabi being the dominant season for area, production and yield in Cooch Behar district from 2009-2010 to 2019-2020. In Cooch Behar district, maize is predominantly grown during the Rabi season, accounting for approximately 65% of the total maize production. The Rabi season

in this district starts with sowing between October and December, and the crop is harvested between March and May. The Summer season contributes around 30% to the district's total maize production. Sowing for the Summer maize begins between January and March, with harvesting typically done between May and June. The warmer weather and availability of irrigation play an essential role in this season. In contrast, the Autumn season sees the least maize production, contributing only about 5% of the total production. Sowing for Autumn maize begins in June to July, and it is harvested around September to October. This season is typically monsoon-dependent but less popular for maize cultivation in the district. Up to 2011-2012, the total area under maize cultivation in Cooch Behar district was highest during the summer season. During the same period, maize was cultivated on 4,290 hectares in the Rabi season, while the Autumn season saw a much smaller area of 656 hectares. A year later, in 2012-2013, maize cultivation expanded significantly, with the Rabi season reaching 7,100 hectares and the Autumn season increasing to 1,797 hectares. By 2019-2020, the Rabi season had the highest maize cultivation area. Although the yield rate remained similar between the Rabi and Summer seasons, it was noticeably lower during the Autumn season.

Class	Range of Instability
Very low Instability	0 to 5
Low Instability	5 to 15
Medium Instability	15 to 30
High Instability	30 to 50
Very high Instability	>50

Table :1 Season-wise Maize Area, Production, and Yield in Cooch Behar District (2009-2010 to 2019-2020)

Year	Maize								
	Rabi			Summer			Autumn		
	Area (Hectare)	Production (Tonnes)	Yield (Tonne/ Hectare)	Area (Hectare)	Production (Tonnes)	Yield (Tonne/Hectare)	Area (Hectare)	Production (Tonnes)	Yield (Tonne/Hectare)
2009 - 2010	6,010.00	35,038.00	5.83	4,374.00	26,603.00	6.08	407	933	2.29
2010 - 2011	4,075.00	23,818.00	5.84	4,391.00	26,465.00	6.03	484	1,306.00	2.7
2011 - 2012	4,290.00	25,204.00	5.88	4,400.00	27,280.00	6.2	656	1,487.00	2.27
2012 - 2013	7,100.00	46,150.00	6.5	4,388.00	26,780.00	6.1	1,797.00	4,375.00	2.43

2013 - 2014		12,750.0	82,875.00	6.5	4,393.00	26,841.00	6.11	2,677.00	7,434.00	2.78
2014 - 2015		12,750.0	82,875.00	6.5	4,394.00	26,847.00	6.11	2,745.00	6,982.00	2.54
2015 - 2016		12,755.0	82,754.00	6.49	4,397.00	27,064.00	6.16	2,944.00	8,470.00	2.88
2016 - 2017		12,753.0	82,818.00	6.49	4,399.00	27,177.00	6.18	3,686.00	9,679.00	2.63
2017 - 2018		16,000.0	178350	6.9	4,500.00	29,700.00	6.6	3,884.00	9,519.00	2.45
2018 - 2019		9,390.00	56,528.00	6.02	12,655.00	77,512.00	6.13	3,203.00	10,252.00	3.2
2019 - 2020		29,000.0	178350	6.15	10,200.00	62,475.00	6.13	2,215.00	6,544.00	2.95
Total		**1,26,873**	**8,06,810**	**69.10**	**62,491**	**3,84,744**	**67.83**	**24,698**	**66,981**	**29.12**

Source: Ministry of Agriculture & Farmers Welfare, Government of India.

The data presented in Table: 2 shows the Instability Index for maize production across three seasons Rabi, Summer, and Autumn in terms of area, production, and yield in Cooch Behar district. For the Rabi season, the instability index for area is 37.84, for production it's 37.19, and for yield it's 5.03, suggesting that while there is significant variation in area and production, yield remains more stable. Similarly, for the summer season, the indices for area (38.65) and production (37.55) indicate high variability, while the yield index is 2.24, showing relatively stable output per hectare. The Autumn season has the highest instability in yield (8.23), indicating that maize production during this season is most inconsistent, likely due to climatic factors and lower production levels. Overall, the Rabi and Summer seasons show comparable levels of instability in area and production, while the Autumn season exhibits the most instability in yield

Table: 2 Season wise Maize area, production and yield in Cooch Behar district from 2009-2010 to 2019-2020.

Maize									
	Rabi			**Summer**			**Autumn**		
	Area (Hectare)	Production (Tonnes)	Yield (Tonne/Hectare)	Area (Hectare)	Production (Tonnes)	Yield (Tonne/Hectare)	Area (Hectare)	Production (Tonnes)	Yield (Tonne/Hectare)
Instability Index	37.843459	37.1963852	5.029317697	38.65375	37.552366	2.236947	33.09459	30.23768	8.226016

Source: Ministry of Agriculture & Farmers Welfare, Government of India.

The Compound Annual Growth Rate (CAGR) data for maize cultivation in Cooch Behar district in Table:2 reveals distinct trends across the Rabi, Summer, and Autumn seasons. The Rabi season showed strong growth, with a 14.16% increase in the area cultivated annually and a 7.64% rise in production. However, its yield rate saw a decline of 5.71%, indicating that while more land was being used for cultivation, the efficiency or productivity per hectare slightly decreased. The Summer season experienced more moderate growth. The area under cultivation expanded by 4.02% annually, and production rose by 7.21%, reflecting stable growth. The yield for the summer season also improved by 3.07%, signifying an overall positive trend in both the efficiency and output of maize during this period. Autumn season, while having the smallest area and production figures, showed the highest growth rates in both. The area under cultivation expanded rapidly at 15.27% per year, and production grew by 18.02%. Despite this, the yield rate only increased by 2.40%, indicating that although more land was being used and more maize was being produced, the productivity per hectare remained relatively low compared to the other seasons.

Table: 3 Compound Annual growth rates of maize in Cooch Behar District from 2009-2010 to 2019-2020.

Maize									
	Rabi			**Summer**			**Autumn**		
	Area (Hectare)	Production (Tonnes)	Yield (Tonne/Hectare)	Area (Hectare)	Production (Tonnes)	Yield (Tonne/Hectare)	Area (Hectare)	Production (Tonnes)	Yield (Tonne/Hectare)
CAGR	14.16%	7.64%	-5.71%	4.02%	7.21%	3.07%	15.27%	18.02%	2.40%

Figure: 1 Instability of Maize cultivation in Cooch Behar District

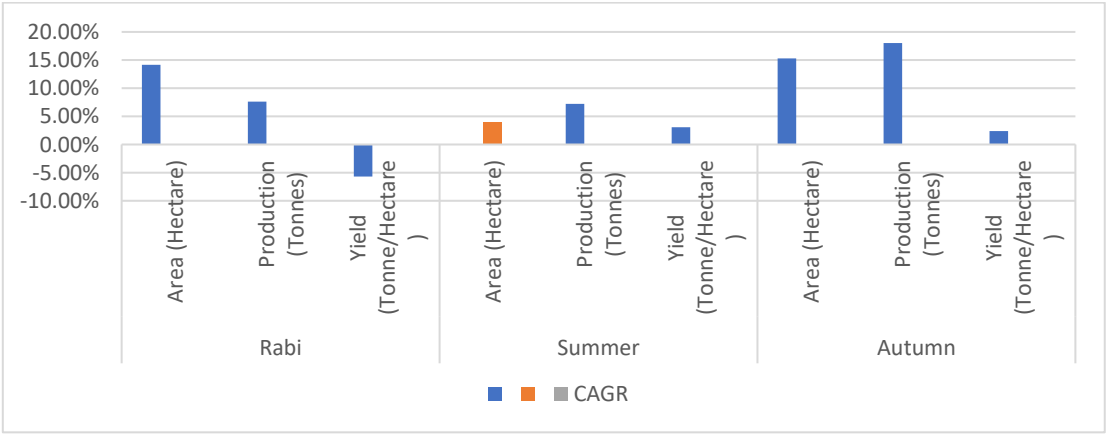
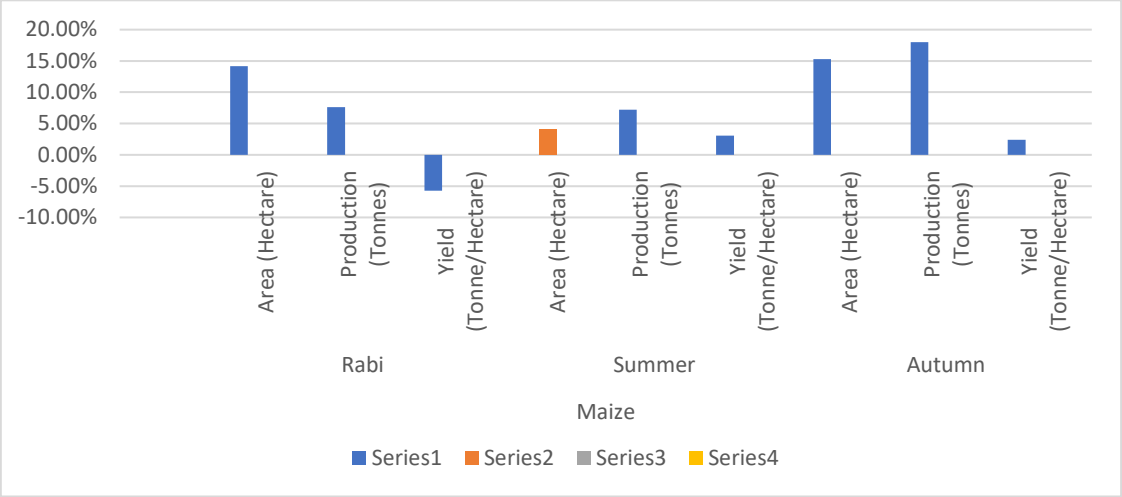


Figure: 2 Compound annual growth rate.



CONCLUSION:

In Cooch Behar district, maize is cultivated year-round, but most farmers focus on the Rabi and Summer seasons. In North Bengal, particularly in Cooch Behar, many farmers are involved in potato farming, which is a cash crop but requires significant capital investment and is subject to unpredictable price fluctuations. In contrast, maize cultivation demands far less capital, and its market prices are more stable compared to potato. Potato farming also involves the heavy use of fertilizers, whereas many farmers who grow maize in the summer season do so on land previously used for potato cultivation, allowing them to grow maize without the need for additional fertilizers. Farmers with small landholdings can easily manage maize cultivation on their own. Given these factors, many farmers are opting to grow maize instead of potatoes during the Rabi season. To mitigate risks, some are choosing to cultivate both maize and potatoes. Additionally, during the summer season, farmers are increasingly replacing jute with maize, as jute farming is labour-intensive and less profitable compared to maize. Due to these reasons, there has been a notable shift towards maize cultivation in recent years. Despite facing several challenges in maize farming, many farmers rely heavily on local maize vendors, known as "paikers." Establishing industry linkages could further promote maize cultivation, enabling farmers to secure better crop prices and improve their livelihoods.

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