

## RESEARCH ARTICLE

# Growth and Instability of Organic Maize Crop in the Eastern Himalayan State of Sikkim, India

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## Abstract

Agriculture serves as the backbone of the majority rural populace of Sikkim, the country's pioneer state to practice organic farming. Maize stands as an important crop for the population of the hilly state. Besides providing food security for the rural population, it is also used as feed and fodder for animals. In recent years, the state has seen a rise in the demand for Maize with its expanding population and the expansion of the animal feed and poultry sector. This study attempts to understand the growth and instability in the area, production and yield of maize crops by using secondary data collected from the Directorate of Economics and Statistics, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture, Government of India. Information on the area, production and yield of maize production in Sikkim was collected for the years 2001- 02 to 2020-21. The overall area under maize recorded negative growth in the entire study period. The production and yield of maize registered low growth rates in the periods considered in the study. Instability analysis in the study shows that the magnitude of instability of area, production and yield of maize has declined in Period II. Instability for area and production in the overall period has remained lower than that of Period I but higher than the magnitude of instability in Period II. In the case of yield, instability in the overall period is the highest.

**Keywords:** Organic maize, Growth, Instability, Cuddy Della Valle Index, Sikkim.

## Introduction

Agriculture serves as the backbone of the majority rural populace of Sikkim, the nation's pioneer state in practicing organic farming (FAO, 2018). The economy of the state, which is connected with farming, fills in as the wellspring of living and monetary security of the considerable rural native populace. The agriculture and related sectors serve as the basis for economic, food and nutritional security for more than 80% of the Sikkimese population (Government of Sikkim, 2022<sup>a</sup>). In 2023-2024, the primary sector contributed about 8% of the GSDP, at current prices, while agriculture, forestry and fishing shared about 99.88% of the total primary sector contribution (Government of India, 2024). Nearly 13.66% of Sikkim's total land area is under agriculture because of its altitude, climate, and hilly terrain (Government of Sikkim, 2014-15) and about 83.9% of the total cultivable area of the state is the operational land of the small and marginal farmers (NSSO, 2019). With a share of about 35% of the total cultivable area of the state (Government of Sikkim, 2022<sup>b</sup>) maize stands as an important crop for the population of the hilly state. Besides serving the dietary needs of the rural population it is also used as feed and fodder (Borah *et al.*, 2012). Maize provides the state's farming community with a guarantee of food security because of its demonstrated capacity and insurance against the failure of crops through greater profitable returns from the intercrops. (Basnet *et al.* 2003). Furthermore, the state has seen a rise

in the demand for Maize with its expanding population and the expansion of the animal feed and poultry sector. Although the state has experienced an increasing demand for maize in recent years, yet, the maize productivity of the state has remained low (Borah *et al.*, 2012, Basnet *et al.* 2003). Maize productivity of the state has remained low with a decadal growth rate of 6.88% between 2010-2011 to 2020-2021(Government of Sikkim, 2022<sup>b</sup>). Thus, given the limited supply of arable land (Subba, 2009) the state is yet to provide for the rapidly increasing demand for the staple

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crop in the state. Factors like climate change, rainfall and temperature affect agricultural production and cause its deviation from the trend, thereby, increasing the production risk and consequently affecting their livelihood and income (Raju *et al.* 2014). The decline in the output production of maize affects the farmers of the state, forcing them towards the cultivation of less profitable crops. Since maize serves the livelihood of the rural farming community, instability in its production and yield directly affects their livelihood. This calls for understanding the growth and instability in the production and acreage use and yield of the crop. Against this backdrop, this study to understand the growth and instability in the production and acreage use and yield of Maize in Sikkim was undertaken. Although several studies have been conducted concerning maize crops in Sikkim (Kumar *et al.*, 2023; Guha & Mandal, 2020; Chakraborty, 2020) however, this study is the first of its kind in the study area.

### Objective

The study was undertaken with the twin objectives of studying the growth rate and investigating the instability in the area, production and yield of maize crops in Sikkim.

### Data and Methodology

This study is based on secondary data collected from the Directorate of Economics and Statistics, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture, Government of India. Information on the area, production and yield of maize production in Sikkim was collected for the years 2001- 02 to 2020-21.

#### a). Growth Rate

To analyze and study the trends in maize production, the formula for measuring compound annual growth rate has been used, as follows;

$$\text{Log } Y = \beta_0 + \beta_1 t + u_t$$

Where  $Y$  = Area/Production/Yield of Maize in Sikkim

$t$  = time (years)

$\beta_0$  = intercept

$\beta_1$  = slope co-efficient

$u$ = disturbance term

$$\text{CAGR (r)} = (\text{Exp}(\beta_2)-1) \times 100$$

#### b). Instability

While there are different methods, this study employs the Cuddy Della Valle Index (CDI), to measure instability, because it is a better method and is widely used.

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

Where,

CV is the Coefficient of Variation

$R^2$  is the Coefficient of Determination

This methodology has been used to analyse growth and instability by various authors (Ralte, 2023, Gurung and Choubey, 2021)

### Results and Discussion

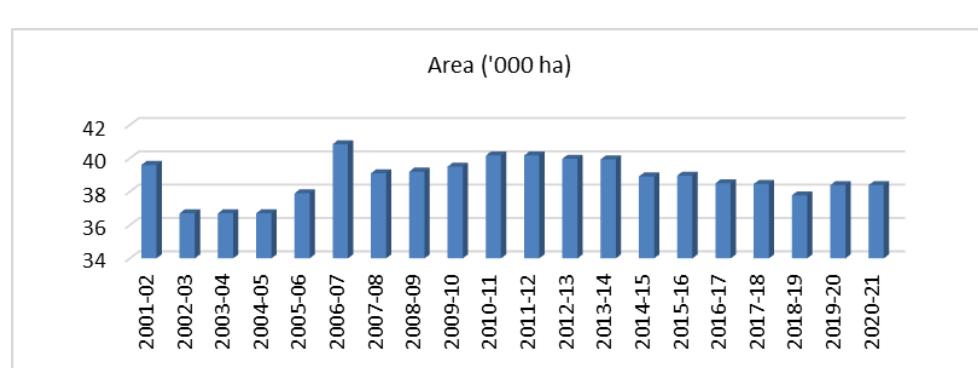
#### Growth Trends in Area, Production and Yield of Maize in Sikkim

The growth analysis would indicate the general pattern of growth of the crop. A perusal of Figures 1, 2 and 3 presents a general trend in the area, production and yield of maize production in Sikkim over the last two decades. As evident from Figure 1, fluctuations are observed in the area under maize. However, there is a marginal increase in the production and yield of the maize crop in the district as evident in Figures 2 and 3

To understand the growth rates in area, production and yield of maize crop in the entire period of study was divided into two sub-periods. The growth rates for the periods are presented in Table 1.

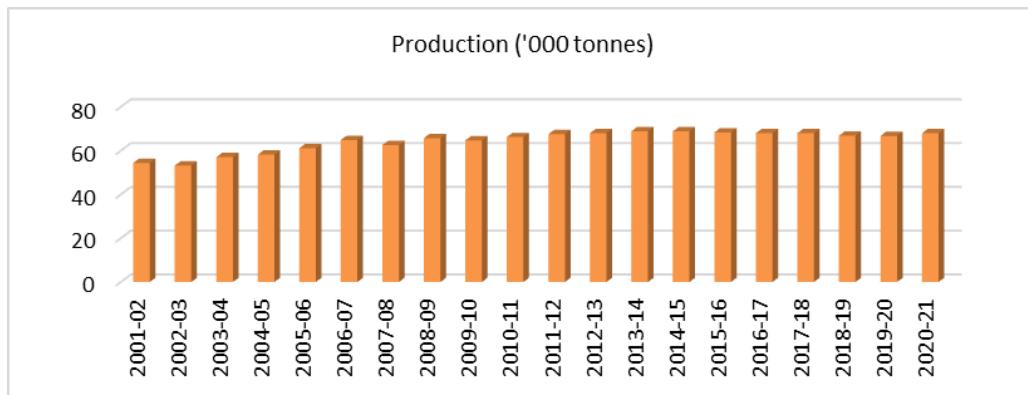
#### Growth in Area

It is seen from Table 1 that in the first-period maize area recorded a positive growth of 0.0015%, while in the second period, it recorded a registered marginal decline in the growth of - 0.0050%. As evident from Table 1, during the overall period area under maize in Sikkim recorded a negative growth of - 0.0016%.



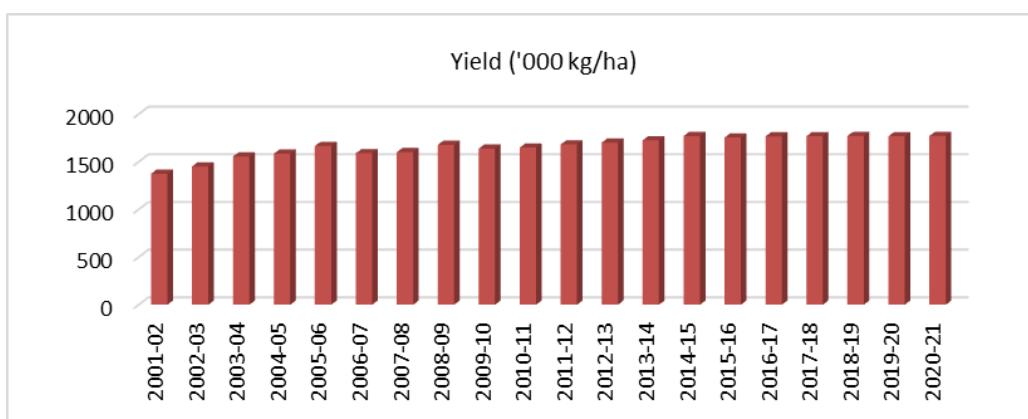
Source: Ministry of Agriculture, Government of India

Figure 1: Total area under maize in Sikkim, 2001-02 to 2020-21



Source: Ministry of Agriculture, Government of India

Figure 2: Total production maize in Sikkim, 2001-02 to 2020-21



Source: Ministry of Agriculture, Government of India

Figure 3: Total yield of maize in Sikkim, 2001-02 to 2020-21

### Growth in Production

The production of maize, however, has recorded positive growth in both periods. It can be seen in Table 1, that the growth of maize production was 0.0224% in the first period I. It, however, marginally declined to 0.0006% in period II. The overall growth rate of maize production was registered at 0.0117%. The overall growth rate is lower than the growth rate of maize production in period I.

### Growth in Yield

Similarly, the yield of maize in Sikkim registered a positive growth rate of 0.024 in period I, which declined marginally to 0.057% in Period II. Just like the overall growth rate of production, the overall growth rate of yield of maize is comparatively lower than the growth rate in Period I.

### Instability Analysis

To measure the instability of maize in area, production and productivity the Cuddy Della Valley Index (CDVI) is used. All these are assessed in two phases – Period I and period II. The results of the Cuddy-Della Valle index analysis are given in Table 2.

The result revealed that period-I in Sikkim had marginally the highest instability in the area (39.76%) and production

(79.08%), followed by the overall period in the area (31.09) and production (76.41). The lowest instability for area, production and yield was observed in period II. It indicates that the production of maize faced more variation in period I and the least variation in period II (from 2011-12 to 2020-21). The highest instability for the yield of maize was seen in the overall period whereas the least instability was noticed in period II.

### Discussion

Maize is the staple as well as the cash crop of Sikkim and cultivation of the crop serves as a source of source of income for the majority rural farming populace of Sikkim. With the decline in the acreage use over the years the cultivation of

Table 1: Growth rates of maize in Sikkim during 2001-02 to 2020-21

Period	Area	Production	Yield
Period I: 2001-02 to 2010-11	0.0015	0.0224	0.0204
Period II: 2011-12 to 2020-21	-0.0050	0.0006	0.0057
Overall Period: 2001-01 to 2020-21	-0.0016	0.0117	0.0134

Source: Computed using retrieved data from the Ministry of Agriculture, Government of India

**Table 2:** Instability in area, production and yield of maize in Sikkim

Variables	Period I	Period II	Overall
Area	39.76	20.84	31.09
Production	79.08	10.62	76.41
Yield	61.66	18.95	67.26

**Source:** Computed using retrieved data from the Ministry of Agriculture, Government of India

the crop is affected by factors such as attacks by mammalian pests and insect pests, altered climatic patterns, declining labor availability, inadequate irrigation, and lack of quality planting materials (Sharma et al., 2016). Such decline in area, leading to less cultivation of the crop has led to a drastic fall in the incomes of the farmers who are dependent on maize cultivation for their livelihood. During the second period area under maize cultivation recorded a marginal decline, while the overall period area under maize recorded a negative growth. The production of maize, however, has recorded a positive, yet, marginally low growth rate over the periods of study. Likewise, the yield of maize has registered a low growth rate in the periods considered in the study.

Analysis of the instability of food grain production is important as it enables us to understand the nature of food security at the regional level (Mahendradev, 1987). For such significant implications, the instability analysis for maize crops in Sikkim has been conducted in two sub-periods- Period I and period II in this study. The findings show that maize production faced greater instability in terms of area, production and yield in phase I while it faced lower instability in phase II. It indicates that the production of maize faced more variation in period I and the least variation in the recent period i.e., period II (from 2011-12 to 2020-21). Thus, major policy interventions to improve crop production would be to increase the area under maize, better management of farms and pest control measures. Training can be organized to help farmers learn methods to protect the crops from the effects of climate change.

## Conclusion

This study attempts to examine the growth and instability of maize in Sikkim over the period 2001- 02 to 2020-21. The analysis in the present study shows that the growth rates of the area of maize were positive in period I (2001-10) but in period II (2011-21) maize crops registered a negative growth rate. On the other hand, rates of growth of production and yield were positive in period I but marginally declined in period II. However, for the overall period (2000-01 to 2020-21), growth rates of production and yield witnessed a favorable growth rate while only the area saw undesirable growth. Instability analysis in the study shows that the magnitude of instability of area, production and yield of maize has declined in period II. Instability for area and production in the overall period has remained lower than that of period I but higher than the magnitude of instability

in period II. The overall period has the highest level of yield instability.

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