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## Growth rate, trend and Instability in area and production of watermelon in Haryana vis-a-vis Karnataka

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### Abstract

The *Citrullus lanatus* (watermelon) is one of the most important fruit crop grown in tropical regions and eaten around the world. The, the present study aimed to examine the Growth rate, trend and Instability in area and production of watermelon in Haryana and Karnataka. For growth rates CAGR, and for instability Coefficient of Variation (CV), and Cuddy Della Valle's instability indices were used. The study was based on secondary data. Data related to the area, production and productivity of watermelon was collected for the period 2011-2020 from different published reports. In India, the results showed that, the area, production and productivity of watermelon have an increasing trend over the period from 2011 to 2020, similar trend was observed in Haryana state but, in Karnataka the area and production showed a decreasing trend, while productivity followed an increasing trend with the growth rate of 1.78 per cent due to improved technology. In Haryana, the instability in the area and productivity was moderate found to be (15.52 and 20.39%), similarly, in Karnataka the instability in the area and production was moderate (18.79 and 15.51%).

**Keywords:** Growth rate, instability, coefficient of variation, productivity

### Introduction

Indian agriculture is gradually changing on the one hand, the amount of land suitable for agriculture is decreasing as urbanisation increases. On the other hand, there is a rapidly increasing demand for higher crop productivity and returns from the arable land; all of these developments have created the perfect environment for significant trends towards diversification, primarily in favour of horticultural crops. India has the advantage of being able to cultivate a variety of crops in general and horticultural crops in particular because the country is blessed with a wide range of soil types and agro-climatic conditions.

The *Citrullus lanatus* (watermelon) is one of the most important fruit crop grown in tropical regions and eaten around the world. In many regions of India, the word "watermelon" is also known as "tarbuj", "tarmuj", "kalingad", and "kalindi". Generally speaking, melons are sweet, juicy, and delectable fruits that are primarily consumed during the warmer season, comprising the family Cucurbitaceae. Due to the fruit's size and shape, as well as its delicious, pulpy flesh, the word "melon" was given to it. Greek and Latin roots both contribute to the scientific name of the watermelon. It is well known to have few calories while being very nourishing and satiating.

The fruit is consumed more widely than any other cucurbit in the world. According to FAO (2019) statistics, China, Turkey, India, and Brazil are the world's largest producers of watermelon. Watermelon was grown on 110 thousand acres of land in India in 2021-2022, with a production of 2,787 thousand tonnes. Watermelon production in the state of Haryana was 147.76 thousand tonnes, with 6.23 thousand ha area under cultivation. Watermelon production in the state of Karnataka was 298.39 thousand tonnes, with 7.13 thousand ha under cultivation.

West Africa is where the watermelon was first cultivated. It is a fruit that is very beneficial to the health system and is extremely medicinal.

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Watermelon has 46 per cent calories yet offers 20 per cent vitamin C and 17 per cent vitamin A. It has significantly more lycopene than tomatoes to combat free radicals. It soothes tight muscles and is healthy for body hydration. The minerals included in watermelon seeds prevent cancer and lower levels of harmful cholesterol in the body. Water melon's economic viability is influenced by its multiple uses. It has 91 per cent water and around 6 per cent sugar. It is low in fat and sodium, also a good source of vitamin C, just as other fruits.

Around the world, a lot of people enjoy eating fresh watermelon. The cucurbitaceous plant with the highest iron content is the watermelon. Watermelons with red flesh contain high levels of lycopene. The brown, flat seeds have a nice, nutty flavour and are more nutrient-dense than the meat. Minerals, fats, and vitamin C are all abundant in them. They can be eaten raw or roasted and added to flour mixtures. According to a study, the pulp from the seeds is used to make soups thicker. A local sweetener called "ogiri" is made from the fermented seeds, and another sweetener called "igblo" can be made by boiling them with leaves. *Citrullus lanatus* seeds are increasingly employed in the cosmetic and pharmaceutical industries in addition to being used for their oil. Seeds are utilised to promote baby feeding because of their high protein and fat content. Watermelon is well recognised for having little calories and for containing vitamins C and A that aid with dry skin, dermatitis, and psoriasis as well as night blindness.

Comparative studies conducted in two separate areas can be very beneficial in providing alternate solutions that farmers, marketers, and policymakers may choose to implement.

### Selection of study area and collection of data

For the study, Haryana and Karnataka states are selected purposively. The present study was based on secondary data. The secondary data related to the area, production and productivity of watermelon was collected for the period 2011-2020 from different sources such as the published reports of National Horticultural Board, Horticulture Department (Government of Haryana), Department of Horticulture (Government of Karnataka).

### Analytical techniques

#### Growth Rate

The growth rate in area, production and productivity of watermelon was computed from the year 2011 to 2020 for India, Haryana and Karnataka states. In the present study, compound growth rates in the area, production and productivity of watermelon were estimated using an exponential function, i.e.,  $Y_t = ab^t$  (Muhammed 2018) [5].

The compound growth function is specified in the following formula:

$$Y_t = ab^t e^u \quad (1)$$

Where

$Y_t$  = area/production/productivity in the year t

t = time period

a = intercept value (value of Y when t = 0)

b = (1+r), 'r' being the growth rate

e = error term

Equation (1) was converted into the logarithmic form by taking natural log to facilitate the use of linear regression. Taking logarithms on both sides of equations we obtain,

$$\ln y_t = \ln a + t \ln b + u \quad (2)$$

$\ln a$  and  $\ln b$  are obtained by application of ordinary least squares (OLS) procedure to equation (1), and the growth rate 'r' is computed as below:

$$\text{CAGR (\%)} = (\text{Anti } \ln \text{ of } b - 1) \times 100 \quad (3)$$

### Instability Analysis

The instability in the area, production and productivity of watermelon, the Coefficient of Variation (CV), and Cuddy Della Valle's instability indices were used. The coefficient of variation is commonly used for estimating instability but in the case of time series data characterized by time trend, the CV sometimes overestimates the instability, so Cuddy Della Valle's instability index given by Cuddy and Della (1978) [4] and (Udhayan *et al.* 2023) [7].

$$\text{Coefficient of variation (CV)} = \sigma / \bar{x} \times 100 \quad (4)$$

Where,  $\sigma$  is the standard deviation given by the following formula:

$$\sigma = \sqrt{\sum (x - \bar{x})^2 / N} \quad (5)$$

The formula for Cuddy Della Valle's instability index (CDVI) is

$$\text{CDVI} = \text{CV} (\sqrt{1 - R^2}) \quad (6)$$

Where,

CV = Coefficient of Variation

$R^2$  = Coefficient of determination

### Decomposition Analysis

Any change in the production of a crop, either increase or decrease, fundamentally depends on the changes in the area and its yield. To disintegrate the effect of area and productivity and their interaction in increasing the production of a crop, the equation given by Sharma *et al.* (2017) [6].

$$\Delta P = A^\circ \Delta Y + Y^\circ \Delta A + \Delta Y \Delta A \quad (7)$$

Where,

$\Delta P$  = Change in production

$A^\circ$  = Area in the base year

$Y^\circ$  = Yield in the base year

$A^\circ \Delta Y$  = Area effect

$Y^\circ \Delta A$  = Yield effect

$\Delta Y \Delta A$  = Interaction effect

### Results

#### Trend in area, production and productivity of watermelon in India, Haryana and Karnataka

In India, the area, production and productivity of watermelon have shown an increasing trend over the period from 2011 to 2020 which is presented in table 1, and graphically depicted in figure 1. Area of watermelon in the year 2011 was 70.6 thousand ha and increased to 119.03 thousand ha in the year 2020. While, in case of production was 1727.5 to 3254.21 thousand tonnes in 2011 to 2020, respectively. Whereas, productivity also increasing from 24.47 to 27.34 Mt/ha during the period 2011 to 2020, respectively. Thus, the total growth rate was found to be 5.78, 7.42 and 1.56 per cent in area, production and productivity, respectively.

**Table 1:** Area, production and productivity of watermelon in India: 2011-20

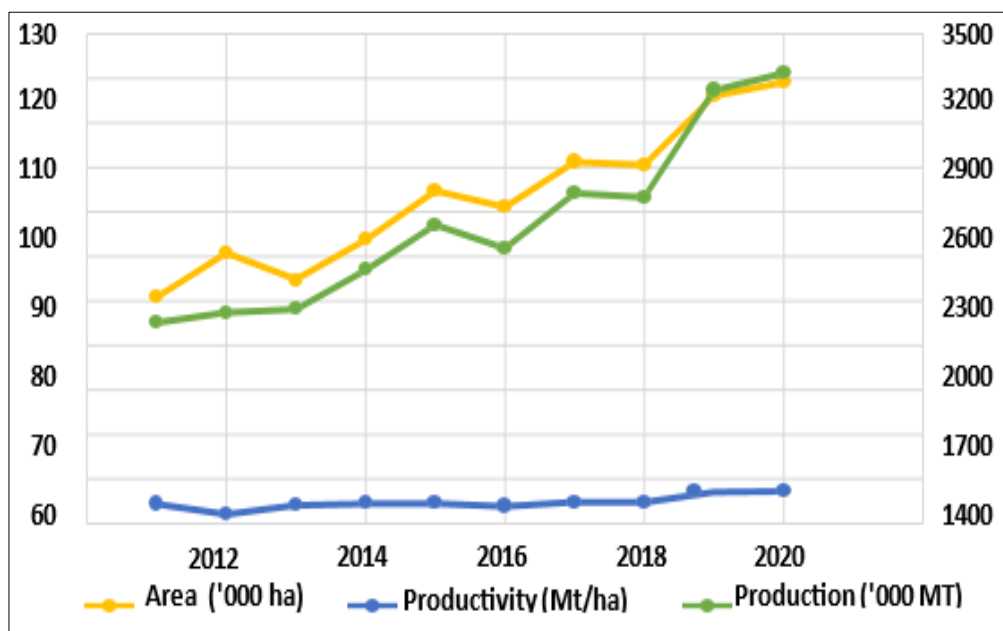
Year	Area ('000 ha)	Production ('000 Mt)	Productivity (Mt/ha)
2011	70.6	1727.5	24.47
2012	80.6	1789.2	22.20
2013	74.64	1809.83	24.25
2014	83.58	2049.25	24.52
2015	94.59	2325.44	24.58
2016	90.93	2181.64	23.99
2017	101.08	2520.1	24.93
2018	100.41	2494.64	24.84
2019	116.02	3148.66	27.14
2020	119.03	3254.21	27.34
CAGR (%)	5.78	7.42	1.56

Source: National Horticultural Board, Gurgaon

**Table 2:** Area, production and productivity of watermelon in Haryana, 2011-20

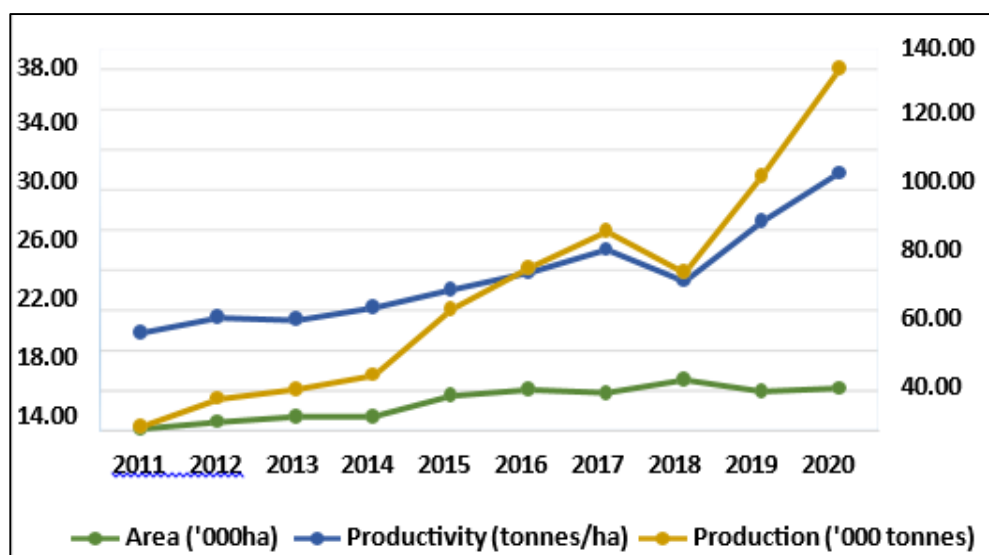
Year	Area ('000 ha)	Production ('000 tonnes)	Productivity (tonnes/ha)
2011	2.24	21.52	9.63
2012	2.89	30.25	10.47
2013	3.44	33.25	9.68
2014	3.45	37.62	10.91
2015	5.49	58.46	10.65
2016	6.07	71.42	11.77
2017	5.80	82.89	14.28
2018	7.06	69.89	9.90
2019	5.92	100.42	16.97
2020	6.24	134.05	21.50
CAGR (%)	12.55	20.77	7.30

Source: Horticultural Department, Panchkula-Govt. of Haryana

**Fig 1:** Area, production and productivity of watermelon in India, 2011-20

The total area under watermelon cultivation in Haryana had showed increasing trend from last decade (2011-2020) *i.e.*, area under watermelon cultivation increased from 2.24 to 6.24 thousand ha in the year 2011 to 2020, respectively. Whereas, production increased from 21.52 to 134.05 thousand tonnes in the year 2011 to 2020, respectively. In case of productivity

also increasing from 9.63 to 21.50 tonnes/ha during the year 2011 to 2020, respectively. Thus, the total growth rate found to be 12.55, 20.77 and 7.30 per cent in area, production and productivity, respectively. The data regarding area, production and productivity in Haryana is presented in Table 2, and the trend is graphically depicted in Figure 2

**Fig 2:** Area, production and productivity of watermelon in Haryana: 2011-20

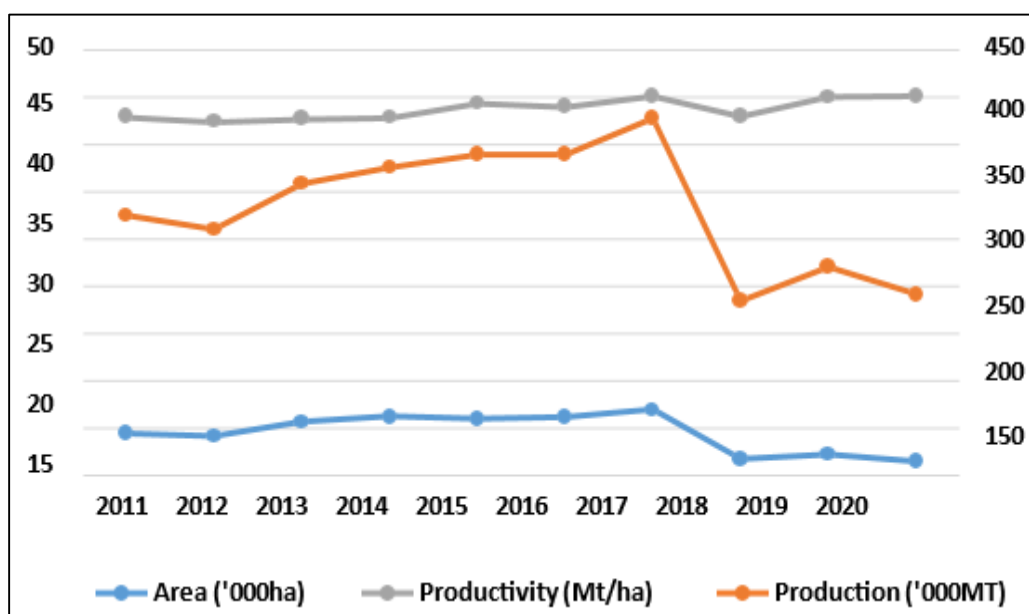
**Table 3:** Area, production and productivity of watermelon in Karnataka, 2011-20

Year	Area ('000 ha)	Production ('000 tonnes)	Productivity (tonnes/ha)
2011	9.33	313.80	33.61
2012	9.04	302.17	33.39
2013	10.58	340.02	32.14
2014	11.14	353.39	31.71
2015	10.87	364.16	33.50
2016	11.05	363.98	32.94
2017	11.85	394.29	33.27
2018	6.67	242.71	36.38
2019	7.14	270.80	37.92
2020	6.42	248.47	38.70
CAGR (%)	-4.23	-2.53	1.78

Source: Department of Horticulture, Bangalore-Govt. of Karnataka

In Karnataka, the area under watermelon cultivation has declined from 9.33 thousand ha to 6.42 thousand ha between the period 2011 to 2020, the production has also fallen from 313.80 thousand tonnes to 248.47 thousand tonnes with the annual growth rate of -4.23 and -2.53 per cent, respectively.

Only productivity was found to be increasing with the growth rate of 1.78 per cent due to improved technology. The data regarding area, production and productivity in Karnataka is presented in Table 3, and the trend is graphically depicted in Figure 3.

**Fig 3:** Area, production and productivity of watermelon in Karnataka, 2011-20**Table 4:** Instability in area, production, and productivity of watermelon

Particulars	Area		Production		Productivity	
	CV	CDVI	CV	CDVI	CV	CDVI
India	17.59	4.74	23.13	6.17	5.99	3.92
Haryana	34.57	15.52	55.37	12.91	31.10	20.39
Karnataka	21.51	18.79	16.43	15.51	7.07	4.75

Note: If CDVI value, 0-15=Low instability, 15-30=Medium instability, above 30= High instability

The instability analysis of watermelon in India, Haryana and Karnataka is depicted in Table 4, which showed that the instability in the area, production and productivity was low (4.74, 6.17 and 3.92 per cent, respectively). In case of Haryana, instability analysis of watermelon cultivation

depicted that the instability in the area and productivity was moderate (15.52 and 20.39 per cent, respectively). Whereas, instability analysis of watermelon production in Karnataka showed that the instability in the area and production was moderate (18.79 and 15.51 per cent, respectively).

**Table 5:** Source of growth in production of watermelon (Decomposition analysis)

Particulars	Area effect (%)	Yield effect (%)	Interaction effect (%)	Change in production ( $\Delta P$ )
India	13.27	77.62	9.11	1526.71
Haryana	23.59	34.22	42.19	112.53
Karnataka	-72.83	150.07	22.75	-65.33

Note: Area, Yield and Interaction effects are in per cent.  $\Delta P$  denotes change in production, which is in actual quantity as per measuring unit of crop. If  $\Delta P$  is negative then a negative effect will be positive in actual values and a positive effect will be negative in actual values.

Change in the production of a crop either decrease or increase fundamentally depends on the changes in the area and its yield. The results (Table 5) showed that, in India yield effect is the major contributor to increase in production (77.62%). Area effect (13.27%) and interaction effect (9.11%) contributed less to the increase in production.

Decomposition analysis showed that, in Haryana state, the increase in production was mainly due to interaction effect (42.19%). Area effect and yield effect also contributed positively to the increase in production but in lesser extent than interaction effect.

In Karnataka, the results of decomposition analysis depicted that, when change in production value is negative, then negative values will have positive effect. So, area effect (-72.83%) contributed positively increase in production than yield (150.07%) and their combined effect (22.75%) which caused decrease in production.

## Conclusion

**Based on the findings of the study, the following conclusions emerged out:**

- In India, the area and production of watermelon have shown an increasing trend over the period from 2011 to 2020 with a growth rate of 5.78 and 7.42 per cent, respectively.
- Whereas, productivity had remains almost same during the same period with a growth rate of 1.56 per cent per annum.
- The instability analysis of watermelon in India shows that the instability in the area, production and productivity was low (4.74, 6.17 and 3.92 per cent respectively).
- In India, the increase in production of watermelon in India was mainly due to the yield effect.
- In Karnataka both area and production show declining trend from 2011 to 2020 with a negative growth rate of -4.23 and -2.53 per cent, respectively.
- In Karnataka the instability in the area and production was moderate (18.79 and 15.51 per cent, respectively).
- In Karnataka increase in production is mainly due to the area effect than yield and interaction effect.
- The total area under watermelon cultivation in Haryana had showed increasing trend from last decade (2011-2020) with a growth rate of 12.55 per cent per annum. Whereas, production increased from 21.52 thousand tonnes to 134.05 thousand tonnes with a growth rate of 20.77 per cent per annum.
- Instability analysis of watermelon cultivation in Haryana depicted that the instability in the area and productivity was moderate (15.52 and 20.39 per cent, respectively).
- Decomposition analysis showed that, In Haryana state, the increase in production was mainly due to interaction effect.

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