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Trend Analysis of Area, Production and Productivity of Minor Millets in India

Sathish Kumar M.[1*], Y.A. Lad[2] and Ashish B. Mahera[3]
[1]Research Scholar, International Agribusiness Management Institute,
Anand Agricultural University, Anand (Gujarat), India.
[2]Associate Professor and Head, Department of HRM and PM,
International Agribusiness Management Institute, Anand Agricultural University, Anand (Gujarat), India.
[3]Assistant Professor and Head, Department of Marketing Management,
International Agribusiness Management Institute, Anand Agricultural University, Anand (Gujarat), India.

(Corresponding author: Sathish Kumar M.)*
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ABSTRACT: India is one of the largest producers of minor millets, and cultivation of these millets has been decreasing past few years. Minor millets play a vital role in rain-fed regions of India due to their characteristic of drought tolerance. It can be cultivated in adverse soil and climatic conditions. Consumption of minor millets is high in the northeastern part of India due to the presence of high nutrients. Other than north eastern region, the consumption of millets is less due to awareness about millets among peoples. Eventually the nutritional deficiency among children's high in India. The secondary data of the area, production, and productivity of minor millets between the periods 1990-91 to 2019-20 has been collected from Indiastat.com. By using descriptive statistics and linear growth rates (Compound Annual Growth Rate) data were analyzed. The study revealed that the area and production of minor millets have been decreasing due to the cultivation of cereals, pulses, and commercial cash crops. The productivity of minor millets is drastically increasing due to the availability of high-yielding varieties and new cultivation technology adoption. The study will help to increase the consumption rate of minor millets and avoid the nutritional deficiency disease.

Keywords: Minor millets, Area, production and productivity, Compound Annual Growth Rate, trend analysis.

INTRODUCTION

India is the largest producer of rice, wheat, and other cereals. India's cereals production stood at a record 297.5 million tons in 2019-2020. Production and productivity of rice, wheat, maize other dominant crops have been increasing due to advanced technology, which replaced the production and productivity of other important crops such as minor millets. There are two types of millets cultivated in India: major and minor. The major millets include sorghum, bajra, maize, and minor millets include finger millet, foxtail millet, banyard millet, kodo millet. In India, farmers grow major millets in larger quantities than minor millets, but minor millets contain more nutritional values. The peoples living in the northeastern part of India include Manipur, Meghalaya, and Nagaland, using millets as their staple food.

Millets have easy adoption and can grow successfully in diverse soil and climatic conditions. The growing season of millets in India is between June to November, and the suitable soil type for cultivation is well-drained loamy soil. It requires a warm temperature of 20-35(°C) degree Celsius for germination and is susceptible to frost. Millets are rain-fed crops, and they can be grown with less rainfall. The average rainfall requirement is 450 mm for major millets and 350 mm for minor millets.

The leading producer of millets in India includes Maharashtra, Rajasthan, and Karnataka (Agarwal *et al*., 2018). The high consumption of millets is in rural areas of Assam (18.82 kg/hsh/m) and Bihar (18.69 kg/hsh/m). The cultivation area of minor millets was high in Madhya Pradesh (84,000 hectares) followed by Chhattisgarh (63,370 hectares) and Uttarakhand (53,000 hectares). The most increased production was recorded in Madhya Pradesh (74,000 tons) followed by Uttarakhand (70,970 tons) and Tamil Nadu (37,340 tons). The highest productivity was recorded in Pondicherry (2274 kilograms/hectare) followed by Telangana (1711 kilograms/hectare) and Tamil Nadu (1444 kilograms/hectare) (Indiastat.2018-19).

The minor millets can be used as food for human beings and fodder for animals because they contain more energy and nutrition than major millets. Minor millets are a good source of protein, fiber, essential fats, and minerals like calcium, zinc, magnesium, phosphorus, and potassium. Minor millets do not contain gluten which is beneficial to diabetic patients, people having cancer, oxidative stress, obesity, celiac disease, and gastrointestinal disorders.

In recent years, many researchers have been using compound annual growth rate to predict area, production and productivity of agricultural crops. Surendar and Satinder (2014) predicted area, production and productivity of sugarcane in Haryana. They found that the area's growth rate was declined in all states of Haryana, and the growth rate of production was positive in only two districts, Bhiwani and Karnal. The productivity growth was increasing in all sections of Haryana except Gurgoan, Rewari, and Sirsa. Shabana and Madhulika (2018) investigated growth and instability analysis in Indian agriculture. They revealed that rice and maize's area has increased, the production of pulse and wheat has increased, and the productivity of wheat and pulses has increased in the period. Nethravathi and Yeledhalli (2016) forecasted growth and instability in area, production and productivity of different agricultural crops in Bengaluru. Neethu *et al.* (2017) investigated growth and instability in area, production and productivity of Cassava in Kerala. Abid *et al.* (2014) forecasted area and production of Maize in Khyber Pakhtunkhwa, Pakistan. Production and consumption of minor millets in India investigated by Balaji *et al.* (2017). Kumari *et al.* (2017) investigated forecasting models for predicting pod damage of pigeon pea in Varanasi region. Kumari *et al.* (2016) forecasted yield of pigeon pea in Varanasi region by using different statistical models. Kumari Prity and Sathish Kumar (2021) forecasted area, production and productivity of citrus in Gujarat by using different artificial neural network models. Sathish Kumar M and Kumari Prity (2021) forecasted area, production and productivity of sapota in Gujarat. Gayathri (2018) investigated trend analysis of area, production and yield of ground nut in India. Prajneshu and Chandran (2005) computed compound growth rate of different agriculture crops in India. Saikia and Gosh (2021) found growth rate of area and production of silk in different areas of Assam. Kumari *et al.*, (2018) investigated trend analysis of area, production and productivity of Jute crop in India. Unjia *et al.* (2021) investigated trend analysis of area, production and productivity of maize in India. In another study, Nida and Rahman (2020) applied compound annual growth rate to find out growth rate of area, production and productivity of Sugarcane crop in India.

With respect to above literature the main purpose of the study was to evaluate the growth rate of area, production and productivity of minor millets in India by using compound annual growth rate.

Earlier studies mostly covered major agricultural and horticultural crops. Minor millets have more nutritional values than major crops. Even our Indian government announced 2022-23 as International Year of Millets. This study has wide scope to find out growth rate in area, production and productivity of millets India which suggest some measure to increase the cultivation of area of millets. This study also spread the importance and nutritional benefits of millets among consumers.

MATERIALS AND METHODS

The secondary data of the area, production, and productivity of minor millets from 1990 to 2008 were collected for this study. The primary sources of data were government reports and the India stat website. The widely used methodology Compound Annual Growth Rate was selected for this study.

The exponential compound annual growth rate is estimated using linear functions on time series data on minor millets' area, production, and productivity.

The semi-log exponential functional form was used to analyze the trend in growth rate. It is one of the appropriate applicable forms to estimate the growth rate. The following semi-log functional form was used to estimate the growth rate.

$$\log Yt = a + bt \quad (1)$$

This equation (1) can be elaborated in detail as:

$$Yt = Yo\,(1+r)\,t \quad (i)$$

Taking log on both sides,

$$\text{We get } \log Yt = \log Yo + t \log (1+r) \quad (ii)$$

Equation (ii) can be rewritten as

$$Y = a + bt \quad (iii)$$

Where

$Y = \log Yt$

$a = \log Yo$

$b = \log (1+r)$,

In equation (iii)

Yt = area/production/ productivity, as the case may be, of minor millets as discussed above

A = constant

t = Time variable in year (1, 2...n)

b = Regression Coefficient that shows the rate of change or growth rates in a series

The annual compound growth rate (s) can be worked out by using:

Antilog (b) = Antilog (log (1+r)).

Antilog (b) = 1+r

and

r = Antilog b-1

It gives the percentage growth rate in the area, production, and productivity of minor millets multiplied by 100 (Surendar and Satinder 2014).

Compound Annual Growth Rate (CAGR) (%) = r = (Antilog B-1) ×100.

RESULTS AND DISCUSSION

The secondary data of minor millets from 1990-91 to 2019-20 were used to meet the objectives of the study. The purposes include trends analysis in India's area, production, and productivity of minor millets. The data of the area, production, and productivity of minor millets from 1990-91 to 2019-20 were mentioned in Table 1—compound Annual Growth Rate calculated separately for the area, production, and productivity of minor millets.

The trend of area, production, and productivity of minor millets in India has mentioned in Fig. 1. The overall area of cultivation of minor millets has decreased from 2447 thousand hectares to 458 thousand hectares during the period 1990-91 to 2019-20. The reduction of 81 percent cultivation area has occurred due to over-cultivation of major cereals, pulses, and cash crops. The cultivation area of minor millets has reduced 42 percent from 1990-91 to 1999-00. In the second decade from 2000-01 to 2009-10, the area has decreased another 42 percent. The third decade from 2010-11 to 2019-20 has reduced 43 percent. The result of CAGR showed that the overall cultivation areas of minor millets were highly significant, and production reduced by 5.13 per annum. It indicated that cultivation area was decreasing in trend and it will decline further in upcoming years.

The overall production of minor millets has decreased from 1190 thousand kilograms to 370 thousand tons from 1990-91 to 2019-20. The reduction of 68 percent production has occurred due to the reduction of cultivation area. The production of minor millets has reduced 48 percent during the period 1990-91 to 1999-00. In the second decade from 2000-01 to 2009-10, production has decreased another 35 percent. The third decade from 2010-11 to 2019-20 has reduced 16 percent. The result of CAGR showed that the overall productions of minor millets were highly significant and production reduced by 3.30 per annum. It indicated that production was decreasing in trend and it will thicken further in upcoming years. The overall productivity of minor millets has increased from 486 kilogram/hectare to 809 kilogram/hectare from 1990-91 to 2019-20.

Table 1: Growth rate of area, production and productivity of minor millets in India.

Sr. No.	Year	Area (In 000 Hectare)	Production (In 000 Tonnes)	Productivity (In Kg./ Hectare)
1.	1990-91	2447	1190	486
2.	1991-92	2088	882	423
3.	1992-93	1983	869	438
4.	1993-94	1888	917	486
5.	1994-95	1792	798	445
6.	1995-96	1662	779	469
7.	1996-97	1601	728	455
8.	1997-98	1529	645	422
9.	1998-99	1495	671	449
10.	1999-00	1411	618	438
11.	2000-01	1424	587	412
12.	2001-02	1311	577	440
13.	2002-03	1201	459	383
14.	2003-04	1191	564	473
15.	2004-05	1101	478	434
16.	2005-06	1064	472	443
17.	2006-07	1010	480	475
18.	2007-08	1039	551	530
19.	2008-09	905	445	491
20.	2009-10	831	382	460
21.	2010-11	800	442	553
22.	2011-12	798	452	565
23.	2012-13	754	436	578
24.	2013-14	682	430	630
25.	2014-15	590	386	654
26.	2015-16	650	391	602
27.	2016-17	619	442	714
28.	2017-18	546	439	804
29.	2018-19	454	333	734
30.	2019-20	458	370	809
	Total	**35324**	**17213**	**15695**
	Mean	**1177.467**	**573.7667**	**523.1667**
	Std	**528.2089**	**202.0204**	**117.7027**
	CAGR%	**-5.13 *** **	**-3.30 *** **	**1.92 *** **

Source: Ministry of Agriculture & Farmers Welfare, Govt. of India
Note: Std: Standard Deviation
CAGR- Compound Annual Growth Rate
*** Significant at 1 percentage, ** Significant at 5 percentage and * Significant at 10 percentage

The increase of 66 percent productivity has occurred due availability of high-yielding varieties, nutrient-rich varieties, pest, and disease-resistant verities, and the adoption of new cultivation technology. The productivity of minor millets has reduced 9 percent from 1990-91 to 1999-00. In the second decade from 2000-01 to 2009-10, production has increased 12 percent even though the reduction in the first decade. The third decade from 2010-11 to 2019-20 has increased 46 percent. The result of CAGR showed that the overall productivity of minor millets was highly significant, and productivity increased by 1.92 per annum. It indicated that productivity was increasing in trend even though area and production decreased. It will increase further in upcoming years.

Table 2 shows the percentage changes in area production and productivity of minor millets in India from 1990-91 to 2019-20 and also calculated 10-year intervals. The coefficient of area and production has been calculated by considering the area as independent variable x and production as dependent variable y. It clearly showed that overall area and production positively related with each other. The broad period (1990-91 to 2019-20) 0.36-unit changes in the area led to 1-unit changes in production. The positive relationship between area and production has occurred 0.51 in the year 1990-91 to 1999-00, which means 0.51-unit changes in the area led to 1 unit of output. In the last decade, 2010-11 to 2019-20 drastic changes occurred, and 0.24 units in the area led to 1-unit changes in production.

Table 2: Percentage changes and coefficient.

Year	Percentage			Coefficient
	Area	Production	Productivity	Area(x)- Production (y)
1990-91-2019-20	-81	-68	66	0.36
1990-91-1999-00	-42	-48	-9	0.51
2000-01-2009-10	-42	-35	12	0.30
2010-11-2019-20	-43	-16	46	0.24

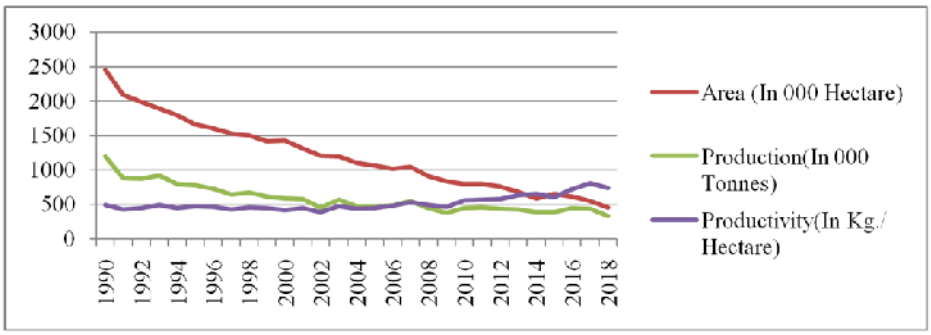

Fig. 1. Tread on area, production and productivity of minor millets.

CONCLUSION

Cultivation of minor millets has been decreasing over the decade due to increasing the cultivation of cereal crops in India. Consumption of minor millets is more in eastern parts of India, especially Manipur, Meghalaya, and Nagaland. Minor millets contain more nutritional values than cereal crops. An absence of gluten is beneficial to diabetic patients, people having cancer, oxidative stress, obesity, celiac disease, and gastrointestinal disorders. Totally 30 years of data on the area, production, and productivity of minor millets has been collected for this study between 1990-91 to 2019-20. Even though decreasing the cultivation area and production, the productivity of minor millets has been increasing. The overall time series data of minor millets showed that the cultivation area has been reducing 5.13 percent per annum due to expanding the cultivation area of cereals, pulses, and cash crops. The production of minor millets has decreased 3.30 percent per annum due to shifting the cultivation area for other crops. The productivity of minor millets has been increasing by 1.92 percent per annum due to the availability of high-yielding varieties, pest, and disease resistant varieties, and improved cultivation practices. Analyzing the growth rate trends in the agricultural area, production and productivity across space and time have remained issues of significant concern for researchers and policymakers. It has been argued that analysis of the growth rate trends helps us identify the changing pattern of crops and land use patterns under different crops and the rate of change in area production and productivity of a crop. Further help in designing the appropriate agricultural policy for a region or state. The growth rates in the area, display, and productivity of minor millets crop showed exciting results. The growth rate in minor millets was found noticeably negative all over India. A similar picture of the growth rate in the production of minor millets was seen almost all over India. On the contrary, the growth rate of minor millets' productivity was found positive all over India.

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Conflict of interest. None.

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