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A Study on Area-Production-Productivity of Minor Millets in India

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ABSTRACT: India produces about 11% cereals of the world and ranks third in production after China and U.S.A. Due to technological advancements, the output and productivity of other significant crops like minor millets have been supplanted with those of dominant crops like paddy, wheat, and maize. Minor millets are susceptible to frost and can grow at warm environment with temperatures between 20-35 degrees Celsius. Millets may be cultivated with less rainfall since they are crops that are fed by the rain. Major millets require 450 mm of rainfall whereas small millets only need 350 mm. Area, production, and productivity data from 1950-2022 for small millets were collected for the present research from Indiastat.com. Compound Annual Growth Rate analysis was performed for drawing the conclusions from the data set. Using a time series data set of small millets and linear functions, the exponential CAGR was estimated. The major challenge in the present study is availability of data regarding small millets as it required the credentials of Indiastat.com. In India the growth rates of area, and production of minor millets were found negative and a similar picture of the growth rate in the production was also noticed. On the contrary, the growth rate of minor millets' productivity was found positive in India.

Keywords: Minor Millets, Area-production-productivity, Nutritional, Temperature.

INTRODUCTION

Paddy, wheat, and other cereals are grown in larger quantities in India. More than 288 million metric tons of cereals were estimated to be produced in India at the end of financial year 2022 and that accounts for 55 percent of total cropped area. India produces about 11% cereals of the world and ranks third in production after China and U.S.A. Due to technological advancements, the output and productivity of other significant crops like minor millets have been supplanted with those of dominant crops like paddy, wheat, and maize. Major and minor millets are the two varieties grown in India. Sorghum, bajra, and maize are among the major millets; finger millet, foxtail millet, banyard millet, and kodo millet are minor millets. Major millets are grown in greater quantities in India than minor millets, although minor millets have a higher nutritional value. Millets are a common food source for the people of Manipur, Meghalaya, and Nagaland, who are located in northeastern India.

India's top three millets-producing states are Maharashtra, Rajasthan, and Karnataka (Sathish *et al.,* 2022). Millets are heavily consumed in rural Assam (18.82 kg/hsh/m) and Bihar (18.69 kg/hsh/m) areas. Madhya Pradesh (84,000 hectares) has the highest amount of minor millets under cultivation, followed by Chhattisgarh (63,370 hectares), Uttarakhand, and (53,000 hectares). Madhya Pradesh saw the largest rise in production (74 000 tonnes), followed by Uttarakhand (70 970 tonnes), and Tamil Nadu (37,340 tons).

Millets are simple to adopt and can flourish in a variety of climate and soil conditions. In India, millets can be grown from June to November, and loamy, well-drained soil works best for growth. Minor millets are susceptible to frost and can grow at warm environment with temperatures between 20-35 degrees Celsius. Millets may be cultivated with less rainfall since they are crops that are fed by the rain. Major millets require 450 mm of rainfall whereas small millets only need 350 mm.

Due to their higher energy and nutritional content small millets are used as human food and animal feed. A good supply of proteins, fibers, healthy fats, and minerals including calcium, zinc, magnesium, phosphorus, and potassium are abundant in minor or small millets. Minor millets are advantageous for diabetics, persons with cancer, oxidative stress, obesity, celiac disease, and people with gastrointestinal diseases because they are gluten free grains.

REVIEW OF LITERATURE

- Surendar and Satinder (2014) forecasted the Area, production, and efficiency of sugarcane in Haryana. It was revealed that all of Haryana's states saw a fall in the area's growth rate, and only the districts of Bhiwani and Karnal had positive development in production. With the exception of Gurgoan, Rewari, and Sirsa, all parts of Haryana had an increase in productivity.
- Shabana and Madhulika (2018) delved growth & instability analysis in Indian agriculture. They found that during the study timeframe, the area used for rice

and maize, the quantity of pulses and wheat produced, and the yield of wheat and pulses were increased.

- Nethravathi and Yeledhalli (2016) predicted growth and instabilities of Bengaluru's agricultural crops in term of area, production, and productivity.
- Neethu *et al.* (2017) predicted growth and instability in area, production and productivity of Cassava in Kerala and highlighted the factors for shifts in Cassava cultivation.
- Abid *et al.* (2014) investigated the area and production of Maize in Pakistan and predicted the trend is positive.
- Balaji *et al.* (2017) forecasted the production and consumption of minor millets in India.
- Kumari *et al.* (2017) studied various forecasting models for predicting pod damage of redgram in Varanasi.
- By using Artificial Neural Networks Kumari Prity and Sathish Kumar (2021) predicted area, production and productivity of citrus and sapota in Gujarat.
- Gayathri (2018) examined on the area, production, and yield trends for ground nuts in India.
- In different regions of Assam, Saikia and Gosh (2021) discovered growth rates for both the area and the production of silk.
- Unjia *et al.* (2021) studied the area, output, and productivity of maize in India.
- To determine the growth rate of the area, production, and productivity of the sugarcane crop in India, Nida and Rahman (2020) adopted compound annual growth rate.

In the above-mentioned literature, the primary purpose of the research was to determine the growth rate of the area, production, and yield of minor millets in India through compound annual growth rate. Earlier literature mostly focused on important horticultural and agricultural crops. Minor millets are more nutritious than major crops. Even the Indian government declared 2022–2023 as the International Year of Millets. This study has a broad scope to determine the rate of growth in the area, production, and productivity of millets in India, which suggests some actions to improve the area under millet cultivation. The significance of millets and their nutritional advantages were also made known to customers by this study.

MATERIALS AND METHODS

Area, production, and productivity data from 1950-2022 for small millets were collected for the present research from Indiastat.com. Compound Annual Growth Rate analysis was performed for drawing the conclusions from the data set. Using a time series data set of small millets and linear functions, the exponential CAGR was estimated. The functional form of the semi-log exponential was used to examine and determine the growth rate trend.

The following semi-log functional form was used to estimate the growth rate.

$$\log Qt = a + bt \quad (A)$$

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

$$Qt = Qo\,(1+r)^t \quad (1)$$

Taking log on both sides,

$$\text{We get } \log Qt = \log Qo + t \log (1+r) \quad (2)$$

Equation (2) can be rewritten as

$$Q = a + bt \quad (3)$$

Where

Q = Log Qta = Log Qo

b = Log (1+r), in equation (3)

Qt = Area, Production, Productivity of minor millets

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 compound annual growth rate (CAGR) can be calculated by using:

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

Antilog (b) = 1+r

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); Sathish *et al.* (2022).

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

RESULTS AND DISCUSSION

To fulfill the study objective, the secondary data pertaining to minor millets from 1950–1951 to 2021–2022 were utilised. The objectives include an analysis of regional trends in India and the production & productivity of minor millets. Table 1 shows the year wise statistics for the area, production, and productivity of minor millets from 1950–1951 to 2021–2022. The compound annual growth rate (CAGR) of minor millets for the selected variables was estimated independently.

During 1950–1951 and 2021–2022, the overall area under cultivation of minor millets declined from 4605 thousand hectares to 440 thousand hectares (as shown in Table 1). Due to the over-cultivation of cereals, pulses, cash crops, and commercial crops, the area under cultivation of minor millets has decreased by 90.45 percent as shown in Table 2. Minor millets accounted for 11.79 percent of the area under cultivation between 1950 and 1960, but from 1960 to 2020, it decreased by 4.48, 16.33, 32.02, 42.34, 41.64, and 42.75. The CAGR analysis revealed that area under cultivation of millets was highly significant but decreased by 3.25 per year during 1950 to 2022. It also indicates that the cultivated area was in declining phase and this trend would continue to shrink in the following years by taking suitable measures**.**

From 1950–1951 and 2021–2022, the total production of minor millets in India was plunged from 1750 thousand tonnes to 370 thousand tonnes as shown in Table 1. Due to the reduction of cultivated area, production has decreased by 78.86 percent as shown in Table 2. In India, millets were produced at a high rate of 15.71 percent between 1950 and 1960 but between 1950–51 and 2019–2020, there was a 9.27, 28.32, 17.03, 48.0, 34.92, and 16.06 percent decrease in the production of minor millets. The CAGR analysis revealed that the overall production of small millets was significant but it has decreased by 2.20 per year. It

suggested that the trend in output was declining and that it would expand even more in the next years.

The overall productivity of minor millets has increased from 380 kilogram/hectare to 789 kilogram/hectare from 1950-51 to 2020-21 as shown in Table 1. The availability of high-yielding, nutrient-rich, pest- and disease-resistant cultivars, as well as the use of innovative farming techniques in minor millets, contributed to the production rise of 107 percent between 1950 and 2022 (as shown in Table 2). In 1960 and 1980, the output of small millets decreased by 4 and 14 percent, then climbed by 21.97 percent between 1980 and 1990. Due to the contributions made by the ICAR-Indian Institute of Millets through their extensive research on millets, minor millets have already had exceptional productivity for the past 20 years. The CAGR result demonstrated that minor millets' overall production was highly significant and increased by 1.05 percent annually. It also indicated that productivity was in increasing trend even though area and production decreased and this will increase further in upcoming years (Sathish *et al.*, 2022).

Table 1: Year wise Area, Production and Productivity of Small Millets.

Year	Area	Production	Productivity
1950-1951	4605	1750	380
1951-1952	4764	1915	402
1952-1953	5044	1926	382
1953-1954	5677	2477	436
1954-1955	5630	2495	443
1955-1956	5335	2070	388
1956-1957	4976	1930	388
1957-1958	4870	1733	356
1958-1959	5159	2179	422
1959-1960	5148	2025	393
1960-1961	4955	1909	385
1961-1962	4868	2050	421
1962-1963	4772	1855	389
1963-1964	4621	2022	438
1964-1965	4558	1964	431
1965-1966	4564	1555	341
1966-1967	4584	1488	325
1967-1968	4857	1907	393
1968-1969	4746	1804	380
1969-1970	4733	1732	366
1970-1971	4783	1988	416
1971-1972	4477	1669	373
1972-1973	4265	1552	364
1973-1974	4567	1966	431
1974-1975	4466	1613	361
1975-1976	4672	1924	412
1976-1977	4680	1752	374
1977-1978	4574	2070	453
1978-1979	4397	1894	431
1979-1980	4002	1425	356
1980-1981	3976	1574	396
1981-1982	3787	1638	433
1982-1983	3500	1229	351
1983-1984	3638	1676	461
1984-1985	3214	1194	372
1985-1986	3155	1217	386
1986-1987	2975	1162	391
1987-1988	2901	1169	403
1988-1989	2743	1164	424
1989-1990	2703	1306	483
1990-1991	2447	1190	486
1991-1992	2088	882	423
1992-1993	1983	869	438
1993-1994	1888	917	486
1994-1995	1792	798	445
1995-1996	1662	779	469
1996-1997	1601	728	455
1997-1998	1529	645	422
1998-1999	1495	671	449
1999-2000	1411	618	438
2000-2001	1424	587	412
2001-2002	1311	577	440
2002-2003	1201	459	383
2003-2004	1191	564	473

2004-2005	1101	478	434
2005-2006	1064	472	443
2006-2007	1010	480	475
2007-2008	1039	551	530
2008-2009	905	445	491
2009-2010	831	382	460
2010-2011	800	442	553
2011-2012	798	452	565
2012-2013	754	436	578
2013-2014	682	430	630
2014-2015	590	386	654
2015-2016	650	391	602
2016-2017	619	442	714
2017-2018	546	439	804
2018-2019	454	333	734
2019-2020	458	371	809
2020-2021	444	347	781
2021-2022	440	370	789
Total	212149	87899	33195
Mean	2947	1221	461
Standard Deviation (S.D)	1767.231	659.4766	114.6122
Compound Annual Growth Rate (CAGR)	-3.30**	-2.20**	1.05**

Source: Ministry of Agriculture & Farmers Welfare, GOI
Note: ** Significant at 1 percentage; * Significant at 5 percentage

Table 2: Percentage changes and coefficient of Small Millets.

Year	Percentage			Coefficient
	Area	Production	Productivity	Area (X) -Production(Y)
1950-51-2021-22	-90.45	-78.86	107.63	0.98
1950-51-1959-60	11.79	15.71	3.42	0.93
1960-61-1969-70	-4.48	-9.27	-4.94	0.46
1970-71-1979-80	-16.33	-28.32	-14.42	0.77
1980-81-1989-90	-32.02	-17.03	21.97	0.79
1990-91-1999-00	-42.34	-48.07	-9.88	0.96
2000-01-2009-10	-41.64	-34.92	11.65	0.81
2010-11-2019-20	-42.75	-16.06	46.29	0.70

Table 2 depicts the percentage changes in area, production, and productivity of small millets in India over the course of the last seven decades (from 1950 to 2020). By using 'area' as the predictor variable (x) and 'production' as the predicted variable (y), the coefficient of area and production has been determined. It was shown that the production of small millets and total area were positively correlated (Kumar *et al.*, 2022). Over the long period (1950–1951 to 2019-2020), changes in the area of 0.98 units caused changes in output or production of 1 unit. From 1950–1951 to 1959–1960, there was a positive relationship between area and production *i.e.*, 0.93 units, implying that changes in the area resulted to an increase in production of 1 unit for every 0.93 units. In the last decade, 2010-11 to 2019-20 drastic changes occurred, and 0.70 units in the area led to 1-unit changes in output (Sathish *et al.*, 2022).

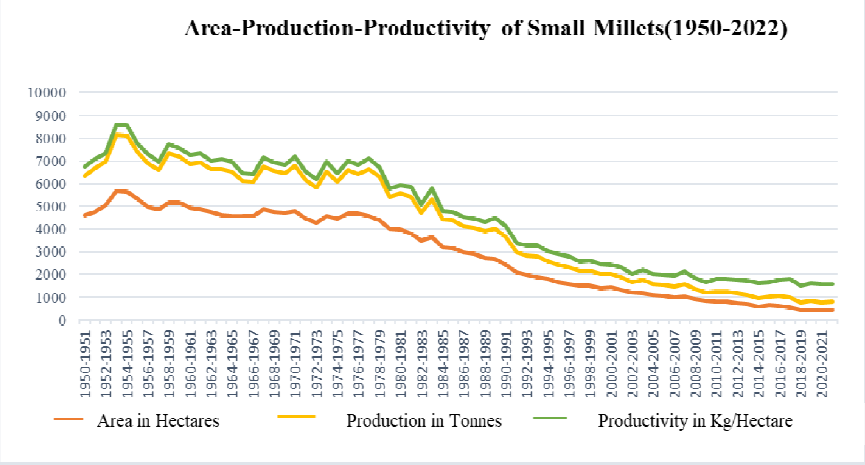

Fig. 1. Area-Production-Productivity of Small Millets (1950-2022).

Table 3: Selected State-wise Area, Production and Productivity of Small Millets in India (2020-2021).

States/UTs	Area (In ' 000 Hectare)	Production (In ' 000 Tonne)	Productivity (In Kg/Hectare)
Andhra Pradesh	22.00	19.01	864
Arunachal Pradesh	26.82	27.62	1030
Assam	4.97	3.26	656
Bihar	2.17	1.64	753
Chhattisgarh	84.62	21.83	258
Dadra & Nagar Haveli	-	-	-
Goa	-	-	-
Gujarat	8.46	13.04	1541
Himachal Pradesh	2.41	2.34	972
Jammu & Kashmir	8.11	2.14	264
Jharkhand	-	-	-
Karnataka	26.00	20.23	778
Kerala	0.05	0.04	745
Madhya Pradesh	78.00	69.42	890
Maharashtra	37.00	16.72	452
Meghalaya	2.89	2.72	941
Nagaland	8.83	9.98	1130
Odisha	35.25	18.01	511
Puducherry	0.06	0.15	2375
Punjab	-	0.00	-
Rajasthan	6.50	4.29	660
Sikkim	2.05	2.13	1038
Tamil Nadu	24.47	30.51	1247
Telangana	-	-	-
Tripura	1.62	1.30	801
Uttar Pradesh	12.00	9.18	765
Uttarakhand	49.00	71.00	1449
West Bengal	0.76	0.38	502
India	**444.05**	**346.95**	**781**

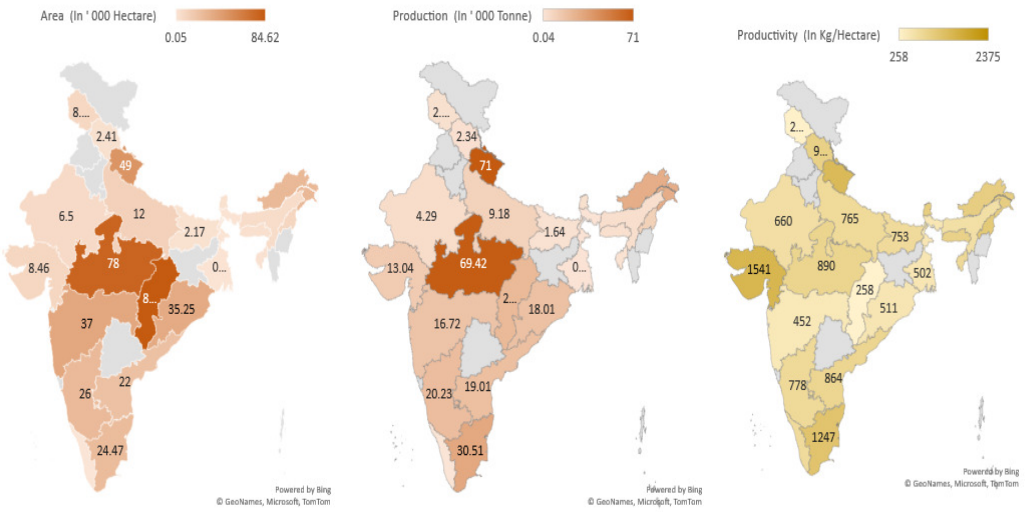

Fig. 2. State Wise Area-Production-Productivity of Small Millets in 2021.

It could be seen from Table 3 that, total area of small millets cultivation in India during 2021 is 444.05 thousand hectares with production and productivity of 346.95 thousand tonnes and 781 Kg/Hectare. The state wise graphical representation of availability of small millets was shown in Fig. 2. Chhattisgarh, Madhya Pradesh and Uttarakhand states have highest area under millet cultivation during 2020-21 i.e., 84.62, 7800 and 49.00 thousand hectares. Uttarakhand is the leading state with highest production of 71.00 thousand tonnes followed by Madhya Pradesh (69.42 thousand tonnes) in 2021. In terms of small millet Productivity, Puducherry is the leading state with 2375 Kg/Hectare followed by Gujarat (1541 Kg/hectare) and Uttarakhand (1449 Kg/Hectare).

CONCLUSION

Due to increased cultivation of cereal crops in India the cultivation of minor millets has been declining over the past five decades. Eastern regions of India, particularly Manipur, Meghalaya, and Nagaland, consume more minor millets as they are more nutrient-richer and gluten free compared to cereals. Minor millets are susceptible to frost and can grow at warm environment with temperatures between 20-35 degrees Celsius. Millets may be cultivated with less rainfall since they are crops that are fed by the rain. Major millets require 450 mm of rainfall whereas small millets only need 350 mm. For this study, data covering a total of 72 years, from 1950 to 2022, were gathered on the area, production, and productivity of minor millets. The productivity of small millets has increased even the area under cultivation and the production have declined. Due to the expansion of the cultivation of cereals, pulses, and cash crops, the overall time series data of minor millets revealed that the cultivation area has been decreasing by 3.30 percent annually. The transfer of the cultivation area for other crops has resulted in a 2.20 percent annual drop in the yield of small millets. Minor millets' output has increased recently due to the availability of high-yielding varieties, pest and disease resistant varieties, and improved cultivation techniques, rising by 1.05 percent annually. In India the growth rates of area, production, and productivity of minor millets were found negative. 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 in India.

FUTURE SCOPE

The results of this paper help to understand the trend of area, production and productivity of small millets and help policy makers to focus on increasing the area of millets through enriched cultivars and support to IYOM-2023.

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Conflict of Interest. None.

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