A Study on the Growth and Instability in Area, Production, Productivity and Minimum Support Price of Major Millets in India

G. B. Chaitra and S. Jeyavel
Department of Psychology, Central University of Punjab, Bathinda, Punjab - 151 401
e-Mail : chaitragb519@gmail.com

Authors Contribution

G. B. Chaitra :
Conceptualization, data collection, data analysis, manuscript preparation and review;

S. Jeyavel :
Guidance and correction

Corresponding Author :
G. B. Chaitra

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Abstract

After the Green Revolution in the 1960s, high-yielding varieties of wheat and rice gained popularity, resulting in a decline in the cultivation of millets and their use in human consumption. The study analyzed the growth and instability in the area, production, productivity and Minimum Support Price (MSP) of four millet crops. Time series data for the period from 1950-51 to 2020-21 pertaining to area, production, and productivity of Sorghum (Jowar), Pearl millet (Bajra), Finger millet (Ragi) and Small millets (*kharif* season) were collected. The MSP data from 1995-96 to 2022-23 were collected. Compound annual growth rate, co-efficient of variation and instability index (Cuddy Della Valle Index) were computed. All the millets selected for the study have shown a significant negative growth rate in the area (From-0.60 to -3.60%). However, only pearl millet has shown a positive growth rate in production (1.67%). Despite the decline in area, there was a significant positive growth rate in productivity for all millet crops (0.74 to 2.28%). With respect to trend is MSP, highest CAGR of MSP was observed for finger millet (10.15%), followed by sorghum (9.37%) and pearl millet (8.15%). Sorghum and pearl millet showed low instability in the area, while finger millet and small millets showed moderate instability. Moderate instability was observed in production for all four millet crops, while productivity showed low instability for sorghum and finger millet, moderate instability for pearl millet and small millets. MSP showed high instability in sorghum and finger millet and moderate instability for pearl millet. Facilitating the sustenance of millets can be achieved through the regular procurement of millets at MSP besides establishing processing facilities and the creation of market linkages.

Keywords : Millets, Sorghum (Jowar), Pearl millet (Bajra), Finger millet (Ragi), Small millets, MSP

Agriculture contributes significantly to the country's Gross Domestic Product (GDP) and employs many people, especially in rural areas (Siddayya *et al*., 2016). Apart from meeting the population's food requirements, agriculture also provides raw materials to several industries, such as textile, sugar and food processing, among others (Yeledhalli *et al.,* 2012). The agriculture sector is not only generating employment opportunities but also driving economic growth in many regions (Sharma & Patil, 2018). In the face of challenges to feed an ever-growing global population, resilient cereals such as millets offer an affordable and nutritious option, and efforts must be intensified to promote their cultivation. Millets have the potential to contribute significantly to our collective efforts to empower smallholder farmers, achieve sustainable development, eliminate hunger, adapt to climate change, promote biodiversity and transform agrifood systems (Kumar, 2023). Millets, including sorghum, are receiving increased attention from governments and industry for their potential to help build resilience for farmers and address major issues such as climate change, malnutrition and diabetes (Kane-Potaka *et al.,* 2021).

The Government of India recognized the importance of millets and declared 2018 as a National Year of Millets, followed by the establishment of a national Millet Mission and a proposition to the Food and Agricultural Organization of the United Nations (UN) for a UN International Year of Millets. Several state governments in India also established state millet missions, all of which included components to engage with consumers to drive demand, in addition to investing in agricultural production and productivity. In 2023, the United Nations declared it the International Year of Millet, following India's proposal (Kumar, 2023).

India is a major contributor to the global production of millets, producing approximately 40 per cent of the 29 to 30 million tonnes produced worldwide. The majority of global millet production, which amounts to 97 per cent is shared between Asia and Africa (Reddy, 2021). Following the Green Revolution, the production of millets decreased significantly and the crops that were once a staple in every household became fodder in just a few decades (Kumar, 2023). Between 1962 and 2010, India's per capita consumption of millets declined sharply from 32.9 to 4.2 kg, while the consumption of wheat almost doubled from 27 to 52 kg (Kane-Potaka *et al.,* 2021).

Millets play a crucial role as staple food crops for millions of people in arid and semi-arid regions worldwide, owing to their exceptional resistance to pests and diseases and their adaptability to diverse environmental conditions (Abinaya *et al.,* 2020). Millets are gaining attention both in India and globally due to their nutritional value and climate-smart characteristics, as they can grow in harsh climatic conditions. Millets have the ability to thrive in drylands where other crops cannot grow, as they can survive extreme drought conditions (Kane and Kumar, 2019). However, their average yield of 1,111 kg per hectare is much lower than paddy's 2,600 kg and wheat's 3,500 kg per hectare, so there is a pressing need to develop and promote high-yielding varieties of millets in India (Reddy, 2021). The popularity of organic food is also on the rise and there are growing apprehensions surrounding the quality and cost of such products (Beniwal and Patil, 2022).

The growth of the agricultural sector is affected by various factors such as changing climatic conditions, water availability, availability of agricultural inputs, government policies and international trade (Chaitra *et al.,* 2020). Compared to rice, millets require 70 per cent less water, grow in half the time of wheat, and need 40 per cent less energy for processing. Millets are hardy crops that can withstand extreme heat conditions (Kumar, 2023). Millets are known for their resilience, ability to survive under high temperatures and in degraded soils and minimal requirements of water, pesticides and fertilizers (Saleh *et al.,* 2013). Additionally, their farming methods result in a lower carbon footprint than major staples that require greater use of fertilizers and pesticides (Kane-Potaka *et al.,* 2021).

Millets have traditionally played a significant role as a staple food in local food cultures, as many kinds of foods and beverages were made from them in various regions. However, their presence in the Indian food basket has declined over the years, mainly due to government policies favoring the production and consumption of fine cereals like rice and wheat (Kane & Kumar, 2019) and rising incomes and urbanization. Despite being a good source of protein, millets are also rich in minerals like iron, zinc and calcium, which offer health benefits to all age groups and genders, depending on the variety and species. There is a need for interventions to replace a major portion of the diet currently occupied by rice, wheat and maize with highly nutritious grains like millets (Kane-Potaka *et al.,* 2021).

The declaration of 2023 as the International Year of Millets highlights the significance of these crops in ensuring food security and promoting sustainable agriculture. As such, it is crucial to conduct a detailed analysis of the growth and instability in the area, production, productivity and minimum support price of millets. Studying the growth in the area of millet cultivation can provide insights into the level of adoption of this crop among farmers, as well as the extent to which policies promoting millets have been effective in expanding their cultivation. Similarly, analyzing the production of millets can shed light on the level of efficiency in millet farming practices and the impact of weather patterns and climate change on millet yields. Moreover, evaluating the productivity of millets can provide a comprehensive understanding of the extent to which millet farming practices are sustainable and can be improved. This would involve examining factors such as crop management practices, soil health and water management, among others. Lastly, examining the minimum support price of millets can provide insights into the economic viability of millet cultivation and the level of support provided by governments to farmers cultivating millets. This would involve analyzing government policies related to the procurement and pricing of millets, as well as market trends and demand for millets in different regions. Overall, studying the growth and instability in the area, production, productivity and minimum support price of millets is essential to promote sustainable agriculture, ensure food security and empower small holder farmers. Therefore, the present study is an attempt to analyze the growth and instability in the area, production, productivity and minimum support prices of millets in India.

METHODOLOGY

Nature and Sources of Data : The study was based on secondary data collected from various published sources. Time series data for the period from 1950-51 to 2020-21 pertaining to area, production and productivity of Sorghum (Jowar), Pearl millet (Bajra), Finger millet (Ragi) and Small millets (*kharif* season) were collected from the Directorate of Economics and Statistics and indiastat website. The Minimum Support Price (MSP) data from 1995-96 to 2022-23 were collected from the Commission for Agricultural Costs and Prices (CACP) website.

Analytical Tools and Techniques Employed : The analytical tools and techniques employed to fulfill the specific objectives of the study based on the nature and extent of data availability were Compound Annual Growth Rate Analysis and Cuddy Della Valle Index for instability analysis.

Growth Rate Analysis : The Compound Annual Growth Rate (CAGR) was obtained from the logarithmic form of the equation

$Y = ab^te$ as below

$\ln Y = \ln a + t \ln b$,

the per cent compound growth rate (y) was derived using the relationship

$y = (\text{Anti ln of } b\text{-}1) \times 100$

Instability Index : The present study utilizes the Cuddy Della Valle Index to measure agricultural instability. While various methods exist for measuring instability, including the coefficient of variation and the Coppock Instability index, the Cuddy Della Valle Index is preferred in this study as it first detrends the given series and provides a clear direction about the instability. The coefficient of variation, on the other hand, can be overestimated if the time series data exhibit any trend. The Cuddy Della Valle Index attempts to de-trend the coefficient of variation by using the coefficient of determination. To measure the magnitude of variability in area, production and productivity for the total period, the coefficient of variation (%) was computed. The instability index (I) was also calculated using the formula:

$I = CV \times \sqrt{(1-R^2)}$ to examine the instability in area, production, productivity and MSP of millets in the country over the study time period. The Cuddy-Della Valle index was originally developed by Cuddy and Valle in 1978 to measure the instability in time series data characterized by trends.

RESULTS AND DISCUSSION

Growth Performance of Major Millets

The Compound Annual Growth Rate (CAGR) for the area, production, productivity and MSP of millets were calculated and are shown in Table 1. The period of

TABLE 1

Growth in area, production and productivity from 1951-52 to 2021-22 and MSP from 1995-96 to 2022-23 of millets in India (%)

Crop	Area	Production	Productivity	MSP
Pearl millet (Bajra)	-0.60 **	1.67 **	2.28 **	8.15 **
Sorghum (Jowar)	-1.85 **	-0.62 **	1.25 **	9.37 ** (Maldandi) 9.32 ** (Hybrid)
Finger millet (Ragi)	-1.26 **	0.12 NS	1.40 **	10.15 **
Small millets (*kharif* season)	-3.60 **	-2.88 **	0.74 **	—

** Significance at 1 per cent level; NS Non-significant

study considered for calculating CAGR for the area, production and productivity was from 1951-52 to 2021-22 and MSP was from 1995-96 to 2022-23.

A significant negative growth rate has been observed for area under all the millets selected for the study. The highest decline in area of millets was observed for small millets (-3.60%) followed by sorghum (-1.85%), finger millet (-1.26%) and pearl millet (-0.60%). After the Green Revolution in the 1960s, high yielding varieties of wheat and rice gained popularity, resulting in a decline in the cultivation of millets and consequently their use in human consumption (Reddy, 2021). This shift is reflected in the decreased area under nutri-cereal cultivation, which fell from 37.67 mha in 1950-51 to 23.83 mha in 2020-21. In contrast, the area under rice and wheat increased to 45.07 mha and 32 mha, respectively, from 30 mha and 9.75 mha during the same period (Agricultural Statistics at a Glance, 2021).

With respect to the production performance of study crops, significant positive growth rate was observed only in pearl millet. Even though positive growth rate of 0.12 was observed in finger millet production but it was non-significant. The highest decline for production was observed for small millets (-2.88%) followed by sorghum (-0.62%). Providing just one critical irrigation during their growth stage can potentially double the yield of millets. Therefore, it is essential to incentivize farmers to provide critical irrigation to enhance millet yield. From 1950-51 to 2020-21, the production of wheat has increased by 16.8 times, rice by 5.8 times and nutri-cereals by 3.3 times (Agricultural Statistics at a Glance, 2021).

A significant positive growth rate was observed in productivity of all the millet crops under study. The highest increase in productivity was in case of pearl millet (2.28%) followed by finger millet (1.40%), sorghum (1.25%) and small millets (0.74%). Millets have a unique ability to survive in drylands, where other crops cannot grow due to their tolerance to extreme drought conditions. However, despite their resilience, the average yield of millets in India is only 1,111 kg per hectare, which is significantly lower than that of paddy (2,600 kg per hectare) and wheat (3,500 kg per hectare). This low productivity highlights the urgent need to develop and promote high-yielding varieties of millets in the country (Reddy, 2021).

The MSP, which is the price at which the government purchases the crops from the farmers, has shown a significant increase for all millet crops over the years except small millets for which MSP is not announced. The highest increase (CAGR) in MSP was for finger millet (10.15%) followed by sorghum (maldandi) (9.37%), sorghum (hybrid) (9.32%) and pearl millet (8.15%).

Instability Analysis of Major Millets

Table 2 data reveals the variations in the area, production, productivity and MSP of Sorghum across

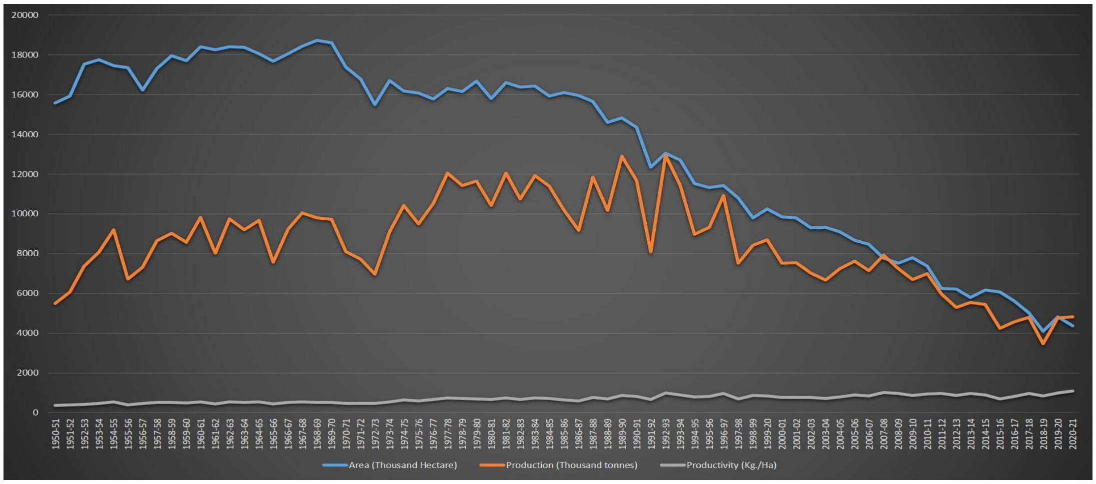

Fig. 1 : Area, Production and Productivity of Sorghum (Jowar) in India

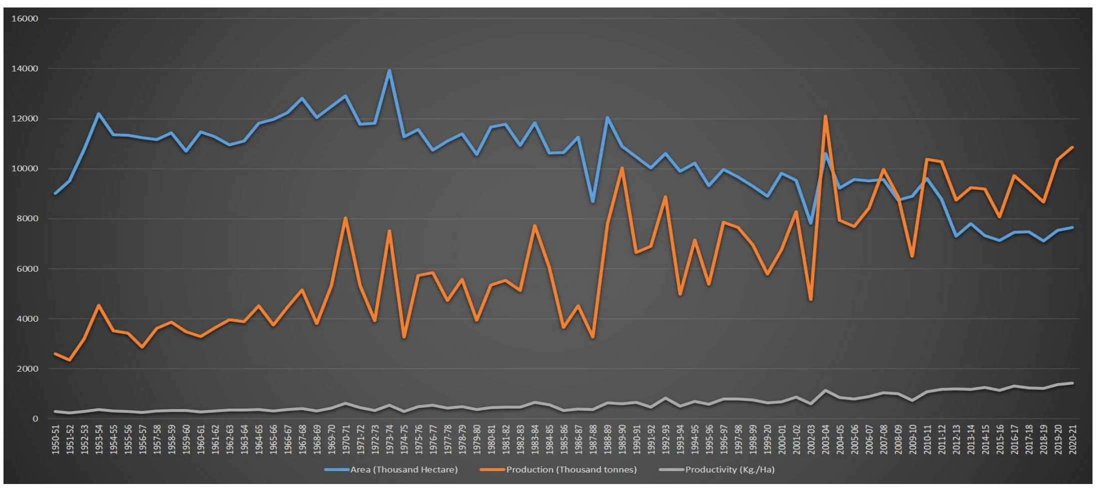

Fig. 2: Area, Production and Productivity of Pearl Millet (Bajra) in India

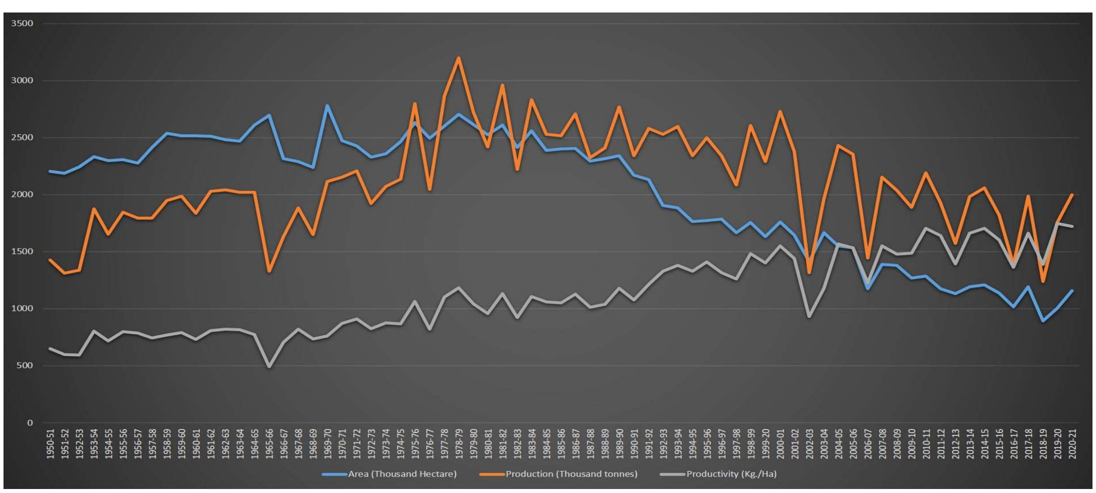

Fig. 3: Area, Production and Productivity of Finger Millet (Ragi) in India

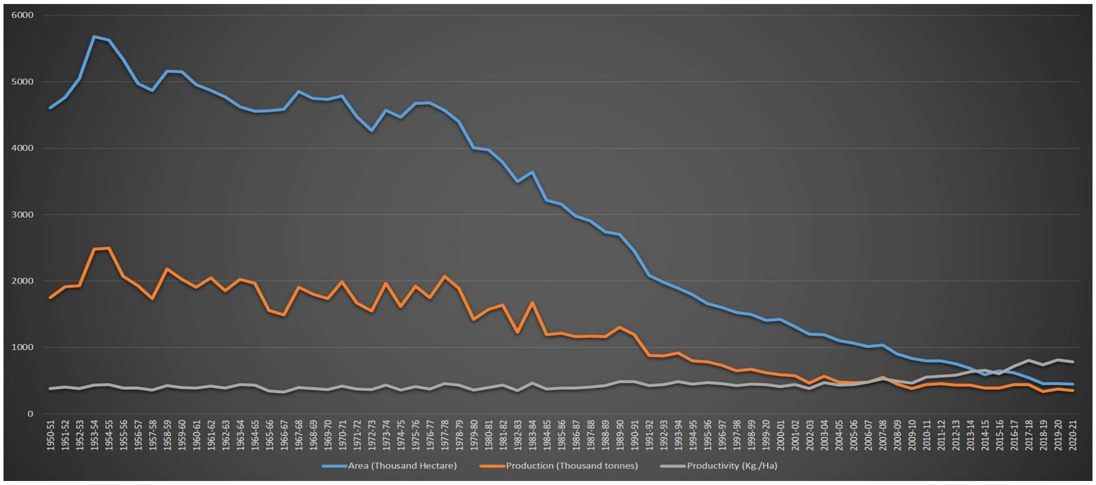

Fig. 4 : Area, Production and Productivity of Small Millets (*kharif* season) in India

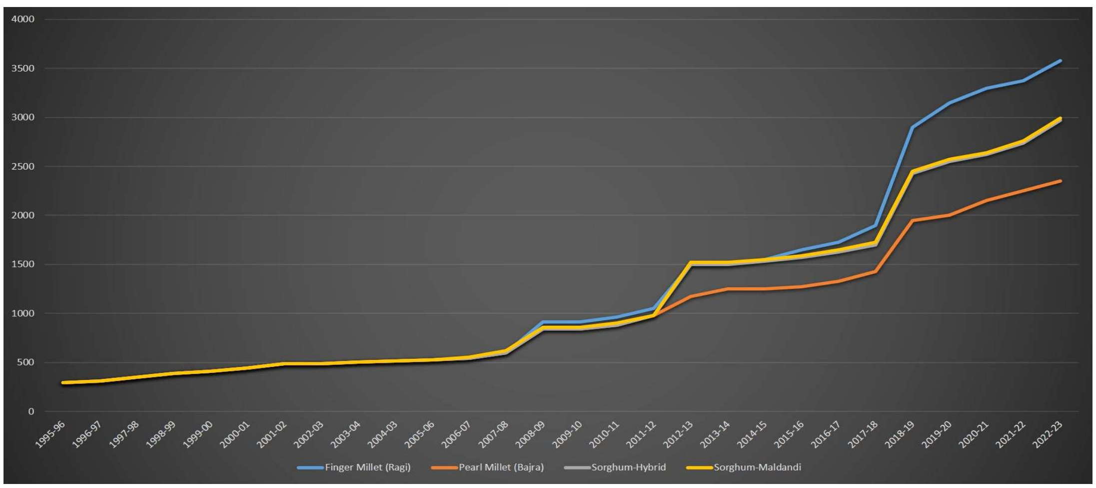

Fig. 5 : Minimum Support Price of Millets in India (Rs./Quintal)

TABLE 2

Variations in area, production, productivity and MSP of Sorghum in India

Particulars	Standard Deviation	Mean	CV (%)	Instability
Area	4591.96	13277.52	34.58	12.81
Production	2255.09	8511.39	26.49	24.59
Productivity	187.85	692.87	27.11	11.91
MSP (Maldandi)	856.16	1159.04	73.87	26.87
MSP (Hybrid)	848.72	1147.43	73.97	27.29

India. The Sorghum area had a mean of 13277.52 thousand ha with a standard deviation of 4591.96 and showed moderate variability coefficient of 34.58 per cent. Similarly, production had a mean of 8511.39 thousand kg with a standard deviation of 2255.09, resulting in a CV of 26.49 per cent and a production instability of 24.59 per cent. The productivity, which is the production per unit area had a mean of 692.87

kg/ha and a standard deviation of 187.85, resulting in a CV of 27.11 per cent and productivity instability of 11.91 per cent. Regarding MSP, both Maldandi and Hybrid varieties had significant standard deviations (856.16 and 848.72, respectively) against their means (1159.04 and 1147.43, respectively). This resulted in high CVs for MSP (Maldandi: 73.87%, Hybrid: 73.97%) and considerable instability (Maldandi: 26.87%, Hybrid: 27.29%). The analysis emphasizes the volatility and fluctuations in Sorghum cultivation and millet prices, possibly due to various factors such as climatic conditions, market dynamics and policy interventions. This requires further investigation and strategic interventions to ensure the stabilization and sustainability of Sorghum production and pricing across India. Banu *et al.* (2022) proposed that facilitating millet procurement at the minimum support price, along with government support for farmers and entrepreneurs to establish storage facilities, could contribute to enhancing farmer's income.

Pearl Millet

Data depicted in Table 3 presents the variations in the area, production, productivity and MSP of Pearl Millet in India. The standard deviation for the area was 1593.56 thousand ha with a mean of 10301.46 thousand ha. This indicates relatively low variability with a CV of 15.47 per cent. However, production showed higher variability with a standard deviation of 2436.64 and a mean of 6231.80. This resulted in a CV of 39.10 per cent and instability of 21.79 per cent. Productivity had a standard deviation of 329.38 and a mean of 634.85. This led to a CV of 51.88 per cent and instability of 22.46 per cent. Regarding MSP, the standard deviation was 644.84, with a mean of 992.86. This resulted in a CV of 64.95 per cent and instability of 21.80 per cent. These findings highlight the substantial differences in Pearl Millet cultivation, production and pricing across India. Production, productivity and MSP showed higher CV and instability values, underlining the challenges and uncertainties faced by farmers in Pearl Millet cultivation. The decline in the area and production of millets can be attributed to a shift in production from millets to cash crops in pursuit of higher returns. The productivity of nutri-cereals increased by 5.25 times, whereas the productivity of rice and wheat increased by 4.06 and 5.22 times, respectively, between 1950-51 and 2020-21. Jena and Mishra's (2020) study revealed that the decline in millet production in Odisha state from 1990 to 2010 was mainly due to the reduction in cultivation area, but the yield effect also played a role.

Finger Millet

The results presented in Table 4 show variations in the area, production, productivity and MSP of Finger Millet in India. The area had a mean of 2017.55 and a standard deviation of 542.76, resulting in a CV of 26.90 per cent, suggesting moderate variability. Production had a mean of 2115.41 and a standard deviation of 441.15, resulting in a CV of 20.85 per cent and instability of 20.87 per cent. Productivity had a mean of 1121.31 kg/ha and a standard deviation of 338.73, resulting in a CV of 30.21 per cent and instability of 11.45 per cent. As for MSP had a mean of 1279.36 and a standard deviation of 1057.77, leading to a CV of 82.68 per cent and instability of 34.93 per cent. These findings highlight the different

TABLE 3

Variations in area, production, productivity and MSP of Pearl Millet in India

Particulars	Standard Deviation	Mean	CV (%)	Instability
Area	1593.56	10301.46	15.47	10.15
Production	2436.64	6231.80	39.10	21.79
Productivity	329.38	634.85	51.88	22.46
MSP	644.84	992.86	64.95	21.80

TABLE 4

Variations in area, production, productivity and MSP of Finger Millet in India

Particulars	Standard Deviation	Mean	CV (%)	Instability
Area	542.76	2017.55	26.90	14.08
Production	441.15	2115.41	20.85	20.87
Productivity	338.73	1121.31	30.21	11.45
MSP	1057.77	1279.36	82.68	34.93

levels of variability and instability in Finger Millet cultivation and pricing across India. The high CV and instability values for MSP underscore the challenges farmers face in millets cultivation, emphasizing the need for targeted interventions and policy measures to enhance stability and sustainability in Finger Millet production and pricing practices throughout the country.

Small Millets

The results in Table 5, depict variations in Small Millets' area, production and productivity across India. The mean area under cultivation for Small Millets was 2981.82 thousand ha with a substantial standard deviation of 1754.05, indicating considerable variability in cultivation extends across different regions. The CV for the area stood at 58.82 per cent, indicating a moderate level of dispersion relative to the mean. Production figures exhibited similar trends, with a mean production of 1232.80 thousand tonnes and a standard deviation 656.23. The CV for production was slightly lower at 53.23 per cent, suggesting a relatively more stable production scenario compared to the cultivation area. Productivity demonstrated the lowest variability among the parameters, with a mean productivity of 456.42 kg/ha and a standard deviation of 108.47. The CV for productivity was 23.76 per cent, indicating relatively stable productivity across different regions despite variations in cultivation and production. Instability measures further elucidate the fluctuations within the variables, with area instability at 14.28 per cent, production instability at 17.10 per cent and productivity instability at 16.59 per cent. Policymakers and agricultural stakeholders could focus on promoting best practices, introducing resilient crop varieties and implementing region-specific strategies to enhance overall small millet productivity including price support scheme. Additionally, understanding the factors contributing to instability in production can inform risk mitigation strategies for small millet farmers, ensuring more sustainable and resilient agricultural practices in the long run.

Hiremath *et al.* (2013) observed a decline in the production of foxtail millet and minor millets in Karnataka, which was attributed to the variability in the cultivation area. The opinions of farmers indicated that the unstable production was caused by low yields (77.8%), low prices (72.2%) and the transfer of cultivation area to more profitable crops (72.2%). These findings highlight the need to address these factors to promote sustainable cultivation and production of millets in the region.

TABLE 5

Variations in area, production and productivity of Small Millets in India

Particulars	Standard Deviation	Mean	CV (%)	Instability
Area	1754.05	2981.82	58.82	14.28
Production	656.23	1232.80	53.23	17.10
Productivity	108.47	456.42	23.76	16.59

During the Green Revolution, the focus was on cultivating high-yielding varieties of cereals such as rice and wheat, which were highly responsive to inputs. With better technologies, inputs and mechanization, wheat and rice showed a significant increase in production and productivity. However, indigenous varieties of millets are not as input-responsive and yield was less compared to improved varieties of wheat and rice. Consequently, as farmers gained access to fertilizers, agrochemicals and high-yielding varieties of wheat, rice and other commercial crops, millets were replaced by more profitable crops.

All the millets selected for the study have shown a significant negative growth rate in area and production except pearl millet were showed a positive growth rate in production. The production was not impressive due to decline in area, however, there was a positive growth rate in productivity of all the major millet crops under study. The highest CAGR of MSP was observed in finger millet followed by sorghum and pearl millet. Sorghum and pearl millet showed low instability in area, while finger millet and small millets showed moderate instability. Moderate instability was observed in production for all four millet crops and low instability was found in sorghum and finger millet for productivity, while pearl millet and small millets showed moderate instability. MSP showed high instability in sorghum and finger millet and moderate instability for pearl millet.

To promote millet consumption, various factors need to be addressed, including the perception of millets as an inferior cereal, the substitution of millets with more refined diets and the easy availability of rice and wheat through the Public Distribution System (PDS). To reverse this trend, there is a pressing need to raise awareness of the nutritional benefits of millets and invest significantly in research and development to increase their productivity. Facilitating the sustenance of millets can be achieved through the procurement of millets at Minimum Support Price (MSP), the establishment of processing facilities and the creation of market linkages.

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