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A study on area, production, productivity of nutricereals in India: An overview of growth and instability analysis

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Abstract
The present study revealed that among nutricereals, in case of Jowar crop the area and production was found to be negative whereas productivity was positive (0.86%). Similarly in bajra, area was decreased by 0.59% whereas the growth in production was positive with 1.77% and in case of productivity the growth was 2.42% in comparison with all the nutricereals have registered negative g growth in both area and production during the period 1961 to 2022. On the other hand, the observations on instability index in area, production and productivity shows that, the bajra crop revealed higher degree of Variation during the study period from 1961 to 2022, which was followed by Jowar, Ragi and small millets. The total instability index was low for overall area, production and productivity.

Keywords: Growth, Millets, Instability, Nutricereals, Area, Production

Introduction
In India, Millets have been implemented under Sub-Mission on Nutri-Cereals (Millets) under National Food Security Mission (NFSM), the present status reveals that, bajra is being promoted in 89 districts of 9 states including 14 districts of Gujarat in the country. In future many states such as North Eastern States, Himachal Pradesh and UTs of Jammu & Kashmir and Ladakh have been given flexibility to adopt and also to include the districts under programme. Through this intervention made by government, it was possible to witness the overall production of millets has increased from 14.52 million tonnes in 2015-16 to 17.96 million tonnes in 2020-21. In particular, the production of bajra has also increased from 8.07 million tonnes to 10.86 million tonnes during the same period.

On the other hand, the State Governments is also promoting cultivation of millets and bajra under Rashtriya Krishi Vikas Yojana - Remunerative Approaches for Agriculture & Allied sector Rejuvenation (RKVY- RAFTAAR) with the approval of the State Level Sanctioning Committee (SLSC) constituted under the chairmanship of the chief secretary of the respective State in the country.

On April, 2018, in view of the nutritional value of the millets, the Government has notified millets as nutri-cereals and also the National Year of Millets was celebrated in 2018. Many studies shows that, millets are rich in Protein, Fibre, Minerals, Iron, Calcium and have a low glycemic index. To create awareness among both domestic and global level demand and to provide nutritional food to the people, our country had proposed to United Nations for declaring 2023 as International Year of Millets (IYoM). The proposal of India was supported by 72 countries and United Nation's General Assembly (UNGA) declared 2023 as International Year of Millets in March, 2021.

Over the years, the agriculture and allied activities sector significantly contributed to the country's overall growth and development by ensuring food security. The Indian agriculture sector has been growing at an average annual growth rate of 4.6 per cent during the last six years. It grew by 3.0 per cent in 2021-22 compared to 3.3 per cent in 2020-2021. In recent years, India has also rapidly emerged as the net exporter of agricultural products. In 2020-2021, exports of agriculture and allied products from India grew by 18 per cent over the previous year. During 2021-2022, agricultural exports reached an all-time high of US$ 50.2 billion. This period of buoyant performance could be ascribed to the measures taken by the

Government to promote farmer-producer organisations, encourage crop diversification, and improve productivity in agriculture through support provided for mechanisation and the creation of the Agriculture Infrastructure Fund. Thus, enabling the country, in the spirit of Vasudhaiva Kutumbakam, to provide necessary and essential support to other countries for the losses faced during Covid-19. Further, income support to farmers through the Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) and the promotion of allied activities has led to diversification in sources of farmers' income, improving their resilience to weather shocks.

The interventions of the Government have been in line with the recommendations of the Committee on Doubling Farmers' Income, which had identified improvement in crop and livestock productivity, diversification towards higher value crops, better resource efficiency, enhanced cropping intensity, improvement in real prices received by farmers and shift from farm to nonfarm occupations as being significant sources of growth. Several policy measures, such as the Minimum Support Price (MSP) to secure the price at one and half times the all-India weighted average cost of production, schemes and price measures to focus on high-value added crops such as oilseed, incentives for crop diversification through price policy measures, improvements in agricultural marketing and by enhancing resource use efficiency etc. have been adopted. While Indian agriculture has performed well, the sector needs re-orientation in the backdrop of certain challenges like adverse impacts of climate change, fragmented landholdings, sub-optimal farm mechanisation, low productivity, disguised unemployment, rising input costs, etc.

India is the largest producer of millet as of 2021, with a total share of 41%, followed by Niger (~12%) and China (~8%). India also ranks 12th among those countries that produce high yields of millet. Millets have been an integral part of our diet for centuries. They offer a plethora of health benefits and are also good for the environment with low water & input requirements for production. With the aim to create awareness and increase production & consumption of millets, the United Nations, at the behest of the Government of India, declared 2023 as the *'International Year of the Millet*". With this backdrop, the present paper aims to analyze the growth and instability in area, production and productivity of Jowar, Ragi, Bajra and Small millets, collectively these are known as nutricereals.

Methodology

The present status aims to study the nutricereals growth and instability in terms of area, production and productivity was selected for the study during the period from 1961 to 2022. The crops such as Jowar, Ragi, Bajra and small millets were selected for the present study as these are most widely cultivated millets in India in terms of area and production and considered as nutricereals. Thus, secondary data related to area, production, and productivity of Jowar, Ragi, Bajra and small millets were collected and analyzed from the year 1961 to 2022 to draw meaningful conclusion using appropriate tools for the study. The tools for assessing the growth trend analysis was used and for Instability analysis Co-efficient of Variation and instability index suggested by Cuddy and Della was used. The details as follows;

Trend analysis: The exponential growth function was used to estimate the growth rates of the selected economic variables and the model as mentioned below

$$Y = abt\ e$$

Where,
Y= Dependent variable for which the rate of increase/ decrease is estimated (area, production, productivity)
a = intercept
b = regression coefficient
t = time variable (1961 to 2022)
e = error term

The compound growth rate was obtained from the logarithmic form of the equation $Y = abt\ e$ as below ln Y= ln a+ t ln b, the percent compound growth rate (y) was derived using the relationship y= (Anti ln of b-1) X 100.

Instability analysis: The coefficient of variation was used as a measure to study the variability in the area, production, productivity and consumption of millets. The coefficient of variation (CV) was computed using the formula Co-efficient of Variation (CV)= (SD/Mean)*100

In order to study the variability in the area, production and productivity of millets, an instability index suggested by Cuddy and Della (1978) was used:

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

CV = Coefficient of variation

Adjusted R^2 coefficient of multiple determination, Coefficient of variation was multiplied by the square root of the difference between the unity and coefficient of multiple determinations (R**2**).

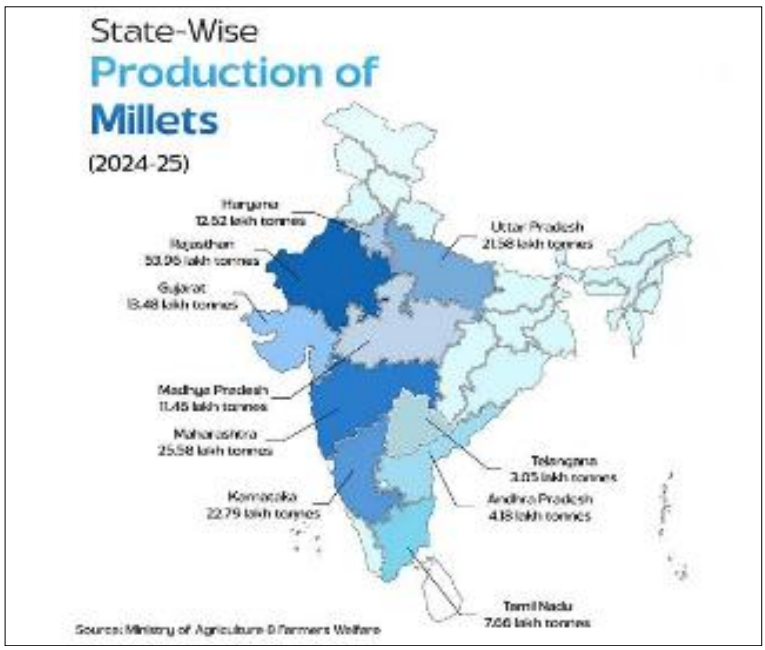
Results and Discussion

Trends of Millet reveals that, the estimated millet yield in India has more than doubled since 1961. India's average yield in Millet farming (2021-22) is 1208 kgs per hectare. The production of millets has also increased by 7% (1966-2022) despite the area for millet cultivation in India decreasing consistently since 1971-72. A major drop in the area for millet cultivation occurred between 2006-2016. The consistent improvement in yield estimates over the years indicates the adoption of better farming practices in India in the past few decades. Per capita availability of millets has also been fluctuating over the years. It is at its lowest since the all-time high seen in 2019. In 2021, approximately 12.3 kgs of millet was available per person. The total millet production is presented in the fig.01. Highest percent of production was observed in Rajasthan followed by Uttar Pradesh, Gujarat and Madhya Pradesh and Haryana as major growing states in India.

The State wise distribution of Millets reveals that, Millet cultivation and production is found to be higher in the western part of India. In 2021-22, Rajasthan contributed to ~36% (~4300K hectares) of the total area for millet cultivation in India. It is also the largest producer of millet in India. ~26% (more than 4000K tonnes) of Indian millet production is from Rajasthan. Although Rajasthan has the largest area and production of millet cultivation, its yield is

on the lower side. Comparison with Minimum Support Price for rice, wheat, and major millets

While the Minimum Support Price for rice, wheat, and major millets has significantly increased over the years, the highest hike has been for Finger millets. It increased by 3076 Rs per quintal - more than 4000% hike since 1975! This is a promising sign and can provide more incentives to farmers for millet cultivation. Minimum Support Price is the price set by the government to purchase crops from the farmers, whatever may be the market price for the crops. The Indian government has also been promoting millet production as part of its National Food Security Mission. To commemorate the 'International Year of the Millet', the Government of India has held various interactive activities around Millets. As a result of these factors, millet production in India is expected to continue to grow in the coming years. With the appropriate promotion of millets for their health benefits and benefits as a sustainable crop to cultivate, it can widely increase the consumption of millets. This will further contribute to improving nutrition, food security, and the welfare of farmers.



India produced a total of 180.15 lakh tonnes of millets in 2024-25. This was an increase of 4.43 lakh tonnes compared to the previous year. Rajasthan produced the highest quantity of millets in 2024-25. It was followed by Maharashtra in the second position and Karnataka in the third position.

The compound growth was used to assess the change in area, production and productivity of nutricereals during 1961 to 2022 and it is presented in table.01. The findings reveals that, the Compound annual growth rates (CAGR) for the area, Production and productivity of Jowar, Bajra, Ragi, Small millets and total production of nutricereals was analyzed using the exponential growth function. From Table 1 it can be observed that for Jowar over The period of time, the area under cultivation has decreased and even in production also and only in the growth was found to be positive in case of productivity.

However, in Bajra though area was found to be decline the growth in both production and productivity has increased and in case of Ragi, both area under cultivation and production

has decreased but productivity has increased over the period. Similarly in case of small millets was also in the same lines as of ragi's growth. In nut shell, the total nutricereals the growth in area and production has decreased over the period of 1961 to 2022, however, the compound annual growth rates (CAGR) for productivity has increased.

Table 1: Growth in area, production and productivity of nutricereals during 1961 to 2022.

Crop	Parameter	CAGR
Jowar	Area	-2.22%
	Production	-1.41%
	Productivity	0.86%
Bajra	Area	-0.59%
	Production	1.77%
	Productivity	2.42%
Ragi	Area	-1.44%
	Production	-0.32%
	Productivity	1.13%
Small Millets	Area	-3.71%
	Production	-2.86%
	Productivity	1.01%
Total Nutricereals	Area	-2.25%
	Production	-0.56%
	Productivity	0.97%

From Table 2 it can be observed that the variability was calculated using co-efficient of variation, the findings shows that, the area in bajra showed higher degree of Variation during the period (1961 to 2022) followed by jowar and Ragi and small millets. On the other hand, production of bajra displayed higher degree of variation as compared to other nutricereals during the study period. Similarly, the instability index was calculated using Cuddy and Della (1978), the results show that, the total nutricereals area, production and productivity falls under the category of medium range instability index. Among the Jowar, Bajra and Ragi found to be low instability index in terms of area, whereas in case of production it was found to be medium in both production and productivity such as ragi and small millets. Similar findings were reported by Bellundagi *et al.* (2016) [2] and Mehta (2013) [5].

Table 2: Variations in area, production, and productivity of pearl millet and finger millet during 1961 to 2022

Crop	Parameter	CV	CDVI	Instability Range of CDVI
Jowar	Area	37.94	8.84	Low
	Production	28.46	20.92	Medium
	Productivity	22.26	12.20	Low
Bajra	Area	64.20	7.82	Low
	Production	55.89	20.96	Medium
	Productivity	25.50	20.20	Medium
Ragi	Area	29.75	11.13	Low
	Production	19.89	19.49	Medium
	Productivity	26.27	11.15	Medium
Small Millets	Area	16.66	15.73	Medium
	Production	33.14	18.54	Medium
	Productivity	46.35	16.33	Medium
Total Nutricereals	Area	32.05	7.17	Low
	Production	14.60	14.24	Low
	Productivity	26.79	8.84	Low

Conclusion

The overall study reveals that, the growth in area, production and productivity was decline and only in case of bajra the growth was positive and increasing. Hence, the intervention of government is very much needed to increase the area and development of suitable varieties for increasing the production in near future for fast growing population. Presently the Government is popularizing nutri-cereals through Research & Development support and has established 3 Centres of Excellence (CoE). Support is also given to start-ups and entrepreneurs for developing recipes & value added products that promotes consumption of millets. At present there are 8 bio-fortified varieties/hybrids of Bajra have been released for cultivation from 2018 to till date. The research on other millets should be intitated to develop best technologies for farmers at low cost for better production especially for nutricereals.

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