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# An Analysis of Millets in Odisha and Madhya Pradesh, India: A Comparative Study

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

The study examined the growth in area, production and yield of millets in Odisha and Madhya Pradesh, India. The data for the study was obtained from the website of indiastat.com. The crops selected were bajra, jowar, ragi and small millets. The data on area, production and productivity were collected from 2000-01 to 2020-21. The analytical tools used in the study are compound growth rate and coefficient of variation. The results showed that millet area had been declining over time but the production has increased. Area and production of bajra was declining in Odisha, it was increasing in Madhya Pradesh. Jowar's area and production are declining in both states but the

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yield is increasing. In terms of yield, ragi exhibited the highest variability in Odisha, whereas in Madhya Pradesh, the highest variability was observed in the area and production of ragi. Odisha showed the highest growth rate in the yield of bajra, while in Madhya Pradesh, the highest growth rate was observed in the yield of small millets. Millets consumption needs to be promoted among people who require gluten-free fiber rich diet, and wants to consume organic products for health benefits. The promotion of organic farming in millets by state governments should be encouraged, considering its inherent resistance to a wide range of pests and diseases.

*Keywords: Compound growth rate; coefficient of variation; millets.*

**JEL codes:** Q10, P50, D24.

## 1. INTRODUCTION

Millets belongs to the family poaceae and in comparison to cereals they are resistant to pest, diseases, drought and have a shorter growing period. In semi-arid areas with little rainfall and low nutritional value, millets are grown on marginal soils. Millets, which are C4 plants, can adapt to degraded saline and acidic soils and have excellent photosynthetic efficiency and dry matter production capability [1]. As the world is facing challenges of food insecurity and climate change, millets have shown its ability to thrive in challenging agro-climates, and frequent weather uncertainty. The majority of millets are grown and consumed in developing nations. Across the World, 93 countries produce millets, however, only seven countries have over one million hectares of area under cultivation. Minor millets includes Ragi (Finger millet), Barnyard millet, Little millet (Kutki), Porso millet, Kodo, and Foxtail millet. Major millets comprises Bajra (Pearl Millet), and Sorghum (Jowar). Millets are a great alternative to traditional cereals because they are gluten-free. They help to control diabetes and obesity. Dietary fibers, poly-phenols, anti-oxidants and, proteins are high in millet [2]. Millets provide a good amount of methionine and are a good source of important amino acids. Millets are a good source of micro-nutrients and phyto-chemicals [3].

With 41 per cent share of global production, India is the largest producer of millets in the World. With a total production of 12.5 million tonnes, India leads in terms of production followed by Niger (3.5 million tonnes) and China (2.3 million tonnes) [4]. According to FAOSTAT [4], the average yield of millets in India in the year 2020 was 1285 kg/ha, more than twice the yield in Niger (520 kg/ha). In terms of area, India leads with 9.71 million hectares in 2020, followed by Niger with 6.74 million hectares [4]. While production declined from 32.79 million metric tonnes in 2010 to 31.02 million metric tonnes in 2018, the area under millets except sorghum showed a downward trend during the same period, from 36 million hectares in 2010 to 33.56 million hectares in 2018 [5]. The area under millets may have decreased due to area under millet cultivation being shifted to other crops like wheat and paddy, guaranteed returns from commercial crops, and dietary changes. India is the world's fifth-largest exporter of millets, and during the past five years, exports have grown at a CAGR of three percent. In the year 2020–21, India exported millets valued at USD 26.97 million. The top three millets importing countries from India in 2020–21 were Nepal ($6.19 million), UAE ($4.84 million), and Saudi Arabia ($3.84 million). Libya, the UK, Yemen, Tunisia, Algeria, Morocco, and Oman were among the other popular import destinations [6]. Major millet producing states are Rajasthan, Karnataka, Uttar Pradesh, Tamil Nadu and Madhya Pradesh. Other important millet producing and consuming states includes Maharashtra, Odisha, and Uttarakhand.

It is important to consider the scenario of millets in India in consideration with Madhya Pradesh and Odisha. The Madhya Pradesh and Odisha have traditionally cultivated and consumed millets but these states also accounts for large share of malnutrition which millet can alleviate. The study conducted by Satapathy *et. al*, [7] concluded that the main causes of malnutrition were poverty, inadequate environmental sanitation, poor dietary practices, low socioeconomic status, inadequate household food security, high rice consumption, and frequent illnesses. In this connection this study aims to examines the growth in area, production and yield of Odisha, Madhya Pradesh and India.

## 2. LITERATURE REVIEW

Kumar *et.al* [8], conducted a study to analyze the trend in area, production and productivity of minor millets in India. The data was analyzed

using descriptive statistics and compound growth rate. The results showed that small millets area and production has been decreasing due to cultivation cereals, pulses and other commercial crops. High yielding varieties and new cultivation practices has led to increase in productivity of minor millets.

Meena *et.al* [9], conducted a study to analyze the global scenario of millets. The study shows that over the past 58 years, global millet production has generally declined everywhere except in Africa, particularly in West Africa where there was a significant increase, nearly doubling since the 1960s. In Asia, although millet cultivation area has decreased, production has gradually risen, leading to increased productivity. In India, millet production peaked in the 1980s but has since declined due to a sharp decrease in cultivated area. India stands as the top millet producer globally, accounting for 37.5% of the total output, followed by Sudan and Nigeria.

Singh and Sharma [10], conducted a study to compare the trend and growth rate of small millets in Madhya Pradesh and India. The study was conducted for the period of 15 years from 2001-2015. The data on area, production and yield was obtained from various secondary sources. The results showed that the area and production has been decreasing while the productivity has increased in Madhya Pradesh and India over the study period.

Malathi *et.al* [11] conducted a study to assess the growth pattern of millets in India. The data on area, production and productivity was collected from Directorate of Economics and Statistics. The study was conducted from 1950-51 to 2011-12. The results showed that between 1950-51 and 1980-81, the cultivation areas for sorghum, pearl millet, finger millet, and total millets showed positive growth, which then turned negative in the following years. Total millet production saw significant growth throughout the study period due to increased yields. The growth in production of sorghum, pearl millet, finger millet, and total millets was primarily driven by yield improvements, while the area cultivated and its interaction with yield had a negative impact on production.

## 3. METHODOLOGY

The study is based on secondary data. The crops selected were bajra, jowar, ragi and small millets. The data on area, production and yield was obtained from indiastat.com. The study period is from 200-01 to 2020-21. The following are the statistical tools applied in the study:

**Absolute Change:** It is calculated by taking the difference between the initial and final values. The absolute change was calculated for area, production and yield by taking average of the base year (average of 2000-01 to 2002-03) and average of current year (average of 2018-19 to 2020-21) [12]. The absolute change was calculated by:

**Absolute change= Yn – Yo**

where,
Yn = average of the current three years
Yo = average of the beginning three years

**Relative Change:** The relative change provides comparison analysis. This measure has been estimated for comparing change across the selected variables in each crop [12]. The following formula was used to calculate relative change:

$$\textbf{Relative change} = \frac{Yn-Yo}{Yo} \times 100$$

**Compound growth rate (CAGR):** Compound growth rate of area, production and yield were calculated by using the following formula:

**Yt = abt**

Compound annual growth rate (%) = (Antilog b-1) × 100

Where,
Y= Area, production, and yield in the year 't' for which the growth rate is estimated
t= Time in year
b = Regression coefficient

## 4. RESULTS AND DISCUSSION

The results of absolute change, relative change, growth rate and variability in Odisha are presented in Table 1. Bajra has seen a significant negative growth in area (-4.09 per cent) and production (-3.01 per cent). However yield has increased with a significant positive growth rate of 1.42 per cent. Bajra has seen highest variability in area (30.77 per cent) followed by production (23.25 per cent) and yield (10.39 per cent). The area has decreased by 2.53 thousand hectare and production by 0.93

thousand tonnes while yield has increased by 143 kg/ha. Jowar in Odisha has seen a significant negative growth rate in area (- 4.03 per cent) and production (-3.46 per cent) whereas yield has increased by 0.58 per cent. Variability was highest in area (26.09 per cent) followed by production (23.42 per cent) and yield (5.19 per cent). Area and yield has decreased in relative terms by 49.03 and 43.7 per cent respectively while yield has increased by 10.99 per cent. Area and production has decreased by 5.93 thousand hectare and 3.03 thousand tonnes while yield has increased by 62.66 kg/ha. In bajra and jowar, increased yield could not compensate to reduced area, resulting in negative growth rate in production. Area of ragi has increased at a positive but insignificant pace (1.48%) throughout the period. Production has shown a significant 2.19 percent decline in growth. Yield has seen an insignificant negative growth rate of -3.62 per in the two decades. Yield was found to have highest variability of 164.98 percent followed by area (46.58 per cent) and production (18.56 per cent). Area and production has decreased by 39.14 thousand hectare and 13.99 thousand tonnes whereas yield has increased by 190.33 kg/ha. Small millets has seen a insignificant negative growth of -0.22 per cent but production has a positive but insignificant growth of 0.76 per cent. Yield has increased significantly by 0.99 per cent over the years. In relative terms small millets area has decreased by 12.03 per cent while production and yield has increased by 2.52 and 18.28 per cent respectively. Over the last twenty years small millets area in Odisha has decreased by 4.59 thousand hectare while production and yield has increased by 0.42 thousand tonnes and 79.66 kg/ha.

The results of absolute change, relative change, growth rate and variability in Madhya Pradesh are presented in Table 2. There was a positive growth rate in bajra area (3.30 per cent), production (4.73 per cent) and yield (5.44 per cent). Highest variability was seen in bajra area (113.27 per cent) followed by production (60.30 per cent) and yield (35.57 per cent). Yield has increased by 1039.33 kg/ha and area and production has increased by 150.96 thousand hectares and 493.65 thousand tonnes respectively over the years. Jowar area and production has significantly decreased by -9.54 and -5.22 per cent respectively whereas yield has increased by 4.77 per cent over the years. The variation in area was 52.35 per cent, 36.49 per cent in production and 30.71 per cent in yield. The area has decreased by 546.7 thousand hectare and production by 365.69 thousand tonnes while yield has increased by 1036.66 kg/ha. Ragi has seen a negative growth rate in area (-6.91 per cent) and production ( -5.79 per cent), while yield has increased by 1.8 per cent. Variability was highest in area (207.36 per cent) followed by production (183.68 per cent) and yield (54.83 per cent). Small millets area has drastically decreased over the years by -8.24 per cent whereas yield has significantly increased by 7.74 per cent. Production has seen a negative and insignificant growth of -1.13 per cent. Area and production decreased by 81.54 and 28.9 per cent in relative terms whereas yield has increased by 286.34 per cent.

The results of absolute change, relative change, growth rate and variability in India are presented in Table 3. There was a significant and negative growth rate in area (-1.62 per cent) under bajra in India over the years however production and yield has seen a positive growth rate of 1.52 and 3.19 per cent respectively. Area under bajra has decreased by 1628.33 thousand hectares but production and yield has increased by 3356.93 thousand tonnes and 615.33 kg/ha. Variability in yield was 21.81 percent, 18.47 per cent in production and 12.90 per cent in area. Jowar has seen a significant but negative growth in area (-4.17 per cent) and production (-3.21 per cent). Yield has seen a positive growth rate in yield (0.99 per cent). Variability was highest in area (25.8 per cent) followed by production (21.64 per cent) and yield (12.12 per cent). Over the course of the study, there was a relative decrease in area by 54.07 percent, a decrease in production of 40.90 percent, and a rise in yield of 28.30 percent. Ragi has seen a significant but negative growth rate of 2.5 per cent while production has seen a negative and insignificant growth of 1.32 per cent. Yield has a positive growth of 1.21 per cent over the years. The variance is nearly same for area (17.97%), production (19.99%), and yield (13.62%). Small millets area and production has significantly decreased by -5.56 and -2.11 per cent respectively. The yield has significantly increased by 3.65 per cent in the last two decades. Variability in area was 34.51 per cent,15.98 per cent in production and 23.73 in yield. Area and production has decreased by 859.28 thousand hectares and 190.71 thousand tonnes respectively while yield has increased by 363 kg/ha.

**Table 1. Absolute change, relative change, growth rate and variability of millets in Odisha**

| | | Odisha | | | |
|---|---|---|---|---|---|
| **Crop** | **Area/Production/Yield** | **Absolute change** | **Relative change** | **CAGR** | **CV (%)** |
| Bajra | Area (‘000 ha) | -2.53 | -58.91 | -4.09** | 30.77 |
| | Production (‘000 tonnes) | -0.93 | -46.06 | -3.01** | 23.25 |
| | Yield (kg/ha) | 143 | 29.89 | 1.42** | 10.39 |
| Jowar | Area (‘000 ha) | -5.93 | -49.03 | -4.03** | 26.09 |
| | Production (‘000 tonnes) | -3.03 | -43.70 | -3.46** | 23.42 |
| | Yield (kg/ha) | 62.66 | 10.99 | 0.58** | 5.19 |
| Ragi | Area (‘000 ha) | -39.14 | -50.77 | 1.48 | 46.58 |
| | Production (‘000 tonnes) | -13.99 | -33.21 | -2.19** | 18.56 |
| | Yield (kg/ha) | 190.33 | 34.69 | -3.62 | 164.98 |
| Small Millets | Area (‘000 ha) | -4.59 | -12.03 | -0.22 | 31.23 |
| | Production (‘000 tonnes) | 0.42 | 2.52 | 0.76 | 31.16 |
| | Yield (kg/ha) | 79.66 | 18.28 | 0.99** | 8.54 |

**Table 2. Absolute change, relative change, growth rate and variability of millets in Madhya Pradesh**

| | | Madhya Pradesh | | | |
|---|---|---|---|---|---|
| **Crop** | **Area/Production/Yield** | **Absolute change** | **Relative change** | **CAGR** | **CV (%)** |
| Bajra | Area (‘000 ha) | 150.96 | 91.12 | 3.30$ | 113.27 |
| | Production (‘000 tonnes) | 493.65 | 273.49 | 4.73* | 60.30 |
| | Yield (kg/ha) | 1039.33 | 95.11 | 5.44** | 35.57 |
| Jowar | Area (‘000 ha) | -546.7 | -84.75 | -9.54** | 52.35 |
| | Production (‘000 tonnes) | -365.69 | -66.75 | -5.22** | 36.49 |
| | Yield (kg/ha) | 1036.66 | 122.15 | 4.77** | 30.71 |
| Ragi | Area (‘000 ha) | -0.53 | -55.17 | -6.91$ | 207.36 |
| | Production (‘000 tonnes) | -0.2 | -60 | -5.79$ | 183.68 |
| | Yield (kg/ha) | 9.33 | 3.03 | 1.80 | 54.83 |
| Small Millets | Area (‘000 ha) | -369.6 | -81.54 | -8.24** | 46.66 |
| | Production (‘000 tonnes) | -27.42 | -28.90 | -1.13 | 22.77 |
| | Yield (kg/ha) | 601.33 | 286.34 | 7.74** | 55.06 |

*Note: $ values calculated through mathematical formula, YT =Y0 (1+r)T where r is growth rate in fraction*

**Table 3. Absolute change, relative change, growth rate and variability of millets in India**

| | | India | | | |
|---|---|---|---|---|---|
| **Crop** | **Area/Production/Yield** | **Absolute change** | **Relative change** | **CAGR** | **CV (%)** |
| Bajra | Area (‘000 ha) | -1628.33 | -17.96 | -1.62** | 12.90 |
| | Production (‘000 tonnes) | 3356.93 | 50.81 | 1.52* | 18.47 |
| | Yield (kg/ha) | 615.33 | 85.18 | 3.19** | 21.81 |
| Jowar | Area (‘000 ha) | -5218.83 | -54.07 | -4.17** | 25.80 |
| | Production (‘000 tonnes) | -3013 | -40.90 | -3.21** | 21.64 |
| | Yield (kg/ha) | 216 | 28.30 | 0.99** | 12.12 |
| Ragi | Area (‘000 ha) | -588.66 | -36.63 | -2.50** | 17.97 |
| | Production (‘000 tonnes) | -476.62 | -22.26 | -1.32 | 19.99 |
| | Yield (kg/ha) | 312 | 23.84 | 1.21* | 13.62 |
| Small Millets | Area (‘000 ha) | -859.28 | -65.52 | -5.56** | 34.51 |
| | Production (‘000 tonnes) | -190.71 | -35.25 | -2.11** | 15.98 |
| | Yield (kg/ha) | 363 | 88.17 | 3.65** | 23.73 |

## 5. CONCLUSION

This study examined the growth in area, production and yield of millets in Odisha, Madhya Pradesh and India. The results showed that millet area has been decreasing over the years however the yield has shown positive growth rate. Area and production of bajra is decreasing in Odisha while it is increasing in Madhya Pradesh. Jowar area and production has been decreasing in both states and the yield is increasing over the years. This shows that use of high yielding varieties have aided in improved yields. Madhya Pradesh has the largest area under small millets, however the area has drastically reduced over the years while yield has improved significantly. In Odisha highest variability was found in yield of ragi while in Madhya Pradesh highest variability was seen in area and production of ragi. Highest growth rate was found in the yield of bajra in Odisha and in Madhya Pradesh highest growth rate was seen in the yield of small millets. To make millets competitive with alternative crops, farmers need be encouraged through market intervention and suitable technological inputs in seed, harvesting, and storage. It is time to expand the consumption set of the millets to people who require gluten-free fiber rich diet, and wants to consume organic products for health benefits. State government should also promote organic farming in millets as it is resistant to wide range of pest and diseases.

## DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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