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Production Trend, Constraints, and Future Strategies of Millets in Odisha

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ABSTRACT: This study investigates the growth & instability in area, production and productivity of different millets in Odisha based on secondary data during the period 2001-01 to 2021-22. In addition to that, an empirical study on 96 finger millet growers & 16 value added actors covering four tribal and rainfed districts of the state was made to assess the constraints in millet production & marketing and millet value addition. Our findings showed, LGR & CGR of area and production were negative for finger millet, jowar, bajra and total millets in Odisha. However, trends of total millet showing an upward trend in area, production & yield for total millets after 2017-18. This proves, there was some trend shift in the state in millet production which can be attributed to the implementation of Odisha Millet Mission (OMM) in 2017 in the state. Moreover this study highlighted delayed & partial payment of incentives in OMM and limited market demand as the most important constraint for millet farmers & processors. In findings, authors' strategies on expansion of millet cultivation into semi rainfed areas and creation of millet recipes & outlets in rural areas to create market demand for millets in the state.

Keywords: Millets, Trend shift, Odisha Millet Mission (OMM), CGR, incentives, rain fed, recipes.

INTRODUCTION

Agriculture and allied sectors' share of overall economy GVA (%) at current price is 18.3 in 2022-23 (MoA & FW, Contribution of Agricultural Sector in GDP). Millets have been referred to be "Shree Anna"—the mother of all grains—in the union budget for 2023–2024. Millets are small seeded annual grasses used as grain crops on marginal soils in dry locations across temperate, subtropical, and tropical countries (Bachate *et al.*, 2022). A group of very nutritious small-grained cereal food crops called millets, such as sorghum, pearl millet, finger millet, little millet, foxtail millet, barnyard millet, kodo millet, and others, are grown on marginal or lowly productive soils with very little assistance from pesticides or fertilizers. Meena *et al.* (2017) found that finger millet cultivation is less hazardous to the soil, environment, and crops since it consumes less inorganic components. In Odisha, the millets grown and reported are ragi (finger millet), jowar (sorghum), bajra (pearl millet) and small millets *i.e.* suan/gurji (little millet), kangu (foxtail millet), kodo, proso millet and barnyard millet among other. Maharashtra, Rajasthan, and Karnataka are India's top producers of millets (Agarwal *et al*., 2018). Ragi holds the lion share of production with 86.46 percent of total production. The share of bajra production is just 0.53% in the state. Millet production area was continuously decreasing from 201 thousand ha in 2013 to 187 thousand ha in 2022 in Odisha. It is also noticed that there was a significant increase in productivity of millets from 819kg/ha to 964kg/ha during same period (Watershed Support Services and Activities Network, WASSAN). Sathish Kumar *et al.* (2022) revealed that the area and production of minor millets have been decreasing due to the cultivation of cereals, pulses, and commercial cash crops. As millets are basically grown in worse land of rainfed areas of the state and grown as an alternative crop, it is basically confront with various constraints in its cultivation. According to Gyawali (2021), lack of domain-specific high-yielding varieties, high preference towards major cereals, and poor marketing infrastructure particularly in marginal areas are the constraints mainly considered for unexpected production of millet. To bring millets back to farms and dinner tables, and to increase the productivity of millets, the Odisha government's Department of

Agriculture & Farmers Empowerment established the Odisha Millet Mission in 2017. So, to strategies the millet cultivation in the state, we studied about the growth & instability in millet cultivation in the state for last two decades and also highlighted the major constraints in its marketing, production and value addition. The results will also assist close the research vacuum that currently exists in Odisha's millet economy and direct future programs and policies targeted at advancing millet farming, processing, and value addition.

MATERIAL AND METHODS

The multistage sampling method was adopted for the study. In the first stage, convenient sampling method was adopted for selecting the four districts *i.e.* Koraput, Kandhamal, Nuapada & Gajapati under 7 operational districts of OMM implementation in kharif 2017 from three physiographic zones. In the second stage of sampling, two blocks from each district were purposively selected. In the 3rd stage, one cluster from each block was also selected purposively based on high concentration of farmers under OMM. In the final stage of sampling, 12 millet farmers from each cluster were selected randomly for study. So, the sample size was 96. Apart from that, 16 value added actors covering four tribal and rainfed districts of the state were interviewed to find out the problems regarding millet value addition. Data were collected using well designed interview schedule and questionnaire from the selected farmer-respondents growing finger millet. Additionally, Department of Agriculture & Farmers' Empowerment, Odisha and WASSAN (Watershed Support Services and Activities Network) provided the study's secondary data on area, production & yield of millets.

ANALYTICAL TECHNIQUES

Growth rate

'To analyze the millet cultivation in Odisha, it was proposed to estimate the growth and instability in area, production and yield of millets. There are two types of growth rates *viz*., linear and compound growth rates. In present study both linear and compound growth rates of cotton were estimated. The exponential function provided below was fitted to determine the CGR of area, production, and productivity of several millets across different time periods as well as the full period.

$$Y = A \times B^{t} e^{u}$$

The function is transformed into a linear form by the logarithmic transformation.

$$ln\, Y = ln\, A + t\, ln\, B + \; u$$

Where, Y = Area / production/ and yield of finger millet

t = time variable in years (1, 2, 3 ...),

A = intercept,

B = trend co-efficient, and

u = disturbance or error term

Dandekar (1980) found that when the exponential form is utilized to estimate compound growth rate,

$$CGR(r) \; = \; [Antilog \; (log \; B) \; - 1] \; \times \; 100$$

Where, CGR = Compound growth rate

and B = Regression parameters'

Based on average data spanning three years, the growth rate of agricultural output influenced by climatic conditions has been calculated (Dandekar, 1980; Minhas, 1966; Singh and Rai 1997; Deosthali and Chandekar 2004). The t-test statistic was used to examine the coefficient of time B.

$$t = \frac{\hat{B}}{SE\ of\ B}$$

$$\text{S.E of B} = \sqrt{\frac{\sum (Y - \hat{Y})^2}{N}}$$

Instability analysis. Any measure of instability must take into account the possibility of a divergence from the data series brought on by a secular trend or growth. This is how the instability analysis was done.

Cuddy-Della Valle index (CDVI). This approach is used to assess the level of risk associated with the production of millets. The following Cuddy-Della Valle Index was used to measure the instability in area, production, and yield.

The equation's estimable form is as follows:

$$CDVI = CV \; \times \sqrt{(1 - \; Adj.R^2)}$$

Where, CDVI

$=$ Cuddy $-$ Della Valle Instability index in per cent

CV $=$ Coefficient of variation in per cent

Adj. R^2

$=$ Coefficient of determination from time trend regression adjusted

by the number of degree of freedom.

The value of (CDVI) has a range of 0-15 categorized as low, 15-30 as moderate and above 30 as high.

Garrett ranking analysis for constraints

Utilizing Garrett's ranking approach, the problems that millet farmers and processors experienced throughout production & marketing and in value addition were examined. The following formula was utilized for converting the farmers' rating of the criteria into % terms:

$$\text{Percent position} = \frac{100 \times (R_i - 0.5)}{N_J}$$

where, R_{ij}

$=$ Ranking given for i^{th} item by j^{th} respondent

$N_j =$ Number of items ranked by j^{th}respondent

Garrett and Woodworth's (1969) table was used to convert the percent position of each rank so acquired into scores. Next, the total number of farmers and processors for whose scores were added was divided by the sum of the individual farmer scores for each difficulty. All of the problems mean scores were sorted by placing them in descending order.

RESULTS AND DISCUSSION

Growth trend and instability of millets in Odisha. The LGR & CGR and CDVI of different millets in Odisha during the period 2000-21 are given in Table 1. The Table indicates a negatively significant growth in area & production and positively non-significant growth in yield for total millets. The LGR & CGR for total millets in area and production were -2.12 per cent &-2.13 per cent and -1.97 per cent &-1.55 per cent; however, for yield the rates were positive at LGR & CGR of 0.29 per cent & 0.59 per cent respectively.

Instability in the area, production and yield of different millets was measured by Cuddy-Della Valle index. For total millets the CDVI was medium in production (27.81%) & yield (21.24%) and low (5.42%) in area. This shows there was much higher instability in production and yield of total millets compared to its area. From figure1, it is observed that the trend in area, production & yield has shifted from downward to upward after 2017. These findings were due to the recent promotions of OMM from 2017 for the cultivation of ragi and some small millet. The reason for the decrease in the area under millets cultivation can be attributed to many factors. As finger millet (ragi) and small millets contribute more than 90 per cent of total area and production of millet cultivation in the state, there was much higher instability in production and yield of total millets of the state. Similarly, the study matched with the findings of Bellundagi *et al.* (2016); Mehta (2013). The findings suggests, there is a need to stabilize the production of millets by arresting then decline in area to maintain food security by incentives-based approach. It should be continued for a few more years and should be extended to the rest of the millets in the state. In addition to that, millet should be promoted in the semi rainfed areas of the state with suitable varieties to increase its production in whole state.

In case of finger millet (ragi), the LGR & CGR in area and production were (-2.38% &-2.48% and -2.22% & -1.76% respectively) negatively significant and for yield LGR & CGR were positive but not significant. For jowar the LGR & CGR in area and production were -3.90 per cent & -3.85 per cent and -3.25 per cent &-3.25 per cent respectively. The LGR & CGR of jowar yield were 0.60 per cent & 0.62 per cent respectively. The growth analysis for jowar is statistically significant at 1 per cent. In case of bajra the LGR & CGR in area and production were (-4.00% &-4.18% and -3.18% &-3.38% respectively) negatively significant at 1 per cent and for yield LGR & CGR were0.81 per cent & 0.84 per cent respectively which are positively significant at 1 per cent. There was positive growth observed in area, production and yield for small millets. The LGR & CGR were 0.24 per cent & 0.36 per cent in area, 1.59 per cent & 1.51 per cent in production and 1.08 per cent &1.14 per cent in yield respectively. The growth analysis is non-significant for both area and production of small millets but statistically significant at 1 per cent for its yield. Similar findings were also presented by Bairwa *et al*. (2020). Here it shows, there are negative growth in area & production of all millets except small millets where the growth rate are non significant, during the study period. Talking about the yield, the rates are positive and significant in all millets except finger millet. So it is interpreted that with time there is increase in productivity. It is suggested here that the impetus can be given to increase the millet productivity further which can help in increase in area and production of millets in future. In case of ragi, the instability was higher for production (29.79%) and yield (25.58%) compared to area (8.08%). The CDVI in area (31.82%) and production (29.93%) of small millets were found to be high and medium respectively, while for yield it was low. For jowar, CDVI was low (ranges between 0-15%) in all three variables *i.e*., area, production and productivity which indicates that there exits low instability in all three variables. Instability in area (13.86%) & production (15.94%) were higher compared to the instability in yield (4.61%) of bajra. These higher instability in millet production & productivity are observed because millets are basically cultivated in the worst land of rainfed areas where there are numerous risks observed in millet cultivation. To stabilize the millet production, major steps like crop insurance, drought resistant varieties and other suitable schemes fir millet cultivation can be taken. Similar findings were reported by Jena & Mishra (2020) for different millets at Odisha state level.

The constraints of millet production, marketing & value addition. The constraint analysis of millet farmers and processors was made through Garrett mean score method. Out of many constraints faced by farmers and processors, ten most important problems were taken into consideration for farmers and processors separately.

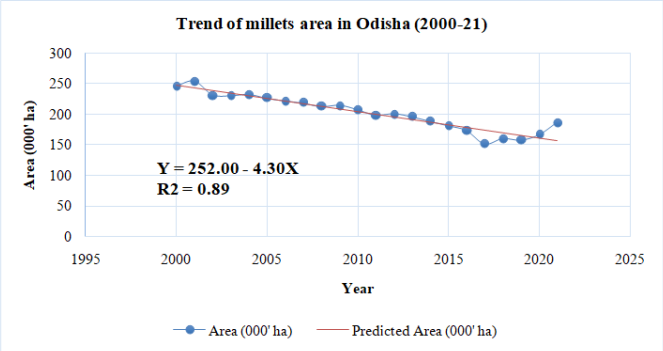
Constraints perceived by farmers and processors. The opinions of 96 sample farmers about the constraints in different millet production and marketing are presented in table 2. It indicates that delayed & partial payment of incentives was the main problem, and it was ranked 1st with Garrett Mean Score (GMS) of 61.17 and transportation and logistics cost ranked 2nd with a Garrett Mean Score (GMS) 60.61. With Garrett Mean Score (GMS) 57.14, farmers gave opinion that there was lack of high yielding varieties and with GMS 53.31, farmers opined lack of processing facility which ranked 4th. Farmers also indicated proper infrastructure unavailability (GMS53.02), non-availability of credit facilities (GMS 48.90), limited or misleading marketing information (GMS 48.70), erratic /unfavorable rainfall (GMS46.57) are other constraints of millet cultivation. Irregularity in training, demonstration & exposure (GMS 46.28) and more travel cost for training and awareness camp visits (GMS 38.44) were the least important problems faced by farmer producers. Similarly, the opinion of 16 processors in value addition if different millets is presented in table 3. It shows that limited market demand was most important problem, and it was ranked 1st with Garrett Mean Score (GMS) of 68.50 and unpopularity of enterprises was ranked 2nd with a Garrett Mean Score (GMS) 60.90, lack of improved equipment/technical guidance was ranked third with a garret mean score of 59.80. Other constraints were non-availability of market information, lack of standardization/branding of products, non-availability of proper market linkage, less preference to local packaging and high raw materials cost were ranked fourth, fifth, sixth, seventh and eighth with Garret mean score of 59.20, 57.05, 54.55, 53.35 and 51.60 respectively. Unaware about government entrepreneurial schemes (GMS 51.50) and skilled labor scarcity (GMS 43.85) were the least important constraints faced by value adding entrepreneurs. So, authors have suggested various points regarding the

constraints to solve them out. Such suggestions say, a timely and need-based incentive support system for millet cultivation should be strengthened through regular & proper monitoring. Introduction of millets and millets-based products for adolescent women and other women groups should be a think tank of policy measure. Authors also pointed about sufficient training and capacity building among rural youths is the need of the hour to take the value-added enterprise through market led extension. Consumption demand of the millets should be extended in rural and urban areas through millet café & restaurant to maintain sustainability Similarly, Pushpa *et al.* (2023) found, among the constraints faced by millet farmers, animal menace was ranked first, followed by a lack of knowlegde about improved varieties in second place, rainfall uncertainty in third place, and an inability to fetch a remunerative price in fourth place. Among the limits faced by the processing units, absence of millet polish machine ranked top, followed by lack of cooperation among members of the processing unit ranked second, and lack of flexibility to operate on different phases of electricity ranked third.

Table 1: Descriptive statistics, growth and instability in area, production and yield of millets in Odisha.

Year	FINGER MILLET			JOWAR			BAJRA			SMALL MILLETS			TOTAL MILLETS		
	A	P	Y	A	P	Y	A	P	Y	A	P	Y	A	P	Y
2000-01	189.02	151.55	801.77	13.00	7.48	575.38	4.12	2.35	570.39	40.52	15.63	385.74	246.66	177.01	717.63
2001-02	196.01	359.42	1833.68	12.26	7.09	578.30	4.09	2.31	564.79	42.36	20.12	474.98	254.72	388.94	1526.93
2002-03	186.63	127.49	683.12	11.00	5.72	520.00	3.76	1.82	484.04	30.44	11.44	375.82	231.83	146.47	631.80
2003-04	189.63	139.71	736.75	11.09	6.38	575.29	3.27	1.72	525.99	26.57	11.51	433.20	230.56	159.32	691.01
2004-05	194.49	142.46	732.48	10.07	5.45	541.21	3.16	1.61	509.49	24.88	11.10	446.14	232.60	160.62	690.54
2005-06	189.94	141.81	746.60	9.52	5.74	602.94	2.93	1.58	539.25	23.74	10.39	437.66	226.13	159.52	705.43
2006-07	189.73	144.25	760.29	9.50	5.82	612.63	2.39	1.40	585.77	20.28	9.28	457.59	221.90	160.75	724.43
2007-08	187.16	165.29	883.15	9.32	5.78	620.17	2.74	1.63	594.89	18.94	8.96	473.07	218.16	181.66	832.69
2008-09	182.89	163.83	895.78	8.88	5.60	630.63	2.98	1.80	604.03	17.79	8.63	485.10	212.54	179.86	846.24
2009-10	185.26	173.86	938.46	9.03	5.78	640.09	2.78	1.68	604.32	17.78	10.06	565.80	214.85	191.38	890.76
2010-11	179.48	147.39	821.21	8.90	5.35	601.12	3.34	2.07	619.76	15.75	7.28	462.22	207.47	162.09	781.27
2011-12	169.22	151.42	894.81	8.63	5.44	630.36	3.09	1.90	614.89	17.20	8.95	520.35	198.14	167.71	846.42
2012-13	172.99	149.21	862.54	7.83	4.89	624.52	2.84	1.73	609.15	17.38	8.86	509.78	201.04	164.69	819.19
2013-14	165.80	143.74	866.95	7.46	4.66	624.66	3.03	1.85	610.56	19.32	9.70	502.07	195.61	159.95	817.70
2014-15	158.27	137.36	867.88	6.69	4.19	626.31	2.35	1.44	612.77	20.78	10.45	502.89	188.09	153.44	815.78
2015-16	147.29	127.65	866.66	6.21	3.89	626.41	2.11	1.29	611.37	25.35	12.70	500.99	180.96	145.53	804.21
2016-17	138.34	120.92	874.08	5.47	3.44	628.88	1.84	1.13	614.13	27.41	13.84	504.93	173.06	139.33	805.10
2017-18	114.35	100.58	879.58	5.62	3.55	631.67	1.76	1.09	619.32	29.18	14.94	511.99	150.91	120.16	796.24
2018-19	117.88	104.92	890.06	7.19	4.56	634.21	2.16	1.34	620.37	32.78	16.98	518.00	160.01	127.80	798.70
2019-20	116.85	128.73	1101.67	5.81	3.68	633.39	1.87	1.16	620.32	32.87	16.99	516.88	157.40	150.56	956.54
2020-21	124.47	137.49	1104.60	5.50	3.47	630.91	1.27	0.79	622.05	35.00	18.00	514.29	166.24	159.75	960.96
2021-22	140.94	156.06	1107.28	6.14	3.86	628.66	1.56	0.96	615.38	38.37	19.61	511.08	187.01	180.49	965.14
Descriptive statistics															
Mean	165.30	150.69	915.88	8.41	5.08	609.90	2.70	1.58	589.68	26.12	12.52	482.30	202.54	169.87	837.49
Range	81.66	258.84	1150.56	7.53	4.04	120.09	2.85	1.56	138.01	26.61	12.84	189.98	103.81	268.78	895.13
SE	6.00	10.64	50.11	0.47	0.25	6.89	0.17	0.09	8.59	1.73	0.82	9.71	6.30	11.06	37.90
CV	17.02	33.11	25.66	26.45	22.81	5.3	29.07	26.01	6.83	31.15	30.9	9.45	14.6	30.53	21.23
Growth and instability															
LGR (%)	**-2.38* (0.000)**	**-2.22** (0.043)**	**0.36 NS (0.687)**	**-3.90* (0.000)**	**-3.25* (0.000)**	**0.60* (0.000)**	**-4.00* (0.000)**	**-3.18* (0.000)**	**0.81* (0.000)**	**0.24 NS (0.823)**	**1.59 NS (0.129)**	**1.08* (0.000)**	**-2.12* (0.000)**	**-1.97** (0.042)**	**0.29 NS (0.691)**
CAGR (%)	**-2.48* (0.000)**	**-1.76** (0.024)**	**0.73 NS (0.300)**	**-3.85* (0.000)**	**-3.25* (0.000)**	**0.62* (0.000)**	**-4.18* (0.000)**	**-3.38* (0.000)**	**0.84* (0.000)**	**0.36 NS (0.734)**	**1.51 NS (0.139)**	**1.14* (0.000)**	**-2.13* (0.000)**	**-1.55** (0.032)**	**0.59 NS (0.335)**
CDVI (%)	**8.08**	**29.79**	**25.58**	**8.00**	**9.04**	**3.72**	**13.86**	**15.94**	**4.61**	**31.82**	**29.93**	**6.47**	**5.42**	**27.81**	**21.24**

Source: Department of Agriculture & Farmers' Empowerment, Odisha and WASSAN (Watershed Support Services and Activities Network)
A = AREA in '000 ha., P=Production in '000MTs., Y=Yield in Kg./ha., ***Parenthesis indicates the P value;*** **NS** ***indicates non-significant and*,** &# indicates significance at 1% , 5% & 10% respectively.***



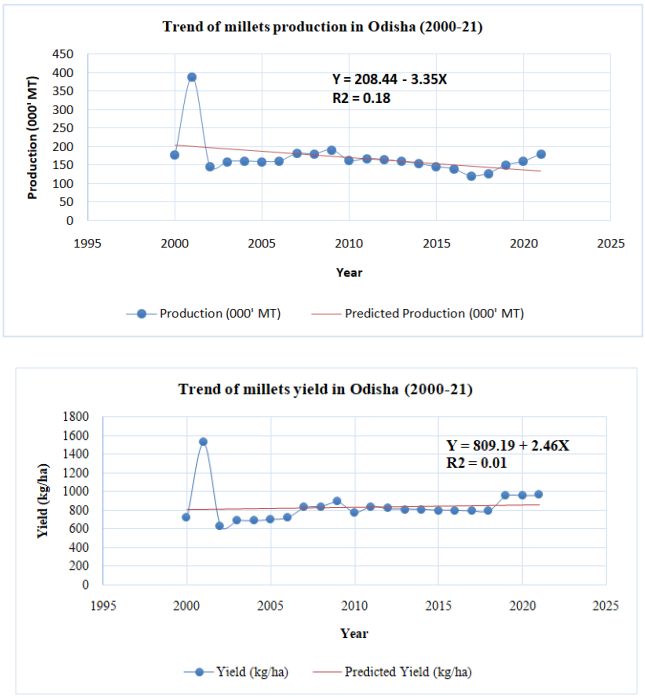


Fig. 1. Trend of millets area, production and yield in Odisha (2000-21).

Table 2: Constraints perceived by farmers in production and marketing of millets ($n = 96$).

Sr. No.	Constraints factors	I	II	III	IV	V	VI	VII	VIII	IX	X	Total	Cal. Value	Garret Value	Garrett Mean Score (GMS)	Rank
1.	Delayed & partial payment of incentives	29	15	10	7	7	9	4	6	5	4	96	5	82	61.17	I
2.	Transportation and logistics cost	24	19	11	9	8	5	0	14	2	4	96	15	70	60.61	II
3.	Lack of processing facility	10	8	7	14	22	5	9	15	5	1	96	25	63	53.31	IV
4.	Non availability of credit facilities	2	9	6	12	18	12	15	12	5	5	96	35	58	48.90	VI
5.	Lack of high yielding varieties	11	22	14	15	9	0	10	7	0	8	96	45	52	57.14	III
6.	Erratic /unfavourable rainfall	5	8	12	0	4	16	19	17	6	9	96	55	48	46.57	VIII
7.	Proper infrastructure unavailability	11	5	6	17	18	9	20	2	4	4	96	65	42	53.02	V
8.	Irregularity in training, demonstration & exposure visit	7	4	11	14	17	1	7	12	0	23	96	75	37	46.28	IX
9.	More travel cost for training and awareness camp visit	8	0	8	1	0	4	20	6	28	21	96	85	30	38.44	X
10.	Limited or misleading marketing information	3	15	8	13	0	8	24	9	9	7	96	95	18	48.70	VII

Table 3: Problems faced in value addition of finger millet products (n = 16).

Sr. No.	Constraints factors	I	II	III	IV	V	VI	VII	VIII	IX	X	Total	Cal. value	Garret Value	Garrett Mean Score (GMS)	Rank
1.	Unaware about government entrepreneurial schemes	2	2	1	5	0	0	2	7	1	0	20	5	82	51.50	IX
2.	Lack of standardization/branding of products	3	2	2	3	4	0	5	1	0	0	20	15	70	57.05	V
3.	Non-availability of market information	6	3	4	0	0	1	1	2	1	2	20	25	63	59.20	IV
4.	Lack of improved equipment/technical guidance	5	2	5	2	1	1	1	1	0	2	20	35	58	59.80	III
5.	Less preference of customers towards local packaging	2	0	3	3	3	7	0	0	1	1	20	45	52	53.35	VII
6.	Unpopularity of enterprises	7	5	0	0	0	1	5	0	0	2	20	55	48	60.90	II
7.	High raw materials cost	1	1	4	4	0	6	0	0	3	1	20	65	42	51.60	VIII
8.	Skilled labour scarcity	1	3	2	1	1	1	1	1	5	4	20	75	37	43.85	X
9.	Limited market demand	13	2	0	1	1	0	0	0	0	3	20	85	30	68.50	I
10.	Non availability of proper market linkage	3	4	3	1	2	0	0	4	1	2	20	95	18	54.55	VI

Source: Authors' own compilation from primary data

CONCLUSIONS

It was concluded from our study that in Odisha, during 2001-21, growth rate in area and production were negative for finger millet, jowar, bajra & total millets. During the same period, the instability was higher (medium range) in production of total millets and all millets. However, the trends of total millet showing an upward trend in area, production & yield for total millets after 2017-18. This proves, there was some trend shift in the state in millet production which can be attributed to the implementation of Odisha Millet Mission (OMM) in 2017 in the state. Delayed & partial payment of incentives was the main problem, and it was ranked 1st among many constraints in the production and marketing of millets by the farmers. Similarly, limited market demand was the most important problem out of major constraints faced by processors in millet value addition. Lastly, authors' strategies on expansion of millet cultivation into semi rainfed areas and to Introduce millets and millets-based products for adolescent women and other women groups should be a think tank of policy measure. It was aso suggested to implement a timely and need-based incentive support system should be strengthened for millet cultivation through regular & proper monitoring to capitalize on the recent shift towards millet cultivation in the state.

FUTURE SCOPE

It is here suggested growth and instability of different small millets like foxtail millet & little millets can be studied as OMM has given already a scope for their cultivation in the state. Along with that, a cconsumer preferences analysis with consumer willingness to pay for processed millet products can be studied. Similarly, consumer awareness and consumption pattern (farm to fork approach) can also be studied to study the rate of millet adoption by the people of Odisha.

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Conflict of Interest. None.

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