Millets: Climate change and nutritional security

Abstract

Millets have been widely recognized as 'nutricereals' as they are rich in nutrients. India is the leading producer of millets. These are crops which require low moisture, are short duration and can bear elevated temperatures. It is known that the effects of climate change will have a negative impact on Indian agriculture by reducing yields, deteriorating quality of grain, increase in price, etc. Hence, there is a demanding need to look for solutions that ensure food security, income security as well as nutritional security. This study is an attempt to provide a comprehensive overview of status of millets in India in terms of growth, nutrition and climate resilience. Annual growth trends were calculated for pearl millet, finger millet, sorghum and small millets. The results revealed that the growth rate of area & production for small millets has shown negative trends while the yield has shown positive trend. In decadal analysis the highest negative growth was witnessed in the last decade i.e., 2010-2020. While varied trends were reported for jowar, bajra and ragi individually. Literature review showed that be it pearl millet, finger millet or small millets are used as antidiabetic food option. And are proven to be a solution for food and nutritional security in case of climate change events. It is required that these crops be incentivised by government through proper market linkage and remunerative price.

Keywords: Millets, climate resilience, food security, small millet.

JEL Codes: Q10, Q18, Q19, Q54

1.0 Introduction

The sustainable development goals have been pivotal in shaping the policies and the face of the human livelihood. Out of the 17 goals the first SDG- Zero hunger and second Zero poverty have tried to eradicate the vagaries and uplift the mankind to afford the bare minimum necessities. Zero hunger means not only access to food but affordability and availability of healthy food. Zero poverty is the intertwined objective that realises the affordability of food as one of the many aspects. Globally rice, wheat and maize are among the staple food. But, the recent reports on malnutrition Global Hunger Index shows that malnutrition exists in the nook and corners of the nations. India ranked 107th out of

121 nations in the global hunger index 2022. Added to this is the advent of impact of climate change. Which has threatened the food security, income security and livelihoods. With already evident instances of adverse effects of climate change it has the potential to reduce food grain production, reduced nutrient contents in the crops, increased cost of living, rise in heat waves, cold waves, adverse impact on health, erratic rainfall, disturbances in diurnal temperature rhythm etc. Studies have shown that the rise in mercury will threaten the production of wheat, rice, sugarcane in India (Mall et al., 2006; Patel et al., 2022; Jaiswal et al., 2023). Major crops of the staple diet of the country. This situation of meeting the SDGs, fighting malnutrition, adapting to climate change calls for search of robust alternative solutions. Like, changing of cropping pattern, shifting of crops, change in dietary habits, use of resistant varieties etc. to name a few. History of Indian agriculture shows that apart from the rice, wheat, maize, millets also known as the "coarse cereals", "cereals of the poor", "superfood", "nutricereals" have been an integral part of Indian agriculture since time immemorial. These belong to the family poaceae, are small seeded and used as both feed and fodder. Millets are rich in protein, vitamin, minerals, are gluten-free and have a low glycemic index. They are drought tolerant, have short growing season, grow well in low fertile soil andlow moisture (Kumar et al., 2018). Thus, recognised as good for health and easy to cultivate as well. This offers huge potential in safeguarding the food security as these are climate resilient crops. Millets is a collectively used term for small grained cereals and consists of - pearl millet, sorghum, finger millet, and small millets that includes - foxtail millet, barnyard millet, kodo millet, proso millet, brown top millet and little millet (Table 1).

Table 1: General information about millets

Crop	Scientific name	common name
Sorghum	*Sorghum bicolor*	The king of millet, great millet, Jowar
pearl millet	*Pennisetum glacum*	Bajra
finger millet	*Eleusine coracana*	Ragi/Mandua
Small millets		
foxtail millet	*Setariaitalica L*	Kakum/Kangni
barnyard millet	*Echinochloa, E. fru- mentacea* (Indian)	Sawa/Sanwa/ Jhangora
Kodo millet	*Paspalum scrobicu- latum L*	Kodo
Proso millet	*Panicum miliaceum*	Cheena
Brown top millet	*Urochloaramosa*	
Little millet	*Panicum sumat- rense*	Kutki

Sorghum and pearl millet are the majorly grown millets covering 90% of the millet production (ASSOCHAM 2022). Globally, millets are grown majorly in Africa and Asia, and India is the leading producer and second largest exporter. According to FAO, the world production of millets is 89.17 million metric tonnes from an area of 74.00 million hectare during 2020. India exported millets of around $64.28 million in 2021-22. In India millets is produced in majorly inRajasthan, Andhra Pradesh, Chhattisgarh.

India declared 2018 as the National Year of Millets and recognised millets as the nutricereals for nutritional security. Sincere steps and initiatives were taken to promote millets and as a result the production, productivity and export of millets increased in last two years. As proposed at the United Nations General Assembly by India,2023 has been recognized as the 'International Year of Millets' by the United Nations. The objectives set are to elevate the importance of millets in food and nutrition security, promote stakeholders to adopt millets and attract investment in research and development and extension of millets and their importance. It thus becomes imperative to present a comprehensive overview of the situation of millets in India, the research taken so far and the prospects of millets in India at this stage. Thus, this paper envisages the trends in production, area and productivity of millets over the time, the importance of millets in nutrition and climate change adaptation.

2.0The story of millets so far

India produced 43% of the total millets in the world followed by China and Niger in 2021 (FAO, 2022). In India, millets are grown in an area of 13.83 million hectares, producing 15.53 million tonnes. And sorghum is the fourth largest cereal produced in the country after rice, wheat and maize.

The trends in area, production and productivity were studied individually for sorghum, pearl millet, finger millet and small millets for a period of 1950-2020 i.e., 70 years. It was observed that there has been a steady decline in area under millets(figure 1).The major change was observed in area under cultivation which reduced by 90% for small millets, followed by sorghum 71%. The fall in production

was not at the same pace due to rise in productivity i.e., 105% to 315% rise. While, in case of finger milletnot much decline was observed becausethere was a moderate decline in area (47%) and production increased by 39% which was compensated by the 169% rise in productivity. And, despite the reduction in the area (15%) for pearl millet its production and yield have increased constantly as the highest number of varieties have been released for pearl millet. The unanimous increase in productivity is due to the development of high yielding varieties (Rao et al., 2003; Sreekala et al., 2023). The country has Indian Institute of Millets in Hyderabad (2014) and the Indian Council for Agricultural Research runs All India Coordinated Research Project (AICRP) on sorghum (1969), pearl millet, finger millet and small millets for research and development of millets.

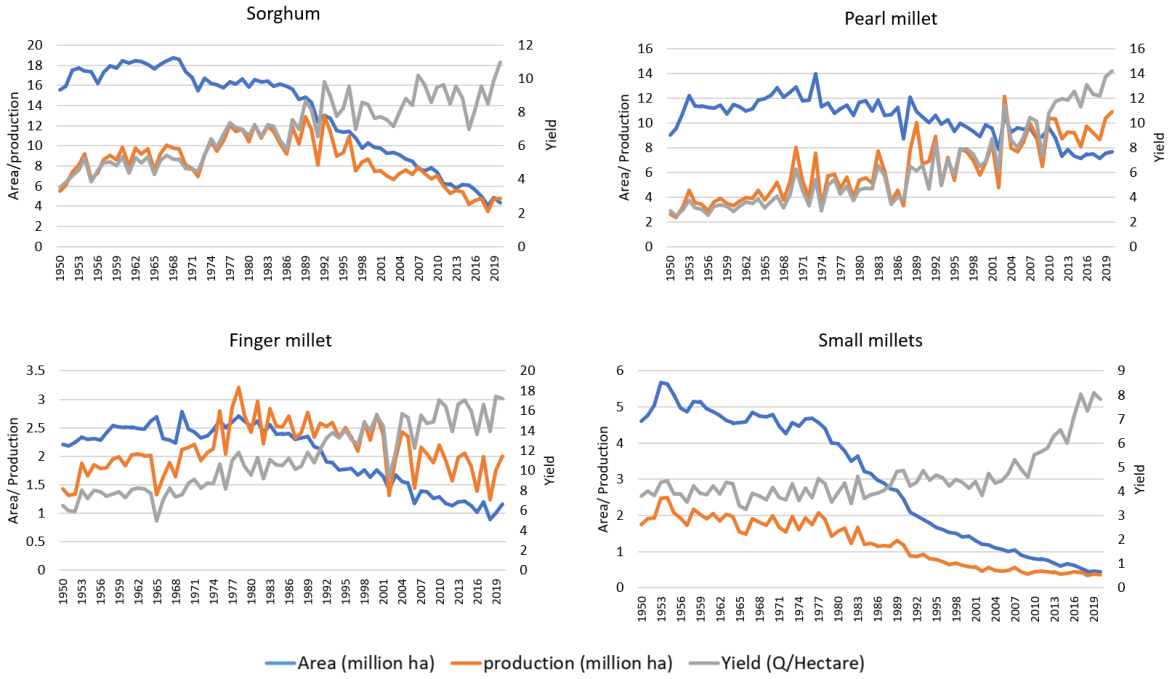

Figure 1: Trends in area, production and productivity of millets in India for a period of 1950 to 2020. *Source- Indiastat.com*

A detailed analysis of the decadal compound annual growth rates (CAGR) is presented in table 2. Since 1970s there has been a gradual decline in the area under millet cultivation ranging from 1% to reaching up to a highest of 5% per annum in case of small millets. The CAGR of production has shown variations barring the last decade i.e., 2010-20 where there is negative growth rate uniformly. The reasons for reduction in area is owed to the fact that there has been rise of rice -wheat cropping system post minimum support price procurements, farmers have shifted to other crops like maize,

soyabean because of increasing demand, higher production, subsidies and also distribution of rice and wheat through public distribution system. (NAAS, Bhagwatula et al., 2013; Nagaraj et al., 2012; Nagaraj et al., 2013). Similar findings have been reported by Sreekala et al., 2023 and Reddy et al., 2013. They concluded that the rise in productivity led to growth in production despite reduction in area. But in general, the rise in production was not observed as the rise in productivity failed to compensate the decline in area. Despite this fact, India is the leading producer of millets across the globe.

Table 2: Compounded annual growth rate of millets for 1950-2020 and decadal.

Time period	Area	Production	Yield
Sorghum			
1950-59	1.29	4.56	3.21
1960-69	0.10	-0.10	-0.21
1970-79	-0.41	3.69	4.14
1980-89	-0.63	2.15	2.79
1990-99	-3.31	-2.92	0.40
2000-09	-2.33	-1.16	1.19
2010-20	-4.64	-6.31	1.34
1950-2020	-1.77	-0.83	1.61
Pearl millet			
1950-59	1.71	3.02	1.28
1960-69	0.86	4.96	4.06
1970-79	-1.97	-6.85	-4.99
1980-89	-0.67	6.50	2.91
1990-99	-1.62	-1.39	-0.12
2000-09	-0.98	-0.38	0.61
2010-20	-2.05	0.66	2.53
1950-2020	-0.23	2.04	2.27
Finger millet			
1950-59	1.35	3.35	1.97
1960-69	1.02	1.42	0.40
1970-79	0.56	2.36	1.79
1980-89	-0.75	1.35	2.11
1990-99	-2.80	-0.22	2.66
2000-09	-3.22	-3.63	-0.42
2010-20	-0.94	1.01	0.10
1950-2020	-0.90	0.77	1.39
Small millets			
1950-59	1.12	1.47	0.34
1960-69	-0.46	-0.97	-0.50

1970-79	-1.77	-3.27	-1.55
1980-89	-3.79	-1.85	2.01
1990-99	-5.36	-6.34	-1.03
2000-09	-5.24	-4.21	1.11
2010-20	-5.21	-	3.19
1950-2020	-3.24	-	1.02

Source- calculated by author

3.0 Climate resilience

It is projected that by 2050s the global temperature will rise by 1.5℃ and if carbon emissions are not controlled, India would be among the hardest hit countries due to its ramifications and reduced crop production, increased heat waves, negative impact on livestock, disease outbreak, economic losses being a few of them (IPCC, 2022). This calls for coming up with adaptation options like introduction of heat tolerant and drought resilient crops in the vulnerable regions. Millets are hardy crops that require less moisture and can tolerate elevated temperatures (up to 42°C) (Muthamilarasan and Prasad, 2021). Millets have a growing period of about 45 to 120 days and hence are short duration crops. Cultivated in majorly in kharif season and also sometimes during summer and rabi under rainfed as well as irrigated conditions. The physiology of millets that contribute to this characteristic is that they are C4 plants, have better water use efficiency and also nitrogen use efficiency (Gupta et al., 2014). They are also resistant to pest and disease attacks. Pearl millet is drought resistant which is developed through its rooting system, water use efficiency, leaf adaptations etc. (Shrestha et al., 2023). Sorghum developed drought tolerance through extensive root system and tolerance of water potential decrease (Tari et al., 2013). Both pearl millet and sorghum are heat tolerant crops and are grown in semi-arid regions (Rai et al., 2008). Finger millets are also been documented to perform well in extreme climate conditions (Gupta et al., 2017). A conundrum of research has said that millets are reliable crops for food and nutrition security under changing climate conditions (Singh et al., 2022; Chaturvedi et al., 2022; Maithani et al., 2022). They help in crop diversification and also can be used as contingency crops at time of crop failure /delayed rain (Fischer et al., 2016).

4.0 The strength of millets

Malnutrition is one of the major concerns at present among many. In India 4 out of every 10 children are malnourished. 3 out of every 5 are underweight and the infant mortality rate is 32 out of every 1000 children born (Patel et al., 2021). Diseases such as diabetes and obesity are also prominent specially among the younger generation. India has 77 million people suffering from diabetes, second largest after China at global level. And predictions show that by 2030, 79.4 million people will be affected (Wild et al., 2004). One of the possible solutions to cope with this is inclusion of food with low glycemic index, nutrient rich diet. Although, the trends showed that millet production has gradually decreased in the country yet the small grains encompass in them a huge store of nutrients and termed as 'nutricereals' (Gazette of India, No. 133 dated 13 April, 2018). It can be consumed directly or in the form of various value-added products. Millets have low glycemic index, contains proteins, fat, carbohydrate, crude fibre, riboflavin (Vitamin B2) and thiamine (Vitamin B1), essential amino acids and trace elements like phosphorous, Magnesium, Iron, Zinc, Calcium, Copper, Chromium in higher concentrations as compared to rice and wheat (Muthamilarasan et al., 2016). Sorghum is a rich source of carbohydrate, fibres, vitamins like B complex, A, C & D, its proteins have low digestibility and different phenolic compounds. This attributes sorghums importance in cancer prevention, diabetes & obesity prevention, antioxidant and anti-inflammatory properties as well (Xiong et al., 2019). Finger millet has high concentration of calcium (0.34%), protein (6-13%), fiber (18%), phyates (0.48%), minerals (2.5-3.5%) and phenols (0.3-3%), potassium, vitamins and essential amino acids as well (Chandra et al., 2016; Shobana et al., 2013). It has health benefits like anti-diabetic, anti-ulcer, anti-diarrheal, anti-umerogenic, atherosclerogenic, anti-inflammatory, antioxidant and antimicrobial properties (Chandra et al., 2016). Pearl millet, is called as the 'powerhouse of nutrition' and contains phytic acid, is gluten free, micronutrients like iron, zinc, magnesium, calcium, phosphorous, copper, manganese, riboflavin and folic acid in addition of protein, carbohydrates, fiber (Satyavathi et al., 2021). It is used as a food option for celiac disease, anti-diabetic, antioxidant, prevention of cancer, heart disease, atherosclerosis and obesity. Foxtail millet isan option for prevention of cancer, hypoglycaemia and, improve digestion (Sharma and Niranjan, 2018). Proso millets are majorly used as bird feed but now human consumption is also gaining pace. Studies have

shown that small millets are rich in micro and macro-nutrients and are used in low glycaemic index food preparation (Muthamilarasan and Prasad, 2021).

5.0 Challenges ahead

It has been discussed that millets are the nutricereals and are climate resilient hence serve as a potential solution for combating climate change and food security issues. But there are certain gaps that need to be addressed. For example, the yield of millets is comparatively low and hence, introduction of high yielding varieties needs to take place (Grovermann, 2018). The minimum support price is not announced for millets and these are sold at low prices i.e., low income is generated. When it comes to the pearl millets efforts need to be taken for extended shelf life of the flour (Nantanga et al., 2008). And, also it is to be taken care that when processed food items are prepared from millets, the amount of sugar and oil used does not surpass the millet content and hence reduce the nutritional value of the food item.

6.0 Conclusion

Millets have been cultivated since a long time in India. Their nutritional quality and climate resilience can be exploited to address the food security and negative impacts of climate change on food production. The opportunity of International Year of Millets can be harnessed for promotion and improvement of status of millets in India. As a decline in production has been observed over the years, it can be boosted through careful policy intervention. What is most important is to ensure market linkage and reach the consumer basket.

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