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Government Support for Millets in India: The Need to Integrate Permaculture Principles

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Abstract:
With the world experiencing an agrarian crisis, the need was felt to have agrifood systems that would be more efficient at combating rising hunger, poverty and malnutrition. The search is on to find substitute crops. The government of India began to actively further millets as the 'future crop', declaring 2018 as the Millets Year, followed by the United Nations (UN) declaring 2023 as the International Millets Year. This study attempts a holistic understanding of millets as a substitute crop by discussing its characteristics, historical background and the various governmental interventions undertaken in order to promote it. It suggests that though the governmental interventions have gone a long way in increasing millet production they have not been able to ensure its consumption at the mass level and have not been able to establish it as a substitute staple crop either. True, to a great extent its lack of consumption is due to the support schemes' emphasis on the supply side of the chain but to establish it as a sustainable substitute crop requires a permaculture approach and focus on consumer research which are missing. The current approach to millet production is still a modern industrial agriculture one with known harmful consequences. Only a permaculture approach which represents a total way of life integrating agriculture, livestock, people, cultures and the environment into one ecosystem would perhaps reinstate millets as that future staple realizing the sustainable development goals (SDGs) of 'Zero Hunger', 'Good health and well being', 'Responsible consumption and production' and 'Climate action'.

Keywords: *Millets, Government Initiatives, Permaculture, Sustainable Development*

1. Introduction

The world is going through an agrarian crisis. The Food and Agriculture Organization (FAO) background paper 2023 stated that since the world is facing rising hunger, malnutrition, climate crisis, and an acute depletion of natural resources, our global agri-food systems should become more efficient to withstand shocks, in handling poverty and should adopt approaches that prioritize farmers and the needs of the local communities. In addition, this agrifood system should also be more resilient to climate change, should work towards the conservation of natural resources and must also support dryland zones where the majority of vulnerable populations reside. Recognizing this kind of situation demanding attention the world-over search is now on to find sustainable crop substitutes (Jadhav and Londhe 2023). However, missing from these initiatives is the discussion of a permaculture approach. This study attempts to understand the viability of millets as the new permaculture staple. Broadly speaking the term '**permaculture'** refers to a total system that strives to attain agricultural sustainability by consciously designing the agricultural ecosphere in such a manner that it is a diverse, stable and resilient as natural ecosystems (Leahy 2021). It believes that only sustainable agriculture governed by an ethics of care can lead to the establishment of a sustainable society. Though this approach to agriculture founded by Mollison and Holmgren has been in practice since 1978 in certain parts of the globe, it has gained currency recently owing to the current food crisis. Since permaculture emphasizes a kind of lifestyle change in the ways in which we organize, produce and consume food by thinking of substitute crops, millets present an opportunity. This is so because millets have good nutritional values, established health

benefits, are sustainable in low-input agriculture and are amenable to organic cultivation (Bhat et al 2018). Research on millets showed that they were the earliest crops to be cultivated by Asia and Africa. Most varieties of millet are also native to India. They are indigenous crops and constitute an important component of traditional culinary cultures of many countries and yet they somehow seem to have been forgotten as important crops providing food security.

The government of India understanding the significance of millets as an eco-friendly and hardy future crop requiring low inputs and having the potential to contribute towards the food and nutritional security of the country observed the year 2018 in honour of the millets. Soon after, based on the government of India's recommendations, the United Nations announced the year 2023 to the cause of the millets. The idea was to revive millets as the forgotten crop with characteristics that make it a 'smart crop'. It is smart because it is good for the consumer with huge health and other nutritional benefits, for the planet as it is a resilient crop with low maintenance requiring little water and for the farmers as it is a high-yielding crop with multiple uses as food, fodder and fuel. Given this kind of context, this study attempts to understand the viability of millets as a permaculture staple. In specific, it looks at different governmental interventions to reinstate it as a substitute staple and their consequences. In the first section, the study provides an overview of millets discussing their historical background, types, and regions that produce them in India highlighting its relevance. The second section reflects upon different governmental policies that have been undertaken in order to boost millet production and consumption both at the central and state governmental levels. The third section attempts a critical discussion on how best we can inform policies to reinstall millets as the future permaculture staple. In so doing, the study hopes to contribute to the realization of the UN 2030 sustainable development goals (SDGs), in specific SDG 2 (Zero Hunger), SDG 3 (Good health and well-being), SDG 12 (Responsible consumption and production) and SDG 13 (Climate action).

1. Historical Background and Types of Millets

Popularly known as nutri-cereals, millets are groups of small-grained rain-fed cereal food crops. They are nutritious and are the major staples of people living in the desiccated parts of the world. Due to their resilience, during times of famine, millets are grown as the last option left for farmers because of their assured yields. As they have shorter growing seasons and can be grown in rotation with other crops, they promote diversified cropping systems. Since most millets are rich in proteins, carbohydrates, vitamins, antioxidants, dietary fibre and minerals, they are considered to be nutritious and healthy. Scientific evidence demonstrates that because of a low blood sugar index, millets are good cereals for diabetic patients. Rich in dietary fibre, they also prevent constipation and other bowel disorders. Broadly speaking, millets are of two types: major and minor. While Sorgum (Jowar) and Pearl millets (Bajra) are major millets, little millet (Kutki), Kodo millet, Finger millets (Ragi/Mandua), Foxtail millet (Kangni/Italian millet), Proso millet (Cheena) and Barnyard millet (Sawan/Jhangora) are minor millets. Tef, Fonio, Quinoa are also varieties of minor millets grown in other parts of the globe. In India, the 'Kharif' seasons of May and June are dedicated to millet cultivation and the 'Rabi' seasons of October and March and from January to April for harvesting. Table 1 is a description of the types of millets grown in the world along with their common names, areas of production and energy value/Kcal.

Table 1: Millet Production and Energy

Millet	Common Names	Energy Value / Kcal)#	Areas of Production
Sorgum	Egyptian millet, Jowar, Guinea corn, Shallu, Solam, Kafir corn etc	334	Nigeria, India, Sudan, Ethiopia, USA, Mexico, Argentina, China
Pearl Millet	Bajra, Munga, Sanyo, Cattail, Seno, Candlestick etc	347	India, Eastern and Southern Africa, Western and Central Africa
Little Millet	Blue Panic, Heen Menen	346	India

Kodo Millet	Varagu, Ditch, Naraka, Water Couch, Amu	331	India
Finger Millet	Ragi, Hunsa, Koracan, African bird's foot, Telebun etc	320	Ethiopia, Nepal, India, Uganda, Sri Lanka, Rwanda, Burundi
Foxtail Millet	Italian, German, Navane, Kangani, Siberian, etc	331	India, Myanmar, Eastern Europe, China.
Proso Millet	Russian, Panivarigu, Panic, broom, Hog, Mahameneri etc	341	Russia, South Korea, Kazakhstan, Poland, Iran, USA, India.
Barnyard Millet	Sawan, Japanese, Korean, Sanwa	307	Japan, China, Malaysia, India.

Historically speaking, millets have been one of the first crops known to humankind and were perhaps grown in the 'hoe age'. According to Bhat et. al (2018), while Proso and Foxtail millets seem to have originated in China around 8000 BC, Barnyard millet in Japan, Sorgum seems to have been domesticated first in Ethiopia and sub-Saharan Africa some 5000 years ago. However, the secondary centre of origin of Sorghum is attributed to the Indian subcontinent dating back to some 4000 years. It is rich in copper, magnesium and phosphorus and is a source of thiamin, niacin, vitamin B6, iron and zinc (FAO 2023). Pearl millet owes its origin to West Africa. It is mineral rich and is a source of thiamin and vitamin B6. Finger millet owes its origin to Sudan. India happens to be its largest producer today. Like the other millets described above, finger millet is also nutritious and is abundant in thiamin, copper, magnesium, iron, phosphorus and selenium. Little, Kodo and Brown top millets are native to India. Most of these millets travelled from their places of origin to other parts of the globe through trade routes and were domesticated subsequently. Figures 1 and 2 are a representation of the nutritional values of millet in comparison to rice and wheat.

Figure 1: A Comparison of Nutritional Composition of Different Cereals. (Values in 100 g with 12% moisture)

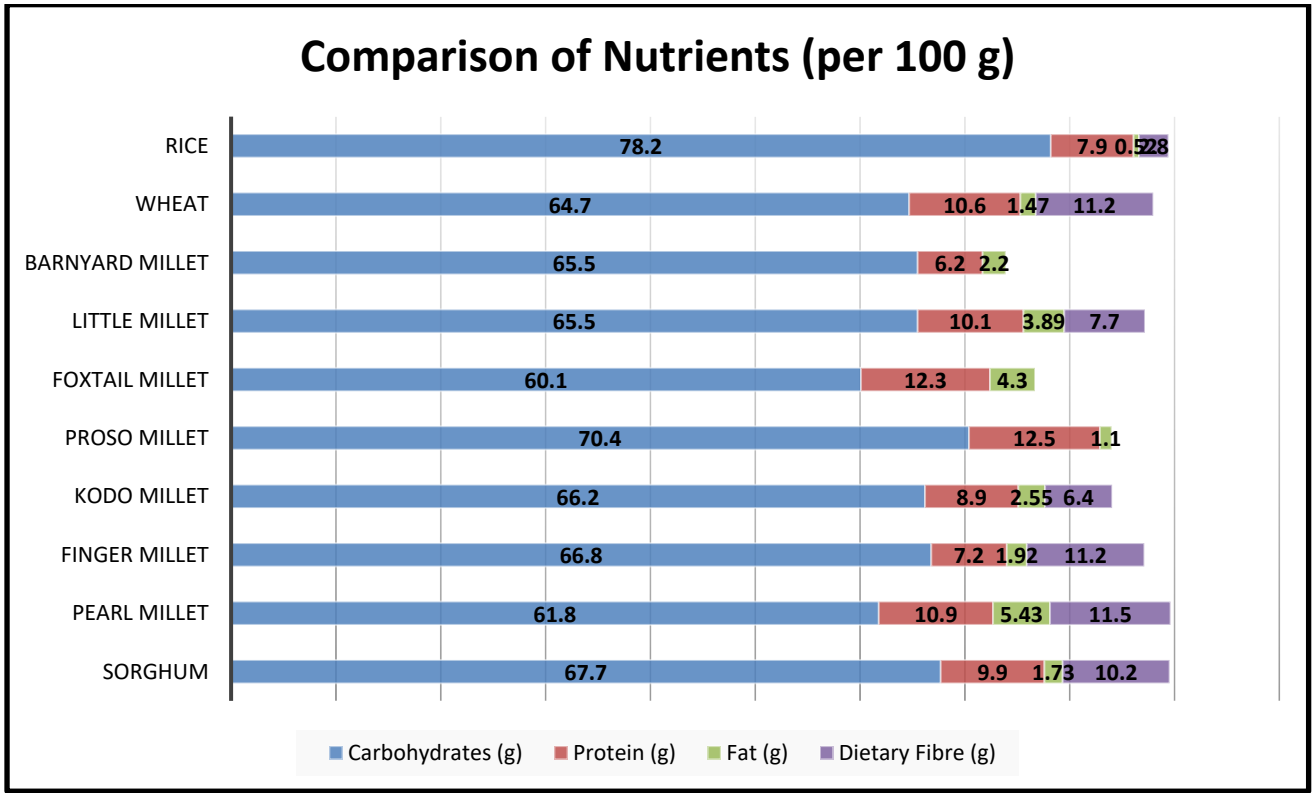
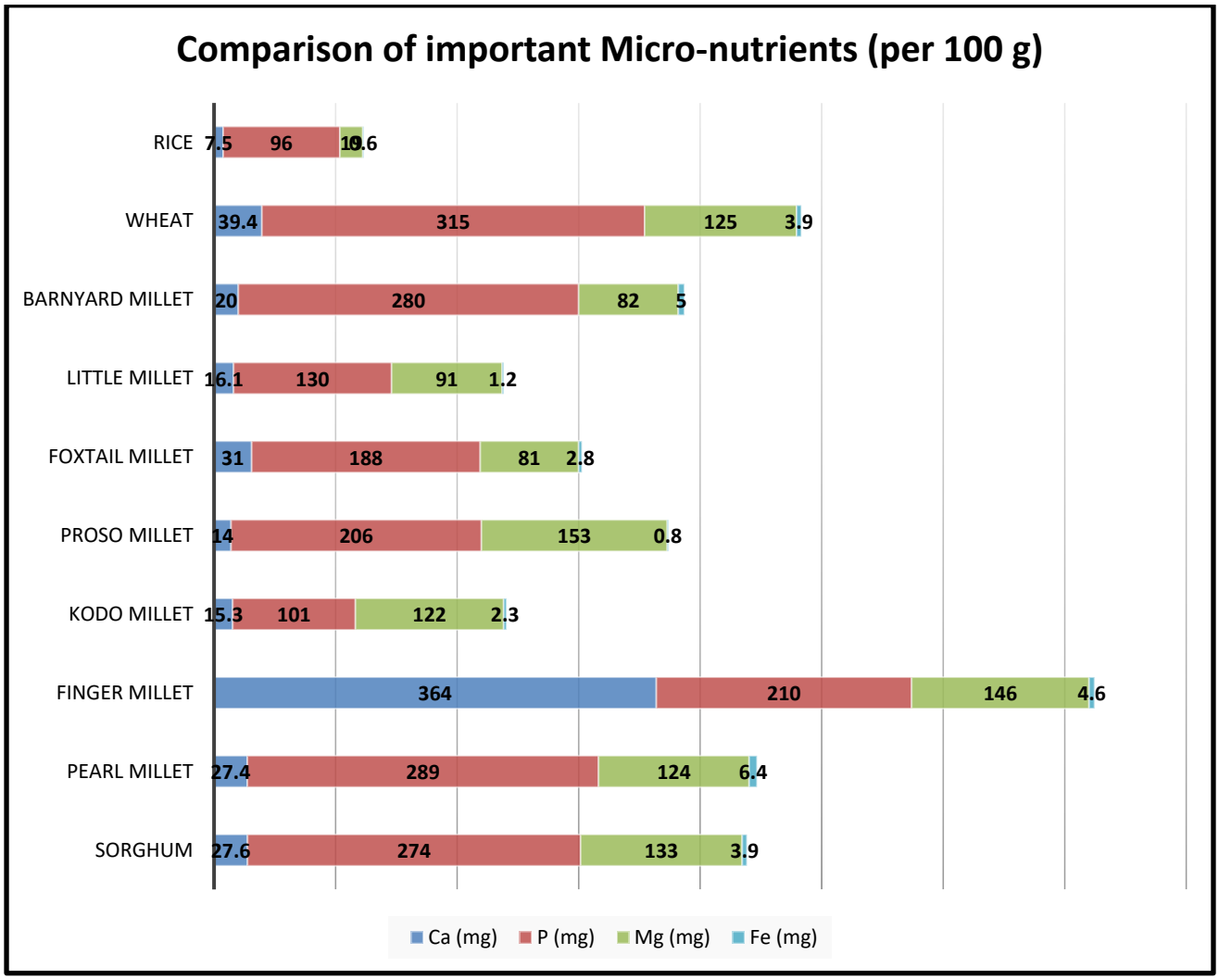


Figure 2: A comparison of important Micro-nutrient composition of different cereals (Values in 100 g with 12% moisture)



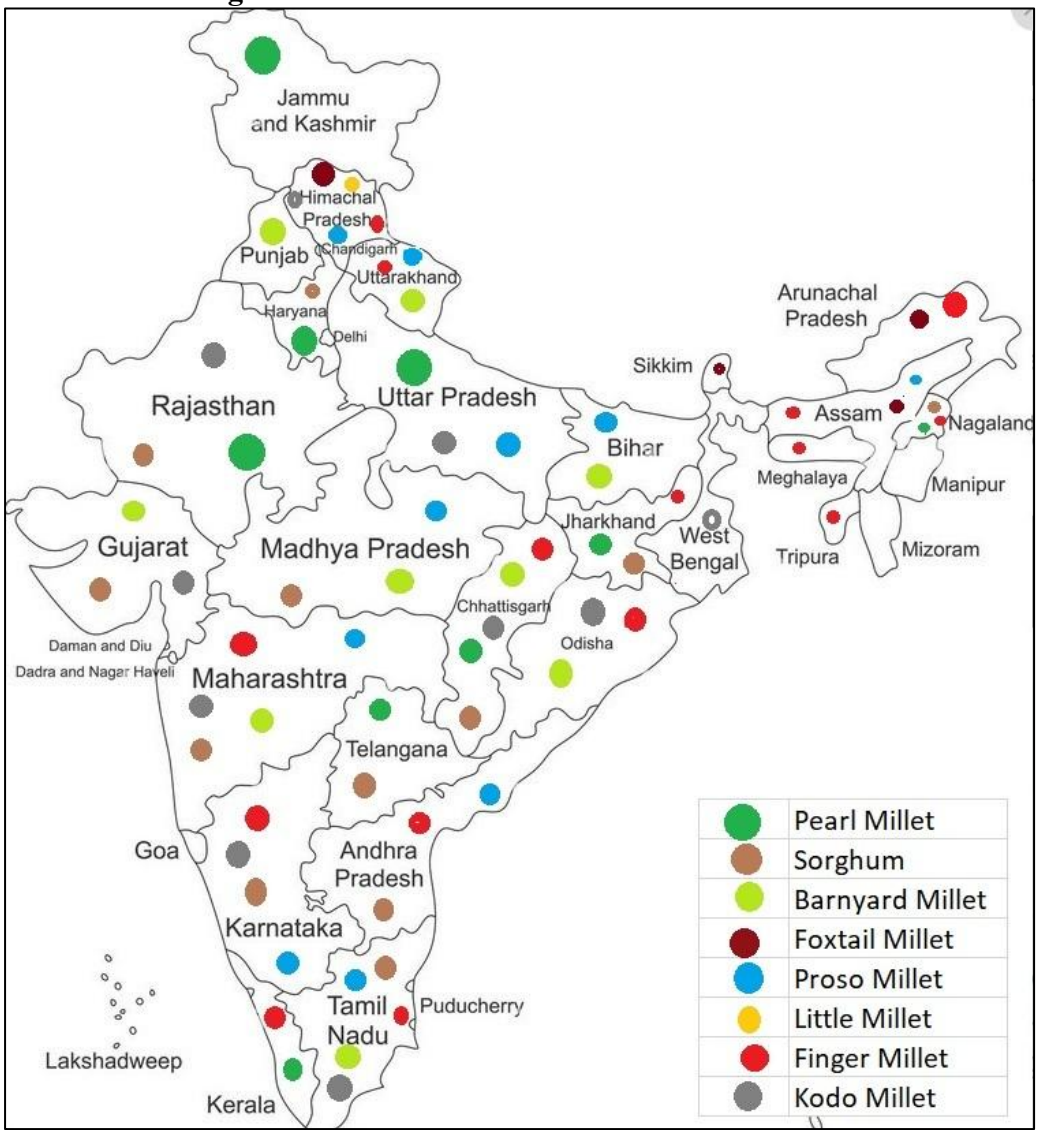
#Source for Figures 1 and 2; Table 1: Graphs based upon data from Indian Food Composition Tables, Indian Food Composition Tables. National Institute of Nutrition. (Indian Council of Medical Research 2017.

Sanskrit texts such as the Yajurveda mention the consumption of Proso, Foxtail and Barnyard millets during the Bronze Age dating back to 1500 BC. According to Ankita and Seth (2025), during the first to third century AD, Sorgum was used over rice in the Indian subcontinent. Sorgum finds mention in the 'Charaka Samhita' (100-200 AD), while Kodo, Foxtail, and Barnyard millets have been included in the Vishnu Purana (450 AD). Millet cultivation was also recorded during the Mughal period in Abul Fazl's Ain-i-Akbari and Jahangir's autobiography referring to millets as a significant component of the Indian diet during the 16th and 17th century AD. However, in the colonial period owing to different agricultural practices and preferences of the European colonizers, millets were relegated as insignificant crops. With time as irrigation systems evolved and the techniques of growing rice and wheat got perfected, millets began to lose their significance as staples (Chera 2017). Soon they began to be referred to as 'the poor man's crop' or 'the famine crop' etc. Gradually they began to disappear from the diet baskets and from being a staple they got reduced to the status of supplemental foods confined to a minority.

However, with the current food crisis affecting the world and with both the government of India dedicating 2018 and the United Nations declaring 2023 to the cause of millets, efforts are on to revive millets as a substitute sustainable crop. In India today, Sorgum is widely grown in Maharashtra, Karnataka and certain areas of the northeastern states. It is regarded as the world's fifth major cereal food crop. On average it grows to a height of around 2-8 feet. It is of three types: Grain sorgum (for

consumption), Forage sorgum (for pasture and hay) and Sweet sorgum (for syrups and biofuel). Pearl millet is grown in states like Rajasthan, Maharashtra, Haryana, Gujarat and Uttar Pradesh. It is the most widely cultivated grain in India after rice and wheat. It is a tall plant and grows to a height of around 6-15 feet. Southern India mostly cultivates finger millet with Karnataka as the major producer. These are dwarf-like plants and reach a height of around 30-150 cm. Barnyard millet is extensively grown in the hilly tracts of Uttarakhand. It is cultivated in marginal lands found unsuitable for rice cultivation. Little millet was grown in the Eastern Ghats of India and was an important part of the diet of the indigenous people residing there. In addition to other nutrients, little millet is a source of nutraceutical components such as phenols, tannins and phytates (DMI 2023). Kodo millet is grown throughout India. It is a hardy, drought-resistant plant grown in poor soils requiring very little care. This is also a source of protein and other minerals. A high amount of lecithin present in them supports the nourishment of the nervous system. Figure 3 is a map showing state state-wise production of millets in India and Table 2 gives us a description of the state-wise production of the same.

Figure 3: State-wise Millet Production in India



(Source: Picture based on Ministry of Agriculture & Farmers Welfare 2023b. Embracing Millets: The Key to Enhancing Food Security and Nutrition. Millets and Other Ancient Grains International Research Initiative.)

Topping the list in millet cultivation are the states of Rajasthan, Karnataka, Maharashtra, Uttar Pradesh, Uttarakhand, Madhya Pradesh and Haryana. Madhya Pradesh leads in terms of space used for cultivation and yield of small millets and contributes 20% to the total output. Uttarakhand (19%), Karnataka (10.1%) and Tamil Nadu (10.07%) follow soon after (Lokesh et al 2022). Though India has been among the top

10 millet-producing countries in the world, with a millet market production share of 36.08 %, the area under millet cultivation has been declining steadily. Gowri and Shivakumar (2020) contend that there has been a declining trend in the space dedicated to millet cultivation in India from (1950-1955 to 2015-2019). The decline in terms of crop growth rate (CGR) of 16.21 per cent. According to the Department of Agriculture and Farmer's Welfare (DA and FW), 'International Year of Millets' Conference 2022, the area under millet production has decreased by 56%, while productivity has increased due to the adoption of high-yielding varieties/hybrids. Figures 4, 5, 6 and 7 are a description of the mean area, production and yield of millets in India. The cause for concern is the fact that until 1965-70 millets comprised 20% of the total food grain basket but now occupy only 6%. Though being an indigenous, culturally significant and highly nutritious crop, millets somehow have lost their significance in comparison to rice and wheat after the Green Revolution. Scholars contend that this is because of a lack of equal emphasis to the demand and supply side. Negative perceptions of millet as the 'poor man's food', policy neglect, consumption of other cereals, and its slightly bitter taste are factors that influence its consumption on the demand side. Non-availability of the same in markets, and restaurants, limited productivity and non-recognition of its potential to yield additional income are factors at the supply side that undermine millets as the substitute crop.

Figure 4*: Impact of Green Revolution on Millets Area Harvested, Production and Yield

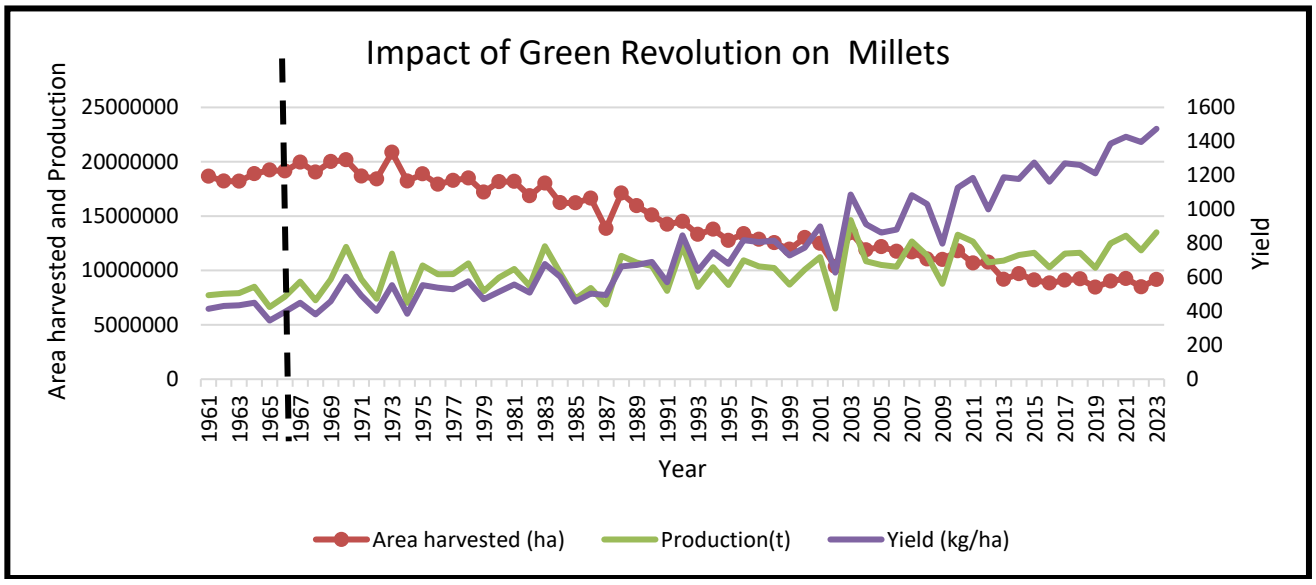


Figure 5*: Green Revolution and Area Harvested: Comparison of Wheat, Rice and Millets

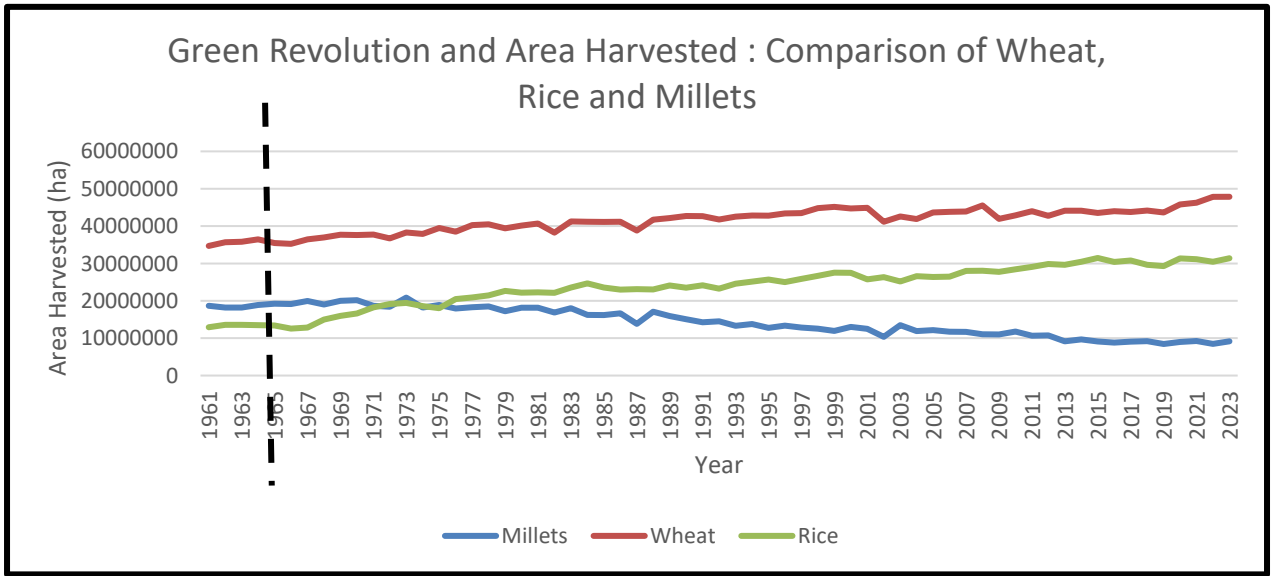


Figure 6*: Green Revolution and Production: Comparison of Wheat, Rice and Millets

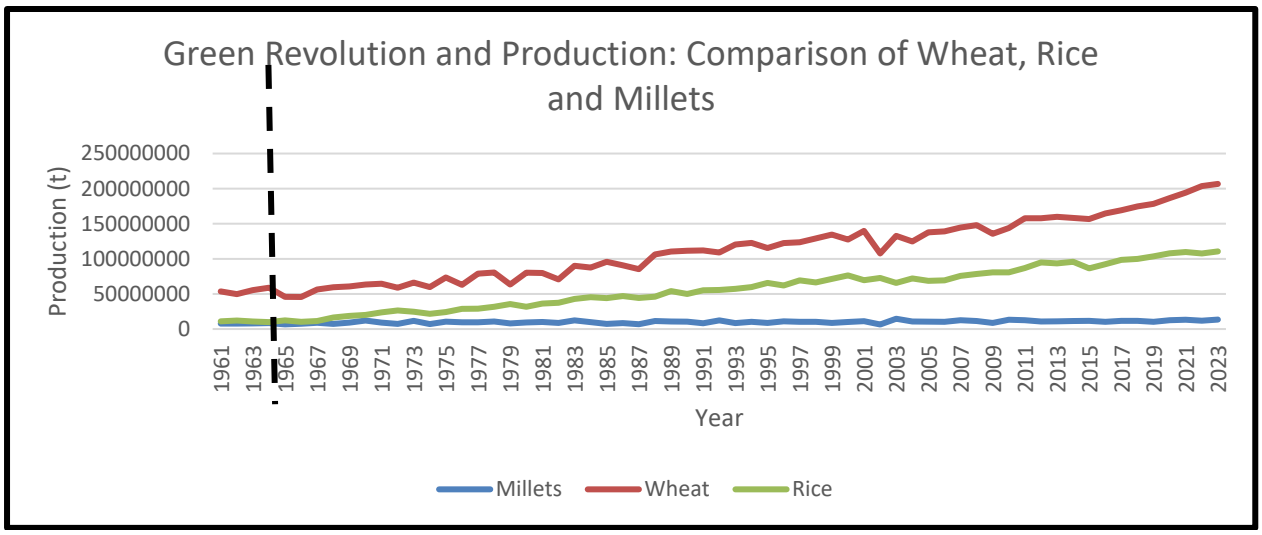
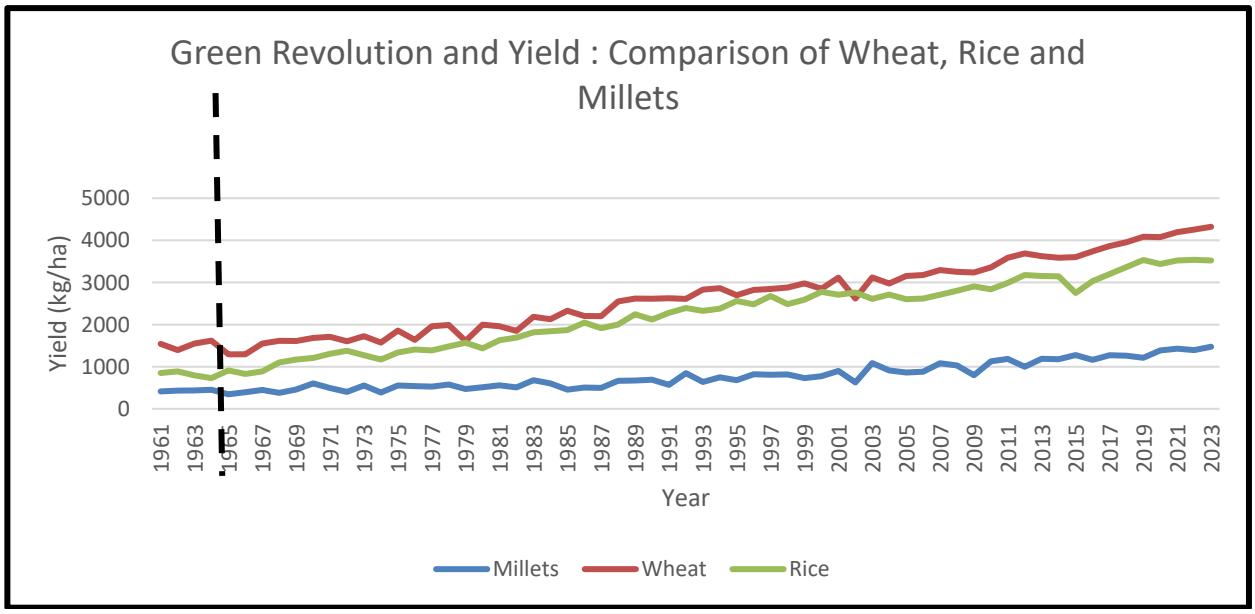


Figure 7*: Green Revolution and Yield: Comparison of Wheat, Rice and Millets



*(*Source: Based on Statistics obtained from Food and Agricultural Organisation of United Nations (FAO) https://www.fao.org/faostat/en/#data Accessed on 14-4-2025)*

Table 2: State/UT-wise Production of Millets (in 000's tonnes) for 2022-23

State/ UT	Bajra	Ragi	Jowar	Small Millets	Total Millets
Uttar Pradesh	2,045.52	-	315.41	7.64	2,368.57
Gujarat	1,293.68	8.3	46.12	15.99	1,364.09
Rajasthan	5,105.02*	-	567.18	1.41	5,673.61
Haryana	1,199.85	-	14.12	-	1,213.97
Madhya Pradesh	943.44	-	169.46	140.65*	1,253.55
Maharashtra	467.93	91.03	1,312.25*	27.37	1,898.58
Karnataka	177.4	1,148.17*	681.68	25.35	2,032.60
Tamil Nadu	113.38	206.5	292.81	17.52	630.21
Andhra Pradesh	50.68	32	283.78	9.46	375.92
Telangana	11.81	-	119.54	1.05	132.4

Jammu and Kashmir	10.32	0.12	-	0.17	10.61
Delhi	4.65	-	3	-	7.65
Bihar	2.68	2.36	0.98	1.16	7.18
Nagaland	2.21	0.37	0.3	11.12	14
Odisha	1.14	37.4	5.58	32.22	76.34
Dadra and Nagar Haveli	0.75	1.4	-	-	2.15
Punjab	0.41	-	-	-	0.41
Himachal Pradesh	0.26	0.98	-	1.1	2.34
Jharkhand	0.14	12.72	0.76	-	13.62
Puducherry	0.07	0.17	0.01	-	0.25
Chhattisgarh	0.05	0.86	1.1	21.53	23.54
West Bengal	0.03	5.78	0.09	0.28	6.18
Kerala	0.01	0.21	-	0.05	0.27
Arunachal Pradesh	-	28.45	-	-	28.45
Assam	-	-	-	4.79	4.79
Meghalaya	-	-	-	2.83	2.83
Sikkim	-	0.3	-	-	0.3
Tripura	-	-	-	1.04	1.04
Uttarakhand	-	114.23	-	61.54	175.77
All India	11,431.42	1,691.37	3,814.18	384.26	17,321.23

Source:PIB https://static.pib.gov.in/WriteReadData/specificdocs/documents/2023/dec/doc2023125278801.pdf
*Largest producer

2. Central and State level Policy Initiatives for promotion of millets

Recognizing the significance of millets as a sustainable crop, the government of India has undertaken numerous steps both at the central as well as at the state levels to reinstate millets. More so, because globally the search is on for substitute crops that are not only healthy, nutritious and resilient but also that connect the local communities and culture to the food that they produce and consume. Since millets have occupied a prominent place in the historical journey of India, the government of India began to pursue the cause of the millets aggressively by declaring 2018 as the year of the millets and on its recommendations, the UN declared 2023 as the international year of the millets.

2.1 Central Government Initiatives

Some of the important initiatives/schemes at the central government level are as follows:

Integrated Nutritional Security through Intensive Millet Promotion (INSIMP) 2012 was a central government initiative to improve nutritional security by intensifying millet production and consumption. It began as a part of the 'Rashtriya Krishi Vikas Yojana' (RKVY) and later merged with the 'National Food Security Mission' (NFSM). By the use of improved technologies such as crop-based cluster demonstrations, distribution of quality seeds, and improved post-harvest technologies the objective of the INSIMP 2012 was to increase the nutritional intake of people of the Marathwada region through millet consumption (NITI Aayog Report 2023).

National Food Security Act (NFSA) 2013 provides for subsidized food grains under the 'Targeted Public Distribution System' (TPDS) by including millets then referred to as coarse cereals. In so doing it intended to provide nutritious support through the introduction of millets to the vulnerable populations including women and children.

National Nutrition Strategy (NNS) 2017 announced by the NITI Aayog in 2017, aimed at reducing malnutrition across the country among the critical groups with the introduction of coarse cereals such as millets. It recommended that the Ministry of Agriculture and Farmers' Welfare should work towards crop diversification and cereal productivity by including millets.

National Year of Millets 2018 declared millets as nutri-cereals. The National Food Security Mission (NFSM) by the Department of Agriculture and Farmers Welfare carried out a sub-mission on millets with an initial budget of INR 300 for 2018-19. Its objective was to increase millet production, area and productivity in 212 districts spanning over 14 states. Millets like Sorgum, Pearl, Finger, Foxtail, Proso, Kodo, Barnyard, Kutki and pseudo millets (Buck-wheat and Ameranthus) were categorized as Nutri-cereals. The aim was to enhance the nutri-cereals system by not only improving the seed supply mechanism but also improving price realization for farmers through better market linkages. In the year 2018, On the Government of India's recommendations, the United Nations declared 2023 as the 'International Year of the Millets' (NITI Aayog Report 2023).

Production Linked Incentive (PLI) scheme on millet 2021 approved by the Government of India was an initiative linked to the food processing industry. Having an initial outlay of INR 10,900 crores its main objective is to encourage the manufacturing of millet-based 'ready-to-eat' and 'ready-to-cook' food products to be sold in the global market. This scheme to be realized over a period of seven years from 2021-2027, this scheme provides support to start-ups and entrepreneurs for innovative recipes and value-added products that would make millet consumption an attractive proposition (Ministry of Agriculture and Family Welfare 2023a). In addition, in the year 2021, the Government of India revised its rules for acquiring, granting, disseminating and disposing of millets. Millets have been an integral part of the public distribution system (PDS). To facilitate the smooth transportation of millets to the consuming state, the Food Corporation of India (FCI) introduced inter-state conveyance of surplus millets.

POSHAN mission 2.0 by the Ministry of Women and Child Development 2023 focused on diet diversity, food fortification, and the popularizing of millets. It made it mandatory to include millets in the 'Take Home Ration' and hot cooked meals in its 'Aanganwadi service platforms'. Targeting malnutrition in children, adolescent girls, and pregnant and lactating women, the mission's objective is to challenge malnutrition by adopting alternative nutrition content and delivery. Rich in several nutrients, millets were seen as a viable alternative. Under this mission, several states and UTs were selected for the PM's award for excellence in the promotion of millets (PIB, GoI, Ministry of Women and Child Development, 22.3.2023).

Launching of the Seven Sutras 2023: The GoI prepared several committees, a position paper and six task forces for the 'International Year of Millets 2023'. It launched 'Seven Sutras: Themes' delegating specific ministries and departments as in-charges of the themes (Ministry of Agriculture & Farmers Welfare (2023a). For instance, for the theme 'Enhancement of Production/Productivity', the Departments of Agriculture and Family Welfare (DA and FW) and the Department of Agriculture Research and Education (DARE) were the in-charges; for 'Nutrition and Health benefits', the ministry of health and the food safety and standards authority of India (FSSAI) was the in-charges; for 'Value-addition, Processing and Recipe Development': the ministry of food processing industries (MOFPI) and Tourism; for 'Entrepreneurship/Start-up/Collective Development': Commerce and DA and FW; for 'Awareness creation-Branding, Labelling and Promotion': ALL; for 'International Outreach': Commerce and the Ministry of external affairs (MEA); and for 'Policy interventions for mainstreaming': Department of food and public distribution (PD) and DA and FW were the in-charges. Under each of these themes, several conferences, research work, promotion campaigns, distribution strategies etc were undertaken. The states were also instructed to adopt specific measures for the promotion of millets (Ministry of Agriculture and Farmers Welfare, 2023c). In addition, the Indian Council of Agricultural Research (ICAR) released one variety of Quinoa (Him Shakti), supported 200 start-ups with a turnover of around INR 320 crores through the Indian Institute of Millets Research (IIMR) Hyderabad, 67 value-added technologies

advanced by the centres of excellence and released 13 high yielding varieties of millets (Ministry of Agriculture and Farmers Welfare, 2023c).

2.2 State Level Interventions

Millets Cultivation in North Coastal Andhra and parts of Rayalaseema, Andhra Pradesh (AP):
This was a state of Andhra Pradesh initiative of 'Comprehensive Revival of Millets Cultivation by tribal people in North Coastal Andhra and parts of Rayalaseema' in 2016. The project aimed at increasing productivity, household consumption, and value addition by making millet-based food products such as Idlis, Dosas, Ragi biscuits etc. Its main components were the promotion of decentralized processing enterprises, increasing productivity, building linkages with the market federations, establishing farmers organizations and developing efficient hiring centres for agricultural implements. Due to this, millet production for the state registered an increase of 2.35 lakh quintals followed by an increase in household millet consumption. The ripple effect of the surplus was visible in the PDS, mid-day meal inclusion, etc (ASSOCHAM 2022; NITI Aayog 2023).

Chhattisgarh Millet Mission 2021: The mission's theme is 'Cultivation to Consumption' indicating that its approach to the issue is multipronged starting from cultivation to consumption. It emphasized the cultivation of Kodo millet, Little millet and Finger millet. It had an initial funding of INR 170 crores and an input grant of INR 9000 per hectare. The mission along with aiming to increase the average millet consumption per person also targets to increase the cropland from 69,000 hectares to 1,88,400 hectares and the output from 0.45 MT/hectare to around 1MT/hectare (NITI Aayog 2023; Verma and Verma 2023; Babu et al 2024).

Bhavantar BharpayeeYojana (BBP), Haryana: It is an innovative scheme that is pro-farmers with the introduction of a set-prices that protects the farmers during periods when there is a significant drop in prices of crops. Aiming to diversify agricultural production, the Haryana government included Pearl Millet (Bajra) in the BBP. According to this scheme, if the private players end up paying less, the Government will compensate farmers for the price gap by reimbursing up to Rs 600 per quintal on average of the yield. The price difference that is the average market price and the Minimum Support Price (MSP) of pearl millet is the 'Bhavantar' price. The BBP helped the subsistence and smallholder farmers of the state who mostly happened to be millet growers. According to the NITI Aayog Report 2023, this also encouraged farmers to increase the land for growing millets.

Promotion of Kodo and LittleMillets in Madhya Pradesh: Owing to the prominence of rice and wheat in the PDS, millet cultivation has reduced among the Gonds in the Mandla district of Madhya Pradesh who have been growing it for generations. The absence of modern millet processing machines also contributed to the same. In order to revive millet production, the government in association with the philanthropic organization 'Action for Social Advancement' (ASA) targeted 30-40 for millet promotion. These groups were provided with modern de-hulling machines. An important component of this mission has been the empowerment of women. About 3700 women of the tribal districts of Mandla and Dindori are now involved in the production of minor millets. An MoU has been signed between the women and child development department and the women farmers to supply' kodu barfi' for 5000 children at 226 Anganwadi centres (NITI Aayog Report 2023).

Odisha Millets Mission (OMM): The mission worked towards the promotion of Ragi as a staple crop emphasizing the promotion of household-level consumption, improvement of productivity, marketing, agronomic practices. Through the Integrated Child Development Services (ICDS), Mid-day Meals (MDM) and PDS it made the incorporation of millets mandatory. The mission currently targets 142 blocks with 54495.83 hectares of land under millet cultivation. The OMM addresses both the demand and supply side of millet use involving various stakeholders at different levels. Owing to the mission, the farm revenue per household went up and the gross value of produce per farmer household increased. Around 50 lakh beneficiaries in 14 districts benefitted from Ragi distribution under the PDS. Odisha won

the 'Poshak Anaj Awards' and was declared as the 'Best Millet Promoting State.' In addition, the OMM collaborates with the Self-Help Group (SHG) Mission Shakti, a flagship program of the government of Odisha aimed at empowering women. Under this collaboration, efforts are made to develop innovative recipes along with the training of SHG women to bring back millet into the mainstream food basket (Garg et al 2022; Bandyopadhyay & Patnaik 2023; NITI Aayog Report 2023).

Tamil Nadu Millets Mission: The objective of the Tamil Nadu millets mission was to retain the farmers dedicated to millet cultivation by equipping them with new technological inputs and by providing adequate market linkages so that they could produce a market surplus. In order to achieve this objective, the farmers were given 11,500 kits having bio-fertilizer fungicides etc at a subsidized rate of INR 3000/hectare for major millets and INR 2000/hectare for minor millets (NITI Aayog Report 2023). Training was imparted to farmers on farming methods to augment millet cultivation. As a consequence, both arable land for millet cultivation and yield have tripled in Tamil Nadu during 2015-2020. Millet awareness programs have not only led to an increase in consumer demand for millet-based food but also have resulted in increased income for the farmers.

Uttarakhand Millets Production and Certification: The state targeted to increase the productivity of Finger millet and Barnyard millet besides the establishment of advanced facilities for primary and secondary processing of multi-grains. Though the state being a hilly region has been growing millets as their traditional crops, they had failed to reach their mainstream markets. The objective of the mission was to develop a supply chain that would provide infrastructural support, and market linkages, eliminate barriers and at the same time ensure a fair price for the farmers. Under the initiative during 2021, a total of 131.2 MT of both Finger and Barnyard millets were procured highlighting the success of the project (NITI Aayog Report 2023).

Apart from these state-specific millet-based projects, the inclusion of millets in ICDS played a crucial role in ensuring millet consumption in states/UT like Chandigarh, Chhatisgarh, Madhya Pradesh, Odisha, Tamil Nadu, and Telangana.

2.3 Research-Based Interventions

Since independence, the Indian Council for Agricultural Research (ICAR) along with other state universities and ICAR research institutes has been involved in research work on millets. Finger millet breeder CH Lakshmanaiah is credited for having developed the 'Indaf' varieties by crossing Indian varieties with African ecotypes in the year 1964. The project for intensification of regional research on cotton, oilseed and millets (PIRRCOM) in 1956 led to the establishment of 17 different centres spread out in different parts of the country some of which were solely dedicated to Sorgum and Pearl millets research (Bhat et al 2018). In 1987, the National Research Centre for Sorgum (NRCS) and the All India Coordinated Sorgum Improvement Project (AICSIP) were integrated. In 2009, the NRCS was renamed the Directorate of Sorgum Research which finally culminated in the formation of the Indian Institute of Millets Research (IIMR) in 2015. Dr NGP Rao is credited for having developed the first Sorgum hybrid in India. Similarly, the launch of the 'All India Coordinated Pearl Millet Improvement Project'(AICPMIP) and the 'All India Coordinated Small Millets Improvement Project' (AICSMIP) contributed significantly to research work on smaller millets.

More recently, the ICAR-IIMR carried out a case study on Sorgum in rice fallows of the Guntur district of coastal Andhra Pradesh from 2008-2011. Rice fallows are those areas that remain un-cropped during the winter season for several reasons. The ICAR-IIMR conducted field experiments in these areas to grow a hybrid variety of Sorgum developed by them. The results were by and large successful in establishing millets as a substitute crop during those seasons. Another notable initiative is the 'Nutrihub-Technology Business Incubator' (TBI) by the 'Department of Science and Technology' (DST), supported by the ICAR-IIMR, Hyderabad in 2016. Nutri-hub is the converging point where ideas, technology, funders, policymakers and all millet stakeholders involved meet for the creation of a knowledge-based

economy that translates agricultural technologies into attractive commercial propositions for one and all (NITI Aayog Report 2023). 'The 'International Crops Research Institute for the Semi-Arid Tropics' (ICRISAT) and ICAR-IIMR have been working towards the development of sweet sorgum as a source of ethanol since 2014. Supported by the national policy of bio-fuels, it intends to blend ethanol with petrol by the year 2025 to reduce pollution and import of petrol. The Indian Institute of Food Processing Technology (IIFPT), on the other hand is innovating with different millet-based products to increase millet consumption as well as with appropriate post-harvesting technologies (Ministry of Agriculture and Farmers Welfare 2023c). Under the South-South collaboration, several bio-fortified Sorgum and other millet varieties have been developed. ICRISAT was the first to develop a bio-fortified Pearl millet variety known as Dhanashakti in 2012, and Sorgum variety Parbhani Shakti in 2018. Bio-fortified varieties ensure that the produced food crops are also nutrient-rich in content. In order to assess the health and nutritional benefits of millets, scientific evidences were generated by systematic reviews and meta-analyses conducted by a team of seven organizations from four countries: India, the UK, Japan and Malawi. The studies established that millets have the potential to reduce diabetes and improve cholesterol among other health benefits (NITI Aayog Report 2023).To enhance the storage shelf life of Sorgum flour which normally has a very low shelf life of 5-15 days, the Central Food Technological Research Institute (CFTRI) developed a process means it could be stored for 6-8 months. Initiatives such as these make Sorgum market ready for consumption and export. Table 3 summarizes central-level, state level and research initiatives undertaken for millet cultivation, production and consumption to reinstate it as a staple.

Table 3: Central and State-Level Initiatives for Promoting Millets

Policy Interventions/Support Schemes	Primary Objectives	Notable Outcome
Central-Level Policy Interventions/Support Schemes		
1.Nutritional security through intensive millet promotion (INSIMP) 2012	To improve nutritional security by intensifying millet production and consumption of millets	•Support to 16 states •Increasedmillet productivity through technological support •New awareness initiatives and product development. •Increased yields in UP, Karnataka, Tamil Nadu and Uttarakhand •Increase in area harvested in Andhra Pradesh, Jharkhand, Maharashtra, Karnataka and Tamil Nadu. •Financial assistance to set up three National Centres of Excellence
2.National Food Security Act (NFSA) 2013	Included millets in TPDS	•Wider distribution and access to millet
3.National Nutrition Strategy (NNS) 2017	Reducing malnutrition across the country among critical groups like women and children with the introduction of coarse cereals such as millet	•Strategy recommendations to fight malnutrition and anaemia •Recommendations towards crop diversification and cereal productivity by including millet
4.National Year of Millets 2018	Declaration of millets as nutri-cereals and increase in the area, production and productivity of millets	•Millets recognized as Nutri-cereals •Increased focus on Millets at Central and state level •Awareness programs for farmers and consumers

		•Focus on biofortification of millets
5.Production Linked Incentive (PLI) scheme on millet 2021	Encourage the manufacturing of millet-based ready-to-eat and ready-to-cook food products Support to start-ups and entrepreneurs for innovative recipes and value-added products	•Outlayof Rs.800 Crore, for Millet-Based Products •30 applications (8 large entities and 22 SMEs) were approved in the category since 2021-22 (PIB Ministry of Food Processing Industries 24-3-2023) •Revised guidelines for procurement, allocation, distribution and disposal of millets. •Food Corporation of India (FCI) to facilitate transportation of millets.
6.POSHAN Mission 2.0 by the Ministry of Women and Child Development 2023	Focused on diet diversity, food fortification, and popularizing of millets. Aimed to counter malnutrition by adopting alternative nutrition contents and delivery.	•Introduces across all the 36 States/UTs with more than 9 crore beneficiaries •Mandatory inclusion of millets in the 'Take Home Ration' and hot cooked meals in its 'Aanganwadi service platforms'. •Several states and UTs were selected for the PM's award for excellence in the promotion of millet.
7.Launching of the Seven Sutras 2023	Delegating specific ministries and departments in charge of the themes	•Several conferences, research work, promotion campaigns, distribution strategies etc were undertaken. •The states were instructed to adopt specific measures for the promotion of millet. •Indian Institute of Millets Research (IIMR) Hyderabad supported 200 start-ups with a turnover of around INR 320 crores through, 67 value-added technologies advanced by the centres of excellence and released 13 high-yielding varieties of millets.
State-Level Policy Interventions/Support Schemes		
8.Comprehensive Revival of Millets Cultivation by tribal people in North Coastal Andhra and parts of Rayalaseema' in 2016.	Increasing productivity, household consumption and value addition by making millet-based food products	•Millet production increased to about 2.35 lakh quintals.
9.Chhatisgarh Millet Mission 2021	Emphasized on the cultivation of Kodo millet, Little millet and Finger millet	•Budget of Rs. 170 crore from 2021-2026. •An inducement of Rs. 9000 per hectare for farmers •Fixing of minimum support prices (MSP) of Rs 30/kg for Kodo and Little Millets and Rs 33.77/kg for Ragi. •Expected increase in yield and consumption
10.Bhavantar Bharpayee Yojana (BBP), Haryana	Introduction of a fixed protected prices scheme for farmers	•2.71 lakh farmers were registered under the scheme for bajra in 2021

11.Promotion of Kodo and Little Millets in Madhya Pradesh	To revive millet production	•Output and intake of millets have gone up in some tribal districts. •Empowered 5000 women
12.Odisha Millets Mission (OMM)	Promotion of household level consumption, improvement of productivity, marketing, agronomic practices of Millets	•Increase in MSP of millets. •More than 11 lakh farmers grow millets now through improved farming techniques. •Odisha received "Best Millet Promoting State" award in accordance with the "Poshak Anaj Awards" by ICAR-IIMRand FAO in 2021 •Millet Shakti Cafes served freshly cooked and bakery items made of millets to 4.4 lakh people in two years. •Ragi Laddu under the scheme covers 7066 Anganwadi centres
13.Tamil Nadu Millets Mission	Retain the farmers dedicated to millet cultivation by equipping them with new technological inputs and by providing adequate market linkages so that they could produce a market surplus.	•Yield and output for millet cultivation has tripled in Tamil Nadu in five years.
14.Uttarakhand Millets Production and Certification	To develop a supply chain that would provide infrastructural support, and market linkages, eliminate barriers and at the same time ensure a fair price for the farmers	•An area of 1.16 lakh hectares is dedicated to chemical-free farming and authentication of millets. •In 2021, 131.2 MT of both Finger and Barnyard millets were obtained

3. Millets as the New Substitute Crop and a Permaculture Staple

Despite several interventions, the majority of the world's population still consumes rice, maize and wheat. These three cereals account for 60 percent of caloric intake (Willett et al.,2021). Research shows that support schemes at the governmental level in India have gone a long way in increasing the output and yield no doubt, but consumption still remains low. A study by Sreedhar and Shaji (2017) on finger millets and oats contends that millet consumption remains low due to ignorance and there is a need to promote the same.

Most of the government initiatives work at the supply end of the supply chain. They target improving production, productivity and widening distribution. This exhibits a push distribution strategy which assumes demand and focuses on making the product in sufficient quantity and stocking it with the sellers. However, a true marketing approach is missing in these initiatives. The marketing approach focuses on customer needs. It involves creating a marketing mix that helps in satisfying these needs. Government and private organizations must engage in extensive marketing research to understand the reasons behind low demand for millet and millet-based products and design the mix to overcome the issues be it the product taste, pricing, accessibility or lack of information.

The factors affecting consumer choice of millet need to be examined to understand the positioning of millet and millet-based products. Should millets be promoted as an easily available and cheaper alternative to other food grains (as in the case of PDS) or should they be positioned as a sustainable health food and sold at a premium price or can different positioning be adopted for different market segments?

Who are the important influencers for the consumption decision process- family, doctors, social media or Government agencies? Further research on these issues is required to improve millet consumption. As the recent bibliometric study by Mathur and Priyadarshini (2025) demonstrated most of the research work done in the field is about increasing yield and productivity, how to further augment the nutritive value of millets, the sustainable aspect of millets and what kind of farming and agricultural techniques is to be adopted to enhance millet production. Very few studies elucidate the consumer's perspective on the issue. Consumer choices and preferences are often dictated by the categories that are caste, class, tribe, gender etc that they belong to in society. Governmental support schemes fail to consider these. Instead of having one uniform policy for all, the objective should be to target individual groups in different states. Based upon historical and socio-cultural aspects of these groups policies should then be affected to promote millet consumption.

True, in some states like Madhya Pradesh, gender-based initiatives were taken through the 'Tejaswini rural women empowerment program' in ICDS to empower women by providing them with loans to purchase equipment and an MoU was signed with the women farmers to provide 'Kodu Barfi' in the breakfast menu for children of Anganwadi centres, but these are not enough to reinstate them as staples. Similarly, in Odisha, there is an integrated approach by the Odisha Millets Mission (OMM) and Self-Help Group (SHG) Mission Shakti to innovate millet recipes and train women SHGs to promote millet consumption. According to the NITI Aayog Report 2023, more than 70 lakh women have been empowered through this scheme and several 'Millet Shakti' tiffin centres have also been planned. Most of these government initiatives target the supply side; successful adoption of millets by the masses is only possible through a two-pronged approach catering to issues related to both demand as well as supply. The government needs to create incentives for promoting research on these issues and then take steps to create a suitable marketing mix for millet and millet-based products. Such a mix will enable the implementation of a pull strategy where customer demand will drive production. For instance, Kodu Barfi, Ragi Laddu, and millet biscuits are good innovations and by ensuring their supply in the Mid-Day Meal (MDM) schemes the government is making them accessible but that is not enough to ensure their consumption at the mass level. Though under the OMM, tribal districts of Odisha are being targeted, these aim at promoting better agronomic practices, processing units, value addition etc. Millet Shakti tiffin centres and Millet Shakti cafes are functional in these districts too but they are in their initial phases. Studies need to be undertaken to understand the extent to which they have been successful or unsuccessful endeavours.

Again, the Tamil Nadu millets mission emphasizes imparting training to the farmers on the adoption of better agrarian practices and how to convert dry land agricultural lands into fertile ones for millet cultivation. Interventions such as these have no doubt increased the production area under millet cultivation and have also raised the socio-economic status of the millet-cultivating farmers but they do not consider the consumer's preferences. The Uttarakhand millets mission's primary objective is to increase the production of finger millets and MT Barnyard millets besides the establishment of grain blending and preparation plants for millets. It has worked out an extensive plan for the supply chain. But, very little has been done as regards the demand chain to ensure millet consumption. Under state-sponsored schemes such as the 'Mukhyamantri Suposhan Yojna' of Chhatisgarh, the take-home ration includes ready-to-eat food packets of Finger millets along with wheat, soybean, Bengal gram, sugar, ground nut etc but it is distributed only among children below six years, undernourished children, expecting and nursing women, and among adolescent girls in the aged between 11-14 years. The government hopes to reduce malnutrition and anaemia through these interventions. Again, these are very restrictive and may not influence consumer choices on a long-term basis.

Research and technology development to promote millets have been lopsided. Most of these have emphasized the development of better varieties, more resilient hybrid varieties, de-hulling machines, better processing units, bio-fortification, how to use them as alternative fuel sources etc. Very little research has been done on why despite such intervention's millet consumption is still low in comparison

to rice and wheat? There are many millet-based recipes, stalls and cafes that have come up but their presence is still negligible in comparison to other food items. Most research publications in reputed journals like Scopus in the past five years have been in the field of millets as a sustainable crop, their resilience to climate change and their great nutritive value. Moreover, these studies are also not uniformly spread-out all-over India which would have served to highlight the advantages, disadvantages and challenges associated with millet cultivation and consumption in different geographical locations (Mathur and Priyadarshini 2025). There are a few scattered studies on consumer behaviour and millets in urban settings but very few on how people belonging to different categories like caste, class and gender respond to millets. A survey of seven major cities by Kane-Potaka et. al (2021) demonstrated that most people consumed millet because of health reasons (28%), followed by people who were weight conscious (15%), and people who didn't consume it for its taste comprised (14%). The survey also revealed that people who didn't consume it for its taste didn't do so because it was not consumed at home (40%). Most restaurants/malls/hotels etc operating in the urban areas still do not have millets in their menu though incidences of diabetes in urban areas are high.

4. Conclusion

From the above analysis, it is apparent that there exists a disjuncture between policy, practice, the various stakeholders involved and the environment. Different initiatives undertaken have led to some positive consequences but they need to be integrated leading to the formation of a robust ecosystem. Given this kind of context, this study advances the use of a permaculture approach to successfully reinstall millets as a substitute staple. This is so because in addition to what agroecology suggests permaculture additionally includes a set of principles to design, implement and maintain resilient agroecological systems. This is significant because it is not just about how to increase yield, production area, or consumption but also about a total ecosystem design that integrates research, theory, and practice in agriculture and the well-being of the entire planet simultaneously ensuring sufficient supply of food (Krebs and Bach 2018). As the current study demonstrates though the government understands the significance of millets as a sustainable crop the approach to agrarian systems and millet cultivation is still a modern industrial one that emphasizes large-scale cultivation, use of heavy machinery, chemicals etc that impact bio-diversity, water resources, greenhouse gases, nitrogen and phosphorus cycles. Such an approach may enhance productivity but it cannot contribute to the realization of the SDG goals of Zero Hunger (SDG 2), Good health and well-being (SDG 3), Responsible consumption and production (SDG 12) and Climate Action (SDG 13) to combat the food crisis. In the process millet as the future crop will also lose its claim.

Instead, the incorporation of the permaculture approach may perhaps offer solutions to the food crisis that the world is experiencing. Permaculture principles include a) oscillating engagement with specific systems to have an in-depth understanding about it b) exploring other sources of energy and improvising ways of storing them c) obtaining a yield that is not purely economic but also ecologic and social (Have a holistic understanding of yield it relies on 'emergy analysis') d) to create systems that are autonomous and self-reliant such as biological control, biogeochemical cycle, soil and water quality managemet etc. e) to use and value renewable resources and services f) to produce no waste (Whatever waste is produced is to be treated as a resource to be put into use for some other purpose) g) to design natural ecosystems as patterns for sustainable land use. (This would entail detailing landscape patterns like geomorphology, catchments, etc to be used in permaculture designing for better site planning) h) to integrate crops and livestock to generate synergy effects i) to use small and slow solutions (It suggests that small farms are more intense and productive just as slow-growing systems such as tree-based systems are more secure and reliable) j) to value and use diversified farming systems k) to recognize the significance of edges and field margins (Studies demonstrate that these areas often regarded futile are of consequence in sustaining ecosystem functions containing a variety of pest species that operate as pollinating agents or as beneficial insects) and l) to include flexibility to be able to have the ability to adapt to change.

The above-mentioned permaculture principles as given by Holmgren (1978) represent a total way of life. It is unique in the sense that it tries to integrate agriculture, people, livestock, the environment, cultures and the food that we consume as part of one ecosystem. Its principles coincide with the need of the hour, that is to have more sustainable agrifood systems as the world has come to realize the harmful consequences of modern industrial agriculture (Hathaway 2016). The current intervention regarding millets is a piecemeal approach. This study suggests that unless we adopt a permaculture approach and design our agrarian systems configuring it based on the current situation it will be difficult to reinstate millets as a staple akin to rice and wheat even though it possesses most of the characteristics of a sustainable and nutritive crop. Perhaps at the global and at the national level policies should encourage research on scientifically proven permaculture-based systems and incorporate them into current agrarian policies on millets as a prerequisite for an ecologically sustainable society.

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