



RESURGENCE OF MILLETS AS SUPER CROPS PROSPECTS & CHALLENGES

EDITORS

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Discussions pertaining to the publication of this book began in the form of healthy academic discussions in our department. The first attempt at realizing this was the organisation of a national seminar by bringing scholars from across the country. The preparatory work involved a series of discussions within and outside of the department. The ideation, execution and publishing of the book in its current form involved the efforts of many individuals and institutions. It is our duty to acknowledge the support we received.

All articles included in this volume are revised versions of research papers presented in the two-day national seminar organised by the Department of Economics, SIES College of Arts, Science & Commerce (Autonomous), Mumbai. This edited volume became possible because of the gracious financial support we received from NABARD. *The financial assistance received from the Research and Development Fund of the National Bank for Agriculture and Rural Development (NABARD) towards the publication of the book is gratefully acknowledged.*

We also express our sincere gratitude to JCCS Bank, Ajmer, Rajasthan for the financial support they extended to organise the seminar. The seminar was instrumental in bringing together scholars from multiple disciplines to obtain a holistic understanding of the prospects and challenges that confront the millet policy ecosystem in India. We take this opportunity to thank all resource persons and paper presenters who have enriched the quality of the seminar deliberations and of this book with their intellectual inputs. We thank the South Indian Education Society (SIES) for facilitating the compilation of this book with all necessary administrative support. We would like to place on record our sincere gratitude to Dr. Uma Shankar, Principal, SIES College of Arts, Science & Commerce (Autonomous), Mumbai for her able guidance and support. We thank Mr. Ankush Jaiswal for designing the book cover. We acknowledge the meticulous support received from Mr. Vivek Devadiga and Mr. Sai Shyam Iyer in

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Editors

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FOREWORD

It is an honour for me to write this foreword and to have attended and participated in the two-day National Seminar on ‘**Resurgence of Millets as Super Crops: Prospects & Challenges**’ organized by the SIES College of Arts, Science & Commerce (Autonomous), Sion(W), Mumbai, that was held during 15-16 September 2023. The event is a part of the larger global celebration with 2023 being the International Year of Millets. The food served during the seminar (a sumptuous meal with millets) and a food stall by students added to the papers that covered different aspects of millets. Several presentations were made at the seminar on various aspects of millet's revival as a future crop. Some of them have been revised and are part of the current publication.

The seminar resonated with the breaking of the silos. Even though the initiative was from the Economics department, one observed that faculty and students from other departments participated and contributed. This is important and necessary as we articulate the resurgence of millets as supercrops. This is also aptly reflected in the themes covered in the book and at the seminar. Be it their importance from climate resilience, or their contribution to the sustainable development goals (SDGs), or focus on production, or their processing with particular emphasis for small millets that Dr Khadar Vali refers to as the positive grains, or their health benefits including medicinal properties.

I also recall the enthusiasm that the college had from the principal to the faculty to the students in engaging in discussion and having a critical look. I compliment Dr. Shruti Panday and her colleagues for putting in their efforts in bringing out this book.

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Preface

The year 2023 is being celebrated as the International Year of Millet (IYoM) as announced by the United Nations Organisation. It was following India's proposal to the Food and Agricultural Organisation (FAO) supported by more than 70 countries, that UNO declared 2023 as the IYoM. To quote the FAO, "IYM 2023 will be an opportunity to raise awareness of, and direct policy attention to the nutritional and health benefits of millets and their suitability for cultivation under adverse and changing climatic conditions".

India is the largest producer of millets and accounts for twenty percent of global and eighty percent of Asia's millet production with yield above the global average. Millets are nutritionally superior to wheat and rice with their rich protein and vitamin content and low glycaemic index. They are drought tolerant and are mostly grown in the arid and semi-arid regions of India. Millet cultivation has immense potential to safeguard farmers' income in these challenging times of climate change. Millets are highly adaptable to various soil conditions and can also resist acidification. They can be a prominent component in efforts to achieve the sustainable development goals (SDGs), namely SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being), SDG 12 (Sustainable Consumption and Production), and SDG 13 (Climate Action). Additionally, millets can be helpful in reducing nutrition gaps and inequalities. Hence, millets are the next superfood or 'nutri-cereals' of the world.

The post-green revolution policy ecosystem in India has not been in favour of millet production. Changes in dietary patterns have also reduced the prominence of millets. However, in recent years, recognizing the importance of millets and their role in strengthening food and nutrition security, India has diverted greater attention to the promotion of millets. India observed the National Year for Millets in 2018 and launched several national and state level programs for promoting millets. The International Year of Millets declared by the UN is the result of India taking its millet promotion efforts to

the international stage. More recently, India again took millets to the international stage by including a millet dominated menu in the dinner hosted by President Draupadi Murmu during the G-20 meet held at Delhi.

Despite its nutritional superiority and significant promotional efforts, mainstreaming millets as crops of mass production and consumption face several challenges. Against this backdrop, it is imperative to have informed and constructive deliberations on the prospects and challenges confronting millet promotion in India. Serious discussions focused on different aspects related to enhancement of millet production and productivity, nutritional and health benefits of millets, entrepreneurial and policy interventions required for mainstreaming millets need to be undertaken. The aim of this book is to cover these aspects and thereby add to the national and international efforts directed towards the promotion of millets.

Special Disclaimer -The edited book is based on the various papers presented during a two days seminar organised by the Department of Economics, on “Resurgence of Millets as Super Crops: Prospects & Challenges”. The views expressed are of paper presenters and for any copyright infringement the respective authors are responsible though utmost care was taken by editors to proofread the articles.

INTRODUCTION

In the forthcoming pages, readers shall be introduced to various aspects of the millet production, processing and marketing in India. As mentioned before, the two day national seminar organised by the Department of Economics with financial support from NABARD served as a prelude to the publication of this edited volume. A quick look at the deliberations we had during the seminar is necessary to understand the multi-disciplinary content of the seminar which has inspired the compilation of this volume. An executive summary of the same is included to serve this purpose. The summary gives details of the different technical sessions and presentations that formed a part of the seminar.

The main contents of this volume is divided into three sections. Section I entails two special comments given by experts in the field of millets. Dr. G. Mythili brings out the advantage of millets in the event of monsoonal delays and argues that millet promotion should form a part of the climate adaptation policy of India. Mr. Jitendra Sinha outlines the prospects and challenges associated with the resurgence of millets and gives his comments on the future path to be adopted for the promotion of millets.

Section II consists of papers contributed by scholars and faculty members. This section has five chapters dealing with various aspects of millets. Dr. Harshad and Mr. Pramod focus on millets and SDGs. They argue how millets can pave the way for a healthy, hunger free, climate resilient and sustainable future. Dr. V. Prakash outlines the economic, health and sustainability benefits of millets. He also explores the status of production and demand of millets in India. Ms. Shivangi and Dr. Shaifali present a disaggregated analysis of two major millet crops in India namely jowar and bajra. Analysing state-wise area, production, and productivity, they bring out the geographical concentration of these crops and suggest measures to be adopted to encourage cultivation of millets. Mrs. Nithya R. Mahajan in her chapter gives an overview of millet primary processing units in India. Relying on secondary data sources, she outlines

the challenges in setting up and operating such units and emphasises upon the necessity to enhance infrastructure requirements to realise millet targets. Ms. Vrushali Gupte brings out the spiritual and philosophical dimensions associated with Ahara by revisiting yogic and ayurvedic darshanas. She traces information regarding millets contained in ancient manuscripts and identifies the present policy push as a step in the right direction to reclaim what was once an integral part of the Indian diet.

Section III of this volume contains selected case studies compiled by the editors. It gives brief accounts of selected best practices adopted for millet promotion in India. It covers institutional efforts undertaken under the aegis of public institutions like NABARD and various state agriculture departments. Emphasis is placed on, lesser known yet promising experiments, like the one happening in Madgyal, Maharashtra. The section also covers initiatives undertaken by notable non-profiteering private initiatives like Dhan Foundation and SAI. The section also outlines millet promotion efforts undertaken by five personalities namely Dr. Khadar Valli Dudekula (Millet Man of India), Ms. Sharmila Oswal (Millet Evangelist of India), Mr. Bhalubhau Kisan Ghode (Tribal Farmer from Maharashtra), Raimati Ghiuria (Queen of Millets) and Lahari Bai (Millet Ambassador of India)

The concluding remarks by the editors summarise the insights shared in this edited volume along with some of the major challenges that need to be addressed in the promotion of millets.

We hope this volume will enhance the awareness of the reader regarding millets. We will call our endeavour to publish this edited volume a success if at least one of our readers gain a meaningful introduction to the world of millets and incorporate millets into their diet.

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ACRONYMS

UNO	United Nations Organisation
IYOM	International Year of Millets
FAO	Food and Agricultural Organisation
SDGS	Sustainable Development Goals
ICMR	Indian council of Medical Research
NFHS	National Family Health Survey
OMM	Odisha Millet Mission
NFSM	National Food Security Mission
PMFME	Pradhan Mantri Formalisation of Micro food processing Enterprises
IIMR	Indian Institute of Millet Research
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ASSOCHAM	Associated Chambers of Commerce and Industry of India
e-NAM	Electronic National Agricultural Market
FPO	Farmers Produce Organisations
PDS	Public Distribution System
CFTRI	Central Food Technological Research Institute
NIFTEM	National Institute of Food Technology, Entrepreneurship and Management
RTE	Ready To Eat
RTC	Ready To Cook

MoAFW	Ministry of Agriculture and Farmers Welfare
CAGR	Compound Annual Growth Rate
ICDS	Integrated Child Development Scheme
MSP	Minimum Support Price
FSSAI	Food Safety and Standard Authority of India
FPOS	Farmers Produce Organisation
MOA	Memorandum of Association
MOU	Memorandum of Understanding
SFAC	Small Farmers' Agri-Business Consortium
NABARD	National Agricultural Bank for Rural Development
POSHAN	Partnership & Opportunities to Strengthen & Harmonise the Actions for Nutrition
IFPRI	International Food Policy Research Institute
FMCGs	Fast Moving Consumer Goods
NUS	Neglected and Underutilized Species
PLIs	Production-Linked Incentive scheme
RKVY	Rashtriya Krishi Vikas Yojana
RAFTAAR	Remunerative Approaches for Agriculture and Allied Sectors Rejuvenation

EXECUTIVE SUMMARY

Resurgence of Millets as Super Crops: Prospects and Challenges

The two days national seminar on 'Resurgence of Millets as Super Crops: Prospects & Challenges' was organised by the Department of Economics, SIES College of Arts, Science & Commerce (Autonomous) on September 15th & 16th, 2023. The seminar aimed to sensitise students and young researchers to understand the potential of millets as a super food and its role in promoting SDG 2, 12 and 13. The seminar focused on the prospects and challenges confronting millet promotion in India. The various sub themes of the seminar included papers on Economics of Millets, Millets and SDGs, Millets - Health and Nutritional Value, Millets and Entrepreneurship, Millets and Government Policy. This section is a brief summary report of the various points deliberated over during the two days seminar.

The explorative tone was set by a very pertinent question on what forms a yukta ahar. Is the food we consume giving us the life force we require? This is a life changing question for Millennials and Gen Z who are born in a globalised world with increasing temptation set by smart food markets and visually appealing food items. Traditional Indian food and the philosophy centred on it lay emphasis upon the role of food for a balanced living than for sensory pleasures. In this context, re-establishing the importance of millets in our diet and exploring their role in Indian culture since centuries becomes an important task. The importance of millets not only in terms of nutrition but also in the context of sustainable farming practices and production for trade gains is being deliberated. Millets are commonly categorised into major millets (neutral grams) and minor millets (positive grains).

Dr. Srijit Mishra, Professor at Indira Gandhi Institute of Development and Research in the keynote address emphasised the critical state of Indian agriculture and the looming crisis due to the neglect of millet crops. There was a shift in production from coarse grains to refined grains namely rice and wheat during the Green Revolution of the 1960s. In his presentation titled 'Inclusive and Sustainable: Millet for Millions through Lessons from Odisha', Dr Mishra drew on the "triple vulnerability" of millets, affecting the crop, the land, and the people who cultivated them, often tribal and vulnerable populations. Citing the inclusive philosophy inspired by visionaries like Ambedkar, Gandhi, and Rawls, a clear divide can be seen between the "Haves" and the "Have-Nots" in agriculture. He underscored the cultural significance of millets, illustrating how the millets and rice were regarded as "daughter" and "son" by tribals in Odisha, emphasizing the need for a balanced approach to agriculture. Dr. Mishra addressed the supply-demand mismatch issue, where millet prices were often higher than production

costs. The inclusion of Mishra's Orissa study in the 2016 Odisha budget for millet revival indicated growing recognition of millets in policy-making. Odisha millet mission has gained reputation in establishing the benefits of millets for both the planet and producers, retrieving increased returns for farmers. Farmers' mindset towards millets has now evolved, from considering them "poor man's food" to seeing them as profitable crops, a definite shift in cultivation approach of farmers.

Mr. Jitendra Sinha, Co-founder of Sai-sustainable Agro, in his special address titled 'Beyond the Comfort Zone: A Journey to a Million Dreams' touched upon some of the crucial and engaging points regarding challenges faced by farmers in India for growing millets. India has a vast potential with 50% cultivable wastelands and despite that farmers continue to struggle with poverty. Economic soundness of the cultivator class is an important factor of production. This raises an important issue "Can millet be an answer?" There is no denial that the Green revolution has achieved food security and transformed the Indian economy from largest food importers to net exporters of food grains. However, it also led to a decrease in productive land and the unfortunate neglect of millet crops. The intentional or unintentional disregard for millets during the Green Revolution had long-lasting consequences. He opined that the occasion of the International Year of Millets should be used to focus and identify various challenges in the revival of millets including low processing productivity, limited public awareness, insufficient use of millets in food products, and inadequate government support. Sai-sustainable Agro is an Indian Start-up which has successfully designed, piloted, and scaled an agroforestry model on degraded land as a social venture in India.

The distinguished lecture by Dr. Antony Caesar, Senior Scientist, Division of Plant Molecular Biology and Biotechnology at Rajagiri College of Social Sciences, Cochin, focussed on the relationship between millets and different SDGs set under UNO Agenda 2030. Millets have been cultivated in semi-arid regions of Africa and Southeast Asia for centuries. Its root in Africa can be better understood as reminisced by the former South African president, the anti-apartheid activist and Nobel Peace laureate, Nelson Mandela, in his autobiography 'A Long Walk to Freedom' mentioned millets, particularly sorghum. He writes, "Maize (what we called mealies and people in the West call corn), sorghum, beans, and pumpkins formed the largest portion of our diet, not because of any inherent preference for these foods, but because the people could not afford anything richer". Similarly in Indian culture there is mention of millets in Yajur Veda's verses. There are evidences of mention of millets in Sushruta Samhita which classified cereals as dhanya varga, khudhanya varga and samidhanya varga where khudhanya varga included various millets, Kannada poet Kanakadasa personified ragi metaphorically for the weaker sections of society, 'Rarnacilaanya Charitre', elucidates conflict of millets with the 'mighty' rice. There is mention of millets and its various properties in the Arthashastra, a treatise written by Chanakya and Ain-i-Akbari, written by Abul Fazl, records millets and their cultivating regions¹. Cultural customs also

¹ Yojana: January 2023 | Millets, <https://samajho.com/upsc/yojana-magazine-january-2023-millets/>

reflect the prevalence and usage of millets. Millets are used for fasting purposes, songs sung by women during sowing and harvest times mention millets and in many communities, they were also used to bless the bride and groom during marriage ceremonies.

Millets offer not only impressive nutritional benefits but also have a lower carbon footprint and shorter growth cycles than rice or wheat. A mapping of millet with SDGs shows positive outcomes.

1. **SDG 1:** Millets reduce the need for costly fertilizers and pesticides, alleviating poverty among farmers.
2. **SDG 2:** Certain millets, like finger millet, have long shelf lives, contributing to food security.
3. **SDG 3:** Millets, rich in essential nutrients, promote health and well-being.
4. **SDG 12:** Millet cultivation supports responsible production and growth among subsistence farmers.
5. **SDG 13:** Millets, with their lower carbon footprint, align with climate action goals.

Technical session on Economics of Millet shed light on the profound impact of climate change on agriculture, the direct correlation between climate conditions and agricultural outcomes. Dr. G.Mythili, Professor, IGIDR has proposed diversifying crops through the cultivation of millets to combat the challenges imposed by climate change. India is in a position to make significant contributions to global production. A policy backup to millets can help in leveraging the numerous advantages and potential of millets in terms of climate resilience, adaptability, reduced input requirements, and their ability to enhance soil carbon levels. As mentioned earlier, millet crops are aligned with Sustainable Development Goals 2, 3, 12, and 13, and thereafter marking their importance in addressing global sustainability challenges. Nevertheless, economics of millets is faced with challenges in millet production, such as declining yields, rising prices, shorter shelf life, and taste preferences. This calls for outlining a vision for the future consisting of rejuvenating millet production to generate employment opportunities and strengthen the agricultural value chain. Enhancement of production of millets such as: to strengthen the quality of seed chain. Specially enlightened on the government initiative of seven sutra for popularising millets and turning it into a revolutionary movement.

In the technical session on ‘Millets - Health and Nutritional Value’, resource person Dr. Paras Sharma, Senior Scientist, ICMR-National Institute of Nutrition at Hyderabad, India and currently head of department of Food and Technology at Mizoram University, Aizawl, explored the topic ‘Inclusion of Millets in Diet: Opportunities and Challenges’. The problem of undernutrition and overnutrition results in a double burden on

malnutrition. On the one hand, approx. 35 percent children under the age of 5 years are malnourished with high figures across stunted, wasted and underweight categories and approx. 18.9 percent women under the age group of 15-49 years are malnourished (NFHS 2015-16). Obesity and lifestyle diseases are also becoming rife. About 71% of cases are non-communicable diseases with most prominent being cardiovascular diseases. High consumption of refined grains and foods containing high levels of sugar can be cited as major factors contributing to this phenomena. As being accepted and examined by various studies, millets provide good bacteria, have a cooling effect, help in detoxification, and build strength. Growing millets and eating millet based foods harmonizes health with the environment. He also mentioned that millet grain is abundant in nutrients and health-beneficial phenolic compounds, making it suitable as food. Millets also contain a significant amount of anti-nutrients including phytic acid (PA), tannins (condensed tannins) and moderate amounts of oxalates.

The sessions on ‘Millets and Entrepreneurship’ elucidated the need for recognizing gaps in the market. Innovation at all levels, right from production techniques to harvesting and marketing is the key for the success of any millet promotion effort. To expand the market with varieties of healthy options made of millets an attitudinal change in consumption is also important. In this regard yogic and ayurvedic insights on millets and mindful eating practices are of paramount importance. Other papers presented in the session focused on comparison over large millets and small millets, methods of preparation, the traditional tools of grinding millets and post harvesting techniques, nutritional benefits and government initiatives to promote millets. Technological enhancement is important to get better results. Several methods were introduced such as the hydrothermal process. There is a need to improve the industrial scale building technology to improve the seed quality. Details of these are included in the chapters of the book. There is no doubt that millets have the potential to change the food market landscape.

Lecture by Dr. Vikram Sankaranarayanan, Director, Policy Advocacy Research Centre, Mumbai, titled ‘Millets & Government Policy: Empowering Stakeholders along the Value Chain’ explored the challenges in millet production. He emphasised on the need to improve primary processing, maintaining both quality and quantity, and the necessity to invest in equipment and logistics. The gradual decline of millets from staple crops to coarse crops and from a super food to poor man’s food has resulted in shooting up of non-communicable diseases during the period after the green revolution. Shifting cultivators from rice to millets would require a significant change in government policy related to agricultural investment, subsidies and pesticides and other input factors. Though millets can be advocated as a low-input crop, high operating costs have made it difficult to hit the break-even with some processing units shutting down, rendering equipment unusable and limiting millet processing. The promotion of millets & nutri-cereals in India, as a source of micronutrients and plant-based protein needs to be taken up with intentions of enhancement of nutrition on the global platform. It is necessary to address questions of food security and nutrition security, emerging globally, through

sustainable, less-resource intensive, gluten-free, low-cost crops, namely a range of nutri-cereals. Emphasis should also be placed on financial sustainability, alongside environmental sustainability, for stakeholders along the value chain from farm-to-fork. The government needs to focus on developing dry-land/ rain-fed sustainable agriculture to empower farmers and stakeholders along the food value chain with state-of-the-art technologies in food processing.

Sri-dhanya has been the traditional food grain in tribal and marginally developed areas. The reference to millets as laghu dhanya or muni dhanya implies their therapeutic property in Ayurveda. Millets have a high nutritive value comparable to major cereal grains as explored by Ms. Sejal in her paper. It is worth noting that the effect of eating between meals- Adhyashan, over nutrition- Atyashan and malnutrition have been spoken of in our ancient treatises pertaining to health & well-being and how the consumption of grains like Sri-dhanya function as a solution to alleviate such ill-effects. Millet was also explored as a possible practical solution to mitigating nutritional aberrations caused on account of lifestyle and non-communicable diseases.

Millet consumption and cultivation is well documented in India's food culture and tradition. There is a need to explore millets beyond being coarse grains or poor man grain and greater awareness needs to be spread on minor millets. At present popular perception recognises only Bajara (pearl millet), Jowar (sorghum) and Ragi (finger millet). This needs to be expanded to understand and incorporate nutritional and economic value of minor millets such as Foxtail Millet (Kangni), Barnyard Millet (Sanwa), Little Millet (Moraiyo), Proso Millet (Chena / Barri), Browntop Millet (Korle).

Various states are coming up with programs to create an ecosystem for revival of millets and to generate awareness to bring a shift in food choices for healthier diets. Government projects like NFSM and PMFME aim at furthering millet cultivation. India is one of the largest producers of millets and Indian farmers are realising the potential of planting millet as a drought-resistant crop. At present, India accounts for 20% of global production and 80% of Asia's production. India's average yield of millets (1239 kg/hectare) is also higher than the global-average yield of 1229 kg/hectare. The Indian government is also promoting and encouraging millet production as part of its National Food Security Mission. As a result of these factors, millet production in India is expected to continue to grow in the coming years.

The Ministry of Agriculture and Farmers Welfare (MoAFR) Report of 2022 showcases the initiatives of the Indian government for the promotion of millets. The Government of India declared 2018 as the National Year of Millets and the Union Budget of 2023-24 had coined a term 'Sri Anna' for millets. The Union Budget has accorded high priority to millet grains such as jowar, bajra, ragi for their potential health benefits. The government has accorded the status of the Centre of Excellence to the Indian Institute of Millet Research- based in Hyderabad for sharing best practices, research and technologies pertaining to millets. The National Institute of Millets Research (NIMR)

has incubated more than 250 start-ups under Rashtriya Krishi Vikas Yojana-Remunerative Approaches for Agriculture and Allied Sectors Rejuvenation (RKVY RAFTAAR). FMCG companies like Britannia, HUL, Nestle and ITC, Tata Souful and Slurpp Farms have been accelerating their millet-based products eyeing the robust consumption markets for millet products. The Government of India's Millet Mission is covered under the National Food Security Mission (NFSM), launched in October 2007 and POSHAN Abhiyan launched in 2018 incorporates millets to tackle malnutrition and leverage traditional knowledge systems.

IYOM 2023 aims at increasing awareness to understand millet as the future amidst challenges of climate change looming over agriculture all around the year. With the estimate of temperature increase, international institutes and governments are desperate to switch to a crop which is climate resilient. The GOI has taken a lead in promoting millet as a "People's Movement" and positioning the country as a 'Global Hub for Millets'.

Interestingly, the government is encouraging millet not only to celebrate the International Year of Millets but also to rejuvenate the indigenous food knowledge system on which our ancestors relied on. Millet as a soft power can be an interesting and explorative avenue for policy makers and researchers to explore. Soft power in international diplomacy has emerged as a force to reckon with. Adding to the success of Yoga as India's contribution to global cultural capital, reinforcing millet into popular food diet culture can also be exercised as Indian contribution to the world gripped with non-communicable diseases owing to changed food habits. The United Nations' resolution of IYOM has already highlighted the global recognition of problems looming in front of humanity in terms of food and nutritional insecurity, nature depleting unsustainable commercial agriculture, overuse of chemical fertilizers harming land, man, animal and plants ecosystem and change in climate dynamics, increasing cases of non-communicable diseases such as diabetes, obesity and cancers.. These pressing issues reasserts the significance of active promotion of millets in regular diet practices. The wider acceptance of the importance of millet in the current global scenario would be a golden opportunity for Indian agriculture to meet the global demand for millet crops both major and minor. As the largest cultivator and exporters of millets, India can leverage its potential to brand the millets both in Global North and Global South. The millets can be normatively part of India's soft power agenda for tackling the problem of hunger and malnutrition in Global South and an alternative of clean, healthy, organic sustainable diet option for Global North. India along with African Nations, which also enjoys many indigenous varieties of millet crops and has a rich history woven around millets can forge a partnership to capture more space for millet products in markets of Global North.

Millets have the potential to restore dignity to farmers and contribute to a more sustainable agricultural future. The sustainable development and empowerment of farm women is considered as a key factor for development of any country. Millet production

may add to women empowerment especially for women of tribal areas engaged in minor millet cultivation. The significance of integrating millets as a staple part of diets, acknowledging their potential to contribute significantly to both economic and nutritional well-being cannot be ruled out. Last but not the least for the success of resurgence of millets as super crops, each and every individual has to take an active role by prioritizing product quality over brand names when making purchases and everyone should incorporate at least one millet into their daily diet.

Dr. Shruti R. Panday

About the Editors



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SECTION I

SPECIAL COMMENT

MILLETS PROMOTION AS CLIMATE ADAPTATION POLICY FOR INDIA

Dr. G. Mythili

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INTRODUCTION

Among the many problems posed by climate change, risks to agriculture are well known. Past studies have documented extreme weather events brought down global grain production by 10% over the past 5 decades (Lesk *et al.* 2016). This has posed challenges to the government in providing food security to the low income population. Moreover small and marginal farmers of India are affected more due to climate change as they are more vulnerable to its consequences. Significant proportion of land under rainfed cultivation has only exacerbated the problem.

Time has come to identify suitable crops that survive in the toughest of climate and weather situations. One option to meet the challenge is ‘**Millets**’. Termed as ‘super grain’, India is the top producer of millets in the world with about 40% share as per 2022 statistics and it is the second largest exporter of millets (Millet portal, GOI)

Millet as a crop has many advantages for cultivation as well as consumption. It is climate resilient- can withstand extreme -heat and drought. It requires less water and chemical inputs. Duration of the crop is shorter than rice or wheat and hence it helps farmers escape from financial stress. (Saxena *et al.* 2018). The crop is suitable for sustainable agriculture because the high carbon content in the residues help the soil to maintain carbon levels. Compared to other main cereals, millets possess higher carbon sequestering ability thereby reducing GHGs and helping mitigation of climate change.

Millets have many health benefits too; high in iron, zinc and calcium content; rich in protein and Vitamin B; scores high in dietary fibers and antioxidants. Its low glycemic index helps control blood sugar; regulates blood pressure and lowers cholesterol (IIMR, 2018).

Millets and SDGs

From the Context of Sustainable Development Goals (SDGs), enhancing the role of millets can contribute both directly and indirectly to the mission of achieving SDGs. To put it precisely, it can tackle directly the following goals:

Goal 1: End poverty in all its forms. Since millets are climate smart, it assures stable income for rainfed farmers by reducing their vulnerability to monsoonal shocks.

Goal 2: Zero hunger: helps food security.

Goal 3: Achieve good health and wellbeing by diversifying the present consumption pattern towards nutrient rich millets.

Goal 12: Sustainable Production and Consumption

Goal 13: Climate Action: Action to reduce climate change impacts.

Composition of Millets

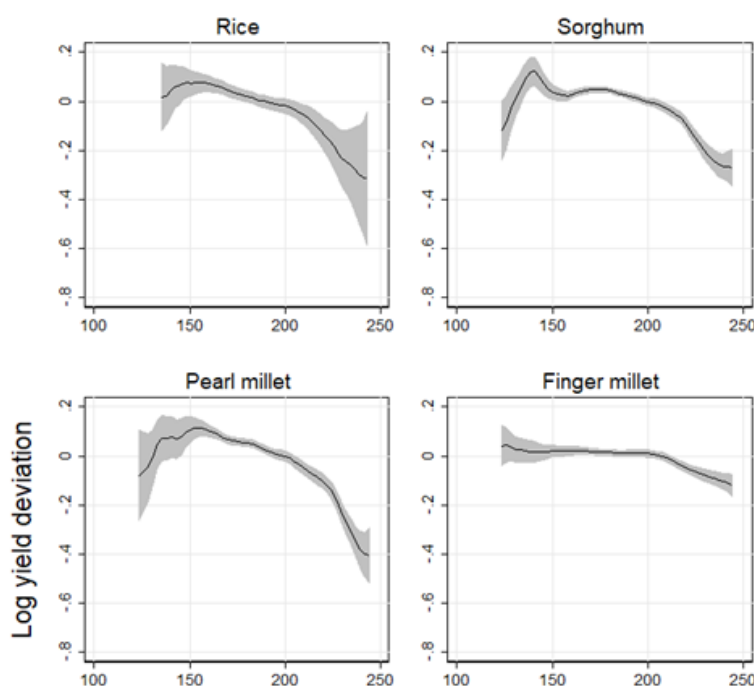
India mainly cultivates 3 types of millets: Pearl Millet (Bajra), Sorghum (Jowar) and Finger Millet (Ragi). Pearl millet is the predominant crop contributing about 60% of the total millets production. There are six states, which contribute about 83 % to the total country's production: Rajasthan, Karnataka, Maharashtra, Uttar Pradesh, Haryana and Gujarat.

Until the Green Revolution was introduced, millets formed around 40% of total grains, which saw a gradual reduction and dropped to around 20% over the years. Understandably, since the onset of the Green revolution, the production of rice has doubled and wheat production tripled, as Government policies favoured rice and wheat production.

Some Evidence on Monsoonal Delay and Millets Advantage

Delay in the arrival of monsoon has been a feature of Indian monsoon according to the statistics of past 50 years' monsoonal data. The monsoon arrival has shifted forward over time and this has many adverse implications for the growth of the farm sector in terms of livelihood and farm income. Figure 1 demonstrates the advantage of Millet's group vis-a-vis Rainfed rice in case of monsoonal delay. Results of an exercise conducted (Singh, 2022) using ICRISAT and IMD data in the form of graphs is depicted in figure 1. It shows the yield deviation from exponential trend related to monsoonal delay for rainfed rice against 3 major millet crops. Higher and steeper decline in rice yield is witnessed starting from a 10 days delay beyond 150 days, which is approximately end of May-beginning of June. In fact, for Sorghum and Finger Millet, the decline is meager even for a delay of more than a month.

Figure 1:- Monsoonal Delay and Yield Deviation from Normal



Monsoon Arrival date (using Jan 1st as day 1)

Source of Data: ICRISAT, Tata Cornell Institute and IMD, GOI historical data

Millets Revival Program and Policies

Acknowledging the role of millets, Government of India declared 2018 as the National Year of Millets and gazetted millets as Nutri-Cereals. The U.N. General Assembly declared 2023 as the International Year of Millets which was mainly sponsored by India and supported by many countries. The aim of this resolution is to promote millets in a holistic manner including production, consumption and trade, besides facilitating Research and Development in millet farming.

The UN resolution endorsed “urgent need to raise awareness of the climate-resilient and nutritional benefits of millets and to advocate for diversified, balanced and healthy diets through the increased sustainable production and consumption of millets.”

Corporates’ also leveraged government incentives to introduce a variety of millet based products in the market that promised tastier food products to draw the attention of consumers.

CHALLENGES

Research and development has to focus more on developing high-yielding varieties, and more action is needed to address problems facing processing facilities and value addition.

Need of the hour is to address the challenges in Millet Processing. The millet processing plants in India suffer from a low **recovery rate of 70-80% of grains** and it is a challenge to process millets on a large scale. Inadequate infrastructure such as processing technologies, and unique milling equipment affects the total value chain. Insufficient primary processing facilities at the village level leads to higher transportation cost and this causes undue increase in the cost of processed millets. Shorter shelf life for some processed products is also a concern (ASSOCHAM, 2022).

The inclusion of millets under PDS is yet to pick up in a big way, because millet procurement for the Central Pool is very meagre. Efforts are needed to increase the scale of procurement. With regard to consumption, millets need a further push. Latest NSSO Household Survey reports confirm that below 10 percent of rural and urban households consume millets.

According to a survey conducted by ‘Transforming Rural India and Sambodhi Research Group’ in 2023, it was found that 80% of Indians were well aware of the nutritional benefits of millets but millets score less in terms of its culinary appeal due to its unfavourable odour and taste. This calls for developing more tasty millet based products to boost its consumption.

ROAD AHEAD

There is an urgent need for networking of small and marginal millet farmers to **online marketing platforms**, such as the Electronic Agricultural National Market (e-NAM). As we expect increasing scale in production due to various supportive policies, online platforms will reduce traders' role and help farmers reap the full benefits of trade. Farmer producer organisations (FPOs) can further help to increase the bargaining power of millet producers in both the domestic and global markets.

Public distribution system (PDS) has to gain momentum by increasing the scale of procurement and distribution. Decentralized State level push has been initiated already. The Odisha model is

one example. Governments of Karnataka, Tamil Nadu and Andhra Pradesh have also initiated Millet Action Plan.

A significant change in consumption is possible, if millets could be made a staple part of children's diets. Besides midday meals, millets could be served in the form of ready-to-eat foods such as cookies and sweets.

Millets' value chain issues have to be addressed on a high priority. More value addition initiatives and technological upgrading of the processing sector of millets are needed in major millets' growing regions to fast track the revival of millets. Improvement and dissemination of post-harvest processing technologies for millets need immediate attention in rural areas, which would generate more employment opportunities and promote agribusiness, and this would lead to increase in the demand for millets based food products.

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RESURGENCE OF MILLETS: CHALLENGES, PROSPECTS AND WAY FORWARD**Mr. Jitendra Sinha**

Cofounder of SAI Sustainable Agro

Millets are small-seeded annual grasses, cultivated globally as cereal crops or grains. The term "Millet" originates from the "mil," a diminutive form of the dialect term "miliun" from Latin. This nomenclature alludes to the substantial yield of grains from a single seed, with "mil" signifying a thousand

Figure 1: Millets: Global Scenario

Millets have deep roots in various cultures and were historically cultivated across the world. They are grown in 131 countries and have served as a staple for 59 crore individuals in Asia and Africa. The earliest known evidence of millet cultivation dates back to around 3000 BC during the Indus civilization.

There are eight crops under the millets, which are put in two categories of major and minor millets. There are also two crops which are known as Pseudo millet/cereals.

Table 1: Millets: Local & Botanical Name

S. No	Common/Local Name	Botanical Name
Major Millets		
1	Sorghum (Jowar)	<i>Sorghum bicolor</i> (L.)
2	Pearl Millet (Bajra)	<i>Pennisetum glaucum</i> (L.)
3	Finger Millet (Ragi/Mandua)	<i>Eleusine coracana</i> (L.)
Minor Millets		
4	Barnyard Millet (Sanwa/Jhangora)	<i>Echinochloa frumentacea</i> (L.)
5	Proso Millet (Cheena)	<i>Panicum miliaceum</i> (L.)
6	Foxtail Millet (Kangni/Kakun)	<i>Setaria italica</i>
7	Kodo Millet (Kodo)	<i>Paspalum scrobiculatum</i> (L.)
8	Little Millet (Kutki)	<i>Panicum sumatrense</i>
Pseudo Cereals (Millets)		
9	Purple Amaranthus (Chaulai)	<i>Amaranthus cruentus</i>
10	Buck Wheat (Kuttu)	<i>Fagopyrum esculentum</i> & <i>F. tataricum</i>

The barnyard millet and Pseudo cereals (Amaranthus and buck wheat) are used during their fast as these are rich in nutritive values.

Millet: The Smart Food

Millets are referred to as Nutri-cereals and Smart Food due to their benefits: (i) they are beneficial for people; (ii) they are environmentally friendly; and (iii) they contribute to the prosperity of farmers. Additionally, millets play a crucial role in addressing some of the most pressing global challenges, including poverty, inadequate health and nutrition, as well as the impacts of climate change and global warming.

According to the NFHS India Report 2022, health indicators reveal concerning statistics: 59.1% of women suffer from anaemia, 35.5% of children are stunted, 32.1% of children are underweight, 24.0% of women and 22.9% of men are obese, and 8.9% of the population is diabetic. Millets provide an excellent source of vital nutrients including iron, calcium, protein, and various micronutrients to deal with above disorders. The polyphenols stand out as the most crucial phytochemicals in millets due to their valuable nutraceutical properties, encompassing antioxidant, anti-inflammatory, anti-carcinogenic, antimicrobial, anti-diarrhoeal, antiulcer, and anti-cardiovascular effects. Additionally, polyphenols play a significant role in managing diabetes and hypertension.

Good for People (Health Benefits of Millets)

- Prevent onset of Cancer
- Help to protect against heart diseases.
- Help to prevent Type 2 diabetes.
- Helps to optimize the kidney, liver, and immune system.
- Effective in reducing Blood Pressure.
- Aids in treating respiratory conditions such as Asthma.

Good for Planet

- Consume less water (Low water footprint).
- Grow faster, putting less stress on the environment.
- Can grow with minimal fertilizers and pesticides (high resistance).

Relative water requirement (in mm of rainfall)

Finger Millet: 350 mm

Sorghum: 400 mm

Maize: 500mm

Wheat: 650 mm

Rice: 1250 mm

Source: ICAR, IIMR 2022

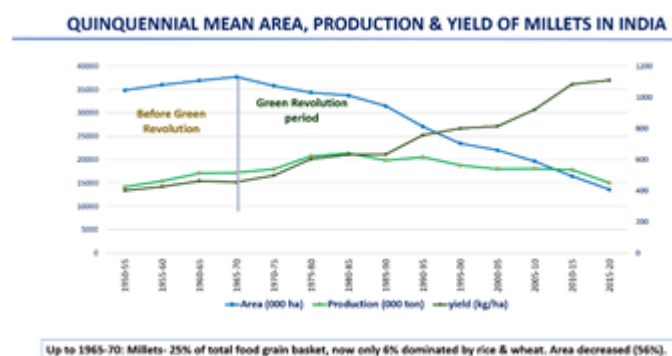
Good for Farmer, Brings Prosperity

- Resilient to climate change (C4 plant) & ideal contingent crops.
- Potential to offer food, fodder, and fuel security.
- Dryland crops, short duration, grow well in marginal land.

The Dip

Prior to the advent of the Green Revolution, millets were a staple food for numerous communities, comprising approximately 25% of the staple food supply in the early 1970s. However, the Green Revolution and subsequent policy regulations favoured rice and wheat, providing them with a significant advantage over millets. This shift in focus led to the neglect and subsequent decline of millets production and consumption.

Figure 2: Production & yield of millets in India



Source: Ministry of Agriculture and Farmers Welfare, 2023

Consumer bias against millet was built in the terminologies which designed rice and wheat as fine or superior cereals and millet as coarse or inferior cereal. Additionally, it was often referred to as "Poor Men's Food." As a result, the proportion of millets in the overall cereal consumption in the country plummeted from 25% to less than 6% in recent years.

The Resurgence

In 2012, the government started taking initiative to promote millets. Millets were officially declared as Nutri Cereals in 2018. The year 2018 was also declared as the National Year of Millets. The current year 2023 is declared as the International Year of Millets. Millets are also re-named as Shree-Anna. The government declared that the National Food Security Mission to be renamed as National Food Security & Nutrition Mission –nutri cereals included in all districts. The other noticeable steps taken are:

- Studies by IIMR, CFTRI & ICRISAT on Health benefits & clinical evidences and Nutrition & bioavailability of nutrients- focussing on Diabetics, suitability for school children, Bone Health and Nutrition Profiling
- Research & development on traditional/contemporary millet recipes by IIMR, CFTRI & National Institute of Food Technology, Entrepreneurship and Management (NIFTEM) with higher shelf life with proper packaging & branding & ready to use products.
- Development of recipes, books & online modules through chef's & hotel management schools.
- Indian diaspora involvement for food festivals. All embassies started serving millets in their functions. Involvement of famous cuisine shows such as Masterchef.

- International food influencers as brand ambassadors. Millet recipes food festivals - Eat Right India. Celebrity Endorsements.

The Challenges

The majority of millet cultivation occurs in rainfed conditions, using traditional landraces with limited yield potential. Consequently, millets struggled to compete with more profitable crops such as rice, wheat, cotton, groundnut, and maize, which received preferential treatment in the past.

Inadequate public awareness regarding the uses and value-added products of millets has contributed to reduced demand for this crop. Many still perceive millets as "Poor Man's Food." Furthermore, increasing urbanization and rising per capita incomes have shifted consumer preferences towards commercialized food products. Additionally, the social status of millets and the lack of knowledge on how to prepare millet-based products have further hindered their popularity.

One of the primary reasons for the low consumption of millets is the weak value chain, including insufficient primary processing at the village level and considerable distances between productions and processing units. This not only hampers local production but also inflates the cost of processed millet products.

While many entrepreneurs have recently ventured into millet-based Ready to Eat (RTE) products like vermicelli, pasta, noodles, mixtures, etc., inadequate investment support, limited demand for millet food products, and competition from established private players have made their social businesses largely unviable.

The Prospect

Now-a-days, people are getting conscious about their healthy living practices to overcome metabolic disorders and lifestyle diseases. It has increased potential demand for various types of millets. Though the millet food-products are known for nutrition, its awareness among the consumers has been scanty, especially on their nutritional and therapeutic values.

The Government is a critical stakeholder in strengthening the value chain of value-added millet products and is making dedicated efforts to provide policy support to the small and marginalised farmers growing millets and other stakeholders. The Minimum Support Price (MSP) for millets has already been announced in most states. The Government has already issued guidelines to include millets in the Public Distribution System (PDS), depending on their availability in a particular state.

Various ministries are already providing different kinds of support, e.g., finance, infrastructure, technology, etc., to various stakeholders. The Ministry of Agriculture and Farmers Welfare (MoA & FW), via its schemes, supports Self-Help Groups (SHGs)/Farmer Producer Organisations (FPOs) in primary processing at the village level. The Ministry of Small and Medium Enterprises (MSME), via its schemes, supports the secondary processing, provides soft loans, gives accreditation to private entrepreneurs to enable easy access to funds, and promotes adoption of a co-pay model to incentivise decentralised RTE/RTC processing units at sites closer to production.

Nutritional quality and drought-resistant properties of millets have drawn attention of various researchers all over the world and have increased focus to improve the millet varieties and to enhance their use in processed food products.

The Way Forward

To increase the consumption of millets, it is imperative to raise awareness. It's crucial to widely publicize the nutritional, functional, and health benefits of millets. Interventions in processing are needed to create millet products with enhanced nutritional value. This step will significantly contribute to the promotion of millets, bolstering nutritional security. Efforts should also be made at following levels:-

- Effective strategic planning, technological advancements, and timely implementation can lead to an expansion in both the area under millet cultivation and its production.
- Establishing sufficient marketing infrastructure and ensuring early payment of minimum support price to small farmers for their millet products will play a pivotal role in motivating them to cultivate this crop.
- Encouraging and supporting local entrepreneurs, as well as women's self-help groups, in setting up processing units near to farms will be instrumental in attracting more farmers towards millet cultivation. Promoting entrepreneurs to produce millet-based food items will be particularly beneficial in this regard.
- The preparation and production of various millet products by entrepreneurs, self-help groups, and small-scale industries can stimulate demand for value-added products. This, in turn, can enhance the socio-economic and health status of consumers.

SECTION II

MILLETS AND SUSTAINABLE DEVELOPMENT GOALS (SDGS)**Dr. Harshad Laxman Jadhav¹ and Mr. Pramod Prakash Waghe²**¹Head, Research Centre in Economics, RSSKB Patil College, Vashi, Navi Mumbai²Assistant Professor, Department of Economics, RSSKB Patil College, Vashi, Navi Mumbai**ABSTRACT**

With their distinctive qualities and advantages, millets have become important for fulfilling several Sustainable Development Goals (SDGs). The chapter emphasises millets' important contributions to tackling global issues and fostering sustainable development. These water-efficient crops support Clean Water and Sanitation (SDG 6) while requiring fewer resources overall, including water. Additionally, millets are a low-glycaemic index, gluten-free substitute that supports good health and wellbeing (SDG 3). We can support Sustainable Cities and Communities (SDG 11) and lessen the environmental impact of food consumption by incorporating millets into urban diets (SDG2). Millets also aid in climate action (SDG 13) support for Biodiversity Conservation (SDG 15). Partnerships for the Goals (SDG 17) are additionally required for millet promotion. Strengthening millet value chains and reaching shared goals require cooperative efforts from governments, agricultural organisations, researchers, and communities. Scaling up millet production, consumption, and market expansion calls for coordinated work and the creation of cross-sectoral alliances. This abstract emphasises the significance of acknowledging millets as nutritional, climate-smart, and sustainable crops. It emphasises millets' potential to help achieve SDGs for hunger elimination, health promotion, water conservation, mitigating climate change, conserving biodiversity, and building sustainable partnerships. Millets can help us pave the way for a future that is more sustainable and inclusive.

Keywords: *Millets, Sustainable Development Goals (SDGs), Nutritional Security, Climate resilience, Food security*

INTRODUCTION

Millets are a type of small-grained cereal food crops that are very nutritious and cultivated on soils with poor fertility or marginal soils with minimal inputs like pesticides and fertilizer. These crops make a significant contribution to the nation's food and nutritional security. The majority of millet crops are indigenous to India and are referred to as "nutri-cereals" since they contain the majority of the nutrients needed for the body to operate normally. Millets are rain-fed crops that thrive in areas with little precipitation, giving them a bigger role in sustaining agriculture and ensuring global food security. The millets are divided into big millet and small millets based on the area farmed and the size of their grains. The two most common millets are pearl millet (bajra) and sorghum (jowar). Minor millets include foxtail millet (kangni/Italian millet), finger millet (ragi/mandua), small millet (kutki), kodo millet, barnyard millet (sawan/jhangora), proso millet (cheena/common millet), and brown top millet (korale). Other millets like fonio and tef are grown in some parts of Africa. Millets were the first plants that humans tamed in Asia and Africa, and they later spread to other parts of the world as vital food sources for the advancing civilizations. All of these millets have shorter growth seasons and

finish their life cycles in 2-4 months. They also fit into a variety of cropping systems and are able to adapt to shifting environmental circumstances, particularly during monsoon season.

The oldest crops consumed by humans were millets, but due to industrialization and urbanisation, which led to large-scale rice and wheat farming, their relevance and cultivation declined. Millets have re-emerged as a feasible alternative to live a healthy life and can lower the incidence of major lifestyle disorders as diabetes, hypertension, and cardiovascular disease become more common due to newly acquired life-styles and eating habits. Millets are rich in fibre and their starchy nature has a significant part in lowering the risk of diabetes and other related disorders. They also have many nutritional, nutraceutical, and health-promoting characteristics. In fact, millets function in our inner environment as a prebiotic feeding micro flora. Our intestines will be hydrated by millet, preventing constipation. The abundance of tryptophan in millet results in the production of serotonin, which elevates mood. Millet's niacin can aid in lowering cholesterol. Consuming millet lowers triglycerides and C-reactive protein, protecting against cardiovascular disease. All types of millet exhibit considerable antioxidant activity. Both gluten-free and allergy-free, millet. Millets have been shown to have positive benefits on human health in several publications, many of which are online.

Millets: Nutritional Powerhouses

The nutritious properties of millets have slowly been uncovered thanks to recent scientific advancements. Millets were the first crops to be cultivated by accident, but they were also more nutrient-dense. However, until current biochemical, food, and health science investigations were conducted, their goodness remained unknown.

The world's population, which is heavily dependent on cereal-based diets that are lacking in micronutrients, faces a serious threat from nutritional insecurity. Millets have great nutritional value since their grains are rich in important amino acids, minerals, and vitamins, as well as proteins. In the majority of poor nations, millets are almost exclusively used for human food, whereas in wealthy nations, their usage has mostly been relegated to animal feed. In terms of carbohydrates and energy, millets are nutritionally comparable to main cereals and are an excellent source of protein, minerals, and phytochemicals. 7–12% protein, 2% fat, 65–75% carbs, and 15-20% dietary fibre are all included in millets.

Millets offer special nutritional qualities, including complex carbohydrates, a high content of dietary fibre, and phenolic compounds and phytochemicals with therapeutic benefits. In India, the issue of malnutrition must be addressed, and millets offer a natural supply of iron, zinc, calcium, and other nutrients. Niacin, B6, folic acid, calcium, iron, potassium, magnesium, and zinc are all present in increased concentrations. The richest source of calcium (300–350 mg/100 g) is finger millet, whereas other small millets are also significant sources of phosphorus and iron. Millets are great for boosting the neurological system since they are simple to digest, rich in lecithin, and easy to digest.

Table 1: Nutritional Composition of Millets

Grain	Carbo-hydrates (g)	Protein (g)	Fat (g)	Energy (Kcal)	Dietary fibre (g)	Ca (mg)	P (mg)	Mg (mg)	Zn (mg)	Fe (mg)	Thiamin (mg)	Ribo-flavin (mg)	Niacin (mg)	Folic acid (µg)
Sorghum	67.7	09.9	1.73	334	10.2	27.6	274	133	1.9	3.9	0.35	0.14	2.1	39.4
Pearl Millet	61.8	10.9	5.43	347	11.5	27.4	289	124	2.7	6.4	0.25	0.20	0.9	36.1
Finger millet	66.8	07.2	1.92	320	11.2	364.0	210	146	2.5	4.6	0.37	0.17	1.3	34.7
Kodo millet	66.2	08.9	2.55	331	06.4	15.3	101	122	1.6	2.3	0.29	0.20	1.5	39.5
Proso millet*	70.4	12.5	1.10	341	-	14.0	206	153	1.4	0.8	0.41	0.28	4.5	-

Source: Indian Food Composition Tables, NIN – 2017; *Nutritive value of Indian Foods, NIN – 2007

Comparing little millets to fine cereals, they are more nutrient-dense. They have higher levels of protein, fat, and fibre. Due to its greater viscosity and capacity to store water, dietary fibre is crucial in lowering blood glucose levels and insulin sensitivity. Additionally, it lowers cholesterol levels and lessens the incidence of gastrointestinal diseases. Dietary fibre components primarily exert their beneficial effects by lengthening transit time in the small intestine and by their swelling capabilities.

Millets: Wellness and Defense against non-communicable diseases

Consumers are discovering that millets are excellent nutritious grains that are good for human health, and data on scientific evidence for millets' nutritional and health benefits are now available. Millets are advised as suitable for the health of newborns, nursing mothers, the elderly, and convalescents. Millets have a low glycaemic index and slow-releasing glucose. This is crucial in the fight against the diabetes epidemic on a global scale. It is widely acknowledged that among the population who use these grains as a staple food, the incidence of diabetes mellitus and illnesses related to the gastrointestinal tract is very low. Additionally, its high fibre content aids in preventing constipation and may lower the chance of developing bowel problems, such as colon, colon, and intestine.

Function	Health consequences	Millet
Water absorbing and bulking property	Energy diluents to formulate low calorie diets	All Millets
Increased transit time of food in the gut	Reduced risk of inflammatory bowel disease.	Sorghum and Finger Millet
Bile acid and steroid binding	Hypocholesterolaemic activity and reducing the risk of cardiovascular diseases	Pearl Millet, Sorghum and Finger Millet
Retardation of carbohydrate absorption and impaired glucose tolerance	Management of certain type of diabetes	Sorghum, Pearl Millet and Finger Millet
Binding of toxins	As a detoxifying agent	Sorghum

India's SDG Advocacy

India has been leading the way in change. But there is a paradox in its evolution. On the one hand, despite the COVID-19 pandemic, Indian agriculture has been able to effectively overcome various obstacles to remain the economy's shining spot. We are not only a food-secure but also a food-surplus nation because of our agriculture's resilience, and our exports of agricultural and related products in 2021–22 increased by 19.92% to \$50.21 billion, which is by far the biggest amount. Ironically, though, we still fall short of some of the nutritional standards set forth in the Sustainable Development Goals (SDGs).

Data from the National Family Health Survey-5 (NFHS) in 2019–21, which was just published, revealed alarmingly little progress in easing India's malnutrition problem. Every fifth child is wasted (low weight for height), and more than one-third of all children under the age of five are stunted (low height for age) and malnourished. Due to the growing threat of "overnutrition," India is also struggling with a double burden of malnutrition. Overweight or obese, about one-fourth of adult Indians are at increased risk for developing non-communicable diseases like diabetes and cardiovascular diseases.

Our imbalanced and subpar diet is the main cause of our poor nutritional status and the corresponding nutrient deficits. The National Nutrition Monitoring Board has provided data on national consumption levels for the years 1979, 1991, 2002, and 2012. These data show a high intake of calorie-dense foods that are deficient in vital micronutrients including iron, vitamins, folic acid, and other nutrients.

The significance of millets cannot be overstated given the difficulty. Millets, which are widely regarded as superfoods, "Miracle Crops," or "Crops of the Future," are nutrient-rich, carbon neutral, and resource-efficient, and they play a significant role in improving global health, nutrition, agri-food systems, and climate change. Millets are naturally gluten-free, have anti-inflammatory characteristics, and are rich in dietary fibre, which helps fight and prevent many non-communicable diseases like hypertension, diabetes, obesity, and so forth. Millets are nutritionally complete with macro and micronutrients.

Millets were formerly a staple of Indian meals, but due to numerous supply and demand issues, we have forgotten about them. Over the last five decades, the amount of millet produced per person decreased from 35 kg to 13 kg, decreasing the variety of foods on our plates. Challenges on the demand and supply sides can both be implicated in the downturn. The mainstreaming of rice and wheat in social safety net programmes, rising urbanisation and per capita income, and changes in consumer taste and preference are a few examples of demand-side influences. India's per capita consumption of millets dropped dramatically between 1962 and 2010 from 32.9 to 4.2 kg, whereas that of wheat nearly doubled from 27 to 52 kg. Farmers are further discouraged from growing millets, and the use of millets-based products is constrained due to a lack of public awareness of the nutritional advantages of millets. Millets are no longer in high demand because of the longer preparation time.

The largest supply-side problem reducing millets' profitability has been the lack of a technological advancement in millet yield comparable to the green revolution raising millet production in rice, wheat, and maize. Farmers were further deterred from growing millets by a weak value chain for millet production and processing, a lack of innovative technology to

support decentralised processing, and a lack of industry demand for millet products with added value. The infrastructure needed to support millet production, including processing technologies and specialised milling machinery to meet the entire value chain, is insufficient. Additionally, the crops' relatively short shelf lives raise storage and spoilage-related issues.

But there are certain bright spots that ought to be mentioned. Despite a drop in the acreage and output of millets, India is still one of the top five exporters. Since 2010, the yield has increased positively overall with a CAGR of 2.12%. In 2018, millets were formally recognised as nutri-cereals, and the National Food Security Mission's nutri-cereals sub-mission was established. Millets are also included in POSHAN Abhiyaan to increase their supply and demand.

India proposed the International Year of Millets for 2023, so now is the perfect moment to increase production and consumption. In programmes to encourage the production and consumption of millets, many states are also emerging as success stories that should be scaled up and repeated throughout India.

The Odisha Millets Mission, which aims to revitalise millets on farms and plates, is setting the standard by concentrating on production, processing, consumption, marketing, including millets in government programmes like PDS and ICDS, and entrepreneurial activities like the opening of Shakti cafes. The Mission initially included 30 Blocks (7 Districts) in 2017, but after receiving favourable feedback and farmer demand, it was expanded to cover 142 Blocks (19 Districts), assuring the region's food security.

By utilising women self-help organisations to cultivate, prepare, and market millets, certain States, including Odisha and Madhya Pradesh, have also given livelihood prospects. The Integrated Child Development Scheme (ICDS) in many States, including Chhattisgarh, Madhya Pradesh, Odisha, Tamil Nadu, and Telangana, has also been offering millets, ensuring a steady supply of millets. Further replication of these ideas is required, not only for all *anganwadi* facilities but also for Mid-Day Meals and the Public Distribution System.

To increase millet processing efficiency, it should also be encouraged to invest in research and technology. It is important to promote small-scale, decentralised millet processing infrastructure that is affordable and simple for farmers, food processing organisations, and consumers to increase productivity, ensure quality, create off-farm employment opportunities, and generate financial gain.

In order to increase the production and productivity efficiency of millets, organisations like IIMR, CFTRI, ICRISAT, ICAR, and CGIAR are working to create a favourable ecosystem through research and development, capacity building, skill development programmes, and technology transfer. These organisations are also creating novel millet-based products like millet biscuits, pasta, dosa idli mix, ice cream, and more. In order to ensure *jan andolan* for millets, it is necessary to sensitise all pertinent parties.

The SDGs SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-Being), SDG 12 (Sustainable Consumption and Production), and SDG 13 (Climate Action) could all be accomplished with the help of millets.

Our Prime Minister wanted to elevate millets on a national and international level, and the government has effectively recognised this by referring to millets as Shree Anna, which is

Sanskrit for "food grains of divine grace." Let's position India as the world's millets powerhouse as the International Year of Millets is observed this year.

Millets: The Sustainable Superfood

India is commemorating 2023 as The International Year of Millets in its own special way, with events including national-level Millet *Melas* in several states and international trade fairs that draw visitors from all over the world. From a health standpoint, millets, often known as "smart food," are very nutrient-dense in terms of fibre, proteins, iron, and minerals. But from the perspective of sustainable development, millets are proving to be steadfast supporters in reducing the effects of climate change, food insecurity, poverty, and hunger. Promoting these nutrient-dense and climate-resilient small-seeded grasses in India can significantly advance efforts to meet UN SDGs and advance the much-admired Lifestyle for Environment (LiFE) campaign.

In the global game of achieving the Sustainable Development Goals, the article seeks to provide an outline of how millets might become top goal scorers.

Millets and SDG 1: No Poverty

The first SDG aims to end poverty worldwide. Millets can significantly contribute to the achievement of this objective by giving farmers a steady and consistent source of income. Compared to other crops, millets demand comparatively less money, time, and resources. For small farmers who might lack the funds to invest in high-input crops, they are the perfect crop. Millets are also a significant food source in many developing nations where poverty is rife. They are a reasonably cheap food source that can give those who might not have access to other foods the nourishment they need. Millets are an important part of the diets of more than 90 million people who live in Sub-Saharan Africa and Asia, two continents that are prone to relative poverty. Millets' low production and consumption costs together provide a substantial contribution to SDG 1's achievement.

Millets and SDG 2: Zero Hunger

The worldwide goal of ending hunger is what the SDG 2 aspires to accomplish. Millets, which are incredibly nutritious and loaded with necessary vitamins and minerals that are frequently lacking in the diets of people living in poverty, might be a crucial component in attaining this goal. Because of this potential, millets are being pushed in India as part of the country's efforts to combat malnutrition.

Millets are an excellent protein source and highly digestible diet for babies and young children. They are an economical meal alternative for all socioeconomic groups because they are also a good source of energy and can give long-lasting satisfaction. The inclusion of millets in children's meals in India could avert up to 24 million cases of malnutrition and 12 million cases of stunting, according to a study by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). These qualities show how millets can be effective in reducing hunger and achieving several SDG 2 aims.

Millets and SDG 3: Good Health and Well-being

SDG 3 is focused on good health and well-being. Since millets contain necessary vitamins and minerals that can help prevent chronic diseases such as diabetes, heart disease, cancer etc., they can be path breaking in achieving SDG 3. Having dietary fibre as the constituents, millets promote digestive health and prevent constipation. Further, studies suggest that Millets can even help lowering one's cholesterol levels as they contain omega-3 fatty acids as well as polyunsaturated fatty acids. Due to having relatively low glycaemic index, millets can help regulate blood sugar levels. Additionally, millets consist of antioxidants that can boost the immunity against oxidative stress. This richness of millets in terms of micronutrients helps not only in ensuring good health at individual level but also promoting well-being at community level.

Millets and SDG 12: Responsible Consumption and Production

Achieving SDG 12—which calls for sustainable consumption-production patterns—is directly related to the growth of millets production and consumption. Through consumption-production, this specific SDG encourages resource and energy efficiency, cost-saving for the environment, and poverty reduction. These goals work flawlessly with millets because they use 60–70% less water to grow than rice, mature in half the time as other paddy crops, and use 40% less energy to process. Millets require little to no pesticide application because of their reduced susceptibility to insect attack, further enhancing their production's environmental and health benefits. Additionally, eating millets encourages a sustainable way of life, and such diets maintain biodiversity and help ensure the security of food and nutrition.

Millets and SDG 13: Climate Action

SDG 13 is one of the most important goals because it describes the steps that must be taken to prevent climate change. Promoting millets is a sustainable way to respond to the need for swift action and risk mitigation related to climate change. Millets can be produced on marginal soils and require fewer resources to grow than other conventional crops because of their xerophilic and thermophilic characteristics. This can be useful in addressing the urgent problems caused by land use change, deforestation, etc. Actions to reduce carbon emissions are among the most crucial weapons in the fight against climate change. According to the ICRISAT, millets can reduce the carbon footprint of agriculture by up to 30%. Several research have shown that millets can convert substantially more carbon dioxide to oxygen. A significant value addition of millets is their agro-climatic flexibility, which lowers the likelihood that crops may fail owing to varying weather patterns. Millets are also known to improve soil quality, which can lessen the requirement for synthetic inputs that might have detrimental environmental effects. Millets' distinctive qualities can be extremely useful in the effort to mitigate climate change and fulfil SDG 13.

CONCLUSION

The production, consumption, and promotion of millets have additional benefits in accomplishing other SDGs in addition to all these significant contributions. For instance, Millets can contribute to achieving SDG 8's goal of "Decent work and economic growth" by ensuring the farmers' and society's economic growth through their low-cost production-

consumption. Furthermore, they can aid in achieving the goals of SDG 15 (Life on Land), as they are closely related to ecological and biodiversity issues. Significantly, massive public awareness programmes like those run by the Indian government can create positive alliances amongst farmers, agro-businesses, consumers, and related stakeholders. These collaborations meet the objectives of SDG 17, which calls for steps to create partnerships to advance the remaining SDGs, and no other SDG.

Overall, millets are a highly nutrient-dense, climate-resilient, and ecologically sound food source that can be crucial to accomplishing sustainable development objectives. They are inexpensive, nutrient-dense foods that, particularly in developing nations, can help fight poverty and increase food security. They are a good source of vitamins and minerals that are necessary for optimum health and wellbeing and the prevention of chronic diseases. Finally, millets can aid in lowering greenhouse gas emissions and battling climate change because they take fewer resources to grow than other crops. The Indian government is working to promote sustainable food systems by encouraging the inclusion of millets in regular diets. However, multiple constructive initiatives and innovations in the world of millets still await to help achieve the sustainable development goals efficiently and create a healthy, sustainable and inclusive future for everyone.

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MILLETS PRODUCTION IN INDIA: A DISAGGREGATED ANALYSIS OF PRODUCTION PROSPECTS OF TWO MAJOR MILLET CROPS IN INDIA

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ABSTRACT

Millets are known to be highly nutritious and healthy. In the last six decades, millets have seen a drop in area despite the green revolution in the 1960s; however, the productivity seems to go up with the help of high-yield varieties and better technologies. Millets are one of the oldest foods and small-seeded hardy crops that grow well in dry regions or rain-fed regions under weak soil fertility and moisture conditions. Millets are grown on low-fertile soil, tribal communities, rainfed places and hilly areas. Major millet crops found in India are sorghum (jowar), pearl millet (bajra), finger millets (ragi) and small millets like Barnyard millet, Proso millet, Kodo millet, Kutki millet and Foxtail millet. Traditionally, millets were produced and consumed extensively in the country and had almost equal area coverage to rice and wheat. However, the post- green revolution period witnessed a drastic decline in the area under cultivation of nutri-cereals by 41.65 percent between 1950–51 and 2018–19 (GOI, 2019). The present study carried out the estimation of the growth of millets in terms of area, production and yield in India from the year 1950 to 2020. The study indicates that there will be a surplus in the case of bajra and small millets, while in the case of jowar, there will be a net deficit in the coming years which is a matter of concern. The main reasons reported for this decline are; low remuneration as compared to other food crops, lack of input subsidies and price incentives, subsidized supply of cereals through the Public Distribution System (PDS), change in consumer preference due to difficulty in processing, the low shelf life of flour and low social status attached to millets. However, in recent years, recognizing their enormous benefits, the Government of India has introduced various policies to augment the production and consumption of millets. This study may help provide the roadmap for policy makers and researchers in framing suitable and sustainable medium and long-term strategies to boost the production of millet crops. There is a scope for augmenting the production in the short run by improving the productivity without increasing the area through popularizing new varieties, expanding certified seed distribution, and improving crop management practices.

Keywords: *Millet Production, Production Challenges and Production Strategies*

INTRODUCTION

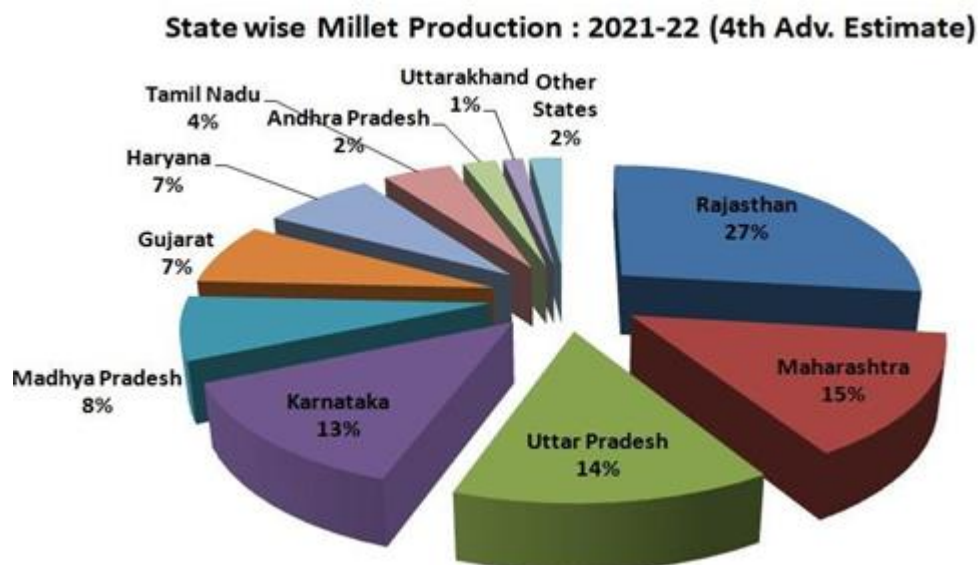
The year of 2023 will be observed as the “International Year of Millets”. In the last six decades, millets have seen a drop in area despite the green revolution in the 1960s; however, the productivity seems to go up with the help of high-yield varieties and better technologies. Millets, recognized as the nutritional powerhouses and alternatively referred to as 'Shree Anna' or 'Nutri-Cereals,' stand out as one of the ancient crops in Indian agricultural history. These are small-seeded hardy crops that grow well in dry regions or rain-fed regions under weak soil fertility and moisture conditions. Major Millet crops found in India are sorghum (jowar), pearl

millet (bajra), finger millets (ragi) and small millets like Barnyard millet, Proso millet, Kodo millet, Kutki millet and Foxtail millet. Six states namely Rajasthan, Karnataka, Maharashtra, Uttar Pradesh, Haryana and Gujarat accounts for more than 83 % share in total millet production. Rajasthan contributes 27 % of the total millet production in India whereas Maharashtra contributes 15% of the total production in India. In the last six decades, millets have seen a drop in area despite the green revolution in the 1960s; however, the productivity seems to go up with the help of high-yield varieties and better technologies.

Traditionally, millets were produced and consumed extensively in the country and had almost equal area coverage to rice and wheat. However, the post- green revolution period witnessed a drastic decline in the area under cultivation of nutri-cereals by 41.65 percent between 1950–51 and 2018–19 (GOI, 2019). The present study carried out the estimation of the growth of millets in terms of area, production and yield in India from the year 1990 to 2020. The study indicates that the area under bajra has increased while the area under sorghum (jowar) has not shown any significant increase. The main reasons reported for this decline are; low remuneration as compared to other food crops, lack of input subsidies and price incentives, subsidized supply of cereals through the Public Distribution System (PDS), change in consumer preference due to difficulty in processing, the low shelf life of flour and low social status attached to millets.

Millets exhibit a remarkable ability to thrive in challenging climatic and soil conditions, offering both nutritious grains and valuable fodder. Their adaptability extends to various cropping systems, making them suitable for both irrigated and dryland farming, thanks to their short growing season. Millets, with their capacity for prolonged and effortless storage under normal conditions, play a crucial role as Famine Reserves, a significant asset for India, particularly in the face of unpredictable monsoon patterns affecting our agricultural landscape. These small-seeded annual grasses form a diverse group cultivated as grain crops, predominantly on less fertile lands in dry regions across temperate, sub-tropical, and tropical zones.

Sorghum and Pearl millet are the major millet crops grown, constituting above 90% of the world millets production followed by Finger millet, Foxtail millet, Proso millet, Barnyard, Little millet and Kodo millet. Sorghum is the major millet grown globally constituting 65% of total millets. India contributes about more than 20% of the total world production of millets and about 20% of the total area under cultivation of millets in the world. Figure 1 shows the state wise millet production in India during 2021 to 2022. Rajasthan (27%) recorded the highest millet producing state followed by Maharashtra (15%), Uttar Pradesh (14%) and Karnataka (13%).

Figure1: State wise share of millets in India

Data and Methods

The study is based on secondary data compiled on various aspects like area, production and yield of major millets Bajra and Jowar found in India. The data on the area, production and productivity of the millets were compiled from the Ministry of Agriculture and Farmer's Welfare from 1950-2021. The data on the consumption of the millets was compiled from the various rounds of Consumption Expenditure Survey (CES) of National Sample Survey Organization (NSSO). The information on the government initiatives for the millets was collected from the various published sources.

Trends in Production

Table 1 shows the decadal average growth of pearl millet and sorghum in terms of area, production and productivity. It has been observed from table 1 that there was a steady decline in the area of pearl millets (bajra) from 11.09 million hectares during 1970-79 to 7.89 million hectares during 2010-20 while, the production has been on a rise that is 5.53 million tons during 1970s to 9 million tons during 2010-20. Further productivity has increased from 0.46 kg per hectare to 1.15 kg per hectare. This is indicative of the fact that the increase in production of pearl millet is due to an increase in productivity. On the other hand, Sorghum recorded the decrease in area from 16.55 million hectares to 7.89 million hectares. Production of sorghum also came down over the years from 9.55 million tons to 5.3 million tons. Although, the productivity of sorghum has increased over the decades.

Table 1: Decadal Average of Millet Cultivation in India during 1970-2020

Year	Pearl Millet (Bajra)			Sorghum (Jowar)		
	Area	Production	Productivity	Area	Production	Productivity
1970-79	11.9	5.53	0.46	16.55	9.55	0.58
1980-89	11.01	5.31	0.48	16.05	11	0.69
1990-99	10.06	6.71	0.67	12.22	10.21	0.83
2000-09	9.33	8.05	0.86	9.01	7.47	0.84
2010-20	7.89	9	1.15	6.04	5.3	0.88

Source: Directorate of Economics & Statistics, DAC&FW

Note: Area in Million Hectares, Production in Million tons, Productivity in Kg/Hectare

Millet production in India is confined to a few states of India. Table 2 shows the major millet producing states in India. The observation from the table indicated that Rajasthan and Uttar Pradesh together hold the major share of pearl millet in area (about 70%) and production (about 62%). In contrast, Madhya Pradesh ranks first in terms of yield (2533 kg/ ha) followed by Gujarat (2368 kg/ha) and Haryana (2318 kg/ha). Top producers such as Rajasthan and Uttar Pradesh were found to have a production of 3.75 m/t and 1.95 m/t, respectively. In the case of jowar, the top three states in terms of area and production are Maharashtra, Karnataka and Rajasthan while the situation of such states in terms of productivity is reversed. Andhra Pradesh stands first in terms of yield (3166 kg/ha) and Madhya Pradesh is the second-best performer in terms of yield (1941 kg/ha). Rajasthan is the leading state in terms of both area and production of nutri cereals. The area under cultivation is more widely distributed in the case of nutri cereals while highly concentrated in the case of Bajra & Jowar. Nevertheless, there is scope for improving the productivity in these states as it is comparatively low. In addition, it is easier to design and target millet-specific programs for production improvement as their cultivation is highly concentrated in a few states.

Table 2: Major Millet Producing States in India

Millets	Area (Million Hect.)	Production(Million Tonnes)	Yield(kg/Hectare)
NUTRI CEREALS	Rajasthan (24.38)	Karnataka (14.34)	West Bengal 7028
	Maharashtra (15.91)	Rajasthan (13.89)	Andhra Pradesh 4835
	Karnataka (14.30)	Maharashtra (11.47)	Telangana 4631
Jowar	Maharashtra (43.30)	Maharashtra (40.49)	Andhra Pradesh 3166
	Karnataka (16.36) Rajasthan (16.28)	Karnataka (17.75) Rajasthan (12.67)	Madhya Pradesh 1941 Uttar Pradesh 1578
Bajra	Rajasthan (55.74)	Rajasthan (38.98)	Madhya Pradesh 2533
	Uttar Pradesh (13.49)	Uttar Pradesh (20.25)	Gujarat 2368
	Haryana (7.21)	Haryana (11.64)	Haryana 2318

*Source: E&S Division, DA&FW*4th Advance Estimates*

Note: Figures in parenthesis is percentage share of millets in terms of production and area at all India level. Yield is measured in terms of kg/hectare.

As shown in Fig2, ICAR-IIMR assessed the utilization patterns of millets, revealing that approximately three-fourths of sorghum production is directly consumed by humans, with 12% used as animal feed, 8% processed into Fast Moving Consumer Goods (FMCGs), and 5% utilized for alcohol production. The remaining portion of sorghum is directed towards exports, both in grain and value-added product forms. Similarly, pearl millet (bajra) sees 69% used for human consumption, 15% as animal feed, 10% in alcohol breweries, and 5% for value addition processing. Around 1% of bajra serves as seed material for multiplication and seed production.

Ragi's usage differs slightly, with about 10% allocated to value-added FMCGs and three-fourths directly consumed by humans. Approximately 13% of ragi is designated for animal feed, while only 1% is earmarked for exports.

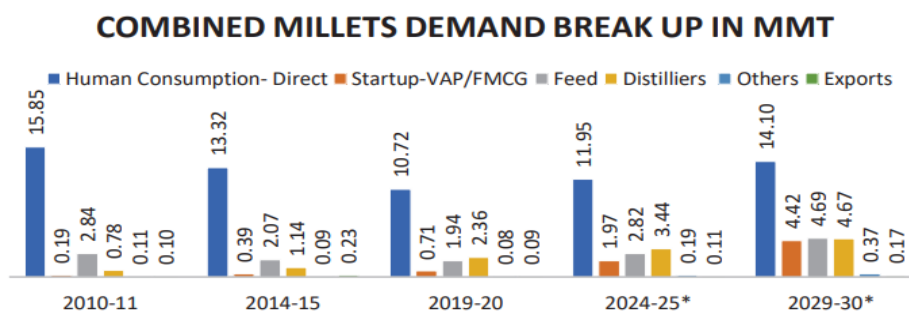
Additionally, millets have potential applications beyond food processing and human consumption. In the animal feed segment, the growing demand for maize in feed production, due to its energy efficiency, poses challenges as its production growth lags behind consumption. Millets like bajra, sorghum, and ragi may serve as alternative grains to address this deficit and prevent an over-reliance on conventional cereals like wheat and rice, primarily consumed as food.

Furthermore, millets are increasingly gaining traction due to rising health consciousness, especially in urban areas. The development of millet-based food products by startups and FMCGs is anticipated to attract more consumers, potentially leading to a resurgence in millet consumption in urban and semi-urban regions. In the animal feed sector, the projected livestock

and poultry population increase may strain the dominance of maize as a feed grain, opening doors for millets to replace maize in this segment.

Moreover, India's initiative to achieve 20% ethanol blending with petrol by 2025 has accelerated, aiming to reduce dependency on costly oil imports. This policy change is expected to drive millet usage in distilleries, with a projected growth rate of 7.05% from 2019-20 to 2029-30.

Fig 2: Consumption Pattern of major millets in India



Source: ASSOCHAM Report 2022

CONCLUSION AND SUGGESTIONS

The emphasis has been given on millet base production system and substituting water intensive crops has paramount importance in ensuring food and nutritional security in the era of climate change. The major millets in India, namely jowar and bajra, were analysed for their state-wise area, production, and productivity. Among the major millets, Maharashtra has the highest area and production of jowar, while Andhra Pradesh has the highest productivity. Rajasthan has the highest area and production of Bajra, with six states contributing to 95% of its production. The decline in area and production of millets has been attributed to easy availability of rice and wheat through PDS, resulting in reduced food consumption of millets in the producing regions. Lack of knowledge on the use of millets in daily diet and low social status of millet food also contributed to the decline. Similarly, the area under jowar has declined over the years, while the production has decreased or increased marginally. The area under bajra has declined by 0.60% per annum, but the production and productivity have increased by 1.68% and 2.28% per annum, respectively. The government could provide incentives and subsidies to farmers to encourage the cultivation of millets. This could help in increasing the area under cultivation of millets. Procurement policies need to be made more farmer-friendly to ensure that farmers get a fair price for their produce. Investing in research and development could help in developing improved varieties of millets that are resistant to drought, pests and diseases, and have higher yield potential.

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A STUDY ON THE ECONOMIC AND HEALTH BENEFITS OF MILLETS

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ABSTRACT

Millets are among the oldest foods known to humanity, estimated to have been under cultivation since 8000 BC. Millets have traditionally been the source of income, dietary energy, and protein for people in the arid and semi-arid tropics of the world. Millet has grown on the Indian subcontinent for 5,000 years and is common all over Africa and Southeast Asia. They are rich in vitamins, minerals, and nutrition and are the most farmer-friendly crops. India is drawing up a roadmap to figure among the top three exporters of millet by 2025, improving upon its fifth rank at present. This study elaborates on the Economics and Health benefits of Millet.

Keywords: *Millets, Economics of Millets, Demand of Millets*

INTRODUCTION

Millets are among the oldest foods known to humanity, estimated to have been under cultivation since 8000 BCE. Millets have traditionally been the main source of income, dietary energy, and protein for people in the arid and semi-arid tropics of the world. Millet has grown on the Indian subcontinent for 5,000 years and is common all over Africa and Southeast Asia. They are rich in vitamins, minerals, and nutrition and are the most farmer-friendly crops. In reality, adaptability and ease of cultivation of millets are reviving interest in it. One may find different types of millet throughout India, Major millets include sorghum (jowar), pearl millet (bajra), and finger millet (ragi) while minor millets include foxtail millet (kakun), proso millet (Sheena), kodo millet (kodo), barnyard millet (sawa), little millet (kutki), and two pseudo millets - buckwheat (kuttu) and amaranthus (chaulai).

Though millets have been grown in India for centuries for their nutritional richness, millet cultivation has decreased significantly since the 1980s, making space for wheat and rice as the cultivator responded to market demand. Recognizing the health benefits and nutritional density, the Government of India has been promoting millet cultivation in recent years. In April 2018, India rebranded nutrient rich millets as “Nutri cereals” and declared the year 2018 as the National Year of Millets. India also proposed declaring 2023 as the International Year of Millets (IYM), which the United Nations General Assembly accepted. Since then, India has been at the forefront of building a “People’s movement” by IYM 2023 while positioning itself as the global hub for millets. The Union Budget for 2024 referred to millets as “Shree Anna” or superfood, meaning the ‘finest foodgrain’.

Sustainability Benefits

Millets have several advantages in terms of sustainability over other crops. When comparing the amount of water required to cultivate rice and millet, it is clear that rice requires more water. A study has found that a rice plant requires approximately 2.5 times the amount of water as a single millet plant. Millets were grown alongside groundnuts and other crops by farmers. When

rice and wheat arrived, three to four decades ago, millet was supplanted as the primary source of food for farmers.

Health Benefits

Millets are unique in terms of nutrients and other health benefits. So, millets are miraculous. Recent studies have enough evidence of the potential of millet for managing and reducing diabetes. The low glycemic index of millet is helping to reduce and manage diabetes. Finger Millet also known as Ragi has the highest Calcium content and it's 3 times more Calcium than milk. This Calcium-dense grain keeps the bones and teeth strong. Millets are rich in dietary fiber and they also help in digestion and prevent constipation. Kodo Millet contains high dietary fiber.

Millets have rich antioxidants which protect human cells from free radicals. A recent study showed that millet can reduce the risk of developing cardiovascular diseases and helps in weight loss. Niacin, found in millet, is necessary for a healthy immune system and healthy skin and organs. Beta-carotenes are abundant in millet, particularly in the darker kinds.

According to research, Millet may also raise humans' "Good" cholesterol levels and lower triglycerides. Eating millet regularly may assist in keeping the heart healthy because it lowers cholesterol levels. Potassium, found in abundance in millet, aids kidney and heart health.

Area under production

India is the largest millet producer in the world, with a share of 44 percent, followed by China (appr.9 percent) and Niger (appr.7 percent). In India, millets are primarily a kharif crop mostly grown in rainfed conditions, demanding less water and agricultural inputs than other staple crops. While the area under millet production has decreased to one third between 1951 and 2022, production has increased marginally at the compound annual growth rate (CAGR) 0.2 percent, driven by improvements in yield (CAGR 1.7 percent) with the adoption of better farming practices.

The area under millet cultivation is concentrated in Rajasthan (35.5%), Maharashtra (20%), Karnataka (13.3%), and Uttar Pradesh (8.8%). Rajasthan also has the highest share in production at 26.7% followed by Maharashtra (14.4%), Uttar Pradesh (13.9%), and Karnataka (12.8%). In 2022, Rajasthan was a major producer of bajra (39%) followed by Uttar Pradesh (20.3%), Haryana (11.6%), and Gujarat (11%). Maharashtra was a leading producer of jowar (40.5%) followed by Karnataka (17.8%), Rajasthan (12.7%), and Tamil Nadu (6.9%).

Environmental Benefits

The environmental benefits of millet are numerous, they are cheaper to grow. These hardy crops are drought-resistant and require little water to grow. Some can grow on their own as weeds, even in rocky terrains. Millets also don't require more water and no expensive fertilizers and no pesticides.

Economic Importance of Millets

India is the largest producer of millets in the world and she is the 5th largest exporter of it. Exports are increasing exponentially as the demand for millets is increasing at a higher rate.

Millets are also helpful in addressing the need for fuel and feeds. It has more potential to produce biofuel.

As the demand for millet is increasing, it is creating more business opportunities for farmers/entrepreneurs. The Millet Market size was over \$9 billion in 2018 and will witness more than 4.5 percent CAGR during the forecast timespan (2018 - 2025) and the value projected is more than \$12 billion.

Demand for Millet in India

More than supply-side promotion will be required to harness the full potential of millet cultivation in India. In 2022, India's millet consumption was estimated at 17.8 million tonnes, growing at 1 percent decadal CAGR from 16.1 million tonnes in 2012. Annual per capita consumption of millets in India has reduced from 30.9 kg in 1960 to 3.9 kg in 2022.

A rising population with sluggish production is manifested in a decrease in per capita consumption of millet. However, consumer interest in millets is seeing some revival with greater health consciousness amongst the youth. In a survey-based research study undertaken in 2021 on millet consumption behaviour, 28 percent of the respondents switched to millet due to health reasons, while 15 percent started consuming millet for weight loss.

The study also observed that 40 percent of the respondents did not eat millet simply because they were not part of their dietary habits. The study concluded that, among other things, an increase in awareness about the benefits of millet may generate greater demand. Other than direct human consumption, millet demand is also expected to increase for animal feed, the food processing industry, ethanol production, distilleries, etc.

Apart from spreading awareness about the health benefits of millets, demand for millets can also be generated through policy support for better accessibility and better branding. Increasing interest in millets across various countries indicates growth prospects of this market in coming years. Shifting consumer perceptions toward the use of natural ingredients and increasing demand for high-protein grains are expected to provide opportunities for production diversification and industry expansion.

Once it was known as inferior grains but millets are now known as "Super grains" for better health, and high economic, and environmental benefits. Millets were an essential part of ethnic cuisine, most ethnic dishes across India are made of one or the other type of millet. Even in rice and wheat producing states like Punjab and Haryana where other food crops were nearly wiped out, dishes such as bajra khichdi remained popular. In drought-prone states such as Rajasthan, Gujarat, and Maharashtra, millets remained part of the daily diet in several regions.

Before the Green Revolution, according to an estimate, millets comprised around 40 percent of all cultivated grains. Now they are just around 20 percent. Millets or Shree Anna, the new name the government has coined for millets, today constitute only 5 to 6 percent of the national food basket.

Minimum Support Prices

On the other hand, Millets being cheaper, they have little attraction for farmers as they offer low marginal revenues. The government does not buy them or offer a minimum support price (MSP)

as well as it does for wheat and rice which are part of its food security program. Bajra, ragi, and jowar are covered by the Minimum Support Prices but farmers struggle to sell these crops at MSP. Millets also need to find a place in the government's free foodgrain scheme for farmers to start growing these crops. On top of the government's measures is to boost exports of millet and millet-based products.

The Millet & Million Target

India is drawing up a roadmap to figure among the top three exporters of millet by 2025, improving upon its fifth rank at present. Canada, Russia, and Ukraine are the top three exporters of millet, followed by the US. Global export of millets had increased to \$402.7 million in 2020 compared to \$380 million in 2019. During 2020-21, India exported millets amounted to \$28.8 million against \$26.7 million during 2019-20, to Saudi Arabia, the UAE, Nepal, Oman, the UK, Japan, Taiwan, and South Africa

India has nearly 40 percent share of global millet production but it exported 1 percent of its millet production in 2021-22, earning \$64.28 million, according to a report. While Canada, Russia, Ukraine, and the US are importing millets and exporting value-added products based on Millets. India just exports millet and the share of value-added products in millet is almost negligible. India has now begun to conduct better research to increase the shelf life of millet products and to manufacture more efficient processing machines.

The government earmarked an outlay of Rs 800 crore for millet-based products under its Production Linked Incentive (PLI) scheme, and 33 applicants were selected for the scheme. To promote the Millets, the Union budget announced funding for the Indian Institute of Millets Research in Hyderabad for R & D and the government has also provided a \$500,000 grant to the Food and Agricultural Organisation (FAO) of the UN.

CONCLUSION

Millets are mostly grown as rainfed crops with poor management and have several advantages, including low maintenance, disease resistance, nutritional value, market demand, fodder value, and ecological benefits. Millets are also considered to be an important crop that will be useful in critical challenges in the future like food, fuel, malnutrition, health, and climate change. With India's growing malnutrition problem, both under-nutrition and over-nutrition, there is a growing awareness of the need to move to healthier, more accessible, and inexpensive diets that include millet.

This study explores the status of production and demand of millets and related aspects that can guide policymakers and researchers in framing strategies to regain the lost glory of millets. There must be an increase in both production and consumption for the benefit of people and the planet. Creating awareness about millets' nutritional and environmental benefits and developing products that suit consumers' demands, including ready-to-eat foods, will foster consumption.

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AN OVERVIEW OF MILLET PRIMARY PROCESSING UNITS**Mrs. Nitya R Mahajan**Associate Professor, Department of Commerce, SIES College of Arts, Science and Commerce
(Autonomous), Mumbai**ABSTRACT**

Millets, in the category of Neglected and underutilized species (NUS) have been propelled to international limelight by the Indian government. Its benefits to human health and environment sustainability is being popularized, retitled as Shree Anna, with accelerating publicity and marketing by the Government of India, intended to result in the conversion of its sporadic demand and consumption locally and globally to a more continuous and large-scale demand. Simultaneously, MoUs with large and small companies have been signed for research and innovation in crop varieties, production, primary and secondary processing, formulating new delicacies in the RTE and RTC categories and marketing. This paper is an exploratory study to find data with respect to an integral part of the millet infrastructure, the primary processing units for millets in general and small millets in particular during the last 5 years in India, that can gauge the extent of such facilities in terms of number and proximity to production centres and also challenges involved in setting up the same. The methodology used is to access, analyse the data available from different institutions involved in the funding and working of the Indian Agricultural sector in general and Millets in particular and discussions with a few stakeholders. The number and proximity of such units is still vague as the data is very scattered and inadequate. The challenges in setting up and operating such units are disclosed in several research articles and discussions. More research on the volume of infrastructure requirement and bridging the gaps will help India fructify the millet funding to realise Millet targets.

Keywords: Processing, Farmers Produce Organisation,

BACKGROUND

Millets, in the category of Neglected and underutilized species (NUS), have been propelled into limelight with the Government of India promoting 2023 as the International year of Millets (IYM). Retitled as Shree Anna, its benefits to human health and environment sustainability are being popularized with accelerating publicity and marketing, intended to result in the conversion of its sporadic demand and consumption locally and globally to a more continuous and large-scale demand.

India is a producer of Jowar (Sorghum), Bajra (Pearl Millet), Ragi (Finger Millet) and small millets such as Foxtail Millet, Proso Millet, Little Millet, Barnyard Millet, Brown top Millet and Kodo Millet. Since 2012, the Government of India has initiated efforts in the form of Intensive Millet promotion, including millets in National Nutrition Strategy, declaring 2018 as the National year of Millets, funding outlay of Rs. 300 crores, proposing International Year of Millets 2023, revising guidelines for procurement, allocation, distribution and disposal of

millets, earmarking an outlay of Rs 800 crore for millet-based products under its Production-Linked Incentive (PLI) scheme ¹

*It seems like the perfect setting for start-ups to seize the opportunity and produce millet unicorns. Despite this, no millet-focused start-up has been able to scale or become a national or local brand.*²

Companies like ITC Ltd., Hindustan Unilever Ltd., Flipkart and others have been roped in for the promotion and production of millet based products. However, reports suggest that the desired increase in millet production (area and quantity) have not been achieved. The area under production of millets has almost remained stagnant from 2018-19 to 2021-22 with a decrease in the areas of Jowar, Bajra and Small millets and an increase in Ragi cultivation area. Production has increased but not at the expected rate and the second estimates in February 2023 are short of the production targets of 2022-23.

In the Millet ecosystem consisting of farmers, traders, corporates, consumers and production technology and equipment for primary processing, secondary processing and marketing, the farmer is an important stakeholder. The challenges faced by the farmer in millet production and processing need to be appreciated, to accelerate the production and area under cultivation of millets. The objective of this exploratory study is to find data and challenges with respect to primary processing units available to farmers, an integral part of the millet infrastructure, for millets in general and small millets in particular during the last 5 years in India. The paper also takes an overview of the involvement of principal institutions in facilitating primary processing units for millets.

METHODOLOGY

Data from principal institutions such as Department of Agriculture and Farmers Welfare (MoAFW, GoI), Indian Institute of Millets Research, NUTRIHUB - Technology Business Incubation Startups Confederation, Small Farmers' Agri-business Consortium, NABARD and other institutions/ organizations including non-governmental, involved in the funding and working of the Indian Agricultural sector in general and millets in particular, were accessed apart from research papers and articles from the web, to analyze the available data by computing simple ratios. Some stakeholders were also interviewed to understand the scenario with respect to challenges involved in primary processing of millets.

Analysis --

A demand level analysis based on a large-scale survey conducted in seven major cities in India for assessing millet consumption behavior in urban India found that the largest group among early adopters of millets were people with health problems (28%), it being the single largest reason for consuming millets, except in Chennai and Hyderabad. (Potaka et al, 2021) The study also found no statistically significant relationship between state-wise per capita production and frequency of consumption of millets in the urban areas and in conclusion recommended

¹ Economic Times, April 2023

² The Hindu Business line - Why start-ups aren't excited about millets- Feb 23, 2023

developing delicious products to satisfy the taste, providing knowledge on nutritional and health facts on millets, and improving accessibility of millets in urban markets.

The current retail prices on Big Basket for polished millets for 1 Kg of Jowar is Rs. 78, Bajra Rs. 57, Ragi Rs. 70, Kodo millets Rs. 127, Foxtail millets Rs. 117, Proso millets Rs. 150, Barnyard millets Rs. 160, Browntop millets Rs. 500 and Little millet Rs. 115. Certain varieties of millets are not easily available. Also, the quality of millets may vary from brand to brand and from time to time.

Table 1: Major Millets & MSP (per quintal)

	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Jowar	Rs. 2430	Rs.2550	Rs. 2620	Rs. 2738	Rs. 2970	Rs. 3180
Bajra	Rs. 1950	Rs. 2000	Rs. 2150	Rs. 2250	Rs. 2350	Rs. 2500
Ragi	Rs. 2897	Rs. 3150	Rs. 3295	Rs. 3377	Rs. 3578	Rs. 3846

Source: Economic survey of Maharashtra 2021-22 and Ministry of Agriculture and Farmers welfare

The supply level analysis of millet production shows that millets are grown in about 12.45 million ha. with an annual production of 15.53 million tonnes contributing 10% to the country's food grain basket³. As per data from DoAFW Sept 8, 2023, small millets witnessed an increase in area to 5.24 lakh hectares in 2023 as compared to 4.93 lakh hectares in 2022 whereas, other cereals such as Jowar, Bajra, and Ragi saw a decrease in area covered in 2023 as compared to 2022.⁴ Major Statistics with respect to area under millet cultivation and production quantities for a period covering 2018-19 to 2021-22 are presented in below tables for inferences:

Table 2: Area under cultivation ('000 hectares)

CROP	2018-19	2019-20	2020-21	2021-22
Jowar	4093.29	4823.76	4377.87	3800.81
Bajra	7105.03	7542.68	7652.10	6840.80
Ragi	890.94	1004.46	1159.40	1218.43
Small millets	428.92	453.75	458.35	444.05

Source: Department of Agriculture and Farmers Welfare

³ ASSOCHAM - knowledge paper on Millets - The future superfood for India - June 2022 prepared by IIMR and Nutrihub

⁴ Kharif Crop Sowing Surpasses 1,088 Lakh Hectares: Department of Agriculture & Farmers' Welfare, Krishi Jagran, sept 11, 2023

Table 3: Production of Major and Small Millet ('000 tons)

Crops	2018-19	2019-20	2020-21	2021-22	2022-23	
					II nd Advance Estimates)	Target
Jowar	3475.41	4772.11	812.07	4150.57	4075	
Bajra	8664.13	10362.60	10863.17	9780.63	9785	
Ragi	1238.70	1755.06	1998.36	1701.12	1669	
Small millets	333.00	370.81	346.95	367.44	380	

Source: Department of Agriculture and Farmers Welfare

In Karnataka and Odisha, through government intervention and support from IIMR and NGOs, farmers have turned into entrepreneurs, and consumption and productivity has gone up. States of Maharashtra, Madhya Pradesh, Odisha, Tamil Nadu and Telangana are forerunners in millet based products. In terms of highest area and production volume, Maharashtra tops the states for Jowar, Rajasthan for Bajra, Karnataka for Ragi, and Madhya Pradesh for small millets, with an increasing trend for Ragi in Karnataka while others indicating a decreasing trend or stagnancy up to 2021-22.

'The primary focus of the mainstream has been on market centric approach, however to usher sustainable food systems, what needs to be strengthened is people centric decentralized community owned processes'⁵

Infrastructure for Primary Processing Of Millets

Primary processing includes the removal of the inedible part of the grain. Traditionally, this tedious and time consuming process was manually done, mostly by the women folk. Destoner, Grader, Aspirator, Dehuller and Millet polisher are the major equipment required for such processing. Few companies that manufacture primary processing equipment are Perfura Technologies (India) Private Limited, Borne Technologies Private Limited, Bhavani Industries, AVM Engineering Industries, Nabhitha enterprises and other organizations such as Dhan foundation.

Setting up a small scale processing unit for 100- 500 Kgs. per hour requires up to 150 sq.ft space for equipment and 600 sq.ft for storage costing between Rs. 4 to 7 Lacs while a medium scale processing unit for 600 - 1,000 Kgs. per hour requires up to 400 - 600 sq.ft for equipment and 5,000 sq.ft for storage costing between Rs. 12 to 15.4 Lacs. A tabletop small millet processing machine costs around Rs. 75,000 for smaller capacity of 30 kg - 80 kg per hour, and even 0.5 Kg can be processed in it.⁶

To commence a business in processing requires licenses and permissions from FSSAI (depending on turnover), GST, UDYAM, Weight and Measurement. Operating costs of a small scale processing unit is estimated at Rs. 1 Lac or more per month depending on labour and

⁵ LEISA INDIA - Decentralized small millet processing at <https://leisaindia.org/decentralized-small-millet-processing/>

⁶ Tabletop Millet processor, Dhan Foundation

electricity rates in the state, excluding any EMIs on loan borrowed for the capital investment. Further, trained manpower is required to operate the machines.

A search on Google maps for Millet Primary processing units in India revealed only ICAR-IIMR. A further search for Kodo millet processing units in India revealed 12 units, of which some were supplying only polished millets while some also supplied snacks. Another 5 units popped up on searching for Proso millet processing units in India, most of the other names being repetitive.

Indian Institute of Millets Research (IIMR), a premier agricultural research institute under Indian Council of Agricultural Research (ICAR), coordinates and facilitates Millets research at national level through All India Coordinated Research Projects on Millets, Pearl Millet and Small Millets and provides linkages with various national and international agencies. Further, Nutrihub TBISC, the Department of Science & Technology (DST), Govt. of India supported Technology Business Incubator hosted by the Indian Institute of Millet Research, ICAR – IIMR, Hyderabad caters to start-ups needs in the Nutricereals sector of the country. The White paper on Millets- Nutrihub _ ICAR -IIMR- National Mega Multi Stakeholders Meet (Virtual) Sep 2020- Millets Consortium, refers to 400 plus millet startups having emerged in four years up to 2020 with the efforts of Nutrihub, TBI at ICAR-IIMR, including Perfura Technologies, Eat Millet, Kamakshi Foods, Go Bhaاراتi, DMR Foods, Health basket and Millenova among others. Out of the list of 175 Millet Startups incubated/trained from Nutrihub TBI of Hyderabad around 10 are for business ideas related to primary processing/ processing machinery, of which 8 are located in south India.

The data available in the annual reports of IIMR with respect to Memorandum of Agreements/ Understanding for last 5 years has been tabulated below:

Table 4: MOA/MOUs ICAR-IIMR (signed at ICAR-IIMR under Nutrihub)

YEAR	2018	2019	2020	2021	2022
Total number of MoUs	15	13	6	34	49 15 (Nutrihub)
MoUs for Millet primary processing/ Machinery	NIL	1	NIL	2	1 4 (Nutrihub)

Source: ICAR-IIMR Annual reports

Dhan Foundation, a pioneering development institution, recorded sales of 395 primary processing machines from 2019 to 2023 in 24 states and Nepal. (Arunachal Pradesh 83, Telangana 58, Nagaland 50, Tamilnadu 48, Madhya Pradesh 25, Andhra Pradesh 20, Maharashtra 18, Karnataka 15 being the major supplies). Some of these have been supplied to Farmer producer organizations/ companies.

Role of Farmer Producer Organizations

A Farmer Producer Organization (FPO) is typically a society/company consisting of farmers who are actual producers of a specified commodity/ commodities, and act as an aggregator for member farmers including inputs to output which will enhance the economy of scale and

bargaining power of member farmers. The traditional supply chain model includes Farmer-Trader-Bulk processor-Wholesaler-Retailer-Consumer while the suggested supply chain with FPO intervention is Farmer-FPO (processing at Farm gate)-Warehouse-Consumer/Food Vendor ICAR-IIMR is a nodal agency that is working exclusively on millets and handholding 41 millet FPOs in four states (Sangappa, Rafi, 2023) .

State wise list of registered FPOs details under Central Sector Scheme for Formation and Promotion of 10,000 FPOs by SFAC indicates out of 2,773 FPOs, ‘Millet’ is mentioned in the names of

- 11 (10 in Karnataka and 1 in Madhya Pradesh) out of 566 (Allocation in 2020-21)
- 4 (2 in Karnataka and 2 in Haryana) out of 895 (Allocation in 2021-22)
- 8 (2 Karnataka, 4 Tamilnadu, 2 Uttar Pradesh) out of 1,312 (Allocation in 2022-23). Out of 901 FPOs under SFAC old programs 66 are engaged in millet production. NABARD portal shows state wise FPOs ⁷ totaling 2,065 registered up to the year 2022. The search word in the name of the FPO or in the crop or business yielded the following results:

Table5: Number of FPOs in Millet

(Search result in NABARD Portal)

Search word	Millet	Jowar	Bajara	Ragi	Kodo	Total
No. of FPOs	56	15	8	25	1	105

Under Equity Grant Sanctioned Projects under Formation and Promotion of 10,000 FPO Scheme. Out of 79 FPOs registered as on 31.03.2021, 4 included Millets production/ processing out of which 2 were in Tamilnadu, 1 in Karnataka, 1 in Andhra Pradesh. Out of 113 FPOs registered in 2021-22, 6 included Millet's production/ processing out of which 5 were in Karnataka and 1 in Madhya Pradesh.⁸ Out of a total of 569 Farmer Producer Organizations (FPO) in the State of Maharashtra 9 are FPOs with millets⁹. The E catalogue lists 137 new entrepreneurs/ startups, however the business idea is not specified. The catalogue also shows a list of 60 exporters from Maharashtra.

Stakeholder's Comments

Interviews were conducted with a Manglore based farmer and also the founder of a farmers producer company in Maharashtra. Summary of the interviews:

“Farmers are reluctant to shift to millet farming as it is simply not cost effective for them. They also lack awareness and themselves are consuming more rice and wheat rather than millets. Millet farming is left to the tribal population. The current cost of equipment is not affordable for the farmer with a small land holding. A Farmer cannot exclusively grow millets throughout the year as they follow crop sequencing with rice, chickpeas etc. There is also the risk of excessive rainfall or flooding resulting in millet crop failure. They find it more profitable to grow crops

⁷ <https://nabfpo.in/images/staticFPO.html>

⁸ Small farmers Agribusiness consortium

⁹ Ministry of Food Processing Industries, GoI-E catalogue for export of millets and value added products Maharashtra - APEDA

that fetch them a higher MSP. Certain states are still planning for MSP for small millets. They sell their produce of unprocessed millets for Rs. 30 to Rs. 50 per Kg. depending on the variety of millet, to traders and bulk processing companies. Currently, there may be only one processing unit for 20 to 25 villages or even more in most of the states barring a few states like Tamil Nadu. It is not economical nor practical for the farmers to transport their produce to distant processing units. Due to lack of primary processing units farmers in certain states, engage in the practice of bundling up the millets produced in blankets and placing them on roads, so that they get dehusked by the pressure of the vehicles that pass over them. Companies with large scale operations can afford to import processing machinery, but some existing smaller Millet primary processing units, even FPOs are on the verge of shutting down as they are not able to breakeven with the operating costs with limited quantity of millet supply for processing. The Millet processing equipment cannot be refitted to process other grains. Due to non-availability, processing equipment of other grains such as rice are used to process millets, resulting in poor quality of output. The available equipment are few and still require a lot of manual labour prior to machine processing of millets. Initial government support for such units, if any, fades away before the FPOs/ Processing units are self-sustaining, given the erratic demand from consumers and equipment issues. Considering these challenges, farmers, who are faced with poor returns and too much effort, are not motivated to replace production of other lucrative crops with millets.”

DISCUSSION

"It was a great experience to buy cave man's food'- One review about millets, from a visitor to ICAR IIMR. The level of awareness of consumers with respect to its history and also its health benefits is quite low. Ready to cook and Ready to eat millet based products of big and small brands are gaining popularity in health conscious urban consumers, but mainly for those with any ailments.

Statistics clearly indicate that the area under Jowar, Bajra and small millet cultivation have dropped, despite the availability of bulk processors and Government pumping in funds into the millet ecosystem. From 2018-19 to 2021-22 production estimates indicate an increase of around 20% for Jowar, 13% for Bajra, 37% for Ragi and only 9% for small millets. February 2023 second advance estimates 2022-23 are short of the targets for 2022-23. The MSP for Jowar, Bajra and Ragi has been rising, but for small millets the centre is yet to announce any policy for benchmark price. The Government's own procurement of millets (other than Ragi) is not even 5% of the produce which is much lower than its procurement of Rice and Wheat.

In certain states, with hand-holding by government institutions and non-governmental organizations, millet production has made some progress. Probing into the millet ecosystem brings out the existing supply chain model that inflates the retail price of millets. Affordable primary processing equipment suppliers are few. For small and medium scale operators, investment and operational cost of primary processing units does not seem to be feasible. The existing equipment needs to be enhanced for better performance in terms of ease of usage, quantity of output and also the quality of the output.

It is evident that there is a huge gap in the retail price and the sale price that the farmer earns for most of the varieties of millets. Small land holdings, cost constraints and other issues dissuade

small farmers from scaling up their millet output and therefore do not merit a home processing unit. The attempt to find Millet's primary processing units via IIMR- Nutrihub and SFAC data revealed that out of 132 MoUs/MoAs signed at ICAR-IIMR from 2018-2022, only 8 were related to primary processing/ processing machinery, which is around 6%. Farmer Producer Organizations (FPOs) are meant to support farmers at farmgate. An analysis of FPOs for millet related activities is explained in table number 6.

Table 6: Number of FPOs and Activities

Registering agency	Total FPOs (a)	Millet FPOs(production/ aggregation/ processing/ marketing) (b)	Percent (b/a)
SFAC(old program)	901	66	7.33 %
SFAC - CSS - 10,000	2773	23 (only title)	< 1%
NABARD	2065 (upto 2022)	105	5.08 %
Total	5739	194	3.38%

Source – IIMR & SFCA

The percentage of processing units/ equipment manufacturers that are registered or funded is quite minimal, as per available data. There may be other FPOs engaged in millet production and processing, but there is no indication to that effect in the list of FPOs under SFAC - CSS. The processing equipment supplied data shows lopsided distribution among states. In several states, existing processing units for other grains are used for millets processing, resulting in wastage and poor quality millets. Data of such units is not available. Sentiments of stakeholders at farm gate level for millet production are not very encouraging. Farmers are not sure of Government schemes related to millet farming.

CONCLUSION

Ready to Eat, Ready to cook products and secondary processing seem to be the focus of the efforts directed towards millet promotion in the year of international millets. Considering that demand for millet products have not picked up in a big way, such efforts are justified. However, at the supply end, the need for primary processing units at farmgate cannot be ignored, as development of such units can support a more farmer-friendly model by breaking away from the traditional supply chain. Such a model has the potential to encourage farmers to increase the area under millet production and address the pricing gap between unprocessed millets and primary processed millets.

Data availability about small Primary processing units engaged in millets and those engaged in millets and other grains at farmgate or otherwise are limited and scattered. Existing data points to a dearth of such units and any related activities. Farmer producer organizations and self-help groups have been tapped successfully in this respect in very few states. As per available data, the number of FPOs engaged in millets/ primary processing of millets is negligible. Further, it is not clear whether all those FPOs involved with millets, undertake primary processing and are operational. More research in this area is critical to the Millet mission of India. This will help in formulating more fruitful funding schemes that will motivate farmers, complement the efforts of various institutions in promoting millets and bridge the infrastructural gaps to move towards better demand-supply management of this super food.

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REVISITING THE YOGA AND THE AYURVEDIC INSIGHTS TO THE SHREE ANNA

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ABSTRACT

*Aharashuddhay Sattvashuddhah
Sattvashuddhau Dhruva smritih
Smritilabhe Sarvagrathian Vipramokshah
Chandogya Upanishad 7-26-2)*

“Through the purity of food results purity of intellect, through the purity of intellect results steady memory, through the attainment of recollection all the knots are completely broken. Therefore, what we eat may determine our Liberation or Self-Realization.” The significance of food as an energy is discussed in the above shloka by Sage Narada to Sanatkumara. Eating thus, has not remained a basic human motive anymore. As we have evolved, we have modified our food habits by a process of trial and error, selecting the foodstuffs which facilitate growth, well-being, and nourishment. The rising awareness regarding diet and significant shift in food habits have brought a surge of superfoods, revealing their extraordinary nutritious and wellness worth. One such superfood is ‘Millet’- ‘the Shree Anna’ as addressed by the Honorable Prime Minister of India, Shree Modiji for its remarkable nurturing value. The United Nations General Assembly at its 75 th session declared the year 2023 as the ‘International Year of Millets’. This awareness generated to recognize millets as the globally preferred crop, as a gateway to prosperity of farmers, as a medium of agro-economic development and as a wholesome diet is an endeavor to regenerate and reassure social, economic, and dietary well-being. This paper is a humble attempt to revisit the classical systems of Indian Philosophy- Yoga and Ayurveda darshanas to unravel the significance of millets- the nutri-cereals as part of Ahara shastra for a well-balanced life. The texts on Yoga and Ayurveda explicate on how Anna is an essential biological function influencing spiritual awakening for lay people as well as spiritually inclined ones (sadhakas and yogis) to accentuate their vital energies and vigor for bringing in a holistic life functioning. The first section of the paper presents Ahara as an essential pillar of health as discussed in Indian philosophy in general. The second section speaks at length the information on different types of millets as found in the ancient manuscripts. It highlights their nutritious, pertinent in terms of wellness with reference to prakriti guna and doshas as mentioned in the classical texts. The concluding part remarks on the present awareness campaign on millets to popularize its value and usage for its resurgence for economic and social welfare.

Keywords: *Millets, Ahara, Yoga, Ayurveda, Prakriti dosha, Gunas*

Annam Brahma, Rasam Vishnoho

Bhokta Devo Janardanam

Evam Dhyatva Tatha Gyatva

Anna Dosho na lipyate.’ (Bhojana Mantra)

As the saying goes- ‘what you eat, you become.’ Truly, the act of consuming food is the divine essence. The ‘gustatory’ sense is the most widely discussed topic today, especially in the post pandemic times, when we have realized the finitude of life, the value of well-being and the need for a wholesome lifestyle. Eating habits, health issues, dietary restrictions, fitness and regime are the major concerns today.

The WHO defines ‘health’ as “the state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity.” We may go a step further to add spiritual wellbeing to this definition to make it holistic. The term food can be defined as- ‘Any nutritious substance that people or animals eat, drink or that plants absorb in order to maintain life and growth’. Biological science defines food as- ‘Any substance consumed to provide nutritional support for the body, which contains essential nutrients like carbohydrates, proteins, fats, minerals, vitamins etc. to produce energy, maintain life and stimulate growth’. From the above meanings, we may conclude that food is synonymous with nourishment and it is undoubtedly the ‘fuel’ or ‘energy-source’ for the body.

Thus, the need to philosophize about the character of food is to deeply contemplate upon the what, how and why of ‘eating’, as it influences the bio-psychic impulses to promote a healthy, fulfilling and value-oriented life experience. In other words, it is to look at the epistemological, metaphysical and ethical dimensions of food and reflect upon food not just as something that fulfils appetite but as a nurturing phenomenon. While organic eating might have become a fad recently, India has nurtured this culture of nutritious eating and traditional food since its ancestral history. The present chapter is an attempt to revisit the philosophical significance of ‘food’ in general and ‘millets as superfood in particular’ with reference to Yoga philosophy and school of Ayurveda.

The ancient school of Yoga as formally represented by Rishi Patanjali in his magnum opus *Yoga Sutras*, provides the science and art of all-inclusive living. The term yoga is etymologically derived from Sanskrit root *yuj* which means ‘union’- of body, mind and soul. The chitta comprised of buddhi, ahamkara and manas is to be controlled in order to attain spiritual elevation by balancing the inner and outer realm to realize the ultimate bliss-Kaivalya. Apart from Patanjali sutras, the other Yogic texts of equal importance are *Hathiyogapradipika* by Swami Swatmarama and the *Srimad Bhagavad Gita* which is part of the great epic Mahabharata. Ayurveda, on the other hand, is an antique system of medicine, accentuating an all-encompassing approach towards health and wellness. *Charaka Samhita* defines it as, “The science which treats what is advantageous and what is harmful for the body and also the happy and unhappy states of life. It explains what is good and bad for human life, its measurement and other related matters.” Ayur means life and Veda is knowledge. Thus, it is the science of life. Let us have a look at what the *Bharatiya Tattvajnana Darshanshastra* and the philosophical texts of the schools’ state about *Ahara* or food intake in general.

The concept of healthy living is well explicated in our philosophical scriptures. The Vedas, the Upanishads, the Bhagavad Gita, Yoga sutras, *Hathayoga Pradipika*, Ayurveda-Charaka Samhita, Gheranda Samhita etc. have recognized the four pillars of wellbeing- Ahara (dietary habits), Vihara(recreation), Achara(conduct) and Vichara (thinking) respectively.

Ahara or food is not just a biological motive. It is considered as ‘Annam Purna Brahma Swarupam’- a holistic/complete form of the Supreme being. Thus, Annam/Khadyam/Prana/Ahara is that which nourishes. The Charaka Samhita states, ‘Prana Pranamrutumnam’ i.e food is the very life of the living. Taitirya Upanishad speaks at length about the Pancha Kosha theory i.e the five sheaths that cover the pure, pristine Atman/Soul. The first cover is Annamaya Kosha-the gross physical body; the second is the Pranamaya Kosha-the subtle body; next is the Manomaya Kosha-the perceptual body and finally the Anandamaya Kosha-the blissful body. It thus states that Anna or Ahara forms an important part of our existence.

In the Upanishads there is an anuvakya where it is stated- *“I am food, I am the eater of food, I am the uniter, I am the first—born of the true, prior to the gods and the navel of Immortality. He who gives me away, he alone preserves me. He who eats food—I, as food, eats him. I, as the Supreme Lord, overpower the whole world. I am radiant as the sun. Whosoever knows this, attains Liberation. Such, indeed, is the Upanishad.”* The Srimad Bhagvad Gita describes intake of food as YajnaKarma. Sri Krishna says, “All that you do, all that you eat, all that you offer and give away as well as all austerities that you may perform should be done as an offering unto me” (Ch9/27). Sri Krishna says, “Aham vaisvanaro bhutva praninam dehamasritah pranapana samayuktah pacamyannam chaturvidham” i.e. “I am the fire of digestion in every living body and I am the air of life going outgoing and incoming, by which I digest the four kinds of food stuff.” (Ch 15/14)

‘Susnigandhamadhuraaharaschathurthurthansha vivarjitah

Bhujyate shivasamprityai mitaharah su uchyate’

Hathayogapradipika refers to ideal food as ‘mitahara’ i.e., optimal quantity, quality and mindset while eating to facilitate the process of annaprashana and pachana kriya. It means one should eat food as an offering made to (Shiva), food that is agreeable and sweet, leaving one fourth of the stomach empty. Thus, food ought to be eaten with a sense of dharma, jnana and vairagya. The Gita, a quintessence of Yoga, highlights three qualities/gunas of food namely- Sattvika, Rajasika and Tamasic Ahara. Satvapradhana ahara is wholesome, fresh, organic, unrefined food providing spiritual goodness; Rajasika pradhana food is spicy, hot, salty, dry, acidic, polished food that produces stimulation and energy at high levels. Tamasic pradhana food is heavy, oily, canned, artificial, and toxic and generates lethargy, dullness and obtuseness of mind. (Ch 17/8,9 and 10) Thus, the Yoga darshana prescribes Sattvika and moderate Rajasic Anna as part of Aharavidhishastra. Ingestion of food is related to digestion and in turn associated with recreation of healthy functioning. In the Ayurveda Charaka Samhita, food and food items have been classified based on its composition , sources, effects, forms, energies.

Table1: Classification of Food Items under Ayurveda

Basis	Nature	Name used
Composition	quickly digestible, slow to digest	<i>laghu anna , guru anna),</i>
Sources	Corn, pulses, meat, vegetables, fruits, greens, wines, water, milk products, cooked food	<i>suka dhanya shami dhanya, mamsa varga, shaka varga, phala varga , harita varga, madya varga, jala varga , dugdha varga, kritanna varga</i>
Forms	Eatables, drinkables,lickables,masticables	<i>ashita, peeta, leedha,khadita</i>
Effects	Wholesome and unwholesome	<i>Pathyatama, apathyatama</i>
Energies	air and ether-oriented food, fire and water-oriented food and water and earth-oriented food	<i>Vata, pita,kapha (dosas)</i>

Having stated the value of ahara, let us now highlight the significance of ‘millets’ as cited in the above classical texts. The term millet is derived from the Latin root ‘miliun’ meaning small seeds. These nutri-cereals are referred as ‘kanva’ or ‘shyamaka’ in Sanskrit. They are also called ‘Trinadhanya’ meaning grains grown in the wild without cultivation. The generic nomenclature includes under it different types of millets as- foxtail millet (kangu/priyangu), finger millet (ragi/mandukparni/navani), barnyard millet (pradyota/syama), little millet (avalka/samaka/kutaja), kodo millet (kodrava), proso millet (vari), amarantha (chaulai), buckwheat (kuttu), pearl millet (bajra/samva), sorghum (jowar) etc. The names vary depending on their regional and dialectical usage. These ecologically friendly crops are a group of small seeded cereal grains, highly resilient in dry regions and with remarkable nutritional profile. The history of consumption of millets dates back to 7000 years. They were the earliest domesticated crops grown around the Asian and African continent. It has been the staple food of ancient civilizations of India, China, and Africa etc. In India, they share not just dietary significance but are also part of our rich Vedic and Darshanik heritage. In Atharvaveda, millets are referred as ‘sandadurva’ i.e., crops having egg shaped roots or long joints. Similarly, there is reference to ‘brihad durva’ i.e., large millet, ‘pakadurva’ i.e., small millet or edible millet are found in Rig, Yajur, Arthavaveda, Aryanyakas and Upanishads as well.

In the Yoga philosophy, millets are categorized under Sattvika Anna. That which is light, pure and calming to the mind, easy to digest, bringing a balanced effect on body, senses, mind and over all loaded with nutrition. Prana or life force is substantial for vitality and wellness for spiritual elevation. Millets support the flow of prana and contribute to mental and emotional balance conducive for yogic practice. They provide fiber, vitamins, minerals and healthy carbohydrates- making a diet well balanced and wholesome. They are gluten free. Ragi is rich in calcium, Jowar has potassium and phosphorus in great quantities and foxtail is fibrous while kodo is rich in iron. The Yoga darshana speaks at length about Ahara Niyama for yogis and commoners. How much to eat, what to eat and as per age, profession and spiritual level of advancement one need to decide upon food intake. Millet have energizing and healing properties hence perfect for the Yoga sadhakas for their physical and mental health. Millets are alkaline forming food that helps combine with digestive enzymes and maintains the ph balance in the body, thereby preventing illness. Millets have high water content, cooling properties and

hence keeps the body hydrated. They are great to promote weight loss, reduce chronic disease risk, boost metabolism, facilitate calmness and attention, strengthen immunity and enhance longevity.

Since Samhita kala, in Ayurveda Ahara, millets are recognized as one of the most important dhanya-varga packed with nutrition. They are referred 'kudhanya and 'trindhanya'. They are Pathya (regime) for treating numerous Rogas (diseases) and there are Pathya-Kalpanas (wholesome foods preparations) made from them. For instance, Shyamaka or barnyard millet absorbs excess fluids and helps improve normal formation of feces as well as enhances digestion. Kodrava or Kodo millet is pathya in vrana i.e., to heal wounds and ulcers; it is vishahara ie anti-poisonous as well. Priyangu or foxtail millet and vari or proso millet helps in brumhana or nourishing body tissues, shoshana or drying up excess moisture, bhagnasandhanakara or to heal fractures, durjara or help in digestion and vrishya or aphrodisiac. Sorghum or jowar millet has the property of ruchya or enhancing taste-perception, trishnaghna or pacifying thirst, kledaghna or pacifying excess moisture content. Ragi or finger millet is balavardhak i.e., it promotes strength, best in raktapitta and amlapitta (bleeding and gastric disturbances) Millets are best for Khafaja Roga, Pittaja roga and Raktadushti. Ayurveda prescribes its avoidance for Vataja roga as they in general are ruksha or dry. They are greatly effective for Prameha or diabetes, Kustaroga or skin ailments and Sthoulya or obesity. Ayurveda also states the Samskara or preparation and processing mode as important to enhance the effects of millets for health conditions to balance Vata, Pitta and Kapha. Soaking millets in warm water pre-cooking, adding ghee and Deepana-pachana/vata shamaka prashepakas or spices that pacify vata while cooking, milk and millets mixture to be avoided etc. Also, as far as the matra or quantity/frequency of ingesting is concerned, it is to be regulated, for Ayurveda does not list millets as Nitya Sevaniya Ahara. Their consumption is determined on the basis of the 'chikitsa' of the rogi and the roga taken together.

Once an integral part of the Indian diet, the kshudra dhanya or poor man's food now has been rediscovered and honored as 'Sri Anna' by Hon. Prime Minister of India Shri. Narendra Modiji. The super crop of our ancestors has been declared by the UN General Assembly as the superfood and the year 2023 as the "International year of millets" as proposed by India to the food and agriculture organization. Diet consciousness people are switching from cereals like rice and wheat to starch free and gluten free millets. The 'millet for health' initiatives are to raise public awareness to tap nutritional and economic value of millets. Padmashri Dr. Khader Vali, popularly known as the 'Millet Man of India', Ms. Sharmila Oswal- the 'Milletpreneur, millet mom or known as 'Millet Woman of India', Ms. Ruchika Bhuwalka-the 'Millet Amma' and many such personalities are the driving forces behind promoting production and consumption of millets as a way towards sustainable agriculture and mitigating climate change. The top millet producing states are Rajasthan, Karnataka, Uttar Pradesh, Maharashtra, Andhra Pradesh, Tamil Nadu, Uttarakhand, Madhya Pradesh that are bringing in the millet revolution in full swing.

From Indian culinary history, millets have come a long way and have now assumed the center stage with economic potential. To mark the international year of millets 2023, the FAO released a video that had the following wordings. They aptly express the greatness of these small yet power packet cereals.

'I may be small, but I am strong

I grow where others cannot...

I nurture soils and ecosystems...

So, bring me back to your table

I am Millets.'

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INSIGHTS INTO MILLING OF SMALL MILLETS: A COMPREHENSIVE REVIEW**Ms. Sejal Kamat¹ and Dr. Madhura Janve²**¹Research Scholar, Department of Life Science, SK Somaiya College, Mumbai²Research Guide**ABSTRACT**

Millets are a varied group of small-seeded grasses, widely and traditionally grown as fodder for animals or grains for humans. These millets are classified based on their grain size under two sub-categories namely, major millets and small millets. The major millets are sorghum and pearl millet while minor millets are finger millet, foxtail, little millet, proso, barnyard and kodo millet. Like large millets, they too, are enriched with essential nutrients like energy, protein, fatty acids, B -vitamins and minerals like calcium, iron, potassium and zinc essentially required for human consumption. The nutrient profile inherited in each millet is more unique and diversified than the other. The different techniques used in the processing of millet are crucial for their effective utilization. The relevant processing techniques will enhance the bioavailability of nutrients, improve palatability, and increase shelf life. Milling is the conventional process used in reducing the antinutritional factors present in the millet grain making it safe for consumption. The milling process begins with cleaning the grain and removing undesirable impurities and broken grains using different types of sieves or separators. Some of the processing technique also follows decortication in which debranning of the grains is done using a mechanical huller and are grounded into flour with hammer mills. However, the size of small millet limits their potential for milling. Although the major research has been done on the large millets, insights into the milling and utilization of small millets in value-added food products are yet to be explored.

Keywords: *small millet; milling; proso millet; foxtail millet.*

INTRODUCTION

Millets are a varied group of small-seeded grasses, largely and traditionally grown and consumed by humans as well as animals in the Indian Subcontinent for about 5,000 years. Millets are enriched with essential macronutrients such as protein, and fatty acids along with micronutrients such as various B vitamins and minerals including calcium, iron, potassium and zinc (Plaza S and Wutrich et al., 2012). They also entrap a variety of polyphenols and amino acids (Misra V. et al, 2014). Consumption of millet has been reported to have beneficial effects on a plethora of medical conditions by reducing blood sugar, blood pressure regularization, thyroid functioning, cardiovascular disease and celiac disease (Rao et al, 2017). However, over the years, the consumption of millet has shown a significant decline due to difficulty in food preparation accompanied by the lack of awareness of its potent nutritional benefits. The government subsidies promote cereals, especially to wheat and rice over millets which significantly reduced the area under millet cultivation. Additionally, consumers face challenges due to the non-availability of ready-to-use or ready-to-cook foods from millets in the market as well as the unappealing colour and overall appearance. The growing population, climatic variations, and shortage of water have resulted in rising food prices. This increased demand can be met by the cultivation of millets that can adapt to the arduous climatic conditions and

therefore, can be used as an alternative source to meet the dietary and nutritive needs of the growing population. Hence, it is crucial to generate a demand for value-added millet-based processed foods through the invention of diversified processing technologies, improving the nutritional availability to consumers and creating awareness among people. Millets are broadly classified into two categories based on their grain size and husk present namely major millets and small millets. Major millets are namely Sorghum (*Sorghum bicolor* L.) and pearl millet (*Pennisetum typhoides* L.) while finger millet (*Eleusine coracana* L. Gaertn), foxtail millet (*Setaria italica* L.), little millet (*Panicum sumatrense* L.), proso millet (*Panicum miliaceum* L.) barnyard millet and kodo millet (*Paspalum scrobiculatum* L.) are small millets (Maitra, 2020).

The aim of this review paper is to emphasize the utilization of small millets which are grown in a limited area due to the steady decline in Indian agricultural biodiversity. The utilization of small millets faces challenges due to the tedious processing of small millets; less availability of traditional recipes being documented and a lack of small-millet-based recipes itself. Along with finger millet and foxtail millet, proso millet and other small millets are being improved using genetic and genomic resource breeding for yield enhancement and production of value-added products. The area under cultivation has declined from 5290000 ha (in 1951-55) to 479000 ha (in 2021-22) (K Hariprasanna, 2023).

Nutritional Profile of Small Millets

The small millets are packed with macronutrients such as carbohydrates (60-65%), fat (1.5-5%), protein (7-12%), fibre (2-12%) and micronutrients namely, calcium, iron, phosphorus, and magnesium, etc. Apart from these nutrients, they are loaded with bioactive components such as polyphenols and antioxidants which have been proven beneficial in their curative role in human health. (Himansu et al., 2018; Singh and Kumar., 2015; Renganathan, 2020)

Among the small millet, foxtail millet, which is also referred to as Italian millet, is noted as one of the earliest crops in human mankind. In northern China, millet was incorporated as a nutritious drink, porridge, or soup for pregnant and breastfeeding women as a part of traditional food. Historical records have documented the numerous nutritional and medicinal benefits associated with millet consumption. (Gary et al., 2016)

Table 1: Nutritive value of macronutrients in millet (per 100 g)

Grain	Protein (g)	Fat (g)	Carbohydrate (g)	Energy (kcal)	Total Dietary Fibre (g)	Ash (g)
Sorghum	9.9	1.73	67.7	334	2.8	1.4
Pearl millet	10.9	5.4	61.8	345	11.5	1.4
Finger millet	7.2	1.9	66.8	320	11.2	2
Foxtail millet	12.3	4.3	60.9	331	10.5	2.6
Little millet	10.2	3.9	65.5	346	7.7	1.3
Proso millet	12.5	3.5	64.5	341	11.2	2.7
Barnyard millet	10.2	2.2	65.5	307	12.6	1.3
Kodo millet	8.9	2.5	66.2	331	6.4	2.7

(Source: Nutritive value of Indian foods, NIN, 2017; Malleshi, 2021, IIMR data)

Table 1 shows a higher percentage of protein in proso millet and foxtail as compared to all other millets. The foxtail millet reported the highest fat content among all the other small millet, whereas the finger millet showed the least concentration of fat. The energy content of small millets is approximately 320-345 kcal per 100g except barnyard millet which has an energy content of 307 kcal per 100 g.

Table 2: Nutritive value of micronutrients in millet (per 100 g)

Grain	Calcium (mg)	Phosphorous (mg)	Magnesium (mg)	Zinc (mg)	Iron (mg)
Sorghum	27.8	210	146	2.5	4.6
Pearl millet	27.4	289	124	2.7	6.4
Finger millet	364	210	146	2.5	4.6
Foxtail millet	31.0	188	81	2.4	2.8
Little millet	16.1	130	91	1.8	1.2
Proso millet	14.0	*	153	1.4	0.8
Barnyard millet	20	280	82	3.0	5.0
Kodu millet	15.3	101	122	1.6	2.3

(Source: - Indian Food Composition table, NIN-2017; * data not available)

Table 2 shows the highest amount of calcium in finger millet as compared to all other millets. The pearl millet and barnyard millets exhibited an almost similar range of phosphorus. The magnesium and zinc are highest in proso and barnyard, respectively. The iron content among all the millets is seen in pearl millets filled with barnyard millet.

Processing Of Small Millets

Processing is the post-harvest technique used for small millets which alter the physical and chemical properties making them safe for consumption. These techniques eliminate the undesirable components making them favourable for human consumption (Birania et al, 2020) Small millets, known for their rich nutrient content, require processing to enhance nutrient accessibility, remove anti-nutritional factors, and make them suitable for consumption. However, due to its unique size and structure, small millet processing is a current challenge that can hinder their production and consumption significantly.

In general, during the primary processing of the coarse cereals, the offal (unfavourable for human consumption) is separated out (Chavan, 2018) Offal comprises pericarp and germ sometimes. The removal of this offal undergoes a process known as dehulling or decortication, causing a peculiar astringent flavour which makes them less desirable for consumption over rice or other cereals. Also, the lack of specific processing techniques in millets hinders the production of the white colour products leading to a decline in the rate of purchasing and formulating products. Various rice dehullers or abrasive dehullers are used in the dehulling of millets as there are no specialized machines available for its processing. The protein and lysine content from the millet is shown to decline during the processes of decortication or dehulling yet it increases the bioavailability of protein (Sneha and Suri, 2022). Loss of minerals is reported less post decortication and consumer acceptability increases (Hukkeri et al.,2022).

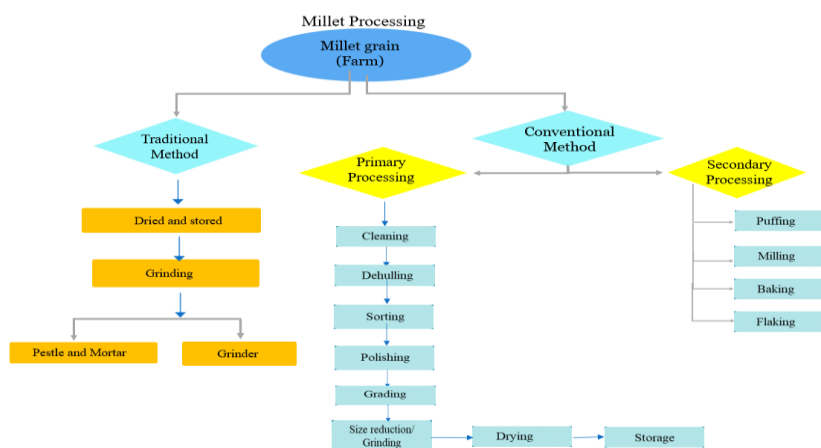
This paper primarily focuses on the various primary and secondary techniques used in post-harvest processing of small millets. These processing techniques can be adopted to increase the utilization of small millets for the formulation of value-added products.

Post-Harvesting Techniques

Figure 1 denotes different types of processing techniques used in the post-harvest processes of small millets.

The primary post-harvest processing of the coarse cereals involves the removal of the offal (inedible part) (Chavan et al., 2018). This offal can be only pericarp or pericarp and germ both. The secondary operational processes which are conducted on small millets make them favourable for consumption by improving their organoleptic characteristics. These processing techniques focus on enhancing the digestibility and nutrient bioavailability, a significant amount of nutrients is lost during subsequent processing.

Figure 1: Schematic elucidating different types of post-harvest millet processing techniques



Dehulling/ Decortication

Dehulling or dehusking is the primary processing technique to remove husk from the millet grain increasing its palatability and improving digestibility properties. Small millets are coated with husk and are covered and protected in glume encasements, which is unfavourable for human consumption thus they need to undergo a dehulling or dehusking process. Traditionally, these dehulling processes were done manually by women using stone/ wooden grinders or pestle and mortar which were time-consuming and exhaustive (Saleh et al., 2013). The equipment used in this traditional processing technique exhibits different forces on the grain to dehulled. A stone or wooden grinder exhibits shear force while pestle and mortar exhibit impact force to dehull. The pestle is usually fixed in the ground and majorly made up of either wood, stone or ground itself while mortar is made up of stone or wood. (Serna-Saldivar, 2010). The dehulling process commences by moistening the grain for about 10 mins before it is used with a ratio of 250 ml of water for 2-3 kgs of grain (Kumar et al., 2016). In pounding action, different strokes like up and down or down, across or rotate which makes the grain rub against each other. This continuous pounding loosens the pericarp which is then removed by winnowing or washing in

water. Depending on further use, the decorticated grain is either dried before storage or further ground to make flour (Serna-Saldivar, 2010; McFarlane et al., 1995).

Figure 2: The traditional dehusking done by manual processes



The traditional dehusking by manual pounding



The traditional dehusking seen in North west Chhattisgarh

In modern methods of processing, advanced machinery like centrifugal sheller is usually used to dehull/decorticate. A double chamber centrifugal dehuller has shown about 95-96% of efficiency rate with a minimum of 4.5-5% of the breakdown of small millets (Dhurairaj M et.al, 2018)

Although decortication processes reduce the total availability of mineral content, the bioavailability of calcium, zinc and iron increases by 15, 24, and 26 g/100 g, respectively (Krishnan et al., 2012). It also significantly decreases total phytic acid, polyphenols, dietary fibre, and the number of tannins with a corresponding increase in protein digestibility (Adhikari et al, 2022).

Milling

Milling is a vital and intermediate step in the post-harvesting of grain. The main objective of the milling process is to dehusking and at times remove the bran layers, and make it edible, free from impurities. The cleaning of the millet grain is the first step of the milling process in which the unwanted impurities and broken grains are removed using vibratory sieves, aspirators, and specific gravity separators. This process leads to some loss of polyphenols, antioxidants and antinutritional factors (Bisht et al., 2023). Consumption of these small millets without milling is undesirable for human consumption (Sharma and Gujral, 2019). The undesirable consumption of these millet grains is due to anti-nutritional factors namely phytic acid, tannins, and oxalic acids (Sachdev and Gommer, 2023). Pre-milling processes namely dehulling, soaking the grain, germination, fermentation, and moist-heat treatment before the post-harvesting technique also significantly reduce or remove the anti-nutritional factors from the bran (Paliwal & Sharma, 2019). The benefits of milling in small millets are as follows.

1. Increase in the digestibility.
2. Keeps pests in control.
3. Reduces phytic acid which acts like an anti-nutritional factor.
4. Improves the organoleptic properties like appearance, taste, and texture.

5. Helps in reducing cooking time.

Milling reduces the protein content, but it is compensated by better consumer acceptability, improved bioavailability of the nutrients, especially of protein and enhanced product-making qualities (Gowda, 2022).

The primary processing of small millets

Millet grain pre-cleaners

Grain pre-cleaner is used to remove stones, unwanted dust, and broken grains from all kinds of grains.

Figure 3: Pre-cleaners of various companies



a. Pre-Cleaner Automatic Painted

b. Grain Pre Cleaner

c. Pre cleaner -X330¹⁰

Source: Westrup, Denmark

Source: Roshan Agro Industries-India mart

Destoner – Grain Cleaner

Destoner is used for removing stones, sand, impurities, and dust particles from millet.

Figure 4: Destoners of some selected companies



a. Destoner Gravity type

b. Grain Destoner

Source: Udawat Engineering Works

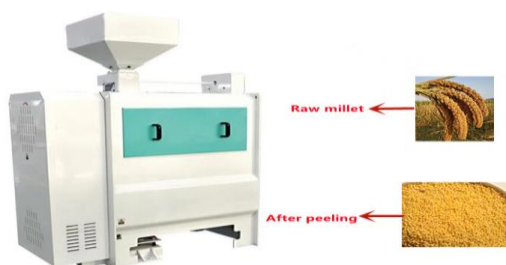
Source: Jogeshwari Industries

¹⁰ Source: <https://grain.cleaning/en/products/optional-grain-cleaning-equipment/pre-cleaner-up-to-50-t-h/>

Pearler/ Polisher

Pearler/ Polisher used for threshing, pearling and dehusking of millet.

Figure 5: Pearler or polishers of some selected companies



a. Millet Peeling and Polishing machine

Source: Golden Grain – mill



b. Millet Huller/ Polisher

Source: C.N Grain machinery

Flour Mills

The flour mill is used to mill the grain into flour.

Figure 6: Flour mills of some selected companies



a. Commercial 12" Stone Type Vertical Flour Mill

Source: toolvilla.com



c. ICAR-CIAE-Millet Mill model 2



b. ICAR-CIAE-Millet model 1

Source: ICAR website

Dehuller

Millet Dehuller is used for removing husk present on millets, especially on little, kodu, foxtail, proso and barnyard millet.

Figure 7: Dehulling of some selected companies



a. All types of grain with grader

c. Victor Single Chamber Dehuller

b. Double chamber except Kodu and Proso millet

Source: DHAN foundation

Hydrothermal Treatment for Quality Improvement of Milled Grains

Hydrothermal treatment or parboiling is a pretreatment that is performed prior to the milling processes to improve the milling efficiency. This process increases its nutritive value with structural change and reducing the breakage during the milling process (Magathi et al., 2018). This technique involves 3 steps. Namely, soaking, steaming or boiling and drying. The optimisation of each step varies with the nutritional content of amylase, bran, and husk present in it. The effect of hammer milling (HM), grinding roller (RM), pin (PM) for grinding of proso millet was evaluated. The proso-millet flour rheology and baking properties are analysed and compared with the quality whole grain flour. The starch damage was reported to be highest in the PM flour (4.64%) than RM (2.46%) and HM flour (2.51%). The nutritional composition was not significantly affected by different grinding methods. The grinding method did not affect the specific volume of bread loaves and C-cell characteristics. (DP Shivprasad et al, 2022). Kapoolu et al. (2016) reported that the foxtail millet using roller mill showed nutritional potential and better flour fractions without dehusking. There was a significant decline in the phytic acid content, fat content of endospermic fractions, and protein contents. A significant change in the total carotenoid was not noted (V Kapoolu. et al., 2016). A study conducted by Chapke et al, 2020 on milling of Barnyard millet in a SATAKE rice polisher exhibited highest yield of 52.97% with minimal loss of protein, fat, ash and fibre. The following perios supplements various studies with this regard.

Table 3: Nutritional changes in various millets during milling accompanied by hydrothermal treatment

Name of millet	Processing conditions	Inference	References
Finger millet	Milling conditions (<i>viz.</i> residence time, and roller speed) were varied to evaluate the quality of finger millet before and after hydrothermal treatment.	Results indicated that hydrothermal treatment led to an enhancement in milling efficiency and a reduction in anti-nutritive components, namely tannin, to as low as 1 ppm. Losses of protein and calcium were 6% and 11%, respectively, have been reported.	Kushwaha et al., 2019
Finger Millet	Hydrothermal treatment of finger millet was carried out at various soaking temperatures (30°C and 70°C) and times (24 hours and 1 hour 45 minutes). The samples were steamed at varying pressures prior to drying. Post this hydrothermal treatment, samples were subjected to milling using a rice polisher forming seed coat, broken millet and head millet.	This study shows that higher soaking temperatures and increased steaming pressure lead to greater milling yields. The hydrothermal treatment enhanced the grain's hardness, which in turn improved the milling yield during the milling process. The optimal treatment conditions were found to be soaking at 70°C, steaming at 2 bar pressure. The final moisture content of sample was below 14%. Under these conditions, the milling yield reached 87.80%, with broken grains accounting for 4.44%, and seed coat matter at 7.68%.	Magathi et al., 2018
Foxtail millet	The hydrothermal treatment on dehulled sorghum, pearl millet and foxtail millet exposed by heat treatment 150-170°C for 1 minute and 30 s.	Foxtail millet exhibited lower lipid content by 27.98%.	Arora et, al. 2022
Little millet	The samples were soaked for 4-hour followed by hot air drying at 45°C	The study concluded that the hydrothermal pre-treatment prior to milling improves the milling	Deshpande et al., 2023

		efficiency (70.21%) and highest dehulling efficiency (96.72%) with improvement in the organoleptic characteristics of the flour.	
Barnyard millet	In this study, milling time for 3 to 6 mins with a degree of polishing at an increment of 1 min at 8%, 10%, 12% and 14% moisture levels. at each % of moisture content the proximate analysis of carbohydrate, protein, fat and ash.	The higher milling time caused a maximum reduction in the proximate compositions. The maximum loss in protein, fat, ash and fibre took place at 14% moisture content followed by 12%, 10% and 8% moisture levels. Protein, fat, ash and fibre were negatively and linearly correlated with the degree of polishing.	Lohani et al., 2022
Proso millet	This study was conducted on proso and pearl millet which stated that decortication increases the yield of proso by 28% and pearl millet by 37%	The study concluded that the phenolic compounds from the outer layer pericarp shift to the inner layers of the grain during parboiling. This leads to the release of phenolic compounds that were previously bound to the cell walls. Parboiling could be an effective way to improve millet decortication yield as well as produce millet products with higher phenolic acids antioxidant activity and lower GI	Bora et al., 2019
Kodu millet	The raw grain of kodu directly processed in a mud grinder is compared with parboiled grains followed by mud grinding.	The parboiled kodu sample proved better than the raw sample with higher head yield and milling efficiency.	Agarwal et al., 2014
Sorghum	Two varieties of sorghum namely white (T1) and red (T2) were used to analyse	The study evaluated that the red sorghum variety was richer in protein, fibre and ash then	Bataric et al., 2021

	incorporation of dry heat of different temperatures (121°C and 140°C respectively prior to milling.	compared to white sorghum. The incorporation of dry heat prior to milling increases the water absorption capacity of both the variety of flour with a lower solubility index and less water retention capacity. It also changes the phytic acid and antinutritional components enhancing the functional and nutritional profile of both the variety of the sorghum. Exposure to this type of treatment proves beneficial for the entrepreneur to produce more nutritional food products using this technique.	
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CONCLUSION

Hydrothermal Processing reduces nutritional loss by improving the milling efficiency. Mill selection plays an important role in reducing the likelihood of nutritional loss. There is a need to develop convenient and sophisticated equipment for optimization of the nutritionally adequate millet processing method. Although advances in the automatic processing of small millets have been observed, manual processing of millet for decortication, milling and sieving is preferred due to better retention of nutrients. There is a need for the development of industrial-scale milling technology in order to manufacture value-added products from small millets. Agricultural quality of small millets can be improved by using various breeding technologies that will help in achieving higher and more timely production.

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SECTION III

CASE STUDIES

BEST PRACTICES UNDERTAKEN TO PROMOTE MILLETS

INTRODUCTION

The millet ecosystem in India is gradually developing through a number of private and institutionalised initiatives. Any assessment of the recent measures to promote millets in the country should acknowledge the promotion of millets through these channels. In this section of the book, we present these as case studies to identify certain best practices undertaken to promote millets. Institutionalised measures directed towards millet promotion may be categorised as public and private measures:

1. Institutionalised Initiatives –

- a) Efforts taken by NABARD
- b) Efforts taken by state agriculture department

2. Private Initiatives –

- a) Sustainable Agro Initiatives (SAI)
- b) Dhan Foundation

3. Individual Achievers

- a) Dr. Khadar Valli Dudekula - The Millet Man of India
- b) Ms. Sharmila Oswal - Millet Evangelist of India
- c) Mr. Bhalubhau Kisan Ghode - The Maharashtrian Tribal Millet Farmer
- d) Raimati Ghiuria – Queen of Millets
- e) Lahari Bai – Millet Ambassador of India

The efforts towards promotion of millets undertaken by individuals are also covered in this section. Our focus is on three personalities - Dr. Khadar Valli Dudekula (Millet Man of India), Ms. Sharmila Oswal (Millet Evangelist of India) and Mr. Bhalubhau Kisan Ghode (Tribal Farmer from Maharashtra). Their efforts can hardly be considered as personal initiatives due to the social impact they have generated. Their initiatives have created a meaningful impact in the promotion of millets in a food ecosystem that has marginal presence of millets.

INSTITUTIONALISED INITIATIVES

A) Efforts Taken By NABARD

NABARD, the apex development institution in agriculture and rural development, has been undertaking various initiatives for the promotion of millets in the country. It has acted as one of the prime agencies promoting institutionalised interventions for the promotion of millets. Its promotional activities may be categorised as follows: a) grant based pilot projects under Farm Sector Promotion Fund (FSPF) b) promotion of millet based FPOs c) Other promotional activities.

The Millet Conclave at Raichur, Karnataka on the theme ‘Making Many Millet Magnets/Making Many Millet Entrepreneurs’ is a notable event that was funded by NABARD under FSPF. The conclave brought out the Raichur Declaration which stressed on the necessity to enhance production and productivity, promote decentralised processing machinery, provide marketing support and introduce millets into nutritional programmes. Under FSPF, NABARD has also supported a number of millet based interventions some of which include 1) Pilot projects on Zero Budget Natural Farming (ZBNF) in the states of Assam, Odisha, Andhra Pradesh, Maharashtra and Uttarakhand. 2) Projects to promote climate-resilient dry-land agriculture through minor millet farming and 3) Promotion of millet technology and entrepreneurial skills. Interventions under National Adaptation Fund for Climate Change (NAFCC) include cultivation of Jowar (sorghum), Rabi Jowar (sorghum) and finger millets in 4000 acres, 1000 acres and 600 acres respectively in 51 villages of two districts of Maharashtra. In addition to these, NABARD has also included promoting millet cultivation as an integral component of its tribal development programme in states like Karnataka, Chhattisgarh, Maharashtra, Odisha, Rajasthan, Tamil Nadu and Uttar Pradesh. Cultivation of coarse and minor millets have been undertaken in about 1.30 lakh ha area as part of watershed development projects undertaken by NABARD covering an area of 25.65 lakh ha. Women self-help groups promoted under the NABARD SHG-Bank Linkage programme in Mahendergarh, Haryana are producing and marketing millet based products like bajra matar, bajra laddoo and bajra cookies. NABARD sponsored a Bajra Food Festival in Rewari district of Haryana in which FPO and SHG members also showcased their Bajra products: Atta, Khichdi, Churma, Laddoos, Millet Pizza, Matar, Namkeen etc.



A cumulative grant of Rs.30 crores has been sanctioned for the promotion of 132 Millet FPOs engaged in various millet based business activities such as input supply, procurement, processing and marketing of millets. Given alongside is the photo of value added millet

products marketed by Arogya Millets Producer Company Limited located in Kothavalasa, Vizianagaram, Andhra Pradesh which is supported by NABARD.

B) Efforts Taken By State Agriculture Departments

Samata Farmers Group - Lessons from Madgyal, Maharashtra

Madgyal is a village located in the Jath Tehsil of Sangli district of Maharashtra. The main crops cultivated in Sangli district include rice, bajra, groundnut, turmeric, soyabean, sugarcane, wheat, grape and pomegranate. Agriculture is the dominant occupation of the region but it faces significant challenges. The region is drought prone and has inadequate irrigation facilities. The region receives an average annual rainfall of 522 mm and suffers persistent issues of water management. In addition to these issues of underdevelopment, the region witnesses high rates of migration to the sugar belts of Sangli, Satara and Kolhapur. It is against this background, that the village has recently experimented and succeeded in the cultivation of millets.

The state agriculture department is trying to replicate the Madgyal model as a sustainable agriculture model using modern agricultural practices. Cash awards have been announced for the top three Madgyal bajra growers in an attempt to encourage more farmers to take up the cultivation of millets. The produce of the Samata Farmers Group has been lab tested to be residue free. This helped the group to fetch a price of Rs. 3000 per quintal for their produce which was sold to a Hyderabad based company. The economic success has now incentivised the farmers to double the acreage for the upcoming year.



Samata group at 'Ek Gaon, Ek Vaan (One village, One Variety)' programme

Image Courtesy: Mongabay

The experiment was the result of collective efforts put in by thirty farmers who formed a collective called 'Samata Farmers Group'. All farm and non-farm activities associated with the cultivation were done collectively by the group. They pooled 25 acres of land and started the cultivation of pearl millet (bajra). The collective efforts of the group towards hiring of tractors, preparation of the fields, installation of drip lines, sourcing of seeds, fertilisers, and organic

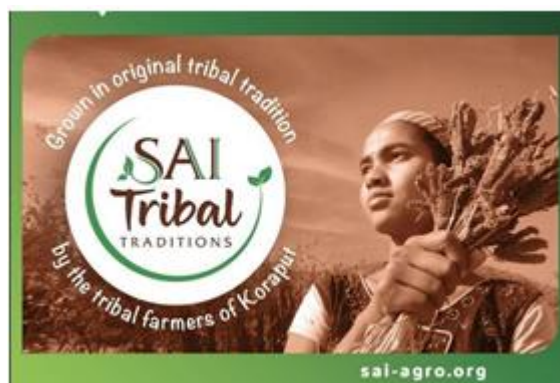
pesticides proved advantageous to the group to reduce costs of production. It helped the farmers cut the cost of production. They received active support from the state agriculture department and the millet mission launched by the Government of Maharashtra. The farmers' group obtained an average yield that is three times more than the national average of 12.43 quintals per hectare. Considering its potential to raise crop productivity and farm income, the group received support under the scheme, 'Ek Gaon, Ek Vaan (One village, One Variety)' run by the state agriculture department and the National Food Security Mission. The farmers also collaborated with Paani Foundation, a non-profit organisation that works for drought prevention, to organise a four day workshop to educate farmers about crop management, seed selection and treatment, and integrated pest management.

PRIVATE INITIATIVES

Sustainable Agro Initiatives (SAI)

Sustainable Agro Initiatives (SAI) is working with small tribal farmers on the principle of *Living with Dignity not on Charity*. SAI improves the livelihoods of small farmers at BoP (Bottom of Pyramid) by transforming degraded land through sustainable agroforestry with millet as inter-crop.

After farmers set aside a portion of their harvest for personal use, SAI steps in to support them in value addition, packaging, and marketing. This is achieved by empowering women entrepreneurs in the millet value chain. These enterprising women procure millets directly from the farmers at the farmgate, aggregate them at the village level, and then undertake the cleaning and transportation process to a processing unit near to their villages. Remarkably, they manage this entire operation independently.



Drawing on their traditional knowledge and technical expertise, these tribal women employ unique techniques to create millet-based products that are subsequently marketed under the brand name "**SAI Tribal Traditions.**" In doing so, these women not only contribute to the well-being of their male counterparts and families, but also supply nutritious, chemical-free premium millet products to the consumers at affordable price. Their efforts represent a commendable blend of empowerment, tradition, and innovation in the millet industry.

SAI's remarkable achievements have gained international recognition and accolades. It has been acknowledged by SEED Uno, a prominent international donor platform, as an exemplary eco-inclusive business model with the potential for widespread replication across Africa. Additionally, SAI received the prestigious **Best Start-up Award from FICCI** and was honoured with the **BRICS Solution Award for SDG 2**, focusing on Zero Hunger.

Furthermore, the **World Economic Forum (WEF)** has identified SAI as one of the **thirteen innovators** actively contributing to the Indian government's efforts to achieve its afforestation and SDG goals by 2030. Over the past decade, SAI has not only successfully piloted but also scaled its social venture across Asia and Africa.

SAI is extending its model to South Asia, Southeast Asia, Sub-Saharan Africa, Central Africa, and West Africa. This expansion reflects SAI's commitment to creating sustainable impact on a global scale.

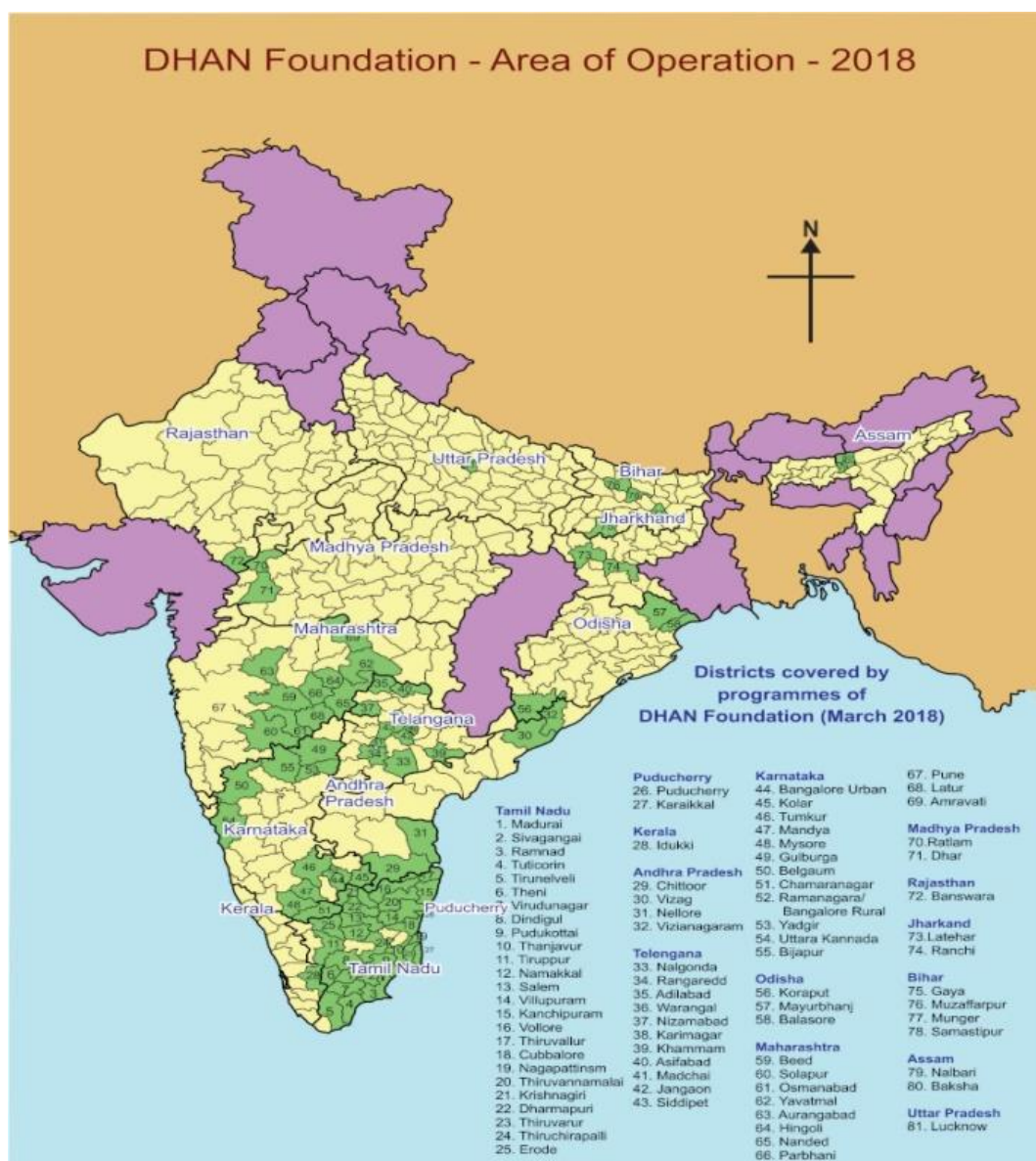


SAI's vision is to *create a world where marginalized sections of society are not viewed as mere recipients, but as active partners in development.* They contribute actively to the economy while simultaneously enhancing their own social and economic standing. This vision **reflects SAI's commitment to inclusive and sustainable progress**, valuing the potential of every individual, regardless of their cultural background or social status.

DHAN Foundation

The Development of Humane Action (DHAN) Foundation is a professional development organisation that came into existence in 1997. It started its operations on October 2, 1997. Its mission is to eradicate poverty from the country. It envisions a poverty free, value based, equitable, ecologically sensitive and just society. The values upheld by the organisation include grassroots action, collaboration, enabling, innovation, excellence, and self-regulation.

It has nine programmes through which it attempts to eradicate poverty and bring about rural transformation. One of these programmes named ‘Small Millet Foundation’ focuses exclusively on mainstreaming millets. It started its operations in 2011 and lays emphasis on inclusion of small millets in regular diets. It collaborated with Canadian Mennonite University, Canada, LI-BIRD, Nepal and Arthacharya Foundation, Sri Lanka to launch a project named “Revalorisation Small Millets in Rainfed Regions of South Asia (RESMISA)” during the period 2011-2014 to increase production and daily consumption of nutritious small millets, pulses and oil seeds in rainfed regions of India, Nepal and Sri Lanka. The project which made use of gender sensitive participatory approaches achieved 20 to 25 percent increase in production of pulses and minor millets. It also brought about significant improvement in the nutrition levels of women and children. As a follow up of RESMISA, DHAN foundation collaborated with McGill University on a project to scale up small millet processing and value addition technologies to reduce drudgery of women and improve the nutritional security in India. DHAN has its programmes running in 81 district spread across 14 states of India namely Tamil Nadu, Puducherry, Kerala, Telangana, Andhra Pradesh, Karnataka, Odisha, Maharashtra, Madhya Pradesh, Rajasthan, Jharkhand, Bihar, Assam and Uttar Pradesh.



<https://www.dhan.org/dhans-reach.php>

Image Courtesy: DHAN Foundation website

INDIVIDUAL ACHIEVERS**Dr. Khadar Valli Dudekula - The Millet Man of India**

Image courtesy: Sridhanya Millet

Dr. Khadar Valli Dudekula is an Indian food expert and independent scientist born in Kadapa district of Andhra Pradesh. He completed his masters from Regional College of Education, Mysore and obtained his doctorate from the Indian Institute of Science, Bangalore. He was awarded Padma Shri by the GoI in 2023.

He traces his fondness for millets back to his childhood when he first had millets at his ancestral house. This continued in the form of casual conversations that centred on the longevity of his grandparents. His professional and more informed journey with millets started when he was pursuing his post-doctoral research in environmental science at Beaverton in Oregon, USA. His research focussed on deactivating deadly chemical substances such as dioxin. He discovered cases of premature menstruation among girls. He identified the bad industrial food culture as the root cause of such problems (Prasad, 2023; Webteam 2023; Yemen, 2023).

In the mid-nineties, he left his job in the United States and travelled across India before he settled down in Mysuru. He used these tours to meet farmers and collect millet seeds. He is credited with the revival of five types of millets namely kodo millet, foxtail millet, brown top millet, barnyard millet, and little millet. He named these five millets as the 'Sridhanya'. He trained marginalised farmers to grow these seeds and provided them with land for cultivation. He proposed jungle farming (Kadu Krishi) as a natural method to cultivate millets. He discovered these when he toured the entire country after returning from the United States. He considers millets as a solution to many lifestyle diseases based on his discovery of the healing properties of millets (Khadar & Khadar, n.d.).

He is also passionate about sustaining the quality of the soil. He advocates eco-friendly agricultural practices to enhance soil fertility and crop productivity. He is against the utilisation of chemical fertilisers. He holds the Green Revolution responsible for shifting the food habits of the entire world away from millets and downgrading it as animal or bird feed. He is of the view that rice and wheat form the cause of a large number of diseases. His research on millets has come out in the form of a book titled 'Siri Lokam' (Khan, n.d.).

Ms. Sharmila Oswal - Millet Evangelist of India



Sharmila Oswal with her millet farmers

Image courtesy: India Times

Ms. Sharmila Oswal is a lawyer turned millet entrepreneur who co-founded a successful millet start-up named ‘Gud Mom’. She hails from Rajasthan and spent her childhood in Poynad, a small village near Alibaug in Maharashtra where her father ran a flour mill. She credits her father for engendering an interest in millets. She studied in a Marathi medium school. Her interactions with her classmates exposed her to issues of domestic violence which motivated her to pursue law for her higher studies. Her life in a village brought her close to issues of crop failure faced by farmers and inculcated in her an interest to specialise in environmental and agricultural law. She obtained her master’s degree in agricultural and environmental law from England and worked there from 1997 to 1999. She later moved to Canada where she practised until 2007.

The high incidence of farmer suicides in Vidarbha region of Maharashtra during 2006-2007 motivated her to get back to India and help farmers. After returning to Pune in 2008, she embarked on a two-year long survey among farmers of Maharashtra, Gujarat and Rajasthan. In 2008, she founded ‘Green Energy Foundation’ (GEF), a NGO which works to promote sustainable farming practices and the conservation of indigenous seed varieties among farmers. Ms. Sharmila used the foundation’s Millet Mission Project to train farmers in millet cultivation. She also used the foundation as a platform to empower women in agriculture. In 2010, she launched her first sustainable water management programme in Buchkewadi, Maharashtra with a financial support of Rs. 10 lakhs from NABARD. The foundation assisted tribal farmers in Dungarpurby, Rajasthan in the cultivation of millets by collaborating with ITC’s e-Choupal which also provided them with market access.

She along with her son Shubham Oswal launched a millet based start-up named ‘Gud Mom’. It sells millet noodles, pasta, cookies, crackers, herb sticks and more through their website and other online platforms. Most items are priced between Rs. 48 to Rs.150. ‘Gud Mom’ has transformed millets into a variety of products which have great appeal among the younger generation. The start-up is a thriving business venture having an annual revenue of more than Rs.16 crores and supports more than 5000 millet farmers.

Ms. Sharmila Oswal advocates the distribution of millets through the public distribution system and incorporation of millets in mid-day meals programme to promote healthy dietary habits and encourage farmers to grow millets. Her start-up received the ‘Poshak Anaj Award’ from the Indian Institute of Millet Research in 2022. She is recipient of several recognitions like the Times of India Social Impact Award and TOI Earth Care Award. Her efforts in millet promotion was also lauded by the Prime Minister in his ‘Mann Ki Baat’ programme (Gautam, 2023; Rathod, 2023; Sarvani, 2023; Webteam 2023).

Bhalubhau Kisan Ghode - The Maharashtrian Tribal Millet Farmer

Image courtesy: Indian Express

Bhalubhau Kisan Ghode hails from the Jahagirdarwadi village in the Akole taluka of Maharashtra's Ahmednagar district. The village is the base camp of Kalsubai peak which is the highest peak in Maharashtra and a popular tourist spot. The local population serve as guides and also offer homestay facilities for the tourists. Rice is the major crop of the region. Millets, primarily finger and little millets, are cultivated primarily for sustenance and form the traditional food of the village.

Ghode, who took to farming at the age of 14, observed that farm labourers in his village consumed finger millets as staple food during the monsoon to help them work even in torrential rains. This prompted him to explore more on finger millets. This was the time when most farmers were shifting to paddy. Ghode who realised the importance of millets collected millet seeds and started his efforts towards millet conservation. He decided to serve his tourists guests millets instead of wheat roti. A liquid concoction of finger millets, popularly called Ambil, was served as a welcome drink and barnyard or little millets were used to prepare desserts. The steady inflow of tourists to Kalsubai provided Ghode a reliable market.

Ghode has over 20 varieties of finger millets, 10 varieties of little millets, 3 varieties of foxtail millet and one variety each of brown top, barnyard and Kodu millet. He is an integral part of the community seed bank project of the Pune-based BAIF Development Research Foundation. He relies on organic inputs for cultivation which keeps the cost of production low. He yields as high as 20 quintals per hectare. The Maharashtra state agriculture department is working closely with Ghode to develop a value chain for millet products. Ghode adorns the role of a resource person in workshops and exhibitions conducted by ICAR's Millets Research Institute in Hyderabad. In the International Year of Millets he is expecting governmental support for branding his basic millet products and thereby promoting millet consumption (Biswas, 2023).

Raimati Ghiuria – Queen of Millets



Image Courtesy: Deccan Chronicle

Raimati Ghiuria, popularly called the Queen of Millets, is a shining light in the entire campaign to popularise millet farming. Raimati has preserved 72 traditional paddy varieties and at least 30 varieties of millets. She is a native of Koraput district of Odisha, dominated by tribal farmers. The district has risen to fame as a tribal farmer Kamala Pujari was conferred the Padma Shri Award for conserving hundreds of varieties of paddy seeds throughout her life. Inspired and trained by Kamala Pujari, Raimati has trained 2,500 other farmers in her block to adopt millet farming techniques. She has adopted the traditional cultivation techniques like initiating pollination in crops and conservation of various kinds of native grains, not requiring high skills and finance (Sahoo, 2023).

Raimati received training from M.S. Swaminathan Research Foundation (MSSRF), a not-for-profit trust, working in agriculture and rural areas with the objective of creating and promoting strategies for economic growth, specifically focusing on increasing employment opportunities for disadvantaged women in rural areas. She learned to adopt the scientific methods of conservation including the System of Rice Intensification (SRI), line transplanting method for paddy cultivation, Seed Multiplication Index (SMI), line transplanting method for finger millets and making bio inputs to promote organic farming. Since 2012, she has been actively training people to practise millet farming in a scientific manner and earn a better income with value addition. Her expertise earned her the position of External Livelihood Support Person (ELSP) under the Odisha Livelihood Mission (OLM). She was awarded the Genome Savior Community Award by PPV&FR Authority, New Delhi in 2012. She was conferred the Best Farmer Award by TATA Steel in 2015, 2017 and 2018. The ICAR – IISWC also honoured her with the Best Farmer Award in 2016 (Roy, n.d.). During G-20 meet at Delhi held in September 2024, she showcased seeds varieties and millet menu, as a staple part of tribal diets. Her story explains the indigenous wisdom and nature friendly practices prevalent in India. It is also an eye opener for those who have departed from nature in the name of development.

Lahari Bai – Millet Ambassador of India

Image Courtesy: The Guardian

Lahari Bai, popularly called by the media as the ‘Millet Ambassador of India’, is a native of the Silpadi village in Dindori district of Madhya Pradesh who earned this title by conserving 150 varieties of millets. She belongs to the Baiga tribe which is classified as one of the Particularly Vulnerable Tribal Groups of India. As per the 2011 census, the population of the Baiga ethnic group is registered at 552,495. The Baiga tribe considers ploughing of land as harmful to mother land and follows a type of shifting cultivation known as Bewar. Their cultivation style is a model of agro-diversity, where millet, legumes and maize are grown in a single plot (Gahatraj 2023; Niyogi 2021; Shukla, 2023).

The 27-year-old Lahari Bai has no formal education but has a deep knowledge of millet varieties, nutrition and food security passed down through generations. She has collected more than 150 varieties of rare millet including She has conserved rare varieties of Millets like Madhia, Salhar, Sabha, Kodo, Kutki, Sanwa, Kuttu, and Cheena. Her two-room mud walled house hosts a seed bank known as Bewar Beej Bhandar started by her to preserve the *mota anaj* or millet varieties. In one room of her home seeds are stored in earthenware jars and clusters of millets are suspended from the ceiling for drying. In 2022, Bai distributed seeds to about 350 farmers across 25 villages in the district. When millet is harvested in January and February, Bai exchanges her seeds, known for their quality, with farmers in her village and surrounding areas. “It’s a two-way process. Where, if I give a kilo of millet seeds, I will get 1.5kg of the same or different variety of millet seeds,” says Bai in one of her interviews. Lahari Bai has become a role model, inspiring 40 other tribal women to start their own seed banks in other districts (Gahatraj 2003).

Lahari Bai was honoured by President Draupadi Murmu with 'Plant Genome Guardian Farmer Award' for the year 2021-22 for her excellent work towards conservation of millets. She was also honoured with a cash prize of Rs. 1,50,000, a commendation letter, and a memento at the Global Farmers' Rights Conference, New Delhi (FPJ , 2023).

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CONCLUDING REMARKS

Millets are associated with the traditional food habits that prevailed in India. In recent years, they have regained public attention thanks to the national and international campaign directed towards their promotion. The papers in this edited volume emphasise the need to explore the potential of millets as a super grain. An analysis of the papers reveal that a multi-pronged approach is necessary to ensure the mainstreaming of millets. Some of the important policy suggestions that emerge from this volume may be summarised as follows:

1. Government support in the form of minimum support price should be extended to all forms of millets. Small and marginal millet farmers should be provided access to sell their products through online marketing platforms such as the electronic agricultural national market (e-nam).
2. Distributing millets through the public distribution system and incorporating them in programmes like the mid-day meal scheme would ensure a gradual change in dietary habits. It may also serve as an indirect encouragement for farmers to increase the area brought under millet cultivation.
3. Setting up millet processing units near farm lands will be instrumental in attracting more farmers towards millet cultivation. There has to be a greater push towards realising the potential of fpos in millet processing. Industrial scale milling technology needs to be adopted in millet processing units.
4. Strengthening millet value chains, encouraging more value addition initiatives and technological upgradation of millet processing units need to be prioritised to ensure the speedy revival of millets.
5. A more conducive policy eco-system for millet entrepreneurs needs to be enhanced in order to complement the value addition initiatives. Only better entrepreneurial talent can stimulate demand for value added products. Millet entrepreneurship offers great opportunities for the promotion of local entrepreneurs and has immense potential for women empowerment. This is also likely to attract more farmers into millet cultivation.
6. Development of a sustainable millet ecosystem by adopting above mentioned measures would enable India achieve the sdgs.

The case studies discussed in this volume shed light on the importance of institutional involvement and individual initiative in the development of a conducive environment for the promotion of millets. The expertise of individual millet warriors should be tapped in developing this environment. Their expertise, combined with strong institutional support and meaningful national and international collaborations, can upgrade the quality of millet promotion efforts in India.

The promotion and mainstreaming of millets necessitates the expansion of the millet universe beyond bajra (pearl millet), jowar (sorghum) and ragi (finger millet). The nutritional and economic value of minor millets such as foxtail millet (kangni), barnyard millet (sanwa), little

millet (moraiyo), proso millet (chena/barri), browntop millet (korle) also need to be emphasised and popularised to make our millet promotion efforts holistic.

Eleven states namely Assam, Bihar, Chhattisgarh, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, Tamil Nadu, Uttarakhand and Uttar Pradesh have initiated state millet missions to promote millets. The Odisha Millet Mission (OMM) is being lauded all over the country for its success. The millet mission in Maharashtra, with a budget of Rs. 200 crore, is trying to emulate the success of OMM. It aims to promote millets through various initiatives such as 'shet tithe poushtik trundhanya', nutri-cereal day, and free seed distribution. While some uphold the view that the cultivation of millets is conducive to the state's geography and climate, enhancing the irrigation potential, especially in Vidarbha and Marathwada is a real challenge. More state governments should come up with their own millet missions that suit the socio-economic and geographic conditions of the respective states so as to ensure the mainstreaming of millets.

Millets have the potential to restore the dignity of farmers and contribute to a more sustainable agricultural future. However, to tap this potential it is necessary to enhance the millet policy ecosystem by providing millet farmers with greater market access, better availability of capital and advanced technology. The green revolution became successful because it placed the right emphasis on these three components - market, capital and technology. It is important not to lose sight of this favorable policy ecosystem that facilitated the success of the green revolution even when we hold it responsible for relegating millets. In addition to all the above mentioned measures, the resurgence of millets as super crops would also require integrating millets as a significant part of our diet by acknowledging their potential to enhance our nutritional well-being. A *milletude* is the need of the hour.

Mr. Sampath V. Sambasivan

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ABOUT THE BOOK

The year 2023 is being celebrated as the International Year of Millets as per the proposal made by India to the United Nations. The edited book **“Resurgence of Millets: Prospects & Challenges”** is as an intellectual tribute to the national and international efforts directed towards observing 2023 as the International Year of Millets. It is the product of deliberations that happened during the two days national level seminar on millets conducted by the Department of Economics, SIES College of Arts, Science & Commerce (Autonomous) affiliated to the University of Mumbai. The book contains scholarly papers on various aspects of millets, the current millet policy ecosystem in India and case studies which expose the role of institutions and individuals in promoting millets. The book would be useful for researchers, teachers and students to gain meaningful understanding on different aspects related to enhancement of millet production and productivity, nutritional and health benefits of millets, role of millets in sustainable development and policy interventions required for mainstreaming millets. The book is edited by Dr Shruti R Panday (Associate Professor, Economics) and Mr. Sampath V. Sambasivan (Assistant Professor, Economics) associated with the Department of Economics of SIES College of Arts, Science & Commerce (Autonomous), Mumbai. The financial assistance received from the Research and Development Fund of National Bank for Agriculture and Rural Development (NABARD) towards publication of the book is gratefully acknowledged.



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