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Majestic Miracle

MILLET

the golden grain

INTERNATIONAL YEAR OF MILLETS 2023

YEAR BOOK 2022

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Processing Prosperity through Millets : the Golden grain for a Healthy future

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Nutrition Smart Agriculture:
Decoding the Myth

Quoting **Sh Tarun Shridhar** Sir, "Orphan crops like Sorghum, Jowar, Barley, Ragi and Bajra to name a few, are back with a vengeance and command a fortune in the market. Smart nutrition, it appears, is being influenced by smart marketing".

Agriculture has always been SMART! Since the Ice Ages, harnessing the power of technology and subsequent growth owes to some very smart initiatives.

Despite this growth, when most of the world is still trying to cope up with a challenge of having two meals a day, NUTRITION is beyond comprehension. So tackling this intimidating challenge at the root level – AGRICULTURE would be the wisest pursuit. With judicious use of agro-chemicals and innovative technologies, **Nutrition Smart Agriculture** needs to be integrated into our agrarian setup.

Millets are cereals from the Poaceae (grass) family that possess exceptional nutritional affluence. Rich in vitamins, minerals, proteins and fibre, Millets have been a part of India's landscape and civilization since ancient times. They are capable of preventing a range of disorders and also ailments associated with a sedentary lifestyle. Their extensive advantages are being increasingly acknowledged, globally.

United Nations has declared the year **2023** as the **International Year of Millets** for which India took the lead and is now being supported by nations around the world. India is poised to become the **global hub for millets** with a production of more than 170 lakh tonnes, which makes for more than 80 % of the millets produced in Asia. Value addition and processing will also fill the gaps in nutrition.

Millets hold great promise for food security and nutrition amid ever-increasing agricultural costs, climate change and a burgeoning population to feed worldwide. They require significantly fewer input costs for cultivation and are naturally tolerant to most biotic and abiotic stresses, accentuating millets as a Crop of Choice. The **January 2023** edition focuses on this amazing **GOLDEN GRAIN – Nature's Gift to Mankind,** which is now under the spot light.

Fond agri-greetings to our readers for a cheerful and prosperous 2023

Happy reading

Mamta

The Millets Lunch @ Hon'ble Minister's Residence

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RAJNI SHALEEN CHOPRA

ATG PROUDLY PRESENTS 13TH EDITION OF THE ATG LEADERSHIP CONCLAVE

The Agriculture Leadership Conclave is the flagship event organized by the Agriculture Today Group. AT Group is proud to present the 13th edition of the Leadership Conclave.

Over the years, the awards conferred by the ATG Group at the leadership conclave have become highly coveted in the agriculture circles. The awards recognize commitment and achievement in diverse fields of agriculture. When these awards were initiated by the Agriculture Today Group 13 years ago, they were the only awards of their kind in their respective fields.

When ATG first announced these awards, professionals and entrepreneurs in the agriculture sector were startled. A large number of agri-professionals and agripreneurs found it unusual that somebody can decide to honour commitment and single-minded focus for improvement of agriculture. Yet this was an idea whose time had come. Year after year, the awards have grown in stature.

An interesting observation related to all such awards related to excellence in various sectors is that they glamourize agriculture. Over the years, many other groups have started awarding achievers and path-breakers in the field of agriculture. These initiatives are important. They lead to a sense of pride and honour in the winners and boost further desire to achieve and to strive.

It has been observed that a sizable percentage of youth tend to avoid joining the family profession of agriculture because they consider it drudgery. The glamourization of this most valuable human occupation has played a role in drawing more youth to agriculture. Their innovations, their new projects and ideas have immensely benefited agriculture. More power to them. May their tribe grow, as the most valued and essential human activity marches on, overcoming all challenges.

WHO STOLE THE GOLDEN RICE?

ANJANA NAIR

The year 2000 was particularly glittering as it marked the debut of golden rice. Yellow rice grains mimicked yellow gemstones when held against a black surface. From nutrition point of view, they were indeed precious as they carried beta carotene, a substance that is converted into vitamin A in the human body. This rice variety could combat vitamin A deficiency in areas of the world where the condition is endemic and where rice was a staple. So the motto was "save a million kids a year." Lack of vitamin A is responsible for a million deaths annually, most of them children, plus an additional 500,000 cases of blindness. In 2016, more than 100 Nobel laureates encouraged use of genetically modified golden rice which can produce up to 23 times as much beta-carotene as the original golden rice.

The hue and cry generated soon died down. Two decades later golden rice remains locked somewhere unavailable to common man. A genetically modified variety, golden rice biosynthesizes beta-carotene, a precursor of vitamin A, with the help of genes inserted from Daffodils and a soil bacterium. Despite passing the biosafety trials, the tag of GM food has deterred many countries from embracing it. As of 2022, Golden Rice has begun pilot-scale deployment in the Philippines. It is still under regulatory review in Bangladesh.

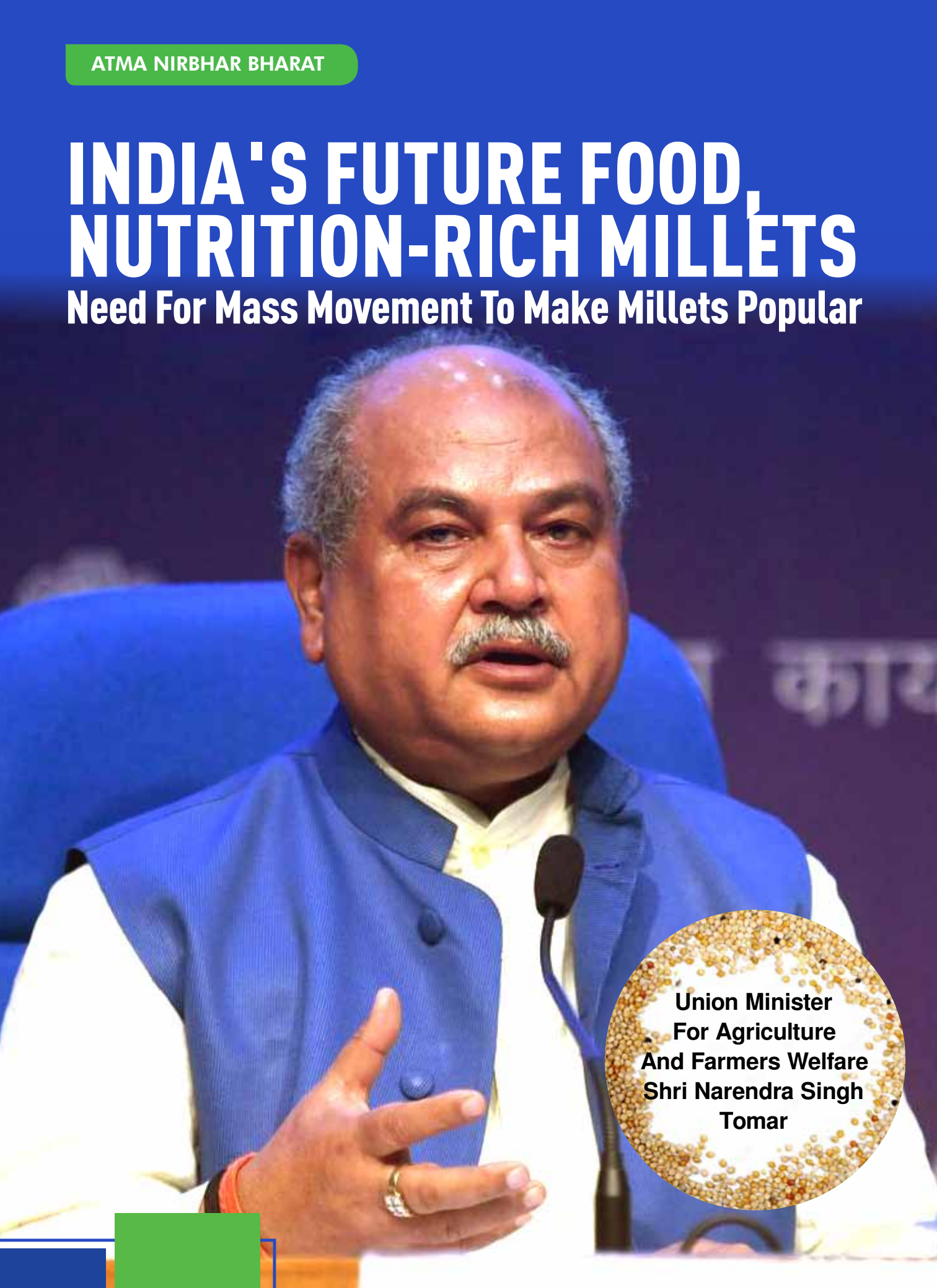
Under nutrition and malnutrition is severe in many developing countries. While encouraging the use of nutrient rich food products seems like an immediate recommendation, it cannot be a standalone solution. The extent of bioavailability of nutrients from natural foods cannot be defined in absolute terms. It can only be an addendum to a regular diet. But if we need to address the problem out rightly, we might need to turn to more scientifically advanced means. There are techniques like biofortification, genome editing, genetic engineering that can enhance the nutrition attributes of existing varieties. Utilising the fruits of these technologies can help ease the burden of malnutrition world wide. Fears and doubts regarding these technologies need to be allayed authoritatively.

Silence may not always be golden!

ATMA NIRBHAR BHARAT

INDIA'S FUTURE FOOD, NUTRITION-RICH MILLETS

Need For Mass Movement To Make Millets Popular



Union Minister For Agriculture And Farmers Welfare Shri Narendra Singh Tomar

More than 500 start-ups are working in the millet value chain, while the Indian Institute of Millets Research has incubated 250 start-ups under RKVY-Raftar

Millets, highly nutritious food, shall enable the farmers to deal with climate change with and become the pillar of small farmers. India's self-reliance in food grains was the first step in tackling our food shortages. There is no doubt that in the last 8 and a half years we have achieved surplus in food grain production on the basis of effective efforts of Government of India, farmers and agricultural scientists under the efficient leadership and guidance of our visionary Prime Minister Shri Narendra Modi. Today our grain stores are full. But along with climbing this first rung, we have started working towards conquering our second diet challenge as well. Our second dietary challenge is to provide adequate nutritional food on the plate of every Indian. Encouraging the production and use of nutritious cereals ie millets is part of this strategy so that we can provide adequate nutritious food to every Indian. In this series, under the leadership of India, preparations have been made to celebrate the year 2023 as the International Year of Nutri-cereals (IYOM). Through this initiative has been taken to bring Nutri-Grains (Millets) on the global stage. Nutritious grains (millets) are the diet of our future. These are the solution to many problems at once.

International Year of Nutri-Cereals

It is also a commendable fact that on the initiative of Prime Minister Shri Narendra Modi, United Nations has declared the year 2023 as the International Year of Nutri-Cereals (IYOM). Through IYOM-2023, India aims to raise awareness about the contribution of millets to food security and nutrition, motivate stakeholders to improve the productivity and quality of millets, and encourage investment for research and development.

At present, wheat and rice are consumed more and more in the form of grains in our country. That is why till now the focus has been on their production only. But millets are very nutritious grains as compared to wheat and rice. In fact, millets are an "indigenous superfood", which are full of protein, fiber, vitamins and minerals.

In the year 2018, millets were notified as "nutrition-cereals" by the Government of India due to their nutritional superiority in comparison to the prevalent food grains like wheat and rice. 2018 was celebrated by declaring “National Nutri-cereal Year” to promote and create demand for Nutri-cereals.

Today, it is necessary that the campaign to make Millets an essential dish of our plate should be given the form of a mass movement. In this direction, the Government of India has started taking concrete steps to create awareness and motivate the market, consumers and farmers towards millets, making a well-planned strategy for IYOM-2023.

GOI in Mission Mode to Boost Millets

Millets not only meet our nutritional and health needs, but also help in climate change mitigation and adaptation. They contribute to the development of small and marginal farmers in arid and difficult regions where development goals are difficult to achieve. India is the world's largest producer of millets, contributing 18% to global production. Through celebrating IYOM-2023, we aim to increase the domestic, global consumption of millets. In this regard, the Ministry of Agriculture & Farmers Welfare is working on a mission mode to increase the production, consumption of Millets in collaboration with other Central Ministries, all state governments and other stakeholder organizations. The future of food systems depends heavily on the participation of small and marginal farmers, especially when it comes to diversification of production and food security. About 86% of small farmers in India have less than 5 acres of land, which is about 47% of the total cultivable land. The government has taken several support initiatives to empower small farmers, including input support, FPO interventions, digitization, agriculture infrastructure fund and many more. Incorporating nutri-cereals into the cropping system will be an important step towards providing farmers with self-sufficiency in nutritious food, increased returns with less input, better market support and climate impact protection. Government has designated millets in 21 districts as "One Country-One Product" and "One District-One Product" to tap the potential of millets production and its integration into high value domestic and international markets. Nutritious Grains In Every Plate Under the National Food Security Mission programme, NFSM-Nutrient Grain Component for Millets is being implemented in 212 districts of 14 states. More than 500 start-ups are working in the millet value chain, while the Indian Institute of Millets Research has incubated 250 start-ups under RKVY-Raftar. Karnataka, Odisha, Tamil Nadu, Telangana, Madhya Pradesh, Chhattisgarh, Rajasthan, Gujarat, Assam and other states have taken initiative to promote millets. Millet Mission has been launched in many states. Ministry of Agriculture and Farmers Welfare and other allied Ministries along with Indian Council of Agricultural Research, IIMR, International Crops Research Institute for Semi-Arid Tropics (ICRISAT), State Agricultural Universities and other institutions are working on this golden opportunity to achieve food and nutritional security in the country. With time it becomes relevant that we change our dietary habits and menu. More attention needs to be given to proteins, minerals, vitamins and fiber than carbohydrates. In the changing lifestyle, making millets an essential part of the diet for a healthy body is now very necessary and indispensable. Let's give this mission of the Government of India the form of a mass movement, take steps towards providing nutritious grains to every plate.

MILLETS

The Smart Food, The Super Food

In the 75th Session of United Nations General Assembly (UNGA), the Indian proposal to observe an International Year of Millets (IYM) in 2023 was endorsed by members of FAO governing bodies. In addition to India taking the lead, over 70 nations supported this resolution, adopted by the United Nations. IYM aims to elevate awareness of Nutri-cereals (millets) for food security and nutrition, enhance investment in R&D and extension, and inspire stakeholders towards improving production, productivity, and quality of millets. India in the year 2018 declared "National Year of Millets", and since then consistent efforts were made to increase awareness, production, and consumption of millets globally.

Millet provide solution to the vicissitudes and variations in the climate change, it has a very light carbon footprint about 25 % less than the staple crops, it's gluten free and can bring down diabetes, has shown to help in mitigating anaemia and it's a resilient crop that can withstand both biotic and abiotic stress and it's a good crop for small and marginal farmers.

Need For Balanced Diet

The world needs to produce more food to feed a rapidly growing population, which is projected to reach 8.5 billion by 2030, and a staggering 9.7 billion by 2050. With a deepening climate crisis and aggravating environmental stress, there is a heightened need for crop diversification by promoting crops suitable for cultivation in the toughest of environments. The staple crops involving high agricultural inputs provides more calories for vulnerable groups, but not a balanced diet. Several lifestyle disease problems are associated with hidden hunger caused due to lack of micronutrients, vitamins, and others, leading to a weak immune system and increased susceptibility to deficiencies. Damage to the ecosystem through increasing chemicalization of agriculture also aggravates the problem.

Millets play a pivotal role in creating sustainable and nutrient sensitive food value chains. They are also widely used for human consumption, animal fodder, and other untapped markets like bio-fuels and fermentation

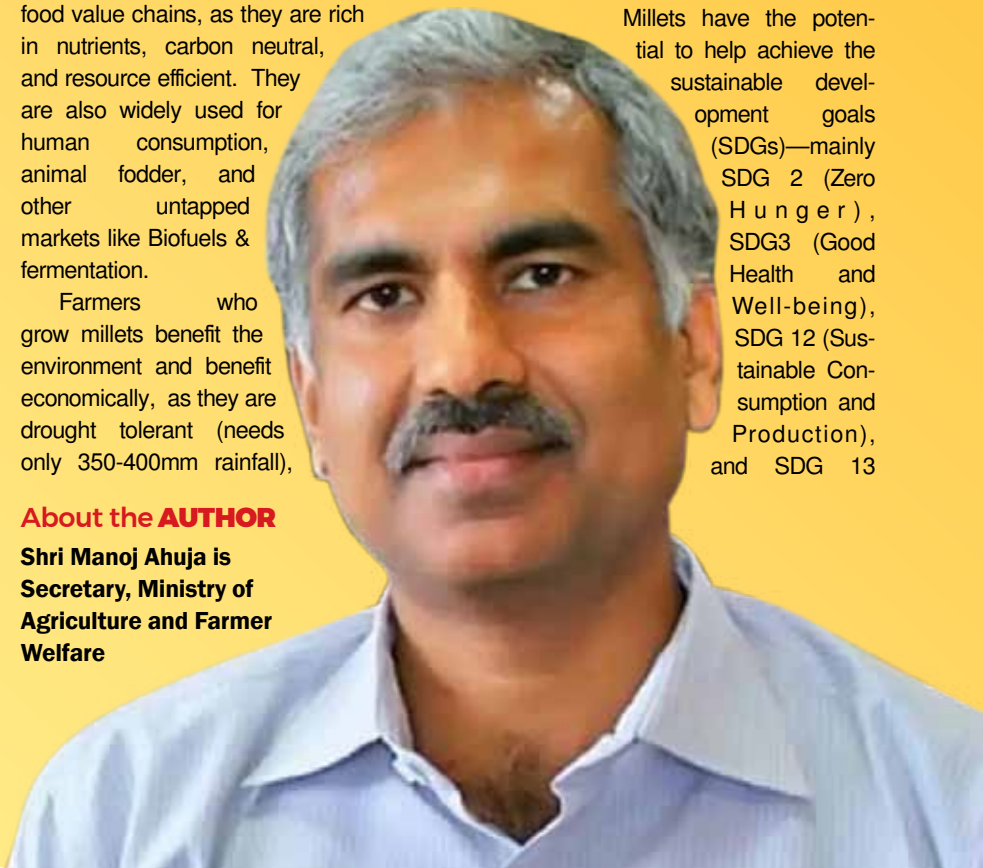
Widely recognized as "Smart Food" or "Super Food", millets play a crucial role in transforming agri-food systems, across the globe. They play a pivotal role in creating sustainable and nutrient sensitive food value chains, as they are rich in nutrients, carbon neutral, and resource efficient. They are also widely used for human consumption, animal fodder, and other untapped markets like Biofuels & fermentation.

Farmers who grow millets benefit the environment and benefit economically, as they are drought tolerant (needs only 350-400mm rainfall), heat tolerant (can survive up to 64 Celsius), grows faster (need only 65 days to mature), grows with minimal fertilizers and pesticides, aids in biological diversity and low carbon footprint (19% less than the staple crops).

The Magic Of Millets

High nutritional value and with health benefits, millets are rich source of nutrients like Calcium (Little Millets contains 3X more calcium of milk and 2X more in Pearl Millet), dietary fibre (3X more than staple crops), proteins, antioxidants, and are also gluten free. They are high in important nutrients like iron, calcium, proteins, potassium, and vitamins, which are essential to maintain a healthy lifestyle. They are effective in reducing blood pressure, help to prevent type 2 diabetes, help to protect against heart diseases and others.

Millets have the potential to help achieve the sustainable development goals (SDGs)—mainly SDG 2 (Zero Hunger), SDG3 (Good Health and Well-being), SDG 12 (Sustainable Consumption and Production), and SDG 13



About the **AUTHOR**

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(Climate Action).

Millets are mainly grown in tropical and sub-tropical regions of the world, with Asia and Africa accounting for major production and consumption centres. Sorghum and Proso millets are most widespread millets being cultivated in 112 and 35 countries respectively. India, Niger, Sudan, and Nigeria are major producer of millets. Millets hold a pivotal place in nutritional security to the dry land region communities. Among the top seven millet growing countries of the world, India is ranked first with 15.29 M ha harvested area followed by Niger (7.03 M ha), Sudan (3.75 M ha), Nigeria (2.7 M ha), Mali (2.15 M ha), Burkina Faso (1.39 M ha), and Chad (1.22 M ha). India being the largest grower of millets contributes about 26.6% of the global harvested area (FAOSTAT-2020).

Bio-Fortified High Yielding Varieties

In recent years, India has developed several nutrient-rich/ biofortified high yielding open pollinated and hybrid varieties of millets, and good agronomic practices. These technologies are being taken to farmers for enhanced local production, consumption, and generation of marketable surplus to ensure increased dietary diversity in food grains, while creating opportunities for product development and increased consumption of millet-based products.

Government of India has decided to celebrate IYM and to make it a people's movement for the country, inspiring Markets, Farmers & Consumers, so that the Indian millets, recipes, and value-added products are accepted globally. Ministry of Agriculture & Farmers Welfare in association with other central ministries, state governments and all other stakeholder institutions are working in mission mode to enhance production and consumption of millets in the country. It is involved in supporting sustainable production, creating awareness for higher consumption, strengthening value chains, developing markets, and funding research and development activities.

Millets are one of the best solutions to many challenges faced by countries, including climate change and food security. Millets are called the Golden Grains because they offer solutions to most of the current challenges.

Various initiatives are taken to develop the millets value chain on a holistic approach.

To improve acreage, production, and productivity of millets across the country, Institutions like Indian Council of Agriculture Research (ICAR) are working on of high yielding climate resilient new varieties/hybrids which are tolerant to biotic and abiotic stresses with enhanced quality. Under National Food Security Mission (NFSM) programme, the NFSM-Nutri Cereals component for millets is implemented in 212 districts of 14 states . Assistance is given through state governments to farmers for interventions like cluster demonstrations on improved package of practices, demonstrations on cropping system, distribution of seeds of High Yielding Varieties (HYVs)/hybrids, improved farm machineries/resource conservation machineries/tools, efficient water application tools, plant protection measures, nutrient management/soil ameliorants, processing & post-harvest equipment's, cropping system-based trainings to the farmers etc.

Strengthening Post-Harvest Infrastructure

To strengthen post-harvest infrastructure, Rs. 1,00,000 crore Agricultural Infrastructure Fund (AIF) has pushed investments across states to support entrepreneurs, including millet growers, primary processing machines for dehulling millets and the formation of farmer collectives. The fund provides credit guarantee loans up to INR 2 crores under Credit Guarantee Fund Trust for Micro and Small Enterprises (CGTMSE) and interest subventions of 3% for 7 years have been designed to provide collateral-free loan opportunities to farmers and banks.

To increase domestic consumption of millets the Government notified Millets as Nutri-cereals in April 2018 and included them under the POSHAN Mission Abhiyan and in public distribution system. The focus is to move from 'calories fundamentalism' to providing a more diversified food basket, including coarse grains and millets to improve the nutritional status of pre-school children and women of reproductive age. NITI Aayog and World Food Program WFP intend to identify and address these challenges in a systematic and effective manner they have partnered to focus on mainstreaming of millets and supporting India in taking lead globally in knowledge exchange using the opportunity of 2023 as an International Year of Millets.

To strengthen the start-up ecosystem, the Indian Institute of Millet Research, has incubated 250 Start-ups under RKVY-RAFTAAR. ICAR-IIMR have developed 32+ millets-based value-added products, which together has helped in formation of 400+ brands across the country. Earlier, millets were stigmatised as the poor man's food, but with changing dynamics there is a shift in perceptions and millets are increasingly sought as healthy and nutritious alternatives to fine cereals.

For increasing exports of millets through quality production and processing, Agricultural and Processed Food Products Export Development Authority (APEDA) signed a Memorandum of Understanding (MoU) with ICAR-Indian Institute of Millet Research (ICAR-IIMR) which is expected to boost value addition and increase farmers' income.

Globally, millets are one of the best solutions to many challenges faced by countries, including climate change and food security. In fact, millets are called the Golden Grains because they offer solutions to most of the current challenges. It is time to utilize IYM to position millets on the global food plate through the right interventions and extensive collaborations across institutions, industry, start-ups, farmers, farmer organizations, and countries.

MILLETS

HIGH NUTRITION, FARMER PROSPERITY

GOI proposed to United Nations General (UNGA) for celebrating 2023 as International Year of Millets which was adopted by the UNGA in March 2021. India has been entrusted with the responsibility of celebrating the International Year of Millets (IYoM) 2023 for mainstreaming the millets to bring them on the common man's plate not only in India but across the globe.

ICAR-All India Coordinated Research Projects

Through ICAR-All India Coordinated Research Projects on Pearl millet, Sorghum and Small millets, during 1969 to 2022 total 681 varieties/hybrids of eight millet crops have been released for cultivation in different agro-ecological zones of the country; which include 194 varieties of sorghum (56), pearl millet (64), finger millet (35), little millet (13), kodo millet (9), foxtail millet (8), barnyard miller (5) and proso millet (4) released during past eight years (2014-22). It is the first crop where marker assisted selection (MAS) strategies and tools were applied to develop pearl millet hybrid Improved HHB 67, and to develop biofortified variety "Dhanashakti" in collaboration with ICRISAT and Harvest Plus programs.

Small millets improvement efforts have contributed significantly by releasing several HYVs and developing crop protection and agronomical techniques. Major milestones of millet improvement programme are presented below.

Timely availability of seeds of high yielding varieties and hybrids of millets to the farmers alongwith improved agronomic practices and other technical assistance will help in enhancing productivity vis-a-vis profitability of these crops, which will help in increasing the area.

Ensured MSP for all millets will also attract farmers for shifting to these crops. For demand creation, awareness about the nutritional benefits of the millets and their products among the consumers specifically young generation is essential step which will increase household consumption.

Currently, there are no standards on the degree of polishing of grain, as in the case of rice, hence studies for preparing the grades, standards and degree of polishing are essential for preserving the quality of the grain, nutrition, etc., and to avoid the malpractices of indiscriminate polishing. The current diversification of product technology is limited to local tastes and preferences, more technologies for continental and export market-

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Prof DK Yadava is Assistant Director General, ICAR

specific recipes are necessary for pushing the demand.

Involvement Of Diverse Stakeholders

Involvement of food industry, hoteliers and chefs is very important for making the diversified products of millets as per choice of young generations. Establishment of FPOs and promoting the startups on millets will further help in enhancing production, productivity, value addition and popularization of millets.

ICAR-IIMR and Agricultural and Processed Food Products Export Development Authority (APEDA), Ministry of Commerce and Industry, GOI have been organizing sensitization events to educate millet startups on value addition, emerging trends and potential export markets. Thus, a framework is in place to work on the refinement of the value chain for export markets, with the involvement of several other stakeholders such as ICRISAT, NIN, IIFPT, DFRL, CFTRI, Private companies, FPOs, etc.

ICAR-IIMR has initiated the popularization of millets as healthy and convenient foods and its suitability for tackling lifestyle diseases is loudly disseminated through road shows, exhibitions, wet sampling in public parks, national stakeholder meetings, conferences, road shows, marathon, cyclathon, wet sampling counters, exhibitions, stalls, cooking competitions, social media campaigns, virtual programs, flipkart, GeM portal, etc.; and commercial malls in a specially designed Mobile van -"Millet Rath".

Involvement of food industry, hoteliers and chefs is very important for making the diversified products of millets as per choice of young generations. Establishment of FPOs and promoting the startups on millets will further help in enhancing production, productivity, value addition and popularization of millets

All media including social media, electronic media and print media are aggressively utilized to raise the message "eat millets-stay healthy". Several entrepreneurship development programmes for farmers, Self Help Groups (SHGs), Small scale processors, Women groups, rural entrepreneurs, etc. were initiated to train them in millet processing. These efforts got manifold with the establishment of "Nutrihub" at ICAR-IIMR, Hyderabad with the support of Department of Agriculture and Farmers Welfare for giving handholding support to millet-based startups which include hand holding of 325 startups, 100 incubators and 41 millet FPOs. ICAR-IIMR has developed 67 products branded as "Eatrite" which have been transferred to 124 entrepreneurs. Start-ups have also transferring 170 value added technologies with development of 260 new millet products.

The above aspects are being accelerated through the various activities under the celebrations of International Year of Millets 2023 in India as well as at global level through Indian Embassies. A round the year programme for mainstreaming millets in India as well as outside the country has been chalked out and being coordinated by the Ministry of Agriculture and Farmers Welfare through its both departments viz., Department of Agriculture and Farmers Welfare, and Department of Agricultural Research and Education. ICAR-Indian Institute of Millets Research, Hyderabad has been entrusted with the responsibility of Nodal Institute for the various activities and technical coordination during International Year of Millets.

The collective efforts of all the ministries of GOI and the state under the coordination of Ministry of Agriculture and Farmers Welfare; and noble guidance of Hon'ble Prime Minister will lead to achieving the target of taking millets to each plate.

WORLD FOOD DAY 2022

LEAVE NO ONE BEHIND

Food and Agriculture Organization (FAO) was founded by the United Nations on 16th October 1945. This day is commemorated every year as the 'World Food Day'. FAO leads global efforts to neutralise hunger and promote nutrition & food security for all people on earth. This vision and goal are captured in its motto - *fiat panis,* which translates in English as **"Let there be bread".**

Notwithstanding this laudable goal, and 77 years of efforts, hunger continues to plague a large section of the global population, particularly across African and Asian countries. Even where hunger has been conquered, there is crisis of nutrition. As reported by Global Panel on Agriculture and Food Systems for Nutrition (2015), an approximate of three billion people representing every one of the world's 193 countries were suffering from low-quality diets. This implies, that nutrition-security goes beyond meeting the calorie requirement, and means a balanced and high-quality diet that can ensure health and well-being of all the people. The FAO mandate targets to:

- Eliminate hunger, food insecurity & malnutrition
- Make agriculture more productive & sustainable
- Reduce rural poverty
- Ensure inclusive & efficient agriculture & food systems, and
- Protect livelihoods from disaster

It is apparent that, the Agenda under Sustainable Development Goals (SDGs) 2030, to which both developed and developing countries are a signatory, is in sync with the above listed mandates of FAO, when it comes to Agriculture. To emphasize, it may be appreciated that SDG 1 aims at removal of poverty; SDG 2 targets to achieve zero hunger; and SDG 3 calls upon realization of total health & well-being.

Health is predicated upon nutritive consumption. Balanced & nutritive diet build immunity and offer needed resistance against external health challenges. The importance of a balanced diet and concomitant immunity came to be more than realised, as the globe hit by the Covid-19 pandemic was unable to cope with the demand for treatment by a large number of people. The health system of almost all countries across the globe fell awfully short of the requirement. The situation demonstrated that the probability of infection, and survival when infected bore a direct and close relationship with the level of immunity one possessed.

The theme adopted by FAO for 'World Food Day 2022' celebrations is **"Leave NO ONE Behind".** The focus, that FAO attempts to bring through this theme is in recognition of the larger vision and mission of the United Nations, which reads as follows:

"We help people build better lives and countries achieve peace and sustainable development"

Food and nutrition security in a way constitutes the basic element of better lives for people and peace for the countries. It is, therefore, appropriate that the FAO has adopted "Leave No One Behind" as its theme for the year 2022. This sets the right target for all stakeholders, such that everyone becomes part of the concerted efforts to extricate every country and every individual from the clutches of poor nutrition, that is known as malnutrition.

About the **AUTHOR**

Dr Ashok Dalwai,
CEO of National Rainfed Area Authority (NRAA)

This theme recognises the unfortunate status of global nutrition & health standards. Malnourishment and Undernutrition continue to grip a large percentage of the global population. It would help in understanding the meaning and difference between the commonly used terminologies, undernutrition and malnourishment.

While **'undernutrition'** refers to insufficient intake of energy & nutrition necessary for growth & health, **'malnourishment'** is more expansive and, means all nature of deviations from adequate & optimal nutritional status, inclusive of energy, undernutrition and over-nutrition.

Evaluating the global nutrition status on the anvil of these definitions, the challenges of 21st century emerge as elephantine in magnitude & complexity. As per the Report of the Global Panel on Agriculture and Food Systems for Nutrition, 2015:

- The world has made substantial progress in reducing hunger and undernutrition. Relatively, there is lesser suffering, lower mortality rates and improved life chances.
- Beyond these gains however, malnutrition in all its forms currently affects one in three people worldwide, far beyond the 800 million (approx.) who experience hunger on a daily basis.

This implies the high intensity of hidden hunger compared to hunger *per se* and, some data points as below highlight the dimensions of this challenge:

- There is stunted & wasted growth on account of which 45 per cent of 16, 000 daily deaths of children below five (5) years of age are attributed to undernutrition and suboptimal breastfeeding at the global level.
- Prevalence rates of overweight, obesity and diet-related chronic diseases such as diabetes & hypertension are gaining currency and, most rapidly in low- and middle- income countries.
- More than two (2) billion people lack vital micro-nutrients, which affects their health and life expectancy.

Re-orienting global food system

The world in its eagerness to conquer visible hunger has been producing more of calories-centric cereals at the neglect of proteins, fats, vitamins & minerals. A new matrix of diversified production, that includes millets within the cereals, pulses, fruits, vegetables, dairy, livestock, and fish is the urgent calling.

Given the challenges emanating from climate change, growing population and competition for land, application of new technology that is sustainably intensive (SI) brooks no delay. Science has no limitations to expansion of its frontiers. It needs to be deployed by appreciating comprehensively the basket of contemporary and future challenges and associated demands. Even as science takes into account the climate change and its implications on the food systems, it cannot be unhinged from sociological and philosophical framework. As **Albert Einstein** said, *"Science without philosophy is blind and, philosophy without science is lame".* To buttress this argument further, one can quote **Masanobu Fukuoka**, the Japanese scientist turned farmer who practised and advocated natural farming. In his popular book "One Straw Revolution", Fukuoka said. *"The researchers before becoming researchers must become philosophers".*

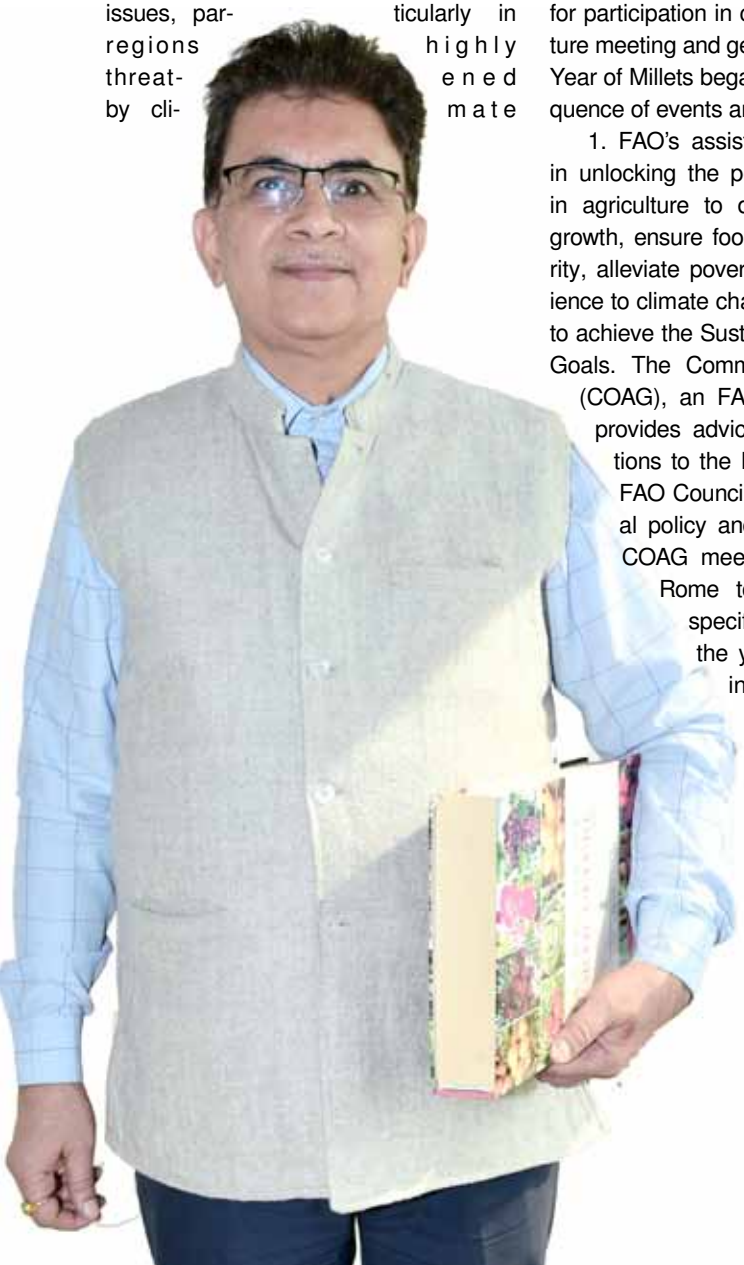
In order to conquer hunger including hidden hunger and fulfil the vision and mandate of UN-FAO, the world today needs new science and new management system in Agriculture. Further, one can never rest on past laurels, for situations constantly change, and demand proportionate response. Remaining alive to the narrative, that *"Today's science will become tomorrow's technology; and tomorrow's technology will become day-after-tomorrow's innovation,"* the system will need to keep working all the time on securing a virtuous cycle of food system. Towards this, the following paradigm is suggested:

i) Nutrition-led production system
ii) Sustainable Intensification of production system
iii) Harmonised global food systems that reconcile public policy (that ensures availability, accessibility, affordability & awareness) and private-corporate sector (that is socially sensitive and not driven merely by profit-interests).

Finally, the theme "Leave NO ONE Behind" warrants, that the world in promoting integrated food systems is guided by three principles, namely, Economy, Equity and Ecology at both technology and policy stages.

GENESIS OF INTERNATIONAL YEAR OF MILLETS 2023

Millets are currently underutilized and their production is declining in many countries. Yet these crops have considerable assets to address food and nutrition security issues, particularly in regions highly threatened by climate change. Considering the importance of millets in the changing scenario of agriculture, India seeks to capture attention on millets and wished to proclaim an International Year of Millets. The opportunity came for India when FAO invited for participation in committee on agriculture meeting and genesis of International Year of Millets began in the following sequence of events and decisions.



1. FAO's assists member countries in unlocking the potential of innovation in agriculture to drive socio-economic growth, ensure food and nutrition security, alleviate poverty and improve resilience to climate change, thereby helping to achieve the Sustainable Development Goals. The Committee on Agriculture (COAG), an FAO's Governing Body provides advice and recommendations to the FAO Conference and FAO Council on global agricultural policy and regulatory matters. COAG meets biennially at FAO Rome to review agriculture specific matters. During the year 2018, India was invited for participation in 26th session of FAO Committee of Agriculture meeting (1-5 October, 2018) at FAO, Rome, Italy. The Government of India, Ministry of Agriculture & Farmers Welfare identified and approved Dr. S.K. Malhotra, the then Agriculture Commissioner as Head of delegation and member Dr. S.K. Chaudhari, ADG (Soil & Water Management) now DDG (NRM) at ICAR.

2. The Head of Delegation, Dr. S.K. Malhotra, Agriculture Commissioner took the initiatives after consultation in the Ministry for Agriculture & Farmers Welfare to take forward the view point from India with respect to each above mentioned agenda items and further new proposal on International Year of Millets was proposed in initial discussions. In this endeavour, he took the matter with FAO through Dr. Alka Bhargav, JS (International Cooperation) and Ms. Reenat Sandhu, Ambassador EoI, Rome with Dr. Robert G. Guei, Secretary of the Committee on Agriculture of FAO for inclusion of IYOM in the agenda. But the FAO wanted a request from Union Agriculture Minister, GOI.

3. This was accordingly done, the letter was forwarded and the agenda was accepted at later stage for inclusion in the already circulated agenda. After having an approval for inclusion of proposal

About the **AUTHOR**

Dr Suresh K. Malhotra is former Agriculture Commissioner and Project Director, Directorate of Knowledge Management in Agriculture, Krishi Anusandhan Bhawan, New Delhi. He has served at leadership positions of Agriculture and Horticulture Commissioner and steered the GOI agenda for ensuring food and nutrition security through higher production

Seeking support from Member Countries in the side event meetings

FAO Committee on Agriculture Meeting 4 Oct 2018, Millet proposal in discussion

from India for consideration for discussion in COAG, the detailed proposal on background, nutrition, multiple uses, resilience to climate change, sustainable production systems, harvest and post harvest operations with broad objectives set for International Year of Millets were developed by Dr. SK Malhotra, Former Agriculture Commissioner and submitted to Secretary COAG FAO for consideration.

4. The proposal from India was examined by the team of Dr. Hans Dreyer, Director, Plant Production and Protection Division of FAO Rome. The proposal was fine-tuned and fitted into the FAO proposal template with executive summary in the agenda format with suggested action by the Committee on Agriculture. Secretariat of COAG conveyed the approved agenda proposal to GOI. It was further requested for preparation of proposal in power point mode presentation and introduction of concept note of IYOM item by the responsible officer from India. Minister of Agriculture and Farmers Welfare, Government of India, identified Dr. S.K. Malhotra, Agriculture Commissioner as Head of Delegation for presenting the proposal in FAO COAG meeting and this item was scheduled for presentation on 4th October 2018 vide Agenda Item 4.6. The excerpts from the embassy report submitted by Sh. R. Ramesh, Attache (Agriculture) Embassy of India, Rome to Ministry of External Affairs is reproduced here point wise.

UNIQUE INITIATIVE

India is ready to provide leadership in observance of International Year of Millets 2023 with the objective to give boost to millets production. Efforts will be to focus on advocating for national public programs on millets, and generating opportunities to farmers in better connection with value chains and markets, and supporting investment policies for R&D.

5. The FAO COAG (1-5 October 2018) reviewed the proposal presented by GOI to establish observance of the International Year of Millets 2023 and decided to submit draft Conference Resolutions for Considerations and endorsement by the 160th session of FAO Council (3-7, December 2018) for further adoption by the 41st session of the FAO Conference (22-29, June 2019). On the recommendations of FAO COAG, FAO Council, FAO Conference the UN General Assembly (UNGA) adopted by consensus a resolution sponsored by India and supported by 70 nations declaring 2023 as International Year of Millets (IYOM-2023) on 3rd March 2021. All co-sponsors especially Bangladesh, Kenya, Nepal, Nigeria, Russia and Senegal and all Member States of UN showed strong support. The 193-member UN General Assembly unanimously adopted the resolution sponsored by India, declaring 2023 as the International Year of Millets, aimed at raising awareness about the health benefits of the grain. The resolution considers the 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. It also recognises the vast genetic diversity of millets and their adaptive capacities to a range of production environments.

6. U.N. Member States lauded India for the initiative and its leadership in facilitating negotiations on the resolution. PM Shri Narendra Modi expressed gratitude to all the nations who initiated and co-sponsored the resolution on International Year of Millets at the United Nations through a twitter message.

Yoga is my hobby to balance my life physically, mentally and spiritually

TRANSFORMING AGRICULTURE TO ACHIEVE SDGs

Transforming food systems would mean strengthening our household food and nutrition security, along with employment, rural development and economic growth, conserving natural resources and responding suitably to climate change. It also implies diversification in our farming systems including structure of landholdings, scaling of technologies and active involvement and capacity building of youth (including women). Such changes do require strong will and policy support to reap the multiple benefits of transforming rural livelihoods through agricultural advancements. Overcoming the complex challenges would require transformative action, embracing the principles of sustainability and tackling the root causes of poverty and hunger. By nurturing our mother land and adopting sustainable agriculture, the present and future generations will be able to sustain ever growing population. Agriculture is the world's biggest employer as well as an important economic sector for many countries, including India.

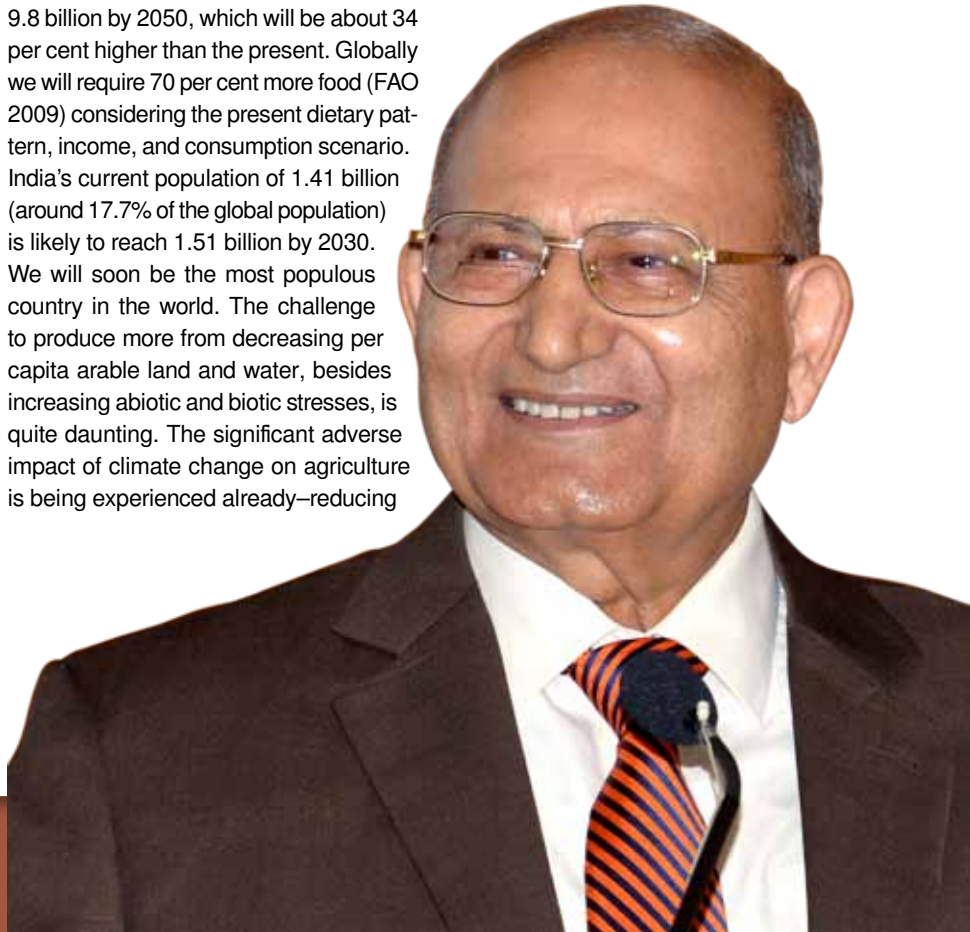
The SDGs were adopted by the United Nations in 2015,with universal call to end poverty, hunger, AIDS, discrimination against women and girls, protect the planet, and ensure that by 2030 people globally enjoy peace and prosperity. The 17 SDGs are integrated, they recognize that action in one area will affect outcomes in others, and that development must balance social, economic and environmental sustainability. Therefore, national commitment, human creativity, technical knowhow, and financial resources are necessary to achieve SDGs. Concerted efforts are thus urgently needed to improve social development index (SDI), especially in the Eastern and Northeastern states which somehow got bypassed by the Green Revolution. Also we shall have to sustainably increase agricultural production and productivity, while conserving our natural resources, improve current supply-chain, decrease food losses and waste, and ensure that hungry and malnourished have easy access to food and nutrition.

Challenges and Constraints

The world population is expected to reach 9.8 billion by 2050, which will be about 34 per cent higher than the present. Globally we will require 70 per cent more food (FAO 2009) considering the present dietary pattern, income, and consumption scenario. India's current population of 1.41 billion (around 17.7% of the global population) is likely to reach 1.51 billion by 2030. We will soon be the most populous country in the world. The challenge to produce more from decreasing per capita arable land and water, besides increasing abiotic and biotic stresses, is quite daunting. The significant adverse impact of climate change on agriculture is being experienced already–reducing production of crops like rice, wheat and maize ranging between 10 – 15 per cent. Hence, reorientation and reforms in agriculture are urgently needed to address the most important SDGs like no poverty, zero hunger and environmental sustainability.

Currently, the country is facing the second-generation problems, especially related to sustainability, nutrition, water scarcity, soil degradation, biodiversity loss, decreasing forest cover, and higher emission of greenhouse gases (GHGs) - mainly due to land and forest degradation, improper management of bovine animals, inefficient fertiliser use and cultivation of crops like rice.

In view of the above, agriculture sector seems to stand at crossroads. At one end, we need to continue producing more



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Dr. RS Paroda
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food to meet the demand of evergrowing population, whereas on the other, we must adopt those technologies and practices that help in sustainability of our natural resources. To face these unprecedented challenges, we need to reorient our agriculture through long-term farm policies that are aimed at scaling disruptive innovations and diversified farming systems around secondary and speciality agriculture. In fact, despite Green, White and Blue revolutions, the problems of poverty, hunger and malnutrition still persists, and the real income of the farmers is a major concern, which requires urgent attention if we have to achieve SDGs by 2030. In this regard, currently we have around 18.7 per cent people below poverty, 189.2 million people undernourished, whereas 34.7 per cent of our children aged under five are stunted. Also, 51.4 per cent of women in reproductive age between 15 to 49 years are anaemic and need nutritious food. Moreover, the challenge is not about lack of food but the economic access to available food, higher farm income and that of retaining youth (including women) in agriculture.

Achieving SDGs

Fortunately, the science-led Green Revolution in late Sixties transformed India from a food-deficit to a food-surplus country. The current science, technology, and innovation (STI)-led 'Rainbow Revolution' has transformed our country from 'ship-to-mouth' status to that of 'Right-to-Food Bill'. Today, we are the second largest agrarian economy in the world. Our country's science and technology initiatives are now geared to produce 'More from Less for More' without overexploitation of our agro-ecosystems. We also need to rely more on diversified local food systems that are more nutritious and healthier.

To meet SDGs by 2030, we would demand enhanced capital investment in agriculture, both by public and private sector, especially in the states of Bihar, Odisha, West Bengal, Assam and the north east where social development index is presently low. Also, doubling of funds for agricultural

research and innovation for development (ARI4D)at the national level is fully justified to scale technologies that help in sustainable intensification. In fact, investments in research give very high returns (more than 10-15 times) compared to any other growth sectors. Doubling farmers' income demands major focus on increased production while reducing cost on inputs, and efficient post-production management, including value-chain leading to better options for linking farmers to market. We shall need a paradigm shift from current 'farming first' to 'farmer first' to attain higher agricultural growth and overall farmer's prosperity. Also, there is urgency for introspection of existing scientific, development and policy related programs, being funded by the government for long, to make them efficient and incentive based instead of subsidy oriented as at present. Time has come to evolve a new strategy with defined 'Road Map', for faster implementation in order to accelerate agricultural growth critical for achieving SDGs in time. This obviously calls for some bold policy decisions to scale existing innovations, invent or import new technologies with policy support for intellectual property and incentives for public-private partnerships. Scaling of proven innovations, some of which are: hybrid technology (maize, pearl millet, sorghum, rice); biotechnology-GM crops (soybean, mustard, maize, papaya, brinjal etc,), conservation agriculture from current 3,0 mha to >20 mha to make grey areas green; expansion of protected cultivation from current 0.5 to 2.0 mha; micro-irrigation area to be doubled from current 10 mha; use of laser levelling, use of biofuel such as ethanol, permitted by government for admixing up to 20 per cent in petrol, from potential crops such as sugarcane and maize; greater use of biofortified crops (quality protein maize, iron and zinc rich rice, iron rich pearl millet, zinc rich wheat, etc.) through right policy on their pricing; and greater use of information communication technology (ICT), internet of things (IoT), artificial intelligence (AI), drones, big data etc., will certainly help in achieving SDGs much faster. Also, for scaling, involvement of skilled youth for better knowledge empowerment, private 'paid' extension services, entrepreneurship, farmer producer organisations (FPOs), custom hire services, agri-clinics, etc., will be quite rewarding and thus help in faster knowledge sharing without dissemination loss.

In view of the Paris Climate Agreement and the commitments made by our Hon'ble Prime Minister in COP 26 in Glasgow last year, concerted efforts need to be made to enhance the use of renewable energy by 50 per cent, and to reduce 1 billion tons of projected carbon emission by 2030, In fact, we need to rely now more on agriculture to reduce GHG emission by arresting land degradation, improving fertiliser use efficiency, diversification of rice, good management of bovine animals and scaling conservation agriculture (CA) or no-till agriculture, especially in the rainfed areas and by laying greater thrust on agroforestry for enhanced carbon sequestration. Accordingly, we must accelerate our efforts to diversify our farming systems eco-region wise, have resilience for improved efficiency, and scale both CA and agroforestry in a Mission Mode to make dryland agriculture both productive and sustainable.

Finally, accelerated investment in agricultural research for innovation and development and enabling policy support with effective coordination and monitoring mechanism will be the key requirements for achieving SDGs. In fact, agriculture sector be seen as solution of the problem rather than to be viewed as cause only. Moreover, attaining SDGs at the global level will depend mainly on the progress India makes on food, nutrition and environmental security front. Fortunately, we seem to be making great progress in this regard, but certainly there is no room for complacency as 2030 is not all that far.

PASTORALISTS SENTINELS OF LIVESTOCK UNSUNG, UNRECOGNISED

The cottage cheese or paneer as we know it was the most delicious I had ever had; it had a unique melt in the mouth pungency, much smoother than the fancy fermented imported cheese. The host, with genuine pride, informed us that he had procured this cheese specially for our dinner from the Bakarwals of Jammu and Kashmir. Since he was a reputed and well connected citizen of the state, now a union territory, he would have got it for a song. But believe me, in Delhi's upmarket stores, it costs a fortune; thanks to the power of branding and marketing. Perhaps, or quite likely, the Bakarwals, happily tending the bakris (goats) from which they derive their identity, as also the heavenly cheese, are blissfully unaware how precious their produce is, and how niche a market it commands.

Bakarwals have their "kin", not by blood or society, but the lifestyle, all across the country; in fact in many other parts of the world too. We come across them frequently on the highways, they are quite a familiar sight herding their cattle, sheep, goat, camels, buffaloes etc., yet we do not bat an eyelid at the wonderment of their lives. Rather we curse them for slowing down the traffic and at times abuse the system that allows them on roads serving no other cause except to slow down the pace of our economic growth. Are we all not guilty of apathy, a sin worse than the sin of indifference?

What to stare in the face, the global Sustainable Development Goals (SDGs) do not even cast a glance at them. The United Nations' Food and Agriculture Organisation (FAO) does no more than lip service to their plight, despite recognising their immense contribution to food and nutritional security. The FAO website provides minimal information on them, largely a cut and paste job, and diverts the curious surfer to sundry links. And at home neither the Ministry of Fisheries, Animal Husbandry and Dairying nor the Ministry of Environment, Forest and Climate Change, nor the NITI Aayog have any information, data or scheme, or even recognition of them. The National Agenda on Doubling Farmers' Income does not expend even one word, nor does the fourteen volume report of the Committee on the subject running into more than a couple of thousand pages spare a thought for them.

And yet these are the human civilisation's original livestock farmers, holding on to their lifestyles amidst the onslaught of modernity, providing the purest of the genuinely organic livestock products to consumers till this very day. They are the pastoralists, raising livestock in the harshest of environmental conditions and producing milk, cheese, meat etc. of the highest quality at the cheapest rates. Sadly, dishonestly and misleadingly claimed and labelled organic livestock products fetch a princely sum. But please do believe that the purest of organic livestock commodities are produced only by these pastoralists; unfortunately they either don't find appropriate buyers or it is the traders who capitalise upon the product quality to obtain the financial gains the label organic fetches.

Common Pool Resources

Defying the norms of statistical probability, the population of pastoralists in the world, according to various studies, is estimated to be between 120 to 500 million, a sizable number even if we assume the lower

About the **AUTHOR**

Dr Tarun Shridhar, Former Secretary, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India

end of the range. Their population in India is assessed to be between 14 to 35 million. Since there are no officially validated figures, either global or national, one has little choice but to base the appreciation of the issues on the basis of data thrown by studies and anecdotal evidence. Pastoralism is not recognised as a sector or even a subsector of the agriculture economy in India or in any other country for that matter. No official definition of such a category exists. Officials are aware of its existence, only at a personal level though, so no wonder they do not give it any official recognition as a distinct system of livestock management and economy.

Indian Pastoralist

Pastoralist systems in India vary from being eternally mobile to what is called transhumant: a seasonal movement of livestock between fixed summer and winter pastures. Animals maintained in mobile systems include camels, cattle, ducks, donkeys, goats, pigs, sheep and yaks; and in some limited areas of the northern Himalayan regions of Himachal Pradesh, Jammu and Kashmir and Uttarakhand, buffaloes too.

The livestock sector in India contributes 4.5 per cent to the GDP, and about 30% to the GDP from the Agriculture sector. And within the overarching umbrella of Animal Husbandry, it is estimated, yes only estimated in the absence of any reliable official data, that we meet more than half of our milk and about 75 per cent of our meat requirement from animals reared by pastoralists. Our livestock is phenomenally resilient and sustains primarily upon common grazing and water resources, including forests, charagahs, gochars, or other such common community lands. According to the National Sample Survey, only one per cent of the land owned by farmers is used for livestock. So it is quite obvious that it is not only the pastoralists who depend on common-pool resources but also a large number of farmers, even though they may be keeping crossbred cattle and high-yielding buffaloes. It is a pointer to questioning the data on the number of stall fed livestock. Anecdotal evidence suggests that stall feeding is minuscule.

Integration of pastoralism with Indian Economy

Pastoralists have been deeply affected by marginalisation. Poor understanding of their livelihood system and non-recognition of their immense contribution to, not only agricultural economy but also to nutritional security, have imposed alien social and governance schemes. These often involve attempts, perhaps well-intentioned too, to make their lives sedentary. At other level are the deliberate hurdles to their mobility which is a sine qua non for their livelihoods and the very existence. Such response may be on account of our inability to provide the basic services such as education and health to these communities, not to mention the veterinary services for the mainstay of their profession. What the governance systems, in the onslaught of economic development, are pushing for is the disruption of pastoral mobility. We do not realise that such an approach has the potential to trigger food insecurity, even if marginal as the pastoral systems are characterised by strong resilience, better productivity, and above all a much superior quality of the products.

Pastoralism is a complex activity, hinging on a fine balance between human population, animal population and natural resources. It continues to provide a valid livelihood for millions of people and has the potential to continue to do so. But the future of pastoralism depends on ecological and environmental conservation, sustainable utilisation of rangelands/wastelands/common lands/pastures etc., the improvement of livestock productivity, and most importantly the redressal of the ever growing conflicts over depleting resources. The key is an integration of pastoralism with agriculture, animal husbandry and the rest of the economy. The governments, as also we, need to acknowledge the critical significance of pastoralists and their extensive livestock tending in our rural economy, the gross domestic product, and the contribution to the food basket; food which is genuinely organic and of an enviably high quality.

The pastoral life is idealised as the writers are usually city people. The idylls written in the name of the pastoralists are far remote from the realities of their life, which is tough, beset with untold hardships, bereft of governance support systems and mystically complex. In reality, it is an existence on the edges of society. Let them not be the lost tribe.

MILLETS
SUSTAINING FOOD AND NUTRITIONAL SECURITY

Indian Millets are nutritionally superior to wheat and rice as they are rich in protein, vitamins and minerals. They are also gluten-free and have a low glycemic index, making them ideal for people with celiac disease or diabetes.

GOI is working in a mission mode to enhance production and consumption of millets in the country. It is involved in supporting sustainable production, creating awareness for higher consumption, developing market and value chains and funding research and development activities. Through the National Food Security Mission under the sub mission of Nutri cereals, interventions such as cluster demonstrations on improved package of practices, demonstrations on cropping system, distribution of seeds of High Yielding Varieties (HYVs)/hybrids and nutrients are implemented in collaboration with states.

Under NFSM, 50 FPOs were engaged with Nutri- Cereals (Millets) during 2018-19 to 2020-21 in Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu, Telangana and Uttar Pradesh. The FPOs were formed by Small Farmers Agri-Business Consortium (SFAC), DAC &FW. The mission has supported 25 Seed Hubs at 19 ICAR Institutes, SAUs and KVKs to ensure availability of quality seed of latest improved varieties of Nutri cereals in the country and to enhance seed replacement ratio by 10% every year.

Cluster Development Of Millets

Through the Ministry of Food Processing Industries, the PM Formalization of Micro Food Processing Enterprises Scheme (PMFME) is promoting millets and millets products in 16 districts of nine states. The millets covered are Sorghum, pearl millet, finger millet ,Kodo and kutki based products. The scheme will adopt One District One Product approach (ODOP) to reap the benefits of scale in terms of procurement of inputs, availing common services and marketing of products. This will help ODOP to utilize the value chain infrastructure including cluster development of millets.

The scheme will support the existing units processing other products as well. For the new units it will be limited to ODOP alone. Individual micro-entrepreneurs would be provided credit-linked Capital Subsidy @35% of the project cost with a maximum unit of Rs. 10.00 lakh per unit.

In view of the nutritional value of the millets, GOI notified Millets as nutri-cereals in April, 2018 and Millets were included under the POSHAN Mission Abhiyan. Over 500 Startups are working in Millet value chain while the Indian Institute on Millet Research, has incubated 250 Startups under RKVY-RAFTAAR.

FPOs, Start-Ups Boosting Millets Sector

Today a lot is being done to promote millets in our country. Along with focusing on research and innovation in production, farmers associations namely FPOs are being encouraged, so that, aggregation, production and processing can be increased.

It feels good to see that many such start-ups are emerging today, which are working on millets. Some of these are making Millet Cookies, while some are also making Millet Pancakes and Dosa. There are some who are making Millet Energy Bars, and Millet Breakfasts. I wish all the

About the **AUTHOR**

Mrs Shubha Thakur is Joint Secretary (Crops and Oilseeds), Department of Agriculture and FW, Ministry of Agriculture, GOI

MyGov platform has become a very important and successful medium for raising awareness through various competitions to capture the imagination and creative spirit of the country. Weekly and monthly national nutritional campaigns are being held to popularize consumption of millets among masses

very best to all the people working in this field. To support the creation of global food manufacturing champions and support Indian brands of food products in the international markets, a Production Linked Incentive scheme has been launched for food processing industry. This will provide support for production of ready to cook/ ready to eat (RTC/ RTE) foods including millet based products.

APEDA has launched a variety of millet products for all age groups at affordable prices ranging from Rs 5 to Rs 15 at the AAHAR food fair, which is Asia's biggest B2B international food and hospitality fair. All the millet products launched by APEDA are gluten-free, 100% natural and patented. The launched products are cream biscuits, salt biscuits, milk biscuits, ragi peanut butter, jowar peanut butter, jowar upma, pongal, khichadi and millet malts (jowar, ragi, bajra).

Department of Agriculture and Farmers Welfare has taken many initiatives for promotion of millets in both the domestic and international market. A series of pre-launch events and initiatives have been organised on the MyGov platform as run-up to the International Year of Millets 2023 to create awareness and a sense of participation in the country around the ancient and forgotten golden grains. The MyGov platform has become a very important and successful medium for raising awareness through various competitions to capture the imagination and creative spirit of the country. Weekly and monthly national nutritional campaigns are being held to popularize consumption of millets among masses.

Multiple Initiatives

Several actions have been taken for reaching international communities. In the year 2023, many international events will be carried out by APEDA and MEA. This will include B2B, B2G and G2G interactions at events, showcasing of millet products, especially those made of the popularly consumed millet in the respective countries. Indian diaspora, Indian embassies, Indian Chefs and local journalists will be engaged in key countries to promote millets and millets based cuisines. Seminars and other public events will also be held in major world cities. Translation of promotional and outreach material in official UN languages is being done on priority.

Through multidimensional efforts, India as a country will be able to showcase the millets/traditional cereals as future alternative healthy options that offer nutritional security to all across the world. Millets also, offer a climate resilient option to the world. In the last decade, research efforts on diversifying uses of millets has been attempted by several R&D institutes, SAUs and private agencies. Today, a wider range of ready-to-eat and ready-to-cook products are available.

We all have to come together and make the International Year of Millets 2023 a huge success.

GLOBAL LEAD
BUILDING NUTRITIONAL SECURITY

India took the global lead in emphasizing on the importance of millets in building nutritional security. The celebration of the National Year of Millets in 2018, several small-scale policies on millets and proposing the International Year of Millets to UNGA are major milestones. UNGA has passed the resolution to observe 2023 as the International Year of Millets (IYM 2023) for creating awareness on millets and popularizing them as the future foods in changing climatic conditions. IYM 2023 is offing the mandate to scale up the interventions for increasing the millets area and production, diversifying the processing machinery and technologies to cater to various segments in domestic and export markets.

Karnataka

Karnataka initiated several steps to popularize millets in India. Millets gain lot of prominence under Govt. of Karnataka organic cultivation. Farmer Co-operatives were set up in the late 2000s to streamline the supply-chain. Millet promotional activities through mainstream and social media reinforced the populations to opt for healthier and nutritious foods and active engagement of key influencers during 2010. Start-ups took up the supply of many millet-based products in Karnataka.

Maharashtra

In Maharashtra, people had been consuming millets since many decades. The state reported first Bhagar mill set up in Nashik during early 1960s to process minor millets for "upvaas" market. More processing units were established with the installation of many cone polishers to provide white millet-rice within the communities. Ragi continues to be consumed as a staple.

Odisha

Odisha Government initiated a special millet program in tribal areas and introduced Odisha Millet Mission in 2017 for promotion of millets. This programme was already implemented in 84 blocks of 15 districts both for procurement from farmers and distribution of millet through PDS. The Ragi-laddo program given to ICDS children in Keonjhar and Sundargarh districts is implemented with community-based organizations with support of local NGOs. Odisha proposed to introduce millets in MDM program and scale up the millet program in 142 blocks of 19 districts. Government of Odisha has increased the funding from Rs 65.54 crores to Rs 536.98 crores (5 yrs) for implementation, procurement and distribution of millet.

Rajasthan

Rajasthan is the largest producer of Bajra in India. Department of Agriculture provides extensive support for implementation of recommended package and practices for the crop, demonstration and subsidy support on certified seed distribution to farmers. In 2022 state budget, the government proposed for a budget allocation of 40 crores to be used for establishing Bajra processing units and promotional activities.

Chhattisgarh

Chhattisgarh established 'State Millet Mission' in 2021 that aimed to boost production, provide employment to farmers and women's groups and youths. Minor cereal crops like Kodo, Kutki and Ragi which are rich in nutrition would be promoted in the state by increasing the yield, making sure procurement

About the AUTHOR

Dr Satyen Yadav is Chairman, India Millets Initiative, GOI

India Millet Initiative has collaborated with stakeholders in entire West Africa, East Africa and South African countries, Dubai, Oman, Abu Dhabi, Doha, Russia, Germany, UK, USA, Japan for market access development through 'B to C' model

arrangements and are taken to the city markets after processing. Chhattisgarh Minor Forest Produce Co-operative Federation would directly procure these millets from farmers. These would be used for providing meals to children under ICDS and MOM. The Government has earmarked 170 crores for the 5 years for promotion of millets.

Major Initiatives

India Millet Initiative is promoted by Horticulture Produce Management Institute, One Life Foundation & SKN Agriculture University, Jobner, Jaipur, Rajasthan with the aim to transform the dreams of our Hon'ble Prime Minister to take India towards Global Leadership in Food & Agriculture and addressing the challenges of food security, nutrition security and climate change.

Five Fold Agenda of India Millet Initiative

* Provide Fortified seeds of Cereal Crops (biologically fortified), released by ICAR through seed banks with a hand holding support to procure as per the GOI guidelines, add value to it and provide to the globe as Super Food.

* To coordinate with all major millet producing countries as production hub and link the rest of the world as consumer hub through aggressive market access development efforts.

* To sensitize consumers for healthy food through Food Therapy Retail stores and food chains with expert nutritionists for counseling for right kind of food which gives nutrition as well as heals, underlining the "Super Food for the Globe".

* To increase farmers' income by enhancing productivity, adopting low input and high return strategy by adopting organic farming and nutrition farming to strengthen our soil.

* Agripreneurship development for value addition with hand holding support including market access development.

Dr Satyen likes to play tennis, badminton, cook, paint and read spiritual or scientific books

National Seminar-cum-Exhibition

We organized the first event at Jaipur during 7-8 May, 2022 which was two days National Seminar -cum-exhibition. Six states participated along with various policy makers, agripreneurs, scientists and farmers.

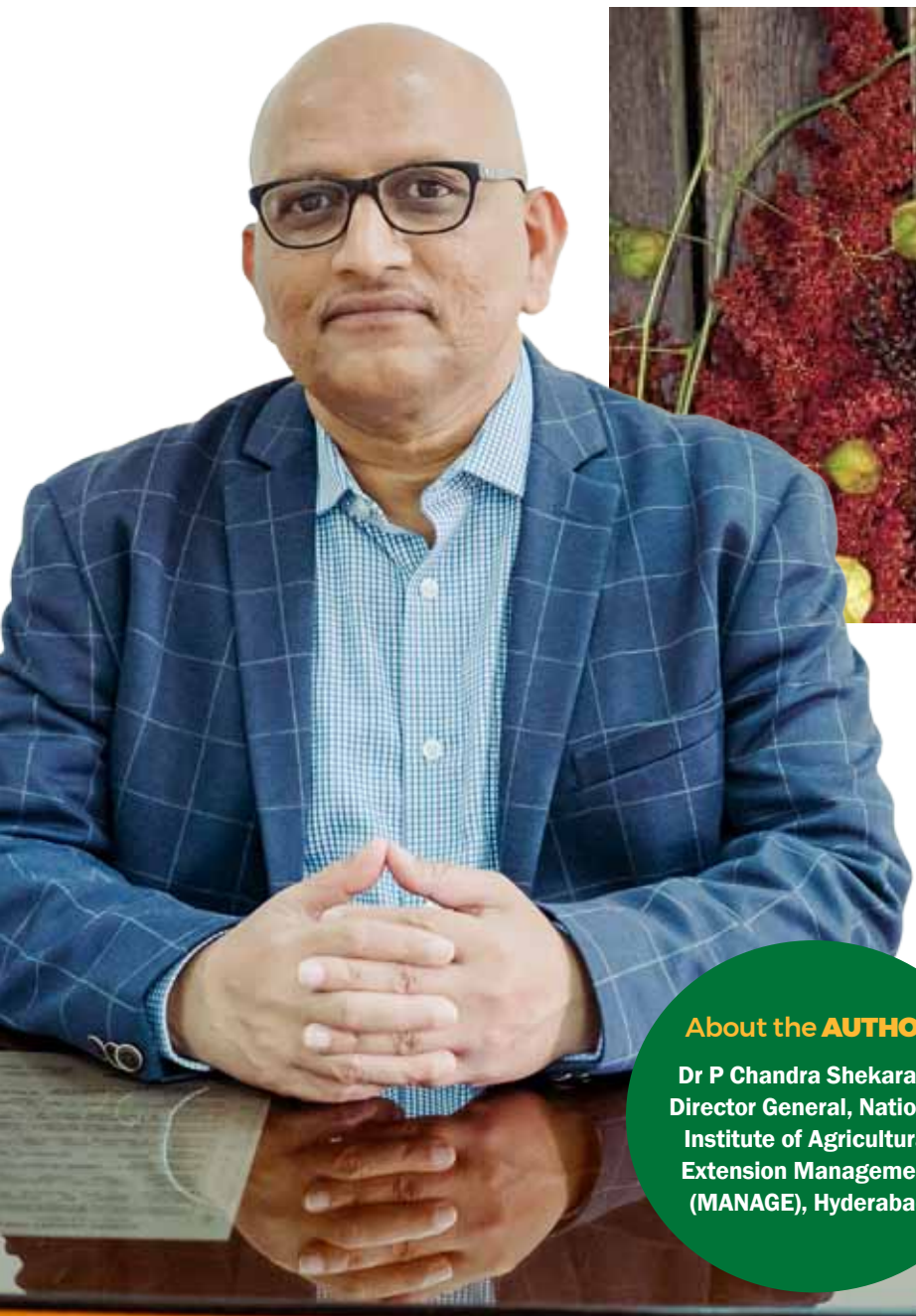
To develop market linkages, India Millet Initiative established Nigeria Millet Initiative in Nigeria under the chairmanship of the Ruler of Niger State and promoted a Commercial organization to bring all West African countries under one umbrella titled West Africa Agribusiness Limited.

India Millet Initiative has collaborated with stakeholders in entire West Africa, East Africa and South African countries, Dubai, Oman, Abu Dhabi, Doha, Russia, Germany, UK, USA, Japan for market access development through 'B to C' model .

India Millet Initiative is promoting 100 Millet Based Industries in Rajasthan, supported by Rajasthan State Mandi Board by providing 40% subsidy on Rs 1 crore project.

India Millet Initiative is operating in Maharashtra, Tamil Nadu, Karnataka and Rajasthan, and has adopted as per the notification of ten Nutri-cereal crops by GOI and also quinoa. We are working one three major millets, five minor millets, and two pseudo millets and one exotic crop, i.e. Quinoa.

MILLETS, MAHILA AND MANAGE



Efforts towards identifying women farmers, self-help group members, and training of women FPOs for equipping them in agro-processing, financial support, and marketing of millets could bring the best women entrepreneurs in millet and also justify the objectives of the International Year of Millets.

Furthermore, to create a better market for millet products, sensitization on mil-

About the **AUTHOR**

Dr P Chandra Shekara is Director General, National Institute of Agricultural Extension Management (MANAGE), Hyderabad

Mrs. Lakshmi Haritha Bhavani is the founder of 'Ancient foods India', aspiring to serve Healthy Millet based food products to people of all ages. The company is into manufacturing Ready-to-cook and Ready-to-Eat Millet-based SMART foods for the Next Generation. She saysthat GOI must waive off GST on Millet-based products.

Sukanya P is the founder of 'Nutrisukan Biotech Private LTD'. 18 years of experience as a food scientist. The company manufactures a wide range of products like Nutrisukan Millet Health Mix, Diabetic Care Atta, Instant Health Mix, and Wellness Tea.

G. Sunitha is the founder of 'VSP NUTRI BITE PVT LTD'. VSP is processing and manufacturing a high-quality, nutritionally balanced, affordable unique plant-based ready-to-cook, and ready-to-eat range of millet products rich in macro and micronutrients.

Vidya Joshi established 'Nutrimillets Foods Pvt. LTD'. The company is working on millets such as Jowar, Bajra, and Ragi. It was started in Nov'2020. Gluten-free, protein and fiber-rich ready-to-eat (RTE) and ready-to-cook (RTC) products are made by the company under the brand 'Nutrimillets'.

The company 'Phytorich'established by Dr. Neelambika Meti, Dr. Alpana Moghe produces high-quality, nutritionally balanced, affordable ready-to-cook, and ready-to-eat range of products, and instant premixes that offer healthy options in day-to-day cooking. They also offer convenient options to those living in hostels, old age homes, and away from home to keep them fit and manage a balanced diet.

Dr Chandra Shekara loves to watch news and reading newspapers during his leisure hours

let products and their benefits is much needed. Therefore, wide publicity may be given on media and Primary Health Centres. Gross root level functionaries, Anganawadi and ASHA workers can be leveraged to disseminate knowledge on the benefits of the consumption of millet among rural households.

To provide publicity and support women entrepreneurs and Agri start-ups in millets, a millets products exhibition was organized at the National Institute of

Dr. Banu Priya Yogeeswaran established 'BR Medical Research and Software Solutions OPC Private Ltd'. The company is involved in manufacturing millet-based diabetic, renal, and baby food with an automatic intelligence-related manufacturing process.

Agricultural Extension (MANAGE), Hyderabad during Mahila Kisan Diwas on 15th October, 2022.

The entrepreneurs said that the challenges faced by them include lack of markets, financial support, tax benefits, lack of handholding industrial support and awareness about the millet products among the people, and high processing cost are hindering the growth of their ventures.

The stock-taking of the above start-ups revealed that most of the women entrepreneurs are mainly in need of financial support, technology, branding, packaging, and better market linkages to expand their business. These entrepreneurs may be encouraged and supported either by designing new schemes and programs or by leveraging the provisions in the existing schemes of the government. One more important intervention may be in terms of linking these start-ups to FPOs for reducing the cost of procurement. Besides, the creation of awareness among consumers about the health benefits of millet-based products will go a long way in the growth of their business. To create more awareness, programs in remote areas about millet and value-added products, exhibitions, and free stalls to support brand visibility are the need of the hour.

Roopa is the founder of 'Vaishnavi Millets'. The products of the company are marketed under the brand name 'Amrutha Siri'. Aim is to ensure quality, healthy and nutritious food products of millets in daily life for future generations. The company produces different kinds of products like Amrutha Siri millet health mix, and instant snacks like millet murukku, millet nippottu, and millet ribbon pakoda.

Deepti Potturi is the founder of 'Nrich Healthy Foods'. The company is manufacturing 50+ products in an area of 2500 sq. ft. The company manufactures ready-to-cook, ready-to-eat, 0% maida, and preservative-free products. There are different ranges of products processed by the company like, multi millet atta, dosa, millet upma mix, millet upma Rava, millet idly Rava, kichadi mix, millet crunchies, millet noodles, millet papads, millet vermicelli, millet pasta, millet fusilli, etc.

C Prema is the founder of 'Uthra Enterprises'. The company manufactures different kinds of millet-based products suitable for all ages and seasons. With traditional tastes and dishes that today's generation enjoys, the products like noodles, vermicelli, and Pongal mix are prepared by the company. She demands that GOI must waives off GST on Millet-based products so that more growth can be achieved.

Deepa Muthukumarasamy is a founder of 'Some More Foods' aims to reinstate our traditional food ingredients substantiated with nutrition science. They have Millet Noodles, Millet Pasta, Millet Sevai (Vermicelli), Millet Bites, Gluten Free Millet Cookies. They also have natural sweeteners like Coconut Sugar, Cane Sugar, Palm Sugar, and also baby food products under the brand 'First Spoon'.

KNOW YOUR MILLETS

Although all millet varieties belong to the Poaceae family, they differ in color, appearance, and species. They include:

Jowar (sorghum)

Ragi (finger millet)

Korra (foxtail millet)

Arke (kodo millet)

Sama (little millet)

Bajra (pearl millet)

Chena/barr (proso millet)

Sanwa (barnyard millet)

BRINGING NUTRITION TO YOUR DINNER TABLE

Discussion With Leading Chefs On Maximizing The Use Of Millets

On 13th December 2022, the Agriculture Today Group in association with Harvest Plus and GAIN organized the 1st Global Nutrition Conclave in New Delhi. The conclave aimed at promoting self-sustainable nutrition smart food systems in the context of existing malnutrition and hidden hunger.

The event graced by the presence of eminent dignitaries and engaging audience was inaugurated by the Hon'ble Agriculture Minister of India Shri Narendra Singh Tomar, further accentuating the importance of the platform.

With the idea of bringing nutritious food on the consumer's radar, notable names of the Indian culinary space at the helm of making healthy meals accessible and palatable came together. The discussion was moderated by Mr Arun Baral, CEO-HarvestPlus and was driven by Chef Manjit Singh Gill, Chef Pankaj Bhadouria, and Chef Natasha Gandhi.

Traditional Foods, Modern Plates

The discussion brought many interesting insights about the return of traditional foods to modern plates and means to improve the acceptability of traditional grains like millets. Stressing the need to understand the nutritional quality of our daily meals, Chef Manjit expressed his delight over the fact that the present generation is keen on referring to the nutritional information imprinted on the food labels. He highlighted the importance of bringing back our traditional millet foods and mainstreaming them in our current dietary habits in wake of increasing consumer preferences towards high-value nutritious foods. He also mentioned his interest in developing and curating recipes of modern taste with traditional grains and is passionate about researching and applying the learning of Ancient Indian Cuisine.

Creating Familiar Foods With Millets

Chef Pankaj emphasized the close relationship between nutrition and balanced food. She said that improvement in the same can be possible only through the consumption of local traditional fresh foods while avoiding processed variants. She presented the audience with the idea of creating familiar foods with unfamiliar ingredients like millets, to create a unique blend of health, taste, and acceptability. Millet based poha, upma, idli were a few such blends mentioned by Chef Pankaj. On being asked about ideas for helping people understand such novel uses of millets, she suggested the inclusion of tiny recipe booklets in the product packages that can be accessible and easy to replicate.

Desserts With Mixed Millet Variants

To bring the spectrum of a younger audience, Chef Natasha Gandhi shared her experience of bringing the long-forgotten millet grains to the Gen-Z plates, paired with a modern (sweet) twist. She mentioned her passion of curating desserts with mixed millet variants balancing the palatability of consumers. She along with Chef Pankaj also shared her in-house nuskha for preventing the rancidity of millets. It was exciting for the audience to know that her dessert recipes completely curated from local millets, jaggery and dates, home-made nut butter, healthier versions of white sugar, and processed oils are gaining modern end-user acceptability.

The discussion brought up many ideas, recipes, and experiences for audience to take home. The chefs closed the discussion with the idea of making food a wholesome and accessible experience for all. They appreciated the conclave platform bringing together crop scientists, food manufacturers, and culinary experts to mainstream millet foods in consumer plates as such events though rare create a huge impact.

Dessert recipes are completely based on local millets, jaggery and dates, home-made nut butter, healthier versions of white sugar, and processed oils, and are gaining modern end-user acceptability

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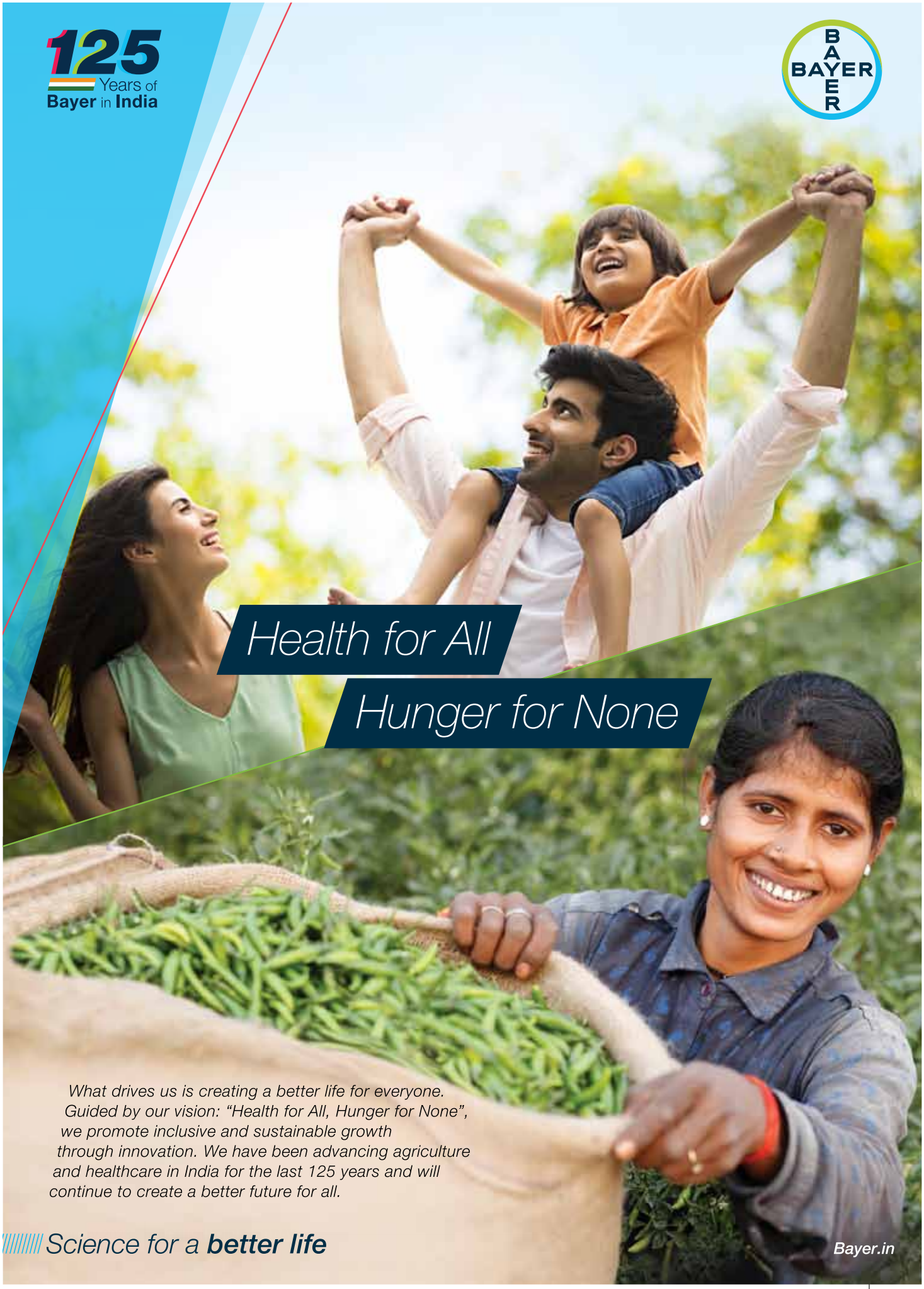

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MILLETS

Foods of Future

Globally, the recent significant challenges including improvement in human health, food security, food safety, improving supply of energy, reducing malnutrition and others are focal point. Millets are easily digestible in nature and can be used to fortifiy (composite flour) for developing value added food products such as drinks, cuisines, soups, sauces, ice-cream, non-alcoholic beverages, porridge, ready to eat meals, confectionery, bakery goods (tortilla, roti, tuwo, kisra, biscuits, bread, flakes, idli, upma, dosa, utappa, chakli, chiwada, cakes), beer and other non-fermented foods.

Apart from the nutritional and functional components, millets are also good source for the starch, which are widely used as swelling agent, thickening agent, emulsifier, gelling and binding agents in food and non-food industries on commercial scale. The consumption of millets and millet based food products may lead to retarded risk of several types of diseases such as anemia, cancer, cardiovascular, low blood pressure, diabetic, risk of high cholesterol, gastrointestinal disorder, and reduction in absorption rate of fat due to the presence of bioactive components of millets.

Challenges For Millets Sector

The lack of consumer awareness about the nutritional benefits of millets, their

About the **AUTHORS**

Dr Chindi Vasudevappa, Vice Chancellor, NIFTEM, Kundli, MOFPI with Dr Ashutosh Upadhyay

regional differences, types of millet varieties, processing technologies, ecological benefits, label related sustainability and label related to locally produced millet are posing challenge in popularity of the millets in masses.

One most of the important reasons behind the lack of consumer awareness is huge gaps between the millet producer, manufactures, suppliers, consumers, and researchers. So there is need to increase awareness in the consumer to use millets as an alternative of staple food i.e. rice, wheat etc. for improving their nutritional and economic status by consuming higher fiber, mineral and gluten free diet. Millets help in the achieving sustainable development goals.

The consumption of millets provides different opportunities such as food security, food safety, economic security and safety from different types of disease to the consumers.

Major Health Benefits

Several researches have demonstrated through in vivo and in-vitro studies, that the consumption of millet and millets based value added products have health promoting effects such as anticancer, anti-viral, anti-inflammatory, anti-diabetic, improving respiratory problems, improving digestive system, protect from metabolic syndrome due to presence of nutrient and anti-nutrients components such as tannins, phenolic compounds, flavonoids, phytosterols and others. On processing aspects of the value added products, different types of processing technologies such as extrusion cooking, irradiation, and high temperature short time etc. are beneficial to increase the bioavailability of micronutrient contents in the foods.

Millet Processing Challenges

Moreover, based on the nutritional and functional attributes of the millets, it must be recognized as a functional food. Therefore, research should focus on investigating the bioavailability in millets and millet based functional food to alleviate nutrients deficiencies in society. In addition, the millet processing challenges such as incentivizing production support, lack of improved methods of production and technology, postharvest technologies, lack of public procurement and marketing support, absence of private and private funded promotions etc. should be addressed to improve the quality of produces and economic status of growers and processors.

Over 500 startups are working in Millet value chain. Indian Institute on Millet Research has incubated 250 Startups under RKVY-RAFTAAR. More than Rs.6.2 crores has been disbursed to over 66 Startups while about 25 Startups have been approved for further funding

NIFTEM-K has made an initiative to bring a complied database for public use on the products and technologies developed in India by different institutions and the same can be accessed at http://fte.niftem.ac.in/Home/Millets. It would be relevant to cite some the work carried by the institute on millet - Development and Standardization of Millet Based Functional Foods for Distribution in Public Funded Program (for Karla and MP State), Millet based pasta and noodles. These noodles were also examined for their suitability for Mid-day Meal programme of government.

Higher Consumer Awareness Essential

In addition, NIFTEM is promoting awareness building, processing and marketing of millets through PMFME scheme following the concept of one district one product (ODOP). The ministry of food processing industries (MOFPI)has launched Promotion Linked Incentive (PLI) scheme to promote millet processing by incentivizing the organized food processing sector of the country.

GOI has taken several steps for promotion of Millets. To create domestic and global demand and to provide nutritional food to the people, The National Year of Millets was celebrated in 2018. In view of the nutritional value of the millets, the Government also notified Millets as nutri-cereals in April, 2018 and Millets were included under the POSHAN Mission Abhiyan. Over 500 startups are working in Millet value chain. Indian Institute on Millet Research has incubated 250 Startups under RKVY-RAFTAAR. More than Rs.6.2 crores has been disbursed to over 66 Startups while about 25 Startups have been approved for further funding.

Uttar Pradesh being one of the major producers of millets in the country, the state government has drawn plans to further boost the production of cereals to make the state number one in millet production in 2023 – the International Year of Millets. With their extraordinary capacity to withstand climate change pressure, globally millets are being portrayed as the only grains that could be tapped for public food systems thus it appears imperative that millets may emerge as 'Foods of Future'.

Recipes by CHEF VIKAS KHANNA

BEETROOT AND MILLET WITH MUSTARD SEEDS TADKA

The tempering of spices brings a zing to this hearty millet-based dish, while the beetroot adds an earthy flavour and lovely hue.

SERVES 4–6 PREP 20–25 MINS
COOK 55–60 MINS

2 tbsp butter
2 tsp black mustard seeds 2 garlic cloves, minced
1 ginger, 2.5cm (1in) long, peeled and minced
1 cup foxtail millet or millet of your choice, rinsed and drained wel
salt and freshly ground black pepper
2 1⁄2 cups vegetable stock, or as required
1 tbsp fresh lemon juice
2 medium beetroots, roasted, peeled, and cut into pieces, 2.5cm (1in) long
1⁄2 cooked butter beans, or beans of your choice
fresh basil, for garnish

Method:
Heat the butter in a heavy-bottomed pan over a medium heat. Add the mustard seeds, garlic, and ginger and cook, for about 2 minutes, until the mustard seeds begin to splutter.
Add the millet and cook, stirring continuously for 2–3 minutes, until slightly toasted.
Mix in the salt and stock, cover, and cook for 40–50 minutes, until the liquid is absorbed. Add more stock if required. Keep warm.
Now, stir in the lemon juice, black pepper, beetroots, and butter beans. Mix well until all the ingredients are combined. Serve hot and garnished with the basil leaves.

PUFFED MILLET AND BLOOD ORANGE WITH TAMARIND CHILLI SAUCE

This versatile dish can be had as a tangy snack. The puffed millet adds an interesting and nutty bite with a hint of sourness courtesy the tamarind in the sauce.

SERVES 4 • PREP 15–20 MINS • COOK 15–20 MINS, PLUS COOLING

3 tbsp tamarind paste
1 tsp chilli powder, or to taste salt to taste
4 tbsp sugar
1 tsp chilli sauce of your choice 2 cups puffed millet
2 medium beets, roasted, peeled and cut into 2.5–3.8cm (1–1⁄2 in) pieces
1 blood orange, segmented fresh coriander leaves, to garnish

VARIATION
Swap the blood orange for a navel orange or a grapefruit.

In a medium-sized saucepan, combine the tamarind paste, chilli powder, salt, sugar, and chilli sauce. Heat the mixture on a medium heat until the sugar melts and all the flavours are well combined.
Then, remove from the heat and cool at room temperature
n a medium-sized mixing bowl, combine the millet, beets, tamarind mixture, and orange segments.
Garnish with the coriander and serve immediately.

SPICED TANDOORI CHICKEN WITH MILLET

Tandoori chicken dates back to pre-independent Punjab. Here, this mouth-watering main course dish is paired with millet, as opposed o the traditional naan.

SERVES 4–6 PREP 30 MINS, PLUS MARINATING COOK HR 40 MINS
MAIN INGREDIENTS
1 whole chicken (900 gm), skinless
1 cup fox millet, or millet of your choice
3 cups chicken stock 2 tbsp tamarind paste
fresh coriander leaves, for garnishing

FOR MARINADE
2 tsp red chilli powder 2 tbsp lime juice salt to taste
1 cup yogurt, drained, or Greek yogurt, whisked
1 tbsp ginger paste 1 tbsp garlic paste
1 tsp garam masala powder salt and freshly ground black
pepper
2 tbsp finely chopped fresh coriander leaves
3 tbsp mustard oil
4 tbsp vegetable oil, for basting

With a sharp knife, make slits in the chicken, particularly on the legs, thighs, and breast. For the
marinade, combine 1 teaspoon chilli, 1 tablespoon ime juice, and 1 teaspoon salt, and rub the mixture all over the chicken. Leave to marinate for about 20 minutes
n a large bowl, combine the yogurt with all the ingredients, except the chicken and vegetable
oil, and whisk well. Cover and leave for 20 minutes to allow the flavours to blend.
Coat the chicken with the marinade, cover, and leave to marinate for at east 2 hours, preferably in a fridge.
Mount the marinated chicken onto a skewer and barbecue over hot coals or cook in a rotisserie,
basting with vegetable oil a couple of times, until tender. Alternatively, place on a baking tray and cook in a preheated oven at 200°C (400°F/Gas 6) for 20–25 minutes, until tender. Remove the chicken from the oven halfway through, to baste it all over with oil.
Remove the chicken and let it cool.

Then, gently pull the chicken, shredding it coarsely.
Heat a medium-sized pan on a medium-low heat. Add the millet and cook, stirring continuously, for
5–7 minutes, until its colour darkens and turns fragrant. Add the chicken stock and salt, cover, and cook, stirring occasionally, for 20–25 minutes, until all the iquid is absorbed and the millet is cooked.
Mix in the shredded chicken, tamarind, and serve hot garnished with coriander leaves.

MILLETS

EXTRAORDINARILY SUPERIOR TO RICE AND WHEAT

PROMOTION OF INDIAN MILLETS AS ORGANIC VALUE ADDED PRODUCT

By any nutritional parameter, every single millet is extraordinarily superior to rice and wheat. In India, millets are mostly cultivated in Karnataka, Andhra Pradesh, Tamil Nadu, Maharashtra, Odisha, Madhya Pradesh, Rajasthan and Uttarakhand. The major millets produced in India are Pearl millet, Sorghum, Finger millet, Small millets (Foxtail, Barnyard, Kodo, Proso, Little millet), Pseudo millets (Buckwheat and Amaranth). In view of health benefits of the millets, GOI notified millets as nutri-cereals in April 2018. Subsequently, to create domestic and global demand of millets, 2023 has been declared as International Year of Millets by the United Nations General Assembly.

Value Addition Necessary

In order to promote the demand for millet, value addition is much necessary as consumption in raw form is unlikely among the consumers. Processed and value added products similar to other grains can be popularized for developing the dietary habit across the globe to compete with fine cereals. Despite of having unique nutritional attributes, value addition in millets is still major challenge due to lack of awareness, food habits, organoleptic characteristics, lack of standardized processing techniques, less availability of ready-to-use products, high fat content mostly in bran and germ, low shelf stability of flour /semolina. Contemporary methods are generally practiced for processing of millet based products. However, other products such as Refined flour, Husk free malt flour, Parboiled grains, Popped products, Expanded products, Extruded products, Drum dried products, Flakes, Health foods, Beverages, Bakery products, Semolina, Composite flour, Noodles, pappads etc. can be scaled up for commercial trade.

Ready to Eat millets products such as puffs, are rich in protein and fibre, while instant mixes made from millets and other lentils have potential demand. Ragi-wheat blend based noodles are being popular in domestic market due to the health benefits as it is high in Dietary Fibre, Calcium and non-gluten nature.

In similar way, millet based pasta along with other cereals can be taken up for commercial production using cold extrusion technique. The by-product from flaking of sorghum i.e sorghum bran and broken flakes are rich in fibre, iron and vitamin content which is used to make sweets, energy bar, fryums, etc. Millet based infant food such as porridge are ideal for infant growth and will help to lower the occurrence of malnutrition in infants and babies.

The demand for Ready to Eat (Cookies, Biscuits, Snacks, Bar, Ex-

About the AUTHOR

Dr M Angamuthu, IAS, is Chairman APEDA

truded products etc) and Ready to Cook (Flours, Mix, Malt, Rava, Infant food, Nutrimix, Sawai etc.) millet products is reported to be increasing to achieve nutritional consumption of food and to fight several health complications of present generation.

APEDA Initiatives For Millets

India holds 5th position in terms of millet export and is exported to destinations such as like UAE, Saudi Arabia, Nepal, USA, Japan, Germany, Bangladesh etc. During 2021-22, millets worth 64 million USD has been exported from India, but the export of millet is less than 1% of millet production. Hence, several initiatives have been taken up by the Agricultural and processed Food Products Export Development Authority (APEDA), under the Ministry of Commerce & Industry for promotion of millet export by creation of Nutri cereals Export Promotion Forum, handholding of millet start ups, organizing sensitization and capacity building programme for quality assurance and value addition and participation in international events.

It is possible that with the collective efforts in expansion of area under millet cultivation, use of technology and packing for value added products and through promotional programme, the export can be geared up to great extent. This has been evident in the export data of millets during 2022-23 as 14% growth has been witnessed in terms of value in USD compared to previous year.

With the introduction of various value added millet based organic products in the trade basket, export can be fostered to wider markets to make mighty millets a popular and healthy food choice for all

As Indian organic market is being diversified with expansion of value added processed product, millets are gaining importance. Organic millets are being mainly produced in Karnataka and Rajasthan followed by Uttarakhand. Sorghum, Pearl millet and Ragi are the commonly certified organic millets. Though much quantity has not been commercially produced as organic, processed millets are being exported as organic from the country. Millet as flour, flakes and in whole are being exported as organic to destinations such as South America, Europe, USA, Canada, New Zealand etc.

Expanding Markets

Millets are gaining prominence in Europe and North America due to their gluten-free and hypoglycemic properties. As millets are already popular in African countries and are largely consumed, the introduction of multiple varieties and processed forms can attract the consumers. Organic millet based products can be substituted in South Asian countries wherein the rice based food is more popular.

As the change in food habits and adaptability to new products requires time, massive promotional activities for millet based products have been proposed targeting the potential markets such as UAE, Indonesia, Saudi Arabia, Japan, Korea USA, Europe, South Africa. In addition, Buyer Seller Meets, shipment to new destinations, strengthening of supply chain by including FPOs/FPCs and start ups, inclusion of wider range of value added products, enhancement of shelf life and standardization of grading through Research institutes, tie-ups with retail chains and supermarkets in potential markets, branding and publicity in overseas are also planned for promotion of millets.

As the integrity of NPOP certified organic products is being maintained in global organic market, India has emerged as one among the major countries for sourcing credible organic products. The strength and integrity achieved by NPOP in past two decades has paved way for growth of organic products export. With the introduction of various value added millet based organic products in the trade basket, export can be fostered to wider markets to make mighty millets a popular and healthy food choice for all.

ICFA
भारतीय कृषि एवं खाद्य परिषद्
INDIAN CHAMBER OF FOOD AND AGRICULTURE

INTERACTIVE MEETING WITH THE ETHIOPIAN AGRIBUSINESS DELEGATION

November 29, 2022

Agenda of the Meeting-

- Strengthening Rural Value Chains (SRVC) in Ethiopia by following Indian patterns
- Learning management and organizational matters of the agribusiness institutions in India, so that they could replicate it in their country.

Dr. MJ Khan, Chairman, ICFA began with greeting everyone and extended a warm welcome to the delegation. He talked about the Institutional infrastructure India enjoys and mentioned about the renowned agricultural universities and national institutions in India. He laid emphasis on the availability of complete range of production system, agribusiness system in India. He also mentioned about the South- South and Triangular co-operation (SSTC) and how GOI is promoting it. He also talked about the Bioagriculture, Biostimulants, Biocrop etc and expressed his views on how the world can learn from India.

The meeting then went on with the address by all the delegates from Ethiopia. The delegation comprised of Presidents and Board members of major Ethiopian agriculture and food chambers and National associations. The meeting was joined by Sh. VK Pipersenia, ex Chief Secretary, Assam, Sh. Tarun Shridhar, ex Secretary, AHDF, Govt of India, besides ICFA Board members, Chairmen of its various working groups and other special invitees.

The meeting basically revolved around on how Ethiopia can learn from the agricultural achievements of India, Strengthening Rural Value Chains (SRVC) in Ethiopia by following Indian

patterns and Learning management and organizational matters of the agribusiness institutions in India, so that they could replicate it in their country. The delegation showed keen interest in collaborating for seeds, farm machinery, agrochem, protected cultivation, bio-inputs, ICT, animal health products, spices, agro and food technologies and agri policies and programs and startups.

Introduction of the Ethiopian delegation members and ICFA members

Brief remarks by the participating dignitaries

Mr Sanjeev Kalra talked about his firm that they have four verticals which deals in accountancy, consultancy, IOT data analytics etc. he said they are partners in Tokyo, Mauritius, Zimbabwe, Germany, Taipei etc. He also talked about India-China trade before Covid 19 outbreak. He said that there is opportunity in Ethiopia, Sri Lanka, Germany through Government of India and also talked about medical tourism.

Dr. Hassen Abdullahi, Board Member, Ethiopia Chambers of Commerce Sectorial Association said that India is a role model for the Ethiopian delegation. He praised India's agriculture, economic developments and mentioned that they enjoy an optimal relationship with India and further hope for more economic cooperation among the two countries.

Tewdros Zewdie, Executive Director, Ethiopia Horticulture Producers and Exports Association expressed his ambitions in horticulture sector and explore opportunities in planting material, fruits, irrigation system, greenhouse, agrochemicals etc. He also mentioned that they are buying agrochemicals from Europe but wish to establish linkage in India also.

Yeworkwuha Assefa, Board member, Ethiopia Pulses, Oil seeds and Spices Processing and Export Association talked about the kidney beans, oilseeds, quality, natural fields etc. He mentioned what all they import from India, food industry collaboration among two countries and they wish more such collaboration.

Hayimanot Asfaw, President, Ethiopia Millers Association mentioned that Ethiopia takes machinery from China and also want collaboration with India regarding the same.

Wondered Abram, Board President, Ethiopia Commercial Milk Producers' Associations said that he is an enthusiast of Dr. Varghese Kurien and have read his biography. He talked about their import of milk from Europe and the deficiency of veterinary medicine, skills and knowledge in Ethiopia.

Ayenalem Tilahun, Manager, Ethiopia Seed Association expressed his ecstasy to visit India and talked about seeds, food security and cash crops. He expressed his concern to regulate issues related to seeds and the ways in which they can learn more from India.

Engedaye Eshete, Board President, Ethiopia Women's Entrepreneurs Association talked about women empowerment and women agripreneurship. She said that women have been transformed and would like to explore opportunities in India to learn how women can become market oriented and also to learn regarding agroprocessing in India.

Assefa Alemirew, President, Ahmara Chambers of Commerce Sectorial Association expressed his aspirations to work with Indian Chamber of Food and Agriculture.

Aschenaki Abebe, Department head, SNNP Agriculture Cooperative Federation mentioned about the experience of Ashish Life Science in Indian market which is the best animal health and veterinary product manufacturers in India. He also talked aboutthe need of new technology in agriculture and to enhance relation with Indian markets.

Yehune Dengewu, General Manager, Tsehy Farmer's Cooperative Union expressed his regards to ICFA and India and said that they export certain agricultural commodities like sesame, chickpea etc to India and expect more cooperation in this sector.

Lilakshi de Mel, Consultant Moderator, Sri Lanka expressed her regards to India and said that she has been here for several times and this is a really good opportunity to enhance the relations among two countries. She is Senior assistant secretary general at the Ceylon chamber of commerce, Srilanka.

Eberhard Hauser, Team leader, GFA said that he has been in contact with India since 2005-08. He said that though Ethiopia has large variety of food yet it is small as compared to India and therefore it is a good opportunity to learn from India and diversify the agriculture.

ICFA Members

Sh. RK Chitkara, Group Advisor, ICFA and Ex Director, Abott began with greeting everyone and said that there is lot to learn in regard to biochemicals, biopesticides, biostimulants etc from each other and these can be future areas of collaboration. Ethiopia is good in fertilizers whereas in India, there is vast knowledge, renowned State Agricultural Universities, private sector, vibrant seed industry, so there can be knowledge transfer. India is the second largest producer of fruits and vegetables and play significant role in exports in vegetable and horticulture sector and also India has grown well in Agrochemicals industry and is therefore major exporter after China. There are many Indian companies already in Ethiopia and this relationship can grow more in so many areas further like Ethiopia can learn regarding Agrochemicals, supply chain management, value chain management etc from India.

Sh. BB Pattanaik, Member, WRDA and ex Chairman, CWC emphasized on seeds and said that there are so many seed manufacturing units in India and there is a great scope in collaboration in seed industry. He also talked about so many other areas in which India is good such as post harvest management, silage, storage, wheat, maize, funding, financing etc and Ethiopia can learn and seek help in these areas from India.

Mr. Vipin Saini, CEO, BioAg Industry Association talked about biope-

sticides, biofertilizers, biostimulants and also mentioned horticulture, floriculture, training to scientists, government officials and farmers, agri inputs and policy interventions.

Dr. Moni, Chairman, ICFA Working Group on ICT and ex DG, NIC mentioned the Ashok Dalwai Committee to double farmer's income. He talked about the digital technology in agriculture and e-governance in farming sector. He said that there could be collaboration on the proposals of Ashok Dalwai committee report for the betterment of delegation.

Mr. VK Pipersenia, Ex Chief Secretary, Assam emphasized on empowerment of farmers and their landholdings. He said that unless farmer start thinking like a businessmen, there won't be great success. He said the problem is that the farmers think just like a producer and not like a businessman and if there would be right and remunerative price for the the produce, then there will be good produce also. He also talked about adequate marketing structure, ensure produce quality, farmers should be at the centre of the marketing mechanism.

Sh. Shivendra Tomar, GM, IFCI Ltd said that he also belongs to farmer family and there is lot of similarity in population of both the countries. He said that Indian rural population has surplus milk and food, good quality animals, quality breeding whereas Ethiopia needs milk, good food, livestock, meat etc for which it can seek help from India. talked about the advancement of farm mechanization and experience of India, use of inputs and training farmers. He said there is a need to decrease imports and increase exports and mentioned that food processing sector is very strong in India. He also talked about the livestock quality, best technologies in dairy sector and also mentioned Amul which has best technology in milk and others can learn from it.

Mr. Javed Yunus, India Advisor, Saudi Aramco spoke regarding the Saudi agri-ties with India.

Dr. Kalyan Goswami, DG, Agrochem Federation of India said that agrochem is the only segment in India which

The delegation showed keen interest in collaborating for seeds, farm machinery, agrochem, protected cultivation, bio-inputs, ICT, animal health products, spices, agro and food technologies and agri policies and programs and startups

is trade surplus. He said that there are 34 members out of which 4 are largest supplier in Insecticides segment. He asked Ethiopian delegates that if they require any help in pesticides industry, they can seek from India.

Sh. Sunil Aggarwal, CEO, Concept Consulting Ltd mentioned regarding CACL as consultancy which has 4-5 verticals which deals with FPOs contract farming, forward linkages, GAP certification, business and agronomy structure etc. He talked about the agripreneurs, cold chains, government tenders for pulses.

Mr. Ashudeep Garg, Director, Absolute said that he has a banking background and has good knowledge in it. He mentioned that they as a company deal in R&D- microbial content, soil etc and also provide IOT devices to farmers, advisory to farmers and help them to produce high yielding, good quality end products and not only this but also help to monetise their produce. He also mentioned about precision agriculture.

Sh. Arvind Saini, GM, International Tractors Ltd said that they don't sell tractors but sell solutions on farm mechanization. He said that they are present in more than 130 countries, are largest exporter in India and have more than 90 variants as in row width, soil structure, tyre size etc. he mentioned that the tractor is the prime mover.

Sh. Shivendra Makhija, Vice President, Jain Irrigation mentioned that he has lived in Ethiopia in 2010. He said that they are second largest company in the field of microirrigation in the world. There are 30 factories- 15 are in India, 5 in USA and 3 in Israel and few more in other countries. He also talked about the best disease free planting material, value addition, Jalgaon which is good in banana growing, tissue culture plants. He also talked regarding their company supplying plants and crop advisory services to farmers and have 1200 acres of research farm in Jalgaon. He mentioned that they are manufacturer of mango pulp, dehydrated onions, banana powder which they provide to companies like Nestle etc, and also deal in spice production and processing. He said that they have another vertical i.e. Solar pumping system, solar pumps, micro irrigation, food processing.

Mr. Girish Aivalli, Director, SAATHI and ex Director, ADM spoke about the Indian banking sector and innovations in India in the last decade such as introduction of Agri commodity exchange, Integrated agri warehouses software, cold stores and IOT. He also talked about Mega food parks installation, dairy farms, vertical farming, hydroponics, agriculture investment, agribusiness, e-commerce, fintech.

Dr Tarun Shridhar, ex Secretary, AHDF, GOI mentioned the agri challenges India tackled successfully. He said that India is the largest producer of milk. He said that 65% of the total population of buffaloes are in india, 5-10% in Pakistan and rest in Africa. He also talked about the agroclimatic zones, crops etc. he said that there is only modern science in modern world whereas in India, one can get traditional knowledge as well as modern science knowledge. He further mentioned the demand of genetically modified crops, chia, quinoa seeds etc and basically India can export knowledge and experience to Ethiopia.

After that, there was question answer session where time was given to everyone to ask if they have any questions or doubts regarding the meeting. Then, the meeting was concluded by Dr. MJ Khan, Chairman, Indian Chamber of Food and Agriculture by thanking all the delegates to visit India and attending the meeting followed by lunch.

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INTERNATIONAL YEAR OF MILLETS

IMMENSE OPPORTUNITIES

India loses up to 4% of its GDP and 8% of its productivity due to the persistence of child malnutrition. The cost of malnutrition is very high. Action against malnutrition will save millions, while inaction costs billions. Therefore, GOI and agricultural experts are stressing the need for food and nutritional security for the growing population.

Food security as a universal slogan for the last few decades has helped scientists and policymakers achieve food security in target countries. But it is not sufficient until the staple food is nutritionally balanced. Raising the profile of millets and linking food security and nutrition discussions to the goals of the 2023 development agenda are significant moves. The commemoration of the International Year Of Millets is expected to enhance investments in research and development and extension services related to millets.

Unified Linkages Are Vital

With the ever-increasing costs of food production, climate change, and the need to feed additional billions, millet holds greater promise for food and nutrition, despite its low input costs, including pest control. Even though GOI launched the Millets Mission under the National Food Security Mission (NFSM), adding interventions may not necessarily increase millet production or farmer income, but rather create unified linkages between advanced delivery approaches. Millets are always underestimated and underfunded, and there are few millet scientists or researchers compared to rice, wheat, and maize. Enhancing research systems that can deliver high-performing products and technology is a must in the coming years. Research organisations and industries need to align their innovative upstream findings to be translated into applied technologies for scaling up production, processing products, competitive grading, and global marketing.

Several varieties are released, but choosing the right varieties for food, nutrition, and fodder makes significant changes in supplies and helps achieve the goals of millet year task forces. India must include prioritised millet in the midday meal for schools and distribute it in anganwadis to combat malnutrition and

About the **AUTHOR**

Dr Mahalingam Govindaraj is Senior Scientist at Alliance Bioversity International and CIAT, Colombia. He is the Recipient of the highly coveted 2022 Norman E Borlaug Award for Field Research and Application by the World Food Prize Foundation

the Public Distribution System (PDS). Encouragement of millet meals weekly in school feeding can supplement cognitive power and physical activities in addition to reducing malnutrition prevalences.

Bio-Fortified Millet Grains

This and other purposes will be served quickly by biofortified millet grains. Biofortified grains will be a good option for dietary advice in hospitals for needy patients and a way to promote new consumer insights.

Many developed countries are devising a mechanism for school feeding (similar to India) with diversified foods, millet can be an alternative food for them to import millet from India and Africa. South-South cooperation can facilitate the movement of millet-quality seed and grain to Africa for increased productivity and area expansion through improved production practices.

Investing in developing and implementing strong national, regional, and global policies for cultivation, procurement, processing/marketing, and implementing agencies will increase millets' potential as a crop commodity by bridging various sustainable development goals (SDGs)—most notably SDG 2 (zero hunger), SDG 3 (good health and well-being), SDG 12 (sustainable consumption and production), and SDG 13 (sustainable consumption and production) (climate action).

More Post-Harvest Applications Needed

A technical committee and operational experts with millet experience should be carefully chosen to develop blueprints of technologies for scaling up and benefiting farmers, industries, and consumers. This is an important time in India for mainstreaming millets for nutrition intervention; therefore, cross-talking and networking with nutritionists, medical doctors, and socioeconomic gender specialists to improve understanding of millets and their role in nutrition for various lifestyles and income groups is essential.

Remember to use human and financial resources wisely to identify critical upstream and downstream application gaps and calls for solutions, as well as replicate scalable models across states, rather than on millet promotional events across the country.

At least 10–15 percent of total millet grain production should be processed to enhance consumer millet market uptake. A large majority of consumers prefer consuming rice and wheat because of their readiness to cook. Packaging and cooking readiness innovation can entice new customers

These opportunities can unlock millets' food, nutritional, and fodder potential by connecting millets farmers to domestic and international markets. Acting between farmers and industries is critical to encouraging a shift in millet consumer preferences. To address the food system's weakness, millet cultivation should be revived. If we do not include millets in the global food system and diets of needy global populations now, it will take several decades to sustain smallholder farmer income and multiply the use of millets.

Millet has very few challenges in terms of cultivation, but it has some for scaling up for market processing and consumption. Minimum support prices are not ensured until procurements in the market are channelized. More research and technologies are required in post-harvest applications.

Higher Consumer Awareness Needed

There are many technologies available for short-term (3 months) and medium-term (4-6 months) storage and millet processing that reduce anti-nutritional factors and improve storage and nutrient bio-accessibility. At least 10–15 percent of total millet grain production should be processed to enhance consumer millet market uptake. Packaging and cooking readiness innovation can entice new customers.

During challenging times, I mostly listen to motivational speeches to charge myself. Gardening and cooking are my relaxing favourites

Recipes by CHEF PANKAJ BHADOURIA

MUSHROOM BAJRA RISOTTO

Rich with mushrooms, this bajra risotto will have you in wonders!

Preparation time: 15 minutes.
Cooking time: 60 minutes
Serves: 4

Ingredients:
salt to taste
1/2 tsp fresh ground black pepper
1 cup chopped onion
300g sliced Button mushrooms
3 cloves garlic, minced
2tsp rosemary
1 cup bajra (pearl barley), rinsed
3 cups chicken broth
50g parmesan cheese, grated
2 tsp lemon zest
2 tbsp refined vegetable oil

Method:
Heat the oil in a pan, add onion and mushrooms and sauté, stirring occasionally, until softened, about 5 minutes. Reduce heat to medium –low. Add garlic and 1 tsp rosemary and cook, stirring, for 1 minute. Stir the lamb, barley and broth into the pan. Cover and cook on low for 2 hours or until the barley is tender and liquid is absorbed . Add parmesan to the pan and stir until melted. Stir in remaining 1 tsp rosemary and lemon zest.

SAMA IDLI

An idli made from sama or sawa rice also known as barnyard millet. These idlis are soft and spongy and quite easily!

Preparation time: 20 minutes
Cooking time: 20 minutes
Serves: 2

Ingredients:
1 cup barnyard millet (sama ka chawal)
½ cup curd
1 tsp fruit salt
Water as required
cashew nuts
1/2tbsp chironjee
Salt to taste
Oil to grease the moulds

Method:

Powder the sama Rice in the grinder to a fine powder.
Mix sufficient water to make a smooth batter of dropping consistency and let stand for 30 minutes.
Add more water to adjust the consistency of the batter. Add salt and the eno fruit salt and mix well. Take 4 large idli molds and grease them well.put a few chironji seeds and 1 cashewnut in each mold and spoon in the batter into idli molds. Put the molds in an idli maker or steamer and steam for 20 minutes or till a skewer inserted in the idli comes out clean.

MILLET UPMA

Preparation Time: 20 minutes
Cooking Time: 20 minutes
Serves: 2-3
Ingredients:
1 cup little millet (sama)
2 cups water
1 medium onion
1 cup mixed veggies (Beans, Carrot, Peas, Capsicum)
2 tbsp coconut grated
1 tbsp coriander leaves chopped
1 tsp lime juice to taste
salt to taste
½ tsp turmeric powder
To Temper
½ tsp mustard seeds
½ tsp cumin seeds
a pinch asafoetida
2 green chilies finely chopped
1 teaspoon ginger grated
few curry leaves
2 tablespoon coconut oil

Method:

Wash the Little Millet and soak it in water for at-least 15 minutes.
Heat oil in a pan and add in the mustard seeds, cumin seeds and let them splutter.
Add hing, green chilies, ginger, curry leaves, turmeric powder and sauté for few seconds.
Add chopped onion. Sauté for 3-4 minute or two till the onion turns translucent pink.
Add the finely chopped mixed vegetables salt to taste and sauté for 3-4 minutes until veggies becomes soft.
Add 2 cups of water and bring it to boil.
Add drained samai and mix well.
Once all the water has been absorbed, completely cooked and looks grainy) turn off the gas and add grated coconut, coriander leaves and lime juice .
Mix Well and serve little millet upma hot with coconut chutney or chutney powder.

MILLETS MAGIC
FOOD, FODDER & FUEL

Millets are a diverse group of small grain cereals. Major millets are Sorghum, Pearl millet, and Finger millet; these grains are without husk and are suitable for consumption as whole grains. Small millets are Foxtail millet, Proso millet, Little millet, Barnyard millet and Kodo millet. These grains are covered with fibrous husk and require primary processing like paddy rice before consumption. The diversity in grain size and tastes lead to wider choices in traditional food use as rice, roti, gruel, and snacks. Apart from food use, green fodder of sorghum and pearl millet are a very popular feed to milch animals for ensuring milk production. Sweet sorghum accumulates considerable amount of sugar in its stem and is becoming a viable supplementary feed stock for fuel ethanol production.

Source: ICAR-IIMR

Climate resilience

Millets are dry land crops requiring very less water compared to rice and wheat. They were widely cultivated in arid regions of India and Africa before availability of extensive irrigation systems. Millets utilize C4 photosynthesis system; and rising temperature and carbon dioxide concentration due to climate change does not significantly affect their grain yield. These short duration crops with drought tolerance and are amenable for intercropping with pulses in rainfed cropping systems.

Combating Malnutrition & Obesity

National Family Health Survey-5 conducted for the years 2019-2021 has indicated stunting and wasting to be 35.5% and 19.3% respectively in children under 5 years of age. Among adults of 15-49 years age, 24% of women and 22.9% of men are overweight or obese. This is a double burden of malnutrition

About the **AUTHORS**

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To enhance the farmer's share of consumer rupee, farm gate processing and value addition through FPOs is emerging as a viable alternative. GOI is lending institutional and financial support for hand holding FPOs and startups

further complicated by changing life styles. Whole grain millets are rich in dietary fiber which helps in slow digestion and hence slow absorption of nutrients. Moreover, they enhance satiety and reduce over consumption of calories. This is beneficial for management of obesity and type 2 diabetes. Furthermore, millets are relatively rich in protein content (10 to 12%) compared to rice and are suitable for growing children. They are gluten free and well tolerated by celiac patients.

Millets are rich in phytochemicals having numerous health promoting properties. Their antioxidant potential is believed to prevent certain types of cancer. Despite of many health benefits, the production and consumption of millets is on the decline. To popularize millets and to ensure food and nutritional security, the year 2023 was declared as International Year of Millets by United Nations. We must seize this opportunity to ensure right place for millets in our food basket.

Popularization and demand

Since the declaration of the year 2018 as year of millets in India, Ministry of Agriculture has supported the scheme of 'Initiative for Nutritional Security through Intensive Millets Promotion (INSIMP)' for intensive cultivation of millets. ICAR-Indian Institute of Millets Research was given the mandate to develop better verities, to establish value chains and to popularize millets. These efforts are bearing fruit in the form of high yielding varieties, scientific data in support of health benefits, and popularization of millets through various training programmes. Now, all types of millet-rice and their products have found place on super market shelves. However, their high price is a concern for general public who are more than willing to incorporate millets in their daily diets. Moreover, the share of farmers in consumer rupee is not encouraging.

Primary processing and value addition

Small millets require many steps of processing to be suitable for consumption. The available machinery required for cleaning, destoning, dehulling and polishing requires retrofitting for handling millets. A few manufacturers have taken initiative that really helped in small scale processing. Value added products like biscuits, cookies, cakes, vermicelli, pasta are already becoming popular in local markets. However, a lot of scope exists for the industry to design and manufacture better equipment for improving processing efficiency and scaling up.

FPOs And Start-ups

To enhance the farmer's share of consumer rupee, farm gate processing and value addition through FPOs is emerging as a viable alternative. GOI is lending institutional and financial support for hand holding FPOs and startups. ICAR-IIMR has facilitated setting up of 33 millet FPOs and is imparting training to state agriculture officials, farmers, and entrepreneurs. 'Cooking with millets' and 'N-grain' are very popular programmes conducted by Nutri-Hub at IIMR for FPOs and entrepreneurs. More than 250 startups have graduated from incubation center at IIMR and successfully established their millet brands in the market. Seed hubs were also setup to assure quality seed availability to farmers.

Research and Development initiatives of ICAR-IIMR had helped in release of high yielding varieties, licensing of processing and value-added technologies, incubation of startups, and establishment of grades and standards for millet trading. Research projects funded by APEDA, NFSM and NABARD are helping to tap the export potential of millets and to generate scientific proof for validating the health benefits of millets. The concerted efforts of Farmers, Government, Institutions, and Industry have set the tone for realizing the potential of millets. The celebration of International Year of Millets-2023, we hope, will consolidate the place of millets in Indian and International food basket.

MILLETS: THE NUTRI-CEREALS A COMPREHENSIVE OVERVIEW

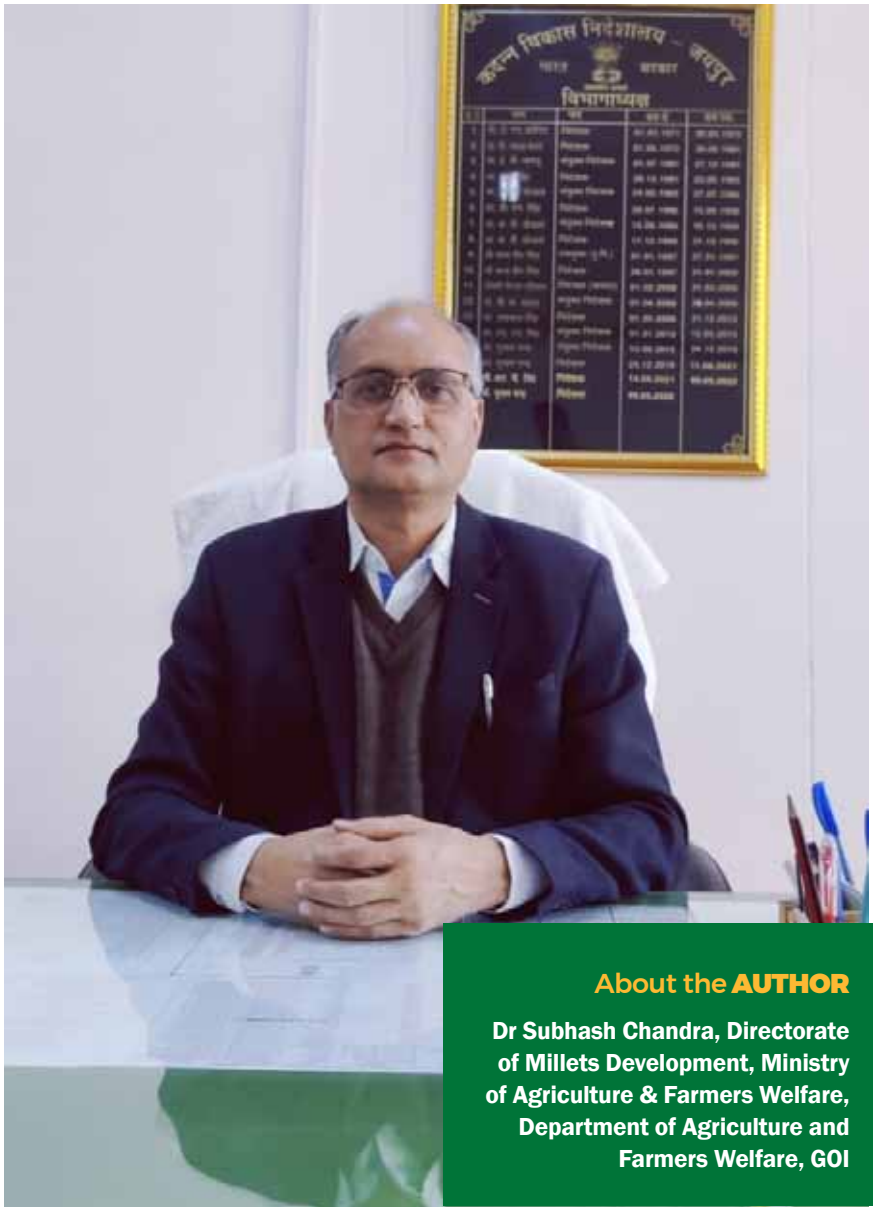
Millets are collective group of small seeded annual grasses that are grown as grain crops, primarily on marginal land in dry areas of temperate, sub tropical and tropical regions. They are broadly categorized into two major groups (1) major millets, viz., Sorghum, Pearl millet and Finger millet (2) Small millets or minor millets viz., Foxtail millets (Kangani/kakun), Proso millet (Cheena), Kodo Millet (Kodo), Barnyard millet (Sanwa/Jhangora), Little Millet (Kutki) and Pseudo Millets (Buck wheat-kuttu, Ameranthus-chaulai). Due to the nutritional superiority of millets, the Government of India declared as Nutri-cereals by GoI vide Gazette Notification dated 13-4-2018. These are highly resilient crops and complete their life cycle within 60-65 days (short duration) with minimal fertilizer and pesticides use and able to survive in the hottest climate & have potential to cope up with climate changes. In India, millets are grown in the states characterized by low to moderate precipitation (200-800 mm rainfall).

International Year of Millets 2023

To create domestic and global demand and to provide nutritional food to the people, GOI had proposed to United Nations for declaring 2023 as International Year of Millets (IYOM- 2023). The proposal of India was supported by 72 countries on 5th March, 2021. United Nation's General Assembly (UNGA) declared 2023 as International Year of Millets. GOI has decided to celebrate IYOM-2023 to make it peoples' movement so that the Indian millets, recipes, value added products are accepted globally. In view of health benefits of the millets, The objectives are create domestic & global demand of millets, focusing on strategies to enhance climate resilient Nutri-cereals production, consumption, export, branding etc.

National Scenario of millets

In India, Millets are grown over an average area of 137.94 lakh ha (11% of the total foodgrains area) with a production of 163.11 lakh tonnes and contributed about 6% to national food basket. More than 80% millets are produced in Rajasthan, Maharashtra, Karnataka, Uttar



About the **AUTHOR**

Dr Subhash Chandra, Directorate of Millets Development, Ministry of Agriculture & Farmers Welfare, Department of Agriculture and Farmers Welfare, GOI

Pradesh, Madhya Pradesh & Gujarat. The area under Nutri-cereals was recorded at 314 lakh ha with production and productivity at 112.69 lakh tonnes and 359 kg/ha respectively in 1950-51, which had changed in 2020-21 at 133.33 lakh ha area with production at 180.20 lakh tonnes and productivity at 1322 kg/ha. Though the area is reduced due to shifting of area to high yielding crops (remunerative crops), but the productivity has increased more than 3 folds over 1950-51.

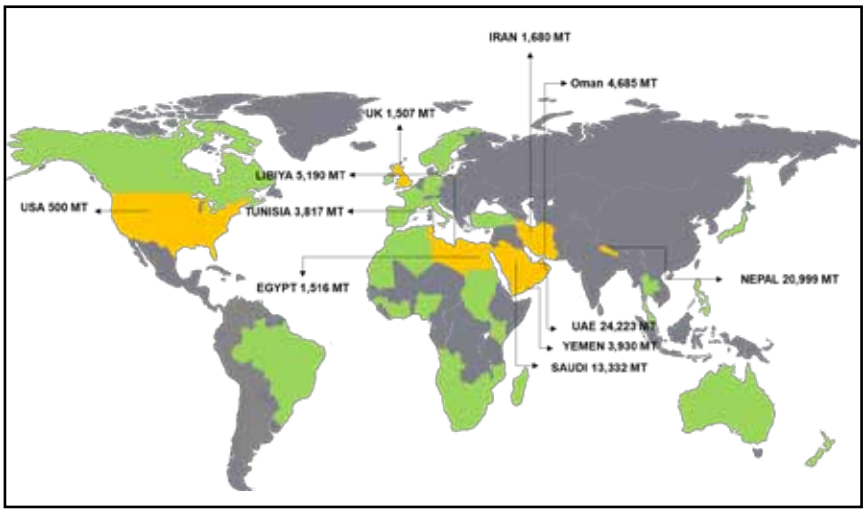
Nutritive Value, Health Benefits

Millets contain high nutritional value, cheapest sources of energy, high content of digestive fibre, protein, vitamin B complex, essential Amino acids, folic acid & vitamin E, high in minerals such as Iron, Magnesium, Copper, Phosphorous, Zinc, Calcium and Potassium. The benefits of millets in different health conditions include gluten-free hence are safe for consumption by celiac patients, reducing risk of development of obesity, helps in the management of type 2 diabetes mellitus, Millets display anti-inflammatory properties, reduces the risk of cardio-vascular diseases, helping in the management of hypertension, helps for bone health, the dietary fibre from millets possesses prebiotic effects, reduce the growth of certain types of cancers including breast and colon cancer.

Value addition

Indian Institute of Millets Research, Hyderabad; CCS HAU, Hisar & University of Agricultural Sciences, Bangaluru are working in the direction of value addition through its Centre of Excellence to fetch better income from the value added products and to create more demand of millets to support millet growers. Millets are used in preparation of so many value added products like Pizza, Ragi biscuits, Jowar Cake, Snacks/Roasted Jowar, snack/roasted mix grains, Pasta, Noodles, malt food and even Bakery products besides, used for industrial purpose like Malting, Brewing/Bakery/Jaggery, value added products for diabetics, poultry and animal feed etc.

Indian Millets reach in Global Market: India is 5th latgest exporter of Millets



Government Initiatives for Promotion of Millets

The Union Ministry of Agriculture has taken Initiatives for accelerating production and productivity and promotion of Millets Pre-International Year of Millets-2023 are given herein:

- National Food Security Mission-Nutri-Cereals: A sub mission of Nutri-cereals/millets is being implemented under NFSM from the year 2018-19 in identified 212 districts of 14 states. Hilly and North East-State have been given flexibility to implement nutri-cereals program as per their local need.
- The name of Millets was changed into “Nutri cereals” and a Gazette notification issued in April, 2018.

1. Pictures of International Event

PM’s address at the launch of 50th Anniversary celebrations of ICRISAT in Hyderabad, Telangana

Consulate General of India - Frankfurt

2. IITF 2021 at Pragati Maidan, New Delhi: 14th to 27th November 2021

3. Pre-Vibrant Gujarat Summit, Anand: 14th to 16th December, 2021




4. 35 "Surajkund International Craft Mela-2022, Haryana: 19th March to 4th April, 2022 at Surajkund, Haryana


5. 36th AAHAR 2022-International Food and Hospitality Fair, New Delhi: 26-30th April, 2022.


6. 75 Azadi Ka Amrit Mahotsava: 16th October 2021 World Food Day.


- The year 2018-19 was declared and celebrated as "National Year of Millets" for promotion and creation of demand for Nutri cereals.
- 18 Centers were established at SAUs / ICAR institutes, to increase the breeder seed production of Nutri Cereals in 13 states.
- Established 25 Seed Hubs at ICAR Institutes, SAUs and KVKs to ensure availability of quality seed.
- Millets included under POSHAN MISSION ABHYAN.
- Over 500 star-ups in millets value chain.
- 50 Farmers Producer Organizations (FPOs) on Nutri- Cereals (Millets) during 2018-19 to 2020-21 formed by Small Farmers Agri-Business Consortium (SFAC), DA&FW in 9 States.
- Approved projects on i) Shelf life enhancement in millets, ii) National Database on Millets, iii) Comprehensive Nutritional Profiling of Millets and bio-availability and iv) National Referral lab on Nutri-cereals.
- One District One Product scheme (ODOP): aimed to provide the framework for value chain development and alignment of support infrastructure. 21 Districts of 12 States covered under One District One Produce (ODOP) under Millet crops.

Export Scanario of Millets

India is the world's leader in the production of millets with a share of around 18% of the world total production. India produces around 16 Million MT of millets annually.. India has exported millets of Rs. 226.81 crore in 2021-22, including to the top 10 destination countries-United Arab Emirates, Nepal, Saudi Arabia, Libya, Oman, Egypt, Tunisia, Yemen Republic, UK and USA. Currently, India is the fifth largest exporter of millets in the world. The India export of millets is Rs. 226.81 crore in 2021-22, which is 10% more as compared to Rs. 205.17 Crore in 2019-20. The major exporting state of millets are Gujarat, Bihar, Maharashtra, Telangana, Tamil Nadu, Rajasthan and Karnataka.

Success stories of beneficiary farmers under NFSM-Nutri cereals

The success of beneficiary farmers under NFSM are given hereunder.

(i) Maharashtra government had awarded one of the sorghum farmers namely, Shri Sahebrao M. Chikane, Village-Songaon, Taluka - Javali, Dist. Satara as "Best Farmer Award" on the occasion of "Krishi Din" also known as “Agriculture Day” celebration on 1st July, 2021. His success story of achieving highest sorghum productivity by adopting innovative crop management practices for benefits of many other sorghum farmers and stakeholders for their motivation and further development. The cultivation practices used by him were recommended cultivation practices by the National Agricultural Research System (NARS) and demonstrated through FLDs during Post-rainy (rabi) 2020-21 with few modifications such as, enhanced plant to plant spacing of 20 cm instead of recommended 15 cm and innovative additional nutrient management using micro fertilizers and inter-cultivation practices. The variety Phule Revati was demonstrated in farmers' fields over 0.4 ha area by the IIMR through FLD programme. The productivity of rabi sorghum (10.1 t/ha) achieved by the awardee farmer is 10 times higher than the FLD (7.20 t/ha), national productivity (1.00 t/ha) followed by, doubled than research station yield (4.50 t/ha) and more than seven times than district average yield (1.40 t/ha) and, ten times more than state average yield (0.80 t/ha).

(ii) Farmers namely, Shri P.Selvaraj S/o Shri Palanisamy, Vill-Iduvai, District-Tiruppur (Tamil Nadu) cultivated sorghum variety COS 30 under NFSM-Nutri-cereals during Rabi 2020-21 over one hectare area. He adopted method of raising sorghum crop with the application of liquid bio fertilizer, MN mixture and followed Improved Package of Practices. The farmer obtained grain yield 1720 kg/ha showed 32% of increase yield over normal yield (1300 kg/ha) of the block. The cost of cultivation per hectare was Rs. 41000/- and he got gross income Rs. 86000/ with net profit Rs. 45000/- per hectare-. He got good profit as expected and could even use the straws to get a additional income.

(iii) Shri Jokhim Lepcha, vill-LowerDong, Suruk, Samther GP, Kalimpong-I Block, Kalimpong, West Bengal is a male progressive farmer. He adopted all technology disseminated from Agriculture Department. He adopted new innovative technologies and teaches other farmers of his village. Earlier he was cultivating local kharif ragi millet. During the season Kharif-2021, he demonstrated hybrid Ragi variety Vegabathi (VR-929) over one acre area, provided under NFSM- Nutri-cereals. 2 kg/acre seed was used for demonstration and farmers adopted transplanting method of cultivation instead of broadcasting which reduces labour cost, seed rate cost and easy intercultural operation. The farmer obtained grain yield 800 kg/acre over normal yield (600 kg/acre). The cost of cultivation per acre was Rs. 16000/- and he got gross income Rs. 56000/ with net profit Rs. 40,000/- per hectare

(iv) Smt. Renukayya s/o Panchaksharayya Neralekere is a female farmer of village-Nitturhobali, Taluk-Gubbi, District-Tumkur (Karnataka). He adopted integrated farming system and grow redgram as inter crop to get an additional income. Farmer was also adopting line-sowing method in place broadcasting method in ragi cultivation. Farmer transplanted Ragi variety ML-365 over one hectare area. The beneficiary farmers got 80% more benefit with improved technology over farmer's practices. She inspired other farmers of the village also to start improved technology in their fields and the people of the surrounding villages also came to her and learned this farming.

v) Shri Krishna pal Singh, S/o Shri Ugra Singh is farmer of vill-Chhabda, Tehsil-Baniyakheda, Janpad-Sambhal, Uttar Pradesh. He has about 1.51 ha land. Under NFSM-Nutri cereals, he got assistance for constrauction of small seed godown. He was cultivating pearl millet, rice, mustard, wheat in his field. Farmer constructed small seed godown costing Rs. 6.68 lakh over an area 56.25 sqm. He got assistance Rs. 3.34 lakh through DBT in his account. The farmer was very happy to get assictance through the scheme. Due to this, he stored his produce in godown safely and were benefitted by selling his produce own choice in market.

MILLETS IN ASSAM
THE CLIMATE SMART CROP

In the light of 2023 as the international year of millets, Government of Assam is going to observe 2023 as year of millets in full and true spirit. It has been decided to set up a full-fledged Mission called Assam Millets Mission (AMM) over a period of seven years starting from 2022-23. The activities under the Assam Millets mission will be taken up in value chain mode covering production (including seed production), post-harvest, processing, value addition and market linkages. The key focus is to address nutritional needs of people of Assam, particularly women and children.

The aim of the Mission is to increase household consumption of millets to enhance nutritional security and to create demand for millet to include in food habit.

Objective of Assam Millet Mission:

- To contribute to crop diversification and to increase cropping intensity,
- To have climate smart production particularly in resource poor, marginal and dry land,
- To improve productivity of millet based cropping system and make them profitable
- To promote millet processing Enterprises to capture markets for value added products of millets
- To Include millets in State nutrition programs and public distribution system &other schemes and
- To Contribute to Doubling farmers' income and State's Agricultural GDP

Millet Research in Assam

Regional Agricultural Research Station (RARS), Gosaigaon under Assam Agriculture University is conducting research and trials of different millets suitable for the state of Assam. RARS Gosaigaon developed a single variety of Finger millet called as Gosaigaon Marua which has recently been notified by Central Variety Release Committee. Numbers of other varieties of millet have also been tested and evaluated in the station for their suitability in the region.

Major Millets Growing Areas in Assam

15 districts of the state occupy around 97 percent of the area under millets. Among different district Nagaon covers an area 1586 ha followed by Bangaigaon 1084 ha and Dhubri 677 ha.

About the **AUTHOR**

Dr Khagendra Sarmah is Deputy Director of Agriculture (Seeds) in Department of Agriculture, Govt. of Assam. He is serving as designated Nodal Officer of APART, MIDH, Organic and Natural Farming and Millet Mission.

Though millet is grown thorough out the state, field survey reveals that districts namely Nagaon, Bangaigaon, Dhubri, Barpeta, Kokrajhar, Baska, Goalpara, KarbiAnglong, Sonitpur, Kamrup, Jorhat, Golaghat and Udalguri are having the potential for area expansion of millet in the state.

Financial Outlay

For promotion of millet in Assam a seven year plan has been worked out by the Department of Agriculture, Govt of Assam. It has beendecided to implement the Millet Mission with an investment of 200 Cr in seven years which includes area expansion, seed sector development, primary processing, infrastructure development, awareness creation and recipe developmentetc. The targeted area of millet after seven years has been earmarked 50,000 ha involving 65,000 farmers. Assam Millet Mission will not only focus on production, rather due attention will be paid on post-harvest management and value addition. AMM aims to cover service centric FPO/ FPC model through functioning of Milletbased FPC for production of local seeds and bio inputs, farm gate post-harvest and primary processing. Similarly,Common Service Centre, awareness camp, Buyer-Sellers meet,and ValueChain Schools (VCS) will also be developed.

Activities under Assam Millet Mission (AMM)

A. Market and nutrition supportive production

B. Farm machinery – Sprinkler system, Seed cum fertilizer drill, Interculture equipment

- Cropping system demonstration with pulses

C. Post-harvest& value addition aspects-

- Post-harvest demonstrations on drying & quality preservation
- Post-harvest machinery – Dryers, Thresher, Pulveriser, Value added product making machinery
- Static storage facilities & Storage bins

D. Nutritious millet products development.

E. Market linkages

- Millet based 30 FPCs, 30 CSCs under FPCs (for aggregation, cleaning, grading, drying, processing etc), 100 Buyer Seller Meets, 60 Value Chain Schools (VCSs).

F. Ensuring better nutrition, healthy & disease free Assam through millets

- Distribution of millets based products in rural areas – Mobile outlets, Awareness creation, Supply of millet based products in rural areas
- Millets in mid-day meal scheme (through education Department –Sarba Siksha Abhiyan)- Awareness creation, Supply and distribution in schools
- Millets nutrition in expecting & lactating women and children (in collaboration with PM-POSHAN Abhiyan, Department of Social Welfare) - Nutrition camps for women & children (urban and rural areas)

G. Administration, operations, training & capacity building

- Governing Body of the Mission at State level
- Millets Mission Cell at Directorates level
- Setting up of PMU at State level
- Setting up of District level Millets Cell
- Exposure visits, Trainings, Millets (& pulses) business conclaves, Millets Knowledge Bank

One of the major advantages of millet is that it can be grown in land not suitable for rice with minimum input and it can withstand adverse climatic conditions

KNOWLEDGE PARTNER OF AMM

AMM tied up with CRISAT and ICAR-IIMR Hyderabad as knowledge partner for technological support of millet sector development.

ICRISAT and are closely working with Agriculture Department and Assam Agricultural University, Education and Social Welfare department. Package of Practices (PoP) of Assam Agricultural University (AAU) will be followed to promote Millet cultivation in the state.

ISSUES FACED BY MILLET GROWERS

As transplantation of finger millet is done in dry land situation it needs more manpower and the process of transplanting is troublesome and labour intensive. Threshing of millet is cumbersomepractice for the farmers. Mechanical Dehusking of millets are also needed by the millet growers. One of the major advantage of millet is that it can be grown in land not suitable for rice with minimum input and it can withstand the adverse climatic condition. Being a climate-smart crop,millet constitute a good risk management strategy as compared to rice and maize which require higher quantities of water and fertilizer supplements.

Recipes by CHEF RANVEER BRAR

KUTKI/ LITTLE MILLET PAYASSAM

Preparation Time: 5mins
Cooking Time: 30mins
Serves: 4

Ingredients
750ml Milk
¼ Cup Little Millet
1/3 Cup Sugar
½ tsp Cardamom Powder

For Garnish
2 tsp Ghee
6-8 Cashew Nuts, halved
1 tbsp Chironji

Process

- Bring milk to a boil. Turn the flame to medium low and simmer the milk.
- Reduce the milk to ¾ of its quantity.
- Add little millet and cook on low flame for 6-7 minutes or till the millet fluffs up.
- Now add sugar and further cook for 3-4mins or till it reaches desired consistency.
- Lastly add cardamom and cook for 2 more mins. Turn off the flame.
- For garnish, heat ghee in a frying pan. Add cashew nuts and stir fry till light brown in colour. Now add in chironji and stir fry till both are golden brown in colour.
- Garnish the prepared payassam with cashew nut and chironji and serve.

PROSO MILLET PIZZA

Preparation Time: 30mins
Baking Time: 20mins
Serves: 2

Ingredients
For Pizza Dough
1 Cup Proso Millet
1 Large Sweet Potato, boiled and mashed
Salt, to taste
1 tsp Italian Seasoning
½ tsp Oil, for greasing
For Topping
¼ Cup Pizza Sauce
½ Cup Pizza cheese, grated
½ Cup mixed Vegetables, sliced & Sauteed (garlic, onion, green & yellow bell pepper)
2-3 Baby corn, sliced & blanched
4-5 Mushroom, sliced
3-4 Black Olives, sliced
½ tsp Italian Seasoning
Few Basil Leaves, hand torn

RAGI CHOCOLATE CAKE

Prep time: 30 minutes
Cooking time: 45 minutes
Serves: 4

Ingredients
1 cup Ragi Flour
1 cup Wheat Flour
½ cup Cocoa Powder
¾ cup Sugar
1 ½ tsp Baking Powder
1 tsp Baking Soda
2 cups Milk
2 tsp Vanilla Essence
¾ cup Melted Butter
A pinch of Salt

For Chocolate Ganache
200 ml Fresh cream
200 gms Dark Chocolate, cut into small pieces

½ cup Chocolate chips
½ cup Almonds, Slivered

Process

- Take a bowl and add in all the dry ingredients. Mix well.
- Now pour in milk, vanilla essence and melted butter. Combine everything well, ensure there are no lumps in the batter.
- Batter should be of thick pouring consistency.
- Line a cake tin with butter paper.
- Preheat the oven to 180* Celsius.
- Pour the cake batter in the lined tin. Tap it gently to remove air bubbles.
- Bake for 35 minutes or until the knife comes out completely clean.
- De-mould the cake and let it cool down to room temperature.
- Meanwhile heat fresh cream in a heavy bottom pot.
- Stir continuously and let it come to a boil.
- Turn off the flame and add in the chopped chocolate pieces.
- Do not mix it. Let it rest for 2-3 minutes.
- Later whisk it well. And let it cool down a little.
- Once the cake cool downs completely, take a serrated knife and cut the top portion to even out the cakes top surface.
- Pour the prepared ganache on top of the cake. Cover the entire cake with ganache.
- Garnish the cake with chocolate chips and slivered almonds.
- Let it set in the fridge for 2-3 hours and serve.

PROCESS

- For pizza dough, make proso millet flour by grinding the millet to a fine powder.
- Now in a mixing bowl, combine millet flour, mashed sweet potato, salt, Italian seasoning and mix well.
- Using ¼ cup water knead into a soft dough.
- When your pizza dough is ready, pre-heat the oven at 220C or 430F for 10 minutes. Meanwhile grease a pizza plate/ baking dish with a little oil.
- Now roll out, press and spread the dough on the pizza plate till you get an even circular pizza base. Bake the pizza base in the pre-heated oven for about 10 minutes.
- Remove from the oven and let it sit for 4-5mins.
- Now apply pizza sauce on the base and grate generous amount of cheese.
- Place the sautéed vegetables, baby corn, mushroom, black olives on the pizza.
- Lastly sprinkle Italian seasoning, place some basil leaves and some more cheese if needed.
- Bake the pizza for about 20 minutes on 200C or 395F.
- Remove the pizza from the oven. Place some more basil leaves and cut into equal portions. Serve hot.

Tips & Tricks
1. Baking temperature is important to follow as also pre-heating the oven.
2. Dough should be sticky like the consistency of a sticky cookie dough.
3. Avoid leaving the dough unused for long as it doesn't do well with excess moisture. Best to keep everything ready before preparing the base dough.
4. Do not skip the base pre-baking step.

MILLETS - NUTRI CEREALS FOR SUSTAINABILITY AND HEALTH

Foods that have some functional potential for preventing disease in addition to providing nutrition are gaining global importance in this era of rising chronic health conditions. Millets are one such cereal grain that are not just rich in macro and micro-nutrients but also packed with several non-nutrient bio-actives/secondary metabolites/ phytochemicals and have been documented to have several health benefits.

They are a group of small-seeded grasses that are grown for food and fodder in warmer climates in low fertile soils and require very low inputs of fertilizers and pesticides. Millets (nutri cereals) are one of the oldest of domesticated crops and probably first cultivated in Asia more than 4,000 years ago. They are now mostly grown throughout the tropics, subtropical and dryland regions of the world.

Millets are the sixth most important cereal crop in the world and have been used as a staple food in India, China, and Japan for centuries. They are highly nutritious and contain a range of vitamins (thiamin, niacin, vitamin B6, vitamin B12, and pantothenic acid) and minerals, including iron, calcium, magnesium, and phosphorus.

Health Benefits Of Millets

Studies have shown that millets can improve anemia as they are a good source

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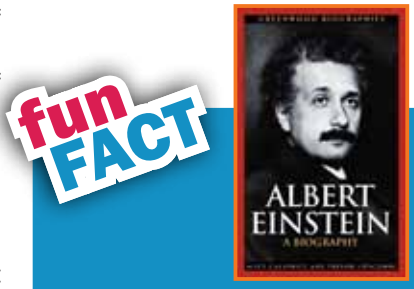
of iron, magnesium, and zinc, all of which can help to improve the function of red blood cells and reduce the risk of anemia. Improved gut microbial function through consumption of millets can also directly and indirectly improve iron bioavailability and absorption which are now shown to be affected by microbial activity in the gut. This can help prevent iron-deficiency anemia which is highly prevalent among women of reproductive age in most developing countries.

There is also some epidemiological evidence to suggest that diets rich in whole grains, including millets, are associated with a reduced risk of chronic diseases such as cardiovascular disease, obesity, type II diabetes, and some cancers. The mechanisms by which whole grains may protect against chronic disease are not fully understood but are thought to include the effects of whole grains on gut microbiota, inflammation, and insulin resistance. Preliminary research suggests that diets high in whole grains and other plant-based foods may promote a more diverse and beneficial gut microbiota. Additionally, the high fibre and nutrient content of millets make them a potentially valuable food for disease prevention.

Good For Gut Health

Millets are also a good source of dietary fibre and resistant starch, which are important for gut health. The gut microbiota is the community of microorganisms that live in the gastrointestinal tract and play a key role in human health. In recent years, there has been



Dr Hemalatha likes to read non-fiction

increasing interest in the role of millets in improving gut microbiota health. Dysbiosis of the gut microbiota (unbalanced gut bacteria) has now been implicated in a wide range of diseases, including obesity, type 2 diabetes, cardiovascular disease, colon cancer and inflammatory bowel disease. Millets are a rich source of dietary fibre, which is fermented by the gut microbiota and produces short-chain fatty acids (SCFAs). SCFAs are important for gut health, as they promote the growth of beneficial gut bacteria and have anti-inflammatory effects.

Studies that investigated the effects of millet supplementation on the gut microbiota of rats, found significant increase in the abundance of the beneficial bacteria, improved gut barrier function and increased expression of anti-inflammatory genes in the gut microbiota.

Studies also showed significant increase in the abundance of the beneficial bacteria *Bifidobacterium longum* and *Lactobacillus plantarum*, as well as a decrease in the abundance of the pathogenic bacteria Enterobacteriaceae and Escherichia coli. Regular consumption of millets increased the production of SCFAs, particularly butyrate. Butyrate is a SCFA that is particularly important for gut health, as it has been shown to protect against inflammation and reduce the risk of colon cancer.

These findings suggest that a millet-based diet may be a suitable strategy to improve gut microbiota health and function. Future studies should explore the potential mechanisms by which millets exert these effects, as well as the potential benefits of adding millets to the food basket and its effect on nutritional status and health in humans.

India is committed to ensuring that millets are accessible and affordable for all, and to helping build a healthier, sustainable and climate-resilient future

Environmental Benefits Of Millet Cultivation

The value of millets can also be estimated by considering the environmental benefits of millet cultivation. Millets are highly drought-tolerant and disease resistant crops, and they can help to improve soil health and reduce water usage. The year 2023 has been earmarked by the United Nations as the 'International Year of Millets' and presents a unique opportunity to highlight the importance of millets as a nutritious and climate-resilient food.

India has been selected as the Chair of the Intergovernmental Organizational Partnership on Millets by the United Nations General Assembly. India will use this platform to lead the global millets movement and promote millets as a key component of food and nutrition security. India will also work to build capacity amongst stakeholders, including policy-makers, scientists, and farmers, to increase the production and consumption of millets.

In addition to its role as Chair, India will also be responsible for organising and hosting the first-ever International Year of Millets in 2023. This will be a year-long celebration of millets, with a focus on their nutritional and environmental benefits. India is committed to ensuring that millets are accessible and affordable for all, and to helping build a healthier, sustainable and climate-resilient future.

UNLEASHING THE POTENTIAL OF MILLETS

MARKETING AND MARKET LINKAGES A MAJOR CONCERN

Millet is a drought resistant crop. It yields good productivity in the areas with water scarcity. It possesses remarkable edible and nutritive values, and ease of processing and food manufacturing.

Agriculture and food security policymakers of developing countries should give due attention in promoting the research work and projects for studying the processing, food manufacturing, improvement in nutritive values and potential health benefits of the millet grains to promote their utilization as food in respective countries. Most of the developing countries have started working in the field of improvement of edible potential of millet grains.

Millet oil can be a good source of linoleic acid and tocopherols. Millet is an alkaline forming grain that is gluten-free. Millets have nutraceutical properties in the form of antioxidants which prevent deterioration of human health such as lowering blood pressure, risk of heart disease, prevention of cancer and cardiovascular diseases, diabetes, decreasing tumour cases etc.

Millet is an alkaline forming food. Alkaline based diet is often recommended to achieve optimal health. In developing countries, cereal-based foods have low bioavailability of minerals like iron, zinc initiate critical problem for infants and young children. Food processing techniques are used to enhance nutritional quality, improve the digestibility and bioavailability of food nutrients with reducing anti-nutrients.

CHALLENGES

Processing Efficiency: Some millets require multiple processing for optimization of grain recovery and optimization of polishing to retain their nutrition value. There is need to develop solutions to improve the efficiency of millet processing (dehulling, separation, polishing etc.) while retaining the nutritional value.

Decentralized Processing: Need to develop machinery and/ or infrastructure for small scale decentralized processing. This should be affordable and easy to use for farmers, FPOs and consumers.

Shelf Life Augmentation: There is need to develop solutions to improve the shelf life of millets – grains, processed grains, flours etc. to make it comparable to competing crops.

Marketing and Market Linkages: There is need to develop market linkage solutions to strengthen the supply of inputs, and outputs (distribution, market access etc.)

About the **AUTHOR**

Mrs Sharmila Oswal is a 'Millet Evangelist'. She is the Founder of Basillia Organics, a women's start up, and the Founder of India Millet Mission

Recipes by CHEF AJAY CHOPRA

BAJRE MUTTON KA SOYETA

Bajra, soaked for 8 hours and drained 80 gm
ghee 20 gm
cumin seeds 5gm
turmeric powder 3 gms
asafoetida 5 gms
Lamb: 350gm
Chopped fresh coriander: 25gm
Ginger Paste: 10gm
Garlic Paste: 20gm
Chopped green chili: 15gm
Sliced onion: 3 nos
Whole green cardamom: 5gm
Desi ghee: 150gm
Garam masala powder: 5gm
Coriander powder: 10 gm
Red chilli powder: 10gm
Turmeric powder: 5gm
Shredded ginger: 5gm
Cinnamon stick: 5gm
Black cardamom: 5gm
Bay leaf: 5gm
Cloves: 5gm
Mace: 5gm
Black pepper: 5gm

For bajra pre prep

In a pressure cooker heat 3 tablespoons of clarified ghee

In the hot ghee now put cumin seeds and asafoetida

Stir ghee on low flame till cumin seeds and onions turn slightly brown

Now add the soaked bajra along with the washed moong dal in the pressure cooker

Add Turmeric powder and salt

Mix the ingredients in the pressure cooker

Close the lid of pressure cooker and on medium flame pressure cook till 4 whistles.

For mutton

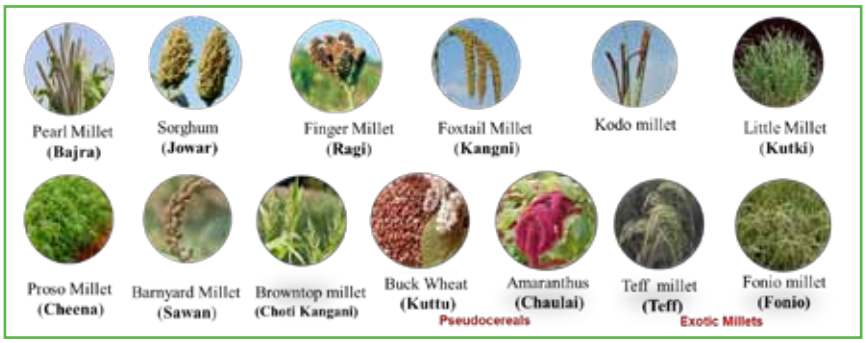
Take a thick bottom handi, pour ghee, add whole garam masala and saute. Wait until the whole masala starts crackling.

Add sliced onion and saute till golden brown, add ginger garlic paste and cook it for 10 minutes.

Add mutton and cook on gentle heat. Once the mutton half cooked, add all the powder spices and close the lid.
When mutton is cooked tender, add bajra and cook till the bajra gets mashed and the gravy is of thick consistency.

STRATEGIES TO UNLEASH THE POTENTIAL OF MILLETS

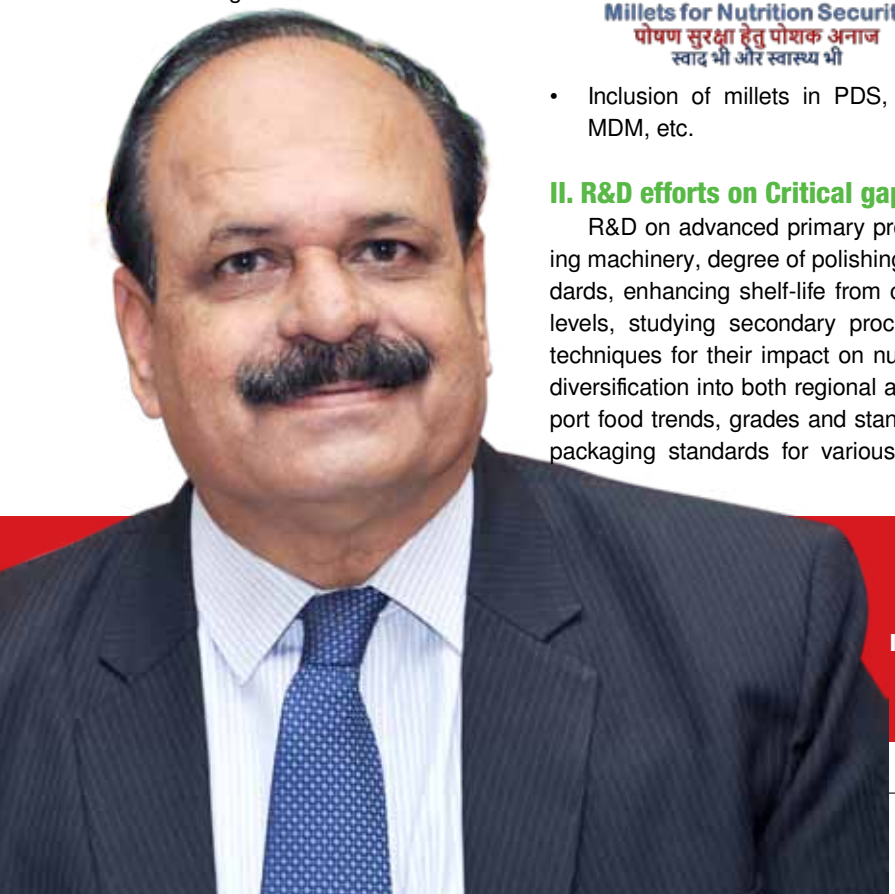
The resolution to increase public awareness on the health benefits of millets and their suitability for cultivation under tough conditions marked by climate change pushes India to draw a roadmap to be among top three exporters by 2025. With collective efforts in expansion of areas under millets and by developing a successful millet value chain ecosystem with end-to-end solutions for creating demand, exports can be increased manifold.



Source: ICAR-Indian Institute of Millets Research

I. Production and Procurement

- Expansion of millets cultivation
- Productivity enhancement
- Development of bio-fortified varieties
- Identification of cultivars and strengthening seed chain
- Promotion of Millet FPOs and farm-gate processing
- Declaring the MSP and Procurement



- Inclusion of millets in PDS, ICDS, MDM, etc.

II. R&D efforts on Critical gaps

R&D on advanced primary processing machinery, degree of polishing standards, enhancing shelf-life from current levels, studying secondary processing techniques for their impact on nutrition, diversification into both regional and export food trends, grades and standards, packaging standards for various products and studies on nutritional evaluation, bioavailability, efficacy for health benefits, etc. are essential for scaling up the value chain.

III. Strengthening the Food Processing

• **Training, Capacity building, Incubation and funding** support to millet start-ups for entrepreneurship development and linking them with government/captive markets, niche markets, and export markets, for increasing the number of food processors and exports within the country.

• **Encouraging the big private food processors** for including the millets into their product portfolio by bringing a policy for incentivizing the setting up of processing units and/or processing activities.

• **Strengthening the Small and Medium Enterprises** would play a pivotal role in pushing the millet products in local markets, and supply to government programs.

About the **AUTHOR**

Dr Vilas A. Tonapi is Former Director, ICAR-Indian Institute of Millets Research, Hyderabad and Presently Technical Consultant, Advanta Seeds, Hyderabad

IV. Strategies for positioning and exporting to Global markets

• **Strategically aligning the Indian millets with emerging food trends** of various potential export markets which draw more than 64% of total millet imports, while balancing India's current exports to traditional export countries in Asia and Africa.

• **Bringing the millet specific export policies** such as allocating the separate HS codes for all millet products, including them in RODTEP scheme, PLI scheme and other schemes such that the wide range of millets products are encouraged.

• **Building the Export specific production cluster and promotion forums** would enhance the exports from India.

• **Other market related activities** such as building market intelligence on export countries, trends, prices, etc. for enabling the informed decisions by exporters.

V. Popularization and Strategic Awareness Creation

• **Leveraging the International Year Millets**. It's important to get ready with calendar activities for organizing as a run up for the International Year of Millets, 2023.

• **Hosting the international and national conferences,** food festivals, trade fairs, etc., for creating dialogue on various policy, scientific, promotional and consumption aspects while acting as a platform for developing linkages would expand the millets reach to various communities.

• **Leveraging on the global platforms such as South-South Triangular Cooperation (SSTC)** for awareness creation, knowledge sharing, capacity building, technological support, incubation, etc. for replicating the successful models of India towards strengthening the global value chain on millets.

• **Building USP** around individual millets and also positioning 2–3 selected millets as champion millets by tying with a unique proposition such as milk for calcium, egg for protein, etc. for effective marketing in both domestic and export markets.

Millet Value Chain linkages
Source:ICAR-Indian Institute of Millets Research

• **Taking millets closer to people** through various awareness creation programs such as advertising in print media, electronic media (TV Channels, Radio), social media, Indian Railway, Anganwadi, etc., should be exercised by the Government, as in case of eggs and milk promotion.

• **Convergence of various departments** such as NITI Aayog, APEDA, MHRD, MOFPI, MSME, etc., and other public institutions, premier institutions, private sector, NGO's, farmer groups, chefs, dieticians, doctors, nutritionists, startups, etc., would open the possibilities for tremendous awareness creation.

VI. Strengthening and Enabling Market linkages

• **Backward linkages:** With proper supply chain in place, FPOs can serve as growth engines for forward linkages with markets.

Creation of Export specific Clusters: Identification and grouping the millet growers, and linking with the export traders/processors will establish the sustainable supply chain for exports

• **A higher share of the producer in consumer rupees:** This intervention will help them realize more income as a share of the consumer rupee.

• **Linking start-ups with Captive Government Markets:** Building the linkages between the captive markets such as publicly funded programs and the start-ups/processors will result in a solid supply-demand chain.

• **Linkages between start-ups and big private players:** Building an ecosystem where start-ups can process the products for big private FMCG player on contract manufacturing will result in inefficient use of capacity. The big players can concentrate on penetrating the nutrient-rich products into domestic and export markets.

• **Creation of Export specific Clusters:** Identification and grouping the millet growers, and linking with the export traders/processors will establish the sustainable supply chain for exports.

• **Creation of Export Promotion Forum:** Building an ecosystem of seamless linkages between producers, processors and export traders will aid in strengthening the value chain for export markets.

• **Market Intelligence:** Analyze the export competitiveness of millets and price volatility of domestic and international markets.

• **Developing segmented markets and upscaling them:** Analyzing and segmenting the markets for building the product portfolio along with appropriate marketing and branding strategies is necessary to position the millets and scale up globally.

INDIA'S PESTER POWER
BRINGING MILLETS BACK TO OUR PLATE

A recent study by seven organizations under the leadership of the Hyderabad based International Crops Research Institute for Semi-Arid Tropics and published in the journal Frontiers in Nutrition depicts that regular consumption of millets can improve hemoglobin levels and reduce anemia-causing iron deficiency, besides meeting all or most of the daily nutritional requirements of an average person. Millets are great sources of zinc: little millet (3.7 mg/100 g), pearl millet (3.1 mg/100 g) and barnyard millet (3.0 mg/100 g) contain much higher levels of zinc compared to rice (1.3 mg/100g) and wheat (2.7 mg/100g).

Pearl Millet (Bajra) which provides more easily absorbable zinc than rice has several nutritional traits such as high dietary fiber, gluten-free protein, and phyto-chemicals. Crop is also widely popular among farmers as it offers high levels of tolerance to drought, heat and soil salinity.

Iron biofortified pearl millet which has 33% more iron and zinc than the regular pearl millet takes the benefits to the next level. Similar bio-fortified varieties are also available for finger millet - CFMV1 (Indravati) -with 100% more calcium, iron and zinc levels. These millets can play a key role in improving the nutrition profile of children in the country.

About the AUTHOR

Mr Ravinder Grover is the Program Lead for Harvest Plus, with more than 15 years of experience as a practitioner and advisor for the leading industry and consulting firms in the agriculture and food domain. After work, he is a guest faculty and a guest speaker at leading agribusiness institutes and industry forums.

Marketing Millets To Kids

Using Kid friendly strategies to commercialize millets is the need of the hour. The India millet based packaged food market was valued at US$ 37.7 Mn in 2022 and is expected to reach US$ 91.1 Mn by the end of 2032, growing at a CAGR of 9.2%. But this is still just 2% of India's packaged wheat flour market. We need to rethink our strategies and involve Generation Alpha into this mission.

One of the brands doing that is Slurrp Farm, with a modern line of products. They have pancake & waffle mix, crunchy puffs, combined with funky packaging. They have been a hit with both mothers and children.

AgroZee Organics, a budding start-up in Maharashtra is on a mission to break the wall of malnutrition with millets. They are selling affordable and nutritious multi-millet ladoos with Madhuca Indica flower as sweetener to the rural and semi-urban areas. Their products are loved by the children in semi urban areas.

Schools for Change

Schools are not only a place where children form long lasting habits but they also act as a key influencer in shaping food preferences. Inclusion of Millets under Integrated Child Development Services (ICDS) and Mid-Day Meal Scheme (MDM) could just be the way to nudge children towards millets.

Serving 120 million children in over 1.27 million schools and Education Guarantee Scheme centres, the Midday Meal Scheme is the largest of its kind in the world.

Mr Grover loves talking about everything and playing corridor cricket with his five-year-old son

Inclusion of millets in MDM will help in making children in rural areas aware about the existence and importance of millets and more importantly get used to the taste of traditional millet foods like Bajra khichdi or modern millet snacks like noodles etc. With the kids liking the millet-based foods and also telling their parents about the same, transition to millets at home will be a lot smoother.

A study jointly conducted by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and Akshaya Patra Foundation has shown that replacing rice in the mid-day meal (MDM) with small millets can boost the growth of children by nearly 50 per cent over three months. This is an example of not only a science-backed nutrition solution, but also a link between agriculture and nutrition.

A similar study on iron deficient adolescents (12-26 yrs) conducted by HarvestPlus demonstrated that after eating flatbread made out of iron biofortified Pearl Millet for 6 months, they were 64 percent more likely to resolve their deficiency. The adolescents also experienced significant functional improvements in perception, memory, and attention.

With a booming startup culture, strong government support for millets and no dearth of responsible marketeers, India is well placed to harness the "pester power" of its tiny tots to boost millets sale and consumption

Recently Honourable Union Agriculture Minister Shri Narendra Singh Tomar emphasized that the time has come for the Public Distribution System to shift the focus of distribution programs from basic calories to provide a more diverse food basket that includes millets to improve the nutritional status of pre-school children and women of reproductive age.

Way Forward: A Golden opportunity

The Ministry of Agriculture is working in mission mode to increase millet production and consumption in collaboration with other central ministries, all state governments and other stakeholder organizations. MoA has also funded 66 startups with more than Rs. 6.25 crores in order to provide support to startup entrepreneurs for recipes and value-added products to promote millet consumption under the International Year of Millet (IYOM) 2023.

It is now time for the food players to utilize this golden opportunity and promote millet-based foods with out of box ideas. India's most conspicuous consumer base of 400 million kids below the age of 15 is lapping up not just toys, gadgets and clothes but also counselling parents on the food choices. With a booming startup culture, strong government support for millets and no dearth of responsible marketeers, India is well placed to harness the "Pester Power" of its tiny tots.

TECHNOLOGY-POLICY INTERFACE FOR SMART AGRICULTURE: *Emerging Trends & Prospects*

The swelling world populace, climate alteration, and sustainable development goals need the farming sector to be effectual and justifiable: thereby confirming food safety and security. Seeing the increasing demand for high quality and environmentally friendly crops and crop products as food, existing agrarian production must increase at least 70 % by 2050. Further, the farming sector has been squeezed by rising labour costs and the unpredictability of weather patterns. From such farming viewpoint, India has huge potential of farming land (~150 million ha), even under wild climatic variations fitted to numerous types of crops, rich soils, plentiful sunshine and a long harvesting season (rabi and kharif). Majority of the programs/schemes run by the government tend to run independently, to assist and subsidise Indian farmers, but certain regressive marketing policies (domestic/global) and a lack of basic infrastructure (storage, processing, transportation etc) have led to net losses for small and marginal farmers. The need of the hour is a cohesive strategy by the government with an emphasis on public-private partnerships for overcoming or at least narrowing such problems. By combining the effectiveness, adaptability, and competency of the private sector with the public sector's accountability, long-term vision, and social interest, such partnerships could provide a perfect policy strategy to indorse social and economic evolution. Looking into prevailing scenarios, the two big game changers could be smarter science & technology at one end, while clever formulation/execution of farming policies at other.

About the **AUTHOR**

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EMERGING AGRICULTURAL CHALLENGES

Key agricultural challenges may be categorised under broader clusters namely; overexploitation of water and land resources, disregard for nature and loss of crop diversity, truncated efficiencies and price led growths, regional imbalances/disparities, wasteful investments, inadequate technology generation/dissemination, viability of smallholders, nutrition/food safety, mismatch structural changes in output/workforces, low income of farmers, and many more. Further assemblage of these challenges in two giant classes may be labelled as (1) productivity enhancing problems (farm sizes, irrigation coverage, credits, extension) and (2) environmental linked problems (soil health, efficiencies & accessibility of water, pollution). Alternatively these may be termed as (i) instability due to monsoon, (ii) cropping pattern having food as well as

non-food crops, (iii) widely dispersed/ fragmented land holding, (iv) land tenure system with in-secured tenancy, (v) un-balanced agricultural labourers with subsistence wage levels, (vi) manures, fertilizers and biocides for depleted/exhausted soils, (vii) deficit irrigation with lower efficiencies, (viii) inadequate farm mechanisation:, (ix) scarce storage & marketing facilities, (x) overexploited natural resources

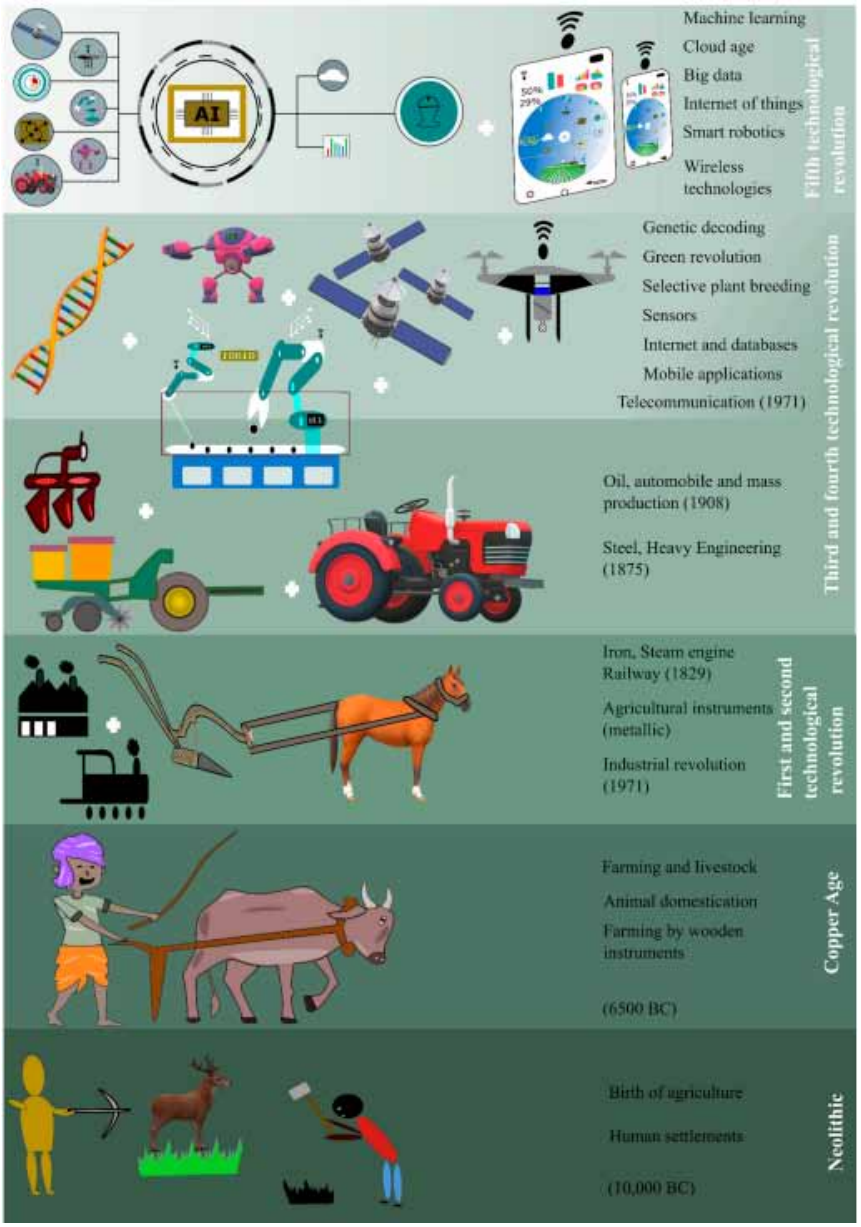
PROSPECTIVE TECHNOLOGICAL OPPORTUNITIES

Technological innovations have greatly shaped agriculture throughout its course. From the creation of the plough to the present days IT & ICT based precision farming equipment, people have developed new ways to make farming more efficient and grow more food. The usage of technology in agriculture domain has very vast spectrum, whose total narration is out of scope here. Moreover, a comprehensive review of such technologies reveals that numerous approaches are well adopted therein for improving the quality and quantity of crops under large number of constraints and resource crunches. If one look towards spectrum of most recent technologies it reflects expert broad domains like optimum conservation of land and water resources, improved inputs (seeds, fertilizer, nutrients), integrated development and management of various sub sectors, digital agriculture, precision agriculture, analytics for crop yield etc. In spite of this, there exists a big scope for user friendly and most updated comprehensive system encompassing technologies at one end while appropriate policies/decisions at another end.

Upmost Technological Options for Smart Farming

Though there remained a plethora of smart technological options such as,

- Agricultural Drones: Such unmanned aerial vehicles-based technology is highly, widely and deeply penetrating in Indian agriculture; to help farmers to overcome variety of hassles with enormous capabilities (carrying not only camera but a plethora of information/data) for added next generation utilities towards monitoring livestock/grazing/crops-NRM systems.
- Agricultural Robotics: It is going to be a boon to resolve labour-scarcity problem in farming with amplified large field operations; offering benefits in terms of great, cheap, timely key farm operations (crop/ fruit-picking, harvesting, planting, transplanting, spraying, seeding, weeding, and many other vital tasks like weighing, incubators, milking machines, and auto feeders).
- Internet of Things (IoT) : It has vast potential to get used as an alternative to traditional farming methods, by way of utilities of sensors that collect data and provide accurate information via digital applications in real-time.
- Artificial Intelligence (AI) : Incorporating AI in agriculture



Key industrial revolutions, with respect to agriculture, over time (Source : Martos et al. 2021)

has started to provide farmers the real-time insights into their field conditions, allowing them to be proactive. Recent adoptions like Chatbots, decision supports, and input recommendations have extremely bright future towards smart farming.

- Precision Agriculture (PA): Owing to its potential for offering site-specific crop/livestock managing options/ operational guidelines; Indian farmers are to get customized for choices on exact amounts of inputs (water, pesticides, fertilizers), to enhance quality and productivity.
- Agrarian Biotechnology: Advanced scientific techniques like plant breeding, hybridization, genetic engineering, and tissue culture have offered very high potential to facilitate the identification of better traits in plants; providing a range of genetic analyses to assist farmers in crop-livestock management decision-making.
- Big Data & Analytics: Being most recent and highly popular, this technology has vast potential to transform everyday farm data into actionable insights.
- Controlled Environment Agriculture: It has been well emerging as one of the big boons for agricultural activities under fluctuating and extreme weather events.
- Regenerative Agriculture: It remained focus towards causing minimal soil disturbance while concentrating on improving soil biodiversity and topsoil revival; via practices like no-till farming, reduced tillage, crop rotation, cover crops etc.
- Connectivity Technologies: It enables true launch/applications of smart farming; as it is not possible without connectivity technologies like 5G, LPWAN, rural broadband/ satellite-enabled communication, IoT devices, robots, sensors enabling speedy communications.

Evolution of Agriculture 5.0

Continuous industrial invention has made it possible that 2021 has been officially marked by the European Commission as the beginning of the era of "Industry 5.0". The industrial world, including the agricultural sector, is starting this year by getting a bit closer to digitalized and automated systems. Although, man started cultivation by making use of wooden instruments and domesticating animals, this was then transfigured through the use of metallic equipment for crop cultivation and this time was categorized as the first and second agricultural revolutions. The third and fourth industrial revolutions brought robotics, machines, telecommunication systems, genetic decoding, etc., to agriculture. The projected fifth and contemporary revolution is based on artificial intelligence (AI) and cloud computing, applied to agricultural remote sensing (RS). The recent characterization of Big Data concept is boosted by adding 4th & 5th dimension (the Veracity & Valorization) in originally architecture of 1st, 2nd & 3rd dimension (Volume, Velocity, and Variety). Overall, the five V (dimensions) of big data stand for: (1) Volume (datasets whose size is beyond the ability of typical database software tools to capture, store, manage, and analyse information), (2) Velocity (capability to acquire, understand and interpret events as they occur), (3) Variety (different data formats like videos/text/voice with diverse degrees of complexity), (4) Veracity (quality, reliability, and overall confidence of the data) and (5) Valorization (ability to propagate knowledge, appreciation and innovation). It altogether gave birth to contemporary version of smart agriculture that is designated as Agriculture 5.0.

WAY FORWARDS

Precise automation in agriculture, is the key point whenever we look towards the way forward for agricultural or allied sectors. It remained highly inclined towards adopting concept that refers to managing farms using technologies like IoT, robotics, drones and AI to increase the quantity and quality of products while optimizing the human resources required by production. For present-day farmers we need to realize and adopt potential technologies encompassing sensors (soil, water, light, humidity, temperature management), software (specialized software solutions targeting specific farm types/ applications/agnostic IoT platforms), connectivity (cellular, LoRa), location (GPS, Satellite), Robotics (autonomous farm machines/processing facilities), and data analytics (standalone analytics solutions, data pipelines for downstream solutions). Though, Hon'ble Indian Prime Minister has continually called for concentrating deeper attention on raising farmers' income; it remained only partially attainable owing to few big reasons like; small and shrinking land size, excess workforce, low productivity and poorly working mar-

kets. Experts have offered quite inclusive new ideas for public intervention in key sectors/sub-sectors of agriculture and allied disciplines. Majority of them involve a paradigm shift in the policy for the sector, out of which some have already been initiated in recent years.

Author has his own view inclined more towards ten key policy zones; namely

1. Smart technology reforms in agriculture
2. Regulating farming inputs & outputs with price supports
3. Balanced merit based subsidies/ grant
4. Initiatives towards inclusive developments
5. Corporate investments and public private partnerships
6. Linking production to processing/ value addition
7. Adoption of demand driven linkages across agricultural R&D, academics and industries
8. Integrated NRM and ecological control
9. Promoting farm producers alliances/ business/market
10. Scaling up success stories of "innovative farmers/other stakeholders

Integration of Agricultural and Information Science

Any kind of information happens to be the seed for generating reliable knowledge and thus the wisdom; which in turn yields the cherished policies. Unfortunately, availability of ample and reliable information and its effectual integration with policy domain; is a poorest link in agricultural and allied sectors. It is the reason why there is a global trend of shifting focus towards data-based agriculture, as it is data only that provides original information for any kind of agrarian intervention or working sphere. Owing to its applicability in numerous subject lines/areas, the information science itself has gained broader wings namely: Bio Informatics, Geo Informatics, Health informatics, and more recently agricultural informatics.

Dealing prevailing Key Issues with Contextual Evidences

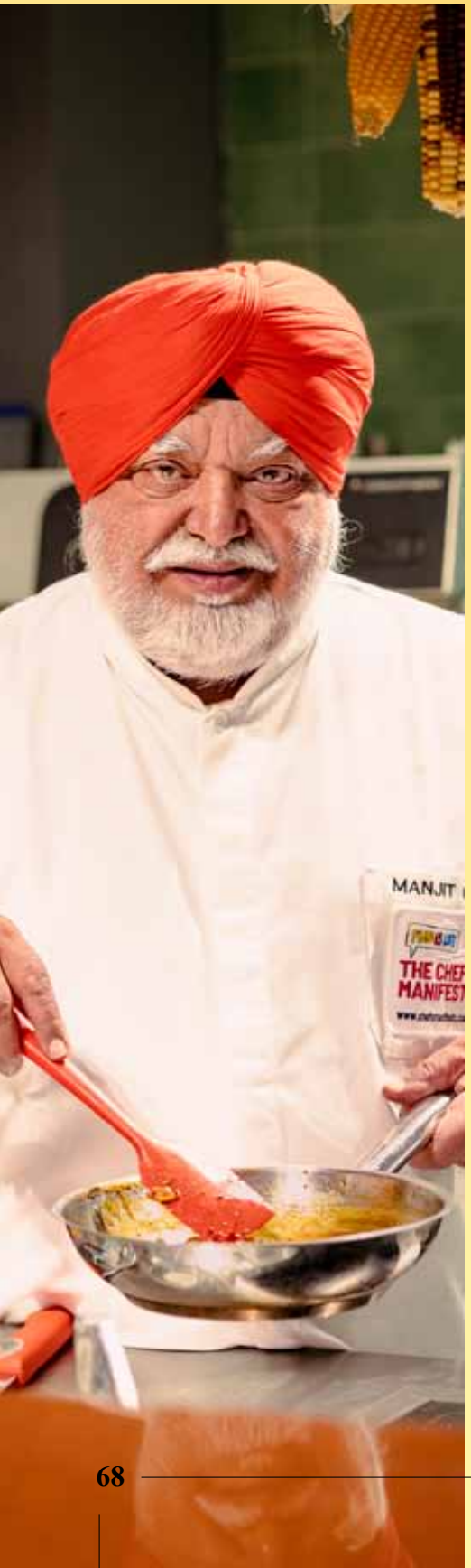
Tendencies and patterns of consumption of farm produces varied exceedingly cutting across regions, farming sub sectors (agriculture, horticulture, dairy, livestock, fisheries, forestry) and prevailing Natural resources Management (NRM) and ecological characteristics. Though Indian agriculture has emerged as a major source of foreign exchange earnings through export of raw materials and processed foods; but it strongly points out for evolving commodity-based strategies for steady export upgrade. Inappropriate NRM along with ever shrinking land holdings still remains a big concern to halt prevailing extent of water and land degradation and thus the health and nutrient status of soils; as even now about 120 million hectares of the arable land suffers from one or the other types of land degradation, and 29.4 million hectares has shown lower fertility with an annual negative balance of 8-10 tonnes of nutrients. It is only recently the National Water Mission established an outline to augment water-use efficiency by 20% by upgrading of distribution channels, institutional innovations like participatory irrigation management, and water-efficient technologies.

CONCLUSION

Indian agriculture sector is undergoing a transformation driven by new technologies, which seems very promising as it will enable this primary sector to move to the next level of farm productivity and profitability. However, taking these advantages to the farm will depend, not only on the willingness of producer. We need to adhere on below given endorsements,

- The huge goal of attaining five trillion-dollar economy by 2024-25 in India, would need sharp upscaling of agricultural growth with well identified region-specific strategies towards adoption of futuristic smart technologies with due inclusiveness ('farm to fork').
- Balanced and reoriented subsidies to agrarian sector focusing more on efficiencies, productivity, sustainability, and upgraded outcomes (socioeconomical & ecological).
- Evolving encouragement mechanisms for generating demand driven ecosystem services and espousing numerous line-ups for linking these services with promoted resource-use efficiency, cost, and NRM.
- Policy based progression towards agricultural diversifications (crops, resources, management, data analytics, and market/business) would continue to be the foremost source of growth for farms/farming/farmers with insertion of high value crop/livestock products at one side while supportive technological institutions & market infrastructure on other side.
- Land reforms and land-lease market is added decent option that is crucially desired to attract farm household investment and thus increase the scale of farming operations. It could greatly help in modernizing land records, tenancy act, and conflicts resolving in contracts; and in turn facilitating prioritised leasing of common/degraded lands etc rural & urban settings.
- Indian agriculture has touched a stage where managing surplus production and exports are crucial needs to uphold the domestic prices and enhance farmers' income.
- Corporate sector's involvement in agri-logistics could greatly enrich the pace of agricultural development and value creation.
- Determined benefits could be ensured for small and marginal farmers/ stakeholders by linking/facilitating them to harnessing optimum gains from ongoing innovative plans and outlines under the umbrella of Prime Ministers Schemes.
- A lot of recent initiatives (agricultural drones, farming data analytics, FPOs, smart KVKs, Intensive R&D, NEP-2020 for agricultural edification etc) from government/corporate sector are valued welcome steps to pave path for tomorrows advanced agriculture.

Recipes by CHEF MANJIT SINGH GILL



DRINK: BAJRA RAAB

A healthy drink prepared with Millet, particularly in Rajasthan and Gujarat. Whenever the temperature is below 20°C or 68°F in any region in India or the world, Raab is a healthy drink to keep the body warm. Raab is nutritious and easy to digest. Raab must be prepared with ghee, as it is the only fat which helps the absorption of the nutrients from millet. Both ghee and millet when combined become nourishing food. Traditionally, raab was often given to growing children and pregnant and nursing women for its nutritional value.

4 tablespoons	Pearl Millet flour (Bajara atta)
4 teaspoons	Ghee
1½ teaspoon	Ginger powder (Sounth)
1 teaspoon	Ajwain
¼ teaspoon	Rock salt (saindha namak)
2 tablespoon	Jaggery grated (Gur)
4 cups	Water
2 tablespoons	Walnut chopped (Akhrot)

Preparation:

- Take ghee in a thick bottom deep pan, place on low heat and warm the ghee. Add bajara flour, start stirring immediately, and increase to low medium and continue stirring for 1 - 2 minutes.
- Now add ajwain and ginger powder and stir for 1-2 minutes or until a pleasant aroma of ghee, bajara and ginger powder starts to come.
- Now remove from heat, add rock salt, jaggery powder, and stir.
- Place on low heat and stir continuously to make sure there are no lumps.
- Add water stir quickly, increase heat to medium and continue until the bajara mixture is completely dissolved and the water starts boiling.
- Reduce heat low, stir, and let it simmer for 4 – 5 minutes or the raab is a drinkable texture. Remove from heat.
- Check sweetness, and salt are well balanced.
- Pour in the glass and garnish with chopped walnuts.

Note: Millet flour should not be more than 5 – 6 days otherwise become bitter and change its taste.

In summer Raab can be taken cold. The recipe is slightly different.

Take bajra flour 4 tablespoons, mix it with 4 tablespoons of curd, rock salt, and 1 teaspoon of roasted cumin seeds, and mix it together. Add 2 cups of water and whisk well until no lumps. Bring it on medium-low heat and stir continuously until the mixture started boiling. Reduce heat to low and continue cooking for 4 – 5 minutes or until the texture is drinkable. Should not be thick. Remove from heat and let it cool, stir two or three times. Pour into a glass ¾th, add a tablespoon of curd and mix with a spoon, let there be some curd lumps. If it is thick, may add cold water and mix. Garnish with roasted pounder cumin seeds.

This excellent drink in the morning is like breakfast. Not advised but you may add little ice. It's a yummy salty drink for summer.

CHANDRAGUPTA MAURYA MALPUA

Chandergupta Maurya was the founder of the Mauryan dynasty 321BC – 297 BC and emperor to unify most of India under one administration. He was fond of Malpua at that time it was prepared by combining millet. His favourite sweet dish was Malpua and made of mixing equal quantity banyard millet and ragi.

Ingredients:

½ cup	Banyard millet flour (samak flour)
½ cup	Ragi flour
2 ½ cups	Milk
1 teaspoon	Fennel freshly pounded
A pinch	Rock salt
½ cup	Jaggery powder
Ghee to fry	

Preparation:

- Gently give the milk a boil. Remove from heat and keep aside.
- Take banyard flour, ragi flour in a bowl. Add fennel, and a pinch of rock salt and mix well.
- Start adding hot milk little by little, keep a continuous flow and simultaneously whisk, to avoid lumps and form a smooth batter. The batter should a thick batter of pouring consistency. Cover and let it rest for 15 - 20 minutes.
- Whisk the batter. If it is not of pouring consistency and milk as desired to correct the consistency.
- Heat ghee on medium heat and pour a small ladle full of batter. It will spread to 7.5 – 8.0 cm. Fry malpua on low medium heat until golden brown from both sides. While a frying splash of ghee on top of the malpua. Flip and fry the other side until golden.
- Remove the malpua from the ghee and drain well.
- Take the jaggery powder in a pan and place it on low heat, add 3 tablespoons of water, stir until it starts boiling and continue cooking for 2 minutes. Remove and keep aside. Dip pancakes in the syrup and remove, and keep warm.

Dry fruit Filling

Ingredients:

½ cup	Almonds
½ cup	Pistachios
½ cup	Walnuts
¼ cup	Raisins
¼ cup	Dried coconut
3 tablespoons	Ghee
¼ cup	Powder Jaggery
¼ teaspoon	Black peppercorn freshly pounded
½ teaspoon	Cardamom powder
1 teaspoon	Ghee
4	Silver leaves.

Preparation:

- Soak almonds, and pistachios in enough water for 6 – 7 hours in separate bowls. Soak raisins for 30 minutes.
- Remove the skin of almonds, and pistachios and keep aside. Remove the raisin from the water, squeeze gently and keep aside.
- Cut dried coconut into thin slices.
- Take jaggery powder in a thick pan and add 2 tablespoons of water. Place on low heat, stir and add almonds, pistachios, walnut quarters and pounded peppercorn, stir until the jaggery is completely melted. Let it cook until a one-string syrup or until well-coated almonds, pistachios, and walnuts.
- Add ghee and mix well until ghee dissolves.

Serve:

- Place lightly warm malpua on a plate, a spoon full of almonds and pistachio mixture in jaggery sauce, now arrange one more malpua on top as it is shown in the picture.
- Top it with a sliver leaf.

AZADI KA AMRIT MAHOTSAV
TIME TO REFLECT AND REDEDICATE

For a nation with a very long history spanning several millennia, 75 years is but a small fraction of its life. Yet, this milestone of 75 years from the time of independence from foreign rule and ushering in of democracy in our country is a time for celebration.

Even as we celebrate, let's rest on the milestone a wee bit to introspect about the country's journey of the last seven-and-a-half decades and envision the path forward that will genuinely reflect the true meaning of democracy and the spirit of India. Let's also ponder why we are where we are today and design the pathway we want to traverse in the decades ahead.

India has a long way to go

India is today one of world's fastest growing significant economies. With GDP in excess of USD Three Trillion, we are the 4th largest economy in the world and in terms of PPP (purchasing power parity) the 3rd largest. Yet, there is belief that India has a long way to go before claiming to be an economic superpower.

We enjoy extraordinary endowments of Mother Nature. The entrepreneurial spirit of Indians is well recognized. Yet, our farm sector which provides livelihood to nearly half of the working population has been performing below potential. We have to leverage our strengths to make the country a truly progressive and forward looking economic power of the world for which all the three growth engines – agriculture, manufacturing and services - have to fire simultaneously.

Importantly, agriculture sector deserves to demonstrate sustained and sustainable growth in the coming years as it employs over 50 percent of the country's workforce but its contribution to GDP is 15-18 percent.

Without doubt, our economic growth story, especially of the last two decades, is inspiring. Maybe we could have done even better than what has been achieved, but it is an inspiring story nonetheless. Where have we slipped? While our economy has been recording impressive growth rates for years, the benefits of such robust economic growth have not percolated equitably among large sections of the population. We have growth, but no equity. We need 'growth with equity'. That's the true spirit and interpretation of democracy. We need to lift millions out of poverty, and quickly.

No wonder, India ranks rather low in Human Development Index and rather high in Global Hunger Index. We have to consciously design policies and work towards substantially improving the rank in a time-bound manner. Our social sector policies are as important and as critical as our economic policies and programs.

About the **AUTHOR**

Mr G. Chandrashekhar, Senior journalist , policy commentator, global agribusiness and commodities market specialist

Both education and healthcare are critical for every citizen. So is food and nutrition security. There is tremendous scope to improve our education and health infrastructure as well as improve the nutrition status. This calls for a thorough review of the existing processes and investment priorities.

If rising production of cereals and export has created a smug feeling among policymakers that the country is fully food secure, it is an illusion. While we may not exactly be food insecure today, newer challenges can thwart our food security in the coming years. If not addressed with due urgency, land constraints, water shortage and climate change can throw our farm growth plans out of gear.

Farm Resurgence through Multiple Technologies

The scope to raise land use intensity, to use water more efficiently and to fight the adverse consequences of climate change is immense. For this we need progressive and long-term farm sector policies that encourage research and investment.

Technology infusion is the way forward for resurgence in Indian agriculture. We need to invest and promote use of multiple technologies including information technology (IT), biotechnology (agbiotech), satellite technology (remote sensing), nuclear agri technology, nanotechnology and more. We have proven expertise in these techs; but need supportive policy measures to promote their adoption.

At the same time, urgent attention is needed to address some structural issues that stymie sustained growth in the farm sector. I have coined the following six mantras for farm resurgence:

1. Strengthen and monitor the input delivery system for seeds, fertilizer, agrochemicals and credit;
2. Rapidly expand irrigation facilities;
3. Encourage adoption of scientific pre- and post-harvest practices;
4. Step up public investment in rural agri infrastructure;
5. Use ICT to deliver weather-alerts, price and market information covering input and output markets;
6. Build capacity among growers, especially FPOs, to manage price volatility.

These may appear daunting; but we need to 'catch the bull by the horn'. We need a national policy for farm resurgence with regionally differentiated strategies. As agriculture is a 'State' subject under the Constitution, it devolves on the Union government to engage with all State governments to come up with a national policy for farm resurgence from a long-term perspective. *If Indian agriculture survives, India will survive.*

It is indeed critical to ensure our long-term food security. As important as food security is nutrition security. India's nutrition status leaves much to be desired. The pervasive nature of malnutrition / under-nutrition is well documented. Persistent undernutrition exerts a long-term adverse impact on human health, raises healthcare costs, reduces labour productivity and often leads to morbidity. These are 'invisible costs' for the economy.

As a commodity food can be imported in times of shortage; but not nutrition. Money cannot 'buy' nutrition. So, even as we focus on agriculture production, we have to recognize the nexus between agriculture, nutrition and health. Our farm policies have to adopt an ecosystem approach.

Currently, our policies focus on higher and higher production of food which is important to meet the expanding demand generated by rising incomes and demographic pressure. At the same time, we have to pay attention to improving the 'quality' of the farm produce as well as to strengthen processing, distribution and consumption.

So, let us all celebrate this milestone of 75 years even as we rededicate ourselves to ensuring economic growth with equity and inclusivity in the decades ahead. In a manner of speaking, no one can stop the march of this country. It is in our hands, especially in the hands of the youth of this country, to ensure we live in an egalitarian and inclusive nation that shines as a beacon of inspiration for others.

2047 is not far away. In 25 years from now we would celebrate the Centenary of independence. That celebration should be for complete independence from poverty and depravity while ushering in prosperity and harmony all around.

UNLEASHING THE POTENTIAL OF NUTRI-CEREAL MILLET
RESTORING LOST GLORY

The year 2018 was momentous. When the country was reeling under malnutrition; a silent pandemic and its avatars like, stunting, wasting, anaemia, obesity and overweight and all pervasive micronutrient malnutrition haunting the individual, society and nation; shaped by the determination of India's Prime Minister, the target driven POSHAN Abhiyaan was launched by the Prime Minister. Nutrition started gradually becoming a buzzword. Indian government declared 2018 as the Year of Millets; a bloom in dryland. The fragrance spread at the direction of the wind.

India's proposal to observe an International Year of Millets was approved by the FAO in 2018 and the United Nations General Assembly declared the year 2023 as International Year of Millets. It was an opportunity to restore the lost glory, create awareness on the contribution of Millets to food security and nutrition; inspire stakeholders for sustainable production and enhanced quality; focus on investment in research and development and extension network towards this goal.

Wrong Food Habits

The self-sufficiency in rice and wheat led to insufficiency in macro and micronutrients. Millet could have resisted drought, monsoon fluctuations and minimised the hunger. With change in cropping pattern, food habits, vanishing colours from the plate and heritage diets, India's malnutrition multiplied.

As per National Family Health Survey -5 (2019-21), 35.4 % children are stunted, 19.3% children are wasted and 67% Children under 5 years of age are anaemic. Anaemia is all pervasive. 57% women are anaemic too. The troubling is double burden on malnutrition which indicates a broken food system. 24 % women and 22.9% men are obese and overweight.

The rising double burden on malnutrition and diet related non communicable diseases are an important cause of death and disability. India's children are not spared. As per the CNNS 2016-18, in India, 10.3% of school-age children and 10.4 % of adolescents are found to

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be pre-diabetic.

As per the CNNS, the prevalence of vitamin A deficiency is 18% among pre-school children, 22% among school-age children and 16% among adolescents. Vitamin D deficiency was found among 14% of pre-school children, 18% of school-age children and 24% of adolescents.

Nearly one fifth of pre-school children (19%), 17% of school-age children and 32% of adolescents had zinc deficiency. The prevalence of vitamin B12 deficiency was 14% among pre-school children, 17% among school-age children and 31% among adolescents. Nearly one-quarter (23%) of pre-school children, 28% of school aged children and 37% of adolescents had folate deficiency.

Micronutrient deficiencies which are commonly known as deficiencies of vitamins and minerals are also a major public health problem among women. Micronutrient deficiencies result in low productivity, poor cognitive and physical development, and can lead to morbidity and mortality.

Strategic Directions Needed

Policies and programs related to millets need to align with program delivery and technical effectiveness. It requires collaboration, better technology, convergence, and skilling. The race to improve self-reliant millets systems is spearheaded by sustainable investments in small holder women farmers and food systems. The transformation of inclusive and accountable food systems comes from policy reform that is evidence based and data driven. With a goal on self-reliant millet food systems, following strategic directions are recommended.

Atmanirbhar Millet – Cooperatives to unleash the potential

The country needs Anand pattern three tier, millet cooperatives that can unleash production, processing, marking and value chain strengthening and use breakthrough technology and modern science. The objective is district level self-reliance on millets. I would recommend millets to regain its lost legacy by making up to thirty six percent of all types of cereals produced by 2030. The Market Intervention Operations (MIO) with a guaranteed price band--for both consumers and farmer producers will be necessary for India becoming millet self-reliant. The demand creation through social behaviour change communication methods and product promotions can increase in consumption and crop diversification. The share of the bio fortified millets to the total share in public funded food programs like ICDS supplementary nutrition, targeted public distribution system and mid-day meal program must reach to minimum fifty percent by 2030.

Policies and programs related to millets need to align with program delivery and technical effectiveness. It requires collaboration, better technology, convergence, and skilling

Institutional Arrangements

A national council on millets under the Chairpersonship of the Prime Minister will be a significant milestone. States with high millet production potential may establish a mission as a Centre of Excellence.

Special Action Research Programs

The country needs evidence based research on how millet can be a complementary or primary diet for these children at risk. ICAR, SAUs and other like ICMR, NIN, AYUSH, IIMR, Central Food Technological Research Institute (CFTRI) and ICRISAT may engage in research and collate evidences.

Food Entrepreneurs to Nutrition Entrepreneurs

Future Generation Millet MSMEs:Start-ups, women self-help groups engaged in millet enterprises with working capital, value added technology, trade channel and support price backstopping will have bearing on promoting this nutri-cereal.

Jan Andolan for Millets

The nutrition and health benefits of millets need to be known to each household. It would require harnessing available social capital potentials like Anganwadi Centres, local government bodies, self-help groups, cooperatives and human capitals like Anganwadi workers, ASHAs, ANMs, school teachers and village leaders. India's POSHAN Abhiyaan, Eat Right Campaign , Fit India Movement, press and media must work in tadem to make it a people's movement.

CROP DIVERSIFICATION: SCOPE AND OPPORTUNITIES IN ODISHA

Crop diversification is generally viewed as a shift from traditionally grown less remunerative crops to more remunerative crops with an intention to enhance profitability and resilience of agricultural production system. Crop diversification is the change in crops or cropping systems in an agricultural production system due to various factors like shift in market demand, mitigating ill effects of climate change, utilization of available resources, augmentation of farm income, etc. This is a continuous process adopted by the farmers to get advantage of prevailing situations by minimizing risk posed by unwanted external factors. Crop diversification is influenced by several factors including price fluctuation, change in the market, change in food habit, weather aberrations, emerging crop production technology, etc.

Crop diversification takes into account various economic returns through effective use of natural and human resources with available market opportunities.

About the **AUTHOR**

Prof. Pravat Kumar Roul, Vice Chancellor, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha

Due to globalization, it has become imperative for crop diversification with an objective to enhance total crop productivity in terms of qualitative and quantitative value under varied agro-climatic situations. It is intended to give a wider choice in production of variety of crops in a given area so as to expand crop production related activities.

Crop diversification is an effective means to enhance crop output under different situations. It has tremendous impact on socio-economic condition of the small and marginal farmers in terms of income and employment generation. Normally, there are two approaches of crop diversification such as horizontal diversification and vertical diversification. Horizontal diversification includes addition of new high value crops to the existing cropping systems for improving overall productivity and profitability. Under vertical diversification, emphasis is given on value addition of agricultural produce through processing, packaging and branding in order to enhance the profit.

Several interrelated factors such as local rainfall & temperature, irrigation availability, soil fertility, geographical location, variety grown, agronomic management practices, access to market, etc. influence the outcome of crop diversification.

Odisha situation

In Odisha, rice is the major crop occupying a vast acerage of cultivated area. In the state, the gross cropped area is 83,38,000 ha out of which rice occupies 44.2 % during 2018-19. Pulses are grown in 23.4 % and oilseeds on 7.1 % of the gross cropped area. Besides, fibre crops are grown in an area of 1,73,720

ha, which account for 2.1% of the gross cropped area of the state. Vegetables are grown in an area of 6,44,250 ha in the state.

As an age-old practice, the farmers grow rice crop in upland, medium land and lowland situations. The total cultivated upland area in the state is 29.14 lakh ha out of which upland paddy covers 5.69 lakh ha during kharif season (2018-19). Growing rice crop in the upland results in less or no profit, thereby causing loss to the farmers. It makes them vulnerable to probable risks arising due to drought and water stress condition.

Odisha produces to the tune of 9.36 lakh tonnes during 2018-19. The production figure of pulses and oilseed crops are below the state requirement. The oilseed production scenario is more acute with a deficit of 17.89 lakh tonnes during 2018-19. Hence, it is required to increase the area under pulses and oilseed crops to narrow down the gap between demand and supply.

Issues to address

In Odisha, there are several challenges for promotion for crop diversification due to socio-economic and technological reasons. Such issues are to be addressed while formulating action plan for crop diversification.

- Ensuring food security is the driving factor for the farmers to grow upland rice during kharif season.
- Farmers grow short duration paddy in the uplands to meet the requirement of rice for some social festivals.
- Unavailability of adequate quantity of good quality seeds of oilseeds and pulses restricts the area expansion of these crops.
- Fluctuation in market price is the major reason for reducing area under vegetable crops.
- Uncertainty in procurement by the industry is a bottleneck for area expansion of commercial crops like jute, cotton and sugarcane.
- As a traditional practice, many of the rural farmers opt for growing rice in all types of land.

Scope in Odisha

Growing paddy under upland situation during kharif season is not profitable. The crops like cotton, arhar, groundnut, maize, green gram, black gram, sesame, vegetables, etc. are more profitable compared to the upland paddy crop. In this context, it is prudent to divert a sizeable area of upland paddy for cultivation of non-paddy crops based on the suitability of agro-climatic situation. Apart from higher profit, growing of pulses and oilseed crops under rainfed upland situation enables the farmers to get rid of the risk due to drought and water stress condition. The scope for crop diversification in Odisha is attributed to:

- Odisha has a vast acreage of 29.14 lakh hectare of uplands suitable for maize, pulses, oilseeds, vegetable and other crops.
- The normal annual rainfall of the state is 1451.2 mm, out of which about 78.9% is received during kharif season (June to September). So, various profitable crops can be grown during kharif season under rainfed situation by utilizing the rainwater.
- There is opportunity to grow off-season vegetable crops like tomato, cabbage, cauliflower, radish, etc. during kharif season in the interior districts to fetch higher market price.
- As there is adequate market for flowers in the state; crops like marigold, tuberose, etc. can be grown in the uplands during kharif season to enhance income of rural farmers.
- There is opportunity to enhance production of ginger and turmeric crops in the districts like Kandhamal and Koraput.
- Diversification of upland rice to these crops can be done for enhancing farmer's income.
- The climate and physiographic feature of Nabarangpur, Rayagada, Koraput, Keonjhar, Kalahandi, Kandhamal, Gajapati, Ganjam, Mayurbhanj etc. are favourable for growing maize. So, replacing upland rice with maize can enhance land profitability in these areas.
- There is possibility of growing groundnut during kharif season in the interior districts of the state, which could be the main source of seed for winter planting in the coastal districts.
- Inclusion of pulses as intercrop in rice to ensure food security and improving soil health.

Crop diversification is required to :

- Mitigate ill effects of climate change
- Increase in farm income through adoption of high value crops
- Change in cropping system to maintain soil health
- Provide employment opportunity
- To address the requirements of family need
- Mitigate adverse effects of mono-culture
- Ensure augmentation of income
- Conserve natural resources
- Effective recycling of farm by-product

Most of the small and marginal farmers cultivating the high land prefer to grow paddy for reasons of food security. Partial substitution of paddy through mixed cropping or intercropping should be more relevant to achieve the crop diversification. Mixed cropping of different crops therefore needs to be popularised among the farmers to overcome risk of drought. These crops may continue to be encouraged by way of promoting new varieties and popularising production & protection technologies through field demonstrations.

Emphasis should be given on crop diversification from paddy to non-paddy crops, particularly in uplands of the state. There is scope for increasing the area under non-paddy crops like maize, greengram, blackgram, arhar, sesame, groundnut, cotton, vegetables, flowers, etc. to enhance the profit of farmers. Mixed or intercropping may be given adequate importance to get insurance against crop failure due to climatic aberrations.

CAN QUINOA FARMING IMPROVE THE HEALTH & WEALTH OF INDIA?

Malnutrition, diabetes, and obesity, related diseases are increasing. It is due to a lack of consumption of nutritious food. Foods with more protein, fiber, minerals, vitamins, antioxidants, and health-promoting factors like flavonoids are the need of the hour. Quinoa is a staple food staple that fits the nutritional parameters for food-of-the-moment.

Rice and Wheat Consumption & Production in India

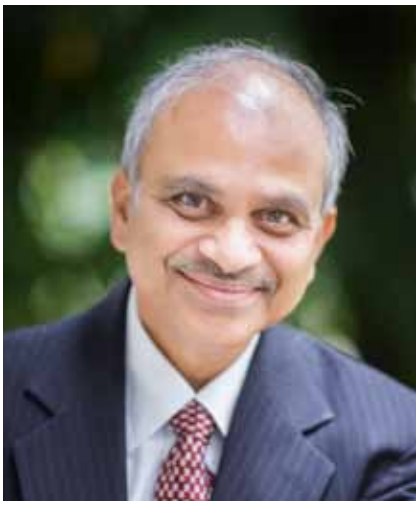
Humans have 20 grains to consume as staple foods. A staple is a food eaten often and in such quantities that it constitutes a dominant portion of a standard diet for a given person or group, supplying a significant fraction of energy needs. As there are significant changes in the lifestyle of people both in urban and rural due to the mechanization of various activities, calorie requirement is less, and the need for nutrients needed for better health is rising. Micronutrient deficiency, also known as hidden hunger, is a significant health problem in the country.

Therefore, there is an urgent need to cultivate new grains that can be used as a staple food with better nutrient profiles.

What is Quinoa

Quinoa is a seed of the plant Chenopodium quinoa and is spinach's close cousin. According to FAO, there are 7,000 edible plants. However, up to 150 crops are cultivated commercially. Only three main crops, rice, maize, and wheat, provide 60% of the world's food energy intake. Many edible plant species are 'Neglected and Underutilized Species (NUS). Quinoa is one of them!

Quinoa has been cultivated in South America for more than 7,000 years. Colonization by Europeans suppressed the crop. But two scientists, Dr. Greg Schlick and Dr. David L Bubenheim, NASA, USA, published that "quinoa has desirable food qualities for long-term space missions — high protein and desirable amino acid composition." The UN's food and Agriculture Organization (FAO) declared 2013 as the International Year of Quinoa as a recognition of the "crop's resilience, adaptability and its potential contribution in the fight against hunger and malnutrition." FAO hopes Quinoa can boost food security and provide economic growth to small-scale farmers as the crop does not demand much soil fertility, water, and la-



About the **AUTHOR**

Dr Srinivasa K Rao, New York, is a biomedical scientist. He engages with GOI to focus on nutrition and health through the improvement of nutritious crops in agriculture. He is persuading the governments of Andhra Pradesh, Telangana, Gujarat, Rajasthan, and Ladakh to start a Quinoa Research Center. In 2016 Dr. Rao founded Granova Naturals India. He introduced science-backed food products that can give better health, like Quinoa, Rice with High Protein and Low Glycemic Index

bor.

Quinoa, Wheat & Rice: Nutritive values

Quinoa's average protein content (> 13%) surpasses that of wheat (12%) and rice (8%). It has high-quality protein and well-balanced amino acids with vitamins and minerals, particularly iron. Quinoa is gluten-free and suitable for people with digestive disorders.

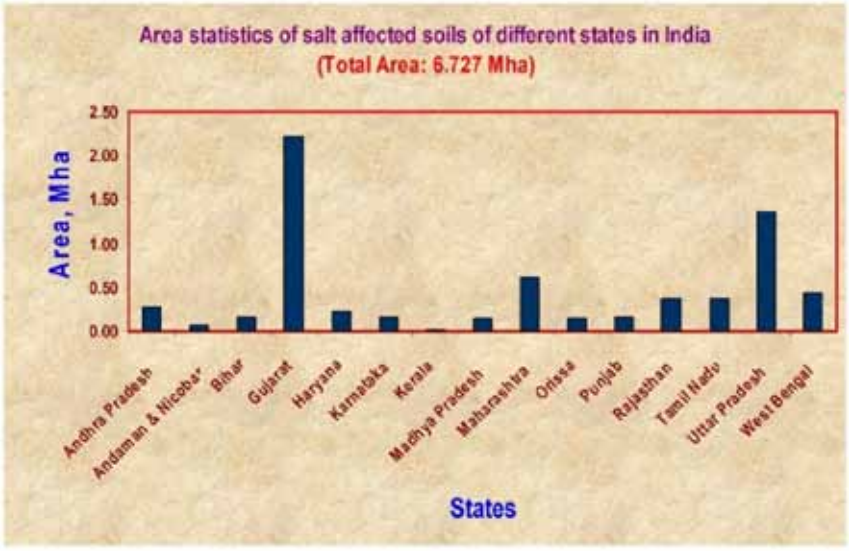
Dr. AA Dixit, Columbia University, New York, reported that "quinoa replacement with one serving of white rice in diet can prevent obesity and cardiovascular disease." It can be consumed like a staple food, replacing wheat or rice, unlike other protein-rich foods.

A million Tons of Quinoa in India by 2025

Quinoa production in India is at a nascent stage, with less than 20,000 tons per year. Large-scale farming can be encouraged if appropriate R&D is taken to improve seed quality and yield and establish pest-resistant varieties. India has 6.727 million hectares of salt-affected lands based on the NRSA and Associates 1996 data. C. quinoa grows well under moderate salt stress (one hundred–200 mM of NaCl) and can withstand a concentration of 400 mM of NaCl. If some of these lands are brought under quinoa cultivation, India can produce more than a million tons of Quinoa per year. Then India can meet not only the country's needs but also export.

Big-Impact Project To Reduce Malnutrition

In 2010, PM Shri Narendra Modi was the chief minister of Gujarat. At that time, he had asked me to take up a project with a Big Impact on India when we discussed the malnutrition situation in India in our meeting in 2010 at his residence in Gandhinagar. In the following two years, I researched whether Quinoa could be that big-impact project to reduce malnutrition and improve health in India. Several students and researchers in India, Bolivia, and The Netherlands helped me



to realize that Quinoa can! Also, with experienced agricultural, and nutritional researchers, I proposed an Indian Quinoa Research Center to the governments of Gujarat, Rajasthan, Andhra Pradesh, Telangana, and Ladakh.

In parallel, I started cultivating Quinoa in 2012 at Araku Valley. After a few years of cultivation, I visited Bolivia and learned how to process the grain for ready-to-cook. We have successfully launched Dr. Quinoa Brand. This brand is instrumental in bringing the price from Rs.1200 per kilo to Rs.200. I published a book on Quinoa Nutrition & Health Benefits. I made it available for free download to encourage people to adopt o quinoa.

I showed that Quinoa could replace rice in all the rice-based recipes. We published the Quinoa Cookbook and made it available for free download. I have been consuming Quinoa as the main staple for the past 12 years. Quinoa farming in India has some teething problems, and if they are addressed well, India can have Quinoa at a very affordable price. Once Quinoa is made affordable to everyone, like rice, its benefits can be seen as reducing malnutrition, obesity, diabetes, and the related disease burden in India.

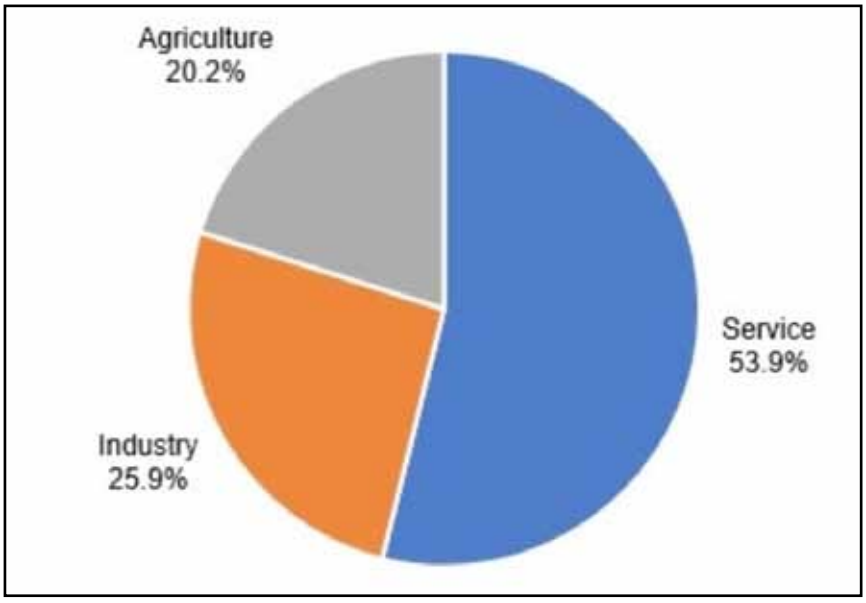
If this approach is adopted for several other crops that are neglected or underutilized healthy India vision can be fulfilled by Indian Agriculture!

NEW AGE DIGITAL AGRICULTURE FOR VIBRANT INDIAN ECONOMY

Agriculture in India is livelihood for a majority of the population and can never be underestimated. Although its contribution in the gross domestic product has reduced to less than 20 per cent as compare to other sectors (Fig 1), the agricultural production has grown. This has made us self-sufficient and taken us from being a begging bowl for food after independence to a net exporter of agriculture and allied products.

According to the World Bank's collection of development indicators, employment rate in the Indian agriculture sector stood at 41.5% in 2020. From a socio-economic standpoint, agriculture is a vital sector which requires focus and awareness at all levels.

In the recent years, the agriculture sector has been facing various challenges such as yield plateaus, soil degradation, water stress, high imports on oilseeds, nutrition deficiency, volatile prices, inadequate infrastructure linkages, post-harvest loss, and information asymmetry. According to a report, India lost approximately 5.04 million hectares of crop area due to cyclones, floods, cloudbursts, and landslides until November 25, 2021. Such calamities have had a severe impact on farmers, especially small farmers who constitute close to 85% of the total farmers in India. Thus, there is a dire need for smart agriculture in India. The Indian government has taken several measures for developing the sector, considering its importance. Notably, the government is exploring ways to enhance agricultural efficiency and profitability of farmers, and to help farmers double their incomes.



Sector-wise GDP in India

Smart farming

More efficient than the traditional methods of farming, smart farming involves the application of sensors and automated irrigation practices and also help to monitor agricultural land, temperature, soil moisture, etc. Smart farming can help integrate digital and physical infrastructures which would benefit small farmers.

One way of enhancing farmer in-

Anup Kalra

Mohan Ji Saxena

About the **AUTHORS**

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comes is the use of Digital Technologies to increase the overall efficiency of the agricultural production processes as well as the entire value chain. They no longer need to apply water, fertilizers, and pesticides uniformly across entire fields. Instead, they can use minimum quantities required and target very specific areas, or even treat individual plants differently. It is worth-mentioning that modern farming methods are a combination of high yielding varieties (HYVs) of seeds, chemical fertilizers, pesticides, irrigation, etc. By using these methods Indian farmers will be able to produce much greater amounts of grain on a single plant. From gene sequencing in seed production to Internet of Things (IoT), networks of implements and sensors that generate data and image recognition technologies that assay and grade crops and commodities, the future of food is unequivocally digital, and the future of digital is inevitably AI (Artificial Intelligence).

AI applications

They are being deployed across different aspects of agriculture. This took the shape of official government policy after the clarion call of the Prime Minister of India to double farmers' incomes and the subsequent budget announcement to this effect. Artificial intelligence is based on the principle that human intelligence can be defined in a way that a machine can easily mimic it and execute tasks, from the simplest to even more complex manner. The industry is turning to Artificial Intelligence technologies to help yield healthier crops, control pests, monitor soil, and growing conditions, organize data for farmers, help with the workload, and improve a wide range of agriculture-related tasks in the entire food supply chain

More efficient than the traditional methods of farming, smart farming involves the application of sensors and automated irrigation practices and also help to monitor agricultural land, temperature, soil moisture, etc.

Applications

- Weather Forecasting: With the change in climatic condition and increasing pollution it's difficult for farmers to determine the right time for sowing seed, with help of Artificial Intelligence farmers can analyze weather conditions by using weather forecasting which helps them to plan the type of crop that can be grown and when should seeds be sown.
- Soil & Crop Health Monitoring System: The type of soil and nutrition of soil plays an important factor in the type of crop grown and the quality of the crop. A German-based tech start-up PEAT has developed an AI-based application called Plantix that can identify the nutrient deficiencies in soil including plant pests and diseases by which farmers can also get an idea to use fertilizer which

helps to improve harvest quality. This app uses image recognition-based technology. The farmer can capture images of plants using smart phones. We can also see soil restoration techniques with tips and other solutions through short videos on this application. Similarly, Trace Genomics is another machine learning-based company that helps farmers to do a soil analysis. Such type of apps helps farmers to monitor soil and crop's health conditions and produce healthy crops with a higher level of productivity.

- For crops, SkySquirrel Technologies has brought drone-based Ariel imaging solutions for monitoring crop health. In this technique, the drone captures data from fields and then data is transferred via a USB drive from the drone to a computer and analyzed by experts.
- AI is also helpful in precision farming & predictive analytics which help farmer about inaccurate and controlled farming by providing them proper guidance to farmers about water management, crop rotation, timely harvesting, and type of crop to be grown, optimum planting, pest attacks, and nutrition management.

Remote Sensing

The application of remote sensing in agriculture can help in the evolution of agricultural practices that face different types of challenges by providing information related to crop status at different scales all through the season. When farmers observe their fields to assess their condition without physically touching them, it is a form of remote sensing. Observing the colors of leaves or the overall appearances of plants can determine the plant's condition. Remotely sensed images taken from satellites and aircraft provide a means to assess field conditions without physically touching them from a point of view high above the field.

Remote Sensing and agriculture go hand-in-hand. The basic working of this technology with UAVs, satellites, and other platforms is almost the same. Energy, in the form of light, will travel from sun to Earth. Light waves travel virtually like ocean waves. The wavelengths that are used for agricultural applications cover a small amount of the electromagnetic spectrum. When electromagnetic energy hits the plants during hyperspectral remote sensing in agriculture, one of three things can occur. The energy will be reflected, absorbed, or transmitted, depending on the wavelength of the energy and the characteristics of the plant itself. The reflected, absorbed, and transmitted energy can be detected by remote sensing technology.

The relationship between the three occurrences determines the spectral signature of the plants. This signature is unique to different plant species. Remote sensing farming helps identify stressed areas by determining the spectral signatures of plants that are healthy.

Applications

- **Monitoring of vegetation cover:** It helps in crop classification, crop acreage estimation and yield assessment. In relation to the crop condition, some remote sensing techniques are more focused on physical parameters of the crop system such as nutrient stress and water availability in assessing the crop health and yield. The most commonly used index to assess the vegetation condition is the Normalized Difference Vegetation Index proposed by Rouse et al., (1974). Hadria et al., (2006). It provides an example of developing leaf area indices from four satellite scenarios to estimate distribution of yield and irrigated wheat in semi-arid areas.
- **Crop Condition Assessment:** It also plays major role by providing timely spectral information which can be used for assessing the Biophysical indicators of plant health. The physiological changes that occur in a plant due to stress may change the spectral reflectance/emission characteristics resulting in the detection of stress amenable to remote sensing techniques. The crop growth stages and its development are influenced by a variety of factors such as available soil moisture, date of planting, air temperature, day length, and soil condition. These factors are responsible for the plant conditions and their productivity.
- **Nutrient & Water status:** Detecting nutrient stresses helps in site specific nutrient management through which cost of cultivation can reduce as well as increase the fertilizer use efficiency for the crops. The spectral reflectance in the visible region was higher in water stressed crop than the non-stressed.

For example, drip irrigation coupled with information from remotely sensed

data such as canopy air temperature difference can be used to increase the water use efficiency by reducing the runoff and percolation losses. Under the conditions of wet tropical and subtropical climates, the risk of nitrogen leaching is more due to spatial variability of soil properties, such as: SOM content, water content and yield zones which are having effects on the N nutrition status of corn plants in the field. This causes the failure of traditional single-rate N fertilization (TSF) which could over-fertilize some sites while other sites may be under-fertilized. This promotes the use of variable-rate nitrogen fertilization (VRF) based on crop sensors which could increase the N fertilization efficiency. Such information when linked with GPS will provide promising results which are more helpful in precision farming. Along with these, remote sensing is also helpful in weed identification & management, pest & disease infestation, etc.

Drones

Drones are Unmanned Aerial Vehicles (also known as UAVs), which are used for surveillance in various industries such as mining and construction, army, and hobbyists. But now, drone technology is increasingly available for use in various sectors of agriculture as well. This emerging technology can help reduce time and increase the efficiencies of the farmers.

Applications

- **Soil & field analysis** through sensors evaluate moisture content in the soil, terrain conditions, soil conditions, soil erosion, nutrients content, and fertility of the soil.
- **Crop surveillance:** Supervision of crop progress from the time seeds are sown to the time for harvest. This includes providing fertilizers at the right time, checking for pest attack, and monitoring the effect of weather conditions. Crop surveillance is the only way that a farmer can ensure a timely harvest, especially when dealing with seasonal crops. Any errors at this stage can result in crop failure. It also helps in understanding and planning for the next farming season. It can help in effective crop surveillance by inspecting the field with infrared cameras and based on their real-time information, farmers can take active measures to improve the condition of plants in the field.
- **Plantation:** Drones can help in planting trees and crops, which was done by farmers before. This technology will not only save labor but also help in saving fuels. It is expected that budget-friendly drones will be used instead of huge tractors, as they emit harmful gases and pollute the environment in the process.
- **Crop Spraying:** Drones can be used to spray chemicals as they have reservoirs, which can be filled with fertilizers and pesticides for spraying on crops in very little time. It is especially effective in reducing the overuse of pesticides, insecticides, and other chemicals. It can detect minute signs of pest attacks, and provide accurate data regarding the degree and range of the attack. This can help farmers calculate the required amount of chemicals to be used that would only protect the crops rather than harming them.
- **Geofencing:** The thermal cameras installed over drones can easily detect animals or human beings. So, they can guard the fields from external damage caused by animals, especially at night.

Technological interventions through IoT (Internet of Things, system that is built for monitoring crop field with the help of sensors like light, humidity, temperature, soil moisture, crop health, etc. and automating the irrigation system), machine learning, wireless communication, deep learning etc. which make farming a fully automated mechanism, will surely help in increasing the return from the soil while strengthening the soil's fertility.

Recipes by CHEF NATASHA GANDHI

RAGI PANCAKES

Makes 6

Ingredients

1 Cup Ragi Flour
1/4 tsp baking soda
1/4 tsp baking powder
4 tbsp Jaggery
pinch salt
1/2 Cup Milk (plant based milk)
1/2 Cup Curd (dairy free curd for vegan)
1/2 tsp oil

Method:-

For batter
In a bowl add all the dry ingredients, ragi flour along with baking soda, baking powder, pinch salt and jaggery
Next create a well in the centre and add milk, curd and oil
Mix into a lump free batter
In a hot pan pour the batter to form pancakes
Once you see bubbles on one side flip and cook on both sides
Serve with fruits of choice, nuts and seeds and top with honey or maple syrup
You can also create savoury pancakes by skipping the jaggery, and adding in chopped onion, coriander and fry spices like red chilli powder and jeera powder

ONE MINUTE MILLET COOKIE IN A BOWL

Ingredients

1/2 cup Foxtail millet flour (or Jowar flour)
1/4 cup coconut sugar
1/2 cup chocolate
1/2 tsp vanilla
1/2 tsp baking soda
1/4 cup plant based milk
1/2 cup hazelnut butter or any nut/seed butter

Method:-

In a bow Mix all the ingredients
Transfer to small serving bowls which can can be microwaved
Garnish with chocolate chips
Microvawe the bowl at high for 1 min.

Or you can bake at 175° C for 12-15 mins.

MILLET EMPANADAS

For the base wrapper
1. In a bowl add 1 cup jowar flour, 1tbsp oil and pinch salt. Mix this with 1 cup hot boiling water.
Once slightly cooled, knead into a medium dough and let it rest for 15-20 mins covered with a cloth

2. For the filling, heat 1 tbsp olive oil in a pan, saute 1 tbsp chopped garlic along with 4 chopped tomatoes. Cook till the tomatoes are soft and well cooked
3. Add salt, pepper and oregano as per taste along with red paprika.
4. Add 1/4 cup boiled corn, 1 tbsp cheese spread along with 1 tbsp ketchup and give it a good mix.
5. Now shape the dough into equal sized balls and roll it out thinly using a parchment paper.
Using a round cutter, cut the shape
Add the filling in the centre
Apple water on the edges and turn over from one end to create a semicircular pocket
To seal the edges take a folk and create impressions thereby giving it a pattern aswell
6. Shallow fry these or Air Fry them for 20 mins at 160 degree Celsius
Serve Hot

ITALIAN STYLE PROSO MILLETS

Serves 4 people
Preparation Time: 30 mins

Ingredients:

1/4 cup Proso Millet
1/2 Cup water
Salt as per taste
1 fresh Sprig of Oregano or 1/2 tsp dried oregano
1 tbsp olive oil
5 garlic cloves
2 large tomatoes
1/2 tsp black pepper powder
1/2 tsp red chilli powder
1/ tsp tomato ketchup
1/2 cup vegetable of choice
Olive and baby tomatoes and basil to garnish

Method

1. In a Pan add 1/4 cup proso Millet or any millet like kodo, Barnyard or even Quinoa. Add 1/2 cup water, salt as per taste and a sprig of fresh oregano, cover & cook for 20 mins on med flame. Once ready, keep aside to cool down.
2. To make the base, In a pan on med heat, add 1tbsp olive oil, 4-5 garlic minced, 2 large chopped Tomato & saute.
3. Once the tomatoes are slightly cooked add Salt as per taste, 1/2tsp black pepper & 1/2tsp red chilli powder along with 1tsp tomato ketchup & fresh oregano.
4. Saute for 1-2 mins & add the vegetables. I have added 1/4 cup carrots & 1/4 cup celery stalk, along with some olives, baby Tomatoes & celery leaves.
5. Serve hot & enjoy

KODO MILLET VEGAN KHEER

Serves: 4 people
Preparation time: 25 mins

Ingredients:

To make almond milk
1 cup soaked blanched Almond
2 cups water

For kheer
2 cups of Homemade Almond Milk
2 tbsp raw cane sugar
1/4 cup soaked kodo millet
Pinch elaichi
Few saffron strands

Method

Soak the Kodo Millet in water for 2-4 hrs
To Extract fresh Almond milk, by add blanched almonds along with water in a mixer, pour the blitzed mixture into a Muslin cloth and squeeze all the liquid
The pulp can be used to make kebabs, Add in Rotis or to make a Halwa
Pour the almond milk in a saucepan, let it reach a boil, on medium flame
Once boiled, add remaining ingredients & keep Cooking on med flame by continuously stirring till it reduces and the millet cooks
Garnish with nuts and seeds
Serve Hot or Cold

RAINFED AGRICULTURE
Challenges And Opportunities

The rainfed regions which includes dryland and rain fed agriculture, support 40 per cent (~53 crore) of human population of the country. Besides, these regions also support, two thirds of livestock (64% cattle, 74% sheep and 78% Goat). It also provides livelihood to more than 19 million rural population of rainfed regions. In term of agricultural products, rainfed agriculture contributes to 60 % of value of agriculture GDP of India. In the drier region livestock, particularly small ruminants play vital role in sustaining the livelihoods of poor farmers.

Of the total 127 NARP zones, 73 are predominantly rainfed which currently constitute 55 per cent of the net sown area of the country. Even after realizing full irrigation potential, about 50 per cent of the cultivated area will continue to remain rainfed. On contrary, agricultural production is more diverse in terms of commodities which is nearly 40 percent of the total food production of country. A total of 89% of Millets, 88% of Pulses,73%

of Cotton, 69% of Oilseeds and 40% of rice are the major agriculture commodities contributed in national food stock.

The rainfed areas are highly diverse in rainfall which ranges from below 500 mm to 1600 mm annually. These areas face all kind of weather aberrations those affect agricultural productions in one way or other and sometimes long dry spell or uneven distributions of rains lead to complete failure of crops. Thus, scarcity of sufficient moisture even though in high rainfall areas due to erratic behavior of rainfall, heavy rainfall for a few days, uneven distribution of rains, long dry spells, high temperature creates water scarcity which leads to complete or partial failure of crops.

Challenges

Low productivity: 1.1 tons/ha versus 2.8 tons/ha

Rainfed agriculture is complex, highly diverse ranging from resource rich areas to resource constrained areas and dry areas which is quite challenging to have high productivity. In dryland Farming low nutrients content in soils, soil erosion, poor water holding capacity, poor quality water & deep underground water, extreme temperatures, low and erratic rainfall are serious challenges. Frequent long breaks in monsoon during crop growth period often lead to water stress. When expectation to have good crop is uncertain , farmers invest minimum in inputs. Thus, the productivity in rainfed areas remain low in comparison to favorable environment

Non- availability of Fodder

Two third livestock is part of this system which largely face scarcity of fodder, particularly green fodder. Most of the crops grown in the region during monsoon season are short duration and have low biomass production. The crops are generally grown for food purposes and only a very small area is under green/ dry fodder crops. The open field grazing is also slowly coming down as *'Charagah lands'* are being diverted in alternate uses. Summer migration of animal herds from these areas to irrigated region where fodder is in abundance has become a common sight.

Socio - economic factor

In rainfed areas particularly in dry areas - farming is subsistence and not growth oriented. Lack of poor infrastructure like road, electricity, rail connectivity etc., hinders the economic activities. Even though, resourceful people hesitate to invest because of poor repaying capacity which results in low investment on inputs of farming due to uncertainty in good and successful crops.

Opportunities

Keeping in view of the large population

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in rainfed areas, the Central and State Governments have launched a number of development schemes to create the opportunities and some of the important schemes are

- National Mission for sustainable Agriculture (NMSA)
- Rainfed Area Development (RAD)
- Pradhan Mantri Krishi Sinchai Yojana (PMKSY)

Besides these major central schemes, the Union Government has exclusively established statutory body National Rainfed Area Authority NRAA which is mandated to develop various programmes for rainfed areas for holistic development and create opportunities for participation of larger rural population in these programmes.

Improved agricultural technologies: The major emphasis is given to develop climate resilient short duration varieties of predominant crops of the region like 60 days maturity hybrid Bajra, Moong, Moth, Cowpea, early maturing and stress tolerant varieties of Guar, Barley, Wheat, Mustard, Groundnut, Seed species and Napier and other multi-cut grasses. Similarly in improved seeds, vegetables and planting materials of horticultural crops give better returns in limited number of irrigations. A good number of fodder tree species have also been identified. These fodder trees are fast growing and a good source of fodder for Goat, Sheep and Camel, while cattle & buffalo are largely depended on dry fodder of crop residue.

Resource Conservation technologies: Emphasis is laid on conservation agriculture or with minimum tillage agriculture, plasticulture and other crops residue mulching to conserve moisture and better control of weeds, protected agriculture to earn more profit from less space.

Rain water harvesting: Rain water harvesting is most common activity popular among the farmers as government provides subsidy to develop water ponds/ diggies. Generally ponds are lined with high density HDPE sheet which is cost effective. The rain water harvested used to save the crops when there is prolong break of monsoon or when monsoon withdraws early or for rabi crops. It is boon for the farmers involved in protected cultivation. There are many farmers in region using these structures successfully to conserve the rain water for raising the crops. Other important technology in irrigation technology that most of farmers in rainfed areas are using is micro-irrigation method; both drip and sprinkler irrigation gaining popularity.

New Industry: In the rainfed areas particularly in low rain fall areas like Rajasthan where land cost is considerably low, there are great opportunities for new industry. Establishment of industries in these areas will lead to various other development activities. Thus, a lot of job opportunities will be created for local people. The waste land can be used for solar energy generation while developing Solar Parks ; Rajasthan Government has taken various initiatives to promote solar energy generation.

Integrated Farming: It is characteristics of rainfed farming to have mixed crops cultivation, but now mechanization plays important role not only in timely sowing but also in inter cropping. However, diary based farming system need to be adopted. As of now, a number of desi cattle breeds are identified which can withstand harsh climate of desert. Sheep and Goat can be also included in system.

Conservation agriculture offers a new paradigm for agricultural research and development different from the earlier one, which mainly aimed at achieving specific food grains production targets. A shift in paradigm has become a necessity in view of widespread problems of resource degradation, which accompanied the past strategies to enhance production with little concern for resource integrity. Integrating concerns of productivity, resource conservation and quality and environment is now fundamental to sustained productivity growth. Developing and promoting CA systems will be highly demanding in terms of knowledge base. This will call for greatly enhanced capacity of scientists to address problems from a systems perspective; be able to work in close partnerships with farmers and other stakeholders and strengthened knowledge and information-sharing mechanisms. Conservation agriculture offers an opportunity for arresting and reversing the downward spiral of resource degradation, decreasing cultivation costs and making agriculture more resource – use-efficient, competitive and sustainable. 'Conserving resources – enhancing productivity' has to be the new mission.

GROWTH VS PROFITABILITY FOR AGRI START-UPS

It is a remarkable time for the start-up industry in India, with a 15400% growth in the number of start-ups making their foray into the market. The toughest steel has to pass through the hottest furnace, and how many start-ups survive the heat of the industry will reveal a winning strategy. However, the biggest challenge a start-up will sooner or later face is to balance growth and profitability. In reality, this balancing act shifts throughout the life of a start-up coupled with changes in the economy. Growth creates more valuation than profitability alone, but focusing on growth alone may create expectations that may soon become unrealistic.

CHALLENGES START-UPS FACE AND WAYS TO BALANCE THE GROWTH VS PROFITABILITY ACT

Loving your idea

The first big challenge revolves around the 'pitch' itself and how easy it is to fall in love with your vision. A careful analysis of start-ups that failed to make it big will reveal this fallacy. Whether an idea is good, works, and is sustainable is not meant for the boardroom. The market proves you right or wrong. Once you fall in love with your idea, you will struggle to iterate, test, and evaluate the product, objectively. Returning to the sketch pad to re-imagine the problem and solution in a way that fits your needs will be much more challenging

Replicating Business Ideas

Most Agri start-ups, at times, try to emulate successful models in other countries. When they do not factor in local conditions or cultural nuances, it could be a direct route to failure. For instance, the fragmented land-holding Indian farmers

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lowers their buying power. Any new service/product at an added cost could be beyond the access of the Indian farmer. They will not be able to afford it. Many start-ups fall apart once they add a price to their offerings. Affordability is a critical matrix in Indian agriculture, and Start-ups should consider the affordability of their offerings from launch day while evaluating their ideas. You may achieve growth initially by offering freebies, but the growth story in such scenarios is short-lived. The model collapses once the focus shifts to return on investments.

The Expectation game

Once a start-up builds its story only on growth, it ends up setting expectations that soon become unrealistic. Booming success in the initial stages always comes with the pressure of expectations. Even when success is short-lived, expectations can be endless. Profitability and sustainability are the winning play and come with consistent efforts. Therefore, startups must focus on profit strategies and set up controlled expectations, keeping in view their ground reality.

Managing Finances

Once income increases, so will expenditure. In the initial stages, start-ups rely heavily on investors for their finances. Once the fundraise comes through, most start-ups utilize the finances to achieve growth at a cost. A "Cash burn" reliant business model is doomed to fail sooner or later. Cash burn erodes capital, and reliance on further fundraises at investors' terms becomes imperative. This vicious circle engulfs most start-ups that do not focus on profitability. They fail to survive. Thus, it becomes cardinal for start-ups to have profitability as a matrix to measure the growth from the initial stage itself.

Generalising & Stereotyping

Start-ups in the agri space, while developing their business model, err in stereotyping the entire market. For want of meteoric growth, the companies assume the Agri markets across different geographies behave similarly. This assumption is untrue. Indian agriculture is very diversified, and thus a one size fits all approach doesn't work. For the success of an idea, the execution strategy must be well-defined at a granular level. There are no quick and easy ways to doing this but a sustained, focused approach to a market-centric offering that is accessible and affordable.

How do start-ups ensure a sustained effort toward profitability?

The balancing act between Growth and Profitability becomes critical for a start-up's survival. These are some of our learnings from sustaining a profitable business from the very first year:

Focus on profitable business streams – It is quite common for the start-up looking for growth to offer secondary products/services even when they don't break even. However, the smarter play would be for the start-up to focus on developing and nurturing profitable business streams and let go of products & services that are not profitable. Another simple practice is maintaining a service/product-wise P&L statement which is reviewed regularly.

Be Wary of Low hanging fruits – Each sector has its version of low-hanging fruits. While experimenting, it is easy to get carried away with initial success and declare the business a successful model. Growth must be gradual and effective for it to be established as a successful business model. No matter how tempting it seems to declare your model successful for the attention one receives, hold on till you have attained some success in solving real problems.

Limit experimentation – Trying new ideas is exciting and interesting. The initial phase also allows for experimenting and trying multiple ways of doing business, but it is essential to understand that each experiment requires time, energy and resources. Hence, it is necessary to be mindful of what allows for the substantial growth of the business. Changing your business model and approach frequently is a recipe for disaster. It is advisable to focus primarily on a core business offering. If you wish to offer a bouquet of services to your clients, which is essential in the Indian context, where the business margins are low, restrict yourself to one or two ideas only in a year. Anymore is a dilution of one's resources.

Focus on Technology – Agritech is grabbing a lot of attention these days and rightfully so. There is a lot of opportunity and possibility in Agtech. However, it is easy to turn your attention to the front end of user experience design while ignoring the back-end processes, which are crucial for delivering the commitments. Start-ups need to have a balanced approach to their internal processes and the UI/UX of products, so scalability is possible as volumes grow.

There are no straight answers to entrepreneurship. If the model works, the team dynamics may change, new technology may disrupt the ways of doing, or new policies might impact your work. Change is constant in the industry, and developing a business is a continuous process of learning, unlearning, and relearning. Your ability to adapt and learn is crucial for a winning strategy and as start-ups, we need not learn from our own mistakes. We can learn a lot from the ecosystem. Small mistakes can be costly to a start-up with limited resources and evaluating successful/ struggling/ failed models diligently can help start-ups complete the learning curve quickly. Learning from the ecosystem gives start-ups a competitive edge and allows them to create offerings in terms of products/ services better than earlier contemporaries. A product that solves for a real need, is affordable, accessible, and designed to ease lives will always win. Our purpose must be to ensure sustainable growth that can bring value to each stakeholder.

Recipes by CHEF HARPAL SINGH SOKHI

SAMA PANCAKE

Ingredients	Quantity
For Batter	
Sama rice flour	1 cup
Almond powder	¼ cup
Curd	2 tbsp
Powdered sugar for frosting	2 tbsp +
Sendha namak	a pinch
Baking powder	½ tsp
Water	as required
For Making Pancake:-	
Butter	2 tbsp
Mix berries chopped garnish	¼ cup + for
Honey	¼ cup

Method:-

For batter

1. Take a mixing bowl and add Sama rice flour, almond powder, curd, powdered sugar, sendha namak, baking powder and water as required mix it well and batter should be in thick consistency.
2. Now let the batter rest for 15 mins.
3. Meanwhile set a tawa on low heat.
4. Further check the consistency of the batter and add water mix well.
5. In a tawa add butter and pour small droplets of batter and cook on low to medium flame for 1-2 mins and carefully flip and cook another side.
6. Remove in a serving plate.
7. Garnish with honey, powdered sugar and mixed berries.
8. Serve immediately.

THALIPEETH

Ingredient	Quantity
Whole Wheat flour	¼ cup
Jowar Flour	½ cup
Rice Flour	¼ cup
Bajra flour	½ cup
Besan/ Chickpea Flour	¼ cup
Ajwain	¼ tsp
Cumin seeds	½ tsp
Sesame seeds	1 tbsp
Onion chopped	1 no.
Ginger- garlic paste	1 tsp
Green Chillies chopped	2 no.
Turmeric powder	½ tsp
Red Chilli powder	1 tsp
Coriander powder	1 tsp
Garam Masala	1 tsp
coriander, chopped	1 tbsp
Salt	to taste
Water	as required
Oil	for cooking
Yogurt	¼ cup

Method:

1. Mix all the ingredients (except oil) together to make soft pliable dough, Knead and leave for few minutes and keep aside.
2. Take water in a bowl and heat a non stick pan.
3. Divide into small balls, apply water in the palms and pat into flat patty.
4. Heat a tawa and place the thalipeethi , Make a hole in the center. Repeat the procedure for remaining dough.
5. Pour oil on the cooked thalipeeth and cook well from both sides.
6. sprinkle water and cover immediately cook for few minutes
7. Serve with a dollop of ghee on top and yoghurt on the side.

MULTIGRAIN PALAK CHILLA

Ingredient	**Quantity**
Besan (gram flour)	1 cup
Multigrain Flour	1 cup
Yogurt	½ cup
Spinach (Palak) Puree	½ cups
Turmeric powder	½ tsp
Carom seeds (Ajwain)	½ tsp
Asafoetida (Hing)	¼ tsp
Salt	to taste
Water	as required
Oil	for cooking
Red chilli powder	for sprinkle
For Mixture:	
Paneer grated	1 Cup
Onion chopped	1 no. (Small)
Ginger chopped	1 tsp
Green Chilli chopped	2-3 no.
Red chilli powder	1 tsp
Salt	to taste
Coriander chopped	1 tbsp

Method:

1. In mixing bowl add paneer grated, chopped ginger, green chilli, red chilli powder, salt, chopped coriander, and onion, mix well and keep it aside.
2. In another mixing bowl, add besan, multigrain flour, yogurt, spinach puree, turmeric powder, ajwain, hing, salt and water gradually, mix well and make like a dosa batter.
3. Heat tawa on medium flame, add 1 tsp of oil and spread all over.
4. Take a spoonful of batter and spread it evenly like dosa.
5. Add a spoonful of Paneer mixture on the chilla.
6. Drizzle little oil and allow it to cook on a low flame till crisp.
7. Once cook fold the chilla and remove it on the plate, sprinkle some red chilli powder on top and cool it in room temperature than pack in Tiffin and serve.

MULTIGRAIN BARFI

Ingredient	Quantity
Ghee	4 tbsp + for greasing
Cashewnuts chopped	1 tbsp + for garnish
Almond chopped	1 tbsp + for garnish
Pistachio chopped	1 tsp + for garnish
Ragi Flour	¼ cup
Besan	¼ cup
Jowar Flour	¼ cup
Bajra flour	¼ cup
Rajgira Flour	¼ cup
Wheat Flour	¼ cup
Nutmeg Powder	a pinch
Green Cardamom powder	1 tsp
Black pepper crush	½ tsp
Ginger powder	½ tsp
Jaggery	1 cup
Khoya	1 cup
Water (warm)	2-3 tbsp
Dried Rose Petals	¼ cup for garnish.

Method:

1. Heat ghee in a pan, ragi, besan, jowar, bajra, rajgira and wheat flour, mix well and sauté for 10-12 min. on low flame.
2. Now add jaggery and mix it well.
3. Then add Khoya and warm water mix it well.
4. Further add half of the chopped nuts, black pepper crushed, nutmeg, cardamom and ginger powder mix it well.
4. Grease the mould/tray with ghee and add dried rose petals and chopped nuts.
5. Transfer the prepared mixture on the greased mould/tray, pat to level and keep it aside for 2-3 hour.
6. When cool and set, unmould and cut into desired sized pieces, garnish with dried rose petals, nuts and serve.

CROP RESIDUE
THE BEST SOURCE FOR IMPROVING ORGANIC MATTER IN SOIL

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Presence of organic matter (OM) is crucial for maintaining high quality of agricultural soil for supporting good growth and productivity of crop plants. It greatly contributes towards soil fertility, aeration, improving infiltration of water and capacity to retain it for longer duration, supply of essential nutrients and having buffer capacity to resist pH shifts. Percentage of OM is just 0.2-0.5, which is quite low, in agricultural soils of Indo-Gangetic Plains (IGP-mainly Punjab, Haryana and Uttar Pradesh), says the World Food Prize recipient soil scientist Dr. Rattan Lal, whereas it is between 3 and 6 percent in American soils as per a fact sheet published by the Cornell University.

Crop residue (CR) is major source of OM when mixed with soil for composting

Primarily, CR is composed of chemical constituents like cellulose, hemicelluloses, lignin, pectin, sugars, amino acids, aliphatic acids, proteins, nitrogenous material, fats, oils, waxes, pigments and inorganic waste. When mixed in soil, CR content are degraded and converted into humus which is stable organic matter. It reduces soil toxicants and promotes

plant growth through increased population of plant growth promoting bacteria and providing nutrients through sequestration from soil. Bacteria, fungi or algae are the agents that generally help to degrade complex biomass substances into simpler ones through aerobic and anaerobic processes. Anaerobic digestion converts CR biomass into biogas leaving solid substances as nutrient rich fertilizers. Mineralisation and availability of nutrients for use of plants becomes possible in due course of time because of complexities involved in different biological processes involved in soil nutrient cycles. On an average CR is rich source of nitrogen (80%), phosphorus (25%), sulphur (50%) and potassium (20%) and can enrich the soil with these elements. If retained in soil, CR facilitates reduction of use of chemical fertilizers and is useful in eco-friendly organic farming.

Huge quantity (about 140 Mt out of total 500 Mt) of CR mostly of rice, wheat and sugarcane remains surplus after its use as fibre and fuel in the country which should be used to enhance OM in soil. But according to Ministry of New and Renewable Energy, about 92 Mt out of the surplus CR is burnt. Of the burnt CR, around 43 % is of rice, 21 % of wheat, 19 % of sugarcane and around 5 % of oilseed crops. From 8-80 % of paddy residue is put to fire across the states of the country. Because of large scale burning of paddy straw, environmental pollution has become a serious cause of concern during the months of October and November every year. As estimate by The Energy and Research Institute (TERI) shows that burning of CR in situ releases about 627 Kilo tonnes (Kt) of particulate matter (PM) and 4677 Kt of carbon monoxide to atmosphere annually in India. The burning of one tonne of paddy straw alone releases 3 kg PM, 60 Kg of CO, 1460 Kg of CO2, 199 Kg ash and 2 Kg SO2. Burning of CR emits greenhouse gases and other pollutants such as non-methane hydrocarbons, volatile and semi volatile compounds as well as increases the level of PM in the air. Fine PM with less than 2.5-micron aerodynamic diameter can remain suspended in air for longer time and after getting in contact with nitrogen oxides, sulphur oxides, smoke etc. form smog which causes serious health hazards. The smoke emitted by paddy straw burning with onset of cooler weather in November get mixed with fog, dust and industrial pollutants forming thick haze over the region. Every year National Aeronautics and Space Administration (NASA) releases aqua satellite captured images showing thick haze and fog blanket over the region showing high magnitude of seriousness of the problem. The problem however, continues and has drawn the attention of the highest court, central and state governments of the country leading to constituting a Commission on Air Quality Management (CAQM) under the legislation passed by the Parliament last year to deal with all the issues related to such air pollution.

CR Management

The Ministry of Agriculture and Farmers Welfare formulated a National Policy for Management of Crop Residue (NPMCR) in 2014 emphasising (i) promotion of technologies for utilization and in situ management of CR (ii) expanding use of relevant machineries (iii) monitoring through satellite-based technologies and (iv) promotion of innovative ideas, multidisciplinary approaches and funding suitable projects. In the very next years in 2015, the National Green Tribunal (NGT) banned the CR burning in Rajasthan and IGP and directed the states for curbing the problem through recycling the CR and spreading awareness among farmers. Stepping up efforts and prioritising CR management in pursuance of NPMCR have met with varying degree of success. A rational appraisal of policy interventions and their implementation by various agencies of the central and state governments brings out some grey areas for making suitable amendments to push up the slow speed of progress made and results achieved so far. Evaluation of impact of various initiatives, it emerges clearly that much more can be achieved through better coordination and educating agricultural community about the good practices for CR management.

As part of conservation agriculture, in situ CR management has more positive than negative impacts. Some decomposers are now available in the market which hastens the decomposition of paddy straw. The decomposer developed by the Indian Agricultural Research Institute (IARI), New Delhi is a mix of seven cellulose, lignin and pectin digesting saprophytic microbes. Available in four capsules, when its jaggery based starter culture is spray applied on paddy straw and stubbles, it enhances the process of decomposition to complete within shorter time as compared to natural process without any decomposer. But it is complementary and not a substitute for any method for in situ management of paddy straw. For paddy straw, both the procedures, leaving straw on the surface followed by no-till or less till procedure for sowing the next crop and incorporating it into soil by mechanical means by ploughing need special and new type of machinery like happy seeder, super straw management system, reversible plough, rotavator etc., which is major obstacle being experienced by the stakeholders as well as policy makers. Despite good amount of subsidy available on purchase of such machinery, desirable results are yet to be achieved for better utilization of paddy straw produced every year. It is expected that incentivising farmers, massive awareness campaigns and supply of more machines by the state governments will desist them from paddy straw burning and will contribute towards in situ management. Motivating farmers to purchase relevant machinery/equipment through cooperatives, farmer producer companies and group of farmers will help to plough CR back to the field as a good agricultural practice in the region.

AGRICULTURAL MECHANIZATION IN INDIA: FUTURE NEEDS AND PROSPECTS

Indian agriculture is undergoing transformation due to technological innovations, modern cultivation techniques, sprawling urbanization, shortage of labour and climate change. The labour availability in agriculture is also expected to go down to 26% of total workforce by the year 2050. Factors such as climate change, population growth and food security concerns have propelled the agricultural industry into seeking more innovative approaches to protect and enhance crop yield. These changes offer unique challenges and opportunities to transform agriculture to more productive, economically remunerative, socially equitable and environmentally sustainable through adoption of smart mechanization technologies.

Agricultural mechanization plays a key role in improving agricultural production in developing counties, and should be considered as an essential input to Indian agriculture. The agricultural mecha-

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nization is at an early stage in India and growing at 7.5% per annum in spite of challenges of small land holdings, cropping pattern, market prices of crops, minimum support price (MSP) and government policies and legislations. The ignorance of these challenges will exaggerate the redundant labour force, low return against inputs for yield and ultimately decrease the enthusiasm in agriculture. The Government of India has taken initiatives and programmes like Sub-mission on Agricultural Mechanization (SMAM), Rashtriya Krishi Vikas Yojana (RKVY), Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), National Food Security Mission (NFSM), National Horticulture Mission (NHM), Gramin Bhandaran Yojana (GBY), scheme on promotion of agricultural mechanization and machinery for in-situ management of crop residue in the states of Punjab, Haryana, Uttar Pradesh and NCT of Delhi etc.

The major objectives of SMAM are to demonstrate agricultural machinery on the farmers' fields to increase farm mechanization and productivity, test and evaluate machines through identified testing centres to ensure quality and performance, support the custom hiring centres of agricultural machinery and hi-tech hubs to ensure the availability of agricultural machinery, increase trained and skilled personnel, etc. In consequence, the concept of 'Custom Hiring' assures the distribution of mechanical power beyond large holding to small/marginal land holdings. It also facilitates availability of farm machinery/equipment on hire and assists in enhancing mechanization level.

Future needs and prospects

Agricultural mechanization should contribute to sustainable increase in yield, productivity and cropping intensity so that the planned growth rates in agricultural production are achieved. Mechanization is capital intensive and substantial sums have been invested in our country. In the absence of good planning and direction, investment on mechanization may not yield the expected results. India adopts a policy of selective mechanization under diverse conditions, which makes the agricultural mechanization a challenging task. An appropriate mechanization technology suiting to the location and crop specific needs of the farmers is required to be adopted.

Globally, the agriculture of the future is likely to be dominated by precision farming techniques like smart tractors, unmanned aerial vehicles, robots for harvesting, agri-bot for covered cultivation, wireless technology etc. From the Self-Reliant India point of view and to promote Make-in-India as envisaged by our Hon'ble Prime Minister, more efforts are needed to introduce next generation machinery using technologies such as machine vision, sensors, AI, IoT, robotics etc., besides the innovations for small and marginal farmers of the country to help them sustain. These technologies will not only make agriculture machinery smart and efficient but also help in saving inputs such as seeds, fertilizers, chemicals, water and energy and make agriculture more sustainable and profitable. There is need to simplify these technologies to rudimentary levels and make them cost-effective for maximum acceptance by the farming community in India.

AI, IoT and drones are the latest technologies to penetrate the Indian agriculture that are adding major value to the integrated agriculture-based systems. The research work in the areas of precision agriculture, digital farming, precision irrigation, AI powered machinery, user friendly mobile applications, etc. has gained momentum in India during the last decade. Most operations in farming, such as seedbed preparation, sowing/planting, pest/disease detection, crop health monitoring and management, irrigation scheduling and watering and harvesting can benefit from these technological advancements. It also includes application areas such as monitoring of animal health, feeding and processing, on-farm storage and product quality assessment including monitoring within farm gate for initial storage. Other benefits include the decreased use of water, fertilizer and pesticides which in turn help in keeping food prices down and reducing impact on natural eco-systems, less runoff of chemicals into rivers and also groundwater and most importantly increasing worker safety.

Drone technology has been revolutionizing the agriculture sector for the past few years by offering cost saving, improved input use efficiency and more profitability. Further, with advancements in technology, drones have started playing a crucial role in precision farming. Prior to drone usage, the agriculture sector was relying on satellite imaging for monitoring vast crop areas. Drone-assisted technology has started reshaping the traditional remote sensing approaches by providing images with better resolution, information content, and efficiency. Agriculture drones, equipped with sprayers and advanced sensors, can detect and measure targets with utmost precision, resulting in reduction in input use. Agriculture automation through information and communication technologies stemming from the lack of skilled labour crisis will also proliferate the demand for Krishi drones in the coming years.

Key policy interventions needed

Baseline survey of farm mechanization should be conducted every five years (similar to livestock census/agriculture census) for proper planning of the mechanization needs of different states in the country. The status survey should also include status of custom hiring centers (CHCs) and agricultural accidents. This

will enable in reduction of regional disparity in mechanization level.

R& D initiatives in frontier areas of research should be strengthened in our country, and collaborative efforts with institutions of eminence in identified areas of research should be taken on high priority with Inter-Government engagement and committed financial support. The R&D efforts should be for application of sensors, AI, IOT, big-data and robotics in development of farming technologies which may ensure optimum utilization of inputs and reduce cost of cultivation. The developed gadgets and technologies may be transferred to industries expeditiously. Adoption of imported machinery through reverse engineering to suit to Indian conditions and needs.

The Indian farmers have limited access to the latest equipment and technology. This results in high production cost and difficulty in competing in international market for sale of surplus produce. There are wide technology gaps in meeting the needs of various cropping systems and regions. To achieve higher production levels, the quality of operations like seedbed preparation, sowing, application of fertilizer, chemicals and irrigation water, weeding, harvesting and threshing will have to be improved by using precision and efficient equipment. Medium and large scale farmers may be provided with Govt. subsidies to encourage them to buy and to use advanced medium and high size machinery such as cotton picker, rice transplanter, sugarcane harvester and combine harvester on their fields.

The widely fragmented and scattered land holdings in many parts of the country need to be consolidated (virtual or real) to give access for their owners to the benefits of agricultural mechanization. The loss of agricultural production, both in quality and quantity, should be reduced through timely operations and improvement in equipment and techniques.

Making available farm equipment having good quality and reliability to farmers is a major concern. There is a need for quality manufacturing and after sales support for reliability of farm machinery. This may be achieved by streamlining of testing procedure, training of engineers and conducting testing of farm equipment for standardisation and quality control in farm equipment manufacturing. The 38 test centres and 4 FMTTIs needs to be further strengthened with proper manpower and instruments to augment testing capacity as well as to enable them testing of upcoming precision equipment. Manufacturing of the agricultural implements are mostly in MSME sector, manufacturing cluster should be developed in line with SEZs. Benefits accrued as per SEZ norms should also be extended to these clusters.

Farm machinery banks may be established for machines being manufactured elsewhere in the country and supply to users/farmers on custom hiring mode. Field worthy improved farm equipment to be intensively field demonstrated in new areas and awareness amongst farmers and extension workers created with capital incentive from Central and State Governments, directly to the farmers.

There are missing links and gap in academia, R&D institutes and the industry. The agricultural engineering institutions should essentially have more liaisons with industry and all SAU academic/governing bodies should have a member from industry. Students may be involved in solving the challenging problems/projects of the industry through their innovative/out of box ideas. Linkages with line departments, farmers' organizations, NGOs, farm equipment manufacturers and rural craftsmen need to be strengthened to facilitate availability and use of improved farm implements and machinery, a public-private-cooperative effort towards farm mechanization.

The benefits of mechanization in India have been so far confined mostly to rice-wheat based cropping system. These benefits have to be extended to all cropping systems including cash and horticultural crops.

NEW HEALTH FOCUSSED WORLD

Organic products are not just all hype - the reasons for their rising popularity are based on a shift in consumer behavior towards a more sustainable, healthier and happier life. Fresh, organic food helps people feel better, and is important for preserving the environment. In actuality, buying organic food is a vote for good health and a healthier planet. The increasing popularity of organic food is an answer to ecological, agricultural and social problems. People choosing organic food are making some sort of statement: some do it for the environment, some to show their support for farmers, others are concerned about biodiversity. We all are also worried about us being exposed to pesticides and other harmful substances through the food we eat.

Organic products have become an important part of modern lifestyle

Many people are raising their voices and showing their concern about the variety of chemicals and poisons used by companies to grow food. Even though the chemicals used heavily in agriculture have been diet tested, their long-term effects are still up for debate. Some of the most toxic pesticides require specialized testing methods which many of the governmental agencies and authorities rarely apply. A lot of food is full of toxic chemicals. So more and more people have started choosing organically grown products. Since organically grown produce cannot be modified in any way, choosing it is a way to be sure that there is no genetic engineering in our meals. Which is why organic foods help say no to GMO (genetically modified food).

Organic practices do not pollute streams and groundwater with heavy chemicals as the commercially grown agriculture does, they do not destroy the quality and fertility of farmland either. The standards forbid the use of any chemicals in farming, and there are special ways to manage the soil, farming process and biodiversity in a responsible way.

Organic farming is based on the concept of harmony with Nature. The rotation of soil and crop keeps the farmland healthy. The lack of chemicals preserves the ecosystem. Because of the farming practices we already mentioned, the organic way is also part of the climate solution. It turns farmland into a sink rather than a source of CO_2.

Buying organic products is an investment in the future. Governments subsidize agriculture, but most of the funds go to commercial agribusiness. The cost of extinction or damage of wildlife and ecosystems, and environmental damages cannot be calculated. By choosing organically grown produce, we support farmers directly. Moreover, spending our money in the organic sector is saying yes to a more sustainable future. Incorporating organic products in our life is a choice, which has many benefits as we already saw. It inspires us for a healthier life, more sustainable food, future for the planet and everyone on it and everything starts with a small organic seed. Organic farming is a big part of the solution for many ecological problems, and modern people want to support that. The modern lifestyle is about being smart, responsible and enjoying it.

Key is to develop trust among consumers

This is only possible when the product is authentically organic which requires tough steps by the entrepreneurs.

- Setting of processing/packing plant in remote villages and not in cities – this will help in packing organic products in clean environment and also in creating jobs for the local youth thus stopping exodus to cities which are already bustling with loads of people. This also will start helping the development of villages/ infrastructure/economy
- Working directly with farmers instead of middlemen. Thus, providing good prices for produce to farmers and also pricing the product at affordable price for consumers
- Making farmers partners in the business, for long term prosperity of all
- Above all due to corona challenges as such it makes sense to migrate industries to villages instead of migrating the labor from Villages
- In view of current situation , critical is to stay on the pitch. Runs will come automatically !!

Together , Let's Heal the World !!

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ICTs Tuning Agriculture Knowledge Systems to IR 4.0

Changing Agriculture Scenario

Agriculture (including crops, horticulture, livestock, fishery, forestry, dairy and agri-engineering) remains the largest sector of Indian economy. It is believed that the next green revolution would be driven by the new generation agriculture technologies, viz., Genetics, Robotics, Informatics & Nano-Technology. The fact that promising information and Communication Technologies (ICTs) unleash agricultural productivity is well established. World over, ICTs in agriculture have contributed to achieving Sustainable Development Goals (SDGs).

High performance computing including intelligent software; Wireless sensor networks; Automation (farm, factory and lab); E-commerce; Digital learning; Supply chain management; Satellite imaging (GIS and Remote sensing); Sensors; Smart packaging and Bio-informatics are revolutionizing agriculture globally. Emerging ICTs like Internet of Things (IoTs) and Smart Farming integrated with big data analytics have accelerated the pace.

ICTs mediate the acquisition and absorption of knowledge and infusion of technologies in to agriculture through value added applications, e-services, input use, automation, scientific management of natural resources, marketing, finance, insurance and learning. In other words, ICTs catalyse transformation of agriculture in to agribusiness. The practical challenges encountered and solutions adopted in agri-business lay foundation for the Fourth Industrial Revolution (IR 4.0). ICTs enabled commercial agri-solutions are well adopted by farmers and agribusiness enterprises.

ICTs Use Status in Agri-Knowledge Systems

Agriculture universities and research institutes, the main constituents of National Agriculture Research and Education System (NARES), develop and provide knowledge products and services in the country. With limited support academic and research institutions are slow in mastering use of ICTs. This almost limits their scope to develop human resources as per the skill sets needed for IR 4.0. Integrating the rapidly evolving ICTs into the research and academic activities is a major challenge. The current status and the scope of ICTs in six major areas in future in NARES are discussed in brief in the following section.

Digital Learning

During 2010-14, the National Agriculture Innovation Project (NAIP) implemented by ICAR supported development of e-learning in agricultural education. This initiative took right direction due to inbuilt component of capacity development of teachers. Being available on open access basis, the digital courses were well received by agriculture students in India and abroad.

The Covid pandemic has provided a live experimental platform for digital learning. Due to the pandemic situation, the implementation as well the learning outcomes were not uniform across the universities. However, students from the universities, where ever it was implemented, reported satisfactory learning through online mode. The learner's satisfaction was

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constrained due to inherent limitations from curriculum and technology . Lack of practical coverage and technology constraints such as lack of access to robust and affordable Learning Management System (LMS), low-end devices and poor internet connectivity impacted the teaching-learning. In the absence of continued support, teachers could not adopt to advances in digital learning.

Scope: Major learning from the pandemic initiatives is for gradual introduction of blended or mixed mode of delivery to address the practical requirement. About 50 per cent of agricultural curriculum include practical aspects like field visits and lab exercises. This need use of digital technologies such as Augmented Reality (AR), Virtual Reality (VR) and Artificial Intelligence (AI).

Maintaining massive servers providing simultaneous connection to thousands of students is a big technical challenge even to the best of technical institutions. Most agricultural universities could not cope with this demand. One feasible solution is to outsource the LMS services.

There is need for a mission mode approach to develop agri-practicals using the AR/VR/AI technologies, coupled with teacher's capacity development.

ICTs in Biosciences

Biotechnology is being extensively used to isolate specific desired traits in crops for determining the most viable candidates. Next higher level of biotechnology enquiry is in to synthetic biology to design and engineer biological systems that process information. Such processes generate many terabytes of data. Information technology is a crucial enabler for turning these data into useful product-development decisions.

Select public-funded research and academic institutions in India are engaged in the cutting edge bioscience research. ICAR established bioinformatics grid by providing access to scientists in NARES. Many ICAR scientists benefited from this resource. However, only a few faculty members from agricultural universities could make use of this due to their absence of technical grooming and lack of funded project support. On the whole, integration of information skills with bioscience work remains a challenge.

Scope: The level of funding and human capacities are major hurdles. Many agricultural colleges lack competent teachers in biosciences. Need affirmative action to enhance scope for capacity development in the projects on one hand and promote live online courses engaging experts in biosciences and bioinformatics for enhancing quality of postgraduate education in agriculture.

Farm Automation

Farm mechanization and postharvest processes, covering the entire agricultural value chain, are providing tremendous scope for automation and growth. World over, this area is hot bed for innovative uses of ICTs in agriculture. Utilizing ICT-based innovations, various startups are providing agribusiness solutions. These innovations in turn are paving way for a shift in production oriented farming to market demand driven farming.

Research in NARES institutions is tuned to development of farm machines and tools and their adaptation to field conditions. The budget support for developing ICT enabled systems is low or modest in most agricultural universities.

Scope: Prevailing IR 4.0 atmosphere is nurturing many startup innovations in farm automation. With limited funding, startups are not able to support and work with the public agri-knowledge system. This segment needs mission mode scheme and policy attention to support public-private partnership projects in the lines of biotechnology.

Data Analytics

The vast amount of farm-related data collected through various machines and sensors can be analysed using advanced mathematics. Development schemes like Soil health card, Crop insurance, Agri-marketing, etc. are being implemented using ICTs for inline management. Quality data with analytic skills enable graduates to provide solutions to many problems and programmes aimed at sustainable development and poverty alleviation.

Scope: The present agriculture education curriculum has low emphasis on mathematical sciences. Students lacking requisite mathematical skills pose big challenge to teach computational subjects in agricultural courses. It may not

be easy for agricultural universities to offer such courses. However, the new National Policy on Education (NPE, 2020) provides an opportunity for students to enroll to courses of other universities.

Extension Service to Farmers

A variety of ICT based enterprises are available in the service of farmers. On supply side, digital platforms are providing a wealth of information to farmers and intermediaries on farm technologies and services along the value chain. The major breakthrough in linking farmers to the digital initiatives is made possible by affordable hand held wireless systems like smart mobiles and tabs. A high level of computer literacy is not essential for using such devices.

Many enterprises are providing value added information to farmers in a business mode. Demand driven e-commerce and agribusiness platforms directly link the farmers to various segments along the value chain. Although access to such models is priced, they are on demand by farmers and agri-enterprises.

Scope: ICT enabled agri-enterprises providing extension services to farmers are largely orchestrated by technology professionals. The agri-knowledge systems have serious invisible entry barrier into this important and rapidly growing domain. Instead of re-engineering them in the public system, it will be mutually beneficial for universities and agri-enterprises to collaborate. Establishing private enterprise platform on university campus will accelerate sharing knowledge services to farmers. It would as well provide means for students learning. NARES will have to come up with workable models.

Skilling

Skilling youth and professionals is yet one more untapped market. Government of India estimates to provide skills to about 173 million out of 230 million people engaged in agriculture by 2022. Skill development aims to move the skilled : unskilled mix from 65:35 (in 2013) to 80:20 by 2022 (www.skilldevelopment.gov.in). Academic and research sectors reach

to develop human capital is restricted to small segment (less than 1%) at higher levels of skill and knowledge pyramid. Rapid change in outreach is possible through diverse courses for students and youth at various levels of skill and knowledge. This is not possible in the present mode of education and training in the NARES. However, it is possible through use of ICTs in education and training. It will be big challenge to NARES institutions and universities for increasing their footprint in skilling through ICTs use.

Scope: In a rapidly changing technology environment, internalization of ICTs is essential to public knowledge institutions. It needs considerable investment and takes time. Digital learning provides a channel to agri-knowledge institutions to enhance their outreach to diverse learners. NARES institutions partnering with successful education and training enterprises would be an option to explore. Such partnerships will be able to develop market oriented human resources at least cost.

Way Forward

The importance of ICTs in academics and research is never in dispute. Hardly any impact assessments are made on ICTs use in agriculture. Established evidence on ICTs implications on the productivity of research and academic institutions would have provided meaningful direction to the funding and strategies for creating enabling policy.

The high standard and quality envisaged in NEP is a beacon of hope. If implemented in letter and spirit, it may bring desired changes in quality of agri human resources. To realise such intentions, what is needed is public funded programmes and matching digital policies. This would reinforce the transformational role of ICTs in bringing the desired change in agricultural research and education. Working in partnership with private agribusiness enterprises is likely to off-set the limitation of public funding.

Tuning agricultural education to the NEP necessitates development of necessary infrastructure, linkages and capacity development for integration of the agri-ICT platforms into existing agricultural education structure in the country. It demands a paradigm shift in planning and funding agricultural education. There is a need for proactive policies and structural changes to work in partnership with agri-enterprises to provide efficient and effective services and also to develop quality human resources. Such partnerships would pave way for more proactive roles to the agri-knowledge system in contributing to the IR 4.0, there by transforming agriculture to agribusiness.

Prathista's Rural Entrepreneurship Programme through Organic Agri inputs and organic nano fertilisers developed by ICAR, focusing on total crop management Manufacturing units for Rural India

Prathista Farmers Welfare Foundation was established with a mission to promote Organic Farming across India with Prathista's innovative **Nano Technology** products. The foundation aims to **encourage rural youth** in every village of the country to **become agripreneurs**, instead of migrating to cities for odd jobs.

In line with Hon'ble Prime Minister's vision of Natural Farming, Prathista invites 3 dynamic youngsters from each district to **partner with the group** and become job providers to more than 100 rural youth with 80 % women participation. With an investment of ₹15000 Crore, the foundation envisions creating **1000 manufacturing units for production of natural & organic inputs with locally cultivated non edible carbohydrates as raw material**.

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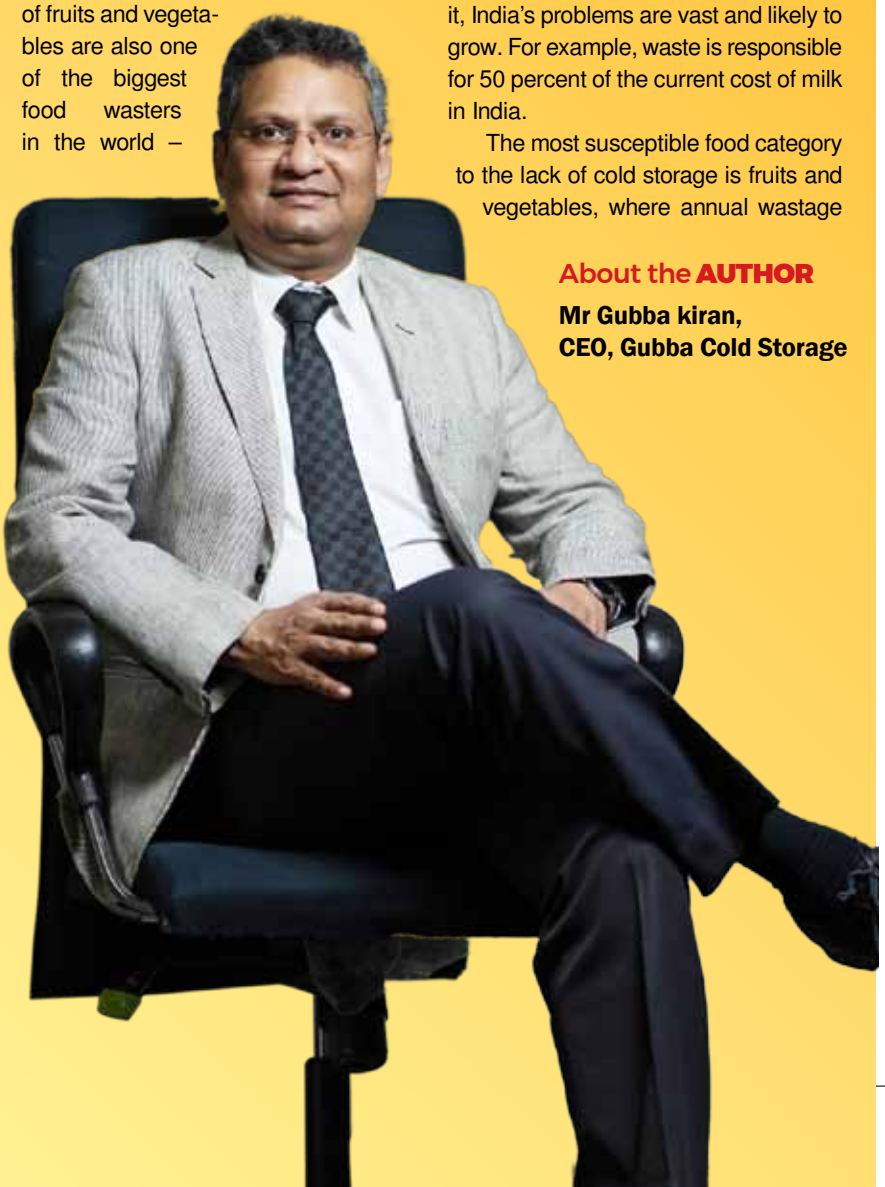
A STRONG COLD SUPPLY CHAIN FOR STRONG FOOD SUPPLY

Food waste is a global issue, and it's not going to go away until we all take a more proactive approach in ensuring foods storage to retain freshness and quality. All businesses, especially those in the food service industry should be taking a closer look at how their produce is managed to help improve their efficiency and profit margins.

India, the world's largest producer of milk and the second-largest producer of fruits and vegetables are also one of the biggest food wasters in the world – wasting INR 440 billion worth of fruits, vegetables, and grains every year. The challenge of feeding India's billion-plus people is not really about agriculture and food production but getting the food to the people. The biggest contributors to waste are the lack of refrigerated transport and adequate high-quality cold storage facilities for both food manufacturers and food sellers (retailers). India lacks and needs a well-developed, world-class cold chain infrastructure. Without it, India's problems are vast and likely to grow. For example, waste is responsible for 50 percent of the current cost of milk in India.

The most susceptible food category to the lack of cold storage is fruits and vegetables, where annual wastage is estimated to be 18% of the total production. Controlling the levels of waste is beyond the capability of individual farmers or consumers. The problem is broader and involves market schemes, availability of power supply, quality of roads, focused government intervention, and a need for a more pronounced investment in the sector.



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One of the major reasons for this food waste and food loss is the lack of an efficient cold chain infrastructure from the farm to the fork, including refrigerated transport, pack houses, collection centers, and cold storage. Another reason for wastage is inadequate knowledge of handling perishables and the skill levels required to take care of these at various stages.

Physical loss of food has a multiplier effect in associated waste of inputs like water, electricity, and fertilizers. It also adds to greenhouse gas emissions, contributing to climate change. Farmers' profit margins dwindle with the increasing perishability of their produce. A well-defined cold chain infrastructure could well reduce food loss, create a positive ecological impact, and directly affect farmers' incomes.

Existing Cold Storage Infrastructure

India has around 6,300 cold storage facilities across the country, with an installed capacity of 30.11 million metric tonnes, 75-80% of which is suitable for storing only potatoes, contributing to only 20% of the agricultural revenue. Adopting proven technology solutions for an efficient cold storage infrastructure will help achieve the goals of improving overall agricultural output and revenues. Let's have a look at some emerging solutions.

Only 10–11 percent of the fruits and vegetables produced use cold storage.

There is a deficit of 90 percent. Storage capacity needs to increase by 40 percent to avoid wastage. The wastage of fruits and vegetables occurs more in the southern and western regions of India due to the tropical and humid climate.

India produces 250 million tonnes of food annually; 65 percent of the population is engaged in agriculture. About 18 percent of the country's fruits and vegetables, worth INR 133 Billion, go to waste annually because of the lack of cold storage facilities.

Meat, milk, and poultry products (except eggs) cannot exist without the cold chain. Hence, the country's cold chain infrastructure for milk, meat, and poultry is still good. In the case of fruits and vegetables, there is a market for fresh fruits amongst people of different economic backgrounds. Overall, there are inadequate cold chain facilities for fruits and vegetables.

Poor cold storage infrastructure not only affects the freshness and quality of products but also the price. Waste can contribute to doubling fruit and vegetable prices; while milk can cost 50 percent more In India, lower-quality fruits and vegetables end up being consumed due to low awareness of food freshness. This is a considerable risk to their health.

Appropriate food storage plays a critical role in preserving the nutritional value of food. It prevents food-borne illnesses caused by harmful bacteria and helps protect vital nutrients. When food is not stored properly the result is under-nutrition affecting large sections of the poor, particularly women and children. Consequently, physical growth and health deteriorate in adults, and work capacity and productivity are reduced in children.

Once caught, marine food products are highly perishable. Marine foods for export typically needs to be quickly frozen after initial processing and kept frozen until purchased by the consumer. New initiatives have been adopted for developing the sector to increase yields and ensure a sustained livelihood for fishermen. There has also been an amplified effort to increase exports to other countries through improvements in infrastructure facilities like cold storage that better address post-harvest management. As a result of this concerted effort, marine product exports have grown by 7.68 percent over the last fiscal year according to the Ministry of Commerce.

The Way Forward

The cold chain industry is an emerging and fast-growing business sector in India. With the present food shortage, food security and safety are issues of growing prominence in India. Considering the current levels of food wasted, cold chain facilities will play an important role in feeding the country.

Understanding the increasing demand for an effective cold chain, the government has established a separate department, National Centre for Cold-chain Development (NCCD), and this development points to the importance of cold-chain facilities.

On an economic level, recent history in other countries shows that income levels rise, food production and consumption patterns change and often lead to an increase in demand for easier-to-obtain, processed food. Along with the growth of the processed food market there comes the need for a better cold chain industry.

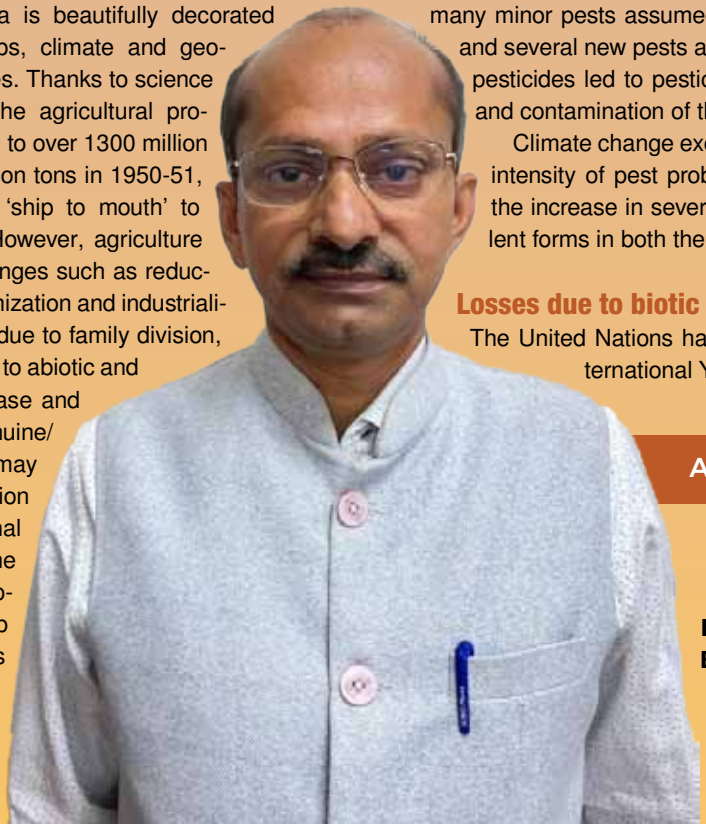
Developments in the food processing sector, organized retail, and government initiatives will drive overall growth for the industry. The industry's progress will also fuel the flow of investment by multi-brand companies and sustain their interest in the retail sector.

To develop a world-class cold chain infrastructure, the government, and industry bodies need to join hands to adopt better and more efficient technologies to prolong the shelf life of food products and bring commensurate economic returns to the farmers. This will not only ensure the year-round availability of perishable food products and reasonable prices to the consumers but also equitable distribution to other parts of the country.

Biotic Stress
IN INDIAN AGRICULTURE
Issues, Challenges and Policy Reforms

Agriculture in India is beautifully decorated with diverse crops, climate and geographical identities. Thanks to science led innovations the agricultural production increased to over 1300 million tons in 2021-22 from 135 million tons in 1950-51, transformed agriculture from 'ship to mouth' to 'self-sufficiency and export'. However, agriculture sector is facing several challenges such as reduction in arable land due to urbanization and industrialization, decrease in farm size due to family division, climate change, yield loss due to abiotic and biotic stresses like pest, disease and weed, proliferation of non-genuine/ illegal agro-chemicals etc. It may be attributed to green revolution technology that steered national food security, which at the same time caused redundant ecologies which favored the build-up of biotic stresses in crops as many minor pests assumed the status of major pests and several new pests appeared. The flawed use of pesticides led to pesticide resistance, resurgence and contamination of the environment.

Climate change exerts a profound effect on the intensity of pest problems, which includes both the increase in severity as well as parasitic/virulent forms in both the insects and microbes.



Losses due to biotic stresses are enormous

The United Nations has declared 2020 as the International Year of Plant Health (IYPH).

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The main aim is to raise global awareness on how protecting plant health can help end hunger, reduce poverty, protect the environment, and boost economic development. FAO estimates that a total annual loss of 20 to 40 percent of global crop production due to pests. Each year, plant diseases cost the global economy around $220 billion, and invasive insects around US$70 billion. While in India, yield loss to crops is estimated as 26, 20, 6 and 8% by insects, plant pathogens, rodents and others, respectively with an annual loss of Rs. 2,25,000 crores. The Crop pests include weeds, insects, rodents, nematodes, and pathogens.

Recently, the losses caused by the pest excluding weeds recorded in the food security hot spots in India ranged from 10-28% for wheat, 24-40% for rice, 19-41% for maize, 8-21% for potato and 11-32% for soybean. The scenario on key pests of crops has been changing rapidly owing to climate change, injudicious use of chemical pesticides and other human interventions. The possible reasons for this emergence of pests are climate changes provoking ecological impacts leading to change in herbivory, increased overwintering, increased number of generations, breakdown of host resistance as well as change of genotypes/impact of transgenics, injudicious use of pesticides, modification of cultural practices/tillage *etc*.

Invasive insect species are also increasing threats to Indian agricultural commodities resulting in huge economic losses. A total of 24 insect species have been reported to invade India. The basic information on bio-ecology, genetic make-up, geographical distribution, resistant cultivars, augmentation of natural enemies, crop management practices, IPM and phytosanitary regulations of invasive insect species would be helpful to manage the invasive insects. Changed patterns in climatic factors like temperature, precipitation, humidity and other meteorological parameters could impact on changes in biology and ecology, increased pest population and their damage potential by expanding distribution, enhanced survivability, allowing to develop the adaptability, alteration in tritrophic interaction, outbreaks, migration, species extinction, change in host shift, emergence of new pests or biotypes *etc*.

Recently, the losses caused by the pest excluding weeds recorded in the food security hot spots in India ranged from 10-28% for wheat, 24-40% for rice, 19-41% for maize, 8-21% for potato and 11-32% for soybean.

Pesticide Resistance is a major challenge

The resistance development in field populations is influenced by biological, genetic and operational factors. An estimated 954 pest species have developed resistance against various types of pesticides. Resistance detection helps in avoiding ineffective molecules and assists in making a proper recommendation of alternative molecules that are less resisted and can effectively control insect pests and by restricting less effective insecticide enhance the pesticide load into environment. Periodical monitoring and following insecticide resistance management suggested by Insecticide Resistance Action Committee (IRAC) would be useful to manage the insecticide resistant insect populations. The possible reasons for this emergence of pests are climate changes provoking ecological impacts leading to change in herbivory, increased overwintering, increased number of generations, breakdown of host resistance as well as change of genotypes/impact of transgenics, injudicious use of pesticides, modification of cultural practices/tillage *etc*.

Invasive insect species are increasing threats to Indian agriculture

Sucking insect pests, mirid bug, mealybug, whitefly, aphids, and plant hoppers on major crops; *Helicoverpa armigera* on vegetables and pulses; *Spodoptera litura* on vegetables, cotton and oilseeds; *Pieris brassicae* on crucifers; *Liriomyza trifolii* on vegetables; *Atherigona* spp. on spring maize; aphid complex like *Sitobion avenae*, *Rhopalosiphum maidis* and *Schizaphis graminum* on wheat, barley and oat; green mirid bug, *Creontiades biseratense* on cotton; eriophyiid and tetranychid mites on bean, brinjal, cotton, cucurbits, okra, apple, ber, citrus and mango; *Maruca vitrata* on pigeonpea and cowpea in, sugarcane pyrilla on wheat, oat, barley in Chhattisgarh *etc*., have been reported to emerge in India.

Fungal Pathogens are important threat to Food Security

Fungal diseases are another major threat to the most important crops. Fungal pathogens causing large yield losses in different crops are well documented which can be exemplified by the Bengal famine in India in 1943 due to the destruction of rice by *Helminthosporium oryzae* and stem rust destruction of wheat in the pre independence era. Blast of rice remains the most important fungal disease in India, however, sheath blight severity and spread, drastically increased in almost all rice growing regions during the past few years causing major losses to the yield as well as increased fungicidal sprays as no effective resistant cultivars are available. Similarly, increased occurrence with high severity of false smut disease of rice has been observed in recent years. Among other cereals, large area under wheat is continuing to be vulnerable to stripe/yellow rust pathogen which is evolving regularly rendering varieties susceptible. The emergence of virulent Tropical race 4 (TR4) of *Fusarium* wilt has devastating effect on banana cultivation in the world and has also been detected in India in recent past with high incidence and crop damage. Climate change has posed a stiff challenge to sustainability of series of *Sr* genes in wheat governing resistance against Ug99 race of *Puccinia graminis* f. sp. *tritici*. Elevated temperature and CO_2 have also posed serious threat to potato to virulent isolates of late blight pathogen, *Phytophthora infestans* and to rice to blast and sheath blight.

Intensive research studies are required on the emerging bacterial and viral diseases of various crops and also soil-borne fungal diseases.

Viral and Bacterial Disease Management is a difficult area

Different economically important crops are now vulnerable to viruses which will be responsible for heavy crop losses in India. Due to the strains variability, both viruses and their vectors, and also because of environmental factors the management of the threatening plant virus diseases could not be achieved successfully in several crops.

There are also over 200 plant pathogenic bacterial species affecting plant health and those considered to be the most important belong to the genera of *Pseudomonas, Ralstonia, Agrobacterium, Xanthomonas, Erwinia etc.* Although, emerging bacteria and plant viruses noticed in the different crops exhibit limited incidence and effect on yield, however in future they may cause heavy losses, once they establish on alternate crops and weed hosts. Hence intensive research studies are required on the emerging bacterial and viral diseases of various crops and also soil-borne fungal diseases.

Innovations in biotic stress management need to be encouraged

Conventional plant protection measures in vogue suffer from loss of qualitative resistance of resistant cultivars due to use of limited number of genes (mostly major genes) paving way for emergence of new strains with aggravated virulence, hazardous environmental risks of using chemical pesticides, farmers' distrust of biocontrol methods, emerging biotic stresses in the era of climate change and transboundary invasions etc. Innovations in biotic stress management should include nanotechnology in pest management, fumigants, volatile and acoustic techniques for stored grains, post-harvest and vertebrate pest management, elaborated tritrophic pheromone/kairomone studies, identification of broad spectrum resistance, utilizing wild species genepool, deployment of remote sensing technology for pest management, development of disease/pest prediction models, determination of factors leading to evolution of pests and pathogens, and development of technologies to minimize the adverse effect of climate change on biotic stresses of plants. Precision on pest survey/surveillance will be more if based upon artificial intelligence by establishing an automated detection system applying remote sensing, image processing, soft computing etc.

Pesticide regulation and pest surveillance need to be

strengthened

Pesticide regulation mechanism in India needs to be strengthened to check manufacturing, sale and distribution of spurious and substandard pesticides, encouraging environmental friendly molecules of botanical biological origin, quality assurance etc. Due to enormous use of spurious pesticides by uneducated small and marginal farmers of country, pest problems remain high. Non availability of branded pesticides and microbial insecticides on credit basis and lack of awareness among large rural farmers are the reasons for use of spurious pesticides. The size of the spurious pesticide market in India is as high as 30% by volume and 25% by value and spurious chemicals market is growing at 20% per year leading to a loss of about 10.6 million tonnes in food grain production.

While importing planting material and other agricultural commodities, India is also bearing the risk of introducing exotic pests and diseases along with imported. Therefore, plant biosecurity seeks to prevent, minimise and control the introduction and spread of these pests in India in the course of international trade. Implementation of ICT-based e-pest surveillance and digital dissemination of advisories across different states facilitated adoption of scientific pest management by the farming community. The future requires a converged functioning of plant protection stakeholders. The quarantine and pest surveillance needs networking, international cooperation, artificial intelligence, diagnosis and data analytics.

Policy reforms

There is an urgent need for national Policy on Agrochemicals with an emphasis on safe use of pesticides. A fast track transparent time bound on-line registration system by revamping the current registration process based on the recommendations of duly constituted independent expert committee is also needed. Guidelines for registration of newer molecules shall also be harmonised and also re-registration of pesticides

Plant parasitic nematodes, particularly the root-knot nematodes, *Meloidogyne* spp. are responsible for causing severe yield losses to vegetable crops under intensive cultivation. They also became major threat to protected cultivation of vegetables and ornamental crops. *Ageratum conyzoides* L. is an annual weed native to South America that has invaded and now naturalized several parts of southern Asia including India. Species of parasitic dodders (*Cuscuta* spp.) are becoming a serious problem in agro ecosystems of south India and are being seen increasingly on many plants, including pulses and oilseeds, throughout the country.

which will take a mandatory period of 10 years after registration. Complete check on sale and use of spurious pesticides indeed is the need of the hour. High quality well equipped quality control accredited national pesticides testing laboratories across the country should be established with international standards. Bio-safety data for new molecules to be generated preferably through notified National Accreditation Board for Testing and Calibration Laboratories (NABL) only. Pesticides of biological origin, growth regulators whose toxicity levels are very low can be relaxed from stringent regulatory ambit. Strengthen and encourage manufacturing of new molecules under Make in India initiative. Capacity building and skill development in assessing unregistered pesticides in imported commodities need to be strengthened. There is an urgent need to move forward to innovations in biopesticides of biological origin, green chemistry pesticides etc. A centre of excellence (CoE) on agrochemicals with multifaceted wide spectrum and modern bioscreening facilities needs to be established urgently. Greater thrust needs to be given to develop low cost technologies for mass production and bulk availability of biocontrol agents and biopesticides.

Addressing the Future challenges

Establishment of national referral laboratories for quick identification/diagnosis and containment can prevent the wide spread outbreak of pest. A well-defined and coordinated mechanism should be developed for safe guarding our country. Artificial Intelligence for monitoring, tracking breeding sites, migration of locusts and aerial application of pesticides for site specific management of transboundary quarantine pests are needed.

Public-Private Partnerships to control biotic stresses can be established. Modelling of crop pest epidemics and disease outbreaks for major pests across the crops should be developed. A nationwide programme on robust monitoring and advisory system for quarantine, invasive, transboundary biotic stresses need to be developed. Robust forewarning systems for timely management of invasive, quarantine pests are to be developed in tune with changing climate. Exploration of semiochemicals/pheromones or allelochemicals for the management of sucking pests is a big challenge ahead of scientific community. Utilization of such chemicals in trapping technology would be of great help to farming community in overcoming losses caused by vector and vector borne viral diseases. There is a need to put in lot of efforts on development of suitable consortia of microbes for the management of biotic/abiotic stresses and reduced cost of cultivation. Weed management policy need to be formulated in urgent basis to control the severity, spread and threat to the environment. Empower the community to manage weeds under the policy.

PROMOTION OF CONSERVATION AGRICULTURE FOR SUSTAINED AGRICULTURAL PRODUCTION

Agriculture in India has achieved self-sufficiency in foodgrain production but the production is still cereal-centric, resource-intensive as well as regionally biased. Moreover, while achieving food sufficiency, the global hunger index 2022 presents a dismal status of hunger and malnutrition scenario. The country still has growing concerns in various aspects of agriculture like the increasing problems of land degradation, water scarcity, increasing climate vulnerability, rapid urbanization leading to limited scope for area expansion under agriculture; the greatest challenge is to make the agricultural systems sustainable and climate resilient for achieving food security of the nation.

Conservation agriculture (CA) is perceived as the system which could meet the ever increasing food demand worldwide with sustainable intensification of crops with least constraints on available resources. CA is a farming system which is designed to hasten sustainability of the agricultural systems through conserving natural and biological resources in combination with external inputs. It conserves biodiversity, natural resources and labour; it reduces heat and drought stress, increases available soil water with build-up of soil health in long run. Minimum traffic on agricultural operations, making a permanent soil cover by managing crop residues, and crop diversification through temporal or spatial means are the three basic principles which are applied to make it a viable system.

Spread of CA in India as well as Global Scenario

The term 'Conservation Agriculture' was coined in 1990s but the idea of minimum soil disturbance dates back to 1930s during Dust Bowl of USA. CA was introduced in Brazil in early 1970s to control the problem of soil erosion initially but considering its positive effects on crops, it took another twenty years and it was in early 1990s when there was a significant adoption level in CA in *Latin American* countries like Brazil, Argentina, Paraguay and Uruguay. CA spread to the developed industrialized countries like USA, Canada, Australia with a big momentum in its adoption thereafter in end of 1990s.

The total area under CA worldwide was estimated to be 180 million hectares (12.5% of the global crop land) during

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2015-16 spreading over 78 countries having diverse climatic condition including *Gangetic* plains. In India, adoption and promotion of CA technologies are moving faster in last 8-10 years though the attempts have been taken since mid-1990s. Rice-wheat cropping system under irrigated agriculture contributes a lion share of the overall spread of the CA technologies. Certainly Punjab, Haryana and Western UP find a place in our country where CA activities are going on under irrigated rice-wheat system. Though joint efforts were made by State Agricultural Universities and ICAR to popularise CA practices among the farming communities but still the progress is not satisfactory under rainfed semi-arid tropics as well as arid and mountainous regions which shares a sizable proportion of Indian agriculture. Still our major focus on CA is based on zero till seed-cum-fertilizer drill for wheat in rice-wheat system. However other potential technologies like laser land levelling, raised bed planting, surface seeding, unpuddled rice transplanting, etc. are to be promoted. In eastern plains, Uttar Banga Krishi Viswavidyalaya achieved immense success in standardising the protocols for unpuddled transplanting of rice, zero-tillage wheat, maize, jute and surface seeded-lentil as well as mustard that are gradually spreading to rural communities with active collaboration of University and State Departments.

CA vs Organic Agriculture vs Traditional Intensive Agriculture

Both CA and organic agriculture protect the soil organic matter and maintains a balance between resources and agriculture, but organic agriculture uses soil tillage without using inorganic fertilizers; whereas CA use a permanent soil cover with less soil disturbances. To enhance food production and improve food security globally, we sometimes ignore yield stability. A global meta-analysis reflects significantly lower temporal stability (-15%) under organic farming as compared to conventional farming. It means despite organic farming takes into account biodiversity conservation and being environment friendly, yield stability is a great concern. In contrast, CA does not differ significantly in terms of temporal stability (-3%) indicating its applicability to a greater extent.

Major Benefits of CA

By minimum disturbance of soil along with judicious use of external inputs, CA does not interfere with various natural processes above and below the ground and thus helps to enhance the biodiversity conservation and natural biological processes. We can say that CA promotes most soils to have a richer biodiversity as well as bioactivity, forms a better structure and cohesion. It has been reported from various parts of the world that CA practices helped to improve the soil physico-chemical properties which in turn support the long term productivity of the cropping systems. It also provides a higher natural protection against abnormal or unfavourable weather conditions. It also protects surface and ground water resources from pollution and also mitigates the negative effects of climatic aberrations. From the perspective of saving money, time and fossil fuel, CA is perceived as a viable alternative of traditional agriculture. Thus the potential benefits of CA includes reduction in cost of production, better quality of soil, C-sequestration and soil organic matter build up, improving nutrient as well as water use efficiency, reduction in GHG emission, protects environment, improves resource use efficiency, reduction in weeds with provision of crop diversification and intensification. Under the context of residue burning, CA is also a viable option through which this problem can be addressed.

Our experience in promotion of CA

In West Bengal, India, the agricultural sector needs options that can address labour scarcity, reduce production costs and improve productivity. Conservation agriculture (CA) based technologies offer potential solutions for these issues, and have been tested in the north of the state since 2012, with promising results. Through a research for development project, a network of actors comprised of research (local university, international research organisations), extension (Department of Agriculture) and farmers groups have been working together through participatory field trials, capacity development, supply chain and policy interactions to undertake research and development activities with the unified aim to take CA to scale across the state of West Bengal. As a result of this, more than 100,000 farmers in the state are now using CA practices, while opening the new window of op-

portunity to attract youths in agriculture with several important factors identified that have contributed to the scaling success.

Prospects of CA in the country

The present day intensive chemo-centric agriculture has a direct impact on climate change, natural resource base as well as energy security. Due to ever increasing production cost and gradual natural resource degradation, there is urgent need to protect our future generations against these threats. The practice of CA may play a vital role in protecting our natural resource base with less vulnerable pathways. The most attractive benefits of CA from the farmers perspective in Indian context is reduction in cost of cultivation through saving water, nutrients, labour with increased yields. CA involving residue retention and zero till planting offers fabulous opportunity to eliminate the problem of residue burning and thus protects the considerable loss of plant nutrients with huge curtailment on GHG like methane, carbon-di-oxide, nitrous oxide, etc emission.

Large scale crop residue burning possesses serious problem in India every year. Proper government intervention towards popularisation of CA practices may reduce the extent of this problem. Zero tillage in combination with residue management results in soil structural improvement in one hand with increased recycling and availability of nutrients on the other. Surface residues as mulching material will moderate soil temperature, reduce evaporation with improved biological activities. From the crop diversification perspective, CA can offer variety of crops to be integrated in new systems.

Constraints faced towards adoption of CA

Convincing the farmers about the potential of CA is a difficult task. That's why the mindset of the farmers, researchers, extension workers, and technicians has to be changed. The major constraints towards its adoption are the equipment issues. Lack of appropriate seeders especially for small and fragmented lands, high cost of equipments and poor availability are major hindrances. Managing crop residues, particularly under rainfed condition, is very difficult as the quantity of biomass is lower under rainfed farming; moreover, these are used as fuel and livestock feed primarily. Again under irrigated agriculture farmers go for burning crop residues to clear the field earlier for subsequent crops for timely sowing. Application of CA equipments in managing crop residues is to be demonstrated in a wide scale to address the issue.

As the cultivation procedure has major departure from traditional practices, more and more extension programmes are to be arranged for making people aware about CA technologies. Access to various information related to CA viz., varieties, package of practices, machineries, etc. is also a major problem. Finally skill is very important for extracting success through adoption of CA technologies. Many a times we lack skilled support staff and trained scientific manpower.

Policy issues and strategies

Institutional arrangements and policy decisions are very important for promoting the CA practices over the country. How CA technologies integrate with other technologies? How to scale up CA practices at regional and national level? How to address livelihood security through CA? Whether there would be any support of subsidies towards promotion of CA technologies? How to support adaptation and validation of technologies? How to mainstream CA with different relevant ministries, departments or institutions? These are the questions to be addressed from appropriate policy interventions. From our experience, we have seen that local level service providers are playing a vital role towards adoption of CA technologies. But proper integration of institutional-technological-policy related issues is the need of the hour to make it a sustained viable option. As CA systems are very complex, building partnership amongst farmers, scientists, extension agents, policy makers, private players is very important for developing and promoting CA technologies.

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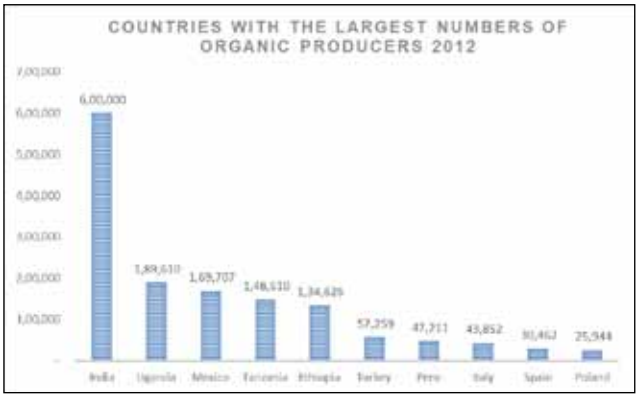
REINVENTING SUSTAINABILITY IN INDIA THROUGH ORGANICS

In the agricultural sector , India is a world leader. It is the largest producer of many agricultural commodities like milk, cotton, rice, bananas, pomegranate, mango, turmeric, papaya, sugarcane etc., with the production of organic certified commodities steadily rising as well.

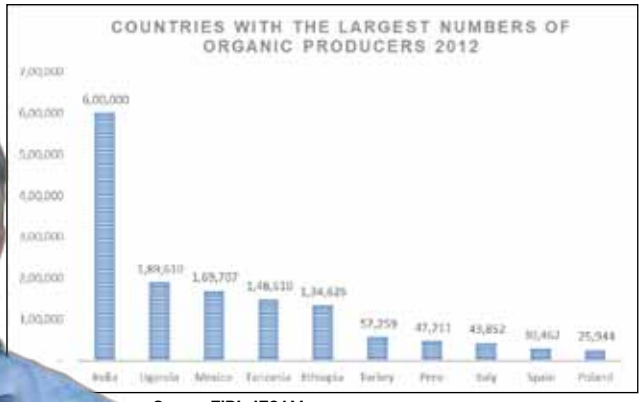
As per a report by the Research Institute of Organic Agriculture (FiBL) & the International Federation of Organic Agriculture Movements (IFOAM), India has the 4th largest land under organic cultivation - 2.66 million ha as on 2020, but in terms of number of organic farmers it is ranked the highest.

India has over 1.9 million farmers as of March 2020, which is 1.3 per cent of 146 million agricultural landholders .The country has 15 agroclimatic zones and favourable biodiversity. Another inadvertent push to the consumption of organic produce resulted from a pandemic-induced focus on immunity boosting food.

The Government of India is doing a lot to boost organic production through multiple schemes like PKVY, MOVCD, 10,000 FPO etc.



Source FiBL-IFOAM survey 2014



Source FiBL-IFOAM survey

The Current Situation

Though India has a massive potential to be a world leader in organics, the truth is that 20% of the world's population is consuming only about 1% of total organic produce. If one compares the USA with India in terms of consumption of organics food, the former with a population of about 100 million is a 50 billion US$ market, while India with a population of about 1.4 billion has a consumption value of only 400-500 million US$.

On the export front, the total volume during 2020-21 was only 1040.95 million US$ as against total agriculture export value of 49.60 billion . This means organic produce is currently only 2% of total agriculture exports. Thus, both from local consumption and export standpoints, organic has a lot of potential to grow.

Strategies for India to become the World Leader in Organic Food Production

Like any other commodity, organic produce is also driven by the forces

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of demand and supply. If enough demand is created, supply always gears up to fulfil that demand. Hence, the demand for organics needs to be increased in India.

Increased organic food production can be helped by a change in the way it is perceived, and by a few simple and logical steps in the way it is approached.

Change in Perceptions & Mind-sets

The first thing to do is to change the perceptions that individuals, companies and government agencies have with respect to "organic food".

a) The West is not necessarily the best: For many of us 'West is the Best'! Currently, Indian Organic Standards and boutique culture of selling organics are all copied from the West.

India, with its diverse culture and topography demands a whole new approach. The middle class population, that is estimated to be about 25% or about 35 crore people, is one of the biggest forces that is making the country self-reliant and not dependent on exports.

b) Organic Food is not just for the Elite: Most people look at organic as "food for the elite". This tag needs to be removed through aggressive marketing and instead a tag of "safe and affordable food for all" should be publicised.

This media campaign needs to be taken up consistently both by the Private and Govt sectors. Such an exercise would have health & nutritional impacts as well, as this would reduce disease incidence and promote healthier lifestyles. Meanwhile, it would also ensure that farmers receive an attractive remuneration and there is conservation of natural resources.

Every possible opportunity should be leveraged like making organics a part of the school and college curriculum, mandatory diet for sports, mid-day meals etc.

c) Organic is affordable: Many state that organic food is expensive as it is costlier to grow as compared to conventional. That, however, is not the complete truth.

It needs to be understood that like all natural processes, converting to organics takes time, but leads to a sure and permanent change in the soil and the produce.

If a farmer receives the appropriate technical guidance during the entire process of cultivation, he could reduce his cost of cultivation over a period of time.

It needs to be understood that like all natural processes, converting to organics takes time, but leads to a sure and permanent change in the soil and the produce. It needs to be planned accordingly. Switching from conventional farming to organics overnight is not possible, and almost always has negative results.

There are multiple technologies and systems that could be deployed to make organic at par with chemically grown crops in terms of prices.

In fact, Clover works on the "CRY" principal - reduction in Cost of production, increase in Rate owing to better quality and higher Yield. Along with production, a separate supply chain needs to be built to facilitate ready availability and traceability at the least cost and in the least amount of time.

d) Building authenticity & trust: In India, the general perception is that the genuineness of organics is suspect even though there are over 35 certification agencies, denting the perception of the authenticity of products available. The fact that most of them have been banned from time to time by APEDA also adversely impacts the trust factor.

Technologies could be leveraged to create transparency along with visits to organic farms. Stringent action for those violating norms along with promotion of those who are adhering to the guidelines needs to be implemented.

All of the above can be achieved through sustained and rigorous marketing and promotion strategies undertaken by the government agencies with the help of partner organisations & agencies.

Changes in approaches to & planning of the Production of Organics

Organic Food Production requires the adoption of simple and logical steps, explained simply below.

a) **Conversion of all eco-sensitive zones into organic zones:** All mountains, hills, river-and-lake catchment areas, areas near wetlands and all islands could be converted into organic hubs. They need to be completely saturated. This will not only help in conserving the environment, but also

increase the income naturally and improve the economy of these areas. In many places, this could lead to self-reliance.

In almost all mountain or hill towns, the majority of the food is imported from the plains. For example, in the Andaman & Nicobar Islands, food is brought in from the mainland. Switching to organics on the islands would mean import substitution through local production.

Realising this, the Government is already working on NMCG to preserve the waters of the sacred river Ganga. This should now slowly be implemented across multiple areas as mentioned earlier.

b) **Singular agenda through Convergence:** For organic demand and supply to increase manifold it becomes important for multiple departments within Government Departments to converge.

Traditionally, most departments work in silos that leads to higher costs, increased time, a lack of data sharing leading to duplication & confusion, non-optimal usage of assets, (e.g., cold storage, processing, logistics etc.), over hiring of manpower or outsourcing skill sets already existing with other departments etc. By synergizing their efforts, various stakeholders in the same project could achieve the same goal more efficiently.

Each department could own a unique agenda best suited to their individual mandates.

Some examples:

i. The Departments of Agriculture, Horticulture & Rural development: These could harmonize their efforts and start saturating all the areas as mentioned under point (a) above. They could together create a comprehensive State Plan to make these areas organic within a given time and budget. They could pool their existing and future assets, manpower and schemes to ensure a common agenda is followed. This would not only benefit them individually as they would be able to realise their mandates more efficiently but will also benefit the states as a whole.

ii. The Departments of Animal Husbandry and Fisheries: Integrated agriculture in the least possible time and cost could be carried out by including animals and fish with agriculture and horticulture crops. Multiple synergistic relationships could be formed, where the waste of one system becomes input for another, thereby saving cost and increasing yield and quality.

Example: Growing fish with paddy. Fish waste and fin movement provide nutrients and aeration to the soil respectively. By feeding poultry waste to fish and letting nutrient-rich waters irrigate the soil, poultry birds live off the pests on the crops and crop harvest waste etc.

This approach not only ensures better harvest and the least possible cost for the farmers, but also mitigates their risk of crop failure or negative fluctuations of market rates.

iii. The Department of Forests: Farming in the mountains and hills cannot take place without the help of forests. Forest leaf litter is an intrinsic input to animals and later the farms. Apart from this, the Non-Wood Forest Produce also supports livelihood, provided it is carried out judiciously.

iv. The Department of Education: Experiential learning is the best form of education. It is shocking to note that many children, especially in the metro cities feel that food comes out from the refrigerators and are not even aware of farms or massive efforts being placed by our farmers! This learning and awareness could be increased by school excursions to organic farms. Additionally, this would also lead to appreciation for organic foods, leading to higher consumption.

Way Forward

According to the report Organic Agriculture Countering Climate Change by IFOAM Organics International, supporting organic food production means supporting climate change mitigation & adaptation. Therefore, safe food not only rejuvenates and replenishes the soil, but at the same time, ensures a healthier populace and effectively counters the ill effects of climate change.

It is through the collective efforts of governments of both developed & developing countries, donor & development agencies, farmers and consumers that the planet can be healed and made safer for all life on it. This makes organic food production not just an option, but the only option for the future, thereby feeding into the act of re-inventing sustainability for India and for the world.

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TACKLING THE ISSUE OF BALANCED HUMAN NUTRITION THROUGH RIGHT PLANT NUTRITION

India is the world's second-largest food producer and a major food exporter. While the country has made huge strides in increasing the quantity of food it grows, the time has come to focus on the quality of food grown in the country. That's because quantity does not necessarily translate to quality. While most Indians have enough to eat, the nutritional requirements of many Indians are often not fully met. The consequences of not producing enough nutritious food cannot be ignored.

Many accomplishments, yet much work to be done

In 1947, India's agricultural output was relatively small, about 50 million tonnes. In 2020, it stood at a mammoth 308+ million tonnes. While before independence the annual growth of the Indian agricultural sector was just 1%, post-independence, government measures combined with the ingenuity of Indian farmers, increased the annual growth rate of the sector to an impressive 2.6 per cent.

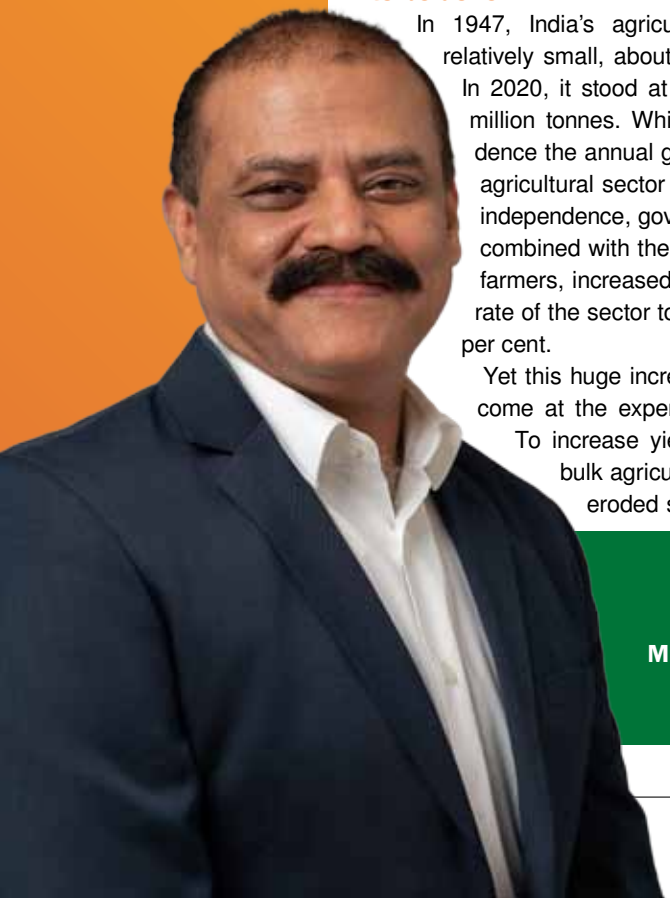
Yet this huge increase in growth has come at the expense of soil quality. To increase yields, farmers used bulk agricultural inputs, which eroded soil quality in many parts of the country. Consequently, the soil was depleted of many essential micronutrients leading to crops grown on them being deficient in these nutrients as well. Growing crops on nutrient-deprived soil results in a gap between yield and quality i.e., the number of crops grown increases, yet these crops aren't as nutritious as they ought to be. This results in malnutrition and nutritional imbalances for consumers.

Finally, farmers cannot export crops grown on nutrient-deficient soil as overseas buyers have exacting standards that crops grown by them cannot meet. This prevents farmers from increasing their income as they are unable to export to lucrative overseas markets.

In addition, there is another, perhaps more pressing reason why growing more nutritious food is more important than ever. Not producing nutritious food portends demographic disaster . The window of time India has to capitalize on its demographic dividend is short and closing fast.

According to some experts, it's already too late. They say India will be forever hobbled by a massive working-age population of hundreds of millions that don't have the skills to be meaningfully employed or to contribute to the nation's economy. Certainly, a jarring picture.

The country's population at 1.4 billion is already massive – it stood at just 340 million in 1947 - and remains on track to overtake China's as early as next year – a dubious distinction indeed! Ensuring that this vast population has adequately nutritious food will remain a challenge. Demographics may well work in India's favor. While the steps to make it so will be varied, supplying people with nutritious food is certainly one move in the right direction. However, the window



About the **AUTHOR**

Mr Sanjiv Kanwar
MD, Yara India

for the same remains brief.

A simple-actionable solution to forestall disaster

Zinc deficiency has long been recognized as a problem by nutritionists, medical scientists, and agronomists. Yet today, it has also caught the attention of economists and social scientists who see it as the cause of health-related, social, and economic problems. Today, nearly one-third of the world's population is believed to be zinc-deficient and thereby suffer from impairments to the immune system and mental well-being.

The remedy to this problem is astonishingly simple. It entails using zinc-fortified fertilizer to grow crops. If India does so, it will keep the country's working-age population well nourished and give it the mental wherewithal to tackle the challenges of our increasingly complex world.

Since the 1980s, zinc has been added to fertilizers to improve soil quality and crop nutrition. In Turkey, adding zinc to fertilizer not only proved to be an effective way to address public health problems but also helped to increase crop yields. In several countries, zinc-enriched fertilizer increased yields by an impressive 5.1%.

~~While growing crops using a fertilizer that contains zinc isn't a panacea that will make the country's demographics work in its favor, it is certainly one easily actionable step in that direction.~~

While growing crops using a fertilizer that contains zinc isn't a panacea that will make the country's demographics work in its favor, it is certainly one easily actionable step in that direction. In addition to adding zinc to fertilizer, there are other ways that nutrient deficiency can be eliminated. These involve concerted efforts from the government, private enterprises, and farmers themselves.

Government's role in achieving widespread nutritional security

Thanks to fortified rice and midday meals, food insecurity is no longer a pressing concern. Yet the Food and Agriculture Organization (FAO) said in a report that 14% of Indians, or approximately 190 million Indians, are undernourished. Because of suboptimal protein consumption in India, children suffer from stunting, wasting, and adults suffer from muscle loss, low immunity and slow-healing wounds.

A diet that consists primarily of staple grains such as rice and wheat is one culprit behind undernourishment in India. Without a diverse diet, many are unable to supply their bodies with the nutrients it needs. For instance, an average Indian gets nearly 60% of his or her protein from cereals. However, such protein is of low quality and because cereals lack certain amino acids, their protein cannot be digested optimally.

Advances in genetic engineering and food processing technology make it possible to provide adequate nutrition to everyone. Thanks to genetic engineering, yields can be increased, and the quality of plant proteins can be improved. Higher yields will lower the country's import bill and make rich sources of protein available to the masses.

Through regulations, the Indian Government can play a vital part in ensuring that genetically engineered crops are safe for human consumption. Before such crops are cultivated, the Government will have to make sure that risks like toxicity, allergenicity, and any unin-

tended effects are eliminated.

A richer and more diverse diet will go a long way in combatting nutrition deficiency in India. The private sector and farmers themselves have a direct role to play in the fight against nutritional deficiency.

Role of private players and farmers

By opening and operating centers in rural areas, private enterprises are already educating farmers on how they can improve the nutritional quality of their plants. At such centers, leading private companies not only provide farmers with the finest quality agricultural inputs but also the know-how to use them wisely. As a result, farmers have far more in their arsenal to fight against nutritional deficiency than they did just a few years ago.

Also, at such centers, farmers are provided digital farming tools as well as soil analytics services, which further bolster their efforts to increase crop nutrition. For instance, private enterprises are collecting soil samples from farmers' lands for analysis. Once soil samples are analyzed, farmers are provided granular insights about their farms and the farming practices best suited to them.

Farmers who successfully apply the new methodologies become role models and their techniques are emulated by others in the community. Their success stories spread far and wide and inspire others to learn from them and adopt their methods.

One of the most fundamental cogs in the wheel of our success will be growing nutritionally rich crops for domestic use and exports worldwide.

The combined efforts by the government, private enterprises, and farmers have the potential to not only improve the nutritional content of food grown in the country but also to propel India to the very top of the global economic order.

USD 5 trillion and beyond

A few weeks ago, the Indian PM publicly relished the fact that the size of the Indian economy grew larger than that of the UK economy. Just sometime later, Rishi Sunak became the PM of the UK. It goes without saying that the aspirations of 1.4 billion Indians are bound together by the desire to see India becoming one of the world's top 3 economies and by Indians' success on the world stage.

One of the most fundamental cogs in the wheel of our success will be growing nutritionally rich crops for domestic use and exports worldwide. Many Indian farmers are currently shut out from selling to overseas markets because their crops do not meet the nutritional standards of consumers in the developed world. Greater production of nutritionally rich grains and fruits will certainly help open many closed doors for such farmers. Consequently, exports will increase which will have a net positive impact on the economy. And perhaps more importantly, farmers' incomes will double from an average of USD 1800 to USD 3600. The former is nearly a prerequisite to India becoming a USD 5 trillion economy.

Also, to become a USD 5 trillion-dollar economy, India will have to grow its agricultural sector. Today it stands at USD 400 billion. The size of the agricultural sector will have to increase to meet the aspirations of all Indians, especially that of farmers. A specialized use of fertilizers that not only improve soil health and crop nutrition but also increase yields is certainly one way to expand the size of the Indian agricultural sector.

The challenges for which the Green Revolution was implemented have to a very large extent been addressed. Today, the country faces fresh challenges. These include the need to grow more nutritious food, increase farmers' incomes, and perhaps most importantly, make agriculture more sustainable. Addressing each of these challenges demands the introduction of new agricultural inputs, easy and widespread access to overseas markets, and innovative agricultural practices that sustainably increase yields. India will have to take step-change measures, to realize this vision and bring the country up in the tally of the top three global economies.

FEMINIZATION OF AGRICULTURE

PROBLEMS AND STRATEGIES

Around the world, women are impressively demonstrating their skills in all areas outside household and related sectors, making important contributions to the country's economy. In agriculture, women are the most important component, accounting for 60% of the labour force. The increasing migration of men from rural areas in search of better job opportunities has led to the feminization of Indian agriculture. This places an additional burden on women.

The world population is expected to increase by 50 percent by 2050, so women will be the key element in handling and managing the agricultural sector. Women working on agricultural processes, such as planting, weeding, transporting, processing, marketing, and storing produce, suffer from various health problems such as muscle fatigue, fever, dermatitis, migraines, respiratory diseases, visual and hearing disorders .

Women-specific activities are not prioritized in the sustainable development agenda

Productivity in agriculture is understood as increasing yields, but human performance in various tasks is usually neglected. Even though women perform many sweaty and low-skilled jobs, women-specific activities are not prioritized in the sustainable development agenda. This is evidenced by the fact that most available technologies are used for male-dominated activities.

Even after 75 years of independence, development efforts in various fields, including agriculture, are focused on rural development. However, the situation of women in the unorganized sector shows low work performance, without the use of modern tools and technologies, stress at work, physical drudgery, work-related hazards, and constraints that affect the optimal work performance of workers.

Little or no access to and control over technologies have made agriculture even more vulnerable, as has the decreasing size of landholdings. Today, small, marginal farms predominate. The average farm size has decreased from 2.28 ha in 1970-71 to 1.08 ha in 2021.

It is estimated that the average share of women in total agricultural labor time in the country is 32%, although this varies by state (less than 10% in West Bengal and more than 40% in Rajasthan), culture, stage of the production cycle, age and ethnicity of the women involved, type of agricultural activity, and several other factors. Women are involved in all agricultural

REASONS FOR DRUDGERY

- Labour intensive field operations
- Excessive reliance on human power
- Low productivity
- Laborious nature of work
- Decrease in the labour available for agriculture
- Lack of gender specific tools

About the **AUTHOR**

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activities, although some activities such as planting are predominantly performed by women and ploughing by men.

Several activities vary by crop and are segregated by gender

Rice, wheat, and jowar are the main crops that are intensively cultivated in large areas in India. Women prepare the seedbed for sowing by cleaning the soil with their hands and feet, removing stones and thorns, and levelling the ground. Transplanting is a women's business and the most labour-intensive process, as the seedlings are planted in knee-deep water all day long under a scorching sun and pouring rain. (Vinay.D, 2005) Weeding, i.e. plucking out the weeds, is usually done by women and children. (Vinay.D, 2016). Harvesting is an important agricultural activity that is strenuous and involves both men and women. The harvest is later tied into bundles with ropes and carried by them as a head load to the threshing place. Where traditional practices prevail, threshing, unless mechanized, is done by hand, knocking down the bundles so that the grains fall to the ground. The threshed grain is threshed to remove the chaff by standing on a raised structure and sifted by lifting the grain load onto sieves. Sometimes men and women beat the head of the sorghum ears with sticks to loosen the grains from the husk. The grain is then transported.

Sugar cane is grown as another main crop in most areas of the country. In sugarcane cultivation, women undertake activities such as weeding, pulling out sugarcane canes, and helping to make jaggery. Groundnut is an important oilseed crop, with many women helping to pull out the weeds. In addition to these, women harvest vegetables and fruits, spray chemicals and fertilizers, etc. in horticulture crops. The role of women as agricultural labourer in silkworm rearing activity is also important because mulberry gardens require labour for pruning, weeding, application of farm yard manure, fertilizers, and other jobs. During the off-season, when the availability of farm work is limited, women undertake non-farm jobs like brick making, jaggery preparation, bidi rolling, etc. A large number of women, in certain pockets of the country work in bidi kharkhana or at home, rolling beedis from morning to night.

HURDLES IN DISSEMINATION OF TECHNOLOGY TO WOMEN FARMERS

- Extra investment involved in existing traditional crop practices
- Socio cultural reasons such as taboos
- Limited access to technologies
- Lack of market research or supply information by companies.
- Lack of access to cash and reluctant on the part of husbands to contributes towards such technologies
- Limited access to training and technical skills in labour- saving technologies.

In the fisheries sector, women are involved in fishing in pools, fish marketing, and net weaving. Their most important contribution is drying fish, one of the most widespread methods of fish preservation. It is their daily routine to spread the fish out in the hot sun, turn them over from time to time, guard them constantly, and pack them back into baskets before sunset. In marine fishing, drying fish is the activity most often performed by women, followed by selling fish and transporting it. Activities such as livestock rearing are also part of women's livelihoods. Nearly 70 percent of livestock work is done in states like Punjab and Haryana. Women are also active in sectors such as backyard poultry and beekeeping.

Availability of the ergonomically designed tool is negligible

Agricultural mechanization has been recognized by the Indian government as an important means of improving the rural economy and agricultural productivity. In addition, the mechanization policy aimed to reduce the drudgery associated with various agricultural activities, rationalize the use of inputs, and thus harness the potential of available resources. Progress in agricultural mechanization has been significant, as cropping intensity has increased and imports of tractors, combines, and other improved equipment. Nevertheless, the development and adoption of technology in India are still far from desirable levels, especially in the case of women farmers where the availability of the ergonomically designed tool is negligible.

Therefore, the goals of mechanization in agriculture should be such that it contributes to a sustainable increase in yields and cropping intensity to achieve the planned growth rates in agricultural production, and makes the working environment friendly, especially for female workers, by reducing drudgery and health risks and improving safety in production operations.

While, the issue of feminization of drudgery is not new, it is not discussed

as much as other issues. The benchmark study of the Family Resource Management component of the All India Coordinated Research Project on Home Science (ICAR) found that the core problem of "drudgery" was related to labour-intensive fieldwork, over-reliance on human power, low productivity of human labour, the arduous nature of the work, and the decrease in the labor force available for agriculture.

AICRP (FRM) researchers have applied an organized approach to developing technologies to reduce drudgery for rural women in 13 state agricultural universities.

The research findings provide important insights into understanding the drudgery of farm women in India

The data shed light on what causes drudgery, how drudgery differs by type of farming activity, what work-related disorders exist, which body zones are priorities, and in which areas technological interventions are useful. The data also help to understand regional differences in different aspects of drudgery in agriculture. The results of the research showed that gender participation varied by culture. Women's exclusive participation was lower than men's for rice, wheat, maize, and cotton crops. Women's dominant participation was lower than women's subordinate participation in the above crops. In sorghum, women and men shared equal roles in about 43 percent of the activities. In cotton, 58% of the activities were performed exclusively by men.

The study also examined the causes of drudgery and how they vary by type of activity. The study observed that the time spent on work, feeling of exhaustion, work posture, manual strain, perception of difficulty, and perception of workload are the factors that cause drudgery almost to a medium extent.

In paddy cultivation, posture is the factor that significantly contributes to drudgery in grubbing and transplanting. The physiological load was the factor that significantly contributed to drudgery in fertilizer application. Temporal stress was the factor that significantly contributed to drudgery in transplanting and uprooting, and MSD stress in picking and land clearing in paddy cultivation. On the other hand, in wheat cultivation, repetitive loading was found to be the factor that significantly contributed to drudgery in weeding, land clearing, and picking, and sowing activities, fertilizer application and seed treatment, bagging, land clearing, and cutting were influenced by repetitive loading compared to other factors. MSD load was the factor that significantly contributed to drudgery in cutting and threshing. Manure application and seed treatment were the least responsive to the MSD load factor. Similarly, in vegetable cultivation, it is observed that the physical load factor in the biplots explained 58.72% of the variation in the two principal components. The physical load was the factor that significantly contributed to the drudgery of manually carrying and broadcasting seed, and channel making. Transporting manure and top dressing activities were least responsive to physical load.

Posture was the factor that significantly contributed to drudgery in weeding, harvesting, clearing, and gathering, and the repetitive strain was the factor that significantly contributed to drudgery in weeding, harvesting, land clearance and gathering, and hoeing

Technology development and refinement took place in the areas of seedling transport containers, seedling transplanters, gloves, sulbha bags, grain picker, Sapling carrier bag, paddy stripper for seed selection, Revolving stool for milking, grain picker, Face protector, water bag, sugarcane harvester, improved sickle, mulcher, head load manager, carrot cutter, Ergo stool for pruning and harvesting in viticulture, Cotton boll plucker four prongs, flower harvesting bag, and medium hoe for bundling and weeding in maize crop.

Many technologies were ergonomically evaluated after field interventions. Some of them are seed dibbler, rice picker, seedling planter and flower harvesting bag, Revolving stool, Dung collector, rice picker and water bag. The findings of the work done conclude that "Mitigating drudgery" is a possible outcome that makes women work with improved production capacity and good health, which can be achieved through technological interventions.

STRATEGY TO MITIGATE THE DRUDGERY OF FARM WOMEN

- Allocate a certain percentage of beneficiaries as exclusively for women (15-20 % in all programs.)
- Design training and skill development programs exclusively for women.
- Prioritize intervention for drudgery reduction as per cropping pattern.
- Disseminate examples of women overcoming cultural barriers to use of labour-saving technologies and practices and encourage exchange visits.
- Design gender friendly tools based on body dimensions and local practices
- Train rural artisans/ women technology groups in repair and maintenance of gender friendly tools in each village
- The role of public policy in increasing accessibility and affordability of women friendly drudgery reducing technologies be promoted through various schemes.

AGRICULTURE 4.0: DIGITALLY TRANSFORMING AGRICULTURE

The agricultural world is continually changing with multidimensional forces at play. COVID and Geopolitics leading to pressures on agriculture production and supply chain systems have made these changes becoming more profound. Especially the impact of these new dynamics on global food prices has made the impact more problematic as it threatens the food security of one-fifth of the world population.

Further, the need is for a more serious approach to one of the biggest challenges faced by humanity in the form of the Climate Crisis. The recent impact of climate change on corn or soya in the USA, wheat or rice in India, and many similar production regions are evidence of the fact that climate change will disrupt food availability, reduce access to food, and affect food quality. The projected increases in temperatures, changes in precipitation patterns, changes in extreme weather events, and reductions in water availability are already resulting in reduced agricultural productivity.

We must look for a reset of the way we conduct our agriculture.

One of the fundamental drivers to address these changes is the digitization of agriculture to enable data-driven decision-making on a real-time basis. Agriculture 4.0 will make the sector more agile to tackle challenges posed by the unprecedented global order.

Agriculture 4.0 can be seen as a subset of the digital economy, which can be defined as the economic activity that results from everyday online connections among people, organizations, and devices with data, and processes at its center. The backbone of Agriculture 4.0 is hyper-connectivity which is catalyzed by the growing interconnectedness of farmers, agribusinesses, policy-makers, global regulators, multilateral agencies, markets, and agriculture machines that results from the Internet, mobile technology, and the evolving new business and operational models.

At the core of Agriculture 4.0 is digital transformation which in simple terms is using the latest technology to do what we already do – but better. As we see going forward two key factors to catalyze Agriculture 4.0 are the ease of connectivity and the multidimensional use of data, both of which are transforming business models, facilitating new products and services, creating new processes, generating more value, and leading to a new culture of policy making.

Impact of Agriculture 4.0

Agriculture 4.0 supportive digital technologies including the Internet, mobile technologies, sensors, remote sensing, drones, data analytics, artificial intelligence, and blockchain, are changing agriculture and the food systems across the globe. Digital technologies are impacting agriculture at different stages of the agri-food value chain for example farm machinery automation allows fine-tuning of inputs and reduces

About the **AUTHOR**

Mr Deepak Pareek is Founder – HnyB Tech-Incubation Pvt. Ltd. Deepak is a well-decorated technocrat honored as Top 10 Agropreneur 2019 by Future Agro Challenge and Technology Pioneer 2018 by World Economic Forum. He has also served as a member of the Expert Panel of the World Economic Forum on Digital Transformation. Deepak is an influencer, investor and advisor in FoodTech and AgTech domain. Deepak sits on Board of Director and Board of Advisors of various AgTech & Food Tech Incubators, Startups, Accelerators and Venture Capital Firms. He has 22 years of diverse experience working across 34 countries on various projects. He also advised various private, public, and multilateral organizations in the agriculture and technology domain. Deepak is a global influencer in the agriculture and food space with demonstrated evangelism in areas of Food Safety & Security, and Digital & Smart Agriculture.

demand for manual labor, remote satellite/drone data, and sensors on the field improve the accuracy and reduce the cost of monitoring crop growth and quality of land or water while traceability technologies, blockchain and digital logistics services offer the potential to streamline food supply chains and create trust amongst the supply chain participants and consumers.

Digital technologies also help governments fine-tune and improve the efficiency and effectiveness of existing policies and programs, and to design new policies which are more relevant and pragmatic. For instance, freely available and high-quality satellite imagery dramatically reduces the cost of monitoring many agricultural activities. This could allow governments to move towards more targeted policies which incentivize farmers based on observed outcomes. Further, digital technologies enable the automation of processes for agriculture and the development of expanded government services, such as extension and advisory services.

Finally, digital technologies can support trade in agriculture and food products, by creating market linkages between producers/suppliers and new markets, and enabling new ways for governments to monitor and ensure compliance with standards and to provide faster and more efficient procedures that are essential, especially for perishable products.

Challenges of Adoption of Agriculture 4.0

The need is for accelerating the urgency for digital transformation to achieve agility, adaptability, and sustainability.

Some of the key challenges in scaling up Agriculture 4.0 include but are not limited to the adoption of new technologies, the emergence of new business models, agility in the creation of a supportive policy environment, global cooperation in sharing of success and failures, and last but not least availability of skilled resources.

As we see new technologies including quantum computing, 5G/6G telecommunication technology, cloud computing, artificial intelligence, and machine learning all acting as positive green shoots, however, their uneven adoption, especially in the agriculture sector, is creating a digital divide which is going to be a big hurdle.

While we have seen the emergence of new business models in both public and private sectors yet the biggest roadblock is these models are still in the early stages and while we have shortened the transformation curve yet it is too slow and can be a speed bump.

On the policy front, we again see governments and regulators, because of their lack of understanding of modern technologies and models, confused. Policy regimes must catch up with the pace of innovations.

Better cooperation and collaboration globally on Agriculture 4.0 initiatives is the need of the hour yet we still see that not happening as much as is desired. We see a few organizations trying to become the pivot but we need more decentralized models of collaboration emerging including a healthy mix of public and private organizations.

Last but not least the severe shortage of appropriately skilled manpower is the biggest threat to the scaling of the digital economy.

Emerging Technologies for Agriculture 4.0

Digital technological advances and transformation can support the goal of achieving more resilient, productive, and sustainable agriculture and food systems, that better meet consumer needs.

We are living in a time when economic paradigms are shifting. Exciting technological innovations are driving transformative change. While many technologies will reshape agriculture a few key ones are listed below.

• **Artificial Intelligence/Machine Learning/Deep Learning:** These are a collection of technologies that can be used to solve problems autonomously and perform tasks to achieve defined objectives without explicit guidance from a human being.

• **Internet of Things**: It is a network of physical objects that can connect to the Internet and seamlessly share data with each other and the central analytical brain on the cloud. These are a collection of technologies in the field of sensor, connectivity, security, and communication protocols.

• **Blockchain:** In short it is a software solution comprising algorithms that allow data to be verified and stored in a distributed network, thereby reducing single points of failure, mitigating fraud, and enabling the automated execution of agreements via smart contracts.

• **Quantum Computing:** Quantum computing is a type of computation that harnesses the collective properties of quantum states, such as superposition, interference, and entanglement, to perform calculations. Quantum computing has the potential to provide computational power on a scale that traditional computers cannot ever match hence better simulation is key to better prediction of weather, and new variety breeding to name a few.

• **5th and 6th Generation Wireless Technologies:** Although it is still early days for 5G wireless technology, top industry players are already busy working on its successor, the 6G Wireless Technology. While 4G gives speeds up to 50 Mbps and latency between 50 milliseconds to 100 milliseconds, 5G gives speeds up to 10 Gbps and latency between 1 millisecond to 10 milliseconds, and 6G is expected to give speeds up to 1 Tbps and latency of 1 microsecond. 5G and 6G will enable computer vision technologies to play a vital role in managing farms more efficiently with better predictive analysis.

Agriculture 4.0 is no longer a luxury but an eminent Necessity!!

Carnot Tech

HELPING RENTAL ENTREPRENEURS GROW

Carnot Tech, India's leading AI-enabled Agri IoT platform, was founded in 2015. Initially established as a tech-enabled solution to increase visibility about the automobile movement, the company pivoted to agri-tech in 2017 and is now the only company in India focused on the growth of Rental Entrepreneurs, a community of more than 60 lakh people in the tractor rental business.

Set out to solve the automobile visibility problem with a small plug-and-play device that would give real-time updates to one's smart phones from the car, about the car, Carnot Tech has now raised substantial investment from Mahindra and Mahindra and is expanding their business overseas as well. Their flagship products Simha Telematics & Krish-e Diary are helping rental entrepreneurs earn up to 30% more.

Helping Those Who Rent Tractors

Unique in its positioning with an impact beyond just agriculture, Carnot Tech is building and disseminating its tech startup journey with business metrics and PMF.

About the AUTHOR

Driven by the zeal to position India as one of the world's leading tech-solution providers across industries, Mr Pushkar Limaye founded Carnot Tech in 2015. As Chief Engineering for his team at the Formula Student Race, Mr Limaye tumbled upon the existing gap in the automobile visibility industry and decided to fill the gap

The largest and smartest IoT platform in its segment, Carnot Tech identified a crucial community involved in agriculture and coined a term for them - Rental Entrepreneurs.

Keen on building products that solve real problems, Carnot Tech found its true potential when the founders got to know about a community of entrepreneurs who were earning their livelihood by renting their tractors. When the company scratched the surface of this business venture, it realized that the tractor rental business was not just a small community but a huge sector of around 60 lakh people.

These rental entrepreneurs were renting out tractors every day. But they were at a disadvantage. Without the relevant knowledge about managing their tractors, their driver, diesel expenses etc, the community was functioning in a very obsolete pattern with no set income. While their business accounted for more than 90% of the tractorization of India, their earnings via the same were not as fruitful as they could be and it was all because of the tech gap.

Understanding The Gaps

Focused on identifying the issue that plagues this sector, the core team spent 6 months in Uttar Pradesh and mapped out this Rental Entrepreneur persona. They understood the gaps in the system and realised that their telematics system could solve these problems with the telematics data. Their product is now helping these Rental Entrepreneurs monitor their tractors and streamline their income. Deciphering that these entrepreneurs did not have the bandwidth to define the average of how much work their tractor has done, Carnot Tech tested their telematics product to accumulate relevant data and make it accessible to the tractor owners. Their product and services now ensure that the tractor is not misused, prevent theft of diesel etc.

Mr Limaye is passionate about technology and building products

These entrepreneurs did not have the bandwidth to define the average of how much work their tractor has done. The products and services from Carnot Tech now ensure that the tractor is not misused, prevent theft of diesel etc

In addition to streamlining income for the rental entrepreneurs, Carnot Tech also brought them to the centre stage as a key cog in the agricultural industry which had long been overlooked.

Winning The Qualcomm Competition

After winning the Qualcomm competition and a grant of 100,000 USD Dollars, Carnot Tech started exploring the tractor and bike space i.e large fleets besides cars that could benefit from a telematics system. After a tryst with the tractor community, Carnot Tech made history with their product.

The IoT platform Simha (rebranded to Krish-e Rental) by Carnot Tech now has over 25,000 tractors, harvesters and sprayers working on over 3 million acres of land each season. The platform is protected by 5 patents. What began with 3 IITians is now a company of over 70+ team members, operating in more than 8 states and impacting over 1.5 Lac farmers.

What gives them an edge over other agri-tech startups is their understanding of their sector. They understood the need for their product before they entered the market. They are the only company in India working with these rental entrepreneurs. Carnot Tech's tractor telematics helps small rental tractor entrepreneurs & Enterprises to take the guesswork out of daily operations. It consists of an advanced IoT device that can be retrofitted onto any tractor or harvester & pairs with the Simha app to provide powerful insights. It includes customizable web dashboards for enterprises and is capable of supporting 100s of tractors.

With the growth of the company, Mahindra And Mahindra has further invested strategically in Carnot Tech. As Service contractors for the Krish-e app, the company is helping Mahindra and Mahindra tap into the farmer community to reach a wider audience of first-time tractor buyers.

Carnot Tech is now working on its global expansion. The company has already started catering to Rental Entrepreneurs in Europe and Africa and is witnessing a massive response to its product.

India Ka Pranam
Har Kisan Ke Naam

The dedicated hardworking farmers of India deserve recognition. Year after year our farmers who battle great odds and adversities to make India self-sufficient deserve our salute.

For the last 4 decades, Dhanuka Agritech Limited is working with farmers and moving forward together. During this journey, Dhanuka took a pledge to bring prosperity in the lives of these farmers using advanced tools and technology. Dhanuka's trained field force is empowering farmers with new age ways of increasing farm yields and crop production.

Dhanuka is committed to bringing a positive transformation to the lives of farmers. At Dhanuka, we believe every citizen of India will salute the farmers for their dedication, determination and grit.

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*Map not to scale