

SOUVENIR

ONE DAY NATIONAL WORKSHOP ON
NUTRI CEREALS

16th OCTOBER 2019

KRUSHI BHAWAN
Gopandhu Marg, Bhubaneswar

ORGANIZED BY



DEPARTMENT OF AGRICULTURE
AND FARMERS' EMPOWERMENT
GOVERNMENT OF ODISHA
(ODISHA MILLETS MISSION)



DEPARTMENT OF AGRICULTURE,
COOPERATION & FARMERS WELFARE
GOVERNMENT OF INDIA
(NFSM-NUTRI CEREAL)





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MESSAGE

Millets have been central to the food and nutritional security of the tribal people. They were grown by other communities as well in the past but have declined due to lack of support. With growing climate vulnerability, it is important to support millet growing farmers. It is with this objective that the Odisha Millets Mission was launched in 2017.

The mission aims at improving production, consumption, processing and marketing of millets. Millets are also being included in the State Nutrition Programmes. Promotion of millets is also an integral part of the Agriculture Policy of Odisha which aims at providing an income support to farmers. We are also promoting the consumption of millets in urban areas and millet-based entrepreneurship.

I am happy that the Department of Agriculture and Farmers' Empowerment, Odisha is hosting the National Workshop on Nutri-Cereals on 16th October, 2019 in collaboration with the Government of India.

I wish the endeavor all success.

(NAVEEN PATNAIK)





DR. ARUN KUMAR SAHU

MINISTER

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MESSAGE

Millets are grown under rainfed conditions by tribal farmers in Odisha. The Government of Odisha launched the Odisha Millets Mission with the primary objective to support these millet growing farmers and rejuvenate production and consumption of millets at the household level. Procurement of Ragi at Minimum Support Price was also initiated last year which also enabled us to provide Ragi to ration card holders.

Such efforts have inspired other States as well to invest on millet promotion. We are committed to the cause of supporting millets in future as well. Integration with different government programmes to increase millet consumption, market linkage with bigger agencies for sustainability of millet cultivation are some of the key areas focused by Odisha Millets Mission. We hope that we will be able to revitalize the millet economy in the state through our efforts in the mission. I hope that the National Workshop on Nutri-Cereals shall enable the participants to discuss at length to make strategies for promotion of millets.

I convey my best wishes to all the delegates and wish the National Workshop all success.

(DR. ARUN KUMAR SAHOO)



SHRI PRADIPTA KUMAR MOHAPATRA, IAS

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MESSAGE

Odisha has made impressive growth in the agriculture sector over the past few years. However, despite this growth, both acreage and yield of millets has continued to decline. The Odisha Millets Mission has tried to support tribal farmers who are cultivating millets and include them in the growth story.

Support has been extended across the crop-cycle on production, processing, marketing and consumption. Technical hand-holding support to the farmer at the village level and a monetary incentive for millet cultivation has been provided for in the programme.

The programme is a case study in successful convergence. The Women and Child Development, Food Supplies and Consumer Welfare, Cooperation, SC/ST, Minorities and Backward Classes Welfare departments have been working with the Agriculture and Farmers' Empowerment Department to implement procurement of Ragi and distribution under the PDS.

The National Workshop on Nutri-Cereals is an opportune moment to share our experiences with scientists, practitioners, farmers and entrepreneurs working on millets. I express my best wishes to the Department of Agriculture and Farmers' Empowerment.

(PRADITPA KUMAR MOHAPATRA)



DR. SAURABH GARG, IAS
PRINCIPAL SECRETARY

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MESSAGE

Millets have traditionally been a part of the culture of Odisha and also of many other states. Millets play an important role in supplementing the nutritional and fodder requirements of the household. They are climate resilient crops which can be grown under rainfed conditions in marginal soils with less input. Finger Millet, Little Millet, Foxtail Millet, Kodo Millet, Sorghum and Bajra are common to the state of Odisha.

In spite of their many benefits, due to lack of institutional support, area under these millets has declined substantially. In this context, the Government of Odisha launched a Special Programme for Promotion of Millets in Tribal Areas (Odisha Millets Mission) to revive millets in farms and on plates in 2017. It is a unique partnership model where the Government of Odisha, Academia (led by NCDS) and Civil Society (led by WASSAN) have joined together to implement the programme through Farmer Producer Organizations (FPOs) in 72 blocks covering 14 districts.

Odisha Millets Mission has a comprehensive approach and includes interventions in production, processing, consumption and marketing. The procurement of Ragi has been a historic

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initiative of the government in providing price support and an assured market to millet farmers. In addition, Ragi was supplied to 16 lakh households on a pilot basis in FY 2019-20.

The Government of Odisha is now planning to include millet recipes in ICDS and MDM in a phased manner. Government of India has also asked other states to adopt the structure, framework and monitoring models of Odisha Millets Mission.

With 2023 scheduled to be declared as the “International Year of Millets”, I am confident that this workshop shall further build on the existing experiences and develop a strategy to overcome obstacles to revive millets in farms and on plates.



(DR. SAURABH GARG)



DR. M. MUTHUKUMAR, IAS
DIRECTOR

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Food Production, Odisha

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MESSAGE

Government of Odisha has launched a “Special programme for promotion of millets in tribal areas (Odisha Millets Mission)” in 2017. The programme aims to address the issues of food and nutrition security through the promotion of 'native' millets. The major objectives of the Odisha Millets Mission (OMM) are increase household consumption, setting up decentralized processing units at block level, increasing productivity of millet crops through improved agronomic practices, conservation and promotion of local landraces, better marketing of millets through farmer producer organisations and inclusion of millets in ICDS, MDM and PDS.

Over 50000 farmers have taken up millet cultivation through improved agronomic practices. The entire programme is funded from the State Plan. Through successful demonstration of interventions on multiple fronts, the OMM won accolades from the Government of India and Niti Aayog.

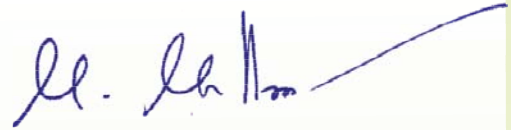
I take this opportunity to sincerely thank Principal Secretary, Agriculture & Farmers Empowerment and the members of the High Power Committee on Millets for their continuous and generous support for the mission. I thank our farmers, department

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staff, OUAT, the State Programme Secretariat (NCDS and WASSAN), partner NGOs for their efforts in making this mission successful.

I thank Government of India for jointly organizing the National Workshop. The timing for this “National Workshop on Nutri Cereals” scheduled on 16th October 2019 is an appropriate one. This workshop aims to deliberate with all stakeholders on different aspects of the millet eco system. Aim is to re-look at our efforts, learn from experiences of other states, and understand the latest technological breakthrough from academia and the market agencies. This is also time to celebrate the efforts of our farmers, department officials, researchers, academia, NGOs and entrepreneurs involved in our mission.

I hope that through this workshop will go long way in sowing the seeds for revival of millets in the state of Odisha.



(DR M. MUTHUKUMAR)

SECTION - 1

DR M MUTHUKUMAR, IAS
Director, Agriculture & Food
Production, Odisha

SPECIAL PROGRAMME FOR PROMOTION OF MILLETS IN TRIBAL AREAS (ODISHA MILLET MISSION)

Special Programme for Promotion of Millets in Tribal Areas of Odisha (Odisha Millets Mission) was launched by **Department of Agriculture & Farmers Empowerment, Govt of Odisha** in 2017 to revive millets in farms and on plates. It emerged from a consultation between Government, Academia (NCDS) and Civil Society (RRA Network, ASHA Network and local NGOS). It was first agriculture programme with priority on increasing consumption in Odisha.

Main objectives of the programme:

1. Increasing household consumption of millets by about 25% to enhance household nutrition security and to create demand for millets.
2. Promoting millet processing enterprises at Panchayat and Block level to ease processing at households and for value added markets.
3. Improving productivity of millets crop systems and make them profitable.
4. Developing millet enterprises and establishing market linkages to rural/urban markets with focus on women entrepreneurs.
5. Inclusion of millets in State nutrition programmes and public distribution system.

The nodal department for the OMM is **Department of Agriculture & Farmers Empowerment**, Government of Odisha. **Directorate of Agriculture & Food Production, Odisha** is the nodal implementation agency within the department for the programme. Programme was launched in 30 blocks covering 7 districts in 2017 with a budget of Rs 65.54 Cr for 5 years. Due to positive response from farmers, it was scaled up to 72 blocks covering 14 districts. The programme is implemented with community based organisations with support of local NGOs at block level.

Government of Odisha has increased the funding from Rs 65.54 Cr to Rs 536.98 Cr. Out of which Rs 223.92 Cr is for project implementation and Rs 313.06 Cr is for procurement and distribution of Ragi in PDS and ICDS. **Entire programme is funded through state plan.**



Unit of the Implementation: Block is the unit of the program. Each block should cover at least 1000 Hac in the 5 years. Crop demonstrations shall be taken up in contiguous cluster basis. Minimum demonstration area per farmer is 0.2 Hac per farmer. Maximum demonstration area per farmer is 2 Hac. Program expects to cover at least 1000 households in a block directly. Programme shall cover 4000 households per block through production, consumption, processing and FPOs.

PROMOTING HOUSEHOLD LEVEL CONSUMPTION

1. Building prestige in consumption of millets through organising cooking competitions and celebration of local millet based food cultures.
2. Exposure to various recipes through a process of training, food festivals and others.
3. Promotion of ready-to-eat foods with millets such as bakery items and other such enterprises.
4. Awareness building programs on nutritional values of millets to different stakeholders, especially mother committees of women and child department programs and school students

SETTING UP DECENTRALIZED PROCESSING FACILITIES

Absence of modern processing facilities is identified as one of the major bottlenecks in revival of millets. It is envisaged that promoting processing facilities helps in easy access to millet grains. The processing facilities to be promoted in a Block include:

1. At least one Processing Unit / enterprise per cluster of villages/GPs that includes de-huller, de-stoner and pulveriser.
2. At least one pulveriser (particularly for Ragi) per Gram Panchayat.

It is expected that successful establishing of such enterprises may kick start local enterprises and encourage household consumption. It is envisaged that with experience and increasing production within the Block, larger processing facilities will get established by private partners.

IMPROVING PRODUCTIVITY OF MILLET CROPS

Millets are cultivated in different farming situations from the low lands to podu lands. There is substantial scope for increasing productivity of millets in these different situations. The action areas include:

- A. **Establishing Community managed seed centres** to enable easy access to quality seed in time. The Seed Centres will be linked to the relevant Research Stations. The activities of the Seed Centres include
 - a. Selection, purifying and multiplication of elite performing local varieties through participatory trials.



- b. Developing and specialising 'Seed Farmers' for multiplication and spread of new varieties and organise them with Seed Centres
- c. Demonstrations of new / improved / purified seed varieties.
- d. Storage and supply of farmer preferred landraces/seeds to farmers.
- e. Conservation and multiplication of indigenous varieties of seeds.

B. Improved agronomic practices: In addition to the improved package of practices the following have shown potential.

- a. Introducing System of Crop Intensification based on suitability.
- b. Promotion of Line transplanting/Line sowing/Inter cropping of millets.
- c. Improved manure/ composting / in-situ practices for better crop nutrition
- d. Pest and disease management practices in the lines of NPM.
- e. Other organic/agro ecological practices as deemed necessary as per local needs.

C. Custom Hiring Centres : Establishing custom hiring centres for implements, machines and post-harvest operations (clean millet harvests) at clusters of Gram Panchayat level. These include a range of useful material such as crowbars, tarpaulin sheets to mechanical weeders.

D. Community Resource Persons: Training of the identified progressive farmers or young persons on different themes and using them in program implementation based on need and for imparting training to the farmers by CRPs. Farmer to farmer learning is the key dissemination strategy.

MARKETING

The program targets two types of markets i.e. Rural and Urban. Strategies of better price realisation are:

1. Promotion and accessing of markets within the Block and district: this happens with help of promotional campaigns and outreach locally.
2. Promotion and linkages with markets in nearby towns/ cities and urban areas.
3. Opening up special outlets for farmers, promotional campaign targeting small hoteliers, push-cart vendors, retail outlets etc are some of the strategies that will be adopted.

FARMER PRODUCER ORGANISATIONS

Comprehensive revival of millets in a Block requires service delivery. The community/ farmers' level institutional base varies from Block to Block. It is envisaged that FPOs are organised one per Block, keeping long-term sustainability and delivery of services in the view. Farmer Producer Organisation shall be linked



with community institutions such as custom hiring centre, community seed centre, etc. FPOs shall also provide aggregation and other need based services.

PROGRAM IMPLEMENTATION STAKEHOLDERS

The programme will implemented with community based organisations with support of local NGOs at block level. A state secretariat for Odisha Millets Mission was formed. State Secretariat had Programme Secretariat and Research Secretariat. WASSAN was chosen as programme secretariat to support the DA&FP at state level and ATMA at district level. NCDS was chosen as research secretariat. State Secretariat was hosted at NCDS.

ROLES & RESPONSIBILITIES OF STAKEHOLDERS

SNo	Level	Agency	Role
1	Sub-Block level	Community Based Organisation	Implementing the program
		Village Agriculture Worker	Supports and Reports the progress to Block AAO
2	Block Level	Facilitating Agencies(FAs) NGOs will be selected as FA.	Facilitating and supporting the Farmers' organisation in implementation
		AAO	Supports FA in convergence and monitoring the program
3	District Level	Collector and District Magistrate DPMU, ATMA Programme Secretariat (WASSAN)	Program Administration, funding and convergence. Convergence and Governance
4	State Level	Program Secretariat (WASSAN)& Research Secretariat by NCDS	Program Management of the Program, Convergence, support to FAs, capacity building, communication and policy development
		SPMU, OMM headed by JDA, Millet	Administration and Monitoring of the programme.
		Directorate of Agriculture and Food Production headed by Mission Director	Approval and Sanctions.
		Department of Agriculture & Farmers Empowerment	Funding and Scheme related amendments and changes.
		Mission on Millets Committee	Governance, Inter departmental approvals and policy development



ACHEIVEMENTS OF THE ODISHA MILLETS MISSION

1. In FY 2017-18 & 2018-19, OMM has reached out to 37910 farmers through crop demonstrations.
2. It was seen average yield for the Ragi has increased from 8 Qntl/Ha to 13 Qntl/Ha despite long dry spells in multiple districts verified through 1000 CCEs.
3. Participatory varietal trials with 185 landraces with 37 repetitions in 2018-19.
4. 72 custom hiring centres have been established.
5. 72 block level seed centres are in process of establishment.
6. Pilots in ICDS initiated in 20 AWCs in Gajapati and Nuapada Districts.
7. Procurement of Ragi through TDCCOL in 8 districts.
8. Distribution of Ragi in PDS covering 16 Lakh Beneficiaries.
9. Mandia Café initiative in **Hockey World Cup** through WSHGs of Mission Shakti.
10. Millet urban internship programme with young students.
11. MoA signed with IIMR for technical partnership.
12. Engagement with CSIR-CFTRI, ICRISAT and FAO on different aspects of millet value chain.

POLICY MAKER ENGAGEMENT

Odisha Millet Mission team also set up many stalls at many state level/national level events. Millet related events were also organised for the following external guests:-

1. Dr Shaktikanta Das, Governor, RBI.
2. Dr N K Singh, Chairman, 15th Finance Commission.
3. Dr Ramesh Chand, Member, Niti Aayog
4. Dr Arvind Subramanian, Ex-CEA, GoI

POLICY MILESTONES

Odisha Millets Mission has achieved following milestones:-

1. Odisha became first state to develop standard specifications for the minor millet machinery through recognised panel of experts from different scientific institutions.
2. Odisha became the first state in the country to complete benchmarking of prices of little millet and foxtail millet.



3. Odisha became the first state to declare direct incentive to farmers for three years through DBT for adoption of improved agronomic practices.
4. Odisha Millets Mission received silver prize under Transformational innovation Skotch” award.
5. Odisha received award for best government initiative on millet promotion by MoFPI-IIFPT.
6. Third state to distribute millets in PDS to 16 Lakh Households in the country.

RECOGNITION & IMPACT

The Odisha Millets Mission have received following recognition:-

- a. Government of India has asked all states to adopt Odisha Millets Mission model for promotion of millets, pulses and oilseeds.
- b. Niti Aayog has chosen Odisha and Karnataka as two progressive models and will to facilitate the learnings of these states for other states.
- c. State Planning Commission of Chhattisgarh has asked Government of Chhattisgarh to start a millet mission on the lines of “Odisha Millets Mission”
- d. Governor of Maharastra has asked state government to explore initiating a project on millets considering the Odisha Millets Mission.
- e. Government of India has set up a task force to understand the framework of Odisha Millets Mission and to revise the National sub mission on millets based on the learnings of the OMM.
- f. Cambridge University partnered with Odisha Millets Mission to explore possibility of design of OMM as alternative to Green Revolution framework.
- g. UN-IFAD and UN-FAO has supported the framework of Odisha Millets Mission as suitable for taking up agro ecological initiatives.

WAY FORWARD

- a. Making Odisha a “Centre for Excellence” on Millets in the country.
- b. Landscape based Agro Bio diversity.
- c. Inclusion of suitable millets in ICDS, MDM and PDS
- d. Start Up Odisha – Millet Odisha.
- e. Millet Value Chain – Seed to Storage to Supply.
- f. Women SHGs led Nutrition revolution by working with SHGs for promotion of millets.



SECTION - 2

DR. P.K. AGRAWAL

VICE CHANCELLOR

Odisha University of Agriculture
and Technology, Bhubaneswar

PROSPECTS OF MILLETS CULTIVATION IN ODISHA

Agriculture plays a vital role in shaping rural economy and providing livelihood support in rural areas. Agriculture in Odisha faces difficulty due to small size land holdings, low investment and frequent occurrence of natural calamities. The State has a cultivated area of 61.80 lakh ha out of which 29.14 lakh ha is high land. Highlands are more prone to the risk of drought and water stress. A sizeable area of highlands can be utilized for cultivation of millets under rainfed situation with minimum investment.

Conventionally, the millets constitute a substantial part of the cropping system in the tribal areas of Odisha. Millets have resilience capacity to cope up with climate vulnerability. They can also be cultivated in marginal land with undulating terrain. Millets can be used to address the problems of crop failure and nutritional deficiency in handicapped ecology of the state.

Small millets consisting of finger millet, little millet, foxtail millet, proso millet, kodo millet and barnyard millet are important to utilize the marginal land. Small millets have the inherent capacity of early maturity, yield under low rainfall, low input and are suitable for dryland areas. These crops are highly resilient to soil, moisture and weather variations and are suitable for contingent crop planning. Out of these six small millets, finger millet (Mandia) and little millet (Suan) are mostly grown in Odisha. Finger millet is grown in an area of 1.66 lakh ha with production of 1.44 lakh tones. The major ragi growing districts are Koraput, Ganjam, Rayagada and Gajapati. Besides, jowar and bajra are cultivated in a meager area of 7.46 and 3.03 thousand hectare respectively.

Millet crops face several bio-physical and technological constraints in the state, which need to be addressed. Majority of millet area is cultivated in rainfed condition under traditional/indigenous landraces with low yield potential. Small millets cannot compete with remunerative crops like vegetables, cotton, groundnut, maize and cowpea. Inadequate awareness among general public about alternative uses and value added products of millets also reduces the demand of the crop. Non-adoption of scientific method of cultivation with poor nutrient management practices result in low yield of the crop. High labour requirements and the tedious work dissuade the farmers from taking up these crops.



FUTURE PROSPECTS

Millets can be suitably cultivated as rainfed crops under marginal conditions of soil fertility and moisture. These crops are favoured due to short growing season under dryland conditions. Millet crops can be grown with limited water resources and usually without application of large quantity of external inputs by small and marginal farmers. In spite of rich inter/intra-species diversity and wider climatic adaptability, cultivation of diverse millet species is gradually narrowing in different parts of the world. It is necessary to provide institutional support for millet crops to enhance millet production and area.

These crops are having several advantages for growing as an attractive crop. Millets are often grown on skeletal soils with poor soil fertility. As the millet crops are grown under traditional methods, there is less risk of pest attack thereby minimizing the use of pesticides. Being grown under different cropping system, millets help to promote agricultural biodiversity. These crops are still the principal sources of energy, protein, vitamins and minerals for millions of people in the world. It is said that millets are nutritionally superior to rice and wheat in terms of proteins, minerals and vitamins. Being highly nutritious, millet crops can be suitably grown to ensure nutritional security, especially in resource crunch situations.

Consumption of millets as food can be increased through creation of awareness of nutritional values and development of processing technologies. It has become imperative to reorient the efforts on the sorghum and millet crops to generate demand through value-addition of processed foods through diversification of processing technologies, nutritional evaluation and creation of awareness. Now-a-days, people are very much conscious about their healthy living practices to overcome metabolic disorders and life style diseases, which have increased demand for various types of millets. Though the millet food-products are known for nutrition, its awareness among the consumers is scanty especially on their nutritional and therapeutic values. The health branding was not exploited enough to commercialize millet foods in the past, despite the fact that, millets are known to have rich composition of nutrients and minerals. The nutritional aspects, functional aspects and health benefits of millets are to be widely publicized.

The spatial distribution of millets, either as a primary crop or as allied crops, largely depends on the growing habitat and the amount of rainfall the region receives. Further, the small millets are found in most of the interior parts of the state. In order to revive the demand of millets in India, there is need to enable to bring all the stakeholders in production to consumption system and value chain on a common platform and link millet farmers with market and the ultimate consumers. This can be achieved through a consortium in public-private partnership ensuring a win-win situation for each stakeholder. The processing intervention need for product development on millet products with enhanced nutritional values. This will go a long way in millet promotion in the country for offering nutritional security.

WAY FORWARD

Strategic planning, technology development and timely action can enhance the area and productivity of millet crops in the state. Nutritional quality and drought-resistant properties of millets have drawn attention of various researchers all over the world and have increased focus to improve the millet varieties and to enhance their use in processed food products. Generation of location specific technology and development of suitable high yielding & disease-pest resistant varieties can ensure good yield of the crop. Extension



machinery is to intensify efforts for wide adoption of such evolved technologies in the farmers' field. Implementation of effective promotional strategies and policy sensitization can attract entrepreneurs to consider preparation of millet products a priority area.

Scaling up of areas under high yielding varieties will enhance yield of the crops. Inclusion of small millets in cropping system will ensure crop production by avoiding risk of climatic vagaries. Awareness regarding the health benefits of the "nutri-cereals" particularly for diabetic patients and healthy value added products to be made. Adequate marketing infrastructure and ensuring minimum support price for products of millet crops will be very much helpful to encourage farmers for growing the crop. Promotion of local entrepreneurs of self help groups for establishment of small processing units for dehulling and flour making of various millets will go a long way for attracting more farmers to grow this crop. Promoting entrepreneurs for producing millet-based food items will be of much helpful in this regard. Preparation and production of various millet products by entrepreneurs, self-help groups and small scale industries can enhance demand for value added products. By promotion of these value added products can improve the socio-economic status and also health status of the consumers.

Odisha University of Agriculture & Technology (OUAT) is contributing through technology development and technology transfer. The University has developed seven high yielding finger millet varieties and four little millet varieties suitable for cultivation in the state. The finger millet varieties are Divyasingha, Neelachal, Bhairabi, Suvra, Chilika Arjuna and Kalua. Similarly, the University has developed four high yielding little millet varieties such as Tarini, Kolab, Sabara and Saura, which can be grown in kharif season under rainfed situation. Besides, various production and protection technologies suitable for Odisha condition have been developed by various research stations of the University. For hassle free harvesting, a ragi thresher-cum-pearler having output of 85.7 kg/h, threshing efficiency of 92.1% and cleaning efficiency of 92.4% has been developed by the University. The Krishi Vigyan Kendras of the University are actively involved in popularization of technologies relating to millets cultivation through various technology transfer processes like farmers' training, on-farm testing, frontline demonstration, farmers' fair, etc.

OUAT is prepared to produce enough quantity of seeds of high yielding millet varieties, timely supply of quality seeds and backstopping of production and protection technologies. The University is also prepared to support the scientific, technological and knowledge components for the success of 'Millet Mision' in Odisha.



SECTION - 3

DR. S.S. TOMAR

ADDITIONAL COMMISSIONER (CROPS)
Ministry of Agriculture & Farmers Welfare
Govt. of India

PROSPECTS OF NUTRI-CEREALS CULTIVATION IN INDIA

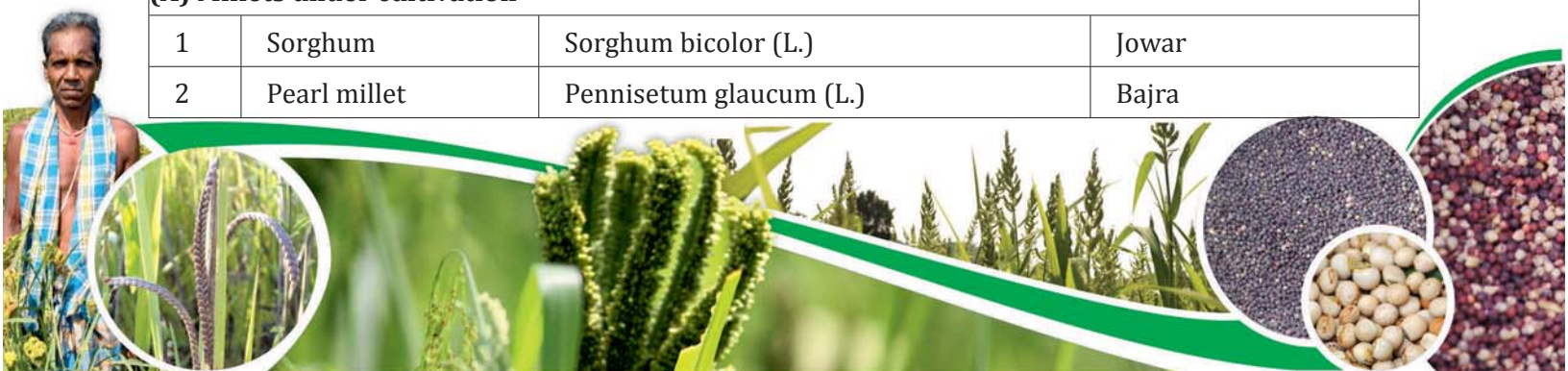
Millets (Nutri-Cereals) are traditional grains, and cultivated in the Indian subcontinent since the past more than 5000 years. India is the largest producer and consumer of millets. Millets are small-grained cereals and grown in warm-weather conditions. They are mostly rain-fed, hardy grains which have low requirements for water and fertility as compared to other popular cereals. These are resilient to drought, climate change and other extreme weather conditions.

The Nutri-Cereals comprised of sorghum, pearl millet (major millets), finger millet, foxtail, little, kodo, proso and barnyard millet (minor millets). Nutri-Cereals are highly nutritious, non-glutinous and non-acid forming foods. These have many nutraceutical and health promoting properties especially the high fibre contents. These act as a prebiotic feeding for micro-flora in our inner ecosystem. The millets hydrate our colon to keep us from being constipated. Niacin present in millets can help lower cholesterol. Millets contain major and minor nutrients in good amount.

The name “Millet” has been derived from the word “mil or thousand” is referring to the large number of grains that can be produced from a single seed. However, the Hindi word “Kadann” has come from a Sanskrit word “Kaddannam”. The barnyard millet and Pseudo cereals (*Amaranthus* and buck wheat) are used by the devotees during their fast and these commodities are rich in nutritive values. The list of crops covered under millets along with their names is given below in Table 1.

Table-1 : NOMENCLATURE OF MILLETS

S. No.	Common name	Botanical name	Local name name(Hindi)
(A) Millets under cultivation			
1	Sorghum	<i>Sorghum bicolor</i> (L.)	Jowar
2	Pearl millet	<i>Pennisetum glaucum</i> (L.)	Bajra



3	Finger millet	Eleusine coracana (L.)	Ragi/Mandua
4	Small millets	..	
4.1	Barnyard millet.	Echinochloa frumentacea (L.)	Sanwa/Jhangora
4.2	Proso millet	Panicum miliaceum (Is.)	Cheena
4.3	Foxtail millet	Setaria italica	Kakun/Kangni
4.4	Kodo millet	Paspalum scrobiculatum (L.)	Kodo
4.5	Little millet	Panicum sumatrense	Kutki
(B) Pseudo-cereals			
1.	Purple amaranthus	Amaranthus cruentus	Chaulai
2.	Buck Wheat	Fagopyrum esculentum & F. tataricum	Kuttu

Prior to the initiation of Green Revolution in mid-1960s, these Nutri-Cereals (millets) were important crops in India with higher area coverage as compared to wheat and rice. The area of nutri-cereals in the country was 36.90 million hectare (m.ha.) during 1965-66 which has declined to 14.72 m. ha during 2016-17 which is 60.2% less area coverage. However, the production of nutri-cereals has gone up to 16.50 million tonnes during 2017-18 from 14.22 million tonnes during 1965-66 despite more than 60% decline in area under Nutri-Cereals during same period. Bajra and Sorghum are the most important food-grain crops in India after rice, wheat, and maize in terms of area and production. Finger millet (ragi) also forms a major part of the food basket in some states like Karnataka, Telangana and Uttarakhand. The other minor millets are also being cultivated in varying scales in various parts of the country, mainly by tribal and marginal farmers. The details of each Nutri/pseudo-cereal are given below:

Sorghum (Jowar): The major portion of sorghum protein is prolamin (kaffirin) which has a unique feature of lowering digestibility upon cooking which might be a health benefit for certain dietary groups. Sorghum proteins upon cooking are significantly less digestible than other cereal proteins, which might be a health benefit for certain dietary groups. It is rich in protein, fibre, thiamine, riboflavin, folic acid, β -carotene, potassium, phosphorus and calcium with sufficient amounts of iron, zinc and sodium.

Pearl Millet (Bajra): It contains considerably high proportion of proteins (12-16%), lipids (4-6%), and 11.5% of dietary fibre. It increases transit time of food in the gut. Hence, reduce risk of inflammatory bowel disease. The niacin content in pearl millet is higher than all other cereals. It also contains foliate, magnesium, iron, copper, zinc and vitamins E and B-complex. It has high energy content compared to other millets. It is also rich in calcium and unsaturated fats which are good for health.

Finger Millet (Ragi): Finger millet is the richest source of calcium (300-350 mg/100 g). Ragi has the highest mineral content. It contains lower levels of protein (6-8%) and fat (1.5-2%). Finger millet proteins are unique because of the sulfur-rich amino acid contents. The grains have excellent malting properties and are widely known for its use as weaning foods. It has high antioxidant activity.



Foxtail millet (Kangani/Kakun): It is high in carbohydrates and has double quantity of protein content compared to rice. It contains minerals such as copper & iron. It provides a host of nutrients, has a sweet nutty flavour and is considered to be one of the most digestible and non-allergic grains.

Kodo millet (Kodo): It has high protein content (11%), low fat (4.2%) and very high fibre content (14.3%). Kodo millet is rich in B vitamins especially niacin, pyridoxin and folic acid as well as the minerals such as calcium, iron, potassium, magnesium and zinc. It contains a high amount of lecithin and is excellent for strengthening the nervous system.

Barnyard millet (Sanwa/Sawa/Jhangora): It is the richest source of crude fibre and iron. Its grains possess other functional constituents i.e., Gamma amino butyric acid (GABA) and Beta- glucan, used as antioxidants and in reducing blood lipid levels.

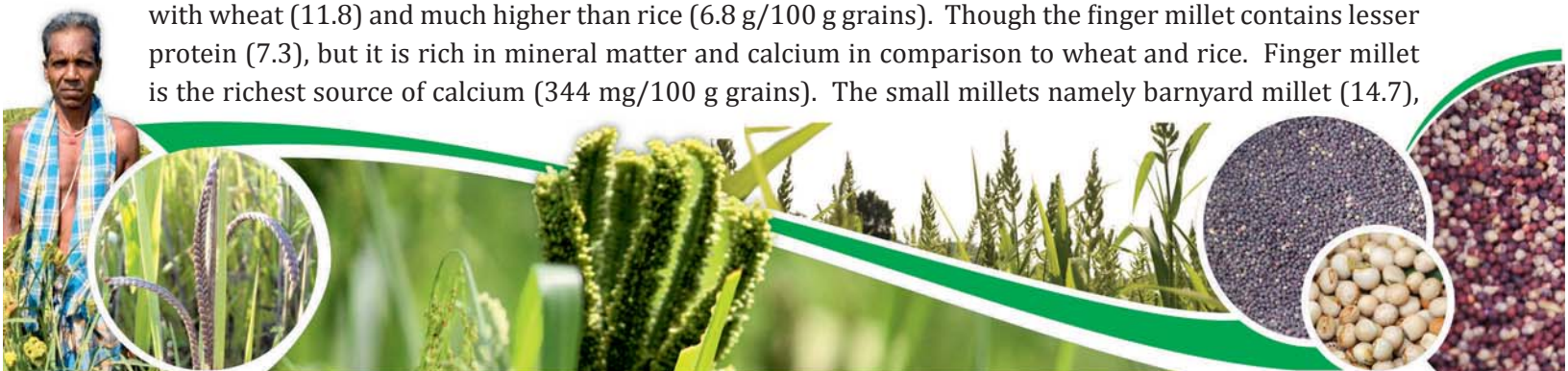
Little Millet (Kutki): It is smaller than other millets. It is high in iron content. It has high antioxidant activities. It contains about 38% of dietary fibre.

Proso Millet (Cheena/Barri): It contains the highest amount of proteins (12.5%). Health benefits of proso millet come from its unique properties. It has significant amounts of carbohydrate and fatty acids. It is cheaper source of manganese as compared to other conventional sources like spices and nuts. It contains high amounts of calcium which is essential for bone growth and maintenance. It reduces cholesterol levels and also reduces the risk of heart diseases.

Amaranthus (Ramdana/Rajgira/Chaulai): High protein content (13-14 %) and a carrier of lysine, an amino acid that's missing or negligible in many other grains. It consists of 6 to 9% of oil which is higher than most other cereals. Amaranth oil contains approximately 77% unsaturated fatty acids and is high in linoleic acid. It is high in dietary fibre, possesses high iron, magnesium, phosphorus, potassium contents and appreciable amounts of calcium. It is a rich dietary source of phytosterols, with cholesterol-lowering properties. It contains a lunasin-like peptide and other bioactive peptides which are thought to have cancer-preventive and antihypertensive properties.

Buckwheat (Kuttu): It contains protein 13-15% protein and rich in amino acid lysine. It is rich in carbohydrates (mainly starch). It contains vitamins B1, C and E. It is also rich in polyunsaturated essential fatty acids, such as linoleic acid. It contains higher levels of zinc, copper, and manganese than other cereal grains, and the bioavailability of these minerals is also quite high. Kuttu is having high insoluble fibre, a rich source of polyphenol compounds, contains rutin, a bioflavonoid thought to help control blood pressure and possess anti-inflammatory and anti-carcinogenic properties.

The nutritive value of millets is given in Table-2. These crops contain substantially high amount of protein, fibre and minerals in comparison to fine cereals like wheat and rice. The protein content in millets like Jowar (10.4), Bajra (11.6), Proso millet (12.5), foxtail millet (12.3) and barnyard millet (11.6) is comparable with wheat (11.8) and much higher than rice (6.8 g/100 g grains). Though the finger millet contains lesser protein (7.3), but it is rich in mineral matter and calcium in comparison to wheat and rice. Finger millet is the richest source of calcium (344 mg/100 g grains). The small millets namely barnyard millet (14.7),



Kodo millet (9) little millet (8.6) and foxtail millet (8.0) are the richest in fibre in comparison to wheat (1.2) and rice (0.2 g/100 g grains).



Pearl Millet



Finger Millet



Foxtail Millet



Little Millet



Proso Millet



Millets contribute to antioxidant activity with phytates, polyphenols, tannins, anthocyanins, phytosterols and pinacosanols present in it having important role in aging and metabolic diseases. All millets possess high antioxidant activities.

Keeping in view the nutritive value of Nutri-Cereals and to combat the prevailing malnutrition especially in children and women, a meeting was conducted in PMO on the issues relating to Science and Technology on 18th July 2017. In the meeting, one issue on introduction of millets in the Public Distribution System (PDS) was proposed so as to improve the nutritional status and decided that the proposal may be jointly examined by ICAR, DAC&FW, DF&PD and ICMR under the leadership of NITI Aayog and recommendations be firmed up within a period of six months. On this recommendation, NITI Aayog has suggested following decisions for initiating appropriate action by DAC&FW:

Table 2 : NUTRITIONAL PROXIMATE COMPOSITION OF MILLETS AS COMPARED WITH MAJOR CEREAL CROPS (PER 100 G)

Commodity	Protein (g)	Carbohydrates (g)	Fat (g)	Crude fibre (g)	Mineral matter (g)	Calcium (mg)	Phosphorus (mg)
Sorghum	10.4	72.6	1.9	1.6	1.6	25	222
Pearl millet	11.6	67.5	5.0	1.2	2.3	42	296
Finger millet	7.3	72.0	1.3	3.6	2.7	344	283
Proso millet	12.5	70.4	1.1	2.2	1.9	14	206
Foxtail millet	12.3	60.9	4.3	8.0	3.3	31	290
Kodo millet	8.3	65.9	1.4	9.0	2.6	27	188
Little millet	8.7	75.7	5.3	8.6	1.7	17	220
Barnyard millet	11.6	74.3	5.8	14.7	4.7	14	121
Barley	11.5	69.6	1.3	3.9	1.2	26	215
Maize	11.5	66.2	3.6	2.7	1.5	20	348
Wheat	11.8	71.2	1.5	1.2	1.5	41	306
Rice	6.8	78.2	0.5	0.2	0.6	10	160

Source: National Institute of Nutrition (NIN), Hyderabad

- a. Millets viz. Jowar, Bajra and Ragi need to be promoted through PDS across the country to improve nutritional content in diet of masses. Instead of calling them coarse grains, millets should be positioned as 'Nutri-Cereals' and their benefits need to be popularized amongst masses through sustained and effective campaign; and



- b. Research needs to be done to develop high yielding varieties and also varieties with longer shelf life. It may also be examined whether nutri-cereals can be promoted as a sub-mission under the National Food Security Mission (NFSM).

ICAR has recently released biofortified varieties of pearl millet are -

HHB 299 (Hybrid): It contains high iron (73.0 ppm) and zinc (41.0 ppm) as compared to 45.0-50.0 ppm iron and 30.0-35.0 ppm zinc in popular varieties/hybrids, Grain yield: 32.7 q/ha, Dry fodder yield: 73.0 q/ha, Maturity: 81 days, Adaptation: *Kharif* season in Haryana, Rajasthan, Gujarat, Punjab, Delhi, Maharashtra and Tamil Nadu.

AHB 1200 (Hybrid): Rich in iron (73.0 ppm), grain yield: 32.0 q/ha, dry fodder yield: 70.0 q/ha, maturity: 78 days, adaptation: *Kharif* season in Haryana, Rajasthan, Gujarat, Punjab, Delhi, Maharashtra and Tamil Nadu.

The Central Government hereby declare millets comprising Sorghum (Jowar), Pearl Millet (Bajra), Finger Millet (Ragi/Mandua), Minor Millets i.e. Foxtail Millet (Kangni/Kakun), Proso Millet (Cheena), Kodo Millet (Kodo), Barnyard Millet (Sawa/Sanwa/Jhangora), Little Millet (Kutki) and two Pseudo cereals (Buck Wheat-Kuttu) and Amaranthus (Chaulai) which have high nutritive value as “Nutri-Cereals” for production, consumption and trade point of view. The notification was published, on the 10th April, 2018. The year 2018 was celebrated as the year of Nutri-cereals.

The Department of Agriculture, Cooperation and Farmers Welfare has launched Sub-Mission on Nutri-Cereals under NFSM program from 2018-19. National Food Security Mission – Nutri Cereals is being implemented in 202 districts of 14 states (Jowar in 88 districts of 10 states, Bajra in 88 districts of 9 states, Ragi in 44 districts of 8 states and other millets in 43 districts of 7 states) of the country. Further the states of J&K, Himachal Pradesh, and NE region have been given flexibility to implement the programme according to their needs.

The Sub-Mission started with the following objectives:

1. Increasing production of nutri-cereals through area expansion and productivity enhancement in a sustainable manner in the identified districts of the country.
2. Restoring soil fertility and productivity at the individual farm level.
3. Enhancing farm level economy to restore confidence amongst the farmers; and
4. Enhancing post harvest value addition at farm gate for better price realization to farmers through efficient market linkages.

The interventions covered under NFSM-Nutri-Cereals include FLD, Cluster FLD on improved package of practices, seed distribution of hybrids & HYVs, certified seed production of HYVs seeds, distribution of micro-nutrients, bio-fertilizers, weedicides, plant protection chemicals, bio-agents, manual sprayer, sprinkler, cropping system based training organizing events (State/District level workshop, festivals, road



show), creation of awareness, publicity, distribution of seed minikits etc. The interventions i.e. formation of FPOs in cluster area, creation of processing units for FPOs, creation/strengthening of Centres of Excellence, creation of seed hubs, creation of breeder seed production are also included under the sub-mission on 100% GOI share.

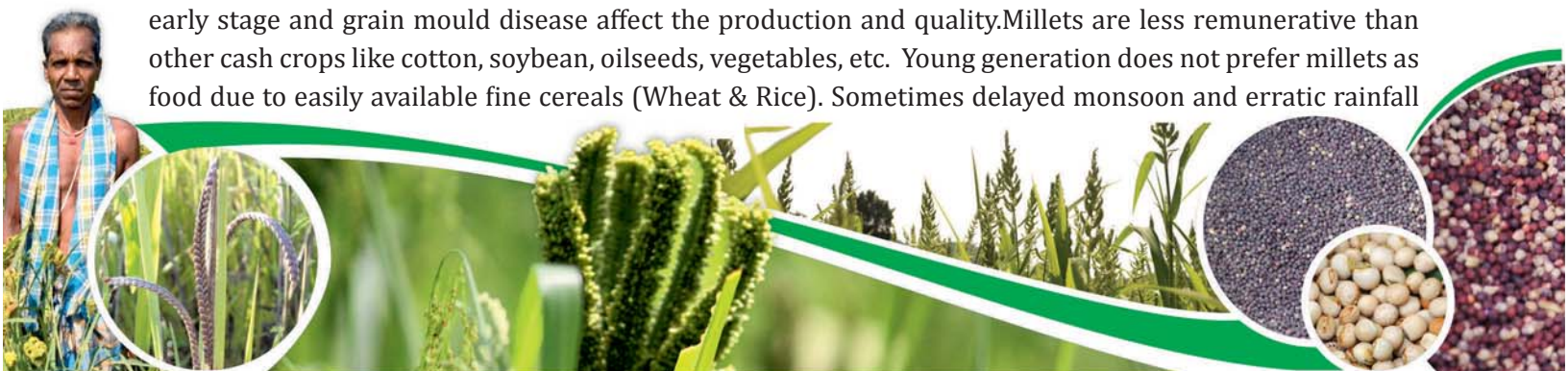
Three National Centres of Excellence (CoE) were already established at CCS Haryana Agricultural University, Hisar for pearl millet, ICAR-Indian Institute of Millets Research, Hyderabad for Sorghum and University of Agricultural Sciences, Bengaluru for small millets by the DAC&FW.

The Government as a part of its doubling farmers' income strategy has prepared a roadmap to promote millets and achieve increase in area and output. The targeted production is 20 million tonnes by 2022-23 taking it up from the current 16.50 million tonnes. The MSP has been hiked substantively assuring the farmers a minimum of 50 per cent as profit margin on the cost of production. A robust procurement system will also be put in place, which will incentivise millet production. Coarse grains including Nutri-Cereals are already a part of the PDS. Some Nutri-Cereals are allocated in terms of NFSA, 2013 at highly subsidized price of Rs.1 per kg. As per Deptt. of Food & Public Distribution's (DFPD) existing guidelines for procurement of Nutri-Cereals (Jowar, Bajra, Ragi), States are allowed to procure these commodities from farmers at MSP under central pool subject to the prior approval of GOI on the detailed procurement plan prepared by State Governments in consultation with FCI and the whole procured quantity of Nutri-Cereals are required to be distributed under TPDS (Targeted Public Distribution System)/OWS (Other welfare Schemes) in the State/UT.

The question arises that why Nutri-Cereals (Millets) are beneficial for Consumers in the current scenario. The following benefits prove that Millets are the lifeline of human being. They are good for prevention and management of diabetics, has anti-cancer properties, effective in reducing blood pressure, rich in dietary fiber that decreases incidence of obesity, regular millet diet reduces the risk of Coronary Heart Disease, they turns the stomach alkaline, beneficial in treating stomach ulcers and gall stones, good for controlling anemia, malnutrition, degenerative disease, Kidney, liver disorders and asthma, beneficial in preventing allergic reactions, gluten free and used for celiac disease (digestive disorder) patients, rich in antioxidants and hence immune system keeps cholesterol level in check, and eliminates problems like constipation, excess gas bloating and cramping.

Therefore, Nutri-Cereals Production is very beneficial. They provide nutritious food and fodder, consume less water than other cereals, grow faster and putting less stress on environment, no insects pest and diseases problem, they grow in even marginal lands, guarantee for complete Food and Nutritional Security and supplement the existing income of the farmers.

The major constraints in Nutri-Cereals production are lack of availability of HYVs and Hybrids, non-availability of seed in local markets at proper time, place and price, some times infestations of shoot fly at early stage and grain mould disease affect the production and quality. Millets are less remunerative than other cash crops like cotton, soybean, oilseeds, vegetables, etc. Young generation does not prefer millets as food due to easily available fine cereals (Wheat & Rice). Sometimes delayed monsoon and erratic rainfall



pattern greatly affect timely sowing, production and quality of nutri-cereals. There is a need to reduce the constraints and follow the strategies as indicated below to increase production and productivity.

- Need to create awareness about positive aspects like the suitability in the dry-land agriculture and more adaptability to the climate changes through demonstration and training programs.
- Development & distribution of HYVs and hybrids of millets among the farmers and promotion of “seed village” program to maintain own quality seeds to avoid purchasing seeds every year from the open market.
- Creation of systematic channel for timely distribution of improved agronomic practices and other technical assistance with utmost priority.
- Assured remunerative price through proper buy-back arrangements, and coverage under insurance scheme to avoid any loss due to crop failure and other natural calamities.
- Need to improve of export competitiveness through release of pests and diseases resistant varieties to improve grain quality for reducing the competitiveness in the international market.
- Need to promote Co-operative or contract farming for reducing the cost of cultivation and improve the bargaining power of the farmers. Value addition of millets products will improve the export competitiveness.
- Promote diversification of export basket for gaining exports like gluten free, sweet sorghum syrup, alcoholic beer, stalks based ethanol/grain based potable spirit, nutri- foods etc.
- Providing incentives to millets growers, processing and value addition enterprises and provide tax benefits to value added millet products to generate demand and area expansion.

The introduction of all nutri-cereals under PDS scheme will automatically create huge demand in the country. This will give a boost to the production of all the nutri-cereals and consequently, it will add to the existing income of the farmers. Assured procurement support with competitive prices will encourage diversification of area under nutri-cereals. Recognition of the nutritive value in nutri-cereals among the consumers including that they are low in gluten and high in glycaemic index apart from being rich in various nutrients will automatically change the food habit of the masses. Keeping in view the importance of nutri-cereals in present scenario regarding nutritive values means full nutritional security, easy growing in poor resources, conditions/situations, resilient to climate change, gluten free healthy foods; therefore, these crops are the future crops.



SECTION - 4

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NUTRI-CEREALS: PRESENT STATUS & FUTURE PROSPECTUS

A. INTRODUCTION

Millets, the name derived from the word mil or thousands referring large number of grains can be produced by one seed. Millets, a group of highly variable small-seeded grasses are known as Nutri-cereals as they provide most of the nutrients required for normal functioning of human body. Nutri-cereals or millets are widely grown around the world for fodder and human food. Millets are traditional grains, grown and consumed in the Indian subcontinent from the past more than 5000 years. Millets are small grained, annual, warm weather cereals and are one of the oldest foods known to humanity. Most of the millets are native of India. In general Nutri-cereals are rain-fed crops and are highly tolerant to drought and other extreme weather conditions. They are having low requirements of water and fertility as compared to other popular cereals but with the development of nutrient responsive genotypes, they also respond irrigated and high nutrient management condition. Millets are cultivated with low chemical inputs, making them mostly organic and environment friendly. As an assured source of income, these crops offer a better role during distress environment. During drought condition, these crops help in generating employment in low rainfall areas where other alternative crops are limited and these crops are used as a contingent crop. Different nutri-cereals are as under (Table 1):



Table 1. NOMENCLATURE OF NUTRI-CEREALS

S. No.	Common name	Botanical name	Local name (Hindi)
Major Millets			
1	Sorghum	<i>Sorghum bicolor</i> (L.)	Jowar
2	Pearl millet	<i>Pennisetum glaucum</i> (L.)	Bajra
3	Finger millet	<i>Eleusine coracana</i> (L.)	Ragi/Mandu
	Small millets		
4	Barnyard millet	<i>Echinochloa frumentacea</i> (L.)	Sanwa/Jhangora
5	Proso millet	<i>Panicum miliaceum</i> (L.)	Cheena
6	Foxtail millet	<i>Setaria italica</i>	Kakun/Kangni
7	Kodo millet	<i>Paspalum scrobiculatum</i> (L.)	Kodo
8	Little millet	<i>Panicum sumatrense</i>	Kutki
	Lesser known millets		
9	Brown top millet	<i>Brachiaria ramosa</i> (L.)	-
10	Crap millet	<i>Digitaria cruciata</i>	-
	Extinct millet		
11	Jobs tear millet	<i>Coix lacryma</i> (L.)	-
	Pseudo millet		
12	Amaranth	<i>Amaranthus cruentus</i>	Chaulai
13	Buck wheat	<i>Fagopyrum esculentum & F.tataricum</i> (L.)	Kuttu

A 1.CROP SCENARIO

Globally, India ranks 1st position in area coverage under millets followed by Sudan and Nigeria. Similarly, the country holds 1st position in millets production in the world followed by USA and Nigeria. These are crops of semi-arid tropics of Asia and Africa (especially in India, Mali, Nigeria and Niger). In India it is cultivated in an area of 12186.92 thousand ha with the production 13967.14 thousand tones and productivity 1146 kg/ha (Table 1). The most widely grown millet is pearl millet followed with jowar. Finger millet, proso millet, and foxtail millet are also important crop species and are a source of food, feed and fodder, grown from sea level to mid hills right from Tamil Nadu in the South to Uttarakhand in the North, and Gujarat in the West to Arunachal Pradesh in the Northeast. These crops are cultivated in a variety of agro-ecological conditions like, plains, coast and hills as well as in diverse soils and varying rain-fall. These crops are indispensable in tribal and hill agriculture where crop substitution is difficult. More than 90% nutri- cereals are produced in Rajasthan, Maharashtra, Karnataka, Uttar Pradesh, Madhya Pradesh, Gujarat, Haryana, Tamil Nadu and Andhra Pradesh, States. The major nutri-millets growing states are given in table 2.



Table 1. AREA, PRODUCTION AND YIELD OF NUTRI-CEREALS IN INDIA

Unit: Area (A) in Lakh ha,

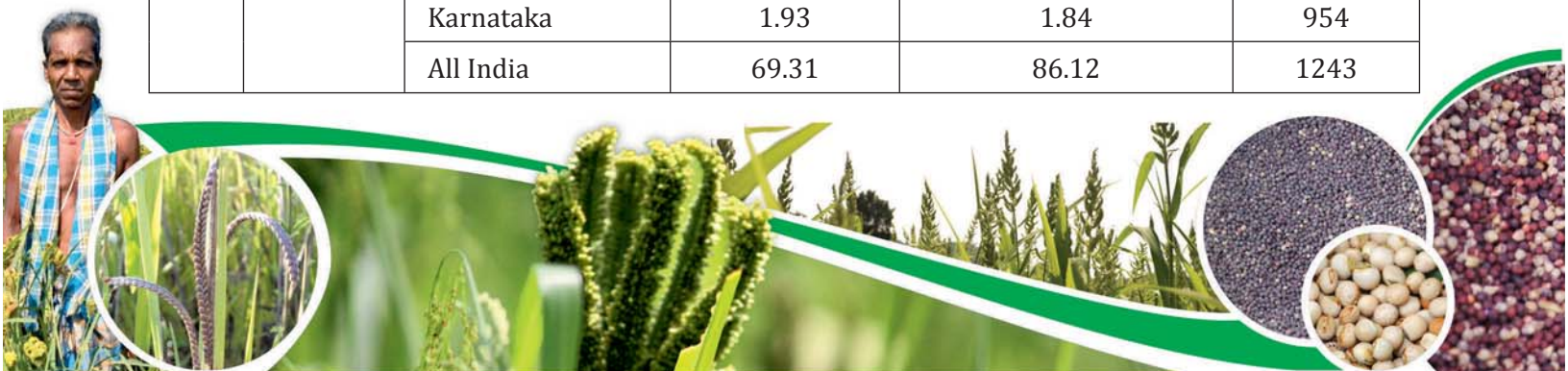
Production (P) in Lakh tones,

Yield (Y) in Kg/ha

Year	Sorghum			Bajra			Ragi			Small millet			Total Millets		
	A	P	Y	A	P	Y	A	P	Y	A	P	Y	A	P	Y
2014-15	61.62	54.45	884	73.18	91.84	1255	12.08	20.61	1706	5.90	3.86	654	152.78	170.76	1118
2015-16	60.77	42.38	697	71.29	80.67	1132	11.38	18.22	1601	6.50	3.91	602	149.94	145.18	969
2016-17	56.24	45.68	812	74.59	97.30	1305	10.16	13.85	1363	6.19	4.42	714	147.18	161.25	1096
2017-18	50.24	48.03	956	74.81	92.09	1231	11.94	19.85	1662	5.46	4.39	804	142.45	164.36	1154
2018-19*	38.41	37.61	979	69.31	86.12	1243	9.17	12.22	1332	4.98	3.72	747	121.87	139.67	1146

* 4th advance estimates.**Table 2. MAJOR GROWING STATES OF NUTRI-CEREALS (MILLETS) 2018-19***

S.No.	Crop	State	Area (Lakh ha)	Production(Lakh tones)	Yield(Kg/ha)
1	SORGHUM	Maharashtra	13.96	8.61	617
		Karnataka	8.65	9.07	1047
		Rajasthan	5.64	4.70	832
		Tamil Nadu	3.85	4.88	1268
		Andhra Pradesh	1.56	3.53	2266
		Uttar Pradesh	1.47	1.83	1247
		Madhya Pradesh	1.38	3.06	2218
		All India	38.41	37.61	979
2	PEARL MILLET	Rajasthan	41.80	38.08	911
		Uttar Pradesh	8.77	17.79	2029
		Maharashtra	5.04	3.14	623
		Haryana	4.25	8.78	2068
		Gujarat	3.96	8.32	2101
		Madhya Pradesh	2.56	6.29	2458
		Karnataka	1.93	1.84	954
		All India	69.31	86.12	1243



S.No.	Crop	State	Area (Lakh ha)	Production(Lakh tones)	Yield(Kg/ha)
3	FINGER MILLET	Karnataka	5.48	7.03	1282
		Uttrakhand	0.92	1.10	1194
		Maharashtra	0.80	0.85	1062
		Tamil Nadu	0.75	2.16	2900
		All India	9.17	12.22	1332
4	SMALL MILLETS	Madhya Pradesh	1.39	1.12	806
		Chhattisgarh	0.86	0.29	332
		Uttrakhand	0.57	0.70	1228
		Maharashtra	0.47	0.22	463
		Odisha	0.33	0.17	518
		Tamil Nadu	0.23	0.29	1237
		All India	4.98	3.72	747

* 4th advance estimates.

A 2. NUTRI-CEREALS FOR FOOD AND NUTRITIONAL SECURITY

Millions of people around the world suffer from hidden hunger of micronutrient. Sometimes they don't get enough food to survive or they do not get enough micronutrients required to lead healthy and productive lives from the foods they eat. Though, the cases of hunger in India are rare but malnutrition, especially among children and women, is widespread, acute and even alarming. Most commonly observed deficiencies in unbalanced diet are iron (Fe), zinc (Zn), calcium (Ca), etc. Traditionally, we consume various varieties of coarse grain. Millets supposed to be poor man's crops for long, have remained neglected with respect to their appropriate position in the commercialized food system. With increasing concerns about food & nutritional security, adverse weather & soil conditions, need for increasing food production per unit resource investment, there is an urgent need to produce millet for an ever increasing population. Due to higher nutritive value, nutri- cereals have good prospects of penetrating the food baskets of a wider range of consumers, both rural & urban and poor & rich in the country.

A 3. NUTRITIONAL VALUE

These are known to be the oldest foods to the humanity. These are highly nutritious, non-glutinous and non acid forming foods having nutritional and health promoting properties especially the high fiber content. Millets contain major and minor nutrients in good amount along with dietary fibre. These are nutritional power house, high in proteins, dietary fibre, Vitamin B complex, essential amino acids, folic acid & Vitamin E and are high in minerals such as Iron, Magnesium, Copper, Phosphorous, Zinc, Calcium and Potassium. Their nutritional and health benefits have created a demand surge for a variety of millets.



The millets contain 7-12% protein, 2-5% fat, 65-75% carbohydrates and 15-20% dietary fiber (Table 3). The essential amino acid profile of the millet protein is better than various cereals such as maize. Millets contain fewer cross-linked prolamins, which may be an additional factor contributing to higher digestibility of the millet proteins. Similar to cereal proteins, the millet proteins are poor sources of lysine, but they complement well with lysine-rich vegetables (leguminous) and animal proteins which form nutritionally balanced composites of high biological value. Millets are more nutritious compared to fine cereals. Small millets are good source of phosphorous and iron. Millets contributes to antioxidant activity with phytates, polyphenols, tannins, anthocyanins, phytosterols and pinacosanols present in it having important role in aging and metabolic diseases. Now bio-fortified varieties are also available which are rich in iron and zinc eg. pearl millet varieties MH 2173 (83 ppm iron & 46 ppm zinc) & MH 2174 (84 ppm iron & 41 ppm zinc). The grain is processed and consumed in traditional way and almost the entire produce is utilized at the farm/village level. In spite of superior nutritive value of grains, their use is confined more to the rural areas and very little to urban markets.

Table 3 NUTRITIONAL COMPOSITION OF NUTRI-CEREALS AND FINE CEREALS (PER 100 G EDIBLE PORTION)

Crop	Protein (g)	Carbohydrates (g)	Total Fat (g)	Total Dietary fibre (g)	Mineral matter (g)	Calcium (mg)	Phosphorus (mg)
Sorghum	9.97±0.43	67.68±1.03	1.73±0.31	10.22±0.49	1.39±0.34	27.60±3.71	274±35.7
Pearl millet	10.96±0.26	61.78±0.85	5.43±0.64	11.49±0.62	1.37±0.17	27.35±2.16	289±25.3
Finger millet	7.16±0.63	66.82±0.73	1.92±0.14	11.18±1.14	2.04±0.34	364±58.0	210±58.4
Little millet	10.13±0.45	65.55±1.29	3.89±0.35	7.72±0.92	1.34±0.16	16.06±1.54	130±27.5
Foxtail millet	8.92±1.09	66.19±1.19	2.55±0.13	6.39±0.60	1.72±0.27	15.27±1.28	101±5.2
Wheat, whole	10.59±0.60	64.72±1.74	1.47±0.05	11.23±0.77	1.42±0.19	39.36±5.65	110±9.8
Rice, raw, brown	9.16±0.75	74.80±0.85	1.24±0.08	4.43±0.54	1.04±0.18	10.93±1.79	267±64.9

A 4. NUTRI-MILLETS AND HUMAN HEALTH

Millets are gluten free and can be a substitute for wheat or gluten containing grains for celiac patients. Act as a pro-biotic feeding for micro-flora in our inner ecosystem. High dietary fibre provides hunger satisfaction and helps to reduce obesity. Reduce the risk of diabetes and cardio vascular diseases. Beneficial in treating and preventing gall stones and stomach ulcer. Reduce anemia, liver disorder and asthma. Its hypo-allergic properties help to prevent allergic reactions. It hydrates our colon to keep us from being constipated. Reduce the risk of Type II diabetes. Rich in anti oxidants and hence reduce oxidative stress. Reduce the occurrence of hypertension. Millets are anti acidic. Effective in reducing blood pressure. Reduce the risk of gastro-intestinal conditions like gastric ulcers or colon cancer. Eliminate problems like constipation, excess gas, bloating and cramping. Niacin in millet helps to lower down cholesterol.



A 5. NUTRI-CEREALS FOR FEED AND FODDER

Millets play an important role in feed and fodder security for livestock or in other words we can't think about proper supply of feed and fodder to the livestock without millets.

A 6. ECO-FRIENDLY NATURE

Further, being C4 plant, these crops have low water requirement, wider adaptability to varied ecologies/climate, environment friendly with low consumption of pesticides, best suited for contingency planning with larger stake of small and marginal farmers.

B. CONSTRAINTS IN NUTRI-CEREALS PRODUCTION

In spite of great importance of Nutri-cereals in human diet, cattle feed and Indian economy, the production has not been yet increased as per expectation. Though, there are so many reasons of low productivity of millets but the important are as follows:

B 1. RAIN-FED CULTIVATION

In general millets are cultivated in rain-fed condition. Water stress at critical stages results poor yields or sometimes no yield.

B 2. UNFAVORABLE WEATHER CONDITIONS

Rains immediately after sowing adversely affect the germination of millets. In the same way rains at the time of maturity also cause significant losses. Continuous rains do not allow performing inter-cultural operations on time. Low rain-fall again affects the crop badly.

B 3. SEED CONSTRAINTS

Though, a number of improved varieties are available in pulses, but it is also true that there is lack of bio-fortified, climate resilient varieties, resistant to biotic and abiotic stresses. Till date, the seed replacement rate is not as per expectations, resulting use of poor quality seed. Though, private player are there in seed production but high rates of hybrids and poor economic condition of farmers are also some of the reasons due to which cultivators are unable to use improved seeds of millets.

B 4. AGRONOMIC CONSTRAINTS

Though, sowing of millets is on the priority but every agronomic operation is important in any crop production. In case of regular rains or scarcity of labours so many times farmers are not able to adopt inter-culture operations well on time, results in low yield. Maintenance of required plant population is necessary for the desired crop production. So many times farmers go for broad casting method for sowing (most commonly used in western Rajasthan), results either excess or low plant population and in both the



conditions we have to compromise with the productivity of the crop. In case of excess plant population there will be competition among the plants for light and water, whereas, in case of low rain-fall, productivity will be less due to per plant yield. Due to intensive cultivation, the soils become nutrient deficient so in such condition also we have to face low productivity of millets. It is also true that there is deficiency in zinc, sulphur, iron, boron and molybdenum in some of the areas, results in low yield of millets.

B 5. PLANT PROTECTION CONSTRAINTS

Now a day the biotic stresses are a big challenge in millets cultivation also. Millets are attacked by so many diseases, nematodes and insect-pests causing heavy losses to the yield. Due to their poor economic condition and improper knowledge, farmers are unable to adopt proper plant protection measures, results in low yields.

B 6. POST HARVEST LOSSES

Post harvest losses are big challenge in all the agricultural products. Storage without proper drying & cleaning, improper/insufficient storage facility, lack of proper care during storage, results in heavy loss of the produce by insects, birds and rats. The post harvest losses are also due to lack of scientific post harvest management system. In such condition farmers are compelled to sell their produce to the middleman at low price, discourage the farmers to grow millets.

B 7. LACK OF VALUE ADDITION

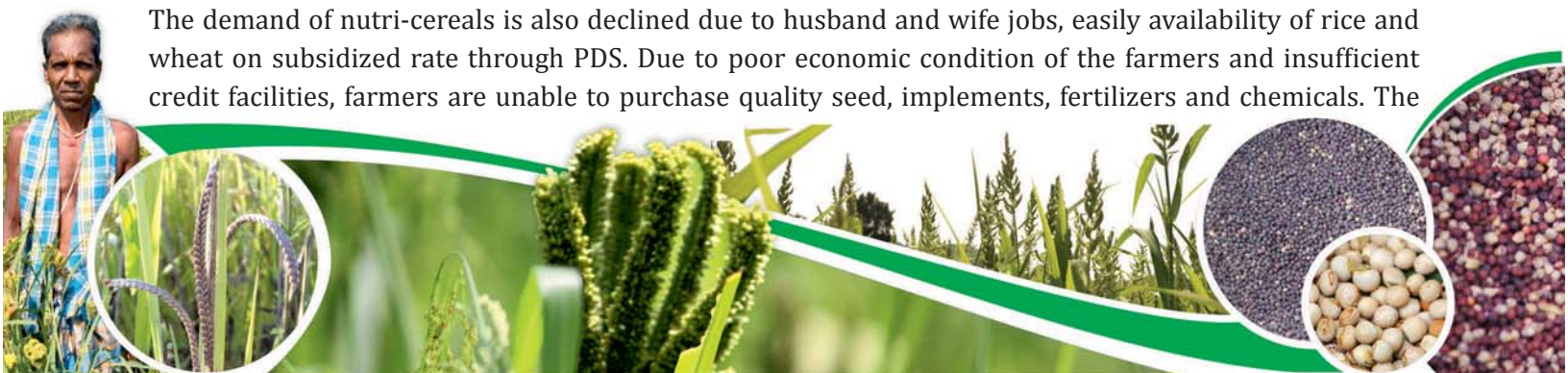
Though, the value addition of millets is started but till date lack of awareness about value addition among the rural cultivators is again major constraint in millet production. Till date the value addition is very limited or negligible.

B 8. INSUFFICIENT EXTENSION SERVICES

Lack of initiative of extension personnel, lack of exposure of farmers to improved technologies and poor interface among state departments of agriculture, research organization and private agencies also play an important role in low yields of millets. Till date there is wide extension gap between research institutes and farmers fields. Till date extension services are not sufficient to transfer the technology generated by our scientists. Unless the scientific technology is transferred to the farmers through demonstrations, kisan mela, media, audio-visual aids or by any method, it is quite impossible to enhance the crop production up to desired level. There is an urgent need to strengthen our extension services to transfer the latest technologies without any delay.

B 9. SOCIO ECONOMIC REASONS

The demand of nutri-cereals is also declined due to husband and wife jobs, easily availability of rice and wheat on subsidized rate through PDS. Due to poor economic condition of the farmers and insufficient credit facilities, farmers are unable to purchase quality seed, implements, fertilizers and chemicals. The



farmers are not able to develop their own irrigation system, not aware with latest scientific knowledge about cultivation, results in low productivity of millets. Farmers are also unable to hold their produce for a longer time, and bounded to sell their produce in low rates, also results to discourage crop cultivation.

B 10. FLUCTUATING AND LOW RATES IN MARKET

Though, minimum support price is declared by the government but in lack of full proof procurement policy farmers are bound to sell their produce in the market. In general these crops are less remunerative than other cereals like wheat, rice maize etc. The market prices are low and fluctuating, results to discourage the farmers for millets cultivation.

B 11. DEGRADATION OF QUALITY

The quality of millets degrades faster than pulses and other cereals so farmers are bounded to sell their produce maybe on lower rates, results in financial loss, so many times, results to discourage the farmers for cultivation.

B 12. CLIMATE CHANGE

Unpredictable weather condition coupled with temperature extremities (both high and low) adversely affecting reproductive phase and grain filling in almost all crops and also widening the scopes of spreading diseases and insect-pests in more disastrous form. Uncertain rainfall also results in low yields of millets in the country.

B 13. POLICY ISSUES

Unorganized market, absence of assured procurement on MSP and poor availability if inputs like seed; fertilizer, micro-nutrients etc. at proper time and place, at nominal rates and insufficient infrastructure facilities are some of the policy issues responsible for low yields of millets.

B 14. GREEN REVOLUTION

Food grain shortages in mid-sixties, green revolution and changes in the infrastructures and incentives including input supplies and price support systems in favour of major cereals altered the traditional cropping pattern against millets. Due to Green revolution the emphasis was given to rice and wheat due to high yield potential and high input responsive genotypes.

B 15. IMPROVEMENT IN IRRIGATION FACILITIES

Improvement in irrigation facilities is also one of the reasons for decrease in area under millets. In general millets are rain-fed crops so due to improvement in irrigation facilities the area was decreased under these crops.



B 16. SHIFTING OF CROPS

Due to the change in rain-fall pattern and availability of early maturing varieties of pulses also results to decrease in the area under cultivation of nutri-cereals.

B 17. FOOD HABITS

The demand of nutri-cereals is also declined due to change in food habits, advent of fast food chains and ready-to-eat food products and the longer time required for Nutri-Cereals food preparation as compared to fine cereals such as rice and wheat.

C. STRATEGIES FOR IMPROVING NUTRI-CEREALS PRODUCTION

To overcome the targeted hunger, human health and to mitigate the effect of climate change in long run, there is an urgent need to promote the production of millets in the country. In general the production of Nutri-cereals is less than the research/demonstration yield. To improve the production of millets there are two ways either by horizontal (enhancement in area) or vertical (increase in productivity), though, there is limited scope for horizontal improvement so we have to think for vertical improvement means to increase in the productivity. The major strategies are as follows:

C 1. ADDITIONAL AREA UNDER MILLETS

With the development of high yielding bio-fortified varieties/hybrid of millets and nutritional security of the country we have to pay attention on expansion of area of millets. Expansion in area under Nutri-cereals is limited due to cultivation of more remunerative/high input responsive crops or increasing demand of land for non agricultural purposes, though, some expansion is possible through cultivation in *spring* and *summer* cultivation or intercropping with pulses.

C 2. IMPROVED VARIETIES AND IMPROVEMENT IN SEED REPLACEMENT RATE

Increase in the productivity is the only viable option for enhancing production of Nutri-cereals and seed is the key input in any crop production. Without quality seed it is very difficult to achieve targeted yield or in other words we cannot think about crop production. The investment on other inputs like irrigation, weeding, plant protection, harvesting etc. is useful only if quality seed is used for sowing. The genotypes are sensitive to weather and soil conditions so only recommended varieties should be used for sowing. Popularization of high yielding bio-fortified varieties/hybrids resistant to biotic and abiotic stresses is again an important factor which should be taken care for higher productivity.

C 3. AGRONOMIC MANAGEMENT

Agonomic management is essential for higher productivity of millets. Timey of sowing, desired plant population, nutrient management, weed management etc. influences the production greatly. For better production all the agronomical practices should be done well in time.



C 3.A. TIME OF SOWING

Time of sowing is an important input in crop production. Sowing should be done well on time. Late and early sowing invites the damage to the crop.

C 3.B. PLANT POPULATION

Now a day lower plant population has emerges as a major constraint in crop production. In general plant population is not maintained at farmer's field especially in rain-fed, results in low yields. Better yields can be obtained by optimum plant population only.

C 3.C. LINE SOWING

Line sowing is beneficial in comparison to broadcasting to maintain the plant population. Line to line and plant to plant distance is again very important. For better production distance between rows and plants should be maintained properly.

C 3.D. NUTRIENT MANAGEMENT

Use of recommended dose of fertilizer and manure is essential for better crop production. The recommended dose of fertilizer (NPK) helps in enhancing production. Perfect placement of fertilizer and manure is again very important. The fertilizers should be placed in the root zone of the plant so that fertilizer may not loss through leaching and plant may take the nutrients easily.

C 3.E. WEED MANAGEMENT

Weeds compete for space, moisture, sunlight, nutrient etc. with main crop and results in low yields. Weeds can be controlled mechanically and chemically. Pre-emergence and post-emergence application of weedicides also helps equally as mechanical weed control.

C 3.F. WATER MANAGEMENT

If irrigation facilities are available application of life saving irrigation will also help in improving pulse production in the state.

C 4. CROP PROTECTION

Pulses affects badly by diseases & insect-pests causing great loss to the crops. Proper management/control measures should be taken for rising of crop and during post harvest. To overcome seed or soil borne diseases and insect-pest damage, seed should be treated with required chemical. A little investment on seed treatment enhances productivity up to great extent. Proper seed treatment is helpful to overcome diseases & insect-pests. To overcome the incidence of biotic stresses in standing crop adoption of proper and timely plant protection measures are important. Absence or delay in plant protection may cause great losses to the yield.



C 5. MINIMUM SUPPORT PRICE (MSP) AND PROCUREMENT

Timely announcement of practicable minimum support price with assured procurement will help in increasing production of millets. Furthermore, farmers should be encouraged for millets production by reasonably increasing the MSP time to time for nutritional and food security of specially the rural/poor population of the country.

C 6. POLICY SUPPORT

Policy support for timely supply of input on nominal rates at desired place, easy credit facility and assured marketing will be helpful in increasing millets production. Practically viable crop insurance is again very important and will be helpful in improving production. Development of organized markets for promotion of export will be helpful in improving production in the country.

C 7. AVAILABILITY OF FARM MACHINES

Improvement in availability of farm machines will be helpful in improving millets production in the country. For agricultural operations proper implement or machinery should be made available to the farmers at reasonable price/rent to improve their working efficiency. This will definitely encourage the cultivators to grow millets.

C 8. IMPROVEMENT IN EXTENSION SERVICES

Extension agencies play a key role in agricultural production and its quality both. It is well known fact that till date the technology developed by the scientists has not reached to the cultivator's field, means the dissemination of technology is very poor. In fact we are very much serious in developing the varieties/technologies but it will be fruitful only when it reaches to the farmer's field. Strengthening of our extension workers is very essential for desired production and productivity or to narrow down the gap between the potential yield and actual yield of the crop. Proper and timely training of extension workers and farmers before sowing of crop, perfect field demonstrations and field days are again equally important to improve the production and productivity of the crop as Field demonstrations or FLDs are most effective tool for transfer of newly developed technologies to enhance the productivity or to minimize the yield gaps of these crops.

C 9. IMPROVEMENT IN SOCIO-ECONOMIC STATUS OF THE FARMERS

It is very sad that a country like India, which is known by its villages, the socio-economic status of its farmers is very poor. For a developing country of 21st century it is very essential to improve the socio-economic status of its back bone "The Farmer" through government support, maybe through subsidized inputs (like seed, fertilizer, chemicals, implements, electricity charges, irrigation system, irrigation charges of canal water etc.), remunerative rates of the produce with assured procurement, easy & low interest finance facility, road network to mandies for transportation of the produce, hygienic living condition, health facilities and proper education to their children. This will definitely improve the millets production in the country.



C 10. STRENGTHENING OF RESEARCH

To enhance the millets production and productivity in the country more funds should be made available for research. This will help to generate the climate resilient varieties and production and protection technology according to the requirement of a specific region, climate or soil type.

C 11. IMPROVEMENT IN POST HARVEST TECHNOLOGY

Besides losses during harvesting, transportation and threshing, millets encounter insect-pest damage during storage, marketing and up to consumption of the produce. To overcome post harvest losses our government or other organization should come forward to provide low cost storage facilities to the farmers at nominal rates so that the farmers may put their produce safely up to a desired time. A mass awareness programme to educate farmers on scientific storage can also check the post harvest losses up to great extent. There is an urgent need to develop post harvest technologies to promote on-farm processing of the produce.

C 12. VALUE ADDITION

Though, some of the agencies and Self help groups are working in the direction of value addition but till date the efforts are as satisfactory. Through value addition we will be able to improve the quality of the produce which will ultimately help the farmers in the shape of more remuneration of the produce. With the help of government support in the shape of more research/training/MOU with some exporter/value addition & marketing in Cooperative manner will be helpful in improving millets production. Definitely, through value addition we will be able to create more demand of millets which will be ultimately helpful in enhancing the millets production in the country.

D. FUTURE PROSPECTUS OF NUTRI-MILLETS

Now a day when we are facing ill effects of increasing population on agriculture, climate change and increasing awareness about health, there is an urgent need to switch on millet cultivation in scientific way to improve production and productivity of nutri-cereals. Definitely, nutri-cereals are the only answer as:

- Natural resources are erasing day by day in our country and millets are in general low input crops.
- Our soils are degrading day by day and millets can be cultivated easily on these soils with limited resources.
- Rainfall pattern is erratic & uneven and millets are the crops require less water.
- We are facing hazardous effect of the chemicals on our environment, whereas, being eco-friendly millets require very less amount of chemicals for their cultivation in comparison to other cereals.
- Till date we are facing the problem of malnutrition and nutri-cereals are able to provide most of the nutrients required for normal functioning of human body.



- Health consciousness is also increasing day by day in our country and nutri-cereals or millets are able to supply nutrients for overall development of body.
- Cheapest source of supply of required nutrients to the human body.
- Millets are also able to overcome so many serious diseases.
- Only option to supply food, feed and fodder to a vast area with low fertility soils and limited rainfall.
- 100% transfer of technology will be helpful in increasing the production of millets in the country.
- Government initiative through different schemes also supports to increase the millets production in the country.
- Increase in MSP again supports the millet cultivation in the country.
- Value addition may open the door of prosperity to the farmers if implemented seriously.

E. STEPS TAKEN BY GOVERNMENT FOR PROMOTION OF NUTRI-CEREALS

Looking to the importance of millets to overcome the targeted hunger and mitigate the effect of climate change millets were promoted during 2011-12 to 2013-14 under the programme of **Initiative for Nutritional Security through Intensive Millets Promotion (INSIMP)** – as a sub scheme of RKVY and then merged as component of National Food Security Mission (NFSM) as NFSM-Coarse Cereals from the year 2014-15. Later, a programme on development of Millets is being implemented from the year 1 April, 2018 by the Government of India named as NFSM-Nutri Cereals under NFSM to promote the cultivation of millets in 202 Districts of 14 States (Andhra Pradesh, Chhattisgarh, Gujarat, Haryana, Karnataka, MP, Maharashtra, Odisha, Rajasthan, TN, Talangana, UP, Uttarakhand & West Bengal) (Table 4) along with two hill states (Himachal Pradesh and Jammu and Kashmir) and 8 North Eastern States (Arunachal Pradesh, Assam, Meghalaya, Manipur, Mizoram, Nagaland, Sikkim & Tripura). The districts having more than 10000 ha area under Jowar & Bajra, 5000 ha area under Ragi and 2000 ha area under Small millets has been identified except hilly/NE States. NFSM–Nutri Cereals was implemented with the objectives, increasing the production & productivity of nutri-cereals, restoring soil fertility & productivity at the individual farm level, enhancing farm level economy and enhancing post harvest value addition for better price realization to the farmers through efficient market linkages. Under NFSM-Nutri-Cereals, the interventions like Cluster Demonstrations, seed minikits, seed production & distribution, INM, IPM, etc are covered. In addition to this, Seed hubs, Breeder Seed Production, Cluster FLDs, Centre of Excellence, FPOs are being promoted under the programme (Table 5, 6).



Table 4 STATES AND NO. OF DISTRICTS COVERED UNDER NFSM-NUTRI-CEREALS

S.No	States/No. of districts covered	No. of Districts covered under NFSM-Nutri cereals			
		Sorghum	Pearl millet	Finger millet	Small millets
1	Andhra Pradesh/07	05	01	02	04
2	Chhatishgarh/10	-	-	-	10
3	Gujarat/19	04	14	02	-
4	Haryana/09	02	09	-	-
5	Karnataka/25	15	07	13	05
6	Madhya Pradesh/24	09	04	-	15
7	Maharashtra/26	23	11	07	-
8	Odisha/06	-	-	05	02
9	Rajasthan/23	10	21	-	-
10	Tamil Nadu/15	11	02	05	-
11	Telangana/04	04	-	-	-
12	Uttar Pradesh/24	05	19	-	01
13	Uttrakhand/09	-	-	09	06
14	West Bengal/01	-	-	01 (Darjeeling)	-
14 States/202 Districts		88 districts / 10 states	88 districts / 09 states	44 districts / 08 states	43 districts / 07 states

Table 5 : APPROVED INTERVENTIONS OF NFSM-NUTRI CEREALS

S.No.	Interventions	Pattern of Assistance
1	FLD/Cluster demonstrations	@Rs. 6,000/ha
2	Seed Distribution	@Rs. 30/Kg for less than 10 year old and Rs. 15/Kg for more than 10 year varieties. Hybrid @ Rs. 100/Kg
3	Seed Production	@Rs.30/kg
4	INM- (Micro-nutrient & bio fertilizers)	@Rs.500/ha
5	IPM- Agro chemicals/weedicides/ bio-agent	@Rs. 500/ha
6	Farm implement (Manual Sprayer)	@Rs. 600/Unit for SC/ST/Women/Small & Marginal Farmers, @Rs. 500/Unit for other Farmers



S.No.	Interventions	Pattern of Assistance
7	Water Application tools (Sprinkler)	@Rs.10,000/ha or 50% of the cost whichever is less
8	Capacity building of farmers	Cropping system based training @Rs.14,000/training (4 Session)
9	Local Initiatives	As per State need (25% of total budget allocation)
10	Creation of Seed Hubs/ Breeder seed production	100% GoI Share
11	Aid for centre of Excellences	
12	Organizations of Event / Workshop/Publicity	
13	Formation of FPOs in Cluster areas/ creation of processing unit for FPOs	

Table 6: APPROVED SPECIAL INITIATIVE

S.No.	Initiative	Proposed Outcome
1	Breeder seed production (18 centres)	Additional breeder seed production and seed hubs of millets would provide more quality seed of HYVs to farmers. Millet seed replacement by HYVs is expected to enhance yield by at least 15-25% based on the outcome of on-farm demonstrations which will lead higher marketed surplus augmenting farmers income.
2	Establishment of seed hubs (19 Sanctioned & 25 under seed production)	
3	Development of National database	Development of database is very crucial for planning, policy making and grades and standards will help in trade on long run and will prevent adulteration.
4	Comprehensive profiling of millets & bioavailability	Evidences on nutritional profiling will help in labelling and demand for millets cultivation when coupled with awareness.
5	Shelf life enhancement	Higher shelf life is crucial for commercialisation. Even at farmers level avoids distress sale and enhances farmers income.
6	National referral lab on nutri-cereals	Through proper selection of cultivars with superior nutrition helps in preventing adulteration of millet products and indiscriminate processing of millets.
7	National/International Year of Millets	<ul style="list-style-type: none"> • 2018 was declared as National Year of Millets, • FAO has considered 2023asInternational Year of Millets



E 1 CENTRE OF EXCELLENCES ON NUTRI-CEREALS

Government of India established Centre of Excellences on Nutri-cereals under NFSM to develop the recipe, value addition of nutri-rich produce, as well as training of entrepreneurs for commercialization and creation of consumption of these products.

Three dedicated commodity-wise Centre of Excellence (CoE) has been operationalised.

- Indian Institute of Millet Research (IIMR), Hyderabad for Sorghum
- CCS Hisar Agriculture University, Hisar for Pearl Millet and
- University of Agriculture Sciences, UAS, Bangalore for Small Millets

The main objectives of Centers of Excellence are

- Capacity building of Scientists and masses through demonstrations and trainings on developed technologies and handling of equipments.
- Training to entrepreneurs.
- Creation of awareness on nutritional superiority of millets.
- To facilitate market linkages between processors and producers for organized sale/delivery.
- Refinement and up scaling of already developed technologies of processing and value addition of millets.

E 2 FARMERS PRODUCER ORGANIZATION (FPOS)

- Total number of FPOs functioning on nutri-cereals through SFAC is 71 and 29 FPOs are working on both Nutri-cereals & Pulses in the Country.
- Six model FPOs allocated to ICAR-IIMR, Hyderabad for developing in different States.
- Main Objective of FPO is collectivization of producers, especially small and marginal farmers to address challenges of improved access to investment, technology, input and market.
- Aggregating small holders into FPOs proven pathway to improve bargaining power, move up value chains and improve access to technology, market.
- These FPOs are operational in the State of Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh etc. through SFAC.



E 3 NATIONAL YEAR OF NUTRI-CEREALS

Government has decided to **declare 2018 as “National Year of Nutri-cereals”** as millets are superior in terms of nutritive value, health benefits and to reduce the malnutrition. Further, these crops have low water requirements and are environment friendly.

E 4 MINIMUM SUPPORT PRICE (MSP)

The Government’s price policy for agricultural commodities seeks to ensure remunerative prices to growers for their produce with a view to encourage higher investment and production and to safeguard the interest of consumers by making available supplies at reasonable prices (Table 7). The price policy seeks to evolve a balanced and integrated price structure in the perspective of the overall needs of the economy.

Table 7: MSP (RS. PER QUINTAL) OF NUTRI-CEREALS DURING 2015-16 TO 2019-20

Year	Jowar		Bajra	Ragi
	Hybrid	Maldandi (Desi)		
2015-16	1570	1590	1275	1650
2016-17	1625	1650	1330	1725
2017-18	1700	1725	1425	1900
2018-19	2430	2450	1950	2897
2019-20	2550	2570	2000	3150
% Increase in MSP over 2015-16	62.4	61.6	56.8	90.9

E 5 RESEARCH WORK ON NUTRI-CEREALS TAKEN BY ICAR

All India Coordinated Crop Improvement Projects (AICRPs) on sorghum, pearl millet and small millets are functioning for agricultural research work. Under these ACRIPs, various centres are located in the specific zone across the country in ICAR/SAUs. A numbers of improved varieties/composites/hybrids have been developed which are resistant to biotic and abiotic stresses. Similarly a number of production and protection technologies are developed for its cultivation.

E 6 INCLUSION OF NUTRI-CEREALS UNDER INTEGRATED CHILD DEVELOPMENT SERVICES

As per the provisions under National Food Security Act enacted in 2013, food grains including millets are provided for preparation of meals under Supplementary Nutrition Programme of Aaganwadi services under the Umbrella of Integrated Child Development Services (ICDS) at subsidized rates through Public Distribution System.



E 7 INTERNATIONAL YEAR OF MILLETS

The proposal of Government of India for celebrating an International Year of Millets by UN was endorsed by FAO Council for 2023.

Definitely the initiatives taken by the Government and support from ICAR, SAUs, State Government and the farmers will be helpful to improve the area, production and productivity of the nutri-cereals. By this way we will be able to contribute towards health security of the nation, avoid malnutrition among growing children and women of poor societies, improvement in economic condition of the farmer and GDP.

Challenges

- Supply of Nutri-Cereals under PDS in addition to Rice and Wheat at cheaper price introduced in non-traditional areas of fine grain cereals.
- Improvement in low shelf life grain and flour of Nutri-Cereals.
- Enhancement of profitability and income of millet farmers.
- Generation of cost of cultivation/production for other Small Millets to facilitate CACP to arrive at MSP recommendation of these crops.
- Declaration of MSP in respect of other Small Millets (Kangani/kakun, Cheena, Kodo, Sanwa/Jhangora, Kutki) on the basis of Ragi Small Millet (Rs.3150/qtl.) by using price differential method.
- Creation of demand of Nutri-Cereals among the people.

F. GOVT. INITIATIVES REQUIRED TO IMPROVE MILLETS PRODUCTION

- Strengthening research on development of climate resilient varieties for changed climate, value addition including bakery products, overcome post harvest losses especially during storage, self life enhancement etc. through financial support to the AICRP projects already working in the states.
- Timely supply of seed and other inputs on reasonable price to easy reach of the farmer to narrow down the yield gap.
- Implements maybe make available to the farmers on rental basis or custom hiring centres may be strengthened.
- Facilities for primary and secondary processing on the door step of the farmers.
- Identification of the areas engaged in organic production maybe due to uncertainty of the production and certification of the same to promote export of grain as such or value added products for better price realization to the farmers through efficient market linkages.



- Collaboration with exporters for the export of value added products.
- Improvement in storage facility through Government initiatives or construction of community storage on nominal charges.
- Enhancing farm level economy.
- Mass campaign for health benefits awareness & value addition and organizing cooking festival/bakery products competition for new ideas/value added products.
- Creation of marketing infrastructure.
- Inclusion of millets in mid day meal, ICDS, Public Distribution System etc.
- Supply of millets especially in the areas/societies affected with the problem of malnutrition.
- Identification of surplus lands for cultivation of millets.



SECTION - 5

VILAS A TONAPI

B DAYAKAR RAO

C SANGAPPA

R MADHUSUDHANA

B VENKATESH BHAT

ICAR- Indian Institute of Millets Research
Rajendranagar Hyderabad (INDIA)

STRATEGIES FOR MAINSTREAMING MILLETS FOR NUTRITION SECURITY IN INDIA

Millets are a groups of cereal food grain crops which are profusely seeding, adapted to cultivation over a range of tropical and subtropical climates, can be grown with very low inputs. These crops are climate resilient, hardy and dryland crops also termed as nutricereals which contribute substantially for food and nutritional security. Generally, these are rain fed crops grown in areas with low rainfall and thus resume greater importance for sustained agriculture and food security.

All these millets are nutritionally rich, complete their life cycle in 2 to 4 months, adapting to the shorter cropping windows that facilitated wider adaption, shifting cultivation and withstanding nature's unforeseen vagaries. Millets are especially drought tolerant and can perform well in areas receiving less than 450 mm rainfall. Data on scientific evidences for nutritional and health benefit of millets are now available, even as consumers are actually finding that millets are superior nutritious cereals beneficial for human health. Investigations have shown that diets rich in millets, including whole grains are potentially protective against the non-communicable diseases like diabetes, cancer and cardiovascular diseases, due to protective effects of health promoting phytonutrients. Among millet crops, pearl millet occupies highest area followed by sorghum, finger millet and other small millets. These crops are grown for both grain and fodder purpose. Much of the grains are consumed at house hold levels and the rest goes for industrial uses including for poultry feed, food processing & breweries. Some quantities are also getting exported as seed, bird feed & processed food items.



The government of India, realizing the importance of millets for the nation, has initiated multi-pronged strategy to comprehensively promote production and consumption of millets. The Indian government has declared 2018 as the 'National Year of Millets' and has officially grouped the millets under "nutricereals". From 2018-19 onwards, a Sub-Mission of NFSM on millets ('nutricereals') has begun with an implementation span of five years (up to 2022-23). This Sub-Mission is aimed at reaching the farmers in all millets growing states through training/demonstrations in improved production practices of producing millet crops, value addition, provision of seeds of improved varieties, establishment of processing clusters for small millets, R&D support for solving strategic issues, increasing awareness about health and nutritional benefits of millets in mass media, etc. for the next five years. The objectives of the mission is to provide an inclusive and integrated development strategy that simultaneously addresses production, demand and research with market oriented approach. The strategy is to increase the production of nutricereals through area expansion and productivity enhancement in a sustainable manner in the identified districts of the country, and enhancing the farm level economy to restore confidence amongst the farmers. This is envisaged through strengthening of millets seed supply systems and enhancing post-harvest value addition at farm gate for better price realization to farmers through efficient market linkages.

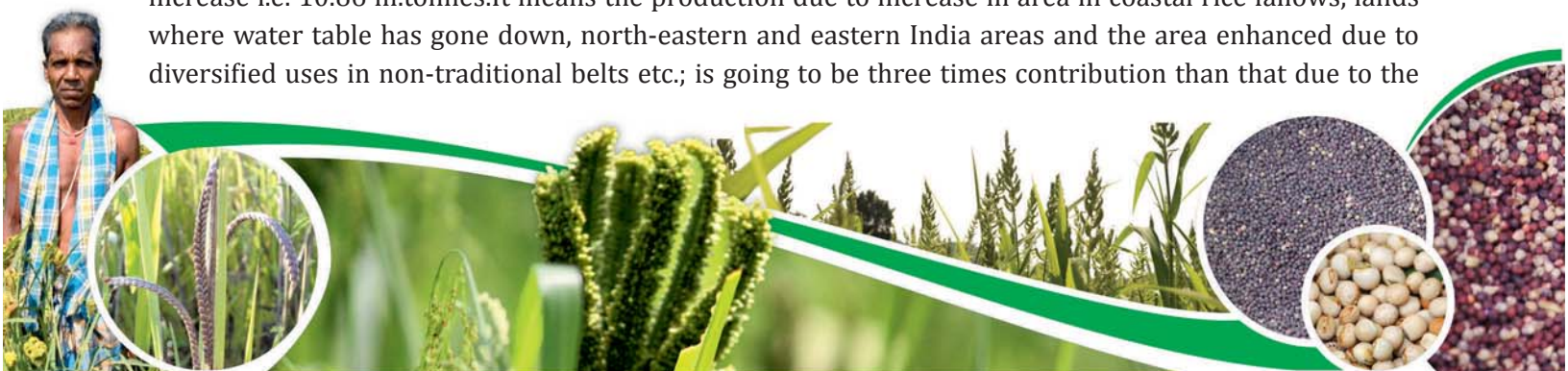
The mission on nutricereals is aimed at fulfilling the sustainable development goals (SDG's) of ending hunger, achieve food security and improved nutrition and promote sustainable agriculture through the cultivation of nutricereals, end poverty in all its forms, provide good health and well-being for citizens and alleviate the adverse effects of climate change.

APPROACH

To target the overall productivity enhancement, following programs and interventions in the targeted areas of 202 districts located in 14 states will be organized and adopted. Front line demonstrations and Intensive promotion of package of practices (crop production technologies) will be conducted on compact blocks in cluster approach. Distribution of seed of high yielding varieties (HYV) and hybrids will be implemented through distribution of seed mini-kits. Breeder seed production of HYVs and establishment of seed hubs for producing quality seeds will be supported.

PROJECTED NUTRICEREALS OUTPUT OVER 2022-23

During the ensuing five years, the increase in estimated total production of all nutricereals is going to be 3.59 m. tonnes higher over the base year 2018-19 when the productivity gains alone are taken into consideration. While the area increase when computed with increased productivity, the production levels for the end year 2022-23 will be 31.74 m.tonnes. The difference in estimates can be attributed to area increase i.e. 10.86 m.tonnes. It means the production due to increase in area in coastal rice fallows, lands where water table has gone down, north-eastern and eastern India areas and the area enhanced due to diversified uses in non-traditional belts etc.; is going to be three times contribution than that due to the



productivity enhancement envisaged (new improved cultivars, soil health improvement, shift from marginal lands to better lands under nutricereals cultivation due to better profits, crop management practices in adoption mode).

Table 1: Annual productivity trends across nutricereals for doubling farmers' income

Crops	Current Level		Yield Growth Targets					
	Yield (kg/ha)	CAGR 1996-97 to 2014-15	2017-18 (%change over 2015-16)	2018-19 (Annual increase %)	2019-20 (Annual increase %)	2020-21 (Annual increase %)	2021-22 (Annual increase %)	2022-23 (Annual increase %)
Sorghum	884	-0.44%	900 (1.83)	950 (5.55)	1000 (5.25)	1050 (5.00)	1150 (9.5)	1200 (4.35)
Pearl millet	1255	2.62%	1275 (1.59)	1300 (1.96)	1350 (3.84)	1400 (3.70)	1425 (1.78)	1450 (1.75)
Finger millet	1706	1.47	1750 (2.58)	1775 (1.42)	1800 (1.40)	1850 (2.77)	1900 (2.70)	1925 (1.32)
Small Millets	654	2.04	750 (14.59)	775 (3.33)	800 (3.22)	820 (2.5)	850 (3.65)	875 (2.94)

Table 2: Dynamics of production estimates on different regimes of area and productivity of different nutricereals in the country during 2018-19 to 2022-23

Crop	Constant area with current productivity			Constant area with Increased productivity			Increased area with Increased productivity		
	Area (M.ha) (TE)	Productivity (kg/ha)	Production (M. tones)	Area (M.ha)	Productivity (kg/ha)	Production (M. tones)	Area (M.ha)	Productivity (kg/ha)	Production (M. tones)
Jowar	5.9	900	5.10	5.9	1200	7.08	7.08	1200	8.50
Bajra	7.37	1275	9.4	7.37	1450	10.69	8.48	1450	12.30
Ragi	1.25	1750	2.19	1.25	1925	2.41	1.5	1925	2.89
Small Millets	0.8	750	0.6	0.8	875	0.7	0.92	875	8.05
Total	15.32	1129	17.29	15.32	1362	20.88	17.98	1765	31.74



Thus, the emphasis therefore, should be investment with dual focus on yield growth and area expansion simultaneously, in order to attain the objectives. In addition, post production value addition through interventions in primary processing and secondary processing with credible market linkages will go a long way in strengthening nutriceals value chain for the benefit of not only farmers income but also the nutritional security of the both rural and urban consumers. This addition coming from Nutriceals, would release pressure to some extent on paddy and wheat tracts.

The envisaged nutriceals output could be realized through area expansion through incentivisation of Nutri-Cereal cultivation, farm gate processing, support to farmer producer organizations, price support, crop insurance and the market assurance schemes and minimum support price being enhanced by 1.5 times of cost of cultivation leading to price efficiency support. This support will trigger Nutriceals being cultivated in more area and enhanced production. It is also expected that awareness about nutriceals as health food till date has shown demand generation growing in geometric proportion and will trigger area expansion to harness enhanced production thus enabling better linkages of nutriceal production systems through value chains to markets for better price realization to farmer. In addition, the enhanced productivity augmentation will be enabled due to absorption of new high yielding varieties, better scientific package of practices and technologies that enhance production efficiencies. Thus projected estimates could be realized in the given time frame with envisaged policies and incentives.

PRODUCTION AND UTILIZATION OF MILLETS IN INDIA

India is the largest producer and consumer of millets with maximum diversity in terms of types of millet crops grown and utilized for various purposes. Millet crops are grown in most of the states in regions characterized by low to moderate precipitation (200-800 mm rainfall). Major millet crops cultivated in India include sorghum (*Sorghum bicolor*), pearl millet (*Pennisetum typhoides*), finger millet (*Eleusine coracana*) and small millets- comprising of foxtail millet (*Setaria italica*), little millet (*Panicum miliare*), kodo millet (*Paspalum scrobiculatum*), barnyard millet (*Echinochloa frumentacea*), proso millet (*Panicum miliaceum*), and brown top millet (*Brachiaria ramosum*), which are now termed nutriceals.

PRODUCTION OF MILLETS

Though traditionally millets have been produced and utilized mainly as staple food and source of fodder in the dryland agricultural communities, now they are recognized as food grains for nutrition and health, besides for their suitability for organic cultivation. India is the leading producer and consumer of millet crops and their products. A total of 16.7 m ton of millets food grains are produced in India from nearly 15.7 m ha area, which constitutes 6 % of national food grain basket. Pearl millet is grown in about 7.7 million hectares yielding 9.1 million ton, followed by sorghum (6.1 m ha, yielding 5.3 m ton), finger millet (1.2 m ha, yielding 1.9 m ton) and other millets (0.7 m ha yielding 0.4 m ton).

Though millets are one of the earliest grains to be cultivated and consumed, in the last 5-6 decades India has witnessed significant decrease in the area under the millets crops. However, the productivity (yield in kg/ha) of these crops has gradually gone up due to development and adoption of high yielding varieties

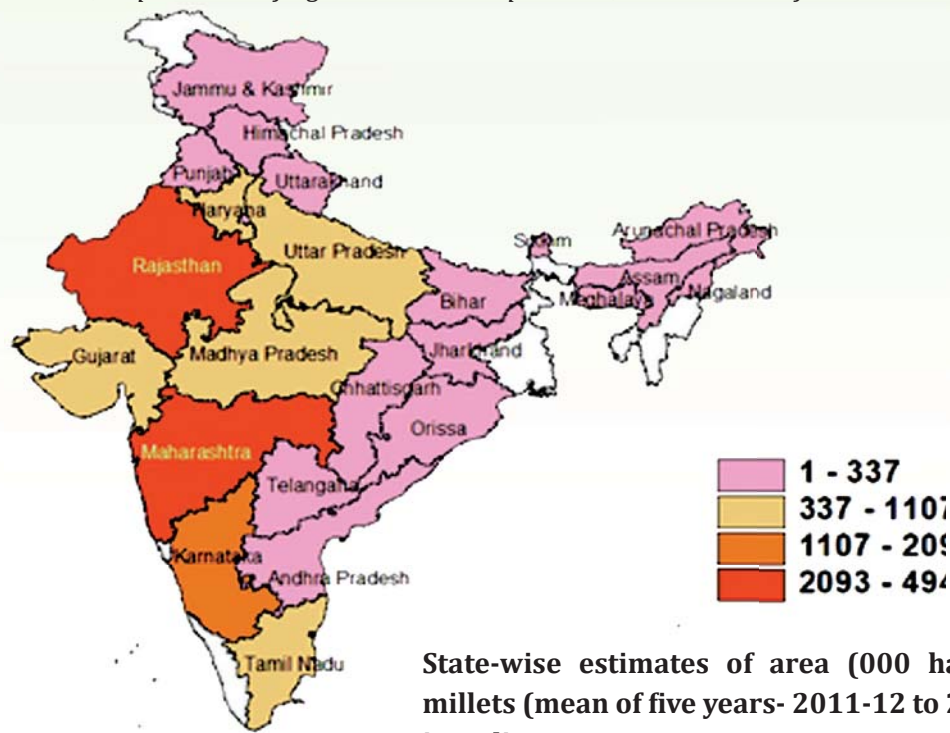


and improved production technologies. Among the states, during 2015-16, maximum area under millets was in Rajasthan (5 m ha; 87% under pearl millet) followed by Maharashtra (4 m ha, 75% under sorghum) and Karnataka (2 m ha, 54% under sorghum, 32% under finger millet).

Area, production and yield of millet crops in India during 2016

Crop	Area (000 ha)	Production (000 tons)	Yield (kg/ha)	Contribution to world production (%)	World Production rank
Barnyard millet	146.0	151.0	1034	99.9	1
Finger millet	1138.3	1822.0	1601	53.3	1
Foxtail millet	72.6	50.2	691	2.2	3
Kodo millet	200.0	84.2	419	100	1
Little millet	255.5	119.9	469	100	1
Pearl millet	7129.0	10280.0	1442	44.5	1
Proso millet	31.0	20.0	645	1.4	9
Sorghum	5650.0	4410.0	781	6.9	6

Source: Estimates based on data from Food and Agriculture Organization, United Nations & Directorate of Economics and Statistics, Department of Agriculture & Cooperation, Government of India.



Source: Estimated based on data from Department of Economics and Statistics, Government of India



The main reasons for the decline in the cultivation of millets crops in India are - low remunerative returns from cultivation as compared to other competing crops, lack of input subsidies and price incentives, subsidized supply of fine cereals to public, and change in the consumer preferences. In spite of the reduced consumption of millets in the country, they are the very important food crops in niche areas of dry lands and hilly regions, for farming communities including tribal regions. Millets as staple foods also provide nutrient security and these are strategically important wherever they are grown and consumed. Kodo millet and little millet in Madhya Pradesh and Chhattisgarh, finger millet in Orissa, Andhra Pradesh and Uttarakhand, barnyard millet in Uttarakhand and Tamil Nadu, among others, continue to be under cultivation and consumption by tribal communities.

UTILIZATION OF MILLETS

Bulk of the millets produce is consumed in the farmer's household and only 5-10% of production enters the commerce and this proportion is now gradually increasing. Millets are traditionally consumed as staple foods in the Indian diet in the form of unleavened bread and porridge. The dehulled grain of small millets is cooked like rice and eaten. They are also made into flour, used for making puddings or cakes. Milled millets are further processed for various food uses such as flakes, quick food cereals, ready to eat snacks, supplementary foods, extrusion cooking, malt based products, weaning foods, and more importantly health foods. Malting of finger millet for food uses is in practice from time immemorial. Millets are being widely used for developing various value added products like biscuits, sweets, vermicelli, ready mixes and multi-grain flour.

Multi-grain millet flour, flakes of sorghum and pearl millet, finger millet malt, sorghum semolina and pasta, millets based breakfast cereals, millets-based regional snacks and fast foods, etc. are the commercially available millets products in India both in retail and online. More extrusion based and bakery products are in the offing from different entrepreneurs. The 'organic' factor of millets is working in favour of uptake of these products in India, where gluten allergy issues are not so much present or ignored.

More data on levels of consumption, commerce, etc. are not available and mostly it is localized in the production belts as well as in some niche market areas in the growing states. Sprouted grains are also eaten as vegetable in some regions. Millets are known to substitute a portion of poultry feed whenever price of maize goes up. Some portion of the millets are also utilized in biscuit and brewing industries.

Millets form the major supplier of green and dry fodder in India and their role becomes important during the lean period of winter and summer months. About 20 to 60% of dry fodder supply in semi-arid area is dependent on sorghum and pearl millet. Finger millet and barnyard millet fodders possess high palatability and are also used for making hay or silage. Proso millet green plants are good fodders for cattle and horses.

In India, due to growing urban demand, several small and medium entrepreneurs have taken to value addition of millets and marketing in urban clusters and online kiosks. This is expected to reach a critical



mass in a couple of years beyond which farmers would be able to realize the benefits of accruing demand. Export of value added products of millet products has been in place and growing, though the portion is miniscule compared to the total of the food and agricultural exports.

Developing the national marketing infrastructure is now underway - which is the most important step for the growth of millet industry, as 85% of the Indian farmers are small and marginal and resource poor. Development of co-operative millets marketing system will significantly enhance the millets producers' bargaining power in the competitive market. Linking the Indian millets farmers with online marketing platforms like e-NAM, will be successful in helping the millet farmers realize better prices for their produce in the nation-wide market.

Other strategies for Sub-Mission on Nutricereals under NFSM: These include interventions for productivity enhancement, nutritional awareness creation, strengthening seed production and storage, farm gate processing facilities, strengthening of Centers of Excellence of value added products technologies, supporting entrepreneurship, training and business, R&D on nutricereals and establishing grades and standards of nutricereals.

EXPECTED OUTCOMES

- The income of nutricereals farmers doubled by 2022.
- Enhancing the production of Nutricereals from existing to 20 million tonnes by 2022.
- Promotion of 100 Farmers Producers Organization in Nutricereals by 2022.
- Increased domestic consumption of nutricereals by three folds.
- Value chain integration of small farmers and promotion of 500 small processing clusters and 100 demonstrations cum processing clusters.
- Establishment of 100 SMEs in nutricereals processing through technology commercialization.
- Establishment of National Referral Lab for nutricereals with major focus on validation for domestic as well as export marketing.

STRATEGIES FOR PROMOTION OF MILLETS

Millets constitute one of the oldest foods known to humanity, estimated to be under cultivation since 2500 B.C. Millets have been the stable diet and main source of income, dietary energy and protein for a billion people in arid and semi-arid tropics in the world. The array of millets offers the range of grains, flavours and textures suitable for a variety of cuisine and healthy consumption.



Millets contain substantially high amount of fat, fibre and minerals in comparison to cereals like wheat and rice, which have been categorized as fine cereals. The protein content in millets, namely, jowar (10.4%), bajra (11.6%), proso millet (12.5%), foxtail millet (12.3%) and barnyard millet (11.6%) is comparable with wheat (11.8%) and much higher than that of rice (6.8%). Though finger millet contains lesser protein (7.3%), it is rich in mineral matter and calcium in comparison to wheat and rice. All the millets contain more fibre than fine cereals. Particularly, the small millets namely barnyard millet (14.7%), kodo millet (9.0%) little millet (8.6%) and foxtail millet (8.0%) are much richer in fibre in comparison to wheat (1.2) and rice (0.2%).

In a way, India with one of the largest extent of arable land, a major part of which is under rainfed systems is capable of being the millet leader in the world. Millets are low in gluten and glycaemic index, apart from being richer in calcium and various other nutrients which are essential for good human health. Now, that various non-communicable diseases like diabetes etc. have begun to afflict a larger section of the society, millets with low gluten character are emerging as healthy food substitutes. Interestingly, the decline in area and production of millets over the last three-four decades and consequential supply coincides with increasing market demand. From the perspective of farmers, it is a propitious situation for them to realize better prices on their produce. Unfortunately millets as of now are confined to less endowed cultivation tracts of the country. The landholdings where millets are cultivated are largely marginal and the farmers are generally small & marginal with poor access to capital and other production resources. They are also raised under rainfed systems with no assured source of irrigation exposing a good crop at its critical stage of production; cascading into lower yield. Further, having remained outside the pale of green revolution centric science & technology, the R&D too has largely by passed them causing outcomes that cannot compete with paddy, wheat & maize in terms of yield increases. The average yields of millets in India today is 1.1 tonnes per ha. in contrast to 2.5 tonnes per ha in case of rice, 3.2 tonnes per ha in case of wheat and 2.7 tonnes of maize. The policy framework, particularly the marketing support by way of procurement has also bypassed the millets as poor cousins of wheat & paddy. The substantial decline in the quantum of production of millets over the decades has also dried up the open market channels. In sum, millets, once the principle staple crops of India, have been relegated as relatively forgotten crops.

Present Scenario: APY Data presented in Table 1 and 2 have shown that about 17.1 m tonnes of millets food grains are produced from nearly 15.9 m ha area, which constitutes around 7% of national food grain basket. Bajra is grown in about 7.9 million hectares yielding 9.4 million tons, followed by jowar (6.1 m ha, yielding 5.4 m ton) and ragi (1.1 m ha, yielding 1.8 m ton) and other millets (0.68 m ha yielding 0.41 m ton). These crops are grown for both grain and fodder purpose. Much of the grains are consumed at house hold levels and the rest goes for industrial uses including for poultry feed, food processing and breweries. Some quantities are also get exported as seed, bird feed and processed food items. At global level, India is the leading producer of millets producing 41% of bajra from 28% of global area under the crop and 7% of jowar from 13% of global area under the crop. Ragi, little millet and kodo millet are mostly grown in India, whereas maximum area under foxtail millet (4-5m ha) is in China and proso millet is grown in Eurasian countries.

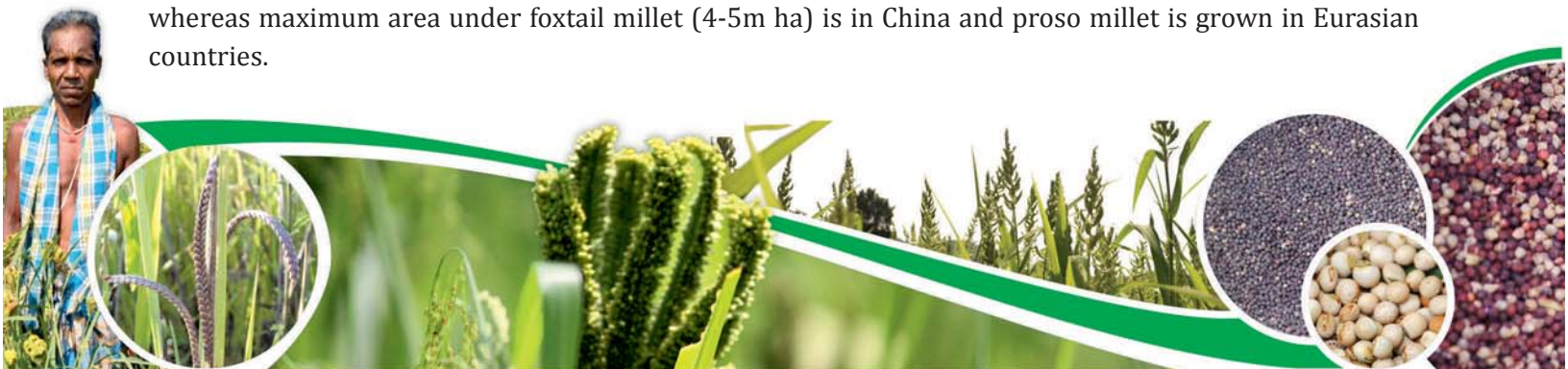


Table 1. Current area, production and productivity of Nutri-Cereals in India (2016-17)

Crop	Area (000 ha)	Production (000 tonnes)	Yield (kg/ha)
Jowar	5129.5	4740.3	0925
Bajra	7469.4	9855.7	1320
Ragi	1046.5	1430.3	1367
Small Nutri-Cereals	0588.2	0436.4	0742
Total	14233.6	16462.7	-

Table 2. Seven yearly average (2011 to 2017) of area, production and Yield of Nutri-Cereals

Crop	Area (000 ha)	Production (000 tonnes)	Yield (kg/ha)
Jowar	6142.71	5460.84	0898
Bajra	7915.79	9391.34	1192
Ragi	1167.91	1855.46	1583
Small Nutri-Cereals	0688.57	0418.37	0614
Total	15914.98	17126.01	-

PROJECTED NUTRI-CEREALS OUTPUT OVER 2022-23 - DOUBLING FARMERS' INCOME (DFI) PERIOD

From the data presented in Table 3, it is evident that during the ensuing five years, the increase in estimated total production of all Nutri-Cereals is going to be 3.59 m. tonnes over the base year 2018-19 when the productivity gains alone are taken into consideration. While the area increase when computed with increased productivity, the production levels for the end year 2022-23 will be 31.74 m.tonnes. The difference in estimates can be attributed to area increase i.e. 10.86 m.tonnes. It means the production due to increase in area (increase in area in coastal rice fallows, lands where water table has gone down, NE and eastern India areas, the area enhanced due to diversified uses in non-traditional belts, etc) is going to be three times contribution than that due to the productivity enhancement envisaged (new improved cultivars, soil health improvement, shift from marginal lands to better lands under Nutri-Cereal cultivation due to better profits, crop management practices in adoption mode).

Thus, the emphasis therefore, should be investment with dual focus on yield growth and area expansion simultaneously, in order to attain our objective. In addition, post production value addition through



interventions in primary processing and secondary processing with credible market linkages will go a long way in strengthening nutri-cereals value chain for the benefit of not only farmers income but also the nutritional security of the both rural and urban consumers alike in the country. This addition coming from Nutri-Cereals, would release pressure to some extent on paddy and wheat tracts.

Table 3. Annual productivity trends across Nutri-Cereals for doubling farmers' income

Crops	Current Level		Yield Growth Targets					
	Yield (kg/ha)	CAGR 1996-97 to 2014-15	2017-18 (%change over 2015-16)	2018-19 (Annual increase %)	2019-20 (Annual increase %)	2020-21 (Annual increase %)	2021-22 (Annual increase %)	2022-23 (Annual increase %)
Jowar	884	-0.44%	900 (1.83)	950 (5.55)	1000 (5.25)	1050 (5.00)	1150 (9.5)	1200 (4.35)
Bajra	1255	2.62%	1275 (1.59)	1300 (1.96)	1350 (3.84)	1400 (3.70)	1425 (1.78)	1450 (1.75)
Ragi	1706	1.47	1750 (2.58)	1775 (1.42)	1800 (1.40)	1850 (2.77)	1900 (2.70)	1925 (1.32)
Small Millets	654	2.04	750 (14.59)	775 (3.33)	800 (3.22)	820 (2.5)	850 (3.65)	875 (2.94)

Source: DFI Committee Estimates

DYNAMICS OF PRODUCTION ESTIMATES

The agricultural output can be increased through increase in the crop area or by increasing the productivity of agricultural crops per unit of area in general. Expansion of area under nutricereal crops is of great limitation given the limited supply of lands and increased demand for lands for non-agricultural purposes. Therefore increase in the productivity of millets remains the most viable option for enhancing the agricultural production in the country. In most of the states, farmers realize lesser yield for the crops as compared to the yield demonstrated by the research institutes and this hinders the achievement of full level potential of the newly released varieties and improved package of practices. Inability of the farmers in ensuring the improved package of practices as demonstrated by the research stations often lead to yield gap. Given the inelastic supply nature of lands, significant income generation of millets farmers can be done by productivity enhancement of millets through reducing yield gaps, including fallow, dry lands and wastelands under millets cultivation.



Table 4. Dynamics of production estimates on different regimes of area and productivity of different Nutri-Cereals in the country during 2018-19 to 2022-23

Crop	Constant area with current productivity			Constant area with Increased productivity			Increased area with Increased productivity		
	Area (M.ha) (TE)	Productivity (kg/ha)	Production (M. tones)	Area (M.ha)	Productivity (kg/ha)	Production (M. tones)	Area (M.ha)	Productivity (kg/ha)	Production (M. tones)
Jowar	5.9	900	5.10	5.9	1200	7.08	7.08	1200	8.50
Bajra	7.37	1275	9.4	7.37	1450	10.69	8.48	1450	12.30
Ragi	1.25	1750	2.19	1.25	1925	2.41	1.5	1925	2.89
Small Millets	0.8	750	0.6	0.8	875	0.7	0.92	875	8.05
Total	15.32	1129	17.29	15.32	1362	20.88	17.98	1765	31.74

Note:

1. Area increase for five years considered in Jowar and Ragi upto 20% but for Bajra and other small millets upto 15%.
2. Productivity figures taken from earlier table on Annual productivity trends across Nutri-Cereals for doubling farmers' income.
3. Constant/current area is Triennium average of previous 3 years ending 2015-16.

The envisaged Nutri-Cereal output could be realized through area expansion through incentivisation of Nutri-Cereal cultivation, farm gate processing, support to farmer producer organizations, price support, crop insurance and the market assurance schemes and minimum support price being enhanced by 1.5 times of cost of cultivation leading to price efficiency support. This support will trigger Nutri-Cereals being cultivated in more area and enhanced production being augmented from rice fallows, additional areas with limited protective irrigation capabilities, and from new non-traditional northern states in February-March planting windows apart from bringing certain sizable portions of cultivable wastelands for Nutri-Cereal cultivation. It is also expected that awareness about nutricereals as health food till date has shown demand generation growing in geometric proportion and will trigger area expansion to harness enhanced production thus enabling better linkages of Nutri-Cereal production systems through value chains to markets for better price realization to farmer. In addition, the enhanced productivity augmentation will be enabled due to absorption of new high yielding varieties, better scientific package of practices and technologies that enhance production efficiencies. Thus projected estimates could be realized in the given time frame with envisaged policies and incentives.



Strategizing Policy interventions for millets in India

Crop	Extent of yield gap*	States	Strategies
Jowar	Lower yield gap	Kharif: Madhya Pradesh, Maharashtra, Tamil Nadu Rabi: Karnataka	<p>A. Strategies for the states under-performing</p> <p>In the short run the states performing below the national average need to be given boost in the supply side factors to enhance the productivity and raise them to the national average in a period of three years. Various supply side factors like provision of timely quality seeds, training programmes, formation of seed villages, assured price and buy back arrangements, insurance coverage, inclusion of all millets under MSP and proper procurement policies etc. will boost the farmers’ motivation towards millets cultivation.</p> <p>B. Strategies for the states above-performing</p> <p>The states with more yield gap are needed to be taken care on the demand side of the policy issues. Generation of demand for millets and millets value added products will help in maintain the good pace of production of these crops.</p> <p>Proper value addition at the farm level, inclusion of millets in the midday meal scheme, creation of awareness about the nutritional benefits of millets, promotional activities etc. will boost the demand for the millet products in the country.</p>

* Yield gap is the difference between State Average Yield (SAY) and Frontline Demonstrations (FLD)s of improved technologies in respective states

ENVISAGED STRATEGIES FOR MILLET PROMOTION

- **Crop wise importance:** In order to reap immediate benefits in short to medium term of 3-5 years, we may concentrate on low hanging fruits where the value chain is relatively well developed. Therefore Sorghum, bajra and finger Nutri-Cereal may be targeted to take advantage of low hanging fruits. This



will enable us to focus on enhancement of incomes in drylands from the stated three crop commodities targeting creation of demand for them concentrating holistically on all functions involved in the value chain right from farm production to end user consumption. The success of value chain development in major Nutri-Cereals may be extrapolated to other small millets which are also store houses of nutrition.

- **Productivity Enhancement and Farmer's Related:** The productivity enhancement measures should be intensified in major Nutri-Cereals parallel to demand creation measures in order to commercialization process which involves volumes may be adequately met from surpluses from farm throughout the year. Involving Farmers Producers organizations (FPO's) and improving the collective bargaining capacity and handling of various operations collectively with local leadership with a special focus on nutri-cereals value chain development. Thus focus will be on low productivity and high potential districts including cultivation of Nutri-cereals crops in rain fed areas, fallow lands and wastelands. Implementation of cropping system centric interventions in a Mission mode approach through active engagement of all the stakeholders at various levels. Agro-climatic zone wise planning and cluster approach for crop productivity enhancement. Promotion and extension of improved technologies i.e., seed, integrated nutrient management (INM) including micronutrients, soil amendments, integrated pest management (IPM), input use efficiency and resource conservation technologies along with capacity building of the farmers/extension functionaries.
- **Farm gate Processing:** Primary processing is the main focus of strengthening the demand for small Nutri-Cereals there by the Farmer-producers may be strengthened in such a way farm gate processing will enable to reap benefits of value addition for enhanced incomes also likely to obtain higher share in the consumer rupee. Processing clusters for startups/rural entrepreneurs/SHG's etc may hasten the value addition at primary levels for off take of the produce. This will be gradually year by year state by state will be empowered through the mission.
- **Strengthening seed storage,** processing, delivery mechanisms for ensured quality seed supply. Creation of marketing infrastructure with innovative supply chain models, online marketing platforms and others will significantly increase the Nutri-Cereals farmers' share in consumer rupee.
- **Strengthening of Centers of Excellence:** A great deal of showcasing of value added products technologies, recipes development suited for various states, training needs of various stakeholders on value addition processing, and machinery handling, storage, marketing and branding will be undertaken. Secondary processing technologies and their upscaling will lead to demonstration to all stakeholders across the country.
- **R&D on Nutri-Cereals:** on primary processing machinery development there should be the priority for developing efficient dehulling machinery for small Nutri-Cereals. R&D should focus on profiling of nutri-cereals cultivars, clinical validation, bioavailability studies, identification specific cultivars



suitable for processing of specific products, shelf life enhancement. Establishing pilot plants on diversified uses to strengthen demand and utilization of cereals including fodder utilization.

- **Establishing grades and standards of Nutri-Cereals** for export purposes to be readied for future. The linkages with various stakeholders including the collaborative research between private and public institutions such as CFTRI, NIN, AICRP centres, ICRISAT, IIT's, private partners will bring in more resources for Nutri-Cereal promotion in the country holistically.
- **State of art facilities on Nutri-cereals:** National referral lab and national museum on nutri-cereals as a centralized facility at IIMR campus will serve as validation centre.
- **Entrepreneurship, Training and Business:** Supporting startups is another important function that will handhold them through seed funding for immediate take off. All the start ups approaching CoE for their technologies to be commercialized may be scrutinized and funded.
- **Nutritional Awareness creation:** Creating awareness about the nutritional and health benefits over other traditional food grains and popularization of Nutri-Cereal products among the consumers could be a major step for demand creation. Awareness creation is a very important as aggressive to address nutritional and health related problems and nutritional benefits of nutri-cereals pan India

FUTURE OUTLOOK

After decades of neglect, millets are receiving growing attention in the country. They are viewed as important for health and wellness of people and can help in preventing many kinds of diseases related to modern life style including obesity and diabetes. The rich diversity of millets crops has made these crops well suited for contingency crop planning and also to address the issues of climate change. The importance of regular food use of nutrient dense millet for achieving a holistic food and nutritional security is widely recognized. The higher prices being offered in some parts of the country to millets duly recognizing their unique nutritional features is making millets a remunerative proposition vis a vis with other crop options in the region. There is a greater demand for organically produced millets which can be further stepped up so that the demand for these crops is increased for the benefit of millet farmers. The interventions made in the area of grain processing and value addition through the development of novel diversified foods in all millets is opening new avenues for expanding consumer base, enhanced absorption for food use. With the rising awareness on the nutrient richness of millets, development of technologies for up scaling and policy options to promote beneficial production and utilization of millets have been receiving due attention.

CONCLUSION

- An additional amount of 48 million tonnes of millets could be produced in the next five years if the waste and fallow lands are brought under cultivation of millets and in a period of 3-4 years an additional amount of 7.88 million quintals of total millets could be produced in India only through reduction in yield gaps.



- The cost of cultivation of millets can be reduced by adoption of recommended package of practices and increased resource use efficiency, technological upgradation and adoption of water saving technologies.
- Resource use efficiency on the other hand can be increased by adopting conservation agriculture and blending indigenous and modern technologies of millets cultivation. Adoption of integrated farming system models with inclusion of millets for cultivation in post-kharif rice fallows will increase cropping intensity in dryland agriculture.
- Value addition for demand creation can contribute upto 30% of additional income required for doubling millets farmers' income by 2022. Demand for millets and value added products can be done through various policy advocacies.
- Development of product specific varieties, creation of farm level grading and standards, fabrication of primary processing machinery and conducting bioavailability and shelf-life studies will create demand for millets in the country. Setting up of nutrition-cum-referral labs on nutrition in IIMR will significantly contribute towards "branding of millets value chain" in the country.
- Addition of nutri-rich fodder in the millets value chain and other millets subsector development will significantly help in doubling the farmers' income.
- Federating the millets farmers to form into FPOs will sufficiently increase the bargaining capacity of millets farmers. These FPOs need to be supplemented with provision for farm gate level processing of millets with technological backstopping from IIMR. The start-up entrepreneurs can be linked with FPOs for creation of innovative supply chain model and bringing remunerative prices to the millets farmers.
- Thus the policies should aim at creation of FPOs with regard to millets with provision of small warehousing facilities for incentivising them to attain the goal of doubling the farmers' income.
- The horizon of contract farming can be explored under millets sector in the dryland parts of the country to provide price security to the farmers. This will also bring out timely and systematic supply of quality millets grains in the market.
- Formulation of steady price policies, expanding the coverage of small millets under MSP, more procurement of millets through MSP and providing insurance coverage to all the nutri-cereal crop enterprises. Improvement in the terms of trade (ToT) of agriculture, extending credit and insurance support to the farmers and providing tax exemption to the millets farmers and entrepreneurs will boost the millet farmers' income in the coming years.



SECTION - 6

DR RAGHAVARAO K S M S
DIRECTORCSIR-Central Food Technological
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PROCESSING OF MILLETS WITH SPECIAL REFERENCE TO FINGER MILLET (RAGI)

Millets, rightly renamed as “nutricereals”, are known for their nutritional significance. Apart from providing the major nutrition, millets do contain different phytochemicals which are known for their health benefits. The major millets are pearl, finger, foxtail, little, proso, kodo and barnyard millet and recently browntop millet is an inclusion to this group. Excluding pearl millet, the rest of the grains are generally called as small millets. It is well known that, the small millets play an important role in nutrition and diet because of the inherited health benefits associated with them. Foxtail and proso millets contain proteins slightly higher (12.5 g/100g) than wheat, while little millet is a very good source of iron (9.5 mg/100g) and finger millet is known for its calcium (350 mg/100g) contents. Millets score high in their nutritional profile compared to milled rice and other major cereals. Moreover, the carbohydrates present in millets are unique because of the starch granules are compactly arranged and surrounded by cell wall materials which contribute for the dietary fiber component of the grain. Thus, millets do provide a good amount of the dietary fiber to the consumer. Apart from this, each millet possess unique features in terms of nutritional benefits. Finger millet contains good amount of sulphur amino acids like tryptophan, cystine and methionine and also is a rich source of polyphenols. Due to the presence of polyphenols, finger millet exhibit good antioxidant activity, shows hypoglycemic, hypocholesterolemic and anti-ulcerative properties thus providing the health benefits to the consumer. Foxtail millet shows good antioxidant potential because of polyphenols, carotenes and tocopherol contents. Foxtail millet also accumulates gama aminobutyric acid (GABA) on germination, which regulates brain function. Little millet also contains good amount of polyphenols and shows highest iron chelating activity. Similar to foxtail millet, proso millet also contains high amount of carotenoids and tocopherols and thus contribute for its antioxidant activity. Kodo millet contains comparatively high lysine content (3.0-3.5g/100g) among all other millets. It also shows highest DPPH quenching activity among millets and hypoglycemic nature and reduces cholesterol levels. Barnyard millet contains serotonin derivative, which exhibits anti-inflammatory activity. It also contains luteolin and triclin which belong to flavonoid group and are cancer preventive in nature.

With such a unique and specific nutritional profile, millets still remained unfamiliar to a wide range of population for several years. However, progressive research on nutritional benefits of millets and increased awareness have attracted health conscious segment of the population towards millet based products. Due to several reasons, the inclination of consumers towards millets has been increased in recent years. Such



an inclination is beneficial in terms of the development of millet economy, increased production, to sustain the competition from major cereals and most importantly to increase the wide spread utilization of the millets.

All the small millets except for ragi need shelling to remove the outer most husk. Thus shelling the grain becomes the primary need in millet industry. The grain once shelled can be used similar to rice in any of the food formulations. However, the shelled grain contains a bran layer, whose presence, even though improves the nutritional benefit of the grain, hinders the consumer acceptability and also the shelf life. Thus, polishing the grain becomes another essential step. However, care has to be taken that, the grains are polished to a minimum extent, but not to deprive the kernel of its nutrients. The judiciously milled millets can be used in different food products similar to rice. The millets, can be popped directly, and can be converted into ready-to-eat products. The millet rice or flour especially from foxtail and little millet shows very short shelf-life of 15 to 30 days because of the presence of fat and lipases. However, these short comings have been successfully overcome by converting the millets either to flour or semolina form using roller milling technology and the products thus prepared showed a shelf life of minimum 4 months.

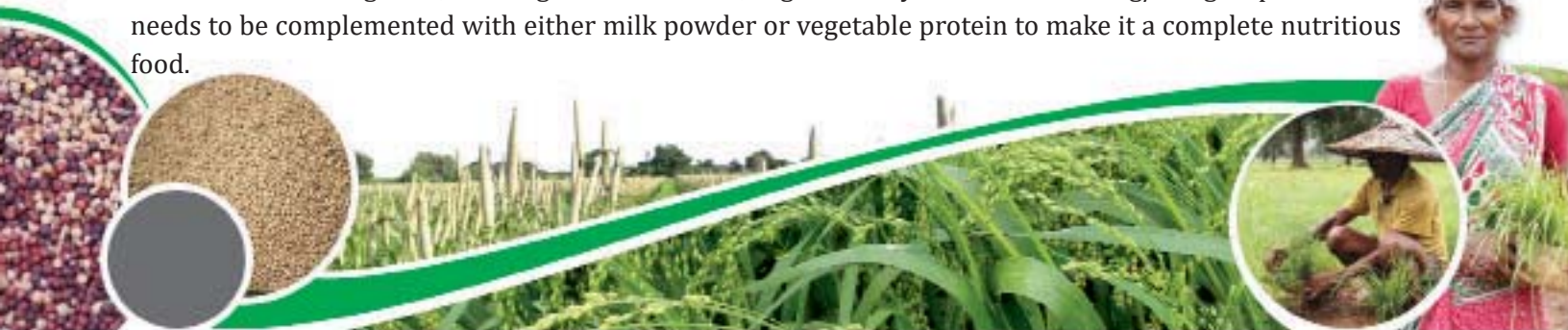
CSIR-CFTRI has also developed several milling machineries for dehusking of small millets. Pedal operated cycle mill is one of such machineries which can be operated without the electricity and ideally suits for small scale processing of millets. The capacity of this mill is about 10-15 kg/h with a dehulling percentage of 80-85 for little millet and 70-75 for other small millets. It is attached with a cyclone system which provides 89-97% of husk separation. The estimated cost of the mill is around Rs. 15,000/- to 20,000/-. This mill can be easily operated by ladies and children also.

Finger millet or ragi being one of the important millets, contains a naked caryopsis and the seed coat of the millet is rigidly attached to the endosperm. The endosperm shows highly friable structure and because of this, the grain powders along with the edible seed coat. The seed coat of the grain contains about 40% of the total calcium, more than 75% of dietary fiber and most of the polyphenols. Because of the presence of dietary fiber and polyphenols, ragi becomes most suitable food for diabetics and obese population. However, the presence of polyphenols and dietary fiber also reduces the bioaccessibility of the calcium present in ragi to 30%. Therefore, ragi needs to



Fig. 1. Pedal operated millet mill

be suitably pre-processed before making foods for children and age old population. The most suitable method for processing ragi is germination. During germination, ragi develops an enzyme called “amylases” and hence, gets hydrolyzed during cooking and finally forms a thin slurry. The body can absorb about 80% of the calcium present in the malted ragi flour. Malted ragi flour is an excellent base material for products like malted weaning food, beverages etc. However, ragi basically contains about 7g/100g of protein and needs to be complemented with either milk powder or vegetable protein to make it a complete nutritious food.



As mentioned earlier, ragi gets powdered along with its seed coat and thus only flour based products can be prepared from this grain. Moreover, because of the presence of seed coat, the products from ragi are generally dark in color and exhibits typical chewy texture. CSIR-CFTRI, has developed a process to harden the ragi endosperm and to remove the seed coat for preparation of decorticated ragi. Decorticated ragi can be cooked like rice into discrete grains, can be used to prepare lemon rice, kichadi, kheer etc. The novel products like flaked and expanded ragi can also be prepared from decorticated ragi. Even though, about 30-40% of the nutrients are lost during decortication, the quality of the nutrients is improved. For instance, the bioaccessibility of calcium increases to 60% after decortication.

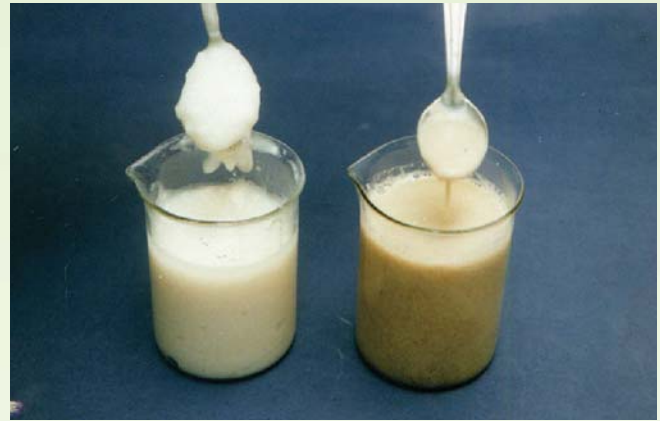


Fig. 2. Cooked (A) malted ragi flour (B) rice flour in same amount of water.



Fig. 3. (A) Decorticated ragi



(B) Expanded ragi



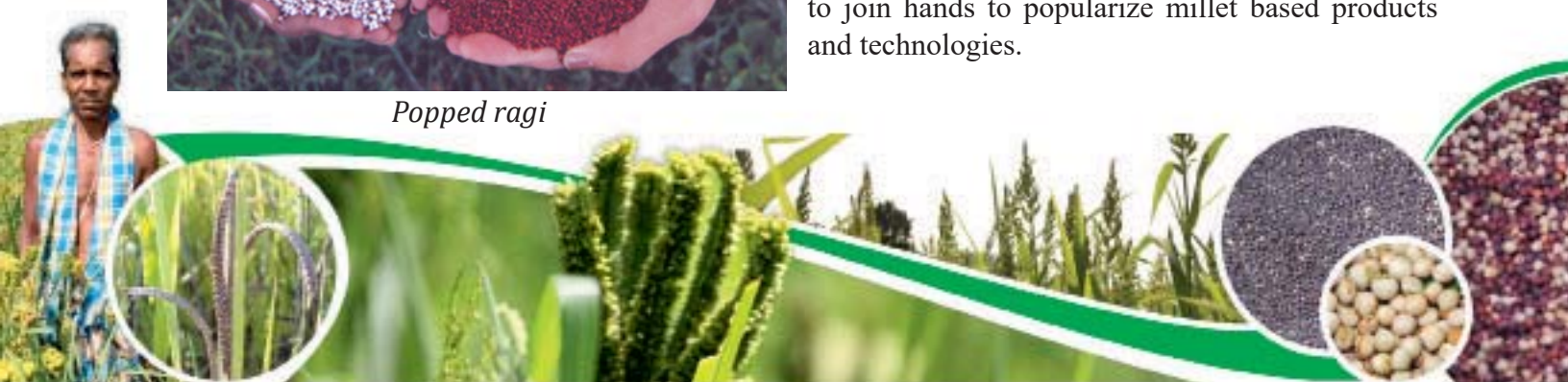
(C) Flaked ragi

Ragi can be processed suitably to prepare drum dried and extruded products for which a part of the seed coat can be removed by a simple method called as refining. Ragi can also be popped to prepare ready-to-eat product, which can be mixed with jaggery and milk before consumption. Thus, ragi can be suitably processed to meet the different nutritional requirement of the target



Popped ragi

population. Research Institutes like CSIR-CFTRI is continuously developing different processing technologies for ragi and other small millets to prepare value added products and diversify the food used of millets. In this direction, the farmers, researchers, technologists, and food industries need to join hands to popularize millet based products and technologies.



SECTION - 7

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STATUS OF SMALL MILLETS IN ODISHA

Small Millets are a group of six millet crops viz., Finger millet (*Eleusine coracana*), Little millet (*Panicum sumatrense*), Foxtail millet (*Setaria italica*), Proso millet (*Panicum miliaceum*), Kodo millet (*Paspalum scrobiculatum*) and Barnyard millet (*Echinochloa colona*). Out of these six small millets, Finger millet (Mandia) and Little millet (Suan) are mostly grown in Odisha. Small millets have their inherent quality of early maturity, capacity to yield in low rainfall and management conditions and are very much suitable to be grown in dry lands and hills, contributing significantly to food and nutritional security as well as sustainable agriculture. These crops are highly resilient to soil, moisture and weather variations, hence suitable for contingent planting. The small millets have high nutritional value, so named as nutri cereals.

Finger millet (ragi) is the 2nd important food crop of the state next to rice occupying around 1.38 lakh hectares with a production of 1.21 lakh tones and productivity of 874 kg/ha. In addition to finger millet, small millets (other than finger millet) is grown in a sizable area, occupying 0.28 lakh hectares with a production of 0.14 lakh tones and productivity of 512 kg/ha. Finger millet is grown in 23 districts and little millet is grown in 20 districts out of 30 districts in Odisha.

The people of South Odisha are more interested for finger millet cultivation. Practically there is no market for the crop. Previously, consumption of ragi was more popular among the small and marginal farmers. But after introduction of BPL rice, there is change in food habit, i.e. more people are able to take rice. On the contrary, ragi consumption is coming up as a food of affluent people.

Finger millet is generally taken up as a single crop in uplands during kharif. In the medium lands, early duration ragi cultivars of 70-80 days are preferred, so that after harvest of ragi farmers can transplant early paddy. Presently due to uncertainty of rainfall in most of the districts, rice crop fails in upland. Hence, it will be better if such lands are diverted for ragi cultivation. In some patches, where irrigation facilities are



available, ragi has been cultivated during summer after harvest of kharif rice. In uplands, ragi is followed by blackgram. In almost all the little millet growing areas it is grown alone.

Average productivity of finger millet and little millet in the state are 874 and 566 kg/ha, which are below the national average. The low productivity is mainly due to cultivation of local types having low yield potential, in adequate application of manures & fertilizers, improper crop management and lack of pest management practices. Thus, with a view to increase the productivity of small millets, the scientists are seriously engaged on the development of high yielding disease resistant varieties with suitable agronomic practices and proper crop protection measures, so as to fit small millets in to local growing conditions.

AREA, PRODUCTION AND PRODUCTIVITY FINGER MILLET IN ODISHA (2011-12 TO 2017-18)

Year	Area ('000' ha)	Production ('000' MT)	Yield (kg/ha)
FINGER MILLET			
2011-12	169.22	151.42	895
2012-13	172.99	149.21	863
2013-14	165.80	143.74	867
2014-15	158.30	137.40	868
2015-16	147.30	127.70	867
2016-17	138.00	120.92	874
2017-18	114.00	101.00	880
SMALL MILLETS (Other than Finger millet)			
2011-12	17.20	8.95	520
2012-13	17.38	8.86	510
2013-14	19.32	9.70	502
2014-15	20.78	10.45	503
2015-16	25.35	12.70	501
2016-17	27.40	13.80	505
2017-18	29.20	14.90	512

This shows that the area under finger millet and production are gradually decreasing, but the yield almost remained static. As regards to other small millets (other than finger millet) there is increase in the area and production. The yield also remained static during these years.

Finger millet is grown in 23 districts and little millet is grown in 20 districts out of 30 districts in Odisha. Major millet growing districts include Koraput, Ganjam, Rayagada, Gajapati, Malkanagiri, Kalahandi, Nuapada, Nawarangpur, Sundergarh and Phulbani.



DISTRIBUTION OF SMALL MILLETS IN ODISHA

Crop	Stability index	Districts
FINGER MILLET	High yield & low spread	Rayagada, Malkanagiri, Kalahandi, Ganjam, Nawarangpur, Nuapara, Sundergarh, Gajapati
	Low yield & low spread	Boudha, Kandhamal, Deogarh, Koraput, Koenjhar, Sambalpur, Sonpur, Nayagarh, Angul, Dhenkanal, Mayurbhanj, Bolangir, Jajpur, Cuttack, Puri
OTHER MILLETS	High yield & low spread	Koenjhar, Bolangir, Sundergarh, Rayagada, Nayagarh, Ganjam, Angul, Dhenkanal
	Low yield & low spread	Gajapati, Nawarangpur, Mayurbhanj, Boudha, Sonpur, Malkanagiri, Koraput, Kandhamal

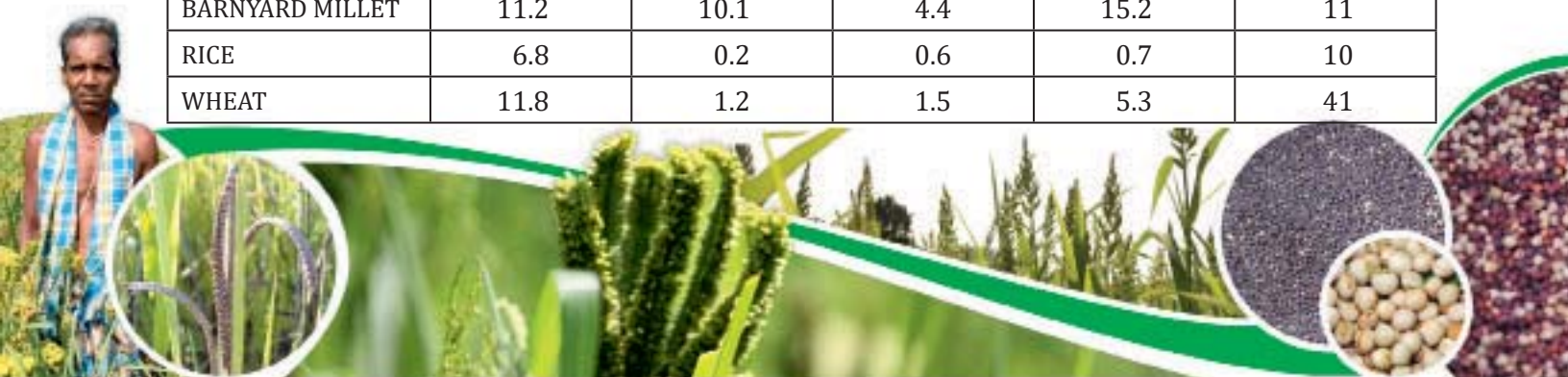


IMPORTANCE OF SMALL MILLETS

- Millets need very little water for their production. They require just around 25% of the rainfall regime demanded by crops such as sugarcane and banana. Thus, they do not burden the state with demands for irrigation or power.
- Millets grow on the poorest of soils, even soils having less than 15 cm depth. Millets are often growing on skeletal soils that are less than 15 cm deep. It does not demand rich soils for their survival and growth. Hence, for the vast dryland area, they are a boon.
- Millet production is not dependent on the use of synthetic fertilizers. They grow well with application of farmyard manures and household produced bio-organics (vermicompost, panchagabya etc). Therefore, they can significantly reduce the huge burden of fertilizer subsidy borne by the Government.
- Millets are pest free crops. Grown under traditional methods, no millet attracts any pest. They can be termed as pest free crops. A majority of them are not affected by storage pests either. Therefore, their need for pesticides is close to nil. Thus, they are a great boon to the agricultural environment.
- Millets are not just crops but cropping system. Most millets grown under traditional practices represents a Cropping System and not just a crop. Most millet fields are inherently biodiverse. This is the tradition of millet farming in the country. Six to twenty crops are planted on the same space at the same time.
- Millets are amazing in their nutrition content. Each of the millets is three to five times nutritionally superior to the widely promoted rice and wheat in terms of proteins, minerals and vitamins.
- Millets produce multiple securities. While single crops such as rice and wheat can succeed in producing food security for India, millets produce multiple securities. They include securities of food, nutrition, fodder, fibre, health, livelihood and ecology.

NUTRITIONAL STATUS OF SMALL MILLETS (PER 100G)

Crop/Nutrient	Protein(g)	Fiber(g)	Mineral(g)	Iron(mg)	Calcium(mg)
PEARL MILLET	10.6	1.3	2.3	16.9	38
FINGER MILLET	7.3	3.6	2.7	3.9	344
FOXTAIL MILLET	12.3	6.0	3.3	2.8	31
PROSO MILLET	12.5	2.2	1.9	0.8	14
KODO MILLET	8.3	9.0	2.6	0.5	27
LITTLE MILLET	7.7	7.6	1.5	9.3	17
BARNYARD MILLET	11.2	10.1	4.4	15.2	11
RICE	6.8	0.2	0.6	0.7	10
WHEAT	11.8	1.2	1.5	5.3	41



Small millet grains having special value as nutritive food are called as **nutri-cereals** and at times are used for curative purposes as in the case of finger millet and foxtail millet by diabetic patients.

Millets as Climate Change Compliant Crops. All these qualities of millet farming system make them the Climate Change Compliant Crops. Climate change portends less rain, more heat, reduced water availability and increased malnutrition. If there is any cropping system that can withstand these challenges, survive and flourish, it is the millet. While wheat and rice might provide only food security, millets produce multiple securities (food, fodder, health, nutrition, livelihood and ecological) making them the crops of agricultural security.

CHALLENGES IN SMALL MILLET CULTIVATION IN ODISHA

- About 95% of millet area is cultivated in rainfed condition under traditional/indigenous landraces with low yield potential.
- The area under small millets has been decreasing due to change in food habit of people.
- Crops like vegetables (Cowpea, Okra, Tomato, Brinjal etc.), cotton, groundnut, maize, cowpea and other remunerative crops compete with small millets.
- Price of small millet is not so remunerative as compared to other crops so as to attract the farmers for growing small millets.
- Unawareness about alternative uses and value added products.
- Non-adoption of line sowing/transplanting leading to inadequate plant population
- The farmers are not applying the recommended and balance doses of manures and fertilizers.
- Weeding and hoeing operations are not taken up in appropriate time.
- Appropriate plant protection measures are not taken up by the farmers
- In marginal, rainfed areas, farmers are losing interest in cultivating small millets due to high labour requirements and the tedious work of preparing harvested grains for consumption.

CHALLENGES OF SMALL MILLETS CULTIVATION DURING CURRENT YEARS

- Occurrence of blast in nursery stage and neck blast in all varieties due to prevalence of warm humid condition throughout the cropping season.
- Aphid problem at 35-40 days & panicle stage of growth in finger millet.



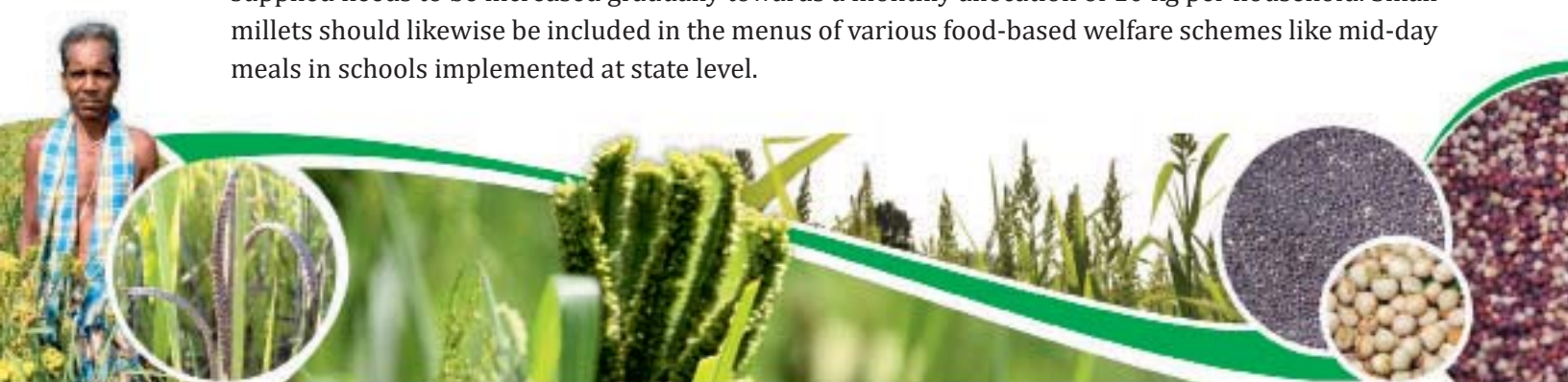
- Viviparous germination due to heavy rainfall at the time of harvesting.
- Inadequate supply of high yielding of varieties of little millet and finger millet.

INTERVENTIONS NEEDED TO ENHANCE PRODUCTION AND PRODUCTIVITY OF SMALL MILLETS IN ODISHA

- Development of suitable high yielding and disease pest resistant varieties.
- Popularization of the high yielding varieties for their large scale cultivation in the farmers' field particularly during Kharif under intercropping system with arhar and groundnut.
- Inclusion of small millet in the cropping system in the changing climatic situations.
- Large scale cultivation of short duration pre-paddy ragi varieties during pre-kharif in medium land paddy fields in changing climatic situations.
- Large scale demonstrations on high yielding varieties, advanced crop production and protection technologies in the millet growing areas through FLD and TSP programmes.
- Increase the area of finger millet during rabi season under irrigated condition.
- Developing and adopting superior post-harvest technology.
- Awareness and trainings to the tribal farmers to adopt line sowing and transplanting of finger millet instead of direct seeding.
- Awareness among the people regarding the health benefits of the "nutri-cereals" particularly for diabetic patients and healthy value added products to be developed.
- Sufficient Marketing facilities to be developed and minimum support price for small millets should be fixed.
- Creating demands and remunerative market price are essential to sustain production.

OTHER ASPECTS NEED CONSIDERATION

- Small millets ought to be included in the Indian public distribution system (PDS), based on regional production and consumption patterns, capitalizing on the National Food Security Act. The quantity supplied needs to be increased gradually towards a monthly allocation of 10 kg per household. Small millets should likewise be included in the menus of various food-based welfare schemes like mid-day meals in schools implemented at state level.



- Establishing small processing units within a radius of 5 km from the village: Investment support should be provided to local entrepreneurs for the installation of processing units for dehulling and flour making of location-specific small millets. Local entrepreneurs already running small mills can be given preference, as they have the necessary infrastructure and clientele in place. This will boost home consumption and the local economy. Wherever possible this activity can also be linked to active women self help groups.
- Small millets clusters: Cluster initiatives should be introduced, covering 100 hectares, or 200 farmers, or some villages (as appropriate), where grains are gathered and processed for commercial distribution. These clusters will produce ready-to-cook grain for shops, rural markets and supermarkets.
- Ready-to-eat small millet food entrepreneurs: Support should be given to micro-, small- and medium-entrepreneurs producing millet-based foods. These entrepreneurs will increase market visibility for millets and introduce new products, more acceptable to contemporary tastes. Special approaches should be designed to incentivize informal entrepreneurs not covered by the micro enterprise definition, including pushcart porridge vendors, who are patronized by large segments of the poor population.

ROLE OF ODISHA UNIVERSITY OF AGRICULTURE & TECHNOLOGY IN SMALL MILLET DEVELOPMENT

Research on small millets in OUAT under All India Coordinated Small Millets Improvement Project (AICSMIP), Odisha Centre started during 1986-87. Since 1979, it was a Millets Centre, under IRDC and on bifurcation, became a Small Millets centre. At present All India Coordinated Research Project on Small Millets under the University is being operating at Centre for Pulses Research, Berhampur, Ganjam, Odisha since 1998. This centre has developed seven number of high yielding multi pest resistance finger millet and four little millet varieties for the state.

Among finger millet varieties like Bhairabi, Suvra(white) and Chilika can be grown both in Kharif and Rabi season in irrigated condition. Recently two finger millet varieties Arjuna and Kalua have also been developed from this centre, suitable for finger millet growing areas of Odisha. Likewise, the centre has developed four high yielding little millet varieties viz., Tarini, Kolab, Sabar and Saura which can be grown in Kharif season in rainfed conditions. Another little millet entry OLM 217 is in pipeline to be released very soon.



HIGH YIELDING FINGER MILLET VARIETIES RELEASED FROM OUAT

Sl. No	Variety	Year of release	Duration (days)	Average Yield(q/ha)	Areas of adaptation
1	Dibyasinha	1971	96-100	17.0	Rainfed uplands of Odisha
2	Neelachal	1985	105-110	25.0	Rainfed uplands
3	Bhairabi	1999	105-110	27.5	Both kharif and Rabi season
4	Suvra	1999	100-105	21.5	Both kharif and Rabi season
5	Chilika	2001	115	26.2	Both kharif and Rabi season
6	Kalua	2014	110	17.6	Both kharif and Rabi season
7	Arjuna	2016	106	26.0	Both kharif and Rabi season

LITTLE MILLET VARIETIES RELEASED FROM OUAT

Sl. No	Variety	Year of release	Duration (days)	Average Yield(q/ha)	Areas of adaptation
1	Tarini	2001	105	12.2	Rainfed uplands in Odisha
2	Kolab	2001	80	11.0	Rainfed uplands in Odisha
3	Sabara	2003	80	10.7	Rainfed uplands of Odisha
4	Saura	2009	105	14.0	Rainfed uplands in Odisha
5	OLM 217	-	106	15.1	Rainfed uplands in Odisha

Besides development of millet varieties, the research is also being focused in development of suitable crop production and crop protection technologies. A good number of recommendations have also been developed in these aspects and already been communicated. Through breeder seed and foundation seed production of these varieties are made available for production of certified seeds and commercial crop from the certified seed by the farmers. After release of new varieties these are tested in farmers field through FLD (front line demonstrations). The tribal farmers are being benefitted through TSP (Tribal Sub Plan) led millet promotion in which inputs like seed, fertilizer and farm implements like plough, phurah, trench hoe, weeder, drum seeder, storage bins etc. are given free of cost to the participating farmers. Farmers are being trained with different crop production, seed production aspects, time to time through different farmers training, exposure visit and diagnostic field survey by the scientists of the centre. The present level of initiatives taken and support given by the state Government, added to the research efforts, will take the millet production to a greater height and establish millets as popular crops and household diet in Odisha.



SECTION - 8

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PROFESSOR AND HEAD

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STATUS OF NUTRI-CEREALS IN TAMIL NADU

Millets as a group of crops are represented by Sorghum, Pearl millet and Small millets like, Finger millet, Little millet, Kodo millet, Barnyard millet, Foxtail millet and Proso millet. They play a significant role in the food, feed, fodder and nutritional securities of developing countries in the semi-arid tropics of Asia and Africa. They are grown on marginal soils and have an inbuilt capacity to tolerate drought, low nutrients and high temperature as compared to other crops. Hence, Millets assume importance as climate-smart crops and are considered as future crops of farming in India. They are also unique being short duration crops. They form an indispensable source of food for better nutrition and health compared to fine cereals available at affordable prices. They are the store houses of major and micro-nutrients. In view of rising health problems due to lifestyle disorder, millets offer excellent food alternative to fine cereals. Recognizing the importance of nutri-cereals, the Government of India had declared the year 2018 as “The National Year of Millets” in order to popularize millets and has officially grouped the millets under nutri-cereals.

Despite their excellent nutritional qualities and health benefits, the area under millet production in the country has declined over the past few decades. There is a great need to bring back cultivation of millets and focus them as future crops in the farming systems, for which the demand for millets consumption should substantially increase. Sporadic information is available on the nutritional value of different millets grown in India. However, it is urgently required to document the benefit of millets to encourage their consumption, discuss about policy matters and prioritize research on processing and value addition for their commercialization.



In India, millets are cultivated in an area of 15.48 million hectare with production of 79.2 million tonnes with an average yield of 1111 Kg/ha. In Tamil Nadu, sorghum is grown in an area of 2,68,391 ha with a production of 1,53,856 tonnes and productivity of 573 Kg/ha. Namakkal, Dindigul, Tirupur, Salem and Coimbatore are the major districts where sorghum is raised under rainfed conditions.

Pearl millet is grown in an area of 49,673 ha with a production and productivity of 1,02,250 tonnes and 2058 Kg/ha respectively in Tamil Nadu. The majorumbu growing districts in Tamil Nadu are Villupuram, Thoothukudi, Cuddalore, Tiruvannamalai and Theni.

Finger millet is widely grown small millet in Tamil Nadu in an area of 61,362 ha with a production 1,14,429 tonnes and 1865 Kg/ha productivity Krishnagiri, Dharmapuri, Salem, Vellore and Erode are the major districts where ragi is grown predominantly.

Little millet is grown in 15,207 ha in Tamil Nadu with production and productivity of

22,169 tonnes and 1,458 Kg/ha respectively. In Tamil Nadu Tiruvannamalai, Dharmapuri and Vellore are the main districts where samai is grown in Jawadhu Hills by the tribal people followed by Salem and Krishnagiri.

Barnyard millet is grown in an area of 5250 ha in Madurai, Virudhunagar, Ramanathapuram and Thoothukudi districts of Tamil Nadu with a production and productivity of 5,016 tonnes and 923 Kg/ha respectively.

Cuddalore, Villupuram, Ariyalur, Madurai and Perambalur farmers in Tamil Nadu grow Kodo millet in an area of 1,861 ha under rainfed condition with a production and productivity of 4,992 tonnes and 2,682 Kg/ha respectively.

Foxtail millet is grown in an area of 893 ha with a production and productivity of 432 tonnes and 484 Kg/ha respectively in Tamil Nadu in the districts of Villupuram, Cuddalore, Salem, Madurai and Virudhunagar district under rainfed condition during monsoon seasons.

Proso millet is grown in about 350 ha especially in Servarayan hills of Salem district with a production and productivity of 165 tonnes and 4,75 Kg/ha.

respectively. A few farmers in Yelagiri Hills of Vellore and Pudukkottai districts of Tamil Nadu also grow panivaragu crop.

All these millets are nutritionally rich, complete their life cycle in 2 to 4 months, adapting to the shorter cropping windows that facilitated wider adoption, shifting cultivation and with-standing nature's unforeseen vagaries. Millets are especially drought and heat tolerant and can perform well in areas receiving less than 450 mm annual rainfall.

The productivity enhancement is linked to adoption of improved cultivation package both under rainfed and irrigated farming conditions. The production of millets is dependent on seasonal precipitation as they are mainly grown as rainfed crops. Associated with this are low value status, declining or



stagnant demand, meager developmental and technology-transfer activities and very poor market avenues; the effects of these being affected in poor growth rates in the past which are continued now also. In spite of this, finger millet has performed well and has shown moderate to high growth rate. There is vast untapped potential available in the technology components presently recommended for productivity enhancement which can be grouped under three broad heads.

- 1. Non cash inputs:** Optimum seed rate, timely sowing, band placement of Manure based on soil analysis, maintaining optimum population, timely weeding and inter cultivation and harvesting at physiological maturity are the major non-cash inputs but enhance the production.
- 2. Low cash inputs:** Seed of an improved variety is considered as one of the cheapest and most cost effective inputs. Up to 50 per cent yield increase is expected by growing the recommended high yielding variety in place of local variety. Availability of seeds of improved variety in millets is highly inadequate. Organised seed production and supply of quality seeds has to be maintained systematically to increase the production of millet crops. Use of seed cum fertilizer drill helps in line sowing which helps in of inter cultivation and population maintenance. Opening furrows at every 3.3 m interval leads to better moisture conservation. Split application of nitrogen after coating with neem enhances the fertilizer use efficiency. Inter cropping with 2 to 3 pulse crops leads to higher yield, risk aversion and improves soil fertility.
- 3. High cash inputs:** Apart from the seeds of such HYVs, application of organic manures in combination with optimum quantities of fertilizers is necessary for obtaining higher yields. Plant protection measures are only need based and should be managed integrately.

There is a large exploitable potential available in these crops. The lower yields are due to combination of factors, namely soil, technological, social and economical. It is well known that these are low energy crops and respond well to each one of the critical inputs *viz.*, HYVs, application of fertilizers, FYM, biofertilizers, biofungicides, micro nutrients and crop management individually as well as collectively. Small supplements of nutrition can result in large increments in productivity. There are good evidences to show that there could be substantial rate of rise in productivity by the adoption of improved technologies in Front Line Demonstrations and Demonstrations under Tribal Sub-Plan. The yield enhancement could be upto 58 per cent in finger millet, 89 per cent in foxtail millet, 72 per cent in kodo millet, 63 per cent in little millet, 91 per cent in proso millet and 96 per cent in barnyard millet.

The results of these demonstrations have indicated the vast untapped potential available in the recommended technology for exploring the production gaps, especially, in rainfed condition. The per hectare yield and income could be substantially pushed up by adapting improved cultivation practices. It was clear that there is a positive impact on the improved recommended technology over the prevailing farmer's practice. The increased yield realized was definitely more than the extra cost incurred in meeting the expenditure on critical inputs like seed and manure. There is appreciable incremental Cost Benefit Ratio.

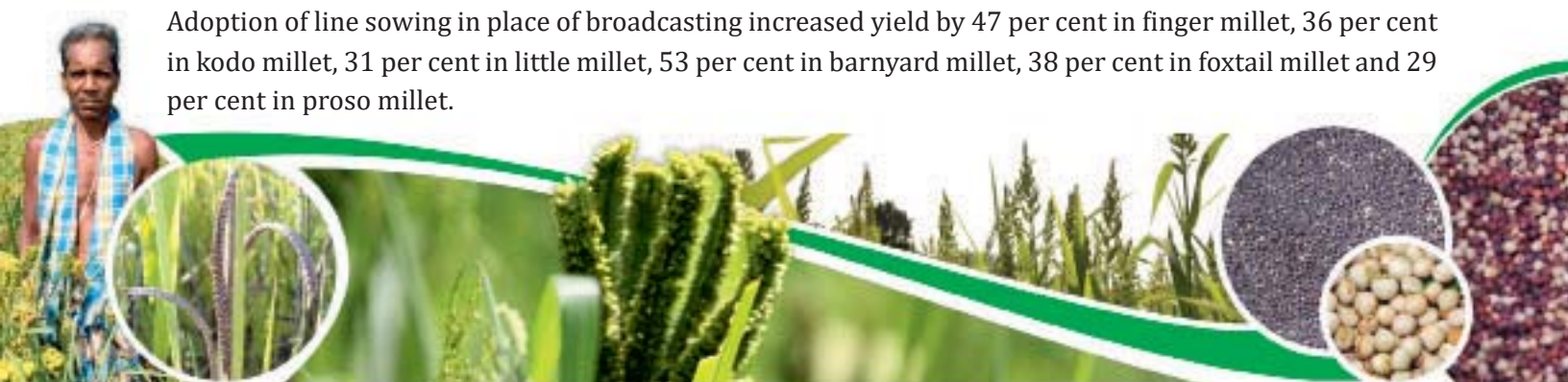


Latest High Yielding Varieties Released by Tamil Nadu Agricultural University

S.No	Name of the Crop	Variety	Year of release	Duration (days)	Yield (Kg/ha)	
					Grain	Straw
1	FINGER MILLET	CO (Ra) 14	2004	110	2774	8428
		Paiyur (Ra) 2	2008	115	2527	3150
		CO 15	2013	125	2950	5030
2	LITTLE MILLET	CO (Samai) 4	2006	75	1567	3123
		ATL 1	2019	90	1587	3109
3	KODO MILLET	CO 3	1980	120	3200	5900
		TNAU 86	2013	104	2709	5600
4	FOXTAIL MILLET	CO (Te) 7	2005	85	1855	5138
5	BARNYARD MILLET	CO (KV) 2	2009	95	2640	5138
		MDU 1	2017	95	1700	3300
6	PROSO MILLET	CO (PV) 5	2007	70	2381	6675
		TNAU 145	2009	80	1819	4600
		TNAU 151	2009	70	1860	4130
		TNAU 164	2010	72	1893	4600
		TNAU 202	2012	71	1872	3700
		ATL 1	2018	70	2152	5970

Small millets are low energy crops and respond well to individual components of improved Technology. For example, in many places, the local varieties are still occupying large areas. As a result, the benefits that would accrue by growing high yielding varieties have not been harnessed by majority of farmers. In demonstrations, where improved variety was grown in place of local variety, the yield has increased by 44 per cent in finger millet, 41 per cent in kodo millet, 46 per cent in foxtail millet, 62 per cent in little millet, 105 per cent in barnyard millet and 65 per cent in proso millet. Seed rate in small millets is low (10 to 12.5 Kg/ha) and hence, the additional cost incurred on this component is minimal while the yield increments are substantial. Seed distribution of high yielding varieties should receive priority attention in small millets.

Adoption of line sowing in place of broadcasting increased yield by 47 per cent in finger millet, 36 per cent in kodo millet, 31 per cent in little millet, 53 per cent in barnyard millet, 38 per cent in foxtail millet and 29 per cent in proso millet.



Similarly, application of recommended dose of manure would enhance grain yield significantly to a tune of 73 per cent in finger millet, 63 per cent in kodo millet, 65 per cent in little millet, 87 per cent in barnyard millet, 81 per cent in foxtail millet and 68 per cent in proso millet. Additionally, such small nutrition supplement could help in better crop establishment through strong root development and in overcoming the adverse effects of moisture stress in critical stages.

From the above results through demonstrations in the farmer's fields, it is clear that among the various components of improved technology, application of recommended dose of manures has the largest influence followed by HYVs and line sowing.

Small millets are highly nutritious and even superior to rice and wheat in certain constituents. Finger millet is the richest source of calcium (300 – 350 mg/100 g of grain) and other small millets are good sources of phosphorus and iron too. The protein content range from 7-12% per cent and fat content from 1.25 to 5.0%. The protein in millets has a well balanced amino acid profile. They are the good sources of methionine, cystine and hyline. These essential amino acids are of special benefit to those who depend on plant food for their protein nourishment. The millet grain contains about 65 per cent carbohydrate, a high proportion of which is in the form of non-starchy polysaccharides and dietary fibre which help in prevention of constipation, lowering of blood cholesterol and slow release of glucose to the bloodstream during digestion. Millet grains are also rich in important vitamins viz., thiamine, riboflavin, folin niacin. It is very well observed that lower incidence of cardiovascular disease, duodenal ulcer and hyperglycemia (diabetes) are reported among regular millet consumers. Due to these excellent nutritional properties and their resilience to climate change, small millets along with other millets are renamed as 'nutri-cereals' (Gazette of India, No. 133, dated. 13.04.2018) for production, consumption and trade and included in public distribution system.

Millet grains are known for good shelf life. The grains dried to 10-12 per cent moisture can be stored for many years in farm houses. There are reports of finger millet kept for more than two decades without adverse effect on grain quality.

The millets flour and their products also show good shelf life. In Tamil Nadu, many kinds of traditional foods are made from millets and they form the stable diet for many rural and urban households. Ragi is eaten as dumpling or stiff porridge (mudde) and/or roti. Many other tasty traditional foods are made from popped ragi flour mixed with sugar/jaggery/ghee/milk/butter milk and salt. In several rural households a vast variety of traditional snacks are prepared from ragi and other small millets.

The millet grains offer many opportunities for diversified and utilization and value-addition. With proper processing it is possible to make many different kinds of food products by adopting appropriate milling, popping and flaking. Except finger millet, other small millets resemble rice in grain morphology containing husk, bran and endosperm. Traditionally, the husk and bran are separated by hand pounding. However, in recent years milling technology has been improved to enhance the grain quality, save time as well as energy. Millet mill is available today both for cottage level and large scale processing. The rice obtained after milling can be further processed towards various food uses such as flakes, quick food cereals, ready



to eat snacks, supplementary foods, extrusion cooking, malt based products, weaning foods and more importantly health foods.

SMALL MILLETS AS FODDER

Finger millet and several other small millets are grown around 2 million hectares. The dry weight ratio of grain : crop residue is about 30:70 for finger millet and 25:75 for others small millets. Finger millet contribute nearly 2.5 million tonnes of grain and 5.9 million tonnes of straw, whereas other small millets contribute 1.2 million tonnes of grain and 3.5 million tonnes of straw. Although utilization of millet grain as animal feed is not a common practice, millet fodder and stover are the most valuable fodder resources in the crop/ livestock systems where millets are grown.

Millet crops are important in the overall development of agriculture in the country. As bulk of the production is consumed at the farm/village level, the real value of these crops has not been appreciated and their role not been recognized in impacting food, feed, fodder and nutritional securities to a large section of farming community who are considered as vulnerable groups in different parts of the country. The assured harvest of the crops has made them an important component of dry land, hill and tribal agriculture in Tamil Nadu.

Millets being eco-friendly crops are suitable for fragile and vulnerable agro-ecosystems and should be preferred crops for sustainable and green agriculture. The promotion of millet crops can lead to much efficient natural resource management and ultimately to a more holistic approach in sustaining precious agro-biodiversity.



SECTION - 9

SWARNA RONANKI

SANGAPPA

DEEPIKA C.

ICAR-Indian Institute of Millets
Research, Hyderabad

PACKAGE OF PRACTICES FOR MILLETS

INTRODUCTION

India is the largest producer of millets in the world, and accounts for more than 40 percent of the global consumption. Millet cultivation is the mainstay of rainfed farming which provide livelihood to nearly 50% of the total rural workforce and sustain 60% of cattle population in India. Millets are most unique amongst cereals. Millets grow under dry conditions, can perform well with relatively poor soils and require low inputs. They are a staple food with superior nutritional qualities compared to other cereals. In India, for the poor, for instance among tribal people residing the highland areas of North East, and for farmers in dry areas including the Deccan, central India, western Indian states such as Gujarat and Rajasthan, and the western ghats, millets have long acted as a source of nutritional supplement. Used as dual-purpose crops (food and fodder), they make strong economic sense in mixed farming systems. In addition, millets sequester carbon, thereby adding to CO₂ abatement opportunities, contribute to improved agro-biodiversity by their rich varietal diversity, allow for mutually beneficial intercropping with other vital crops, and have significant cultural value due to their long history. Millet grains contain higher protein, fibre, calcium and minerals than the widely consumed fine cereals, and can ensure nutritional security to the poor people who cannot afford a variety of food items in their diet. Millets are termed as the last standing crop in times of drought and as wonder grain that has a capability to enhance nutritional security in the country. Despite this, the consumption and cultivation of millets have been on the decline, greatly due to a lack of awareness around them. Bringing millets into mainstream of agriculture and diet is the challenge ahead. Need of an hour is to focus on enhancing cultivation and increasing production through improved agronomic practices.



BARNYARD MILLET

Climatic requirement: Barnyard millet does well in a wide range of climatic conditions. It is a hardy crop and is able to withstand adverse conditions of weather better than other cereals. It requires warm and moderately humid climate. It is grown from sea level to an altitude of 2000m on the Himalayan slopes. It can be grown in regions with mean rainfall of 300-400mm.

Soil: It is generally cultivated in soils of marginal fertility. It can be grown in partially water logged soils such as lowlands on the bank of rivers etc. It thrives best on sandy loam to loam soil having sufficient amount of organic matter. Gravely and stony soils with poor fertility are not suitable for raising barnyard millet crop.

Suitabel varieties of Barnyard millet

STATE	CULTIVARS
ANDHRA PRADESH	DHBM 93-3
BIHAR	VL 181, VL 207, DHBM 93-3
GUJRAT	VL 172, DHBM 93-3
KARNATAKA	DHBM 93-3, DHB93-2, VL 172, VL 181, VL 207
MADHYA PRADESH	VL 181, DHBM 93-3
RAJASTHAN	Pratap sanwa 1, VL 207, DHBM 93-3
TAMIL NADU	DHBM 93-3 VL 181, CO-1, K1, K2, CO-2,
TELANGANA	DHBM 93-3 , DHB93-2
TAMILNADU	DHBM 93-3, Kanchan, VL 172,
UTTAR PRADESH	VL 172, VL 217
UTTARAKHAND	Kanchan, VL 172, VL 207, PRJ-1

Field preparation: Two ploughings with local plough or harrowing followed by planking are sufficient to prepare the seed bed for barn yard millet.

Time of sowing: It can be sown with the first fortnight of July with the onset of monsoon rains. In Tamil Nadu the rainfed crop is planted in September-October and the irrigated crop is planted in February-March. In northern states, particularly in hills, where it is an important crop, sowing in June is ideal.

Seed rate: The seed rate is 8-10 kg/ha for line sowing and 12-15 kg/ha for broadcasting. The seed is broadcast or drilled in furrows 3- 4cm deep.



Seed treatment: To avoid diseases ensure seed treatment before sowing. Treat the seed with Chlorothalonil or Carbendazim @ 2g Kg⁻¹ seed. Treating seeds with Azospirillum brasilense (nitrogen fixing bacterium) and Aspergillus awamouri (phosphate solubilizing fungus) @ 25 g kg⁻¹ is beneficial

Spacing: The ideal spacing is 20.0 cm x 10.0 cm.

Manuring and Fertilization: Farmyard manure or compost at the rate of 5 to 10 tonnes per hectare should be added for boosting the yield. The crop responds well to fertilizers. The recommendations for different states are: (i) Andhra Pradesh 20 kg/ha of N, P and K each, (ii) Bihar, Tamil Nadu and Uttar Pradesh (plains) 40 kg N/ha and 20 kg/ha P and K each, but for Uttar Pradesh (hills) K is not necessary; and (iii) other regions 20 kg/ha of N and P each. All the fertilizer should be added in the soil at the time of sowing. If irrigation facilities are available, half of nitrogen should be top dressed in standing crop after 25 to 30 days of sowing.

Water management: Generally barnyard millet does not require any irrigation. However, if dry spell prevails for a long period, then two irrigations must be given one at the time of seedling establishment stage and second at the time of panicle initiation stage. It is always better if excess water or heavy rains is drained out of the field.

Weed control: The field should be kept weed free upto 25-30 days after sowing. Two inter-cultivation and one hand weeding is needed for line sown crop and two hand weeding for broadcasted crop.

Harvesting and Threshing: The crop should be harvested when it is ripe. It is cut from the ground level with the help of sickles and stacked in the field for about a week before threshing. Threshing is done by trampling under the feet of bullocks or through new millet thresher developed by VPKAS, Almora, Uttarakhand.

Yield: The average yield of grain is 400 to 600 kg per hectare and that of fodder or straw around 1200 kg per hectare. With improved package of practices it is possible to harvest 10-12 quintals of grain per hectare.

KODO MILLET

Climatic requirement: Kodo millet can be grown in warm regions and can tolerate temperature of 35-40°C, however, the ideal temperature for optimum growth and development is 26-29°C. A minimum rainfall of 25-35 cm is required. Kodo millet has high water requirement due to low transpiration coefficient, thus rainfall varying from 50-60 cm is conducive to the proper development of kodo millet plant.

Soils: Kodo millet can be grown successfully in variety of soils ranging from loamy sand alluvial soils to clayey black cotton soils (Vertisols). It can be grown in gravelly and stony soils also such as in the hills regions. Low lying areas where water stagnation during rainy season may occur should be avoided. Two cross ploughing are sufficient to get the soil weed free and well pulverized.



Improved varieties of Kodo-millet

MADHYA PRADESH	JK 137, DSP-9-1, JK 98, JK 106, JK 439, RBK 155, JK 13, JK 65, JK 48, RK 390-25, GPUK 3, TNAU-86
TAMIL NADU	KMV 20 (Bamban), CO 3, TNAU 86, GPUK 3, RK 390-25, JK 13
GUJARAT	GK 1, GK 2, GPUK 3, RK 390-25, JK 13, JK 65
CHHATTISGARH	RBK 155 and JK 439, Indira Kodo-1, JK -48, GPUK 3, JK-65, JK 98, RK 390-25, TNAU-86
KARNATAKA	GPUK 3, RBK 155, RK 390-25, TNAU-86

Time of sowing, seed rate, and Seed treatment: Sowing with the onset of monsoon is beneficial. And accordingly sowing time extends from mid of June to end of July. The optimum sowing time is last week of June. The seed rate is 10 kg/ ha for line sowing and 15 kg/ha for broadcasting and spacing requirement is 25.0 cm x 10.0 cm. To avoid diseases ensure seed treatment before sowing. Treat the seed with Chlorothalonil or Carbendazim @ 2g Kg⁻¹ seed. Treating seeds with *Azospirillum brasilense* (nitrogen fixing bacterium) and *Aspergillus awamouri* (phosphate solubilizing fungus) @ 25 g kg⁻¹ is beneficial.

Manuring, fertilizers and irrigation: In addition to the application of farmyard manure as available. Fertilizer should be applied as (i) for Tamil Nadu 40 kg N/ha and 20 kg P/ha; (ii) for Madhya Pradesh 20 kg/ha of N and P each; (iii) for North East states 60 kg N/ha and 30 kg/ha of P and K each and (iii) for Andhra Pradesh and all other regions 20 kg/ha N, P and K each. Kodo millet is not an irrigated crop. However if irrigation is given in dry spells it is advantageous to the crop as it cannot withstand long dry spells.

Weed management: The inter-cultivation and weeding should be done with hand hoe, three hoeing would be sufficient to control the weeds in problem areas. Preemergence application of Isoproturon (0.5 ai/ha) and post emergence application of 2,4 D (0.75 kg ai/ha) was found beneficial in controlling weeds.

Cropping systems: Crop rotation: Rotation with crops like soybean or niger in Madhya Pradesh was found to be sustainable in realizing higher yields

Intercropping: Intercropping with legumes like pigeon pea, green gram, black gram and soybean in 2:1 proportion found profitable in many states

Harvesting: Normally crop is ready for harvest in 100-120 days after sowing, depends upon variety and local weather condition.

Yield: Grain Yield 15-18 q/ha and Straw Yield 30-40 q/ha.



LITTLE MILLET

Climate: Little millet can withstand drought as well as water logging. Hence it is a good catch crop under rainfed condition. Its cultivation is restricted to hilly regions upto an altitude of 2000m. It cannot withstand colder temperatures below 10°C.

Soils: Little millet can be grown on a wide range of soils including waterlogged soils. Deep, loamy, fertile soils rich in organic matter are preferred for satisfactory growth. It can withstand salinity and alkalinity to some extent.

State wise Varieties of Little millet

ORISSA	OLM 203, OLM 208 and OLM 217
MADHYA PRADESH	JK 4, JK 8 and JK 36
ANDHRA PRADESH	OLM 203 and JK 8
TAMILNADU	Paiyur 2, TNAU 63, CO-3, CO-4, K1, OLM 203, OLM 20
CHATTISGARH	JK 8, BL 6, BL-4, JK 36
KARNATAKA	OLM 203, JK 8
GUJARAT	GV 2, GV 1, OLM 203, JK 8
MAHARASHTRA	Phule Ekdashi, JK 8, OLM 203

Time of Sowing

Kharif : first fortnight of July with the onset of monsoon

Rabi : September to October in Tamilnadu and Andhra Pradesh

Mid March : mid May in the states of Bihar and Uttar Pradesh as irrigated catch crop.

Spacing : 25-30 cm (row to row), 8 – 10 cm (plant to plant). The seed should be planted 2-3 cm in depth.

Seed rate: 8-10 kg ha⁻¹ for line sowing

12- 15 kg ha⁻¹ for broadcasting

Manuring and fertilization: Apply Compost or farmyard manure @ 5-10 tonnes/ha about a month before sowing. Generally fertilizer recommended to get a good crop are 40 kg Nitrogen, 20 kg P₂O₅ and 20 kg K₂O per ha. Soil test based fertilizers application is recommended. Apply entire quantity of P₂O₅ and half of Nitrogen at the time of sowing and remaining half of Nitrogen at first irrigation

Weeding and Intercultural Operation: Two inter cultivations and one hand weeding in line sown crop is recommended. Intercultural operation using a tyne-harrow when crop is 30 days old is also recommended.



In broadcast crop 1st weeding after 15 – 20 days after emergence of seedling and 2nd weeding 15-20 days after 1st weeding is recommended.

Irrigation: *Kharif* season crop require minimum irrigation. It is mostly grown as a rain-fed crop. However, if the dry spell prevails for longer period, then 1 - 2 irrigations to be given. Summer crop requires 2 - 5 irrigations depending upon soil type and climatic conditions.

Cropping systems

Intercropping

ORISSA : Little millet +Black gram (2:1 row ratio)

MADHYA PRADESH : Little millet + Sesamum/soybean/pigeon pea (2:1 row ratio)

SOTHERN BIHAR : Little millet + pigeon pea (2:1 row ratio)

Cropping sequence

SOUTH BIHAR : Little Millet- Niger

Harvesting: Harvest is done once the ear-heads are physiologically mature. The crop is ready for harvest in 65 - 75 days after sowing.

Yield: Grain 12-15 q/ha and 20-25 quintals of straw per hectare

PROSO MILLET

Soil & Climate: Proso millet can be grown both in heavy and poor soil having variable texture ranging between sandy loams to clays of black cotton soil free from *Kankar* and high in organic matter. It is a hardy crop grown extensively in warm regions of the world. It is highly drought resistant and can be grown in areas where there is scanty rainfall. It can withstand water stagnation to some extent.

Suitable Varieties of Proso millet

TAMIL NADU	Co-5, TNAU 151, TNAU 164, TNAU145, TNAU 202, CO-4, K2, CO 3, CO 2, GPUP 21, GPUP 8, TNPm-230
UTTARAKHAND	PRC 1, TNAU 145, TNAU 164, TNAU 151, CO 4
KARNATAKA	GPUP 8, GPUP 21, TNAU 145, 164, TNPm-230, TNAU-202, DHP-2769, TNPm-230
BIHAR	BR-7, TNAU 164, 145, PR 18 , TNPm-230, TNAU-202
ANDHRA PRADESH	Sagar, Nagarjuna, CO 4, CO 3 , TNAU 164, TNAU-202, TNPm-230



Time of Sowing

Kharif : first fortnight of July with the onset of monsoon

Rabi : September to October in Tamilnadu and Andhra Pradesh

Mid March : mid May in the states of Bihar and Uttar Pradesh as irrigated catch crop.

Spacing: 25-30 cm (row to row), 8 – 10 cm (plant to plant). The seed should be planted 2-3 cm in depth.

Seed rate: 8-10 kg ha⁻¹ for line sowing

15 kg ha⁻¹ for broadcasting

Manuring and fertilization: Apply Compost or farmyard manure @ 5-10 tonnes/ha about a month before sowing. Generally fertilizer recommended to get a good crop are 40 kg Nitrogen, 20 kg P₂O₅ and 20 kg K₂O per ha. Soil test based fertilizers application is recommended. Apply entire quantity of P₂O₅ and half of Nitrogen at the time of sowing and remaining half of Nitrogen at first irrigation

Weeding and Intercultural Operation: Two inter cultivations and one hand weeding in line sown crop is recommended. Intercultural operation using a tyne-harrow when crop is 30 days old is also recommended. In broadcast crop 1st weeding after 15 – 20 days after emergence of seedling and 2nd weeding 15-20 days after 1st weeding is recommended.

Irrigation: *Kharif* season crop require minimum irrigation. It is mostly grown as a rain-fed crop. However, if the dry spell prevails for longer period, then 1 - 2 irrigations to be given. Summer crop requires 2 - 5 irrigations depending upon soil type and climatic conditions.

Harvesting: Harvest is done once the ear-heads are physiologically mature. The crop is ready for harvest in 65 - 75 days after sowing.

Yield: Grain 20-23 q/ha and 50-60 quintals of straw per hectare.

FOXTAIL MILLET

Soil and Climate: Foxtail millet needs moderately fertile, well drained soil for good yields, although it can grow on soils ranging from sandy to heavy clay soils. Grows better in place with annual rainfall of 500-700 mm. It cannot tolerate water logged condition or extreme drought.

State Wise Popular Foxtail Millet Cultivars

STATE	VARIETIES POPULAR IN THE STATE
ANDHRA PRADESH	SiA 3088, SiA 3156, SiA 3085, Lepakshi, SiA 326, Narasimharaya, Krishnadevaraya, PS 4



BIHAR	RAU-1, SiA 3088, SiA 3156, SiA 3085, PS 4
KARNATAKA	DHft-109-3, HMT 100-1, SiA 3088, SiA 3156, SiA 3085, PS 4, SiA 326, Narasimharaya
RAJASTHAN	Prathap Kangani 1 (SR 51), SR 1, SR 11, SR 16, SiA 3085, SiA 3156, PS 4
TAMIL NADU	TNAU 43, TNAU-186, Co (Te) 7, Co 1, Co 2, Co 4, Co 5, K2, K3, SiA 3088, SiA 3156, SiA 3085, PS 4
TELANGANA	SiA 3088, SiA 3156, SiA 3085, Lepakshi, SiA 326
UTTARAKHAND	PS 4, PRK 1, Sreelaxmi, SiA 326, SiA 3156, SiA 3085
UTTAR PRADESH	PRK 1, PS 4, SiA 3085, Sreelaxmi, SiA 3156, Narasimharaya, S-114, SiA 326

Seed Treatment: Ridomil @2g/kg, Carbendarium @ 2g / kg

Time of Sowing

Kharif : July-Aug. (Karnataka), July (TN, TS), 2-3rd week July (Maharashtra)

Rabi : August to September

Irrigated/Summer : February to March

Spacing: 25-30 cm (row to row), 8 – 10 cm (plant to plant). The seed should be planted 2-3 cm in depth.

Seed rate: 8-10 kg ha⁻¹ for line sowing

15kg ha⁻¹ for Broadcasting

Manure and fertilizers: Apply Compost or farmyard manure @ 5-10 tonnes/ha about a month before sowing. Generally fertilizer recommended to get a good crop are 40 kg Nitrogen, 20 kg P₂O₅ and 20 kg K₂O per ha. Soil test based fertilizers application is recommended. Apply entire quantity of P₂O₅ and half of Nitrogen at the time of sowing and remaining half of Nitrogen at 30 days after sowing

Weeding and Intercultural operation: Two inter cultivations and one hand weeding in line sown crop is recommended. Information using a tyne-harrow when crop is 30 days old is also recommended. In broadcast crop 1st weeding after 15 – 20 days after emergence of seeding and 2nd weeding 15-20 days after 1st weeding in recommended.

Irrigation: *Kharif* season crop require minimum irrigation. It is mostly grown as a rain-fed crop. However, if the dry spell prevails for longer period, then 1 - 2 irrigations to be given, summer crop requires 2 - 5 irrigations depending upon soil type and climatic conditions.

Harvesting: Normally crop is ready for harvest in 80 - 90 days after sowing

Yield: Grain 20-25 q per ha under ideal condition. & Straw 20-40 q per ha



FINGER MILLET

Climate: Finger millet is a short day plant and grows best in an environment with day temperatures of 30 to 34°C and 22 to 25°C night temperatures along with good sunshine. It thrives best in the areas where annual rainfall is about 100cm.

Soils: Finger millet is cultivated on a variety of soils ranging from rich loam to poor shallow upland soils. It prefers porous and well drained loam to light red loam and sandy loam soils of good fertility and water holding capacity. The soil should be rich in organic matter. It withstands and thrives well on slightly alkaline soils too.

Suitable Varieties of Finger millet

KARNATAKA	GPU 28, GPU-45, GPU-48, PR 202, MR 1, MR 6, Indaf 7, ML365, GPU 67, GPU 66, KMR 204, KMR 301, KMR 340
TAMIL NADU	GPU 28, CO 13, TNAU 946 (CO 14), CO 9, CO 12, CO 15
ANDHRA PRADESH	VR 847, PR 202, VR 708, VR 762, VR 900, VR 936
JHARKHAND	A 404, BM 2
ORISSA	OEB 10, OUAT 2, BM 9-1, OEB 526, OEB-532
UTTARAKHAND	PRM-2, VL 315, VL 324, VL-352, VL 149, VL 146, VL-348, VL-376, PES 400
CHATTISGARH	Chhattisgarh-2, BR-7, GPU 28, PR 202, VR 708 and VL 149, VL 315, VL 324, VL 352, VL 376
MAHARASHTRA	Dapoli 1, Phule Nachani, KOPN 235, KoPLM 83
GUJARAT	GN 4, GN 5, GNN 6
BIHAR	RAU 8

Time of Sowing

Kharif : first fortnight of July with the onset of monsoon

Rabi : September to October

Summer : first fortnight of January

Spacing: 25-30 cm (row to row), 8 – 10 cm (plant to plant). The seed should be planted 2-3 cm in depth.

Seed rate: 8-10 kg ha⁻¹ for Direct sowing

5 kg ha⁻¹ for Transplanting



Manuring and fertilization: Apply Compost or farmyard manure @ 7-10 tonnes/ha about a month before sowing. Generally fertilizer recommended to get a good crop in rainfed condition is 40:20:20 kg NPK ha⁻¹, and for irrigated is 60:30:30 kg NPK ha⁻¹. Soil test based fertilizers application is recommended. Apply entire quantity of P₂O₅ and half of Nitrogen at the time of sowing and remaining half of Nitrogen at first irrigation

Weeding and Intercultural Operation: Two inter cultivations and one hand weeding in line sown crop is recommended. Intercultural operation using a tyne-harrow when crop is 30 days old is also recommended. In broadcast crop 1st weeding after 15 – 20 days after emergence of seedling and 2nd weeding 15-20 days after 1st weeding is recommended.

In assured rainfall and irrigated areas: Pre-emergence spray: Isoproturon @ 0.5 kg a.i./ha. (Rainfed areas), Oxyflurofen @ 0.1 lta.i /ha (Irrigated areas)

Post-emergent spray: 2, 4-D sodium salt @ 0.75 kg a.i./ha Spraying around 20-25 days after sowing effectively control weeds.

Irrigation: Depending on soil type, weather condition and duration of variety, 8-14 irrigations are necessary

Harvesting: Harvest is done once the ear-heads are physiologically mature. The crop is ready for harvest in 65 - 75 days after sowing.

Yield: Grain 12-15 q/ha and 20-25 quintals of straw per hectare.

SOURCE

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SECTION - 10

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PROSPECTS OF MILLET CULTIVATION IN DRYLAND AGRICULTURE

INTRODUCTION

Millets are small seeded grasses those are hardy and grow well in dry zones as rainfed crops under marginal conditions of soil fertility and moisture. Millets are also unique due to their short growing season. Moreover, these food grains can be stored for two or more years. Millet foods are also highly nutritious, non-glutinous and non-acid forming. Hence, they are palatable and easily digestible. Millets are particularly high in minerals like iron, magnesium, phosphorous and potassium. Finger millet (Ragi) is the richest in calcium content, about 10 times that of paddy rice or wheat. Unlike paddy and wheat, those require many inputs in terms of soil fertility and water, millets grow well in dry regions as rain-fed crops. Considering our health and nutrition, if we re-incorporate millets into our food habit it will be an act of encouraging our farmers in dry land areas to grow crops those are best suited for the regions. These crops are indigenous, climate resilient and can thrive well with marginal natural resources and external inputs. Re-introduction of millets in the dry region can bring about sustainability in the cropping pattern of those areas. These crops are also best suited for PKVY project implemented in our state with a thrust.

In India, out of the total net sown area of 141.0 Mha, rainfed area accounts for 85.0 Mha spread over 177 districts. This constitutes approximately 60 percent of the total farming area in the country. Rainfed agriculture contributes 44% of the total food grain production of the country and produces 75% of pulses and more than 90% of sorghum, millet and groundnut. Even after half a century of neglect, the rainfed regions provide livelihood to nearly 50% of the total rural workforce and sustain 60% of cattle population of the country. Millets are traditionally being grown in rainfed conditions especially by the marginal farmers and tribals. These



are among the oldest cultivated crops in India and rest of the world. Millets comprise two main groups of species, major millets includes sorghum and pearl millets and the minor millets are represented by six cultivated species viz. Little millets, Indian barnyard millets, Kodo millet, Foxtail millets, Finger millets, Proso millet. Nearly 60 million acres of land in India are under millet cultivation. India is the largest producer of sorghum and minor millets, accounting for over 80% of Asia's production. Though they occupy relatively a lower position among food crops in Indian agriculture, they are quite important from the point of food and nutrition security at regional and farm level.

IMPORTANCE OF MILLET CULTIVATION

The promotion of millet farming merits attention, particularly from the following perspectives:

1. FROM FARMING PERSPECTIVE

Millets probably provides the best option to the farmers for achieving the triple objectives of farming i.e adaptability, sustainability and profitability. The millets based farming systems have the following advantages:

- a. Millets are highly tolerant to increased temperatures, droughts and floods. Millets can be cultivated well in dry zones/rain-fed areas under marginal conditions of soil fertility and moisture.
- b. Water requirement is very less as compared to other crops due to an efficient root system. For example, pearl and finger millet can do away with 28% of paddy's water needs.
- c. The short rotation (65 days) characteristic of the millets is of vital importance to meet the food demand, especially in the highly populated regions.
- d. Storage life is comparatively high (two years or beyond).
- e. Millets farming requires a small investment
- f. Inputs added are mostly organic.
- g. Millets produce more tillers or branches than other crops.
- h. They provide both food and fodder.

2. FROM HUMAN NUTRITION PERSPECTIVE

- i. Millets are rich source of nutrients. A regular consumption can help to overcome malnutrition among majority of our Indian population.
- j. Millets are richer in calcium, iron, beta-carotene etc than those of rice and wheat.
- k. Millets are rich in dietary fibre, which is negligible in rice. Jowar has 8 times more fibre, ragi has 40 times more calcium and bajra has 8 times more iron and 5 times more both riboflavin and folic acid than rice.



- l. Millets help check diabetes, improve digestive system, reduce cancer risk and strengthen the immune system.
- m. With no gluten and low glycaemic index, millet diet is ideal for those with celiac diseases and diabetes.
- n. Minor millets has the potential to tackle iron deficiency and infertility problems.
- o. Millets contain high amounts of lecithin which is useful for strengthening the nervous system.

3. FROM ENVIRONMENTAL PERSPECTIVE

The added advantage of millet cultivation is that it takes into account the concerns of soil and water pollution and climate change.

- a. The millets don't need synthetic fertilizers or pesticide and mostly grown with organic inputs. The fact that millets are less affected by diseases and insect pests thus keeps pesticides at bay.
- b. Millets help in reducing the atmospheric CO₂ and thus contribute in mitigating the climate change. They have a good ability to sequester carbon and so help climate adaptation.

MILLETS :A PARADIGM OF SECURITIES

While single crops such as rice and wheat can succeed in providing food security for India, millets produce multiple securities. They include securities of food, nutrition, fodder, fibre, health, livelihood and ecology. Most millets have edible stalks which are the most favoured fodder for cattle. Many a times, crops such as sorghum and pearl millet are grown only for their fodder value. Besides food and fodder values, millets are rich sources of minerals and vitamins and hence produce nutrition security. Being hosts to diverse crops such as red gram, millet fields also produce pulses and fuelwood. The companion legume crops are synergistic with millets and are also prolific leaf shedders. This leaf fall acts as natural manure and maintains soil fertility. Thus, millet farms not just use soil fertility for their growth but also return fertility to the soil.

MILLETS : THE CLIMATE RESILIENT CROPS

Due to all the above qualities, millets remain our agricultural answer to the climate crisis that the world is facing. Climate Change is expected to confront us with three challenges.

- Increase in temperature upto 2-5 degree Celsius
- Increasing water stress
- Decline in productivity due to abiotic and biotic stresses arising out of climate shift.



Only millets have the capacity to meet these challenges:

- Since they are adaptable to growing under drought conditions, they can withstand higher heat regimes.
- Millets grow under non-irrigated conditions in such low rainfall regimes as between 200mm and 500 mm. Thus, those can combat water stress and grow successfully. Therefore, those can maintain sustainable productivity. Furthermore each of the millets is a storehouse of dozens of nutrients in large quantities. They include major and micro nutrients needed by the human body. Hence they can help people overcome malnutrition.

DECLINING TREND OF MILLET CULTIVATION

In spite of all these extraordinary qualities and capacities of millet farming systems, the area under millet production has been shrinking continually and more so, since the Green Revolution period. Between 1966 and 2006, 44% of millet cultivation areas were occupied by other crops signifying an extraordinary loss to India's food and farming systems. Disappearance of millet from our food habit and hence, its negligible market demand plays a major role in disappearance of millet from agricultural fields.

Discriminatory support in terms of crop loans and crop insurance has significantly contributed to the fall of millets in Indian agriculture. Unless this is checked urgently through a slew of policy and financial incentives, millets might disappear from the agrarian landscape of India over the next fifty years. This will not only be a loss to India's food and farming systems, but will also prove to be a ecological disaster. Therefore, there is an urgent need for Indian policy makers to refocus their attention towards millet farming systems and enact policies that create an enabling environment for millet farmers.

FACTORS LIMITING PRODUCTIVITY OF MILLET

Production of millets are carried out in sub marginal resource conditions. Moreover the area under cultivation is declining. Excepting sorghum, pearl millet, and finger millet, no other millet have showed any improvement in their area coverage. The major constraints are as follows:

1. Millets are grown on poor shallow and marginal soils under rainfed conditions. Some of these are still grown in the hilly areas under shifting cultivation which is one of the most primitive ways of crop production. The soils on which these crops are cultivated have low moisture retention capacity.
2. Traditional system of agricultural practices are followed for their cultivation. This is a major bottle neck in taking inter-cultivation operation and effective weed control. The mixed cropping practices adopted by the farmers are mostly suited to sustenance agriculture and many of them are not remunerative.
3. They are often cultivated under low manured and low fertilized conditions. Non adoption of improved varieties and timely agricultural operations like tillage, sowing, weeding and interculturing has resulted in reduced returns. Improved crop management practices are not adopted by the farmers due to socio-economic constraints.



SUGGESTIONS FOR IMPROVING MILLET CULTIVATION

As millets are predominantly grown in marginal and sub marginal dry lands by poor farmers, the fluctuations in production not only bring hardship to farmers but also create instability in the total coarse cereal production. So, developmental effort should be made through mini kit demonstrations and state level training programmes. These would help in popularizing the newly released varieties among the farmers in replacing the low yielding local varieties. For this purpose, systematic follow-up action is required for the production of seeds, its processing and distribution. The role of non-monetary inputs such as line sowing, optimum row spacing, depth of seeding, optimum plant population per unit area, timely cultural practices for higher productivity should be explained and demonstrated to the farmers right in the field. Agronomic research should bring out efficient low-cost technology which is within the means of farmers and easy to adopt. Increased use of small millets in various ready-to-eat food products should be encouraged as it enhances their value and market price.

CONCLUSION

The small and marginal farmers in India are facing multiple problems in operating their farms, many of which are systemic and reinforced by other factors in the environment. The farming systems that we need today need to be more resilient and diversified to meet the food and nutrition demands of the nation while ensuring sustainable use of natural resources. It took so many years for the government to recognise the potentials and contributions of millets based farming systems. Though late, the central and state governments have taken several progressive measures during the last decade to promote millets farming on a mission mode and increase awareness among the populace particularly the urban Indians for increased consumption of millets. As a result of which, millets are gaining attention and have been prioritized to a greater extent. There are some of the possible areas of intervention for the government and other stakeholders in future.

1. As millets farming have been traditionally fitted within the multi cropping farming approach, it needs to be ensured that millets do not follow the monoculture route under the government extension programmes.
2. Government should make provisions for incentives to encourage millets cultivation.
3. Greater thrust must be given to value addition of the millets to increase demand among the urban consumers
4. Government and NGOs should work together to generate awareness about the benefits conferred by millets and their role in nutrition and carbon sequestration needs
5. Farm mechanisation should be equally prioritized to remove the drudgery associated with traditional processing of millets.



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SECTION - 11

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SMALL MILLET RESEARCH IN ODISHA

Research on Small Millets in form of All India Coordinated Research Project (AICRP) on Small Millets, Orissa Centre under Odisha University of Agriculture & Technology is operating at Centre for Pulses Research, Berhampur since 1986-87. The project is doing research on crop improvement, production and protection aspects. Berhampur is situated in East and South Eastern Coastal Plain Zone of the state. Geographical location of Berhampur, Orissa is at 19°18'N and 84°54'E and at 34 MSL. The weather remains warm and humid with mean annual maximum and minimum temperature are 34°C and 14°C and mean annual rainfall 1296 mm (65 rainy days). Soil of the research station is mostly sandy loam in texture with pH 5.7 to 6.2. The soil is having low organic carbon content, available phosphorus and potassium.

Small Millets are grouped into six categories: Finger millet (*Eleusine coracana*), Little millet (*Panicum sumatrense*), Foxtail millet (*Setaria italica*), Proso millet (*Panicum miliaceum*), Kodo millet (*Paspalum scrobiculatum*) and Barnyard millet (*Echinochloa colona*). Out of these six small millets, Finger millet (Mandia) and Little millet (Suan) are mostly grown in Odisha. All India Coordinated Small Millet Improvement Project, Berhampur in Odisha has two mandate crops for research i.e., finger millet and little millet with the following **objectives**.



OBJECTIVES

1. To develop high yielding millet varieties having tolerance / resistance to major biotic & abiotic stresses.
2. Collection, evaluation and maintenance of small millet genotypes of the state.
3. To evolve appropriate and profitable crop production and protection technologies for different agro-ecological regions.
4. Transfer of technology through Front Line Demonstration and Tribal Sub Plan scheme.
5. To produce nucleus and breeder seed of popular finger millet and little millet varieties

MAJOR THRUST AT THE CENTRE

1. Development of suitable high yielding and disease pest resistant varieties.
2. Popularization of the high yielding varieties for their large scale cultivation in farmers' field
 - During Kharif under inter-cropping system with arhar.
 - Short duration pre-paddy ragi varieties during pre-kharif in medium land paddy fields
 - Increase the area of finger millet during rabi season under irrigated condition.
3. Large scale demonstrations on advanced crop production and protection technologies in the millet growing areas.
4. Education to the tribal farmers to adopt transplanting of finger millet instead of direct seeding.

RESEARCH ON CROP IMPROVEMENT

VARIETIES RELEASED

All India Coordinated Research Project on Small Millets, Berhampur have developed 7(seven) high yielding multi pest resistant varieties of finger millet and 4(four) little millet varieties. Another little millet entry OLM 217 has been proposed to be released in near future. The details about the varieties are given in table.



FINGER MILLET VARIETIES RELEASED BY OUAT

Variety	Parentage	Year/ status	Duration (days)	Average yield (q)	Pot. yield (q)	Salient features	Season & area of adaptability
DIBYASINHA	Mutant of AKP-7	1971/ State	90-100	17.0	35.5	Earhead slightly top incurved with pale white pericarp, Grains brown in colour	Kharif and Rabi season of Odisha
NEELACHAL (B 4-10-56)	Mutant of IE 642	1985/ State	105-110	25.0	41.5	Light brown and medium bold grain, Semi-compact and top incurved panicles	Kharif and Rabi season of Odisha
SUVRA (OUAT 2)	Mutant of CO 9	1999/ National	100-105	21.5	45.0	Plant height 80-90 cm, top incurved ear heads, white coloured grains, MR to blast & R to Sheath blight	Kharif and Rabi season of Odisha
BHAIRABI (BM 9-1)	Mutant of Budha Mandia	1999/ National	105-110	27.0	44.0	Leaves light green, purple coloured juncture and auricle, top incurved ear heads, Light brown coloured seeds, Lodging resistant, MR -blast & Stem borer	Kharif and Rabi of Odisha, Ktk, AP and MP
CHILIKA (OEB 10)	GE 68 x GE 156	2001/ National	110-115	26.0	52.0	Tall, late maturity leaves broad and light green, top incurved ear heads with light brown bold grain, MR-blast & R-Stem borer	Odisha, MP, Gujarat, AP and TN
KALUA (OEB 532)	GPU 26 x L 5	2015/ State	110-115	25.0	51.0	Semi dwarf and medium maturity, Semi compact, medium to long ear and light brown grains, R-blast, Stem borer & Myllocerus weevil	Kharif and rabi season in Odisha and Chhatisgarh
ARJUNA (OEB 526)	SDFM 30 x PE 244	2015/ National	105-110	26.0	51.0	Semi dwarf, medium maturity, Semi compact, intermediate, light brown grains, Tolerates dry spell of 10-12d at veg. and 6-8dat reprod. stages, MR- blast & Stem borer	Kharif and rabi season in Odisha, AP, MP, TN, Gujarat



LITTLE MILLET VARIETIES RELEASED BY OUAT

Variety	Parentage	Year/ status	Duration (days)	Average yield (q)	Pot. yield (q)	Salient features	Season & area of adaptability
Tarini (OLM 203)	Sel. From Koraput local	2001/ National	105-115	12.0	25.0	Tall plants with thick culm, broad, long dark green leaves, Very large and drooping panicles, grains bold, shining and grey colours, R- blast & Grain smut	Rainfed uplands in Odisha, AP, Bihar, TN
Kolab (OLM 36)	Mutant of SS 81-1	2001/ National	75-80	10.9	28.0	Medium height with thick culm, Long compact panicles, R- brown spot & sheath blight	Odisha,MP, Bihar, Chattisgarh and Ktk
Sabara (OLM 20)	Mutant of SS 81-1	2001/ National	75-80	10.7	29.5	Medium height, thick culm and light green leaves, Long loose drooping panicle and light brown medium bold grains. Drought tolerant, MR- blight, brown spot & shoot fly	Rainfed uplands of Odisha, MP and Chattisgarh
Saura (OLM 208)	Sel. From Lajigada local	2009/ National	100-105	14.1	34.0	Tall plant and large panicle, grains are medium bold, lustrous with light grey colour, R- blast, MR- sheath blight, grain smut & shoot fly	Rainfed uplands in Odisha, Chattisgarh and Gujrat
OLM 217	Sel. From Udayagiri local	2009/ To be released in Odisha	105-110	15.1	39.7	Tall, late maturing (106 d), Large panicles (21-36 cm), lustrous with light grey medium bold grains, R- rust & grain smut, MR-sheath blight & shoot fly	rained uplands in Odisha state

R - Resistant, MR - Moderately resistant





NEELACHAL



BHAIRABI (BM 9-1)



CHILIKA (OEB 10)



SUVRA (OUAT 2)



KALUA (OEB 532)



ARJUNA (OEB 526)





TARINI (OLM 203)
TARINI (OLM 203)



KOLAB (OLM 36)
KOLAB (OLM 36)



SABARA (OLM 20)



SAURA(OLM 208)
SAURA(OLM 208)



OLM 217(to be released)



GERMPLASM MAINTENANCE AND EVALUATION

At Berhampur centre 105 accessions of finger millet and 233 accessions of little millet are being maintained, evaluated and utilised in the breeding programme. Some of the germplasm lines are utilised in crossing programme for development of varieties.

BREEDING LINES DEVELOPED

A total of 37 breeding lines of finger millet and 10 lines of little millet have been developed from the centre which are under station trial testing forgetting superior lines for further testing under coordinated trial and multilocation trial for development of new varieties. Finger milletlines OEB 601, OEB 602, OEB 4, OEB 8 and little millet entries OLM 217-1, OLM 233-1, OLM 18 are in national testing.

NUCLEUS AND BREEDER SEED PRODUCTION

Every year nucleus seeds of all the finger millet and little millet varieties have been produced for production of breeder seed and also to maintain the varieties. As per DAC indent, the centre has produced about 50.0 quintals of breeder seed of finger millet varieties Bhairabi, Chilika, Suvra and distributed to different organizations and farmers. As per the Govt of India project “Enhancing breeder seed production for increasing indigenous production of millets in India” under NFSM the breeder seed of finger millet variety Arjuna and little millet variety Saura have also been taken up since 2018-19.

RESEARCH ON CROP PRODUCTION

A. FINGER MILLET

i.) Sowing / Planting methods

- Optimum time for sowing finger millet in Odisha is found to be second fort night of June to second fort night of July during kharif season and second fort night of December during Rabi/summer season.
- Optimum seed rate for finger millet was found to be 7.5 to 10.0 kg /ha.
- Optimum spacing for early, medium and long duration finger millet varieties found to be 22.5 x 10.0 cm during kharif season and 25x10 cm during rabi/summer season.
- Transplanted finger millet recorded the highest grain yield of 2412 kg/ha which was 31% higher than direct seeded finger millet (1840 kg/ha), closely followed by drilled sown.
- Transplanting of 25-30 days old finger millet seedlings recorded highest grain yield of 2686-2743 kg/ha and straw yield of 5031-5230 kg/ha during kharif. Grain yield was reduced by 6.8-10.1% and straw yield of 3.2 – 7.5 % by transplanting 35 days old seedlings.



- Nursery sowing on 15th December and transplanting of 35 days old seedlings recorded the highest grain (2820 kg/ha) and straw (6870 kg/ha) yield during summer.
- The highest finger millet grain yield(2490 kg/ha) and straw (6100 kg/ha) yield, net return (Rs 12680/ha) and B:Cratio (1.74) was obtained at 25x7.5 cm planting geometry during summer.
- Thinning of plants at 15-20 days after germination and maintaining plant to plant spacing of 7.5-10 cm recorded the highest grain yield of 2361-2448 kg/ha & straw yield of 4478-4718 kg/ha. Grain yield was reduced by 13.2% and straw yield 7.3% adopting thinning at 25 DAS

ii.) Nutrient management studies

During *kharif* season application of recommended NPK dose @ 60-30-30 kg/ha found to be optimum for finger millet. During summer season finger millet variety 'Bhairabi' found to be the best variety and it responded up to 60-30-30 kg N P2O5 andK2O/ha.

Basal application of 50 % N (30 kg/ha) and 30 kg each of P2O5 and K2O /ha recorded the highest grain (2489 kg/ha) and straw (4914 kg/ha) yield as compared to no basal application of NPK which recorded grain yield of 2216 kg/ha and straw yield of 4860 kg/ha.

iii.) Cropping system studies

Application of recommended dose of fertilizer to finger millet (60-30-30 kg N, P2O5, K2O/ha) and pigeonpea (20-40-20 kg N, P2O5, K2O/ha) on area basis in finger millet + pigeonpea (8:2) inter cropping system along with FYM @ 7 t. /ha, azotobacter, phosphobacterin, rhizobium and sodium molybdate @ 4 g/kg of pigeonpea seed as seed treatment found to be most productive and economically viable for Odisha.

Cluster bean-finger millet followed by cowpea-finger millet system was found to be most ideal system in respect to production and net return for Odisha under rain fed uplands.

Finger millets-based sequence cropping systems like finger millet during kharif followed by cowpea/ cluster bean / blackgram during pre-rabi and rabi recorded the highest finger millet grain equivalent yield, net return and B:C ratio under uplands and under partial irrigation facility during rabi.

In finger millet-rice crop sequence early duration finger millet can be grown with RDF 40-20-20 kg N, P2O5, K2O/ha + FYM @5t/ha followed by rice with RDF 60-30-30 kg N, P2O5, K2O/ha for higher system productivity, net return & B:C ratio under rain fed medium land condition.

In finger millet-blackgram crop sequence the highest finger millet grain equivalent yield, net return and B:C ratio was recorded at RDF 60-30-30 kg N, P2O5, K2O/ha + FYM @ 5 t/ha + lime @ 1.25 t/ha to finger millet followed by blackgram at RDF 20-40-20 kg N, P2O5, K2O/ha + FYM 5 t/ha + 2% DAP spray at flowering and pod formation + rhizobium and PSM and sodium molybdate @ 4 g/kg of black gram seed as seed treatment under rain fed uplands.



iv.) Integrated weed control in finger millet

Pre-emergence application of Isoproturon @ 0.5 kg a.i /ha +2 inter cultivations and one hand weeding at 21 days after transplanting found productive and economically viable with 163.5%, 81.4 % and 17079 higher grain yield, straw yield, net return, respectively than the un weeded check.

v.) Agronomic manipulations to mitigate climate change

Sowing after receipt of sowing rains closely followed by sowing after receipt of sowing rains + without gap filling found to be ideal practice for rain fed finger millet. Bhairabi followed by chilika found to be suitable varieties for the situation.

vi.) Management practices for summer finger millet

Nursery sowing on 15th December and transplanting of 35 days old seedlings of Godavari /Champavati / Bhairabi at 25x7.5 cm spacing with irrigation at transplanting, tillering, flag leaf and ear emergence and application of 60-30-30 kg N, P₂O₅, K₂O/ha found to be best management practices.

vii.) Summer ploughing along with opening conservation furrow after every 6-8 rows, mulching with crop residues, weedicide application (isoproturon@0.5kg ai/ha), rotation with legumes produced highest grain, straw yield, net return and B:C ratio

viii.) In intercropping system, Finger millet + maize can be taken in 8:2 ratio to get highest finger millet grain equivalent yield, net return and B:C ratio in comparison other systems and farmers practice

(A) Little Millet

i.) Sowing / Planting methods

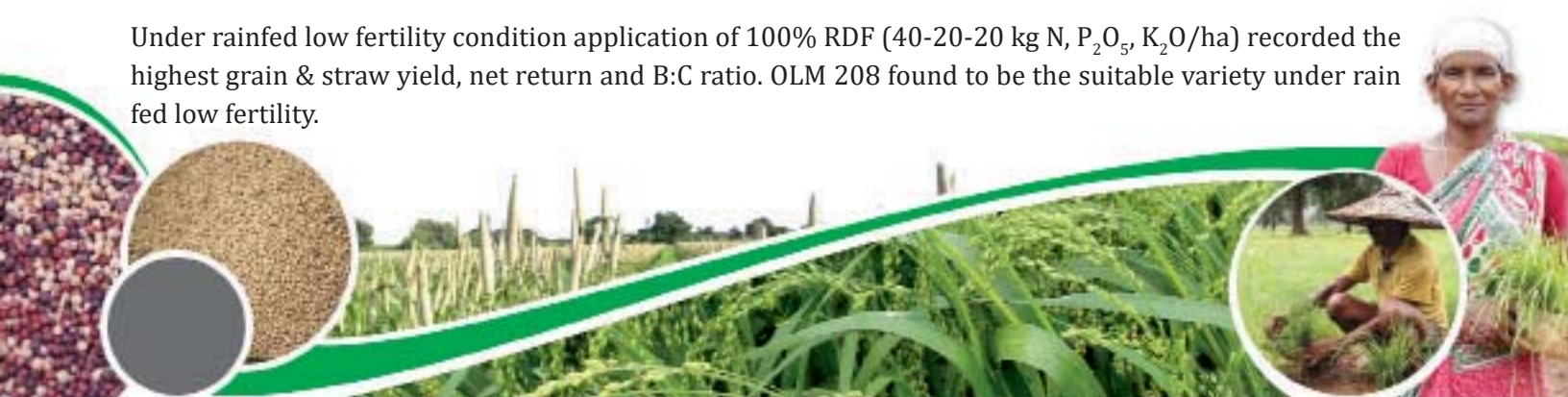
- Optimum time for sowing in Odisha is found to be 1stfort night of July during kharif
- Optimum seed rate for was found to be 7.5 to 10.0 kg /ha.
- Optimum spacing for little millet varieties found to be 22.5 cm x 7.5 cm during kharif.

ii.) Weed control studies in little millet

First 45 days after sowing found to be critical for little millet when the crop should remain weed free for higher yield.

iii.) Nutrient management studies

Under rainfed low fertility condition application of 100% RDF (40-20-20 kg N, P₂O₅, K₂O/ha) recorded the highest grain & straw yield, net return and B:C ratio. OLM 208 found to be the suitable variety under rain fed low fertility.



iv.) Band placement of FYM @ 2t/ha enriched with balance of 100% RDF (40-20-20 kg N, P₂O₅, K₂O /ha) gave higher grain (1204 kg/ha) and straw (4302 kg/ha) yield in little millet.

v.) Application of 50% of RDF (40-20-20 kg N, P₂O₅, K₂O /ha) along with *Azospirillum brasillense* and *Apergillus awamosi* @ 25 g/kg of seed as seed treatment gave the highest grain (1557 kg/ha) and straw (3568 kg/ha) yield.

vi.) Agronomic manipulations to mitigate climate change

Sowing after receipt of sowing rains recorded significantly the highest grain and straw yield, net return & B:C ratio.

vii.) Weed control studies in little millet

First 45 days after sowing found to be critical for little millet when the crop should remain weed free for the higher grain yield, straw yield, net return and B:C ratio.

viii.) In sequence cropping system, little millet followed by guar can be recommended for highest little millet grain equivalent yield, net return and B:C ratio.

ix.) In Organic farming little millet trial INM (FYM + RDF) recorded highest grain yield, straw yield and B:C ratio followed by only organics (FYM 5 t/ha + Vermi Compost 1 t/ha + Neem cake 500 kg/ha)

RESEARCH ON CROP PROTECTION

A. ENTOMOLOGY

(a) Finger Millet

1. Grasshoppers, myllocerus weevils, leaf and ear head aphids are the major pests and leaf folders, ear worm, hairy caterpillars are minor pests of kharif finger millet.
2. Stem borer is the major pest of rabi/summer finger millet.
3. The optimum sowing time of finger millet is last week of June to last week of July. This sowing period reduces the pest load and increases the yield.
4. The early and medium duration cultivars like OEB-87, OEB-259, OEB-219, OEB-526, Bhairabi, OEB-532, VL-333, VL-340, TNAU-1022, KMR-204, RAU-8 and GPU-45 were less susceptible (<10% infestation) to major pests.
5. The late duration cultivars, such as TNAU-1003, OEB-54, OEB-83, OEB-52, Chilika, OEB-57, OEB-265, OEB-211, OEB-530, GPU-63, GPU-64, GPU-66, GPU-67, GPU-70, GPU-72, PR-202, KMR-101 and VR-914 were less susceptible (<10% infestation) to major pests.



6. Varieties such as OEB-530, PR-202, VL-343, VL-346, GPU-48, GPU-73, SANJI-1, RAU-8, VL-352, OEB-54, and OEB-83 were less susceptible (<10% infestation) to major pests.
7. Furrow application of carbofuran performed best recorded 4.6% DH at 20 DAS, 8.3% DH at 35 DAS. Among seed treatment chemicals Imidacloprid @ 3 ml/l water (soaking for 6 hrs) performed best in shoot fly management showing 5.2% & 10.1% DH at 20 & 35 DAS.
8. Spraying NSKE 5% at 35 DAS is a low-cost eco-friendly management option against pink stem borer in finger millet as it can reduce the pest incidence (36.54 and 43.8 % reduction in DH and WEH) and yield loss (85% yield advantage) with higher net return (Rs. 32408.00) and B.C. ratio(2.08) against the existing farmers' practice.



Root aphid



Leaf aphid



Panicle aphid



Aphid-ant association



Stem borer larva



Stem borer adult





Leaf blast



Finger blast



Neck blast



Brown spot



Foot rot



(b) Little Millet

1. Shootfly is the only major insect pest and leaf and ear aphid, gundhi bug, leaf folders are the minor pests of little millet in kharif season.
2. Early sowing of little millet last week of June to 2nd week of July reduces the shootfly infestation.
3. The little millet entries, such as RLM-39, TNAU-108, OLM-52, DLM-80, DLM-93, DLM-314, DLM-409, TNAU-93, TNAU-94, OLM-217, OLM-233, OLM-55, OLM-65 and OLM-203 were found less susceptible (<10% infestation) to shootfly.
4. Spraying 1500 ppm neem formulation at 15 DAS recorded lowest shoot fly infestation with highest mean yield of 11.22, net return of Rs. 7315/- and highest B:C ratio of 1.48 as against mean yield of 7.83q/ha in untreated control with Rs 1160/- net return & 1.08 B:C ratio.

B. PATHOLOGY

1. Leaf blast at nursery and tillering stage, neck blast at early flowering stage and finger blast in post flowering stage have been identified in finger millet.
2. Sowing of finger millet should be taken up between last week of June to 2nd week of July, which will be less infected by all the three blasts i.e. leaf, neck & finger blast.
3. Seed treatment with Carbendazim @2g/kg or Pseudomonas fluorescens 6g/kg is recommended to check the critical disease pressure mainly leaf blast.
4. Spraying of fungicides like Tricyclazole (0.06%)/ Propiconazole (0.1%) /Pseudomonas fluorescens(0.6%) twice i.e. 1st spray at 50% flowering & subsequent at 10 days after 1st spraying against blast found effective.

FRONT LINE DEMONSTRATIONS(FLD)

The newly released varieties of finger millet and little millets, newly released crop production and protection technologies and its management practices have been demonstrated in different years in the farmers' field under different agro-climatic regions and farming situations. About 300 hectares of area have been covered through FLD and about 900 farmers have been benefitted. The yield increase was found to be 64 to 78% in case of improved varieties as compared to local/farmers practice. The OUAT released finger millet variety, Bhairabi and little millet variety, Kolab & Tarini have been adopted by the farmers of Odisha state to the tune of 72% and 68%, respectively. The districts Ganjam, Gajapati, Rayagada and Koraput districts were covered under front line demonstrations.



ACTIVITIES OF AICRP ON SMALL MILLETS, BERHAMPUR



Breeder seed plot monitoring



Monitoring team visit



FLD in Finger millet



Field day under TSP



Demonstration of drum seeder



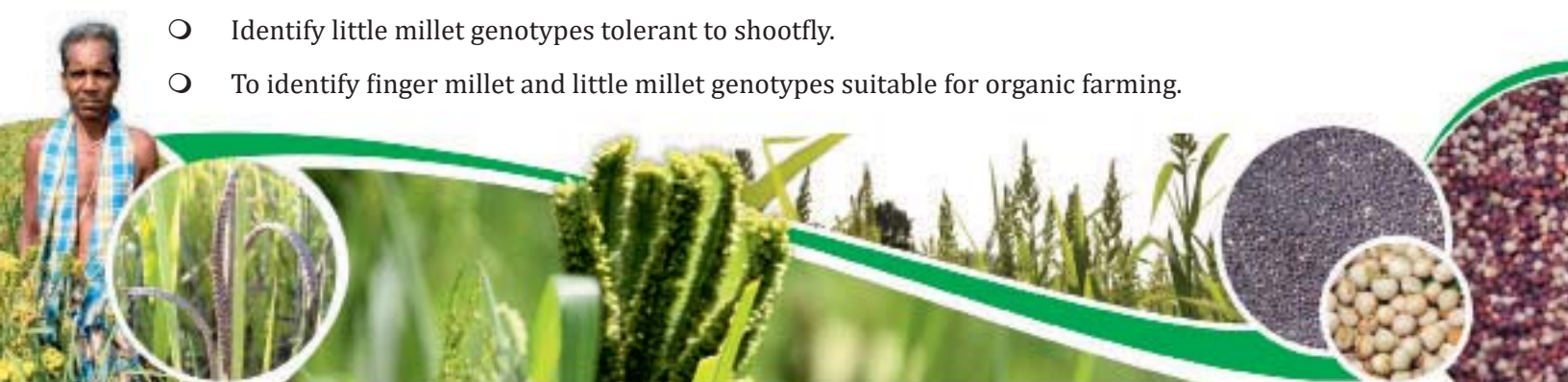
Interaction with PC(Millets)

TRIBAL SUB PLAN (TSP) SCHEME

Under Tribal Sub Plan Scheme the tribal farmers of district Ganjam, and Koraput were given package demonstration of finger millet and little millet in an area of 105 hectares. About 350 tribal farmers were benefitted by the demonstration. The farmers were supplied with inputs like seed, fertilizers, pesticides and farm implements like trench hoes, phawrahs, storage bins, H. S. Ploughs etc. Different skill building trainings and field days were conducted for the said purpose.

FUTURE STRATEGIES

- To develop short duration and high yielding finger millet varieties to fit into the cropping sequences.
- To develop blast resistant finger millet varieties.
- To develop late duration (>120 days) finger millet varieties with high yield, suitable for monoculture areas.
- To develop stem borer resistant finger millet varieties for summer cultivation.
- To develop high yielding, short duration and semi-dwarf little millet varieties.
- Identify little millet genotypes tolerant to shootfly.
- To identify finger millet and little millet genotypes suitable for organic farming.



SECTION - 12

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DISEASES AND INTEGRATED MANAGEMENT PRACTICES OF MILLETS IN VIEW OF FINGER, FOXTAIL & LITTLE MILLET

INTRODUCTION

Millets are important cereals which play a significant role in the food and nutrition security of developing countries in the semi-arid tropics of Asia and Africa, especially in India and Nigeria. They are grown on soils which typically are too poor to support any other crop. They have a higher drought tolerance, low nutrient application, and fluctuations in temperature than other cereal crops and also are unique due to their short growing season. Millets are all-season crops cultivated round the year and produces multiple securities (food, fodder, health, nutrition, livelihood and ecological) which makes them the crops of agricultural security available at affordable prices. Important millet crops grown in India are Sorghum (Great millet), Bajra (Pearl millet), Ragi (Finger millet) and small millets viz., Korra (Foxtail millet), Little millet, Kodo millet, Proso millet and Barnyard millet. These are often referred to as coarse cereals, but realizing their nutrient richness they are now considered as nutricereals. Millets are rich in minerals like iron, magnesium, phosphorous and potassium.

In India, millets are cultivated in an area of 15.48 million hectare producing 17.2 million tonnes with a yield of 1111 kg/ha (Directorate of Economics and Statistics, 2015). Maharashtra, Rajasthan and Karnataka are the leading states of millets cultivation in India. Contribution of millets in total food grain production of India reduced from 22.17 % to 6.94 % over the last six decades from 1950-51 to 2011-12. The main reasons for this reduction are the decrease in the area under production and invasion of diseases and pests. In this article these different biotic stresses have been overviewed.



FUNGAL DISEASES

1. SMUT

CAUSAL ORGANISMS

A. GRAIN SMUT

- Finger millet: *Melanopsichium eleusinis*
- Foxtail millet: *Ustilago crameri*
- Barnyard millet: *Ustilago panici-frumentacei*

B. HEAD SMUT

- Barnyard, Kodo & Proso millets: *Sorosporium paspalithunbergii*

SYMPTOMS

- Ovaries are transformed into velvety gall like sori which are bigger in size than normal grain.
- The initial greenish color of sorus gradually turns pinkish green and finally to dirty black on drying.
- On foxtail millet the fungus affects most of the grains in an ear.
- Head smuts are common in kodo millet, barnyard millet and proso millet. In kodo millet it causes considerable yield loss.

SURVIVAL & SPREAD

- Grain smut: externally seed-borne, air-borne;
- Head smut: seed-borne
- Grain smut sori are developed randomly in the grain, main rachis or in peduncle on finger , barnyard , little and foxtail millets.
- The entire panicle is transformed into a long sorus .Infected panicle may be enclosed in the flag leaf and may not emerge fully. The enclosing membrane bursts and exposes the black mass of spores.

2. UDBATTA

Causal organism: *Ephelis oryzae*



Millet host: Foxtail, Kodo & Little millet

SYMPTOMS

- Infected plants are usually stunted and occasionally the white mycelia and conidia form narrow stripes on the flag leaves along the veins prior to panicle emergence. The affected panicle is transformed into a compact, silver colored, cylindrical spike that looks like an incense stick much resembling an agarbatti or udbatta and hence the name.
- An infected panicle fails to produce the normal grain and becomes sterile.

SURVIVAL & SPREAD:

- The pathogen can infect grasses like *Cynadon dactylon*, *Pennisetum* spp. and *Ergostis tenuifolia* for survival.
- Seed-borne Udbatta is a panicle disease commonly observed on various small millets in India.

3. DOWNY MILDEW

FOXTAIL MILLET

SYMPTOMS

- Downy growth of the fungal structures as observed in many other crops.
- Shredding of the infected leaves is observed during later stage.
- Malformation of the floral organs and conversion of few or many spikelets into leafy structures is commonly observed.

4. BLAST

A. FINGER MILLET BLAST

CAUSAL ORGANISMS: *Pyricularia grisea* (Perfect state: *Magnaporthe grisea*)

SYMPTOMS

- Symptoms can be observed on the seedling, leaf, peduncle and finger, depending on the stage of the crop.
- Characteristic symptoms include elliptical or diamond shaped lesions on leaves with grey centres with water-soaked and chlorotic halo surrounding the lesions .



- Under congenial conditions spots enlarge, coalesce and leaf blades give a burnt appearance.
- Neck blast symptoms develop as elongated black coloured lesions mostly one-two inches below the ear.
- Finger blast symptom starts at the tip and proceeds toward the base of the finger, which becomes brown.
- Neck infection is the most serious phase of the disease that causes major loss in grain number, grain weight and increase in spikelet sterility.

SURVIVAL & SPREAD

- It survives in the crop residues and on other cereals. Initial inoculum comes from weeds or collateral hosts; spread by air-borne conidia.

B. FOXTAIL MILLET BLAST

CAUSAL ORGANISM: *Pyricularia setariae*

SYMPTOMS

- Symptoms are similar to that on finger millet but neck and finger infections almost absent.
- The blast pathogen is highly specialized in its host range and the pathogen population.

SURVIVAL & SPREAD

- Survives on crop residues & other cereals and cause initial infection; spread by air-borne conidia.

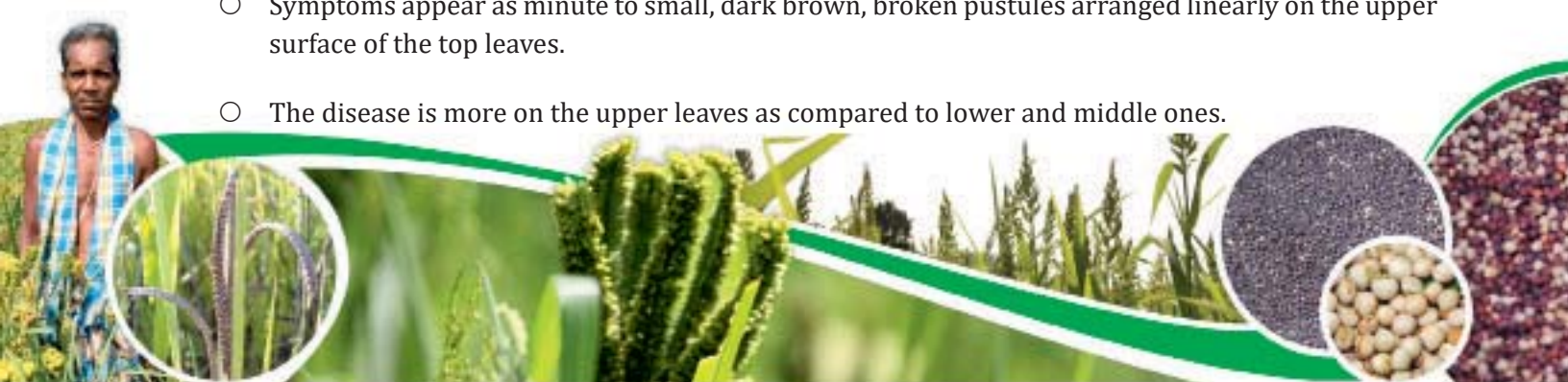
5. RUST

CAUSAL ORGANISM

- Finger millet: *Uromyces eragrostidis*
- Foxtail millet: *U. setariae-italiae*
- Little millet: *U. linearis*

SYMPTOMS

- Symptoms appear as minute to small, dark brown, broken pustules arranged linearly on the upper surface of the top leaves.
- The disease is more on the upper leaves as compared to lower and middle ones.



- *U. setariae-italicae* produces light yellow and *U. linearis* black teleutospores. *P. substriata* develops small brown, oval spots on upper surfaces of leaf.
- Telia are produced on the lower surface of leaf.

SURVIVAL & SPREAD

- Survives on alternate host (Brinjal, Grasses); spread by air-borne spores.
- Small millet rust is common on foxtail and finger millet.

6. HELMINTHOSPORIUM LEAF SPOT

CAUSAL ORGANISM

- Finger & Little millets: *Drechslera nodulosum* (Perfect state: *Cochliobolus nodulosus*)
- Foxtail millet: *Cochliobolus setariae*

SYMPTOMS

- On finger millet the disease is known as brown spot.
- The characteristic symptoms appear as brown to dark brown spots on leaf, sheath Infection on the neck and fingers may occur.
- Early infection may cause seedling blight.

SURVIVAL & SPREAD

- Survive on crop residues, stray crops, collateral hosts and a few may be seed-borne; spread by air-borne conidia.

7. CERCOSPORA LEAF SPOT

CAUSAL ORGANISM

- Finger millet: *C. eleusinis*

SYMPTOMS

- The symptoms are usually observed on the older leaves and then spread to the younger leaves.
- Initial symptoms appear as reddish-brown specks with yellow halo.
- Later several such specks coalesce to form large lesions showing burnt appearance.



- During rains the fungus sporulates and produces grayish white growth at the centre of the spot and then it looks like brown spot.

SURVIVAL & SPREAD

- Survive on crop residues, stray crops, collateral hosts and seed; spread by air-borne spore.

8. BANDED SHEATH BLIGHT

Millet host: Finger, Foxtail, Barnyard, Proso, Kodo & Little millets

CAUSAL ORGANISMS: *Rhizoctonia solani* (Basidial state: *Thanatephorus cucumeris*)

SYMPTOMS

- It is characterized by oval to irregular light grey to dark brown lesions on the lower leaf and leaf sheath.
- The centre of the lesion subsequently turns white with narrow reddish brown margins. Later the spots get distributed irregularly on leaf lamina.
- Under favourable conditions, lesions enlarge rapidly and coalesce to cover large portions of the sheath and leaf lamina. At this stage symptom is characterized by a series of copper color bands across the leaves giving a banded appearance.
- In severe cases, symptoms appear on peduncles, fingers and glumes as irregular to oval, dark brown to purplish necrotic lesions. The mycelia growth along with sclerotia can be observed on and around the lesions.

SURVIVAL & SPREAD

- Survives as sclerotia attached with host tissue in soil.
- Banded sheath blight is a common disease among small millets.

9. FOOT ROT

Millet host: Finger millet

CAUSAL ORGANISMS: *Sclerotium rolfsii* (Perfect state: *Pellicularia rolfsii*)

SYMPTOMS

- The infection occurs in and around the collar region and the infected area remains restricted to two to three inches above ground level.



- The basal portion of the affected plant appears water soaked that later turns brown and subsequently dark brown with a concomitant shrinking of the stem in the affected region.
- Profuse white cottony fungal growth occurs in this area with small roundish white velvety mustard seed like sclerotia bodies.
- Eventually, the leaves lose their lustre, droop and dry and the plant dries up prematurely.

SURVIVAL & SPREAD

- Survives as sclerotia attached with host tissue in soil, pathogen can infect more than 500 plant species.
- Mostly observed in Tamil Nadu, Karnataka, Odisha and Gujarat.

10. GRAIN MOLD

CAUSAL ORGANISMS: *Fusarium* spp., *Curvularia lunata*, *Alternaria alternate*, *Phoma sorghina*, *Bipolaris* spp., *Aspergillus* spp.

Millet host: Sorghum, Pearl millet, Finger millet

SYMPTOMS

- Infection results in blasted florets, poor seed set and production of small, shriveled grains
- Color of fungal bloom on grain varies from whitish, pinkish, grayish, to shiny black.
- Internal fungal colonization sometimes induces grain sprouting.
- It is seen as brown to black discoloration of grains on finger millet.

SURVIVAL & SPREAD

- Crop residues, soil; air-borne spores

BACTERIAL DISEASES

1. BACTERIAL LEAF SPOT

CAUSAL ORGANISM

- Finger millet: *Xanthomonas eleusinae*



SYMPTOM

- Linear spots may be seen on both the surfaces of the leaf spreading along the veins.
- In the beginning, spots are light yellowish brown, but soon become dark brown.
- In advanced stage, the leaf splits along the streak giving a shredded appearance. All the leaves in a plant may be affected.
- The bacterium, mainly affects the leaves, but at times characteristic streaks may be found on the peduncle.

SURVIVAL & SPREAD

- Survives on crop residues in soil; spread by rain-splash.

2. BACTERIAL LEAF STRIPE

CAUSAL ORGANISM

Finger millet: *Pseudomonas eleusinae*

SYMPTOM

- The symptoms on the finger millet appear as brown coloration of the leaf sheath especially from base upwards.
- The affected portion of the lamina invariably involves the midrib and appears straw colored. This symptom spreads to about three-fourths the lamina and then abruptly stops or in some cases reaches the leaf tip.
- Occasionally the strips spread along the margin, leaving the central portion of the leaf, including the midrib. Infected culms show a light brown discoloration along one side.
- The discoloration mostly begins 5–7 cm above the base and extends to leaf sheath.

SURVIVAL & SPREAD

- Survives on crop residues in soil; spread by rain-splash.



VIRAL DISEASES

1. MAIZE STREAK VIRUS- (FINGER MILLET)
2. SUGARCANE MOSAIC VIRUS (SORGHUM, FINGER MILLET)
3. RAGI MOTTLE STREAK VIRUS (FINGER MILLET)
4. RAGI SEVERE MOSAIC

TRANSMISSION: Aphid, *Longiunguis sacchari*

SYMPTOMS

- The virus induces mosaic symptoms on young leaves.
- Infected plants remain stunted; develop nodal roots, and the ears become malformed.
- They are pale yellow or brownish-white and produce few small seeds. The affected crop appears yellow from a distance. Disease severity decreases with age.

5. RAGI MOTTLE STREAK

TRANSMISSION: Leaf hopper, *Cicadulina bipunctella*, *C. chinai*

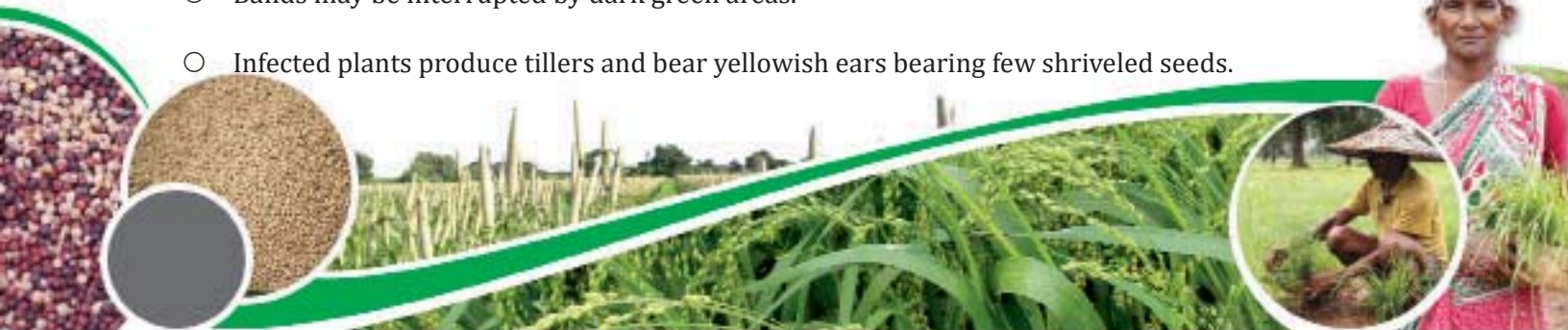
SYMPTOMS

- Symptoms are exhibited as regular dark-green areas along the leaf veins when the plants are 4-6 weeks old .
- Leaf chlorosis and streak are common.
- In the lower leaves, the symptoms are of mottle type in the form of white specks and the affected plants are generally stunted bearing small ears.

6. RAGI STREAK

TRANSMISSION: Leaf hopper, *Cicadulina chinai*

- Symptoms appear on young leaves as pale specks or stripes, which coalesce forming chlorotic bands running parallel to midrib.
- Bands may be interrupted by dark green areas.
- Infected plants produce tillers and bear yellowish ears bearing few shriveled seeds.



INTEGRATED MANAGEMENT

1. CULTURAL PRACTICES

- Collateral and alternate hosts, weeds, volunteer and wild crop species harbor pathogen and serve as source of inoculums. Their timely removal helps to control fungal, bacterial and viral diseases.
- Deep summer ploughing, destruction of crop residues and crop rotation with non-hosts help reducing inoculum load of soil-borne diseases (downy mildew, smut, charcoal rot and a few fungal and bacterial leaf diseases).
- Maintaining optimum plant spacing and regulating the amount of nitrogenous fertilizer reduces incidence of afore mentioned diseases.
- Mechanical removal of sclerotia from seeds, by washing in 30% salt water reduces seed contaminated infection of ergot. In seed production plots, ensuring synchrony of flowering between A and R lines avoids the occurrence of ergot.
- Management of smut diseases requires awareness among the farmers. Practice of clean cultivation like collecting smutted heads in cloth bags and dipping in boiling water to kill the pathogen will reduce the inoculum for the next year and minimize incidence.
- Insect acts as vector for many viruses and injects virus inside the plant. Injury caused by insect in plants sometime help many bacteria to enter and cause disease. Insect control, therefore, plays a pivotal role in managing such diseases.

2. RESISTANT CULTIVAR

- Host-plant resistance provides the most economic and environment friendly method of managing millet diseases. For poor farmers it is the only viable practice, as they hardly use any other methods of disease control in millets.
- Resistance sources against finger millet blast are rare in India and Nepal, and they need to be explored in land races from Africa. GPU 28 and GPU 48 is widely used cultivar highly resistant to neck and finger blast.
- Foxtail millet lines GPUS 27, SiA 3039, SiA 3059, SiA 3066, SiA 3088, TNAU 213 and TNAU 235 remain free from brown spot.

3. BIOLOGICAL CONTROL

- Soil-borne diseases of millets), for which adequate host resistance is lacking, use of biocontrol agents are useful.



- Seed treatment with talc formulation of *Pseudomonas chlororaphis* SRB127 reduces disease incidence and increase seed weight.
- Bio-control agents especially strains of *Trichoderma* and *Pseudomonas* are useful for foot rot and sheath rot in small millets.

4. CHEMICAL CONTROL

Chemicals are not generally used for disease management in millet, because of involvement of high cost of chemical and labor. However, sometimes its use in combination with resistant cultivar becomes necessary. Fungicides are mostly used either as seed treatment or foliar spray. However, combination of them gives better management.

- Downy mildew: Seed treatment with Ridomyl-MZ @ 6g/Kg seed followed by one spray of Ridomyl-MZ @ 3g/L reduces incidence.
- Loose and covered smuts: Seed dressing with sulphur (@ 4g/Kg seed).
- Banded sheath blight: Seed treatment with propiconazole (@ 1 ml/Kg seed).
- Blast: Spraying Carbendazim (@ 0.1% a.i.) or Tricyclazole (@ 0.05% a.i.) or Combination of Mancozeb 63% + Carbenadzim 12% is recommended.
- Rust: Foliar spray of Mancozeb @ 0.2% effectively controls the rust.
- Insect vector: Spraying of Imidachlorprid @ 1.5 ml/ L effectively reduce population of leaf hopper and decrease incidence of viral disease.



SECTION - 13

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SCOPE OF MECHANIZATION OF MILLET CROPS FOR SMALL FARMERS IN ODISHA

Mechanization in agriculture has gained considerable significance today, since shortage of labour in critical periods of crop production system and hike in labour cost pose serious threats to the growth of agrarian sector in the state and the country. Incidentally, mechanization accounts for reduction in labour, cost and drudgery involvement in different field operations. However, it is also equally important that it facilitates to increase the cropping intensity. Mechanization has further opened a lot many avenues which almost guarantee the farmers to earn more by cutting down the cost of cultivation and ensuring better quality of field operation that leads to higher production and productivity. Of late, the agricultural sector in the state and country has gone sea-change during the post green revolution era; in fact, it has articulated the country self-sufficient despite the burgeoning population growth. Since the availability of cultivable land per person cannot but decrease and the climate change is quite a matter of concern; the productivity must maintain a rising trend and so also the economy of the agrarian sector. Furthermore, the increase in population and our social stigma for division of land from generation to generation is reducing the land availability per person and as a result, more than 86% of land holdings in the country fall under small and



marginal category. The Odisha condition is also very similar and about 90 percent of land holdings in the state fall under small and marginal category and the percentage of small and marginal holdings is bound to increase in future. This situation indicates that it may not be feasible to go for high-end mechanization in many parts of the state; rather, mechanization for the small and marginal farmers needs to be augmented with concerted efforts.

The millet crops, which were by far and wide being considered as poor man's crops, have become an integral part in rich man's diet in our urban society due to their health benefits. The millets constitute many nutrients, vitamins and have been the livelihood support for the tribal farmers in many areas. The millet crops are usually grown in rainfed condition without much attention. During recent past, the farmers were shying away from the millet crops which had never been considered remunerative. However, considering the importance of cereals for nutrition supplementation of foods, the millet crops are renamed as Nutri-cereals and farmers are encouraged for cultivation of these crops with handsome support for its cultivation and then through procurement by the governments at state and national level. The Odisha Millet Mission[®] has been in operation in the state since last two years in fifteen districts such as Gajapati, Kandhmal, Rayagada, Koraput, Mayurbhanj, Ganjam, etc. and working extensively for millet farming and value addition for increasing the income of millet farmers and making more millets available for consumption.

While the initiatives have certainly enthused the farmers for millet farming, it is imperative to incorporate some mechanization aspects so that the cost of cultivation can be further reduced to imbibe a certain impetus to the growth of nutri-cereals at farm level. Considering that these districts are dominated by small and marginal farmers to the extent of more than ninety percent, small farm mechanization has got huge relevance in this regard which includes improvement of technologies operated by human and animal power. To support the small farm mechanisation, initiatives have already been taken up at OUAT to develop agricultural implements suitable for primary tillage, secondary tillage, sowing, weeding, threshing and winnowing. The All India Coordinated Research Project on Utilization of Animal Energy (Funded by ICAR) operating under OUAT has been playing a prime role for the development and popularization of improved animal drawn implements in the state. The Centre and the College have developed some machineries, which are under commercial mass production by the SSI (Small Scale Industry) units under Government of Odisha, available for farmers of the state with subsidy. These include OUAT Improved Yoke, mould board plough and single row/five row multi crop seed cum fertilizer drill, which are useful for line sowing of finger millet, small millet, sorghum etc. Recently, the CIAE three row seed cum fertilizer drill was procured from CIAE, Bhopal and was evaluated in farmers' field in Gajapati and Mayurbhanj districts in collaboration with the concerned Krushi Vigyan Kendras and NGOs. Further research is under progress to modify this implement to make it adoptable among the farmers of the state. Line sowing of the millet crops would be accomplished at lower cost, less time and drudgery by using the seed drill which will further ensure optimum plant population in the field followed by better crop growth and yield as compared to the conventional method of sowing behind the plough.





Demonstration of OUAT bullock drawn single row seed cum fertilizer drill for line sowing of sorghum in farmers' field at village Sukhilaamba, Mohana, Gajapati.



Demonstration of CIAE three row seed drill for line sowing of little millet in Jasipur, Mayurbhanj in collaboration with KVK, Mayurbhanj I and Odisha Millet Mission



A good number of post-harvest gadgets such as OUAT Ragi thresher cum pearler, small millet thresher and sorghum thresher-cum-cleaner have been developed through this project which are generally operated by 1.0 hp electric motor. These machines can also be operated by bullock power in rotary mode. The performance of these machines in farmers' fields have been found to be satisfactory. The output of the OUAT ragi thresher cum pearler has been found to be 90 kg.h^{-1} with 93.5 % threshing efficiency and 92.4% cleaning efficiency as compared to output of 5-6 kg.h^{-1} in conventional method of manual hand beating and winnowing by kula. The cost of threshing by this machine is found to be Rs 0.33 per kg as compared to Rs 5.00 per kg in conventional method. A local manufacturer has also been issued a Non-Exclusive License for three years for manufacture of the equipment and thus it is available in the market. A patent application has also been filed for the OUAT ragi thresher cum pearler (Ref. Application no 201831041879 File Application No TEMP/E-1/45619/2018-KOL).



Dr. M. Muthukumar, IAS, Director, Agriculture, Govt. of Odisha, witnessing the performance of the OUAT Ragi thresher cum pearler in CAET premises.





Demonstration of the OUAT ragi thresher cum pearler in farmers' field (Village: Chandiput, Gajapati)



Demonstration of Sorghum thresher cum cleaner operated by bullock power in rotary mode in CAET premises



Demonstration of little millet thresher in CAET premises to the farmers from Mohana, Gajapati district

Recently, two more machines, viz. little millet thresher and sorghum thresher-cum-cleaner have also been developed through this project for threshing and cleaning of little millet and sorghum, respectively. These machines are operated by 1.0 hp electric motor and can also be operated by bullock power in rotary mode. The output of the little millet thresher is around 40 kg.h^{-1} as compared to $5-6 \text{ kg.h}^{-1}$ in conventional manual hand beating method. Similarly, the output of the sorghum thresher cum cleaner has been found to be around 110 kg.h^{-1} as compared to $12-15 \text{ kg.h}^{-1}$ in conventional manual hand beating method. The most important advantage of these three threshers is the better hygienic quality of product, which ensures higher market value and thus higher economic benefit to the small and marginal farmers.

In the meanwhile, an efficient bullock operated rotary system has also been developed at OUAT, where the mechanical efficiency of the system would increase; thus the versatility of this technology would be immensely improved. The efficient utilization of rotary system on community basis will certainly increase the annual use of the bullocks which will reduce the burden of their maintenance cost.

A good number of capacity building programmes, field demonstrations, farmers' fair are also being organised throughout the state for creating awareness about the various technologies in relation to millet crops and their advantages over conventional methods in collaboration with the Krishi Vigyan Kendras, Line department and NGOs. The small and marginal tribal farmers of the state are to be immensely benefited in future with respect to higher output and lower cost of operation with better hygienic quality and huge reduction in drudgery. The cost benefit ratios of the millet crops are bound to improve, which will make these crops sustainable and economically viable for the small and marginal farmers



SECTION - 14

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PROCESSING AND VALUE ADDITION OF NUTRI-CEREALS (MILLETS)

Millets, the small-seeded cereal crop of the Graminae family, are harvested for human food or animal feed. The most prominent and well known millets are the sorghum (*Sorghum vulgare*) and pearl millet (*Pennisetum glaucum*). These two millets account for the majority of millet grain produced around the world. The rest of the millets, often referred to as the small or minor millets include finger millet (*Eleusine coracana*), barnyard millet (*Echinochloa colona*), foxtail (*Setaria italica*), proso (*Panicum miliaceum*), kodo or ditch millet (*Paspalum scrobiculatum*) and little millet (*Panicum sumatrense*). Among these, kodo, foxtail, proso (common millet), little and barnyard millets are the smallest one. Essential similarities of the members of this group of species are the resilience and ability to thrive in harsh environments, along with nutritious seed content. Millets are a group of highly variable small-seeded grasses, widely grown around the world as cereal crops or grains for fodder and human food. Millets are grown spontaneously or cultivated in almost all countries for use by humans as food grains and also as fodder for animals. Millets are indigenous to many parts of the world; it is believed that they had an evolutionary origin in tropical western Africa, as that is where the greatest number of both wild and cultivated forms exist. Millet crops



are still the principal sources of energy, protein, vitamins and minerals for millions of the poorest people in these regions. Therefore, they are mostly consumed by disadvantaged groups; they are often referred to as “coarse grain” or “poor people’s crop”. They are not usually traded in the international markets or even in local markets in many countries.

India is the leading producer of millets accounting for about 80% of the global millet production (Food and Agricultural Organization (FAO), 2015). India continues to be the single largest producer of pearl millet and second largest producer of sorghum in the world. Millets are cultivated in low-fertile land, mountainous, tribal and rain-fed areas. These areas include Andhra Pradesh, Chhattisgarh, Gujarat, Haryana, Madhya Pradesh, Rajasthan, Maharashtra, Karnataka, Uttar Pradesh, Tamil Nadu and Telangana.

Recently, Indian Government has renamed the millets and two pseudomillets as ‘Nutri-Cereals’. The move is aimed at removing a lingering perception that these grains are inferior to rice and wheat, even as their health benefits are larger. In a notification, the agriculture ministry said, “the central government hereby declares millets comprising Sorghum (*Jowar*), Pearl Millet (*Bajra*), Finger Millet (*Ragi/Mandua*), Minor Millets — Foxtail Millet (*Kangani/Kakun*), Proso Millet (*Cheena*), Kodo Millet (*Kodo*), Barnyard Millet (*Sawa/Sanwa/ Jhangora*), Little Millet (*Kutki*) and two Pseudo Millets - Black-wheat (*Kuttu*) and Amaranthus (*Chaulai*), which have high nutritive value as “Nutri Cereals” for production, consumption and trade point of view.” In botanical terms, amaranth and buckwheat are not true cereals. Most cereals (e.g. wheat, rice, barley) are monocotyledonous whereas the pseudocereals are dicotyledonous plants. They are referred to as ‘pseudocereals’, as their seeds resemble in function and composition those of the true cereals. To popularize the consumption of these nutritious cereals, the government has already decided to include millets in the Public Distribution System (PDS) with the objective of improving nutritional security of the country.

The increasing significance and shift towards coarse cereals is also evident from various government schemes and policies. Out of the five components of National Food Security Mission during 12th Five Year Plan, NFSM-Coarse cereals is one of them. The National Food Security Mission, in its 12th Five Year Plan, has set new targets of 25 million tons additional production of food grains encompassing 10 million tons rice production, 8 million tons wheat, 4 million tons pulses and 3 million tons production of coarse cereals by the end of 12th Five Year Plan. One of the objectives of NFSM - Increasing production of coarse cereals through area expansion and productivity enhancement in a sustainable manner in the identified districts of the country is also an indicator of increasing importance of this group of food grains.

Millets are important crops for dry land farmers. They are highly nutritious and climate compliant crops. But due to drudgery in preparation, their consumption is decreased over the years in India. In order to revive the demand of millets in India, there is need to enable to bring all the stakeholders in production to consumption system value chain on a common platform and link poor dry land farmers with market and the consumers at large. The crop is favoured due to its productivity and short growing season under dry, high-temperature conditions.



NUTRITIONAL COMPOSITION OF MILLETS

Millets possess unique nutritional characteristics and specifically have complex carbohydrates, rich in dietary fiber as well as unique in phenolic compounds and phyto-chemicals boasting of medicinal properties. Millets are nutritionally comparable to major cereals and serve as good sources of protein (Table 1), micronutrients and phytochemicals. Being non-glutinous, millets are safe for people suffering from gluten allergy and celiac disease. As millets are gluten free, they could be useful dietary cereals. They are non-acid forming and hence easy to digest and are also non-allergenic. Millets complement well with lysine-rich vegetable (leguminous) and animal proteins and form nutritionally balanced composites of high biological value. The millets are nutritionally comparable or even superior to major cereals such as wheat and rice, owing to their higher levels of protein with more balanced amino acid profile (good source of methionine, cystine and lysine) and hence these are rightly termed as 'nutricereals'. Their high fibre content with its health benefit such as good bowel movement, and reduction in blood cholesterol and sugar has also contributed to their increasing demand. Besides fibre, these coarse cereals are also rich in health-promoting phytochemicals like polyphenols, lignans, phytosterols, phyto-oestrogens, phytocyanins. These function as antioxidants, immune modulators, detoxifying agents etc. and hence protect against age-related degenerative diseases like cardiovascular diseases (CVD), diabetes, cancer etc. (Rao et al, 2011).

Millets are rich sources of insoluble (IDF) and soluble (SDF) dietary fiber and has comparable or even higher total dietary fiber (TDF) than other cereals. Millets generally contain significant amounts of essential amino acids (Table 2), particularly sulphur containing amino acids and provides higher amounts of methionine-an amino acid that is deficient in most grains, giving millet a valuable place in a vegetarian diet. Finger millet proteins are unique because of the sulphur-rich amino acid contents. In general, cereal proteins, including millets, are limited in lysine and tryptophan content and vary with cultivar. The Lipids are concentrated in the germ, pericarp and aleurone layers of the millet grain. The essential fatty acids like linoleic, oleic and palmitic acids found in free form and monogalactosyl diacylglycerols, digalactosyl diacylglycerols, phosphatidylethanolamine, phosphatidyl serine and phosphatidyl choline in the bound form present in millets (Bagdi A, et al., 2011). The niacin content in pearl millet is higher than all other cereals. Kodo millet is rich in B vitamins, especially niacin, pyridoxine and folic acid. Sorghum and millets, in general, are rich sources of B-complex vitamins. Some yellow-endosperm varieties of sorghum contain β -carotene, which can be converted to vitamin A by the human body. Detectable amounts of other fat-soluble vitamins, namely D, E and K have also been found in millets. Millets are generally not a source of vitamin C. On germination, some amount of vitamin C is synthesized in the grain and on fermentation there is a further rise in the vitamin.

Millets contain substantial quantities of several minerals, including calcium, iron, potassium and magnesium. Finger millet is the richest source of calcium (300-400 mg/100 g) and other small millets are good source of phosphorous and iron. Sorghum is considered a good source of potassium and is practically devoid of sodium. Black finger millet contains approximate 1830 μ g/g of magnesium (Glew et al; 2008), while normal finger millet has about 130 mg/100g of magnesium (Amir Gull, 2014).



Table 1: NUTRITIONAL COMPOSITION OF CEREALS AND MILLETS (PER 100 G EDIBLE PORTION; 12% MOISTURE)

Cereals	Protein (g)	Fat (g)	Total minerals (g)	Crude fibre (g)	Carbohydrates (g)	Energy (kcal)	Calcium (mg)	Iron (mg)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)
RICE (BROWN)	7.9	2.7	1.3	1.0	76.0	362	33	1.8	0.41	0.04	4.3
WHEAT	11.6	2.0	1.6	2.0	71.0	348	30	3.5	0.41	0.10	5.1
MAIZE	9.2	4.6	1.2	2.8	73.0	358	26	2.7	0.38	0.20	3.6
SORGHUM	10.4	3.1	1.6	2.0	70.7	329	25	5.4	0.38	0.15	4.3
PEARL MILLET	11.8	4.8	2.2	2.3	67.0	363	42	11.0	0.38	0.21	2.8
FINGER MILLET	7.7	1.5	2.6	3.6	72.6	336	350	3.9	0.42	0.19	1.1
FOXTAIL MILLET	11.2	4.0	3.3	6.7	63.2	351	31	2.8	0.59	0.11	3.2
COMMON MILLET	12.5	3.5	3.1	5.2	63.8	364	8	2.9	0.41	0.28	4.5
LITTLE MILLET	9.7	5.2	5.4	7.6	60.9	329	17	9.3	0.30	0.09	3.2
BARNYARD MILLET	11.0	3.9	4.5	13.6	55.0	300	22	18.6	0.33	0.10	4.2
KODO MILLET	9.8	3.6	3.3	5.2	66.6	353	35	1.7	0.15	0.09	2.0
OATS	17.0	6.0	2.6	11.0	66.0	390	54	4.7	0.22	0.12	3.2

Source: Kaur K D et al, 2012

Table 2: ESSENTIAL AMINO ACIDS IN CEREALS AND MILLETS (G/100 G OF PROTEIN)

Amino acids	Finger Millet	Kodo Millet	Proso Millet	Foxtail Millet	Barnyard Millet	Wheat	Rice
ISOLEUCIN	4.4	3	8.1	7.6	8.8	3.3	3.8
LEUCINE	9.5	6.7	12.2	16.7	16.6	6.7	8.2
LYSINE	2.9	3	3	2.2	2.9	2.8	3.8
METHIONINE	3.1	1.5	2.6	2.8	1.9	1.5	2.3
CYSTINE	2.2	2.6	1	1.6	2.8	2.2	1.4
PHENYL ALANINE	5.2	6	4.9	6.7	2.2	4.5	5.2
TYROSINE	3.6	3.5	4	2.2	2.4	3	3.9
THREONINE	3.8	3.2	3.2	2.7	2.2	2.8	4.1
TRYPTOPHAN	1.6	0.8	0.8	1.0	1.0	1.5	1.4
VALINE	6.6	3.8	6.5	6.9	6.4	4.4	5.5
HISTIDINE	2.2	1.5	1.9	2.1	1.9	2.3	2.4

Source: FAO, 1970



HEALTH BENEFITS

Consumption of millets has been reported to be beneficial in many physiological disorders such as celiac disease, diabetes, obesity, cardiovascular diseases, Cancers, Constipation, Anemia etc.

CELIAC DISEASE (GLUTEN SENSITIVITY)

Celiac disease is also known as celiac sprue, non-tropical sprue, and gluten-sensitive enteropathy. Celiac disease is an autoimmune disease, where the immune system starts attacking normal tissue, particularly the inner lining tissue of the small intestine, in response to eating gluten- the wheat protein. The exact cause of celiac disease is not clear, but it known to have a genetic (inherited) component. Only wheat flour is required to be restricted and there should be no permanent damages caused by it. Millets and minor millets are safe cereals for celiac patients due to non-existence of gluten.

DIABETES

Diabetes has become a highly problematic and increasingly prevalent disease worldwide. Dietary management of diabetes involves the reduction of postprandial hyperglycaemia and good glycaemic control. Heredity, obesity, stress, and a general lack of physical activity are some of the causes for diabetes. The consumption of millet-based food items produce the lowest post-prandial glucose levels after a meal. Thus millets make a good substitute for rice for Type II diabetics. Millet's high fiber content slows digestion and releases sugar into the bloodstream at a more even pace. This helps diabetics avoid dangerous spikes in blood sugar that lead to glucose spilling over into the urine, known as glucosuria. Millet is also a good source of B vitamins, which are important for carbohydrates metabolism.

OBESITY

Millets are rich in dietary fiber and has unique physical and chemical characteristics like bulk to the diet, viscosity, water holding and absorption capacity, which determine the subsequent physiological behavior. The diet with high dietary fiber increase satiety thereby reducing the risk of over eating.

CARDIOVASCULAR DISEASES

Cardiovascular disease generally refers to conditions that involve narrowed or blocked blood vessels that can lead to a heart attack, chest pain (angina) or stroke. Other heart conditions, such as those that affect the heart's muscle, valves or rhythm, also are considered forms of heart disease. Millets are good sources of magnesium that is known to be capable of reducing the effects of migraine and heart attack. These are rich in phyto-chemicals containing phytic acid, which is known for lowering cholesterol. Tannin content of millets is also beneficial in lowering cholesterol.



CANCERS

This disease is due to growth of cells. Millets are a major source of dietary fiber and contain germ, endosperm and bran, in contrast with refined grains, which contain only the endosperm. Whole grains or partially dehulled millets are a major source of several vitamins, minerals, and phyto-chemicals, which have anti-cancer properties and could plausibly reduce the risk of colorectal cancer by several potential mechanisms. Millets are rich sources of fermentable carbohydrates (resistant starch), which are converted by the intestinal bacteria into short-chain fatty acids that help to protect against colon cancer in the gut.

CONSTIPATION

Constipation refers to a disease in bowel movements or difficulty in passing the stool. In some cases, diarrhoea can be considered a form of constipation. Constipation can lead to diverticular disease and hemorrhoids, not to mention a wide variety of ailments. Millet is abundant in dietary fiber, whose 40-50g intake of each can help in reducing constipation. Adequate dietary fiber can be achieved by consuming about two to three servings of whole grains/ millets and around five servings of fruits and vegetables per day.

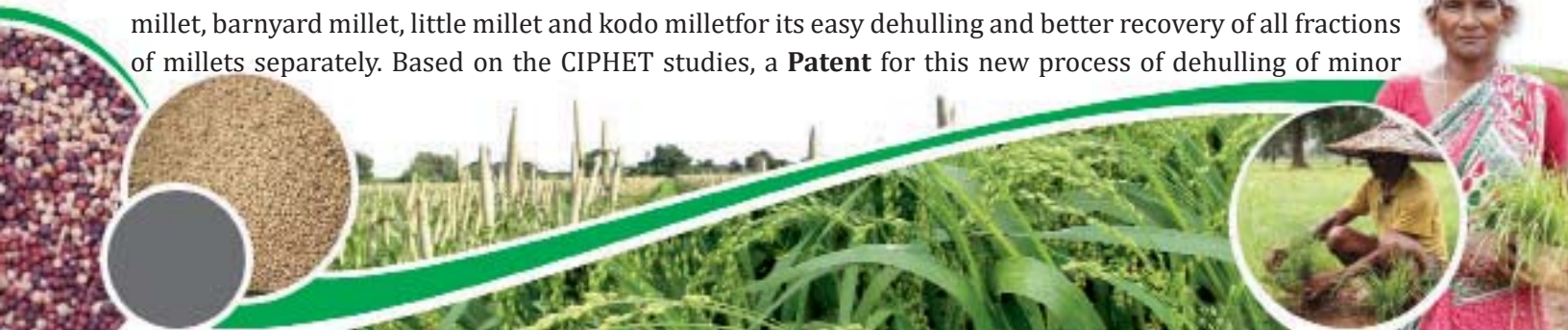
ANEMIA

Anemia is a decrease in the total amount of red blood cells (RBCs) or hemoglobin in the blood, or a lowered ability of the blood to carry oxygen. Dietary intervention using millets can aid in preventing anemia due to being rich in iron content.

PROCESSING OF NUTRI-CEREALS

The primary processing of nutri-cereals includes harvesting, threshing, winnowing followed by storage. The large cereals are often cut at the top of the stalk while the smaller/ minor millets are cut at the base (Reddy 1997; Harvey and Fuller 2005). As a result, minor millets require more intensive labour for processing, and more processing stages. The processing of the coarse cereals is also influenced by the utilization pattern of these cereals and these uses in turn are influenced by cultural traditions of food consumption and taste.

Primary processing i.e. milling to remove the outer bran (pericarp) of the grain is the most common way to process the coarse cereals and millets, a technique similar to those seen in case of rice, which lightens the colour and lead to faster cooking of softer products (Malleshi 1989). The conventional processes for milling millets involve dehulling of the seeds using pearler and then grinding the pearled seeds using burr mill. After dehulling, the mixture separated from endosperm by aspiration comprises of hull, bran, germ and also a portion of endosperm in form of brokens and powder, which goes as waste. ICAR-CIPHET, Ludhiana had carried out detail studies on primary processing of minor millets namely including proso millet, foxtail millet, barnyard millet, little millet and kodo millet for its easy dehulling and better recovery of all fractions of millets separately. Based on the CIPHET studies, a **Patent** for this new process of dehulling of minor



millets has also been granted to ICAR-CIPHET titled as 'A new process for milling of coarse cereals and millets to get refined powder' in 2018.

VALUE ADDITION OF MILLETS

The presence of all the required nutrients in the millets makes them suitable for large-scale utilization in the manufacture of various food products, e.g. bakery products, baby foods, snack foods, dietary foods, etc. in both grain and flour form. The millets lack gluten and hence can be utilized in health foods for celiac disease patients in form of gluten free products. Despite these attributes, millets are losing their pride of place in production and consumption in India. In recent years, there has been some effort towards reviving the use of millets and now millets are getting popular among health conscious consumers.

CONVENTIONAL FOOD PRODUCTS

Roti (unleavened pan cake), *mudde* (dumpling) and porridge are the food products usually prepared from these millets. For preparing *roti*, the flour is mixed with hot water to partially gelatinize the starch. This imparts the necessary binding of particles and helps to roll the dough into thin sheets. The flattened dough is baked on a hot plate. *Roti* resembles the wheat *chapati* or maize tortilla. *Mudde* from millet flour is prepared by steaming the dough and making it into balls. ICAR-CIPHET, Ludhiana had also carried out some studies on traditional foods, which are summarized hereunder.

PEARL MILLET INCORPORATED SATTU

Pearl millet incorporated *sattu* can be prepared from the roasted pearl millet with bengal gram. The optimum condition for roasting of pearl millet at 180°C for 60 seconds followed by slight pearling and grinding. Roasted pearl millet at 10% level with bengal gram (90%) may be considered for good sensory acceptability (>7.0 score at 9 point hedonic scale). The protein, fat and total mineral content of this sample was found as 25.27%, 5.52% and 3.05%, respectively.

FINGER MILLET INCORPORATED SATTU

Finger millet incorporated *sattu* can be prepared from the roasted pearl millet with bengal gram. The optimum condition for roasting of finger millet at 180°C for 45 seconds followed by slight pearling and grinding. Roasted finger millet at 10% level with bengal gram (90%) may be considered for good sensory acceptability (>7.0 score at 9 point hedonic scale). The protein, fat and total minerals content of this sample was 25.11%, 5.31 and 3.1%, respectively.

SORGHUM INCORPORATED SATTU

Sorghum incorporated *sattu* can be prepared from the roasted sorghum with bengal gram. The optimum condition for roasting of sorghum at 220°C for 60 seconds followed by slight pearling and grinding. Roasted sorghum at 10% level with bengal gram (90%) may be considered for good sensory acceptability (>7.0



score at 9 point hedonic scale). The protein, fat and total minerals content of this sample was 25.30%, 5.32% and 3.06%, respectively.



Sorghum Flour

Popped Sorghum flour

POPPING

Popping also called as puffing is a processing technique of cereals to prepare ready to eat products, which are crunchy, porous and precooked. This technique improves the taste and flavor of the product. Popped grains can be consumed in many ways as snack. In ICAR-CIPHET, the effect of popping on various quality characteristics of sorghum flour was studied. It was observed that popping decreased the bulk and true densities of sorghum flour with increased water absorption and solubility index. Popping

significantly increased the *in-vitro* protein digestibility of sorghum upon popping from 40.705 to 48.665%. The protein, fat, total minerals, carbohydrates and crude fiber content of sorghum flour was 8.49%, 2.86%, 1.75%, 81.37% and 2.78%, respectively.

NON-CONVENTIONAL PROCESSING

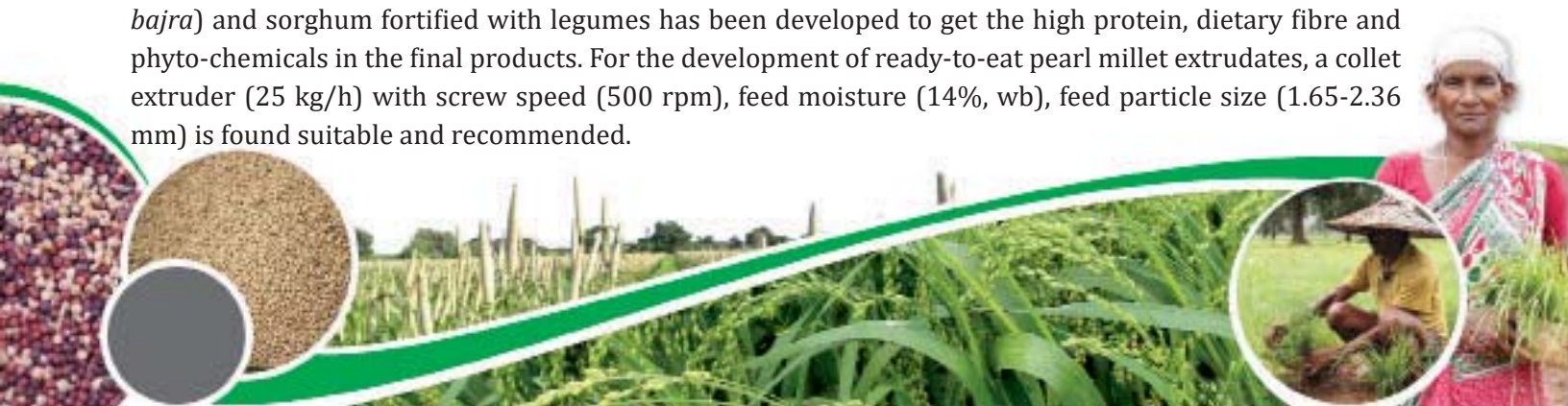
The nutri-cereals are also processed to get variety of food products by applying different processing techniques as follows:

FLAKING

For making flaked products, the pearled/ dehusled millet grains are soaked in water, steamed or cooked under pressure to effect complete gelatinisation of the starch, dried to about 18 per cent moisture and then pressed to requisite thickness between heavy duty rollers. These are then dried to prepare flakes. Flakes hydrate quickly when added to warm water or milk and are used to prepare sweet or savoury dishes.

EXTRUSION TECHNIQUE

Extrusion technique is used for making expanded snack food like kuskus and noodle like products by hot extrusion and cold extrusion, respectively. ICAR-CIPHET has developed various ready-to-eat products from millets using extrusion techniques. A ready to eat puffed products from pearl millet (commonly known as *bajra*) and sorghum fortified with legumes has been developed to get the high protein, dietary fibre and phyto-chemicals in the final products. For the development of ready-to-eat pearl millet extrudates, a collet extruder (25 kg/h) with screw speed (500 rpm), feed moisture (14%, wb), feed particle size (1.65-2.36 mm) is found suitable and recommended.



MILLETS-SOY BLENDED EXTRUDATES USING whole pearl millet, finger millet and decorticated soy bean blended (millet soy) extrudates formulations using a linear programming model to minimize the total cost of the finished product. The desired formulation was obtained having 81.68% whole pearl millet, 7.02% finger millet and 11.29% decorticated soybean. Acceptable quality extruded snack food was developed using twin screw food extruder at different feed rate 9.5kg/h), screw speed 250 rpm, 14% feed moisture, 120 °C barrel temperature and cutter speed as 15 rpm. The snack food thus prepared was of good eating quality. About 150 g of such snack food would be able to provide about 20g protein and 135mg calcium to the consumers. The same amount can fulfill the half of the protein, one third calorie and about 16 percent of the calcium requirement of a 10 year old child as per the RDA for Indian.

SORGHUM BASED PROTEIN RICH EXTRUDED SNACK

A protein rich extruded snack food utilizing sorghum and pearl millet with maize, legume and sesame seeds has been developed at ICAR-CIPHET, Ludhiana. This study indicated that 16% feed moisture, 120°C barrel temperature, and 300rpm/s screw speed may be considered for development of multigrain based health food using extrusion technique with sensory acceptability score 8.64 at 9 point hedonic scale. This snack food provided 382kcal calories, 2.03g crude fibre, 2.49mg iron, 206mg calcium in 100g sample and 19.27% protein with 67.02% in vitro protein digestibility.

MULTIGRAIN BASED EXPANDED SNACKS

Extrusion variables have been optimized for development of multigrain based expanded snacks with 20% sorghum. The optimized processing conditions for this sorghum incorporated multigrain based snack food were feed moisture 14%; die head temperature 110°C and screw speed 342rpm. The protein, fat, total minerals and carbohydrate content in such snack food were 15.50, 3.19, 2.11 and 75.56%, respectively while calcium and iron contents were 116.62 and 4.27 mg/100 g, respectively. The expanded snack had 72.11 % in vitro protein digestibility and energy as 377 kcal/100 g.

PEARL MILLET BASED EXTRUDATES

Pearl millet (95%) with 5% whey protein concentrate (WPC) extrudates can be prepared following extrusion conditions as screw speed 350rpm, feeder speed 23rpm, feed rate 10.5kg/h, and 120°C die head temperature and using food extruder. The protein, fat, and carbohydrate content in such product were 12.4, 14.3, and 67.18 %, respectively with 44.7 mg/100g, 6.6 mg/100g and 208 mg/100g calcium, iron and phosphorus content, respectively.



Pearl millet based composite pasta



Pearl millet-WPC extrudates



SORGHUM INCORPORATED NOODLES

Sorghum incorporated noodles can be prepared using sorghum flour up to 10-20% with mean overall sensory acceptability score more than 7.0 at 9 point hedonic scale.

PEARL MILLET BASED COMPOSITE PASTA

Pearl millet and barley flour were used as base material for pasta preparation. Whey protein concentrate was also added to improve the colour and protein content of this pasta product. Pearl millet flour 1kg, 138g barley flour, 122.7g whey protein concentrate and 276 ml water with some amount of CMC are required for development of good quality **pearl millet based** pasta. The protein, fat, and carbohydrate content in such pasta product were 16.5, 2.9, and 78.6 %, respectively with calcium, iron and phosphorus content as 98.5 mg/100g, 5.4 mg/100g and 315.5 mg/100g, respectively.

VEGETABLE BLENDED PEARL MILLET BASED COMPOSITE PASTA

Vegetables are valued mainly for their high vitamin and mineral content and contain valuable food ingredients, which are important to build up, repair the body and maintain alkaline reserve of the body. The incorporation of vegetables into extruded products can provide balanced healthy nutrition. Wheat flour was replaced by 10% pearl millet semolina for preparation of vegetables incorporated pasta to improve mineral content and 5% WPC to enhance protein content of pasta and developed with varied amount of vegetable juices.



Vegetable blended Pearl millet- composite pasta



Barnyard millet based gluten free muffins

MILLET BASED BAKED PRODUCTS

Baking technique is currently being employed for making numerous coarse cereals based bakery products viz. bread, biscuits, cakes etc. ICAR-CIPHET, Ludhiana has studied the potential of millets in different bakery products such as biscuits, muffins etc. **Pearl millet based biscuits** can be successfully developed using pearl millet flour up to 30% levels with 5% defatted soy flour (DSF) in



the flour blend. **Sorghum soy blended biscuits** can be developed using pearled sorghum flour up to 40% levels with refined wheat flour and 5% DSF with other important food materials. The Institute developed the process for developing **barnyard millet based gluten free muffins** without using any wheat flour with very good sensory acceptability and baking quality.

INSTANT FOOD FORMULATIONS

Several millet based instant food formulations has been developed at ICAR-CIPHET, Ludhiana. To harness the potential of pearl millet, *Upma*, *Halwa* and complementary mixes were developed.

Being, a high energy and protein diet, pearl millet dry mixes can be used in mid-day meals and other feeding programmes.



Pearl millet instant **upma** dry mix



Pearl millet instant **halwa** dry mix



Complementary mix

NUTRITIONAL COMPOSITION OF PEARL MILLET BASED INSTANT DRY MIXES

Nutritional value	Upma dry mix	Halwa dry mix	Complementary mix
Fat (g/100g)	29.5	18.3	9.8
Protein (g/100g)	6.7	4.6	14.7
Carbohydrate (g/100g)	62.9	72.8	67.9
Calcium (mg/100g)	16.3	11.5	354
Iron (mg/100g)	4.3	3.1	5.9
Phosphorus (mg/100g)	129.7	91.2	251.2



CONCLUSION

Today, nutri-cereals are seen as minor crops, except some, that are often used as a food for the poor or fodder for animals. Europeans and American are most familiar with millets in bird seed. However, several initiatives and schemes has contributed in making the world aware of importance and enormous nutritional potential of coarse cereals due to which these are increasingly making their own demand among consumers. The improved processing techniques and diversified health food and functional foods made thereof has opened there opportunities for more utilization in food processing sector. There is still need to further popularize these nutri-cereals and increase their demand by various ways viz. (i) Creating awareness regarding their environmental sustainability, nutritional and other health benefits, (ii) Making them available through PDS, (iii) Value addition, and (iv) Inclusion under feeding programmes like mid-day meal etc.

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SECTION - 15

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DEVELOPMENT OF VALUE CHAIN IN MILLETS: VALUE ADDITION AND ENTREPRENEURSHIP (Development of Nutri cereals)

INTRODUCTION

The value chain encompasses full range of activities that are required to bring the product or services through intermediate's phases from production to final consumers. The activities of the value chain include raw material supplies, processing, marketing, distribution and support to final end user in the market place where the markets could be local, regional, or global (Kapinsky and Morris, 2001; 2008). The value chain approach helps to understand the dynamics of value creation at different stages of the value chain. Value chain analysis is a powerful tool for understanding the key determinants of competitiveness (Kapinsky, 2000).

The value-chain network may be defined as a range of activities that are required to bring a product from its conception, through its designing, sourcing of raw materials and intermediate inputs, marketing and distribution to the final consumer. Millet-value chains encompass activities that take place at various levels (farm, rural and urban), starting with input supply and continuing through product handling, processing, distribution and recycling. As products move successively through the various stages, transactions take place between multiple chain actors, money and information are exchanged and value is progressively added (Da Silva and De Suza Filho, 2007).



The traditional way of food production is being replaced by practices more akin to manufacturing processes, with greater co-ordination across farmers, processors, retailers and other stakeholders in the value chain. Moreover, the value addition and efficient marketing determine the success of most of the production-oriented development programmes. Therefore, particularly in the farming sector where farmers are dependent on many external agencies and marketing of the produce is not well planned, the profit margins are under severe pressure, often resulting in failures. The problems of small farmers are lower scale of operation, outdated technologies, lack of financial support, poor information and communication linkages with the market and exploitation by the middlemen. Small farmers are heavily exploited by series of intermediate traders, while procuring agricultural inputs as well as while marketing their fresh produce.

The agricultural inputs required by small farmers being small in quantity, they tend to procure from local traders, which is about 20-30% higher than the price paid by large farmers, who procure larger quantities. They further suffer due to inferior quality of the inputs and delay in procurement. High cost of borrowing may further increase the cost of these inputs.

Lack of appropriate technology is another major problem of small farmers. Firstly, it takes a longer time for small farmers to collect information on new technologies and inputs which have the potential to increase production. Secondly, small farmers being resource-poor and semi-literate, they are very hesitant to invest in new technologies, which are expensive and uncertain. There are many examples of new varieties which promise very high yield but fail to meet the expectation either due to uncertain weather conditions or newly emergent pests and diseases. Often, small farmers are not able to procure critical inputs well in time, resulting in significant drop in the yield. The overall objective is to deliver maximum value to the end user for the least possible total cost and create a competitive advantage. Hence a value chain model is needed in agricultural system.

VALUE CHAIN DEVELOPMENT IN NUTRI CEREALS

Millet is a common term to categorize small-seeded grasses that are often termed Nutri-cereals or dry land-cereals. It mainly includes sorghum, pearl millet, finer millet and small millets (proso millet, foxtail millet, barnyard millet, kodo millet and little millet). They are adapted to harsh environment of semi-arid tropics. They require low or no purchased inputs, thus they are backbone for dry land agriculture. Shelters, thus, are known for whole plant utilization. Despite of all these, area under millets has declined due to higher demand and profitability of competing crops (Seetharama *et al.*, 2007). Although millets are being nutritiously rich, the consumption of it is declining significantly (Dayakar *et al.*, 2010). To augment the production and consumption of millets, value chain model is needed. Mackay *et al.* (1997) defined value chain analysis as the study of a full range of activities that are required to bring the product or services through intermediate's phases from production to final consumers. But according to Sturgeon (2001),



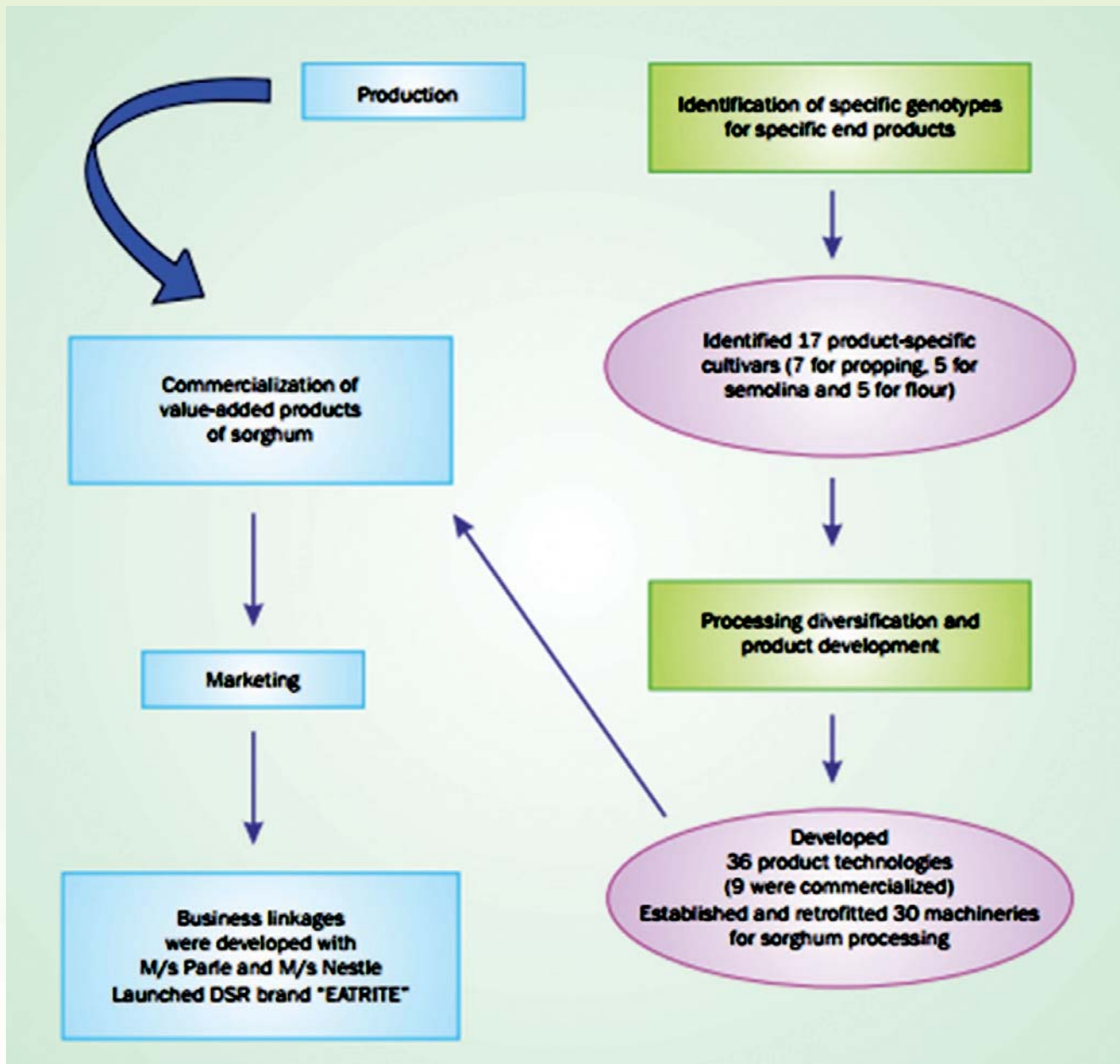


Fig.1. Value chain in millets - NAIP

value chains have three dimensions, namely organizational, spatial and the type of actors involved. From the organization aspect, value chains are both complex and dynamic or simple, depending on their sustained supply of a variety of critical inputs, i.e., human resource requirements, capital equipment and services. The second dimension is spatial which involve some value chains that are global and are sometimes referred to as “global commodity chains” because they operate at international levels. The third dimension is the actors involved in the value chain; these involve the firms that participate in the chain. These actors can either be producers (in the case of the agricultural production value chain), suppliers, retailers/wholesalers or lead firms (Sturgeon, 2001). *A case study of the complete millets value chain is provided below.*



Millet is a generic term used for small “coarse” grains which are heterogeneous grasses (Weber, 1998). Sorghum (*Sorghum bicolor*), pearl millet (*Pennisetum glaucum*) and a group of six small millets together constitute the millets family. Millets cultivation offers chief support to rain fed farming on which 60% of Indian farmers depend. Millets cultivation in India covers an area of 15 million ha with annual production of 16.77 million tons. However, there is drastically reduce in area over the year due to inconvenient, cumbersome and time-consuming preparation of food from millets, lack of processing technologies, lack of awareness of nutritional merits and also the government policy of disincentiveness towards millets and favouring of supply of fine cereals at subsidized prices.

In order to revive the demand of millets in India, ICAR-Indian Institute of Millets Research (formerly DSR) led consortium under the NAIP liberal funding, has undertaken interventions to bridge the identified gaps on different aspects of on-farm production, processing diversification, nutritional certification, promotion and marketing of sorghum in the Indian market. The attempt enabled to bring all the stakeholders in production to consumption system value chain on a common platform and link poor dry land farmers with market as well as consumer. In this regard, the IIMR as the lead institute has built linkages with partners NIN, SAUs and ITC, a private institute. Similarly, with DFRL, CFTRI, CIAE and CIPHET.

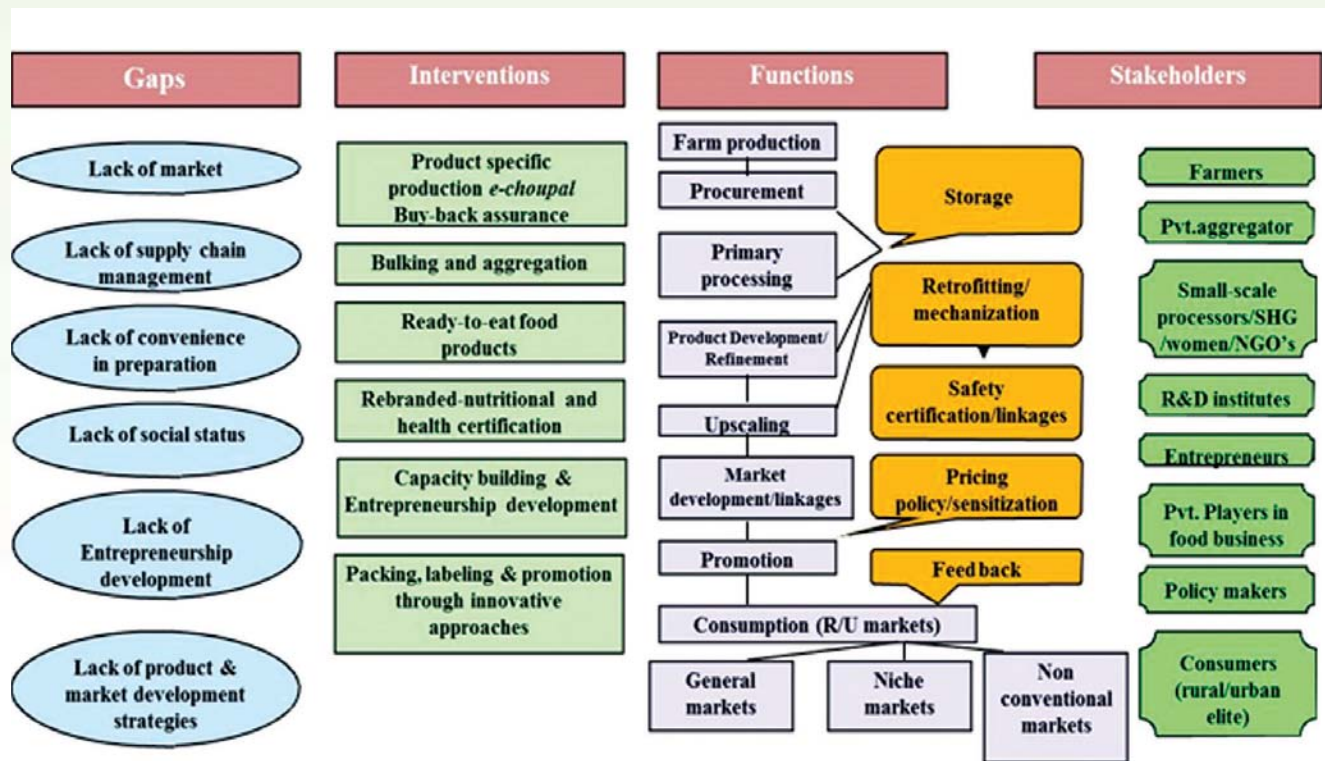


Fig.2. Gaps, Interventions and functions of value chain in millets – NAIP





Fig.3. Successful value chain of millets – IIMR led consortium; Partners: ITC ABD, NIN & PJTSAU (Formerly ANGRAU) an NAIP funded initiative

The individual components of the Millets value chain are:

A) ON FARM MILLET PRODUCTION

The backward integration model of product specific on-farm production covering 3000 acres in Parbhani (rabi) and Nanded (kharif) districts of Maharashtra and Adilabad (kharif for 2 seasons) district in Telangana were tested for 4 successful years under *e-Choupal* market assured model of ITC (ABD). The beneficiaries were technology backstpped by ICAR-IIMR product specific cultivars (more than 12) bringing change in the mindset of farmers on intensive commercial aspects of sorghum cultivation. The recommended package of practices (PoP) for receiving better yield and quality was extended in PPP mode of farm extension services.



The impact is visible through increased farm productivity and assured net incomes over the bench marks determined during the base line survey conducted earlier, which in turn led to shift in allocation of sorghum cultivation from marginal to better soil and water rich environments which is an indicator of stabilization of acreage in the study area.

In fact, backward integration resulted to overall improvement in the crop scenario such as the quality of the produce (sorghum grain), better utilization of fallow land, and commercial colour to the crop through sustainable linkage among all the stakeholders in the value chain.

B) VALUE ADDITION THROUGH PROCESSING INTERVENTIONS IN MILLETS (IIMR & PJTSAU)

One of the major reasons for declined consumption of millets is due to inconvenience in its product preparation. In this regard, interventions through diversification of processing technologies related to millets were attempted to remove the inconveniences and develop, fine tune and standardize sorghum product technologies. For this purpose, the ICAR-IIMR has installed and retrofitted 35 machineries under NAIP. Primary processing and secondary processing methods have been developed and fine-tuned using those equipment and has come out with good quality of more than 50 millets product technologies such as multi grain atta, semolina, flakes, extruded products (vermicelli and pasta), biscuits etc., similarly PJTSAU has come up with another 10 pearl millet and sorghum product technologies. Of which, 9 ICAR-IIMR products and 5 PJTSAU products are targeted for commercialization. Interventions are made to improve the nutritional quality as well as the consumer acceptability of millets. Processing interventions is continuing at ICAR-IIMR to target at niche segment as well as mass marketing at the national level.

FLAKING

The method of preparing flakes from millets is not different from rice. Flakes can make easily by roasting and flaking by flaking machines.



Little millet flakes



Kodo Millet Flakes



COLD EXTRUSION

cold extruded products such as vermicelli and pasta generally made from durum wheat or refined wheat flour. These products also can be prepared with millets with the same machine. Millet suji is used to make vermicelli and pasta by using suitable dies. Mixed material extruded through dies and dried for till the required moisture reach.



Ragi vermicelli



Bajra vermicelli



Kodo millet pasta



Foxtail millet pasta

PUFFING (EXPANDED GRAINS)

expanded rice or murmura is a very popular product. But similar products from other cereals are rare. The reason being preparation of such products need elaborate processing of cereals viz. parboiling and pearling of the grain before subjecting to HTST treatment. Expanded grains of millets are possible by using same method.





Kodo millet puffs



Bajra puffs



Proso millet puffs

HOT EXTRUSION

extrusion cooking and roller drying are highly popular and are largely followed for corn and rice. Millets can also be extrusion cooked to prepare ready to eat products successfully. The products will have crunchy texture and can be coated with traditional spice and condiments. These products being ready to eat nature will have greater scope for use as weaning and supplementary foods.



Extruded snacks



Extruded flakes

BAKING

Biscuits are popular ready to eat products liked by children to old age group in a family. Bakers and home scale industries use the traditional method to preparing biscuits which completely done by hand. The procedure of making biscuits includes creaming (fat and sugar powder) and addition of the millet flour then mixing and making dough, rolling or sheeting, cutting in to biscuits and baking. The process is time consuming, tedious and labor intensive in making the biscuits in large scale. Cake, bun, bread, rusk, muffins, brownie and other bakery items also prepared with millets.





Millet salt cookies



Millet sweet cookies



Ragi cookies

C) NUTRITIONAL EVALUATION AND CERTIFICATION (BY NIN)

The organoleptic study of 20 millet products developed by the ICAR-IIMR conducted by the NIN show that millet products are superior to rice products and on par with wheat based products. This study was followed by nutritional benefits of millet products in diabetes and school children. The studies established millets offer better nutrition in general over the market available products made from wheat, rice and maize. The amino acid profile of pulse (Soy blend) incorporated millet products were containing better amount of lysine, which is limiting factor in millets and also overcome the deficiency of micro nutrients. Glycemic Index of Millet foods was analysed to determine the mean glycemic response for reference and test foods using International standards. The study reported that there was a decrease in the mean incremental area under glucose curve (IAUC) levels after consuming millet products.

D) ENTREPRENEURSHIP DEVELOPMENT

The ultimate goal of Entrepreneurship Development Programmes is to disseminate a thorough knowledge of post-harvest management, which includes linking farmers with markets, processing, the nutritional importance of millets, and marketing. The topics discussed with the stakeholders (progressive farmers, rural entrepreneurs, NGOs, SHGs, small- and medium-scale processors, women and entrepreneurs). Entrepreneurship Development (ED) programme on millets cultivation, processing, and marketing of millet based products was jointly organized by ITC and IIMR with active participation from institutes like IIMR, PJTSAU, NIN and College of Home Science, MAU. Machineries of standardized millet products were demonstrated to the farmers. 2000 Rural women and another 3000 SHGs, farmers, urban entrepreneurs are trained on development in millet food processing.

E) PROMOTION AND POPULARIZATION

ICAR-IIMR launched its own brand as “Eatrite” and the products are popularized as healthy foods while PJTSAU has branded their products as PJTSAU foods. The millets products are fine-tuned and standardized now labelled and branded as health foods based on nutritive value established by NIN studies and targeting separately for urban up marketing (middle and higher income classes) and rural markets. Found a place in



shelf space of retail markets in Hyderabad. Thanks for the promotion which was aggressively undertaken by ICAR-IIMR led consortium on awareness of nutritional merits of millets covering 360 degree communication strategies. For promotion of *Eatrite* products nutritionists/ doctors/ dieticians were sensitized by ICAR-IIMR and for commercial portal ICAR-IIMR launched www.ieatrite.com website.

Simultaneously outsourced the event managers for popularization of millet products (360 degree communication, brand designing logo, etc with BTL and ATL strategies implemented) in urban markets & New age Media. Massive awareness is created on sorghum as health and nutria food through Road shows (100+) in public parks, malls, and institutes etc in Hyderabad and in exhibitions in imparting awareness of millets to across 40000 consumers through fabricated *Jowar* Rath in Pune, Bangalore, Jabalpur, Chennai, Coimbatore, New Delhi etc. Rural consumer drive was undertaken by ITC rural choupal haats to sensitize the convenience and nutritional aspects of the outputs from the sub-project.

F) COMMERCIALIZATION

The pilot commercialization of millets products at Hyderabad starts with launching of ICAR-IIMR brand "*Eatrite*" with a tag line "Eat *Jowar* –stay healthy". The range of products under this brand includes: Millet Rich Multigrain Flour, Millet Semolina, Millet Pasta, Millet Vermicelli, Millet Flakes& Millet Roasted Flakes, and Millet Biscuits/Cookies. In this regard, 5 formats of business plans are commercialized for *Jowar* products evolved under their relative merit assessed in terms of farmers share in the consumer rupee. Suitable packaging, labeling, marketing and pricing strategies are adopted for targeting them to urban markets (IIMR&PJ TSAU). Thus interventions made possible to provide convenient options for consumers among sorghum foods.

G) POLICY SENSITIZATION

The success story of millets value chain in PPP mode has captured the attention of high profile scientists and agricultural policy makers of the country. The importance of millets have been spoken of in popular TV channels besides giving presentations during important national seminars and conferences such as AERA conference, AMA conference and so on besides NAIP and ICAR meetings. Created awareness through participation in several exhibitions both national and international and setting up *Eatrite* Sales counters at NAFED outlets, Krishi Bhavan, NASC Complex, New Delhi.

In order to draw the attention of the policy makers with regard to millets, the IIMR in collaboration with DMD, Jaipur and NIRD, Hyderabad conducted a National Seminar on Millets in November, 2010. The seminar was ultimately followed by Brainstorming Session in which a task force on millets promotion was set up. Consequently, Initiative for Nutritional and Food Security through Intensive Millets Promotion (INSIMP) project, a Rs. 300 crore under RKVK was launched by DAC with IIMR as the Center of Excellence for disseminating processing technologies to around 200 processing clusters that were set up under the scheme across the country. The Centre of Excellence (CoE) at ICAR-IIMR is now in full swing disseminating the technologies developed under NAIP to people from across the country. Three pilot Mid Day Meal scheme studies with inclusion of millets diet are initiated in 3 states of Maharashtra, Karnataka and AP by the



DAC under technical guidance of IIMR and Government is actively contemplating mainstreaming millets in public funded welfare programmes targeted various groups.

This project developed a model for PCS for millets" foods. This led to enhanced consumption levels of targeted groups, income and employment of stakeholders through value-addition and branding of millets as health foods. The demonstration of market-linked production, procurement, primary processing and buy-back (procurement) arrangements were done through ITC"s Ltd market assurance model and this was important to establish the confidence of entrepreneurs for Supply chain management.

SUMMARY

As the model of millet value chain is successful under NAIP project, it can be replicated in other parts of the world where millets is the main crop. For future sustainability, policy makers and concern department should take initiative effort to inspire and encourage the millets farmers to go for commercialization through various approaches such as inclusion of millets in PDS, subsidize machinery for processing of millets and national wide campaign of millet flagging as health benefit food. The value chain of millets will not only secure the economic condition of dry land farmers but also widen the food security of the country. As health benefits, it will a chief component in the present and in near future since it can control various modern life style diseases. Above these, the consumers were now given option of convenience for consumption of sorghum and millets products. The whole value chain of millets will uplift the farmers, entrepreneurs and satisfy consumers in various ways.

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SECTION - 16

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TAKING A SMART FOOD APPROACH

Two of the biggest issues on the global agenda are nutrition and climate change. These are equally important for India. Add to this the plight of Indian farmers and we have some tough challenges. Typically, solutions for these big issues work in silos. **The Smart Food¹ approach is about finding solutions that are good for you, the planet and the farmer, in unison.**

The first step in achieving this is to focus on diversifying staples with Smart Foods. Given that staples are often 70% of a meal and typically refined carbohydrate, hence there is little nutrition being gained, this is where we can have big impact.

Millet and sorghum are excellent foods to target to diversify staples. They fit the criteria of being Smart Foods like the examples shown in Diagrams A, B and C.

smart food
Good for you





In the past, the biggest efforts and investments have been at the growing end. As a result, there is a big gap at the consumer end which especially needs marketing to build awareness and change the image, as well as working with processors to make modern, convenient and affordable products available.

For longer term sustainability of any efforts to bring millets and sorghum into mainstream, they need to be tasty and have a positive image. Marketing, food processors, cooks and chefs play a key role in achieving this. What is often missed is that the **food processors struggle just as much as farmers**. The Small – Medium Enterprises (SMEs) are the pioneers of the millet and sorghum industry and equally deserve supporting.

The need for marketing and tasty products are just as important when being brought into a feeding program as it is when being made into commercially available products.

Also just including millets into a feeding program because they are nutritious, will not always be highly impactful, unless key criteria are taken into account.

Results are about to be officially released to the media of a recent pilot undertaken, which is the first known 'scientific study'¹ on introducing millets into school feeding, that tested the acceptance and nutritional impact. Early presentation of the results of the study are included here which was undertaken by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and Akshaya Patra.

Approximately 1,500 adolescent school children from two schools were provided a millet based mid-day meal for 3 months. Another two schools being fed the standard fortified rice and samba mid-day meals were the control group for comparison. 10% of the children were tracked for their growth rate (using anthropometry measurements) and also sensory evaluations undertaken every month to see how the children were liking each of the millet meals.

The methodology to maximize the benefits was designed based on 6 components:

1. Understanding and targeting the nutritional needs of the consumers e.g. anemia.
2. Selecting the millets that best target the nutritional needs
3. Selecting the variety of the millets highest in the required nutrients
4. Use nutritional data that distinguishes by variety and does not use averages of the nutritional level for a variety
5. Include an edu-tainment program (awareness program that is fun)
6. Especially designed menus taking into account:
 - combinations of foods
 - balancing the whole menu and diet



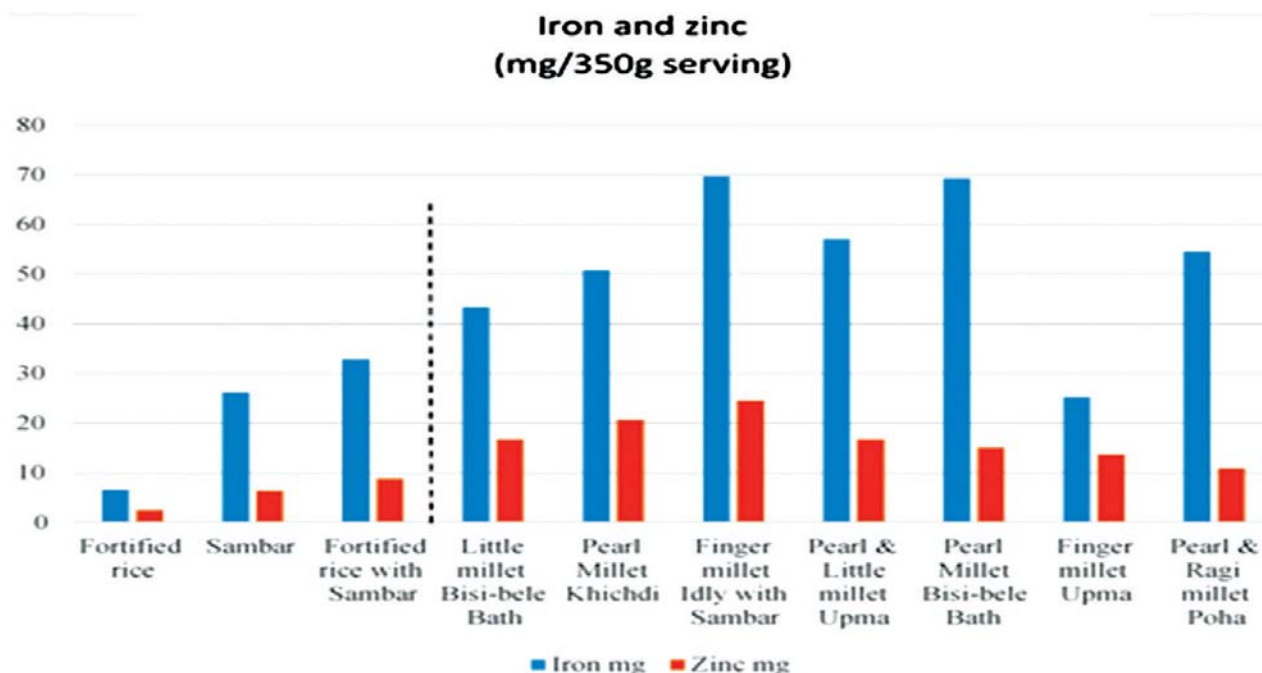
- preparation and cooking methods
- equipment and cooking skills
- cultural sensitivities and taste.

With this approach being followed, the study results, that are about to be officially released, included:

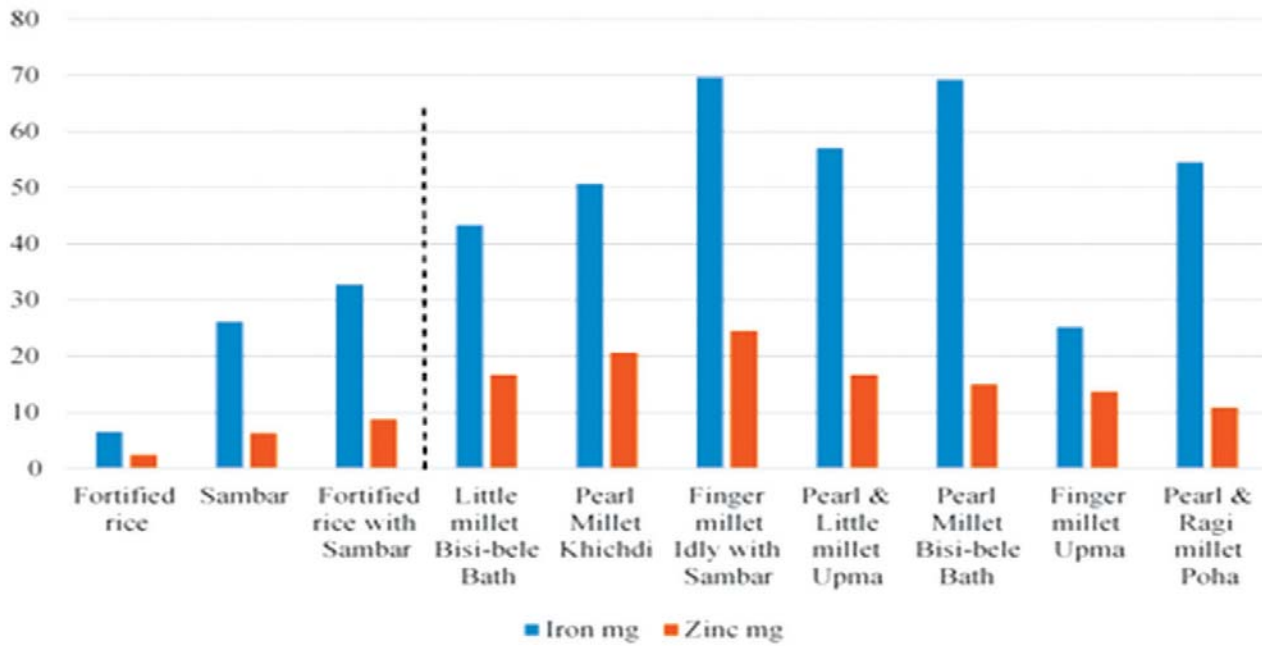
- **50% faster growth** for the children being fed the millet-based meals than those eating fortified rice-based meals, in just 3 months.
- The children rated the meals **4.5 or higher out of 5 for taste**, including eating little millet as rice.

The nutrition composition of the meals was laboratory tested – see graphs A-D. The newly designed millet based meals were significantly superior for nutrition compared to the standard meals normally served of fortified rice and sambar. Rice was not served at all during the three months, and on some days little millet was served as a rice.

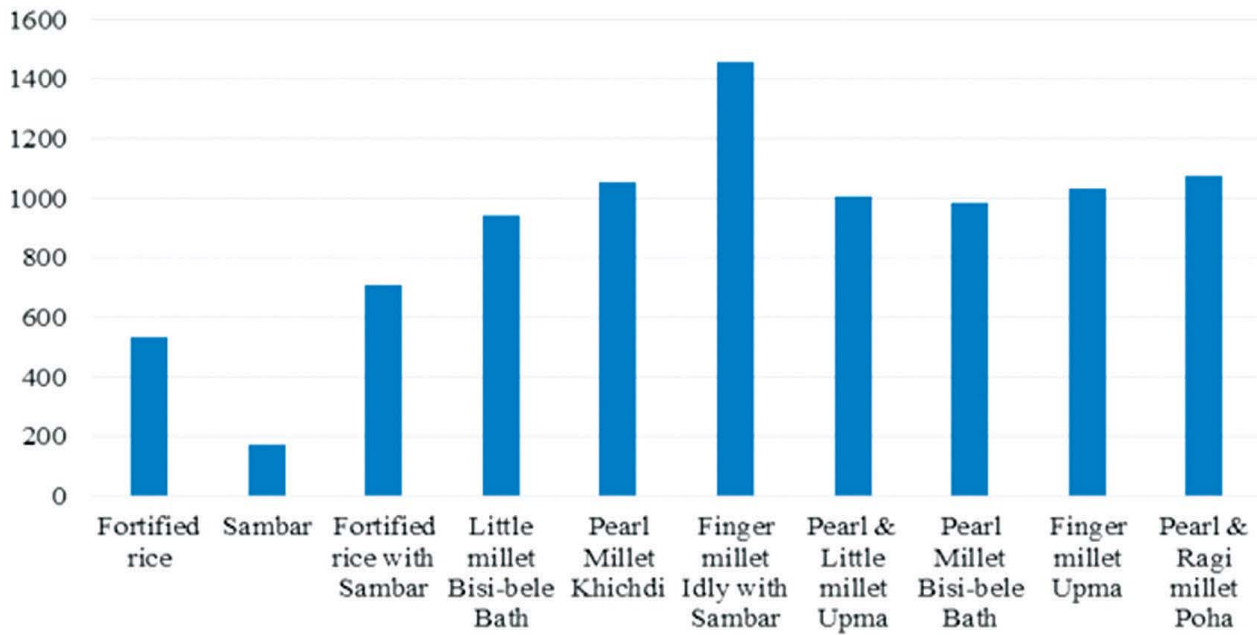
Graphs A-D: Nutrition composition of standard MDM of fortified rice and samba compared to the millet based MDMs.

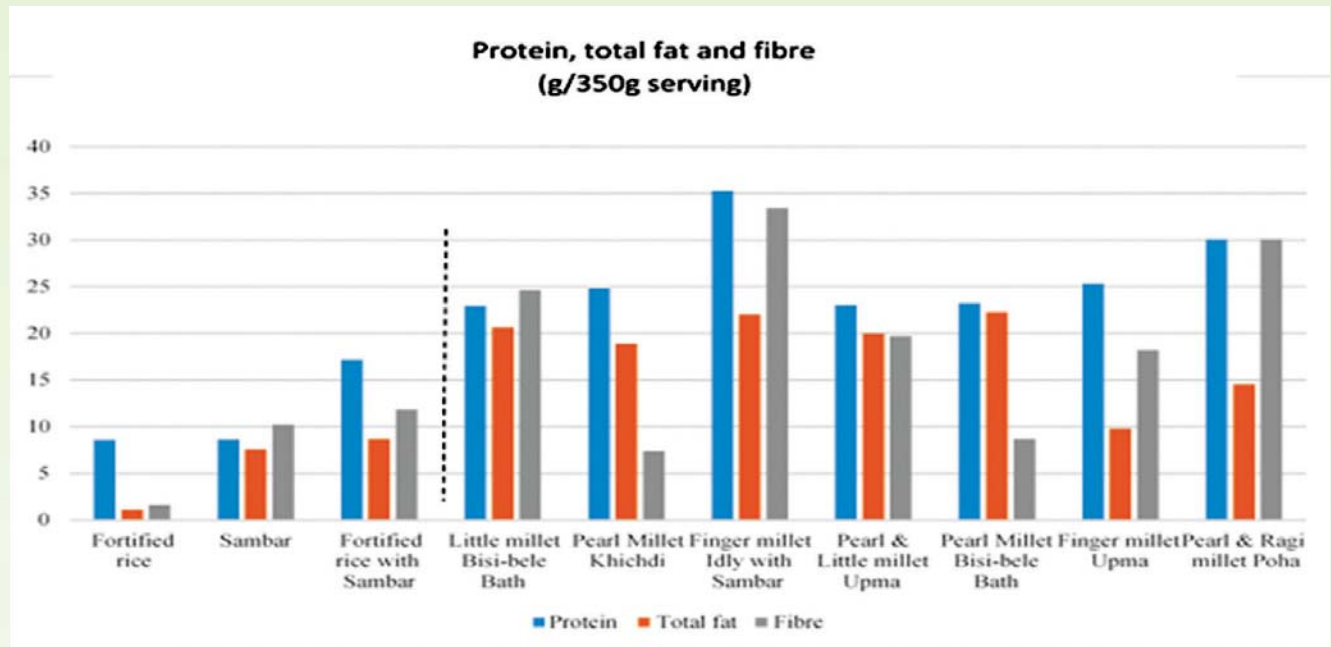


Iron and zinc (mg/350g serving)



Energy (Kcal/350g serving)





MARKET APPROACHES FOR THE FUTURE

Marketing to position the image of millets and sorghum along with ensuring delicious recipes and products, are important components to popularize and mainstream millets and sorghum. This requires market testing and support.

This is important whether it is a feeding program or a commercial product. Keeping food tasty but still healthy is possible but can take extra effort. Maximizing the nutrition and health benefits also takes specific efforts and knowledge.

Now is the time to ensure Smart Food consumer foundations are in place for future growth.



SECTION - 17

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VALUE ADDITION OF UNDER-EXPLOITED MILLETS: KEY TO NUTRITIONAL SECURITY

Milletts are among the important drought and disease resistant crops with a short growing season and is able to deal with frequent climate change. Milletts are widely grown in the semiarid tropics and have different varieties such as pearl millet (*Pennisetumglaucum*), finger millet (*Eleusinecoracana*), kodo millet (*Paspalumsetaceum*), proso millet (*Penicummiliaceum*), foxtail millet (*Setaria italic*), little millet (*Panicumsumatrense*), and barnyard millet (*Echinochloautilis*). These offer both food and livelihood security to human race and feed security to diverse livestock in dry land regions of rural India. The gluten free millet grains are most recognized nutritionally for having potential health benefits. High fibre content, protein quality and mineral composition of these tiny grains contribute significantly to nutritional security of a large section of population residing in the millet growing areas. The nutritious millets traditionally occupied a substantial part of the diets and crop systems in tribal areas of Odisha. Odisha produces substantial quantities of finger millets (ragi), little millets (suan), foxtail millet and kodo millets. Finger millet also is known to have higher crude fiber and mineral contents than those of cereals. Its protein is relatively better balanced with more lysine, threonine, and valine than other millets. Kodo millet and little millet are also reported to have the highest dietary fiber (37% to 38%), and the fat has higher polyunsaturated fatty acids. Foxtail millet protein characterization showed that its protein concentrate is a potential functional food ingredient and is rich in lysine, an essential amino acid. Thus, the presence of all the required nutrients in millets makes them suitable for large-scale utilization in the manufacture of diversified food products.

Prior to consumption, millet grains are usually processed by commonly used traditional processing techniques to improve their edible, nutritional, and sensory properties. Several traditional household food processing and preparation methods can also be used to enhance the bioavailability of micronutrients present in millets. These include both thermal and mechanical processing, soaking, roasting, flaking, grinding, fermentation, and germination/malting. These procedures aim to increase the physicochemical



accessibility of micronutrients and to decrease the anti-nutrients. Therefore, with appropriate processing technologies for preparation of several value-added and healthy food-products, the millet grains can find a place in large urban populations and non-traditional millet users.

PRIMARY PROCESSING

During the last three decades, area under finger millet has declined mostly due to difficulties posed during post-harvest processing. This is because the size of most of the millets is too tiny to be handled by conventional cleaners and dehullers. The traditional methods are time consuming, tedious and less efficient. Therefore, there is a need for innovative decortication technology that can be used to decorticate appropriate amounts of grains in a short time at commercial scale. Specially designed millet machines such as destoners, cleaner-cum-graders and dehullers are now available with different manufacturers. Millets except ragi grains are usually dehulled and subjected to different hydro-thermal treatments for more and efficient recovery. Dehulled millets can be cooked like rice or can be milled to prepare flour and can be used in various traditional products.

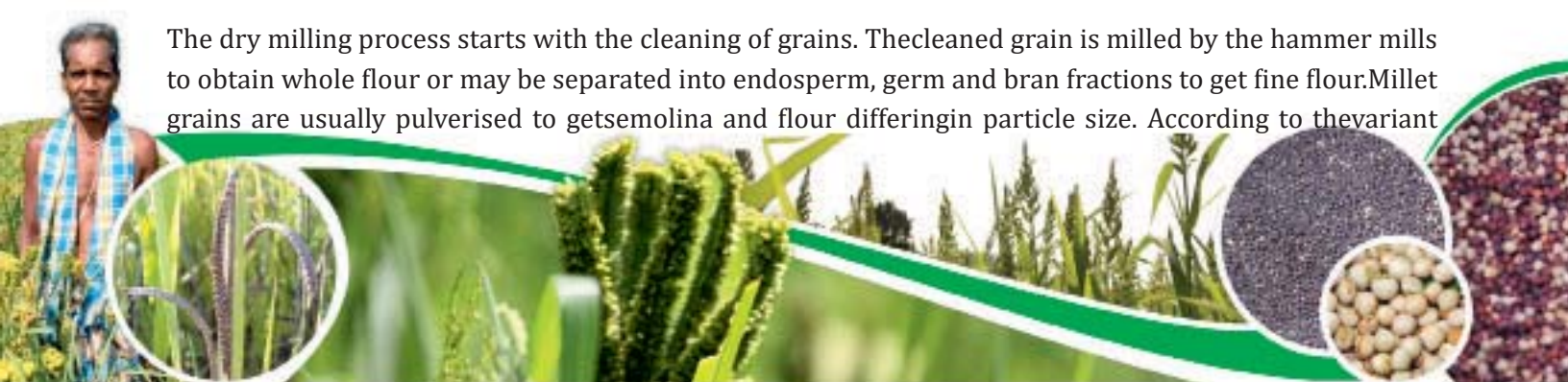
VALUE ADDITION OF MILLETS

MALTED MILLET PRODUCTS

Germination or malting of grains may result in some biochemical modifications and produce malt with improved nutritional quality that can be used in various traditional recipes. The protein digestibility and the contents of thiamine, niacin, total lysine, protein fractions, sugars, soluble dietary fiber is improved after germination, soaking and dry heating where as the level of anti-nutrients is reduced. Malting characteristics of finger millet are superior to other millets and ranks next to barley malt. There are various benefits of malting such as vitamin-C, phosphorus availability is increased and lysine and tryptophan are synthesized. The malted and fermented ragi flour are extensively used in preparation of weaning food, instant mixes and beverages. The malted weaning food is mixed with powdered sugar, milk powder or whole milk along with flavouring agents to make as milk based beverage. This preparation is a good source of nutrition and suitable for all the age groups. This preparation is popularly known as '*ragimalt*' and can be used as health drink or energy drink. Malting of foxtail millets results in flour with a high concentration of minerals. Germination of millet grains can be used as a technique or in combination with probiotic fermentation to prepare malt powder for the preparation of several food products such as infant formula, complementary food products, and composite flours or food blends. However, there is a need for the application of malting at an industrial scale using novel germinators under controlled conditions to provide high-quality malt products to help in promoting millet utilization.

FLOUR/MULTI-GRAIN FLOUR /COMPOSITE FLOUR

The dry milling process starts with the cleaning of grains. The cleaned grain is milled by the hammer mills to obtain whole flour or may be separated into endosperm, germ and bran fractions to get fine flour. Millet grains are usually pulverised to get semolina and flour differing in particle size. According to the variant



needed for value addition, the mesh size in the mill is adjusted. Flour can be stored for few months which is used as a main ingredient for various recipes. Multigrain refers to a food that contains more than one type of grain. This whole grain blend incorporates the bran, germ, and endosperm portions of the grains to make nutritious flour. This blend may be used for preparation of suitable value added rotis, instant mixes, snacks and bakery foods.



Ragi Malt and Bakery products

BAKERY PRODUCTS

The use of millets in bakery products not only offers superior food items in terms of fibre content, micronutrients but also creates a good potential for millets processors or producers to enter into the bakery world as entrepreneurs. Millets flour can be incorporated in different proportions from 10% to 100% levels to standardize cookies, bread/bun, biscuit, nankhatai, muffins, pizza base and cake by replacing refined wheat flour based on the consumer preference.

PUFFED/POPPED/FLAKED PRODUCTS

Popped or puffed millets are popular RTE products with pleasing texture and appealing flavor. Popping improves the nutritional value by inactivating some of the anti-nutritional factors and thereby enhancing the protein and carbohydrate digestibility. It also enhances the appearance, colour, taste and aroma of the processed raw material. For popping or puffing, the whole or dehulled millet grains are conditioned by mixing additional water upto a moisture content of 18-20% and tempered for about 4-6 hours followed by agitation on the hot sand surface maintained at about 230-250°C for short time. Since during popping or puffing grains are dehydrated to the extremely low level of moisture content (3-5%), the shelf-life is enhanced. Now-a-days modern air puffing machines have been developed which can be used for mass production of puffed or popped millet grains. Flaked millets are prepared by treating the grains with steam



and then crushing them between hot rollers. Puffed finger millet grains can be converted into powder by simple grinding which can further be enriched with additional ingredients. Various combination of ingredients can be taken and mix well, this nutritious mix so prepared forms RTE food. The selection and combination of the ingredients is done based on the requirement of the target groups like children, pregnant



Puffed, Flaked and Extruded Products from millets

and lactating mothers etc. The ingredients are selected in such a way that no further cooking requires and hygienically packed in suitable packaging materials.

EXTRUDED/EXPANDED PRODUCTS

The change in life-style is also bringing a drastic change in the food habits since last few years. The extruded foods being RTE products have become a good choice as snack foods. Extrusion cooking is a high temperature and high pressure process of value addition of cereals and other grains for the production of the expanded or compressed extrudates. All the millets can be extruded as these contain good amount of starch. However, the millet flour is required to be conditioned. Finger millet flour or grits exhibit good extrusion characteristics. Extrusion cooking has ability to gelatinize and cook the product and enables its uses as a RTE food. The flour/grit with 16-18% moisture content has ability to extrude in the barrel temperature range of 100-120°C well resulting in good expansion with crunchy, porous and smooth surface texture. Like other preparations, the finger millet flour can be blended with other legume ingredient flours in appropriate proportion with further fortification of minerals and vitamins to design a balanced nutritional extruded food. In the extruder, due to excess heat and pressure from the screws the meal gets heated and the moisture content gets reduced. The meal passes through the extruder and gets cut by the cutting knives into required lengths. Pasta is a popular Italian food item. It comes in various shapes and sizes. These are



made from semolina flour which is extruded into the shape of the pasta like noodles, macaroni, vermicelli and spaghetti etc and dried and packed.

FERMENTED PRODUCTS

Fermented foods like *Dosa* and *Idli* are popular in many parts of India. These are very common as breakfast foods and even as the evening meals in southern part of the country. Finger millet is widely used as one of the ingredient for these kinds of fermented foods. It not only improves the taste but at the same time enriches the food value in terms of protein, calcium and fibre. Sprouting of finger millet grain or the malted millets can also be used for fermented foods depending on the taste and choice.

INSTANT MIXES

Instant and ready to reconstitute foods have become well established products as instant foods include food products that involve the dissolving of a powder in hot water, or the dilution of a concentrated stock solution, such as condensed soup. Instant dosa mix, roti mix, chapatti mix, multi millet khichdi mix, upma mix, etc are being formulated from a single or blend of millets and other grains.

SNACK FOOD RECIPES

A wide variety of snack foods are getting prepared using the flour or grits of millets or different blends. These are becoming popular among the present day consumers in the context of healthy nutraceutical and functional food. Millets soup, pakoda, vada, upma, khichidi, laddu, idli, dosa etc. are gaining popularity.

CONCLUSION

Food uses of millets still have remained underutilized as these are confined only to traditional consumers; limited especially to areas of their cultivation. Awareness among the consumers about the health benefits, finger millet has relatively gained more importance. Processing them using traditional as well as contemporary methods for preparation of value added and convenience products would certainly diversify their food uses. Their exploitation for preparation of ready-to-use or ready-to-cook products would help in increasing the consumption of millets among non-millet consumers. Evaluation of nutritive value and potential health benefits of millet grains and their fractions in animal and human models should be performed in future research studies to support efforts for promoting their utilization. Elimination of drudgery of women by introducing mechanical mini-milling system, innovative millet processing technologies, capacity building among farm women on nutritional quality of millets, in product development and marketing are few essential steps for promoting utilization of millet. With the advancement of post-harvest processing and value addition technologies, it is possible to process and prepare products to be acceptable by both rural and urban consumers. This will not only help in increasing the profitability of its cultivators but will also help in providing income and employment opportunities in rural area and will also contribute to address the food security of nation.



SECTION - 18

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FINGER MILLETS DIVERSITY FOR NUTRITIONAL SECURITY AND AGRARIAN CRISIS

In the present scenario of nutritional security and agrarian crisis specifically in rainfed areas millets got special importance, as it is rich in nutrients and keep potential to adapt with various adverse climatic conditions, marginal land, less water.

Tribal part of Maharashtra are minor millet (finger millet, foxtail, kodo millet, proso millet, little millet and barnyard millet) growing and exhibit specific climatic and edaphic conditions. Most of the tribal farmers are schedule tribes and are below poverty line and suffered with various micronutrient deficiencies. Majority tribal are depend on agriculture for most of the requirement like food, fodder and income generation. Increase use and production of local food and value addition can be helps to minimize micronutrient deficiencies and to increase economic status. In this context finger millet is most important as they are highly nutritious and economy crop. It is highly ignored during and after green revolution and maximum emphasis given on to boost the production wheat, rice and Maiz. These cannot compete with these cash crops in terms of production, demands and returns because of advance agro-practices, enormous use of chemical fertilizers and irrigation facility. In 2016-17, the area under millets stood at 14.72 million hectares, down from 37 million ha. in 1965-66, prior to the pre-Green Revolution era.



These figures clearly indicate the decline in the production of millet due to ignorance during and after green revolution and things continue till date. From the last few years' emphasis given on to increase production and productivity of sorghum and pearl millet by using different innovative practices and providing appropriate inputs. Finger millet is still ignored by farmers, Agricultural Universities and Government in Maharashtra. In most of the parts, farmers has given preference to finger millet landraces (local varieties) as performance of landraces are better than varieties and these are more nutritious. .

Finger millet (*Eleusine coracana*) and its wild relatives are members of the Chloridoideae, one of the four primary subfamilies of the grass family Poaceae. Finger millet, *Eleusine coracana* Gaertn L. ($2n=4x=36$), is an important food crop cultivated widely in India. Small millets are raised on lands where no other crop worth mentioning can give a reasonable quantity of grain and valuable straw. The seeds have high nutritional value as they are rich source of calcium, iron and methionine Ragi is one of the most important sources of natural antioxidants such as phenolic compounds viz. caffeic acid, feralic acid and vanillic acid. Plant also contains hydrocyanic acid.

One hundred twenty landraces were collected from all over Maharashtra, specifically from Nandurbar, Nashik, Palghar , Thane, Pune, Ahmednagar, Kolhapur and Kokan region. All the landraces were studied for various morphological characters. For the Mophological studies 11 characters were selected e.g. colour of grains, height, number of fingers, tillers, number of grains in each unit, length and breadth of the fingers, internode colour, maturity, compactness of fingers and free finger. A good amount of variability was found for all the selected characters. Co-relation studied were carried out to understand the relationship among various characters. Elements and morphological characters showed variation due to varied geographical conditions. Various elements showed co-relation with other elements and with different morphological characters. Significant co-relation was reported between Cu and Zn, Cu and Fe and Cu and Mg, Mn and Mg. Ca and Mg showed maximum significant co-relation. Landraces were analyzed for essential amino acids.

Apart from its nutritional and agrarian importance area under cultivation and production is gradually decreasing, this decrease cause's loss of genetic diversity and important nutritional traits. Therefore the collection and conservation of Finger millet germplasm is extremely importance for nutritional security.



SECTION - 19

DR SANYASI RAO, WASSAN
 MR NARSING RAO WASSAN
 RAVINDRA A WASSAN

DOUBLING YIELDS IN RAGI THROUGH INTEGRATED INNOVATIONS IN SRI IN ANDHRA PRADESH

Tribal agriculture system is predominantly rainfed. Conventionally seed is broadcasted and harvested when the crop matures and farmers raise nurseries and transplant about 25 days old seedlings randomly with about 8 to 10 women labour. Weeds are removed manually using women labour. These simple methods does not allow for various operations and consequently yield levels are low at about 2 to 4 quintals per acre.



SRI-Ragi plants in comparison with conventional

Savara Masaiah, a tribal farmer in Kusumi village in Seethampeta Mandal of Srikakulam district. He owns 5 acres of land, mostly rainfed, and cultivates Ragi (finger millet) and vegetables. Harvest of Rabi 2016-2017 brought several people to his field – scientists from the Regional Agriculture Research station, District and Mandal Agriculture officers, Project Officer, ITDA, farmers from various other places. Masaiah got about 13 quintals yield per acre as observed in



Conventional transplantation



the Crop Cutting Experiments organised in his field to estimate yield; 4 times higher than the conventional! While the conventional plant hill has about 5 to 10 productive tillers, the ragi crop in Masaiah's field has a record 35 to 45. The returns increased from about Rs.10,000 to 32,500 per acre and a saving on inputs of about Rs. 1800 as he managed to complete weeding with his family labour with the new 'cycle weeder'.

The shift in cropping method integrates the principles of System of Rice Intensification (SRI) and the traditional Guli method as practiced in Karnataka with the ZBNF practices. SRI Principles in Ragi consist of square transplantation (in place of random transplantation) of younger seedlings of about 15 days age (in place of 20 to 30 days old ones), inter-cultivation with cycle weeder (in place of manual weeding), application of beejamrutam and Jeevamrutam.



Masaiah, along with several other farmers tried out the SRI principles in Ragi as a part of the network program WASSAN has taken up along with several partners. Farmer Resource persons from Karnataka, cycle weeders from the entrepreneurs promoted by WASSAN, training on SRI principles were integrated. The following Kharif season in 2017, expanded the program to other four districts and villages where



farmers are inspired by the exposure visits in Rabi, 2017. The results were spectacular and attracted farmers and also the agriculture department, ATMA in particular. Crop Cutting Experiments of various farmers showed yields ranging from 8 quintals to 16 quintals per acre without any chemical inputs. Field days were organised in all the places. About 375 farmers practiced SRI-Ragi during the season. 470 farmers have taken to SRI-Ragi during the Rabi season of 2018-19.



Exposure visit for potential farmer Resource persons and for millet farmers; field days in which the Department officials from tribal welfare, agriculture department and others have participated. The results of crop cutting experiments were announced by the officials

from the agriculture department. These strategic interventions helped in first hand exposure to all and a consensus has evolved on the performance of the SRI-Ragi in the Tribal regions at scale. Practicing farmers participated in the district review meetings of the ZBNF and shared their experience.

WASSAN now is focusing on further deepening the SRI-Ragi practices with a focus on reducing labour use.



The techniques of using bullocks for agriculture operations is well established in the drylands of Anantapur districts. Farmers from those areas are brought to the Tribal areas to teach these skills to tribal farmers; particularly in weeding with bullocks replacing human labour. Line sowing enables mechanical weeding and tribal areas have plenty of bullocks which are not used beyond land preparation. It's learnt from the last two years' experience that both bullocks and farmers need skill training.



Another innovation is to introduce two row transplanter for transplanting. This was brought from Central Institute of Agriculture Engineering, Bhopal and is being adapted for SRI-Ragi. This eventually reduces transplantation labour and enables farmers to transplant with their family labour itself. This may take one more year for standardisation and skill building.

The experience is now expanded to little millet and other millets which have good tillering capacity.

SCALING UP



In the series of consultations with in the ZBNF program it was proposed to scale up the program

In the ZBNF clusters. 60 clusters were identified in 4 districts for scaling up to 6000 acres during the 2019-20 kharif season. RySS is fully funding this program. Sanjeevani, partnering with WASSAN will provide the field support for the scaling up while WASSAN provides the strategic and capacity building support.

It is expected that this will result into at least 3 to 4 quintals of additional yield per acre amounting to about Rs. 4.5 Crores annual gross value add! With more than 50 resource farmers now available, the scaling up is well on its way.

The case of SRI-Ragi piloted in the APPI & RySS supported WASSAN – CRZBNF project is a case in point for diagnosing critical interventions required, integrating various technologies on the ZBNF platform, building local skills and carefully evolving conviction and consensus among the department officials, farmers and others. A clear Scaling Up strategy is well embedded into the design of the program. The program will be universalised across all ZBNF clusters once it is pilot tested at the scale of 6000 acres.



INTRODUCTION OF NUTRITIOUS MILLETS AT ANGANWADI CENTRES VIKARABAD DISTRICT, TELANGANA

ABOUT VIKARABAD DISTRICT

Vikarabad district had been carved out of the erstwhile Mahabubnagar and Rangareddy districts. The district is spread over an area of 3,386.00 square kilometres. It receives 690 mm / 781.5 mm of rainfall in a year. It has 18 mandals and 501 villages. Population of the district is 9,27,150. Redgram, cotton, rice, maize, jowar, green gram and black gram are the major crops of the district. It is surrounded by the districts of Sangareddy, Ranga Reddy, Mahabubnagar and the state of Karnataka. It is also one of the driest districts and with more number of lambada hamlets in Telangana state.

Cropping systems of Vikarabad district of the past has little millet (locally known as Samalu), foxtail millet (locally known as Korralu), finger millet (locally known as Thydalu / Raagulu), Sorghum (locally known as Jonnalu) and other millets. Millets are nutritious and requires very little water for cultivation. Usually crops cultivated by farmers are an integral part of their food basket. These crops played an important role in the food and nutritional security of local communities.

VIKARABAD DISTRICT MAP



However, there had been a drastic decrease in the area under millets cultivation. Currently, only sorghum and finger millets are cultivated in small pockets. As crops disappeared from fields, they have vanished also from the local food basket. Reviving millets in farms and bringing back on to the food plates was an important societal need, more so, in the dryland areas of Telangana.



NUTRITIONAL STATUS AND INTEGRATED CHILD DEVELOPMENT SERVICES (ICDS)

About 13.3% of children below five years are severely malnourished in Telangana. A higher percentage of children are stunted and underweight in the tribal dominated districts and placed at the bottom of the human development index (HDI), (Human Development Report 2017, Telangana State).

Even in traditionally millet consuming areas like Vikarabad, children are now served rice- based dishes at Anganwadi Centres. The supply of subsidized rice through public distribution system (PDS) has not only resulted in large scale decline of millet consumption but also adversely affected the food basket of households. A shift in the local cropping patterns and people's diet has a huge impact on the health of kids, women and the larger society.

ROLE OF FARMERS' COOPERATIVES IN THE PROMOTION OF FOXTAIL AND SORGHUM

As a risk mitigation strategy, farmers' cooperatives encouraged crop diversification through promotion of intercropping of millets with pulses. They have not only supplied millets and pulses seeds local farmers but also went into a buy back arrangement with them. The FPOs has set up decentralised processing facilities with the support of the Watershed Support Services Activities Network (WASSAN).

As a result of the efforts of FPOs, area under foxtail millets area has increased to 700 acres in Kharif 2016. Farmers' cooperatives and WASSAN have organised a field day and invited the District Collector. A proposal was submitted to the District Collector requesting to explore creation of market for foxtail millet and sorghum, and introducing them in the state supported ICDS and PDS. The proposal had led to many discussions, which eventually led to introduction of millets in the ICDS & PDS as a pilot by the District Collector.



PILOT – INTRODUCTION OF MILLETS IN THE ICDS AND ANGANWADI CENTRES



As generational change should begin early in the childhood, the District Collector of Vikarabad decided to engage mothers and children in inclusion of millets in their staple diets and increase their supply and consumption through ICDS. A series of three millet-based food festivals have been organized to introduce and finalise millet-based dishes and build consensus among different stakeholders for inclusion of millets in the ICDS.



The District Welfare Officer (DWO) and WASSAN worked on a list of millet-based recipes in discussions with scientists from the National Institute of Nutrition (NIN). Through an online NIN platform, “count what you eat”, energy and nutrition values of each recipe was calculated to meet the standards. Thus a preliminary menu consisting of paddy rice + foxtail millet rice and sambar / dhal, foxtail millet kichidi and sorghum upma were finalised.



Women and children were served millet-based dishes at food festivals and feedback of the community including women, mothers, kids, parents, peoples’ representatives, Anganwadi teachers, and supporting staff was collected at the end of the event. There was an overwhelming positive response from all the stakeholders. There was a broad consensus amongst all sections that millets are highly nutritious and should be served for kids at the anganwadi centres, every alternate day. Based on the feedback, foxtail millet kichidi

and sorghum upma with veggies have been finalized for inclusion in the meals served for kids at anganwadi centres. Training were organized for anganwadi teachers and supporting staff cooking of millet-based dishes and the staff has agreed to put some extra effort in cooking and serving the millet-based dishes. Resolutions have been passed by the local mothers committees recommending the inclusion of millet-based dishes at the AWCs.





After finalisation of the millet-based dishes, it was the time for launching the pilot. The pilot on introduction of millet-based dishes at Anganwadi centres for kids had been launched on 14th April, 2017, the Ambedkar Jayanti. Anganwadi teachers, staff of the District Women and Child Development, Civil Supplies Departments and members of the Farmers' Cooperative and several district officers participated in the event hosted by the District Collector, Vikarabad, Telangana. The event was organized in collaboration with WASSAN. Sri M. Jagadeeswar, Secretary, Women and Child Development and Director, Ms. B. Viziendra, participated as special guests at the event. List of participants include the Joint Director, Women and Child Development, District officials, Anganwadi teachers and WASSAN staff.

Ms. Divya D, District Collector, Vikarabad narrated the process of selection of millet-based dishes and the overwhelming response from the mothers, kids and anganwadi teachers. The pilot program was initiated at 45 anganwadi centers in 3 mandals of the district with about 1000 children. The objective of the pilot is to serve millet-based dishes to kids 4 times a week.

Sri M. Jagadeshwar, Secretary and Ms. B. Viziendra, Director, Women and Child Development Department appreciated the initiative of the District Collector. She suggested that the programme must be extended to the nutrition programs focusing on pregnant and lactating women and adolescent girls who need proper nutrition. They offered support to the District Collector for the same.

It was proposed that programme will be piloted for a period of three months and necessary changes will be made based on experiences. The pilot will continue for an additional three months, if satisfactory, the District Collector will approach the state government to introduce millet-based meals at all the anganwadi centres of the district.



BUDGET ANALYSIS

Rice is supplied to the ICDS for INR. 4 per kg at a subsidized price, but millets are not subsidized, therefore, price of millets per meal is higher. The price of rice based meal per child is INR 6.13, the foxtail millet / sorghum Upma would cost INR. 8.32 and INR 10.39 respectively. Millet-based meals provides not only an equal amount of energy and proteins but also enhanced dose of micro nutrients and fibre. If subsidy is extended also for millets then millet-based dishes would become much cheaper or on par with rice.

RICE				FOXTAIL MILLET KICHIDI				SORGHUM UPMA			
Item	Qty (gm/day)	Rate (Rs/Kg)	Cost/day (Rs)	Item	Qty (gm/day)	Rate (Rs/Kg)	Cost/day (Rs)	Item	Qty (gm/day)	Rate (Rs/Kg)	Cost/day (Rs)
Rice	75	4	0.3	Foxtail millet Rice (60:40)	65	50 & 4	2.06	Sorghum Rice	75	58	4.36
Dhal	15	70	1.05	Dhal	1560	100	1.58	Dhal	13.33	100	1.33
Vegetables	25	28	0.7	Vegetables	25	25	0.63	Vegetables	25	25	0.63
Condiments			0.25	Condiments			0.25	Condiments			0.25
Egg (30 eggs per month)	50	3.5	3.5	Egg (30 eggs per month)			3.5	Egg (30 eggs per month)			3.5
Oil	5	59	0.33	Oil			0.33	Oil			0.33
Cost per child per day			6.13	Cost per child per day			8.35	Cost per child per day			10.4
Additional cost/ day			0	Additional cost/ day			2.22	Additional cost/ day			4.27

For the pilot of 3 months covering 45 AWCs and 1000 children incurred 1.73 Lakhs as additional expenditure. This additional expenditure incurred for the pilot was met from the flexible fund given to the collector by the state government.



OPERATIONAL PROCESSES ADOPTED FOR THE ICDS PILOT

1. PRICE FIXATION

The committee lead by DM, civil supplies would fix the price by considering the prices of both mainstream and local markets.

Farmers' cooperative quoted the price for supply the foxtail millet and sorghum ravva. Committee found that the price quoted by Farmers' cooperative is less than others and an agreement had been signed between the DM, CS and Farmers' cooperative



2. QUALITY STANDARDS

DM, CS has given uniform specifications for sorghum mentioned in the URL:(<http://fci.gov.in/app2/webroot/upload/Quality/KMS-2015-16.pdf>).

Specifications of the foxtail millet (specifications of Andhra Pradesh, MARKFED which procured foxtail millets in Kharif, 2016 in Anantapur District) from farmers cooperative.



3. QUALITY ASSESSMENT

Technical officer, civil supplies visits the stock points, processing units and assess the quality, and issues a quality assessment report.

4. PROCUREMENT

Procurement and processing of sorghum / foxtail millets can be done by the farmers' cooperative. The cooperative received credit from FWWB and NABFINS, to meet requirements of their working capital.

5. Technical officer, civil supplies will give training to the procurement committee on quality specifications and assessment. Processed foxtail millet rice and sorghum ravva will be transported to MLS point by the cooperative.

BUDGETS: District Collector releases the budget required for the pilot to the DM, Civil Supplies from the flexible fund available with the collector, which is provided by the state government. The DM disburses the payments to farmers' cooperatives from this fund.

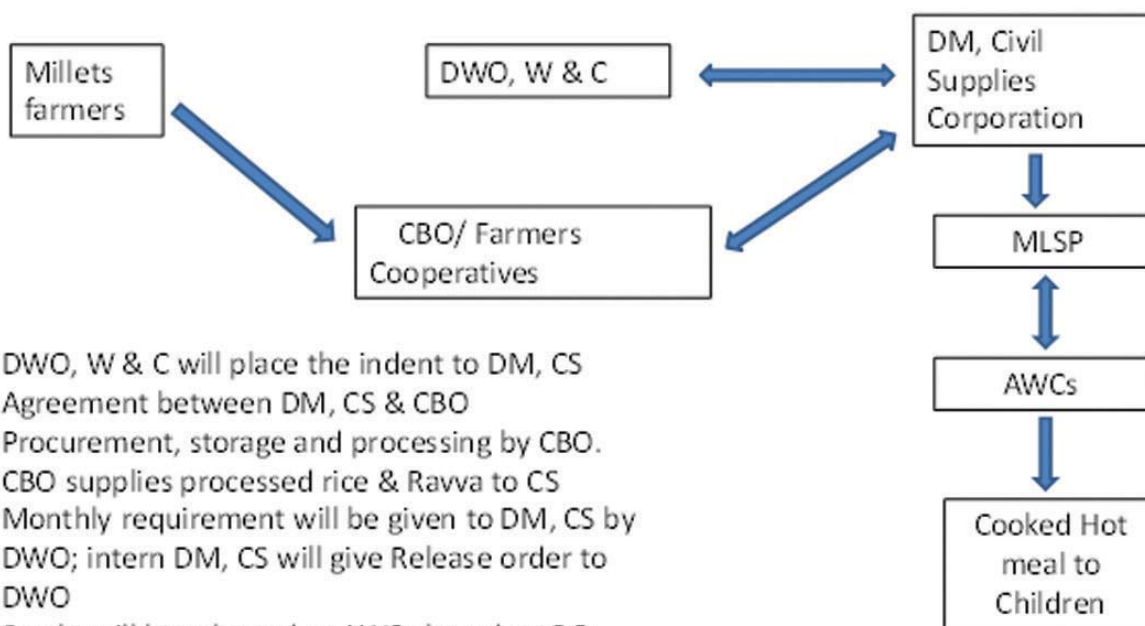


6. PAYMENTS BY THE DEPARTMENT OF CIVIL SUPPLIES

Payment to farmers' cooperative:
Once the stock reaches the MLS point, civil supplies department makes the payment to the farmers' cooperatives. Release Order: Proceedings will be issued by the concerned department officer. AWCs will collect the millets supplies i.e. foxtail millet rice and sorghum ravva from the MLS point, similar to rice.



Schematic Diagram on supply of Foxtail rice & Jowar ravva supply to AWCs



1. DWO, W & C will place the indent to DM, CS
2. Agreement between DM, CS & CBO
3. Procurement, storage and processing by CBO.
4. CBO supplies processed rice & Ravva to CS
5. Monthly requirement will be given to DM, CS by DWO; intern DM, CS will give Release order to DWO
6. Stocks will be released to AWCs based on RO from MLSP



Details of Foxtail Millet Rice and Sorghum Ravva Supplied by the Farmers' Cooperatives

	INR / Kg	Total Quantity supplied in Kgs	Total value (INR)
FOXTAIL MILLET RICE	60	2207	132420
SORGHUM RAVA	50	1598	79900
TOTAL		3805	212320

SCALING UP

Based on success of the pilot, a proposal for scaling-up of the project to the entire Vikarabad district was developed in collaboration with WASSAN and submitted to the Director, Women, Disabled and Child Development, Government of Telangana by the District Collector. It had been given an in principle approval and expected to be taken up shortly. Sambar had been added to the millet-based menu, in response to the feedback from CDPOs, supervisors, and AWCs teachers as kids love to have foxtail millet kichidi and sorghum upma.

OPTIONS AND BUDGETS

Option	Regular rice Menu per child/day rs.7.96	Foxtail millet kichidi Menu per Child/Day	Sorghum upma Menu per child/ day
Option 1 Total regular menu (all 25 days only rice based menu)	25X7.96=Rs.199/ child/month	Nil	Nil
Option 1 Total budget: Rs. 199.00/ child/month			
Option 2 1) 9 days regular menu 2) 8days foxtail millet kichidi @ Rs9.9 /child/day 3) 8 days sorghum upma @ Rs. 11.06 /child/day	9X7.96=71.64	8x9.9=79.2	8x11.06=88.48
Option 2 Total budget: Rs.239.32/child/month			
Total no. Of AWCs	1107		
Total no. of children	16289		
Additional budget required; Rs/child/month	40.32		
Total additional budget required / month (Rs)	656772.48		
Annual additional budget in Rs	7881269.76		
Annual additional budget in Lakhs	78.8126976		



A proposal had been submitted to replicate the pilot to 1104 AWCs. About 59 quintals of foxtail millet rice and 111 quintals of sorghum ravva is required monthly to serve millet-based meals to kids for 16 days out of 25 working days of a month. There is a need to procure 961 quintals of foxtail millet rice and 1803 quintals of sorghum ravva. To supply the amount, foxtail millet crop and sorghum crop should be cultivated in 385 acres and 720 acres respectively during the Rabi 2017-18.

District collector has convened a meeting with farmers' cooperatives and officials of the Department of Agriculture of the district to develop a production plan and asked the cooperatives to take the lead in it. The District collector assured that the district administration would extend support to establish processing units and storage containers for scaling it up over the entire district. It is expected that scale up initiative will begin soon.

POLICY CONSTRAINTS

- a. There is overwhelming response from community to inclusion of millets in ICDS; but its mainstreaming is constrained by lack of a level playing field between millets & paddy/wheat.
- b. Rice is available to ICDS and other state nutrition programs at a highly subsidized rate of INR 4 to 6 per kg. Replacing rice with millets in the diet preparation entails purchase of millets at the open market prices, necessitating provision of additional budgets.
- c. Market prices of some of the millets are higher than (minimum support price) MSP, as MSP for millets is kept very low. There is no regular state procurement of millets; the processes are not well established.
- d. Setting up a local procurement system and finding additional budget outside the regular ICDS programs is necessary to expand the successful millets inclusion programs.
- e. Farmers are not happy with the MSP offered for millets. Though Govt. announces the MSP for few millets, no mechanism had been put in place for corporations to procure the same.
- f. Need special focus to bring back millets into local production systems and consumption. No such comprehensive schemes are there in place right now.
- g. Small millets are not covered in the PMFBY.



SECTION - 21

PARTICIPATORY VARIETAL TRIAL (PVT) IN FINGER MILLET, ODISHA

Mr Susant Sekhar Choudhury, WASSAN

Mr Biswa Sankar Das, WASSAN

Mr Pulak Ranjan Nayak, WASSAN

INTRODUCTION

Finger millet is one of the most important small millets crop grown in large areas of the developing world especially in Africa and Asia. It has the ability to produce higher yield than with a production of 2.19 million tons and average productivity of 1489 kg per ha (Directorate of Economics and Statistics, GOI, 2010-11).

The nutritious Millets traditionally occupied substantial part of the diets and cropping systems in tribal and rainfed areas of Odisha. Millets are more resilient to climate vulnerability and change and can be cultivated even in marginal lands. Crop coverage under Millets has reduced over last fifty years. Reduction in millets resulted in nutrition imbalances and change in cropping systems. In this context, Government of Odisha has launched a special programme for promotion of millets in tribal areas (Odisha Millet Mission) to improve nutrition and mitigate droughts in tribal areas of Odisha. This programme aims to revive millets in farms and bring to plates.

The major millets included in this programme for improvement are Finger millet or ragi (*Elusina coracana*), little millet (*Panicum sumatrense*) and Foxtail millet (*Setaria italic*). One of the objective of this programme is to increasing productivity of millets. There were 20 - 30 finger millet traditional varieties, 5-10 little millet traditional varieties and 4 to 5 fox tail traditional millets available in these districts. Government of India has released more than 100 finger millets varieties suitable to different agro climatic region of the country. Around more than 30 finger millets varieties has also released by the Odisha University of Agriculture and Technology (OUAT). All these released varieties are grown and evaluate under control condition and proper nutrient and water management but when it comes to farmers field the desired characters notified during release are not performing. Whereas farmers have their own traditional varieties which are very much suitable to their agro-ecological condition. But there is a need to proper characterization and evaluation of these varieties in comparison to Government recommended varieties through Participatory Varietal Selection (PVS) or Participatory Varietal Trial (PVT).

Participatory Varietal Trial (PVT) is a simple way for breeders and agronomists to learn which varieties perform well in on-farm and are preferred by farmers. The trial is to identify preferred cultivars in three phases: identifying farmers' needs; searching for suitable material to test with farmers; and experimentation on farmers' fields. Once identified, the seed of farmer-preferred cultivars needs to be rapidly and cost-effectively supplied to farmers for large scale production. Introducing PVT into a variety development program can increase the chances that its products will be well adopted.

Typically, plant breeders develop varieties isolated from active farmers and release varieties that are most productive under ideal conditions; often they are not suitable for marginal farm conditions. Therefore, PVT facilitates development of varieties suitable for marginal soils and farmers' interests.



WHY WE GO FOR PARTICIPATORY VARIETAL TRIAL

On-farm Varietal Trial (OVT)	Participatory Varietal Trial (PVT)
<p>Variety trials conducted on the research station are often managed very differently from farmer practice. For example, researchers apply more fertilizer, achieve more complete weed and pest control, and irrigate more frequently than farmers can. Varieties that perform well under these “high-input” conditions may not perform well under more stressful conditions faced by farmers who cannot spend much on purchased inputs or who lack the labor to completely control weeds.</p>	<p>PVT trials, which are conducted on-farm and under the complete management of farmers, provide information about the performance of new varieties under the real conditions faced by farmers. Traits like weed competitiveness and yield under low-fertility conditions can be assessed in this trial.</p>
<p>Conventional varietal testing focuses on agronomic performance (traits like yield, duration, and disease resistance), but farmers consider many other features of a new variety when deciding whether or not to adopt it. Cooking and eating quality is a critical factor in the adoption of new varieties. Farmers may also be concerned with straw quantity, weed competitiveness, harvestability and storability. These factors are very hard to evaluate in conventional variety testing programs, but may be strongly related to farmers’ decisions on adoption.</p>	<p>PVT trials include formal steps in which farmers express their opinions and preferences about varieties under evaluation. Farmer input is sought on both production and end-use traits, using tools that ensure that traits important to farmers are emphasized. This input is very useful in predicting whether or not farmers are likely to adopt a variety.</p>
<p>Many farmers in rainfed environments rely almost entirely on their own seed supply for planting material, and on their relatives, friends, and neighbors for new germplasm. They may be unaware of or have no access to improved varieties.</p>	<p>PVT trials are an inexpensive and effective way to expose farmers to new germplasm. Farmers often spontaneously adopt varieties they observe or grow on their own farms in the trials. In some situations, dissemination of varieties is one of the goals of PVT trials. However, the main purpose of PVT is to provide information about variety performance and acceptability. Other mechanisms, notably large-scale seed distribution schemes, are likely to lead to more rapid dissemination of farmer-preferred varieties.</p>

Source: Rice Knowledge Bank, IRRI



OBJECTIVES

- To assess genetic diversity and to assess genetic variation in finger millet genotypes. The material comprised of accessions and varieties sown in a Randomized Block Design (RBD) in three replications during Kharif 2018.
- To characterize the genotypes based on seed, seedling and plant morphological traits.

TRIAL DESIGN

Let the total number of traditional varieties of Ragi available in the block will be 11 then we will take another two government recommended varieties 01. So the total 12 number of varieties will be grown in Randomized Block Designed (RBD) in a plot. There should be three replications in a plot. Each replication will be divided into 12 equal parts. The minimum size of a plot/variety/replication will be 25sq.m. (Diagram – I). All this will trial will be conducted in farmer's field.

METHODOLOGY

In 2017-18 Millet mission is initiated his work in 30 blocks of 07 tribal districts of Odisha on millets crop improvement. So we have planned each block has to do one PVT in farmer's field. The local varieties are collected from farmers within the block or district and checked varieties collected from department of Agriculture Government of Odisha.

Awareness creation and training was given to facilitating agencies and progressive farmers. FAs are selected good progressive farmers for this trial with the help of grass root workers. The seed material was put on nursery bed after treatment. A good plot of 1000sq.m was selected and made layout for equal plot for each variety in each replication.

The minimum plot size per variety per replication is 25sq.m. Distance between replication to replication was kept 100cm and variety to variety in the replication was 60cm. 21 to 25days seedlings were uprooted and planted in rows (20 x 10) cm. The coordinators are regularly visited the PVT plots and keep the recordings of date of sowing, planting, weeding and flowering. During physiological maturity stage

The plots were treated with 5ql good dried FYM as basal dose and will be ploughed thoroughly. Equal amount of JIBAMRUTA was applied to each plot after 1st weeding (15days after DAT) and after 30days & 45days of DAT. Ensured water during flowering period.

PROCESS OF VARIETAL SELECTION BY FARMERS IN PVT FIELD:

- Decode the name of the varieties from all the replications and put numerical number.
- Invite male and female farmers (20 – 60age) from cluster of villages to the replication plot.



- Explain them the purpose of their visit.
- Prepare three tags: Best variety: Green, Very well: Blue, Poor: Red.
- Divide the participants into following groups

Only Male group (5-10)	Only Female group (5 - 10)
Mixed Group (5M & 5 F)	Youth female (5 - 10)
Youth Male (5 - 10)	Mixed Youth (5F & FM)

- The groups were entered in to the PVT plot with tags and discussed themselves and put on the tag best, better and poor. The CRPs are collected the information Why the group rank? For which they have ranked? What are the characters of this varieties? Any other information the group want to give.
- The researcher were collected both visual characters from the varieties from each replication and score it as per the following information and also collect quantitative characters from 10 plants/plot/variety/replication and compile it. Both the information will be compiled and the best variety were selected for large scale seed production.

SAMPLE PLOT DESIGN FOR 12 VARIETIES: (11 TRADITIONAL + 01 GOVERNMENT RECOMMENDED)

R1	1	7	2	4	11	9	6	10	8	3	12	5
R2	8	1	5	11	9	2	3	12	4	6	10	7
R3	2	3	8	12	4	5	11	9	10	1	7	6

Note: R - REPLICATION



DETAIL INFORMATION ON PVT EXERCISE 2018 - 19 KHARIF

SI	Name of the district	No. of Block	No. of FA	No. of PVT	No of Farmers	No of Local varieties	Number of Govt. varieties	Total Number of varieties	No of varieties repeated	Date of Nursery	Date of transplanting	Plot size (acre)	Remarks
1	NUAPADA	2	2	3	3	27	3	30	All repeated in three places	28.6.18, to 19.7.18	21.7.18, to 16.8.18	0.5 each	
2	KORAPUT	7	7	7	7	55	13	68	13	07.06.18 to 02.08.18	16.07.18 to 05.09.18	0.25 to 0.5	One at Dasmantpur was harvested by the farmer before selection
3	KALAHANDI	3	3	3	3	29	8	37	4	03.07.18 to 05.07.18	31.07.18 to 10.08.18	0.5 all	
4	RAYAGADA	3	3	3	3	25	3	28	20	24.07.18 to 27.07.18	21.08.18 to 25.08.18	0.12 to 0.25	
5	GAJAPATI	1	1	1	1	3	5	8	0	19.06.18	17.07.18	0.5	Other 03 FAs will be do the PVT activity in Rabi
6	KAMDHAMAL	1	1	1	1	13	1	14	0	05.08.18	04.09.18	0.5	The PVT was damaged and planned to conduct in Rabi
	TOTAL	17	17	18	18	152	33	185	37				



Final selection of varieties by the farmers: Table – 1: Final selection of varieties from PVT exercise – 2018 for quality seed production in 2019-20 Kharif

Sl	District	Block	Organization	Best performed varieties
1	RAYAGADA	Gunupur	Asha	Sana Mandia Bada Mandia
2	RAYAGADA	Rayagada	Opdsc	Kurkuti Mandia Telugu Mandia
3	KALAHANDI	Narla	Sahabhagi Aviyan	Lalsaru Mandia F - 28
4	KORAPUT	Semiliguda	Dhan Foundation	Kerenga Mandia Gpu - 67
5	KORAPUT	Nandapur	Pragati	Mr - I Bada Mandia
6	KORAPUT	Kundra	Mssrf	Bati Mandia Chilika Mandia
7	KORAPUT	Boipariguda	Cysd	Kempu Mandia Dhala Bagada
8	KORAPUT	Boriguma	Harsha Trust	Sri Chaitanya Gpu - 48
9	KORAPUT	Lamtaput	Pradan	Budel Mandia Mami Mandia
10	GAJAPATI	Mohana	Sacal	Kantamara Chilika
11	NUAPADA	Sinapalli	Sva	Pankakhai Mandia Bada Mandia
12	NUAPADA	Komna - I	Ahinsha Club	Bada Mandia (Haladia) Bhoda Mandia

LESSON LEARNT

- The agronomic data could not collected by the FA, even if the data format and process of data collection was explained properly. They have lack of interest on this as it is very new exercise to them. To overcome to this problem, a research team is formed and will look after the Agronomic data collection in 2019-20
- All the PVT plots of Malkangiri were washed out at the Nursery stage.
- Regular monitoring of the PVT plots also difficult for the district coordinators
- Government officials and also other visitors unable visit the experimental plots due to in different blocks
- Some of the FAs were taken more time to understand the concept, so they will plan it in either 2018-19 Rabi or 2019-20 Kharif



WAY FORWARD

- Best two varieties both from farmer's selection and researcher selection will grow in next year from Panicle to row for further isolation
- Developing a database of farmers' indigenous knowledge and its requirements and reasons.
- The best varieties seeds will be purify and grown for large scale seed production to meet the seed scarcity challenges and production enhancement
- Participatory work enable both farmers and researchers to identify the location specific need of farmers. Researcher will aware about the farmer's practice and field condition.
- A farmer can release or registered this varieties as farmer's variety
- A group of farmers can start a seed entrepreneur
- More than 100 local landraces of finger millet varieties are conserved
- Popularization of PVT among farming communities demand for doing PVT in rice, little millet and sorghum

PLAN OF ACTION FOR 2019-20

In Kharif 2019-20, the number of districts from 7 to 14 and blocks from 30 to 72. Total 47 PVTs are planned and 42 PVTs are transplanted. 5 PVTs are damaged due to continuous and heavy rain in Rayagada, Kandhamal and Ganjam districts both at nursery and transplanting stage. 12 selected varieties from PVTs in 2018-19 are transplanted in 24.5acres of land for seed production.

Districts	Planned	Achieved	Balance	Remarks
MALKANGIRI	4	4	0	
KANDHAMAL	7	6	1	Nursery was washed out due to flash flood
KALAHANDI	3	3	0	
RAYAGADA	6	4	2	02 PVT of Gudari & Muniguda washed away during heavy rain and flash flood.
NUAPADA	1	1	0	
BOLANGIR	4	4	0	
MAYURBHANJ	3	3	0	
SUNDARGARH	6	6	0	
GANJAM	4	2	2	02 Nursery washed out twice
KEONJHAR	4	4	0	Completed
KORAPUT	4	4	0	completed
GAJAPATI	1	1	0	
Total	47	42	5	



SECTION - 22

Mr Susant Sekhar Choudhury, WASSAN
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INCREASING PRODUCTIVITY OF FINGER MILLET THROUGH SYSTEM OF MILLET INTENSIFICATION (SMI)

ABSTRACT

In India, millets are cultivated in an area of 15.48 million hectare producing 17.2 million tonnes with a yield of 1111 kg/ha. Among millets finger millet occupies about 60% of the area and contributes 70% to the overall millet production. These are hardy crops and quite resilient to a variety of agro-climatic adversities, such as poor soil fertility and limited rainfall. Nutritionally, they are characterized by a high micronutrient content, particularly with regard to calcium and iron, and high dietary fiber.

In Odisha millets covered in an area of 162.9 thousand hectare (estimated 2018-19) and alone finger millet covered 74% of the area, But the yield of finger millet stagnant in between 7.5ql/ha to 8.67ql/ha in last 5 years which is lower than national average 13.08ql/ha. The area under finger millet cultivation has been decreased from 165 to 120 thousand hectare (estimated for 2018-19). Out of 30 districts of Odisha 14 districts are major millets grown areas. The tribal farming communities are the custodian of millets crop. They are cultivate millets from hill tops to foot hills areas both in solo and multiple cropping system. Finger millet is one of the diet in their daily lunch and breakfast, but its availability for round the year for consumption for a small & marginal family is very difficult due to low productivity. The farmers are resource poor and lack of knowledge on improved package of practices for yield enhancement. Government of Odisha has launched a “special Programme for Promotion of millets in tribal districts of Odisha” popularly known as “Odisha Millets Mission” for **reviving millets in farms and on plates** in the year 2017-18 in seven tribal districts of Odisha. One of the objectives of the programme is to enhance productivity of the millet by adopting System of Millet Intensification (SMI), Line Transplanting (LT) and Line Sowing (LS). 8000 farmers were cultivated different types of millets in 30 blocks of 7 districts by using these methods. Training, demonstrations,



awareness creation and exposures has been arranged to improve their knowledge and practices. Custom Hiring Centres (CHC) are established at block level to support agriculture implements during cultivation on rental basis. Community Managed Seed Centres (CMSS) are established to support quality seed produce, sale and supply. Farmer's incentive has been given to reduce cost of cultivation and increase the area under cultivation. From the crop cutting experiment reports it is revealed that there is an increase in yield around 50 - 60% under SMI than traditional broadcasting method. The paper will explain in detail about the strategies and approaches of Odisha Millets Mission on production enhancement of finger millets from multi-locational agro-climatic region.

INTRODUCTION

Millets are important cereals which play a significant role in the food and nutrition security of developing countries in the semi-arid tropics of Asia and Africa, especially in India, Nigeria and Niger. They are grown on soils which typically are too poor to support any other crop. They have a higher tolerance for drought, low nutrient application, and fluctuations in temperature than other cereal crops and also unique due to their short growing season. Millets are all-season crops cultivated round the year and produces multiple securities (food, fodder, health, nutrition, livelihood and ecological) making them the crops of agricultural security available at affordable prices. Important millet crops grown in India are Sorghum (Great millet), Bajra (Pearl millet), Ragi (Finger millet) and small millets viz., Korra (Foxtail millet), Little millet, Kodo millet, Proso millet and Barnyard millet. These are often referred to as coarse cereals, but realizing the nutrient richness of the grains they are now considered as nutria-cereals. Millets are rich in minerals like iron, magnesium, phosphorous and potassium. Finger millet is the richest in calcium content, about 10 times that of rice or wheat.

In India, millets are cultivated in an area of 15.48 million hectare producing 17.2 million tonnes with a yield of 1111 kg/ha (Directorate of Economics and Statistics, 2015). Maharashtra, Rajasthan and Karnataka are the top most states of millets cultivation in India. Contribution of millets in total food grain production of India reduced from 22.17 % to 6.94 % over the last six decades from 1950-51 to 2011-12. In spite of all the extraordinary qualities and capacities of millet farming systems, the area under millet production has been shrinking over the last five decades and rapidly, since the Green Revolution period due to relentless promotion of other crops such as rice and wheat for intensive farming in select few resource rich areas under irrigated conditions (MINI)

In Odisha millets covered in an area of 162.9 thousand hectare (estimated 2018-19) and alone finger millet covered 74% of the area, But the yield of finger millet stagnant in between 7.5ql/ha to 8.67ql/ha in last 5 years which is lower than national average 13.08ql/ha. The area under finger millet cultivation has been decreased from 165 to 120 thousand hectare (estimated for 2018 -19). Out of 30 districts of Odisha 14 districts are major millets grown areas. The tribal farming communities are the custodian of millets crop. They are cultivate millets from hill tops to foot hills areas both in solo and multiple cropping system. Finger millet is one of the diet in their daily lunch and breakfast, but its availability for round the year for consumption for a small & marginal family is very difficult due to low productivity. Millets are grown in



broadcasting and random transplanting methods in hilly and rainfed areas of Odisha. The cultivators are small and marginal farmers and they have cultivated millets in solo, inter and multiple cropping system in Kharif. Ragi is the major millet cultivated in 165.8 thousand hectare in Odisha with production of 143.74 MT and productivity 8.67ql/ha. Shrinking of crop areas, stagnant in productivity, unavailability of quality seeds, lack of knowledge on improved package of practices, unavailability of organized market and conversion of millet area into cash crop are major challenges for small and marginal farmers to move out from millet cultivation in the state.

The paper will explain the strategies, approaches and activities of Odisha Millets Mission (OMM) to overcome the challenges for a small and marginal millet cultivators on production enhancement and platform a marketing avenues to improve their socio-economic condition.

METHODOLOGY

Government of Odisha in partnership with Watershed Support Services and Activities Network (WASSAN) and Nabakrushna Choudhury Centre for Developmental Studies (NCDS) is launched a “Special Programme for Promotion of Millets in tribal areas of Odisha” in the year 2016 – 17 in seven tribal districts of Odisha. Out of 10 Agro-climatic zones the seven districts fall on four agro-climatic zones (North eastern ghat, Eastern Ghat High Land , Western Undulating Zone & South Eastern Ghat). One of the major objectives of the programme to increase productivity of the millets by adopting Participatory Varietal Trial, Improved Agronomic Practices like (System in Millet Intensification, Line transplanting, Line sowing, promotion of low-cost liquid organic manure, use of cycle weeder etc). Farmers are supported for cultivation incentives as measure inputs. Community Managed Seed System (CMSS) are established in cluster level to produce, procure and supply quality seed to the farmers through Nodal CBO/FPO, Custom Hiring Centres (CHC) are established in cluster level to support agricultural implements on hiring basis. All these systems are easily accessible, acceptable, affordable and available to farmers through Community Resource Persons at Panchayat level. In collaboration with Tribal Development Cooperation and Corporation Odisha Limited (TDCCOL) facilities are provided at GP level to sell their surplus amount with Minimum Support Price (MSP) declared by Government of India.

STRATEGIES OF OMM ON PRODUCTION ENHANCEMENT

Step – I: 30 blocks from seven districts were selected for implementation of millets activities by involving maximum millet growing farmers. In each block one Facilitating Agency/NGO is selected to monitor, execution, training and data collection of millet growing farmers on consumption, production, extension and marketing aspects.

Step – II: Programme Secretary (WASSAN) has organized district level training & demonstration on Agronomic practices of Production enhancement and supported pedagogic materials to follow up during cultivation and monitoring of crop.



Step – III: Farmers' incentives are supported to reduce cost of cultivation by Department of Agriculture and Food Production, Odisha through Direct Transfer Benefit (DBT)

Step – IV: Promotion of System of Millets Intensification (SMI) in large scale through awareness, demonstrations, trainings, field exposures etc by Facilitating Agencies through CRPs and Progressive farmers

Step – V: Establishment of Custom Hiring Centers (CHC) at Gram Panchayat level by Community based Organization (CBO)/Farmers Producer Organizations (FPO) to support agriculture gadgets or implements like – weeder, marker, sprayer, bio-pesticides, thresher-cum-pearlier, diesel operated pumpsets on hiring basis to protect and growth of crops.

Step – VI: Establishment of Community Managed Seed Centers (CMSS) at Gram Panchayat level to grow, supply and sale the quality seed materials through CBO/FPO. The bank is well equipped with moisture meter, polythene, gunny bags, bamboo baskets and electronic weighing machine.

RESULTS & DISCUSSIONS

Odisha Millets Mission adopted SMI with low cost, locally available and farmers friendly organic fertilizers for crop growth and protection. In traditional practices farmers are broadcasted ragi in their bounded or unbounded uplands both in solo, Inter and mixed cultivation. From the baseline survey it was found that more than 60% farmers are small and marginal they could not utilize their ragi production as diet for round the year due to low productivity. They are least aware about improved method of cultivation i.e, SRI in Rice or Line transplanting in Rice. They have given second preferences to Ragi intercultural activities as there is a large number of labour deficiency inside the village and also they have poor economy. Due to low return from ragi, some of the farmers are diverted towards plantation crop or cash crop like eucalyptus and cotton. In these crops the traders are providing advance and agriculture inputs from the beginning and procure at the harvest in case of cotton and after five years in case of eucalyptus. But still the farmers of those seven districts never give up millets even if there is low productivity.

Looking after millets diversification, farmers experience on ragi cultivation and food habits on millet consumption, OMM implement SMI for solo cultivation of ragi to increase the productivity. A package of practices develop which to help the small and marginal farmers on increase in productivity by adopting low-cost technologies. (Annexure – 1). Number of formal and informal village meetings, focus group discussions, personal counselling, trainings and demonstrations has been conducted through WASSAN, FAs, CRPs & CBOs to farming communities with shouldering all hard work & pain.

8000 farmers are cultivated Ragi in an area of 3000ha in seven districts. Out of them 50% area covered under System of Millet intensification. The crop cutting report says the 60% yield has been increased in SMI from traditional cultivation. The farmers can save ragi for consumption for whole the year and also surplus to strengthen the family economy.



Annexure - I : AGRONOMIC PRACTICES OF SMI

Practices	SMI
Seed rate (acre) having more than 80% Germination	500gm
Seed treatment	Bijamruta (1-2lit)
Nursery bed preparation	Size: (5 x 1 x 0.15) for 5 beds and water canal of 0.30m between the bed
Application of FYM	2ql
Application of Jivamruta	1:10 after 5days
Sowing	Mix 1:12 fine sand or fine FYM with seed and sow in line on bed
Age of seedlings on planting	15-20days
Uprooting & planting	Uproot the seedlings along with soil and plant in square (25 x 25)cm
FYM application in main field	30ql/acre
Seedlings /hill	Plant One seedling into 1inch inside the soil
Weeding	Three weeding by Cycle weeder on both way in 15 days interval after DAT
Application of Jivamruta	1:10 Jivamruta one day after weeding
Application of Handikhata	1:40 after 15days of 3rd weeding
Log rolling	Using a light rolling log press down the seedling bending them without damage after 2nd weeding in one direction
Control over fungal disease (blast & brown spot)	Boil 1kg wild Tulsi leaves in 2lit of water and spray this solution @2ml/lit of water for twice at 15 days intervals
Bacterial leaf blight	Spray a solution of cow dung slurry 20kg mixed in 200 litres of water, filtered and diluted with 50 litres of water
Sucking pest (Aphids)	Spray garlic extract (100gms crushed and mixed 50 lit of water) or apply manure prepared using Adhatoda vasica (BASANGA) Apply Neem oil (3ml/lit)



Practices SMI

- Boring pest (stem borer)** Crush 3 kg neem leaves in 10 lit cow urine
Crush 2 kg custard apple leaf, 2 kg papaya leaf, 2 kg pomegranate leaves, 2 kg guava leaves in water.
Mix the two and boil 5 times at some interval till it becomes half
Keep for 24 hrs, then filter squeeze the extract.
Dilute 2-2.5 lit of this extract to 100 lit for 1 acre.
- Rouging** Rouging out the off type
- Seed Selection** Select mother ear head from the middle of the plot
- Harvesting** 80% of ear head turn brown

CROP CUTTING EXPERIMENTS REPORTS ON SMI (RAGI) - 2017-18 (FROM 7 DISTRICTS)

SI No	District	No of Blocks	SMI		
			No of CCE	Lowest Yield (ql/ha)	Highest Yield (ql/ha)
1	GAJAPATI	4	22	10.40	34.00
2	KALAHANDI	4	5	9.00	12.40
3	KANDHAMAL	4	8	9.69	16.00
4	KORAPUT	7	141	16.18	32.80
5	MALKANGIRI	10	35	10.73	33.80
6	NUAPADA	3	8	11.60	19.50
7	RAYAGADA	3	13	16.20	34.60



SECTION - 23

MR AJIT SAHU
 CEO, Taptapani FPO
 MR NAGENDRA NANDI
 SACAL

AN FPO JOURNEY WITH ODISHA MILLETS MISSION IN MOHANA BLOCK OF GAJAPATI DISTRICT

Taptapani Farmer Producer Company Limited formerly known as (TFPCL), was been established in the year 2015-16 to promote farmers through a vision for their upliftment and their livelihood in Mohana block. It has always redefined its position monthly through constant innovation and extension of its position. Its desires to expand its operation and increase the efficiency by continues improvement. It is pertinent to mention that there is active farmers association involved in organic farming. The awareness of affluent classes and rural societies on use of organic foods constantly growing in the state as well. Above all, the Indian domestic market being quite large, there is ample opportunity for marketing organic products in the country.

TFPCL IN NUT CELL

Taptapani Farmers Producers Company Limited (TFPCL) is one of the emerging farmers companies inspired and promoted by SACAL and supported by NABARD registered on 18.07.2016 under section 465(1) bearing incorporation no. U011100R2016PTC025536, of the companies Act 2013 based at Chandiput, Mohana Block of Gajapati District. Initiated by 10 Board of Directors now reached to 715 shareholder farmers. A share capital of 500,000(five lakhs) generated and obtained cash credit limit of 450000(four lakh fifty thousand) from its bank.

The aim is to bring all the farmers into a single platform where they will have greater control over the local market and thus provide increased bargaining power

It is impressive to get a glimpse of the humble beginning and development of the Tribals in the Mohana areas. Which initially cherished to provide welfare and development, with dedication, devotion, commitment and sincerity, for the weaker sections of the communities, which were relatively deprived, marginalized and isolated due to geo-historical and socio-political factors.

The initial phase which advocated welfare measures in consonance with our national policy was expanded subsequently by inclusion of planned development intervention. Keeping in view the policy issues and options, and for a smooth execution of activities



THE MILESTONE OF MILLET INCLUDED IN TRIBALS FOOD PLATE

As of our Past experience in concerned with Tribal society we were happened to inter related with tribal society for last 20 years ago, millet would used to be the main crop for Tribals families. The variety of millet foods were been the daily diet chart included in every tribal food plate. It happened be the source of their livelihood in due course of time the Tribals got entangled with facilitation of the Tibetans proposals, as the Tibetans entered into the community they slowly got converted with the exposure of the maize cultivation in the Mohana block.

With the penetrable gap in-between the Tribal communities, it gave emance chance for the Tibetans to establish themselves in their regular traditional lives of the tribal belt in Mohana Block.

The maize cultivation was widely spread in this region of Mohana belt, the maize cultivation reached the peak as commercial crop but these tribes could not come out of the vicious sphere and were entangled with that Crop cultivation.

As we SACAL were working in the communities of the tribal areas, since last 20 years together with a complete knowledge of this particular tribal area, we could organized programmes related towards the upliftment and welfare of the tribal population in different mode of operand to provide better services for the tribes. Sacal recognized that the basic maize cultivation was also known as commercial crop.

SACAL had been working in Mohana block since last 20 years. Recognizing the core drawback of the tribal population was to get them rid out of the problems which they were and are facing since they started cultivating maize in their farm lands.

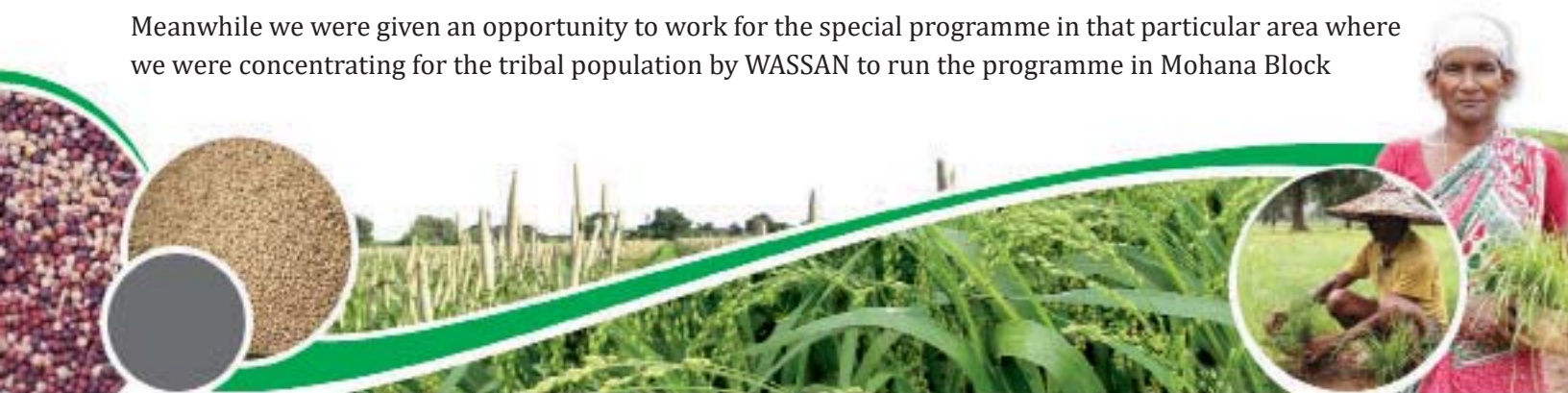
We could establish that Millets are an integral part of tribal life and a staple diet of Tribals of Odisha since time immemorial. Millet is grown mostly in rain deficit areas by the small and marginal farmers.

In due course of time Sacal had organized ample programmes in these areas of Tribals such as we had a intension of diverting the mental tendency towards the RAGI millet crop cultivation through our programme like organizing SEED MELA in villages of Mohana areas.

We in those tough time, we presented a procedure of SEED COLLECTION & SEED EXCHANGES, alongwith these activities in the programme we again organized food festivals in the village level to reorganize the revival nutrition values of the daily diet.

As in the time span Government of Odisha came up with a programme along with the support of WASSAN with SPECIAL PROGRAMME ON MILLET MISSION in Gajapati district which was a fruitful support for to enhance ourselves to get established with Govt. And WASSAN'S Banner,

Meanwhile we were given an opportunity to work for the special programme in that particular area where we were concentrating for the tribal population by WASSAN to run the programme in Mohana Block



On the ongoing process we have organized a processing unit as TFPCL in Mohana Block

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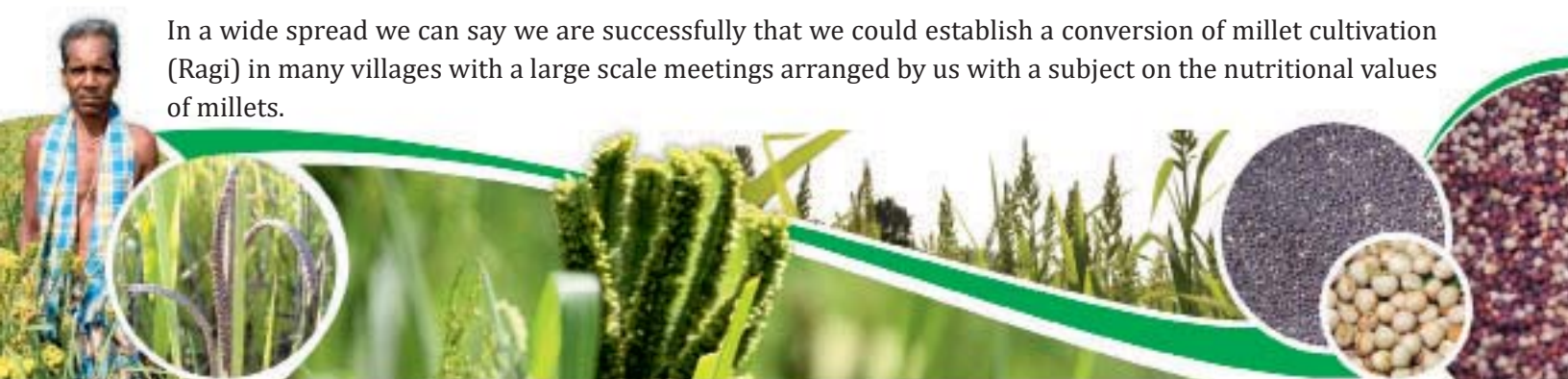
The initial phase which advocated welfare measures in consonance with our national policy was expanded subsequently by inclusion of planned development intervention. Keeping in view the policy issues and options, and for a smooth execution of activities.

1. Aggregation & Marketing
2. Input distribution
3. Value addition,
4. Processing Unit: 1 Nos
5. Custom Hiring centre operation 2 Nos
6. Running Community Managed Seed centre 2 Nos

In a large way to speak we have started Kiosks in Luhagudi and Mohana keeping an eye of spreading a message to the tribal public locally to establish an awareness of value addition to the millets specially on RAGI.

In the continuous process we are in the track of spreading exchange values given by the technical support from WASSAN and AGRICULTURE DEPARTMENT OF ODISHA. We still undergo the procedure of the aforesaid programme conducting meetings in the village level fight against the eradication of MAIZE cultivation in Mohana Block through village development committee (VDC).

In a wide spread we can say we are successfully that we could establish a conversion of millet cultivation (Ragi) in many villages with a large scale meetings arranged by us with a subject on the nutritional values of millets.



With the help of the KIOSK'S established at LUHAGUDU & MOHANA which have tried to literate the general public and the tribal public of the value addition items for their intake as daily diet.

We were been supported by the programme to gain vast exposure into the subject of value additions to different millets through which we could be used their daily diet.

With a cordial and official support by both of the esteemed Organizations "WASSAN & Govt of Odisha we could establish strengths in learning and wide spread of the Programme "Millet Mission Odisha"

Mission To provide reliable, prompt, efficient, transparent, cost effective organic product for the farmers and for the need base of the customers in the market.

We have undergone plenty many training sessions in house and outside the state such DELHI, VISAKHAPATNAM, KOLKOTTA, SRIKAKULAM and many others out of state programmes organized by the support of WASSAN and AGRICULTURE DEAPARTMENTS OF ODISHA which has given us immense knowledge to handle the situation and undergo with easy process into the programme.

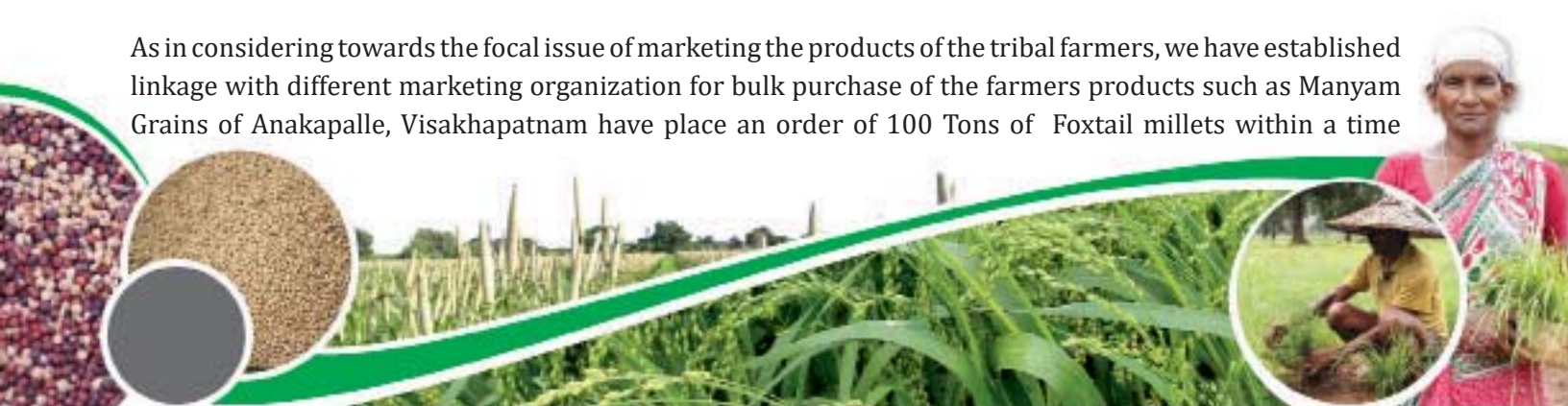
We have learned the maximum valuable knowledge acquired through the exposure visits supported by the programme of Millet Mission Odisha.

TFPCL has an innovative concept and improvements with its unique features in its portfolio. It has been excited in ambition growth plans and it's committed towards futuristic recommend growth stairs. We are excited to redefine the contours of the farmer's upliftment by delivering the qualitative services within time frame structure. That the TFPCL premises comprises of an manufacturing/processing unit with office, guest house and area storage of furnished goods and raw materials with workshop spread in the sprawling campus. TFPCL has a state of art integrated production fund processing facilities for farmer & other Local public. The producing and processing unit is situated in a whole developed road network .The unit is a easy reach for every farmer. This unit is integrated with fully experienced experts for the facilitating purpose of the farmer in Mohana block.

We have introduced different training programmes for the tribal farmers in possible classroom trainings and on field trainings such as Seed treatment, Compost preparation, Use of organic fertilizers, Line sowing and weeding practices, Seed conservation, Water and soil moisture conservation, Demonstration of bulck driven implements and its use, Wedder application, Thresher use for FAQ standard, Promotion of Millet crop, Promotion of vegetable crop, Promotion of paddy in SRI, Promotion of tuber crop, Processing, value addition and marketing of millet food, Leaf plate, Spices like turmeric, ginger.

Apart all in the programme we have worked in an enhanced way for the farmers both those who are registered and those who are not registered with TFPCL.

As in considering towards the focal issue of marketing the products of the tribal farmers, we have established linkage with different marketing organization for bulk purchase of the farmers products such as Manyam Grains of Anakapalle, Visakhapatnam have place an order of 100 Tons of Foxtail millets within a time



frame of six months. We have our plans to deliver the order in the time span occupied procuring from the farmers of the tribal area of Mohana Area. We have obtained a license for input supply from ORISEEDS Corporation for paddy, Dhanicha and other millets, cereals and pulses crops. We have obtained retailer license for organic fertilizer supply for the farmers and other needy public of the Mohana Block. TFPCL has obtained license for procurement of surplus agricultural product on millets and maize from RMC, Paralakhemundi, Synthesis of the farmers growth aspect we acquired a terminology as an Agreement with TDCC to procure and supply MFP to TDCC on MSP adding an additional part helpful for the farmers we based on the terms needed for legal support we have gone for the Membership with the Regulated Market committee, Paralakhemundi, Experimented mushroom cultivation with 22 farmers and it worked out well, and Supplied 500 vegetable kits to its shareholder farmers, slowly the demand has started increasing in the farmers society as the farmers have started cultivating Vegetables, instead waiting time and land.

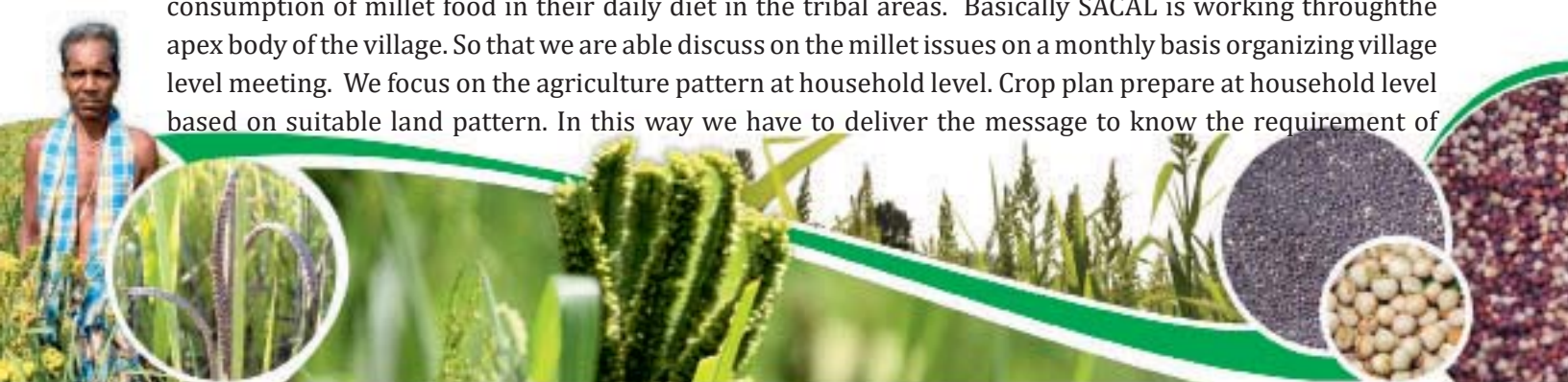
In addition to all aspects of the farmers we undergo a monthly meeting to undertake the Challenges in Marketing Commodities and get solution for the farmers if any other issues arises which has to be undertaken by the FPO and provide solution immediately up to the farmers satisfaction, To enhance livelihood and economical growth we have provided vegetable seeds to the intending 160 farmers during 2018-19 financial year , We are registered with FSSAI, Trademark and GST and all legal formula ties are been completed to beat the market completion.

With best efforts we have cultivated strengths into the farmers establishments of their livelihood and at end results of the tribal population aggressively following our programme.

The special programme ODISHA MILLET MISSION was started in the year 2016 in the tribal areas of Mohana block. This programme provided the different types of trainings, exposures, seeds support and also farm tools. Since then the farmers are getting incentive on millet cultivation .It depends on the method adopted by the farmer. In case of SMI method Govt supports Rs.2000 per acre for the purchasing of farm tools and necessary organic inputs and By the method of Line transplanting govt. supported Rs.1000. Increase the demand of millets when the programme came in to tribal areas. We were also demonstrating the various type of Millet recipes at Anganwadi centre, School etc. Due to the millet foods are rich in nutrition value it got approved to supply the Anganwadi center one day per week. In the programme the involvement has widely been spread which has changed the moral thought towards millet cultivation, as we have planned to organize meeting in house and outdoor at village level to re-organize the farmers to go ahead with millet cultivation and let them revive the past with modern methods and modern equipments provided by the” MILLET MISSION ODISHA”.

As we have marked lot of tribal farmers changed the mindset of the nutritional values in millets, they are ready to enchase the values of the millet cultivation as Govt. has assured them for a (MSP).

SACAL as an organization has cultivated the awareness in tribal belts of Mohana for cultivation and consumption of millet food in their daily diet in the tribal areas. Basically SACAL is working through the apex body of the village. So that we are able discuss on the millet issues on a monthly basis organizing village level meeting. We focus on the agriculture pattern at household level. Crop plan prepare at household level based on suitable land pattern. In this way we have to deliver the message to know the requirement of



seeds quantity and variety. Stepwise we have arranged a seed exchange mela at Village level and GP level. It is been arranged in between village to village. We have arranged conditional collection of variety of millet seeds from the farmers and spread in different location of Mohana block

It is the turning point to motivate the farmers towards millet crop as their prime product and cultivation. Using more technology at this point of time to process the millet grains. On other hand making availability for the tribal farmers at this time period and it will be a time taken process but as well as it would be hard to formulate the process to get established.

One of the main cause is at urban there are certain questions arising towards the acceptancy of the millets in the urban society related towards the values of millet grains at Urban areas. It has to in an awareness programme to enable the millet mission that, what is millet? And etc.

Government has the proposal to introduce in mid-day meal. Now Govt of Odisha has proposed to purchase the ragi millet at Rs.31.50 this financial year. Every house hold will be given 1kg ragi In PDS format.

It is one of the first agriculture initiatives whose primary objective is to increase local consumption instead of production. Increase of consumption of millets in rural and urban areas, Setup decentralized processing units, Improve productivity, better marketing for better price realization

Inclusion of millets in food, Many promotional rallies, food festivals, and competitions were organized both in rural and urban areas to change the mindset of people around millets

Massive awareness campaigns were launched.





SECTION - 24

MR SASANKA SSEKHAR SAHOO
Pradan Ngo, Lamtaput, Koraput

CHANGE IN WOMEN'S LIFE & HER FAMILY AFTER ADOPTING SRI PRINCIPLES IN FINGER MILLET

Change and transformation is not a one day practice, neither a random outcome. It takes proper planning, taking ownership over the planning and execution. From the year 2012 to 2019 women farmer gone through a transformation journey over their primary livelihood and major food crop i.e Finger Millet. They changed their life from no time to have time, no care to careful, food insufficiency to agricultural income, Manual to mechanisation and most important is men's less engagement to men's more engagement in Finger Millet cultivation. All the above change happened due to adopting SRI principle in Finger Millet cultivation. Yes, they smiled, they laughed not because they haven't earlier but because their work got easier through this journey. And currently every woman of Lamtaput is confidently and loudly saying to outer world "i am a farmer"

Koraput- the land of emerald heights, undulating meadows, roaring rapids, enchanting waterfalls, terraced valleys and verdant hills- occupies a unique place of pride in the State of Orissa. However, in spite of its natural beauty bounties of natural and mineral resources and favourable bioclimatic, the district is in famous as one of the most backward district of the country and characterized by high incidence of poverty, incidence of malnutrition, hunger, low level of literacy, unemployment, high concentration of tribe's, agrarian economy, poor infrastructure, highly degraded land, hilly terrain and remoteness, vulnerable conditions and low income level of people.

Lamtaput is one block in Koraput district. It is situated with the boarder of Malkangiri District and Andhra Pradesh state. Block is full of Hilly terrain with no forest and surrounded by three power project reservoir. As in an underdeveloped economy, agriculture and allied activities provide the main source of livelihood and employment. Traditionally people take up agriculture along with animal husbandry and collection of minor forest produces. Agriculture is the primary livelihood for almost 70-80 percent households of Lamtaput, many of them have to depend upon only rain-fed agriculture due to very poor irrigation facilities available.



People used to take boiled finger millet (Mandia Jau) as major food in their plate in the whole day. So they give more focus on Finger millet cultivation in rainy season as only depends on rain fed agriculture. Farmers of lamtaput block usually cultivate Paddy and Millet as major crop and some vegetables in their backyard land for consumption purposes. Which is totally based on traditionally practices and women are the major role player in this cultivating crops. Traditional practices of crop was totally more expensive, laborious and less productive.



Previously some farmers of Lamtaput block have experienced Paddy cultivation in SRI principle with the help and support of agriculture department. But Finger Millet (Vairabi – Variety) was cultivated in that principle (SFMI) with 33 farmers of Majhaput Village in the Financial Year 2012-13 as demonstration by PRADAN, NGO. After the success of demonstration, this principle scaled to other nearby villages.

This SFMI principle has a great impact for women's life and her family. Women are the backbone of agricultural workforce because they perform more than 80 per cent of farm activities. Excluding ploughing women does every labour work in Finger millet cultivation. After broadcasting women major task was to clean weed from her Millet plot which will took 40 to 50 days in the heavy rain in rainy season. Not only women of family engage to do weeding but also her children are force to engage. But 80-90% men are not involved to do this laborious work. Many farming and allied activities performed by women involve a lot of physical strain which adversely affect their work efficiency and lead to several types of occupational health hazards. And also because of this long engagement (from morning 9.00 am to 5.00 p.m-40/50days continuously) in rain and in field, they face various type of health issues like fever, headache, body pain, back pain, hand and palm cutting due to weeds, different insects bites, snake bites etc.

Secondly when women involve in weeding millet and paddy in rainy season for a long days they are not able to do any other crop for marketable purposes.

When different women friendly farm equipment like Line marker, dry land weeder, roller, power sprayer, thresher cum winner introduced with SFMI principle then the manual weeding and other manual work shifted to machinery and major labour work shifted from women to men.

Farmer adopted the following steps in SFMI for increasing productivity:

- Seed treatment
- Seed bed preparation and treatment
- Nursery rising



- Proper care in nursery
- Back up nursery preparation to deal with unpredictable weather.
- Early seedling transplantation.
- Maintaining equal space during transplantation using Line marker. (plant to plant and row to row- 10"*10").
- Using of three times dry land weeder for weeding and hoeing in every 15 days regular interval after transplantation.
- Using three time FYM in the field during weeding and organic products like Jibamrita and Handikhata for healthy crop (Nutrition and pest management).
- Using one time roller rolling on field for getting more tillers in the plant.
- Quality seed selection and preservation for next year cultivation



Different organic products used by farmer



Weeding: Life of women and her children in traditional practices

By adopting this SFMI principle farmer gets following benefits

- Minimise their labour due to introduction of mechanisation (Manual work shifted to machine)
- More work shifted from women to men and women have some time to take her body rest.
- Farmer gets more time for doing other vegetables for marketable purposes along with millet cultivation.
- Health and environmental issue reduces.
- Most importantly this principle reduces expenses and increases productivity (more than 2-3 times from traditional practice of cultivation)
- Meet round the year food sufficiency.





When Odisha Millet Mission starts it brings other benefits to farmer and her family along with increasing productivity of the Finger Millet land. Farmer can able to do more area of Finger Millet, Little Millet and Fox tail millet though she is getting some incentive for doing cultivation. Young generation and children are taking millet through different modern and their local recipes like Pakudi, Bara, Dosha, Khir, halwa, Manda, Idli, Ladoo, Lashi, shup etc...And through MDM and Anganwadi centre children are aware about the benefit of millet in their health. Through Govt. Mandi for purchasing Finger millet directly from farmer increases MRP from RS 16 to 28.97. Through rising in MRP people gets more money. AS we are discussing that, women have a crucial and major role in agriculture but she always got identity and treat as a labour in her land. But Lamtaput women farmer got their identity as a farmer from this Odisha Millet Mission project. Now women are registered in Mandi for selling Finger Millet, and make their DBT card for getting crop Incentive money. And also in Lamtaput block Narishakti Mahila Mahasangha (women federation) taken care of this Odisha Millet Mission project for Lamtaput block.



SHARING OF WOMEN FARMER

“It has become easier for me, now I don’t have to sit whole day weeding grass on field”

Farmer: Maina Krishani
Village: Kangrapada

I hire tools from CHC, I came to know about its uses during training and hence I am using it. I even told my husband and my neighbors’ about the benefits of it”,

Farmer: Bhagabati Malik
Village: Dabuguda



With use of battery sprayer, my hand pain has reduced drastically and my work got finished within 30 minutes. Last year, I had experience of shoulder pain after spraying”,

Farmer: Dalima kumbhar
Village: Majhaput

