God’s Own Crops
National Consultation On Millets
Hyderabad, June 5 & 6, 2008
The book also contains a DVD showing a film 'Milets-The Miracle Grains'
See the inside of back cover for this.
God’s Own Crops
National Consultation On Millets
National Institute of Rural Development, Hyderabad
June 5 & 6, 2008

Millet Network of India

National Institute for Rural Development

Deccan Development Society

Supported by
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God’s Own Crops

Report of a
National Consultation On Millets
organised by the Millet Network of India, Hyderabad
June 5 & 6, 2008

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We live in an age that is witnessing an unprecedented agrarian crisis compounded by catastrophic climate change and growing food shortages. This has led to an alarming surge in search of pat solutions. More alarmingly, this search is led by a predatory biotech industry, closely followed by an emerging eco-industry. This profit-hungry private sector is offering solutions that assure a remedy worse than the disease itself. We in the MINI, Millet Network of India, do not see millets just as crops. For us millet is a concept embedded in our people’s food cultures, agricultural practices and above all its ability to help the millet farmer make her/his agriculture autonomous. The remarkable possibility that millets offer for an internal input based farming, free from chemicals and corporates make them the new age answer to a new age crisis. Through their versatility, millets show us the way out of the web of disaster we have woven around our food and farming future.

Our current development discourse is riddled with a series of insecurities. We truly believe that the damage done in the name of ‘farming advances’ can be repaired only by handing the leadership to farmers, women and the excluded who through their awesome knowledge of farming and nature can bring back sanity to our development thinking. It is against this background that we must notice the eminent role millets can play in reinvigorating the agriculture sector. Food, farming, water, energy, climate change --- name the crisis, and test the resourcefulness of millets to respond to it - you will be in for a revelation. One just wonders why our development thinkers and policy planners failed to notice the awesome range of millet magic!. Over 65% of the Indian farmlands are under rainfed conditions, and millets are ideally at home here. Therefore, the rejuvenation of millet farming, continuously undermined by the Green Revolution protagonists, is the only way we can ensure our food, fodder, health, nutrition, livelihood and ecological securities. It is time for us to work towards an Out of the Box solution.

The National Consultation on Millets, organized by the Millet Network of India and Deccan Development Society in collaboration with the National Institute for Rural Development was an effort in this direction. For two days, farmers, activists, academics, environmentalists, policy makers and scientists sat together to debate and discuss the ways and means of reinventing millets and put them at the centre of our agrarian policy space.
The publication in your hand is an eloquent summary of the issues discussed, ideas offered and the actions contemplated in this Consultation. If this document compels the policy makers, agricultural and development academia and social activists to take a relook at millets, with a new fascination for them, then the purpose of the National Consultation will have been achieved. The Hyderabad Declaration on Millets, at the end of this report is a call for action. The Millet Network of India invites everyone who welcomes the ‘concept that is millet’ to engage in this action.

Misereor, from Germany and the National Institute for Rural Development deserve our deepest gratitude for enabling this Consultation to happen. My colleague Ms Cherukuri Jayasri worked very hard to get this publication out and she deserves my sincere thanks. Yesu and Mayuri provided the photographs for the publication and my special thanks to them. Ms Kanchi Kohli who wrote this report and Dr Raghavendra Manvi who edited it have provided us a succinct document. They merit my earnest thanks. I acknowledge the excellent work done by Ms Supriya Bhalerao who has designed and printed this publication with a lot of love and care.

Hyderabad
August 2, 2008

P V Satheesh
Convenor, MINI [Millet Network of India]
Director, Deccan Development Society
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Millets are truly miracle grains. They can grow on the most marginalized soils - without irrigation, and with very little or sometimes no external inputs. They are veritable storehouses of health and nutrition. Besides, millets are also the pivot around which a vibrant agrobiodiversity survives, wherever it is allowed to survive.
Background

Millets, with the Deccan Development Society believes as *God’s Own Crops*, are truly wonder grains. They can grow on the most marginalized soils—without irrigation, and with very little or sometimes no external inputs. They are veritable storehouses of health and nutrition. Besides, millets are also the pivot around which a vibrant agrobiodiversity survives, wherever it is allowed to survive.

But unfortunately over the decades, the state policies have progressively eroded both the millets as well as all the brilliant farming systems they have represented. Consequently, hundreds of thousands of hectares dedicated to growing millets have degenerated into cultivable fallows, and their size currently stands at a massive 30 million hectares. The millet acreage over the last couple of decades has shrunk from 18 million hectares to 9 million hectares, thus depriving the poor of their nutritional food, livelihood, security and control over their farming.

On the other hand, the recent trend has seen the millets moving away from the poor and falling into the hands of the rich to serve their elite needs. ITC has already engaged farmers in AP and Maharashtra in a contract farming arrangement for millet production. It is eyeing 50,000 villages in the country over the next few years for this initiative, ironically funded by none other than the World Bank.

This move, on the one hand, might be good for millet production. But on the other, it does something grave: it shifts the control from farmers and the poor to the huge corporates, and destroys the seed diversity by replacing the local landraces with High Yielding Varieties (HYVs) and hybrids. It will institutionalize monocultures on lands which always had rich biodiversity and destroy the last niches of ecological dryland farming, and usher in chemical, irrigated production of millets. Therefore for us in the civil society, restoring millets to their past glory and making them the food sovereignty farming of the people of the county becomes an urgent need.

It is against this background that the initiative, ‘MINI, Millet Network of India’ undertaken by the Deccan Development Society in October 2007 assumes a great significance. The Deccan Development Society has been working with millets for the last two decades; pioneering an Alternative Public Distribution System (APDS) based on millets; creating over a 100 millet dominant community seed banks; rejuvenating a food culture through food festivals and an all millet restaurant called *Café Ethnic*; and continuously putting pressure on the policy makers to realize the inevitability of falling back on millets.
The present consultation was envisaged towards building a larger network of people steadfastly working with millets or thinking about them, undeterred by their historical neglect. The broad idea was to put strengths together, to brainstorm and to set an agenda for collective action. It was also envisioned to look at the culture, cultivation and cuisine of millets and find out how their profile could be built, to be able to advance the policy framework around millets.

The workshop had an interesting range of polarized, and yet converging views on the agenda of millets as well as the strategies to promote them. It also gave the participants a first hand flavour of millets through the option of millet based drink instead of tea and coffee and a full breakfast and lunch menu cooked with various millets.

Table 1: Millet Diversity in India

The names of millets have been interchangeably used by speakers in the Consultation according to what they are called in their region. The table below could be used as a reference to understand which kind of millet they are referring to.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Botanical Name</th>
<th>Vernacular Names</th>
<th>Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little Millet</td>
<td>Panicum sumatrense Roth ex Roem. &amp; Schult</td>
<td>Sama (Telugu, Hindi)</td>
<td>India</td>
</tr>
<tr>
<td>Kodo Millet</td>
<td>Paspalum Scrobiculatum L.</td>
<td>Arikelu (Telugu), Khododhan (Hindi), Kodara (Sanskrit)</td>
<td>India</td>
</tr>
<tr>
<td>Italian Millet</td>
<td>Setaria italica (L.) P. Beavu.</td>
<td>Korra (Telugu), Kangi (Hindi), Kanguni (Sanskrit)</td>
<td>China</td>
</tr>
<tr>
<td>Proso Millet</td>
<td>Panicum miliaceum L.</td>
<td>Varaga (Telugu), Cheña (Hindi),</td>
<td>China</td>
</tr>
<tr>
<td>Barnyard Millet</td>
<td>Echinochloa frumentacea Link</td>
<td>Bontashama/ Oodalu (Telugu), Sanwa/ Jhangora (Hindi)</td>
<td>China</td>
</tr>
<tr>
<td>Finger Millet</td>
<td>Eleusine coracana Gaertn.</td>
<td>Ragi/ Tayadalu (Telugu), Mandua (Hindi), Rajika (Sanskrit)</td>
<td>Africa</td>
</tr>
<tr>
<td>Pearl Millet</td>
<td>Pennisetum americanum (L.) Leeke</td>
<td>Gantlu/ Sajjalu (Telugu), Bajra (Hindi), Varjari (Sanskrit)</td>
<td>Africa</td>
</tr>
</tbody>
</table>

Source: Presentation made by K.S. Varaprasad during the workshop
The women farmers from Medak district, Andhra Pradesh, welcomed the panel members of the introductory session with specially decorated millet frames representing the crop diversity of their area. This was followed by a welcome song. Following this, Radhika Rani of NIRD initiated the programme and requested P.V. Satheesh to carry forward the proceedings.

**Introduction**

**P. V. Satheesh**

Director, Deccan Development Society, Hyderabad

P.V. Satheesh began the introduction by explaining the meaning of the song the women farmers rendered before the gathering. The song, he said “takes us through all the rain bearing stars known as *Kaartes* in the local language. Different crops are sown in different *Kaartes* and therefore the song is a veritable list of agrobiodiversity in the region. It is also a reflection of the fantastic knowledge people have of their ecosystems and environments”. He added that “millets are crops which are part of people’s cultures and folklore.”

“It is working with millet farmers for the last twenty years that has made DDS believe that millets are no less than *God’s own crops*. What is important to note is that millets respond to the multiple food and farming challenges of today’s times, including that of climate change. They can grow in harsh environments, with no external inputs, and they can be depended on to make the farmers self-reliant enough to escape the debt trap. Millets, then, are *crops of life* unlike some other crops, such as cotton, which has spelled death as experiences in Maharashtra indicate.”

“The women farmers of Deccan Andhra also call millets *Crops of Truth* (*Satyam Pantalu*). These crops give them six securities: food, fodder, livelihoods, nutrition, health, and ecological. The film by the Community Media Trust,
which comes next will highlight these aspects.”

“There is a need to understand that a crop which has so much to offer has been neglected severely over the decades. Nearly 10 million hectares of millet farms have been rendered fallow over the last three decades. This needs to be analyzed. This has happened as more and more area has come under rice and wheat cultivation. That this should be stopped is no longer an issue but a clear mandate. It is critical to look at how the promotion of certain kinds of crops has led to this scenario.

The loss of millets is not just an agricultural loss, but a civilisational loss.

“At another level, there is an increased corporate interest in millets. There is news that a private company has bought 50,000 acres of land to put it under millet cultivation. There is also the growing research around millets in the United States of America (USA) in order to promote millets as crops to counter the climate change crisis.” These are trends that point to a danger of corporatisation of millets, the crops that were seen till recently as the Farmers Food Sovereignty Crop. Therefore the civil society must come together the privatization of the last public domain in agriculture.

He announced that there would be two presentations; First, a film by the DDS Community Media Trust; and second, a study by Vatturi Srinivas on millet agro-ecosystems in different parts of the country. He said that a summary of the study had already been passed on to the participants.

“This Consultation has brought together a range of people who have been working on millets for several decades. There are farmer leaders, small farmers from Deccan Andhra, and sensitive agriculture and nutritional scientists who have a very important role to play. There are also scientists from ICRISAT, who have joined in for the first time.”

He then introduced the panel members of the introductory session. He said that the Commissioner of Agriculture, D. Srinivasulu could not come as he had to be present elsewhere. Representing him was Mr. M. Subramaniam, Joint Director (Fertilizers), Government of Andhra Pradesh. He requested Mr. Subramaniam to carry the message of the workshop to his department, so that it could wage initiatives to nurture the orphaned millets. He further said that he could see light at the end of the tunnel because both the chief minister and the agriculture minister “are reported to be avid lovers of millets!”

Satheesh also welcomed the other panel members, Dr R. Hampaiah, Chair, AP Biodiversity Board and Mr B.K. Sinha, Director General, National Institute of Rural Development, Government of India’s apex rural development academy. He appreciated the fact that the NIRD had come forward to collaborate on this important topic. Being a top Rural Development institution, “their participation is a blessing.”

He then described the origins of MINI, which he saw as a collective dream. He said that “some people in this room such as Dr Nammalwar from the Tamil Nadu Organic Movement, thought about this along with DDS 10 years back. Since then it has taken nine years for it to get going.” Satheesh acknowledged the role of all those who were part of envisaging the

“Millet have a great answer to all kinds of crisis, including that of water, nutrition and climate change. These crops are an ecological bonus to millet farmers.”

- P.V.Satheesh
need for a network, and then subsequently taking it forward in the last one year. He concluded by saying that “we can breathe a new life into the finest crop that the human civilization has evolved.”

**Millets the Miracle Grains**

*Screening of a film by Community Media Trust*

The film, through vibrant visuals and a strong commentary, puts forth the message that millets are not just food, but are an integral part of the culture of thousands of communities all over the country. In the vast Indian millet landscape, one can find a range of culinary delights. Each region has its own variation of the millet food theme. Further, any food that is culturally so integrated into the lives of communities must be made available to them. Development experts argue that denying such foods can only be termed as political oppression.

It then portrays the vast dryland belt that stretches across the Deccan plateau, Northern Karnataka, Marathwada, the deserts of Rajasthan, the tribal areas in central India and the Himalayas. This is the home of millets, where they are the mainstay of agriculture, diet and the cultural systems of the regions. The film highlights how millets carry the promise of mitigating the miseries of malnutrition prevalent ever so widely in the country. And to crown it all, they can also be trusted to ease the fodder crisis that is plaguing the fate of our livestock.

The film vehemently states that “wanting incentives to farm millets, nearly four million hectares have been left fallow by farmers. Such a fallowisation for a country that never stops talking about the need to feed its billions is nothing short of a scandal.”

But the neglect of millet goes on, while its disdained seed continues to hold on to its sturdy spirit of independence, and grow wherever it puts down roots without much water or the pampering of the status grains. It not only needs less water, but less time, too, to adapt itself effectively to climate change.

In sum, the film rolls on to give clear evidence that millets show a way out of our food, fodder, nutrition and water crises.

It concludes by calling millets “miracle grains.”

**Millets for Agricultural Development**

*M. Subramaniam, Joint Director, Fertilizers (in place of Commissioner for Agriculture), Government of Andhra Pradesh*

Mr. M. Subramaniam Joint Director, Fertilizers, Government of Andhra Pradesh, who was representing Mr. D. Srinivasaulu, Commissioner of Agriculture, began by thanking DDS for taking the initiative, and said that he knew DDS as a group ‘which is enlightening women farmers in Medak district.’ The organization, he said is ‘also working towards encouraging the age old crops like Jowar (Sorghum) and other millets being cultivated in Telangana and Rayalseema where irrigation facilities are not available.’
There is very little land under millet cultivation. The Andhra Pradesh government is trying to educate farmers through Rytu Chetan Yatras for which they are also inviting MLAs and MPs. Through this, the farmers are being informed about various packages which they can avail of and also about credits. These are essentially for rainfed areas.”

“In order to encourage millets, the government is giving Improved and High Yielding Varieties (HYVs) to the farmers. There are several varieties that have been developed earlier, including the ones for Ragi (Finger Millet), Bajra (Pearl millet) and Jowar (Sorghum). It is being done through seed corporations. The government is also carrying out Integrated Pest Management (IPM) demonstrations and Farmer Field Schools in Rayalseema and Telangana areas of Andhra Pradesh.”

He promised that that the Department of Agriculture would try to incorporate the decisions of the workshop wherever possible. He assured the participants that “they are with the millet farmers.”

Millets as Biodiversity Imperative

R. Hampaiah, Chairperson, Andhra Pradesh Biodiversity Board

R. Hampaiah observed that it augured well for the participants that they were meeting on 5th June, the World Environment Day. He hoped that the day would inspire MINI to seek answers to the problems of food shortage and climate change.

He said that there was a time when millets were grown across the country. But following Independence, the agricultural policy shifted towards rice and wheat. There was a clash between a rainfed and irrigated agriculture, as a result of which millets were relegated to the background. At the same time there was a cultural craze for adopting western systems. As a result of this, families forgot about millets and there also developed a social stigma around them. People started believing that millets “are eaten only by the poor. The consumption went down.”

“However today with the increase in ailments like diabetes, millets are back in focus and limelight. People are beginning to eat millets again under medical prescription.”

He declared that the future would see more of millets and less of rice and wheat. “The future is going to be a millet era. It is going to trace a full circle. Millets are very valuable and need to be preserved both in situ and ex situ for the future. Also they need to be saved from countries and corporations who are increasingly trying to patent them.”

Hampaiah took the example of Sona Masuri, a rice variety on which a Malaysian company has taken a trademark. “This is being countered. Such an instance may also happen with millets. We must ensure that all these millet varieties are registered through mechanisms like DNA printing, so that they do not go into the hands of other countries.”
How do I see Millets as a Dryland Organic Farmer

*Bharme Gowda, President, Organic Farming Association of India*

Bharme Gowda spoke to the participants about his experiences and perceptions as a dryland millet growing farmer. He stated that he started cultivation in 1973, and against the advice and warning of his father decided to take up chemical farming with cash crops. During that time most farmers went in for hybrid seeds and high tech crops and quit cultivating millets. It was only after 15 years, in 1988, that he realized that he was wrong and then reverted back to organic farming.

“As we lost millet crops, animal health also deteriorated. The food for the cattle was also made from millets and gram. Today, farmers are dependent on company-produced cattle feeds.”

He observed that it was not the amount of wheat or rice in the government godowns which constituted the benchmark of food security, but the stock of grains that farmers could call their own. He said that farmers in his area “are able to store millet grains for two years through simple, indigenous, non-chemical techniques and can rely on it in case of a drought.”

He further added that irrigation and cash crops “are reasons for farmers’ debt and death. It also leads to degradation of environment, soil and water. In contrast, growing millets is linked with special foods for different festivals and other rituals representing a direct link with culture and lifestyle.”

Bharme Gowda was emphatic in saying that there was an interconnection between people, plants and the land they come from, “so the ideal grains to grow are the ones that are specific to the region.”

He made a request to all the participants to propagate the idea of millets. “In drylands, millets are good yielding-crops with just a little bit of green manure, even when there is no rain. There is a need to use farmer’s methodology, and not the one in the books of the agricultural department.”

Remarks by the Chair

*B.K. Sinha, Director General, National Institute of Rural Development, Hyderabad*

B.K. Sinha initiated his remarks by confessing that he was the most recent convert to millets due to a medical requirement. For him, “this workshop is an eye opener.” He said that he came from Champaan District in Bihar, where Mahatma Gandhi launched his Indigo Campaign against colonial exploitation of India’s resources. He also recalled the availability of a variety of millets in his village, from his childhood. Millets were part of people’s food cycle. “But today they are used as fodder and not as food.”
He then drew attention to Ayurveda which prescribes a different diet for each of the 365 days in a year, and which also includes a number of millets. “The most prosperous Indian community, the Marwaris till date take a piece of a Bajra roti before starting their meal. This was a regular practice earlier, but today it has become just a ritual.”

He said, “Rice and Wheat are in deep crisis. The state of Punjab where farmers have been cultivating food crops for the last 5000-7000 years, the situation has turned so sour that it has got everybody worked up. Indiscriminate use of fertilizers and heavy irrigation has stressed the soil beyond redemption. This distressing situation has also been noticed by the international bodies.”

In this context, Mr Sinha mentioned, “the statement of U.K. Alagh which states that the government should be concerned, as large tracts of land are no longer under cultivation, as people are not able to do so.”

He said that as Joint Secretary in the Ministry of Fertilizers, he used to notice that three major fertilizers were being promoted and not the 12 secondary ones. “Excess use of fertilizers leads to depletion of carbon content in soil. This huge crisis is reflected in the figures of high consumption of fertilizers.”

B.K. Sinha narrated his experience of visiting Barah village in Yavatmal, Maharashtra and watching the farming practices of Subhash Sharma. He hoped that all such practices would be researched.
He finally outlined some of the future plans of NIRD and sought the participation of DDS in it. The plans envisaged upgrading the technology park at the NIRD to include millet farming related technologies. He said that the technology part would be upgraded to a Technology Bank to bring together technologies relevant to various fields of rural farming.

Another future idea was to set up Village Grain Banks in tribal areas, because a major cost of PDS was transportation. The grain banks would devise a system of local acquisition and distribution.

He finally sought cooperation, help and partnership for the proposed initiatives.

**Vote of Thanks**

*A.C. Jena, National Institute of Rural Development, Hyderabad*

A.C. Jena thanked all the panelists of the introductory session and also the delegates from all parts of India. “This is a very original and potential topic for the marginalized sections and crops of India,” he added. He summarized the key focus of all the four presentations highlighting the government schemes, the chronology of the neglect, the revival of millets as well as their relevance for the dryland farmers. “Clearly, the promotion of millets will help solve several food, fodder and nutritional security issues in the country”.

*Workshop in progress*
Vatturi Srinivas, in his presentation highlighted the findings of the study, “Millet-Future of Food and Farming in India” undertaken as part of the project, Promoting Peace and Food Security by Strengthening Biodiversity based Livelihoods, which was funded by South Asian Network on Food, Ecology and Culture (SANFEC) in 2006-07. The purpose of the study was to bring into focus ‘neglected crops’ such as millets, which have been the subject of concern for a large number of communities in South Asia. The issue has gathered additional importance in the context of globalization which is pressuring our government to switch from traditional to technology-based agriculture. The change, powered by the strategies popularized by the Green Revolution, has triggered events that have taken a heavy toll of the rural poor. The profit-oriented technology based agriculture, while compromising the food sovereignty and nutritional security of our farmers, is also endangering the ecological robustness of our agriculture. The study also documented the ground-level, traditional rain-fed farming practices that demonstrate the art of using nature-friendly biodiversity techniques, with a special focus on millet based cropping systems.

He then went on to describe what kinds of crops are considered as millets. Millets primarily constitute a diverse group of small grains. These are usually categorised under ‘Coarse Cereals’ in India and are classified into Major millets and Minor millets (or Small millets). Examples of these were shared.
The presentation highlighted that the study area comprised the arid ecosystem in Bapp region in Rajasthan; Semi-Arid regions of Zaheerabad region in Andhra Pradesh; Satyamangalam in Tamil Nadu; and finally the sub-humid area of Uppari Nagani in Uttarakhand.

**Millet based highly diverse cropping systems**

- *Sarr and Baranaja* in Himalayan Gharwal, where traditional rainfed farming is practiced on the hilltops and hill slopes, and where along with Finger millet, Foxtail millet, Barnyard millet and Proso millet are cultivated.
- ‘Saat dhan’ system in Rajasthan, where farmers with their intimate knowledge of soils manage to cultivate sandy and saline soils in this region, and where Pearl millet based mixed cropping system predominates.
- ‘Pannendu pantalu’ in the Zaheerabad region of Andhra Pradesh, where along with Sorghum, several Small millets are cultivated.
- ‘Ragi pairu’ in Tamil Nadu, where along with Finger millet, a range of Small millets are traditionally cultivated.

Following a detailed description of the kinds of diverse cropping systems in the various regions and the methodology adopted for the study, Vatturi Srinivas presented the key findings of the study, which include:

- The indigenous food farming system is an integration of crops, farm animals and wild or uncultivated plants, which as a ‘total system’, minimises the risks posed by harsh climatic conditions that are common to rainfed regions, and which ensures that farming families are food and nutritionally secure.
- The climatic adaptability of millet is such that about 8 species of millets—Sorghum, Finger millet, Pearl millet, Foxtail millet, Barnyard millet, Proso millet, Kodo millet and Little millet are cultivated across different agro-ecological habitats in India, either as Primary or Allied crops in combination with several other crop species/varieties.
- Farming communities have deliberately selected and manipulated a range of millet species, an approach that reflects a higher degree of genetic variability.
- The local criteria for the quality of millets are primarily based on three aspects of local crops/varieties. These are (i) Agronomic characteristics; (ii) Food and nutritional potential, and (iii) Socio-cultural aspects like rituals and festivals.
- Millet based farming also enables farmers to suitably mix crops to minimise the risk of total crop failure during drought conditions. It reflects farmer’s confidence and faith in the hardness and productive capacity of millets.
- The natural tolerance of millets to storage pests and diseases are considered an added advantage, especially by women.
- Farmers have evolved elaborate techniques for preserving food grains and have gained incredible expertise with respect to the post-harvest and storage of grains. The know-
how of post harvest activities is immense among farm women, who are frequently found threshing, storing, drying, grinding, pounding or sifting food grains at home throughout the year, apart from other work on farmlands.

- Seed selection and storing practices are still in practice, and are deeply interlinked with the socio-cultural norms. In spite of rampant changes in the traditional cropping patterns, several millet landraces continue to remain under cultivation, as they are essential for ritualistic purposes.
- There is a distinct declining trend in the traditional millet based cropping system, and large and medium farmers are overtly inclined towards mono-cropping of non-food cash crops. At the same time most of the small and marginal farmers continue to sow millet based cropping systems.

The presentation also looked at the changing farm scenario, where in recent times, small and marginal farmers are compelled to alter the cropping patterns to reap cash benefits over food/fodder, benefits desired due to economic pressures, market conditions, disabling of local livelihoods, dwindling livestock population, and the small size of land holding.

As its concluding points the presentation highlighted:

- It is imperative for a country like India to encourage dryland farming of food crops such as millets.
- A specialised focus should be on rainfed regions as it continues to accommodate a large number of people (45% of India’s population lives in a Semi-arid habitat).
- The policy thrust should shift to a habitat-specific decentralised ‘agro-diversity based approach’ focused towards peoples’ food and nutritional security at the household-level, rather than the centralised ‘technology based approach.’

He then presented a range of challenges and opportunities ahead to deal with the issue of millets.

Farmers Movement for Regeneration of Rainfed Agriculture

Vijay Jawandhia, Shetkari Sanghatana, (All India Kisan Samanvay Samiti), Maharashtra

Vijay Jawandhia said that unless the Government of India took measures to protect the millets, they would have a hard time gaining ground. He said that not enough attention was being paid to the fate of non-irrigated agriculture in India. Even while the loan waivers are being doled out, there is no mention of the non-irrigated farmer. And to further complicate the situation, all the subsidies are for fertilizers and for irrigation farmers. He said that he came from an area where Jowar was the staple food. The area had a unique traditional system of saving Jowar beneath the earth for three years. All these practices have been lost. Our forefathers were very wise as they rotated cotton and Jowar crop cultivation each year. Jowar is a shallow rooted crop, and cotton a deep rooted one, and both complemented each other in alternate years in terms of
soil nutrition. The farmers earlier were satisfied with this natural system. But it is greed that ate into the soil. Crops like Jowar or sorghum began to be neglected, and so also was animal husbandry. He said that there was an urgent need for direct subsidy and economic support to make rainfed farming possible. He advocated a policy initiative from the government in this direction. Referring to the visit of the Prime Minister, Manohan Singh to his village on 30th June 2006, he said that he had personally requested him to grant a subsidy of Rs.2000 to farmers cultivating Jowar.

He then calculated the current subsidies that are given for sugarcane and presented it to the participants. “For each acre of cultivation, six bags of fertilizers are required. If one compares the global prices of these fertilizers to the subsidized cost at which it is made available, it amounts to Rs.9000 subsidy per acre of sugarcane cultivation.” He questioned as to why the government was not being so generous with regard to millets! Millet is not a poor man’s food, it is a nutritious food. While only 3-4 kg of seeds is required per acre of millets, wheat on the contrary requires 40 kg of seed. Therefore, the economics of farming demands that we grow more millet. There is a crisis today when food prices are soaring in India and across the globe. There is inflation and if a producer does not get returns, how long can he/she go on producing food? How can we continue to import and distribute ‘cheap food’. Just imagine if the farmers of Punjab and Haryana stop producing food or one removes all the subsidies from farming. What will happen? It is only millets which can continue without subsidies.”

He said that the non-irrigated farmer would continue to stand his ground, but there wasn’t enough support to hold and comfort him. “All the benefits are for the irrigated farmer. Even as the fertilizer and food prices are rising, 60% of the land remains under non-irrigated agriculture. The message is clear; there is a critical need to support millets if Indian agriculture needs to survive.”

**Seed Banks Experiment in Eastern Maharashtra**

_Balnath Sonawane, Lokpanchayat, Maharashtra_

Balanath Sonavane presented the work of Lokpanchayat in Maharashtra. He first shared with the participants the context and area of their work in Western Maharashtra and how the organization goes about engaging with the farmers in the region. Lokpanchayat is working with watershed development; Krushakpanchayat; women’s empowerment; women’s social security program; Liberate School Project and Rural Young Professional Training Program. He then discussed the Lokpanchayat’s geographical zones of work and the hurdles in their sustainable agriculture programme. For instance, in the hilly areas there are high slopes and degraded lands. In the drought prone regions there are problems of migration, deforestation, lack of biomass, lack of organic inputs, scarcity of animals and water. For river built areas the issues are related to salinity of land due to over irrigation and poor quality of soil because of chemical practice.
The major activities of Lokpanchayat vis-à-vis Biodiversity conservation include seed collection in 60 villages where 500 farmers were approached for this purpose. 121 types of indigenous seeds were collected and checked for germination. He said that “the organisation has succeeded in conserving the seeds of many varieties of grains, pulses, vegetables and oil seeds. They are being distributed by the Women’s Self Help Groups (SHGs). A seed bank has also been established in Sangamner at the block level and is being looked after by the Seed Management Committee of the village community. Further, Lokpanchayat has established a partnership with a private company, ITC to bring 300 acres of land under organic farming. This will help farmers to connect with the market through which they can economically benefit,” he observed.

Sonavane indicated that some varieties of millets have been totally lost in the area which includes grains known locally as *Batu* and *Khandia*. There is no knowledge about this even in the agricultural universities. These grains are very nutritious and were used extensively earlier. He concluded by outlining the future plans of Lokpanchayat which included setting up a company or an NGO with a sustainable structure for farmers.

**Disappearing of Millets, Shrinking Food Security**

*Jogi Naidu, Sarada Valley Development Samiti, Visakhapatnam, Andhra Pradesh*

Jogi Naidu began his presentation by stating that all the millets are in drylands. There is a need for dryland agriculture because it helps in food security, represents diversity, and allows for labour employment. Dryland agriculture also supports healthy nutritional food as well as cultural sovereignty.

He observed that despite the awareness of the importance of millets for food and fodder, “millets are still finding it hard to retain their place; and it is critical to ask why this is happening! There is also a difference in the old and the new ways of looking at the millets. Many look at it more like medicine than food. Earlier they were staple food, but now they have become fashion food, so they are not eaten on a regular basis.” He wondered why ‘millets are available now only in supermarkets!’

He said that there are various reasons for the disappearance of millets in the Vishakapatnam area where he works. These include massive plantation of *Casuarina* by the Forest Department and also plantations of cashew. 30% of the drylands of the region are occupied by *Casuarina*. Other reasons include the use of land for housing and increase in urbanization. Finally, the promotion of piggery has impacted the cultivation of millets. It is a capitalistic system being promoted.

He then gave the example of how his organization had begun work with a shepherd community village on
Alternate Public Distribution System (APDS) to bring 30 acres out of 116 acres under millet cultivation. However, a doctor from outside the area bought 8 acres of land in the area and planted *Casuarina* on it. The land in this region is being grabbed for various reasons including Special Economic Zones (SEZs), real estate etc.

Another reason for seed disappearance is also the lack of storage facilities. He said that they were trying to adapt the DDS model in their area of work.

**Millets and Food Sovereignty in Action**

*P. V. Satheesh, Convenor, AP Alliance for Food Sovereignty, Andhra Pradesh*

P. V. Satheesh began his presentation by clearly stating that “the second green revolution being planned for India is a recipe for disaster.” He added that since the 1990s, with the advent of liberalization, 50% of the millet growing areas were lost due to the structural adjustment programmes that impacted PDS. “When it comes to food production in the country, Planning Commission expects 91% of the requirement to come from wheat and rice and only 9% from millets. In the period spanning 1965–1995, the amount of millet cropping area lost was: Sorghum: 35%, Little Millet: nearly 60%; Finger Millet: 30% and Pearl Millet: 16%. All the millets together lost 50% of the cropping area during the period corresponding to the processes of Structural Adjustment Programmes and Globalization.

In the ninth and tenth plan for the country, the allotment of grain share given to rice was 42%; Wheat, 35% and coarse grains only 14%.

“Strangely, a major contributor to this problem is PDS. This is because it concentrates only on two grains: wheat and rice, and that too from rich soils grown with subsidized irrigation. These have a ready market and assured prices unlike for millets. In contrast, millet farming does not have any assured irrigation, and no crop insurance. Cheap rice alters food cultures and shrinks markets for millets. Even if farmers want to cultivate millets there will be nervousness in store for them.”

P. V. Satheesh further said “In rainfed areas, farming has been abandoned and large areas have been turned into fallows.” He read out several figures to highlight the disparity with regard to land acreage between rice/wheat and millets.

Quoting from a Planning Commission report, detailing planners’ concerns, P. V. Satheesh said that the prescription it offered was worse than the malady! While lamenting the awful conditions of FCI godowns he said, “half of Food Corporation of India’s (FCI) grain stocks is at least two years old and 30% of it is between 2-4 years old. In fact, some grains are even 16 years old.” He further said that the monitoring of the grains was weak and that both transparency and accountability were much below par. But the report goes on to state that “coarse grains are basic commodities bought by poor and are available to the poor at low prices. Therefore, there is no additional need to
supply them through PDS and give them food subsidy.”

He then presented the work of DDS in the direction of food sovereignty, which included the principles of local production, storage and distribution and support for manure and timely farming operation. He then highlighted the details of the DDS’s APDS programme also known as Community Grain Fund. “The result is that in the very first season, in 30 villages employment days created per village was 7967. The employment generated/acre was 90 person days. The total income for 1000 hectares is Rs. 110 lakhs.”

The presentation then brought to light the nutritional content of different food crops (All values per 100 gm of edible portion), with millets surpassing the rest with higher protein, mineral, calcium and iron content. He finally drew a comparison of the national PDS system and the APDS of Deccan Andhra. “The mainstream PDS is beneficial to irrigated, resource rich areas where women and local communities are marginalized. Whereas the APDS was working in resource poor, rainfed areas, was highly decentralised and controlled by the women and local communities who were central to the programme.” He concluded with a statistical report on the achievements of the APDS programme of DDS, spread over 90 villages.

Chairperson’s Remarks
Ardhendu Chatterjee, DRCSC, Kolkata

Ardhendu Chatterjee summarized the key points of the session and also highlighted additional issues. He observed that while it was heartening to see the participants of the workshop engaged so devoutly in addressing the concerns of the marginalized communities, it was equally sad to be bearing witness to the glaring disparities between the rich and the poor. “It is unfortunate that in a country that boasts quite a few names in the list of world’s richest people, nearly half the population is dying from hunger!”

“The question is about turning food into a commodity. In a country where drinking water is scarce, we are using more and more groundwater for agriculture, and that too for the wrong reasons. The intelligentsia of the country must wake up to the fact that flawed parameters are being applied by vested interests to measure agricultural production. Farmers need to be empowered to resist the sinister moves of the profit-seekers, who first converted oil into food, and are now trying to reverse the process, by converting food into oil.”
He further added that the government behaves in three typical ways. First, if something misfires, then the government is quick to say that it is sad and regrettable, but there was no choice, and that it was all done in the public interest. Second, it promptly kicks off a blame-game, and gets busy pointing accusing fingers at others. Third, it conjures up chic names to seduce the populace. A blatant example of this is the way plantations of *Casuarina* or eucalyptus have been carried out under what is termed as social forestry programmes. These are neither beneficial to the community nor can they be called forests. These trees can grow without social cooperation.

“The government’s commitments lack credibility,” he said, while expressing his fears for the future of millets.
Millets in Agrobiodiversity Promotion for Rural Development

K. Siva Prasad, Principal Specialist cum Coordinator, Action for Food Production (AFPRO), Hyderabad, Andhra Pradesh

K. Siva Prasad began by appreciating the work of DDS, and said that AFPRO has been collaborating with the organization. He then went on to look at the national and global challenge of the food crisis, and said:

“The promotion of millets is a good strategy to meet the requirement of food production. More land needs to come under millet cultivation, but unfortunately, this is not happening. It is important to see the issue in a holistic manner. Today, urban development is being encouraged at the cost of rural development. Millet farmers are increasingly shifting to cotton. The challenge is how to push millets into the mainstream policy agenda. While the DDS is at it, other people and sections need to exert more effort.”

“At a time when the ecosystem has come under strain and so much agricultural land is going fallow, it is essential for NGOs to network and address the paradoxes of the farm situation. Sustainable development should become the priority issue.”

Millets in Ecological Farming for Livelihood Security

G. Nammalvar, General Secretary, Tamzhina Vazhviyal Multiversity, Tamil Nadu.

G. Nammalvar, in his presentation, shed light on how for thousands of years agriculture was practiced through biological processes and with an understanding of ecological phenomena. He said that according to a Russian scientist, at least 356 species of domesticated crops and 326 species of their wild relatives are believed to have originated in India.
He said that unfortunately in the second half of the 20th century, industrialized agriculture was introduced in the country through the Green Revolution, which in its wake brought along the introduction of hybrid seeds, chemical fertilizers, pesticides, weedicides and machines. In contrast to this, traditional agriculture was self-regenerative and focused on village livelihoods along with food, fodder, manure, fuel, fibre, tools and implements, raw materials as well as medicines. But the Green Revolution made farmers depend on costly external inputs and pushed for production of only two grains, rice and wheat under irrigated conditions. This, and the dependence on external inputs have upset the ecological balance, and have rendered agriculture unviable for farmers, thus pushing them to commit suicides in despair. Quoting a Tamil saying, popular among the farm-women, he said that they followed a simple formula with regard to crop production. They believed that a farmer should feed three beings: soil, cattle and humans. After the crop is harvested, its bottom (root and stub) must go to the soil, the middle (stalk) to the cattle and the top (grain) to the farmer’s house. “Any miss in this link of food chain will adversely affect the ecosystem, and this is what precisely has happened through the Green Revolution.”

Drawing attention to the report of the National Farmer’s Commission, he stated that the fertile irrigated lands under rice and wheat had become unproductive because of the application of fertilizers. He elaborated that the unintended environmental consequences of chemical agriculture had resulted in soil and water contamination, food poisoning and degradation. “Neglect of rainfed cultivation, which constitutes 60% of our land, has resulted in loss of food, fodder and income. The final result is malnutrition and starvation. At present the food crisis is threatening the whole world. The World Bank report says that about 850 million people across the world are already hungry and the soaring food prices will push as many as 100 million more people into hunger.”

“In this context, the work of DDS in improving the livelihood security of resource poor people by reviving the cultivation of millets needs to be looked at. Through this, there is a need to rediscover traditional, ecological and nutritionally valuable grains and vegetable varieties. The contribution of millets, combined with ecological practices, have improved human health and reduced medical expenses. There is an opportunity to establish a nationwide network on millets. Sustainability depends on the cultivation of millets which will also improve livelihood security.”

**Millets in Ecological Farming for Livelihood Security**

**Robert Leo, Coordinator, Keystone Foundation Udhagamandalam, Tamil Nadu**

Robert Leo shared information with others on the work of his organization in addressing the nutritional status of the women and children. He said that the traditional millets of his region are *Tenai* (Italian millet) *Setaria italica*; *Samia* (Little millet) *Panicum sumatrense*; *Varagu* (Finger millet) *Eleusine corocana*; *Panivaragu* (*Panicum miliaceum*); *Guthiravali* (*Echinochol colona*); *Kambu* (Pearl millet) *Sorghum vulgare*; *Chollam* (sorghum), *Sorghum*
bicolor. The biodiversity of the millet region was also highlighted through pie diagrams.

He expressed concern over land going out of people’s hands. “Traditional land is an asset which needs to be retrieved, and protected from erosion. Soil health needs to be maintained.”

Leo further highlighted the various ways in which Keystone Foundation was promoting mixed cropping practices and preparation of bio-inputs to enhance productivity. He also spoke about diversity in traditional seeds, storages and technologies. The forward linkage initiatives taken up by the organization include organizing traditional food festivals to revive tastes; value additions and recipes to enhance usage; preparing posters for information; technological interventions for better efficiency and setting up of green shops and cultural corners for revenues.

“In future, the efforts of the organization will include marketing with exclusive Participatory Guarantee System (PGS) labeling; incorporating millet supply into the PDS for tribal areas in Tamil Nadu; promoting millet sale as a health food sector initiative and finally improving intake level amongst local people and school children.”

Biodiversity in Millets

H.D. Upadhyaya, Principal Scientist, Genetic Resources expert, International Crops Research Institute for Semi Arid Tropics [ICRISAT], Hyderabad

H.D. Upadhay began his presentation by indicating that he was going to be talking about the research aspect of millets. He assured the participants that the scientific community was not a silent spectator to the depletion of biodiversity. Germplasm was collected and accessions were saved ex situ. He highlighted various examples of the same. According to the Food and Agriculture Organization (FAO:1998) figures, over 6 million ex-situ germplasm accessions exist and are being conserved in 1308 genebanks worldwide. 10% are held in

<table>
<thead>
<tr>
<th>Crop</th>
<th>Active collection</th>
<th>Base collection</th>
<th>Source countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearl millet</td>
<td>21,594</td>
<td>17,670</td>
<td>50</td>
</tr>
<tr>
<td>Finger millet</td>
<td>5,949</td>
<td>4,620</td>
<td>24</td>
</tr>
<tr>
<td>Foxtail millet</td>
<td>1,535</td>
<td>1,054</td>
<td>26</td>
</tr>
<tr>
<td>Proso millet</td>
<td>842</td>
<td>576</td>
<td>30</td>
</tr>
<tr>
<td>Little millet</td>
<td>466</td>
<td>384</td>
<td>5</td>
</tr>
<tr>
<td>Kodo millet</td>
<td>658</td>
<td>630</td>
<td>2</td>
</tr>
<tr>
<td>Barnyard millet</td>
<td>743</td>
<td>487</td>
<td>9</td>
</tr>
</tbody>
</table>
trust by the Consultative Group on International Agricultural Research (CGIAR) centers’ genebanks.

He presented a list of the most important millets and said that millets are used in several food preparations, including unleavened flat breads (chapatti); fermented breads (Kisra, injera, dosa etc.); porridge; mudde or dumpling; biscuits, snacks, malt and opaque beer. Millet stalks are used as fodder and for thatching. He also presented data on the high nutritional value of millets.

The presentation then looked at the role of millets in sustainable agriculture. It is because of their short life cycle and wide adaptation that millets play an important role in sustainable rainfed agriculture. They can be used as catch or relay crops and can be grown up to an altitude of 3000 m.a.s.l. Further, due to their long storage life, millets serve as reserve food during the time of food shortage.

However, the reason for non-cultivation of millets is because it is not as remunerative as the other major crops, and further there is a lack of improved cultivars. There is non-availability of suitable technology and also the lack of organized crop improvement programs. Millet farmers are also not in a good socio-economic position.

Upadhyay then looked at the details and qualities of the different kinds of millets including pearl millets, finger millet, foxtail millet, Kodo millet, Proso millet, little millet and Barnyard millet.

Among other things, the presentation highlighted the global distribution of germplasm samples (1974 - 2007) with details of the number samples and the number of recipient countries. The details are as follows:

<table>
<thead>
<tr>
<th>Crop</th>
<th>Number of samples</th>
<th>Recipient countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearl millet</td>
<td>143,107</td>
<td>79</td>
</tr>
<tr>
<td>Finger millet</td>
<td>31,400</td>
<td>49</td>
</tr>
<tr>
<td>Foxtail millet</td>
<td>10,937</td>
<td>46</td>
</tr>
<tr>
<td>Proso millet</td>
<td>5,339</td>
<td>36</td>
</tr>
<tr>
<td>Little millet</td>
<td>2,111</td>
<td>27</td>
</tr>
<tr>
<td>Kodo millet</td>
<td>2,029</td>
<td>25</td>
</tr>
<tr>
<td>Barnyard millet</td>
<td>2,514</td>
<td>28</td>
</tr>
</tbody>
</table>

Following this, the presentation highlighted the use of mini-core collections by the National Agriculture Research System (NARS)-India to identify new sources of important traits of millets. Promising accessions have been identified in the finger millet core collection, evaluated at Mahatma Phule Krishi Vidyapeeth (MPKV), Kolhapur, Maharashtra, India. This includes, seed yield (2 accessions); fodder yield (7 accessions); early maturity (2 accessions); Basal tillers (1 accession); and High inflorescence length and width (7 accessions).
The presentation concluded with the following points:

- Despite their importance, millets have remained under-exploited and under-researched crops until recently.
- Conservation of biodiversity of millets is an important objective at ICRISAT and important priority in the CGIAR system.
- ICRISAT research on germplasm diversity assessment and core collection development has provided means to enhance the use of genetic resources in pearl millet, finger millet and foxtail millet.
- Crop improvement programs need to be developed for the food security of the poorest of the poor.

Status and Approaches for Millet Biodiversity Conservation and Rights Protection in the Context of Ecological Farming and Livelihood Security:

K S Varaprasad, National Bureau of Plant Genetic Resources (NBGPR), Andhra Pradesh

K.S.Varaprasad observed that the millet situation was not as bad as it was presented. He said that a good amount of work is going on to improve the quality of millets, especially in the NARS programme. He then gave an overview of millets-species, wild relatives, and land races. Further, he presented full details and names of the small millets varieties in NARS.

The presentation also highlighted the nutritional status of millets (Per 100gm of edible portion), and the need for the conservation of small millets' germplasm.

He concluded his presentation by airing a few issues for discussion of the group. These included the need for:

- In-situ on-farm conservation of millet biodiversity.
- Documentation of traditional ethnic products for possible GI protection and organized marketing.
- Improved/ farmer’s varieties seed supply chain.
- Procurement prices for millet crops.
- Inclusion of millet grains in the PDS.
- Promoting millets as certified organic products.
- Revivals of innovative mixed/ relay cropping systems.
- Rich gene source exploration and protection.
- Therapeutic foods commercialization.
- Soil health revival and eco-system sustainability.
**Open House Discussion**

**Vijay Jawandhia** initiated the open house discussions by agreeing with Varaprasad that it was important to discuss what they should do to be able to put pressure on the policy-makers. He added that millets had been promoted during the food shortage in 1970s by agencies like the Ford Foundation. But they were hybrid varieties, so the farmers could not maintain grain banks. They had to depend on outside sources for seeds, and that was not good for their morale, because it compromised their control over their lives. He asserted forcefully that millets would find it tough to perform well without economic support.

**Vijaya Khadir** regretted the fact that even universities lacked the clout to influence the policy makers. She said that she had more to say on this the following day.

**P.V Satheesh** reiterated the need for all the millet activists to speak in one voice, so that they could prioritize their strategies. He stressed that the most pressing concern was about safeguarding the control of local farmers over their own grain. The challenge was how to continue protecting it while bringing on board the knowledge of the scientific community.

**Debjeet Sarangi** enquired as to whether farmers could have access to the accessions in the NBPGR.

**V.S.Yuvaraju** mentioned that “it is difficult to get subsidy to grow millets. They are also extremely labour intensive.” He enquired of the initiatives contemplated to motivate farmers to grow millets.

**Aardhendu Chhatterjee** affirmed that the issue was not about rice/wheat versus millets. It was about blindly embracing technologies which meddled with ecosystems. He said that nature’s resources were being plundered for seeking immediate gains. And to add insult to injury, such lapses were being rewarded with subsidies. Warning against such practices, he reiterated that we should return to cultivating crops the traditional, ecological way, and restore our bio-diverse riches. “Automatically millets will be back on the farms. There is rice cultivated in Japan too, but they don’t get varieties from China. India was a country where rice originated. We had 30,000 varieties, but now have only 20.”

**T.N. Prakash** stated that he felt apprehensive expressing his views in a context marked by strong ideological positions. He observed that “it would be wrong to look down upon rice and wheat as villains, and proclaim millets as the most favored grains. It is therefore important to complement millet with rice and wheat. Only then can a healthy discussion happen.”

Responding to this, **K.N. Rai** pointed out that “a large number of issues have been raised in the meeting. Since the meeting is specific to millets, it is important to stick to the discussion on what to communicate to the government regarding the promotion of millets. This is more important than getting into the millet versus rice debate.” He then made three concrete suggestions; the first one being to build a network to influence the government; second, to devise appropriate technologies native to our environment; and third, to chart

"The nutritional graph, productivity potential and agro-ecological environment of millets are important to understand, and along with that it is important to see how they can be worked upon further.”

- K.N. Rai
the nutritional values of our traditional crops, and relate their importance to the current health needs.

Ruturaj Patnaik reported his experiences in Koraput, Orissa. He said that the tribals from that area used to grow millets in the past. But they were stopped from doing so by the forest department officials, who thought it would lead to deforestation. Further, most farm scientists in the state were occupied with their work on status grains, such as rice, so there was no encouragement for millets. He also found fault with scientists who operated with limited variables in evaluating the productivity of a crop.

H.D. Upadhyay said that it would be better to discuss issues in terms of rainfed and irrigated agriculture rather than taking positions on the tussle between rice and millets. He said that millet yields in Karnataka were more than average, but more research was needed to enhance the genetic potential of the seed to increase productivity.

P.V. Satheesh reiterated his earlier point on how “it is important that those present in the consultation try and speak in the same voice. It is probably impossible.” But, he was happy to find unanimity on points which mattered most about millets, such as their inclusion in PDS and their nutritional significance. “What is being discussed in the meeting is not about rice and wheat versus millets. What is spoken about is the government policy of promoting rice and wheat as against millets. It is important to recover the space for millets, which is a political question that needs to be tackled. About technology, if the control shifts from a sensitive scientist and community to corporate hands, irrespective of increase in quantum of yield, it would still face a problem. So, it is important to see points where one can come together.” As convener of MINI, he stated, “it is important to have scientists on board.”

H.D Upadhyay mentioned that all the research in ICRISAT was on an international level, and that it was for the public good. The benefit of their research, he said, was available to all farmers. “It is in the public domain and not anyone’s property.”

P.V. Satheesh clarified that what he meant was that “it is a problem when one talks about technology without a social context. There is a need to discuss it at a conceptual level.”

Ruturaj Patnaik stated an instance when INDAF Ragi was brought from Karnataka into Orissa and promoted heavily by Unicef and other agencies in 1984. It was rejected by the tribals. They were used to their indigenous variety of millets and did not enjoy the taste of the INDAF variety.

R. Hampaiah observed “that today a Minimum Support Price (MSP) will not work, what is required is a Minimum Guarantee Price (MGP).”

Ardhendu Chhatterjee said he was worried that “scientists are not concerned that 80% of water of the country is being used to bring just 20% of the land under irrigated agriculture. What will happen when another 20% is brought in? Further, the point to be looked at is related to total farm productivity, even in the case of rice versus rice. The traditional varieties allowed for other food to be grown with it, and as a result more food was produced. With hybrid rice there was more grain, which got more money. The same is the issue with millets. It is traditionally grown with oil seeds, gram etc, and therefore gives more food than grain. With hybridization that will be lost.”
Salome Yesudas brought to light the experiences of a FAO funded programme in Andhra Pradesh, which includes 650 villages. “Farmers have been given training on several aspects of farming, and they are able to use systems like crop water budgeting to choose what they want to grow on their farms. As the technology is with them they are rotating irrigated and dryland crops and are successful in doing so.”

T.N. Prakash shared his experiences of working with farmers in Karnataka. He said that most farmer suicide cases were reported from Mandya, which is called the Punjab of Karnataka. A majority of farmers who committed suicide were the ones who owned borewells, and were irrigating the lands. This, he said, opened his eyes to the complex dynamics of Indian agriculture. And the more he thought about it, the more he was convinced that there was a lot of virtue in hanging on to our age-old seeds, such as millets, which needed to be celebrated with a “common voice and a common song”.

K.S.Varaprasad mentioned that “the mindset of researchers is definitely a problem. There needs to be a balance and not a complete shift to GM related research. The good thing is that the genome of millets has not been meddled with. He referred to the fact that “the consultation has lots of breeders and scientists, and it is an opportunity to introspect and move ahead.” He also mentioned about the social relevance of gene banks and how they could be linked to farmers.” PDS and price support are the most important issues that can be taken forward together because there is no controversy over them. Further, whether one likes it or not there are legislations like the Biological Diversity Act, Patents Act, Geographical Indications Act, and Plant Variety Protection and Farmer’s Rights Act. All these provide some kind of exclusivity, which if we don’t take, someone else will.”
This session included presentations from various participants on their work with millets, while eliciting their opinion on what they would expect from a network like MINI. The session was also devoted to discussing the critical strategies for safeguarding millets. P.V. Satheesh explained the purpose of the session and opened it up for presentations.

- Madhu, YAKSHI, Andhra Pradesh

“Yakshi has been working with adivasi people in Andhra Pradesh where the main issue has been the struggle for control over land and natural resources, as well as forests. Various government programmes like Joint Forest Management (JFM), IFAD sponsored schemes etc have changed the diverse subsistence-economy of these areas into a commercial one.”

Madhu emphasized that “it is important to view land as an ecosystem. Control over land is not enough unless it is linked with farming, forest produce or knowledge. It is a game plan of the government to bring land in tribal areas under plantations to grow commercial crops such as timber, biofuels, tea/coffee etc.”

“MINI can encourage more and more farmers to get land under millet cultivation. But at the same time it needs to remember that adivasis are often not treated as farmers and even the farmer’s movements have ignored their concerns.” He mentioned that there were other political issues such as mining and dams, which needed a closer look.

He said that although it was important to include the scientific community, there were misgivings as to what would happen if Monsanto or Syngenta were invited for discussions! He referred to one of the presentations of the morning session where it was mentioned that crops were being certified and handed over to companies like ITC.” Further, there is a need to build a market chain, not at the international level but within India itself. He concluded by saying that he would like to be involved with MINI if political issues were to be debated.
Abdul Karim, RDT (Rural Development Trust), Andhra Pradesh

Abdul Karim deplored the disappearance of millets in the Ananthpur district of Andhra Pradesh. He said that it was all because of farmers flocking to grow groundnuts which promised them high yields in the beginning. One million hectares of land is under groundnut cultivation in this scanty rainfall zone. He asserted that it was important to bring the farmers back to millet cultivation, and that RDT was working in that direction.

Sanyasi Rao, ANTHRA, Andhra Pradesh

Sanyasi Rao said that Anthra has the experience of working for 15 years on agro-biodiversity and livestock diversity issues. The group strongly believes that livestock cannot be isolated from cropping patterns. He detailed the initiatives of Anthra on building perspectives with farmers; seeking DDS’s help to procure millets for them; and working on diversifying crops and food security and lifestyles.

Anuja Krishna, ECONET, Maharashtra

Anuja Krishna highlighted the concerns of Maharashtra. She mentioned that in the North Western Ghats, even today millets are cultivated through a shifting cultivation system specifically in the tribal areas of the Western Ghats. This scene, however, has come under a cloud because there is a new debate as to whether the cultivators will be granted rights to own and till the lands under the Scheduled Tribes and Other Forest Dwellers (Recognition of Forest Rights) Act, 2006.

She pointed out that in dryland areas millet cultivation is high. There are three or four current threats which will divert this land for other use which includes the construction of small dams, wind energy farms by groups like Suzlon, agrofuels and corporate farming. At the same time there are several neo-farmers (new first generation farms) where there is potential to encourage millets. This refers to the communities who receive agricultural plots as part of livelihood rehabilitation, but who for want of minimal knowledge-base on agriculture often end up selling their land to big farmers who then grow cash crops. This is also one of the reasons that more and more millet fields are diverted to cash crops. In coastal Maharashtra, the issue of water shortage makes the need for millet cultivation very relevant.

Processes like gene banks, documentation through People’s Biodiversity Registers (PBRs) are big grey areas. All are directed towards collecting information without any clarity on the question of transparency. Reintroduction of millet in the coastal agricultural area should be done by targeting it as a soil conservation measure which is one of the big issues there.
Amulya Baul spoke about some of the issues of southern Orissa where the villagers say that land is the biggest concern. Communities, earlier, were practicing shifting cultivation to grow millets, which they are unable to do now. The introduction of HYVs in the area has led to the disappearance of millets. He stressed the need to develop a system of documenting traditional resource use.

Debjeet Sarangi explained that the landless and the marginal farmers of the drylands in Orissa are the ones who continue to grow millets. He also pointed out that there are two Primitive Tribal Groups (PTGs) his organization works with: the Bondo and Dongaria Kondhs who are not traditional rice eaters. However, from the day PDS was introduced to their areas with rice, the communities have grown more and more dependant on this grain, waiting for trucks to arrive with their rations. Ironically, they have been robbed of their traditional food in the name of the Right to Food Campaign. In the plain areas, cotton and agrofuels are being promoted at an accelerated pace. In the current financial year it is proposed to bring 60,000 hectares under cotton and 20,000 hectares under agrofuels in Orissa. Programmes like NREGA are being used to push this. As a network it would be important for MINI to advocate for millets not just as a crop but also as a culture. It is also critical to put food first at the household level and then move on to local markets and from there go further afield.

Prashanth Narayanan spoke about the work of this group in Mayurbhanj, Orissa. Further, he said that the debate was not about millets per se, but about the whole philosophy of biodiverse farming. He finally pointed to the need for sharing of knowledge.

Jayachandran mentioned that his area registers 1800 mm of rainfall and that farming is mostly rainfed. In terms of millets, only finger millet is grown in the region. He then translated a Tamil proverb from his area which says that the one who transplanted finger millet in the field can easily come to the
puja (prayer) room without any worries. He also said that he has declared his village a bio-village.

* Arifullah, VGKK, (Vivekananda Girijana Kalyana Kendra) Karnataka

Arifullah highlighted the work of VGKK with the Soliga tribal community and also the fact that finger millet is a major crop of the Soligas. He shared through pictures several initiatives including that of value additions to crops like Amaranthus, which are now being sold by the community.

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**Can Farmers Access ICRISAT and NBPGR germplasm?**

One question that was brought up a few times at the sessions was, whether it was possible to have access to the germplasm deposited with any of the designated places such as ICRISAT, NBPGR or the genebanks elsewhere! The scientists from some of these institutions present at the meeting mentioned that if a specific accession is sought for, it should not be a problem. However, if there is a requirement for say 600 accessions of finger millet then it is not known what the response would be. Also if it is required by an NGO, then they would need to approach NBPGR which has already repatriated it from ICRISAT, and it is a property of India. It was confirmed that whosoever wants this at the national level, would have no problem seeking it through a letter.

What also came to light was that there is something called ‘passport data’ that is maintained at ICRISAT through which the origins of a species can be traced. So, if there is a specific variety from a region which has been lost (as was a query of Wani Hurda, unique sweet variety from Wani village, Maharashtra), then it can be traced. Further, in response to a query it was confirmed that the passport data can be accessed through a website.

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**Open House Discussion**

One of the participants raised a query as to whether it is possible to replace rice and wheat with millets in the PDS immediately and whether it is possible to change food habits. Another participant responded to this and said that the issue is not about excluding rice, but including millets. P.V. Satheesh urged the participants to seek answers to these questions at the local, village level and not at the country level, which gets very overwhelming. The planners of the country also make the same mistake.

Aardhendu Chhaterjee observed that “it is important to bring back food sovereignty and do a food first audit of every state. This way one can ascertain whether there is a need for a national PDS. It is also important to focus on biodiverse agriculture and integrated farming systems which also must include trees and animals. The total yield of farms should be
assessed rather than that of crops. Further, it is important to give recognition to millet farmers and groups who are doing good work, and not wait for governments to do it. These case studies should be documented and taken forward.” He further said that “there should be a campaign against the use of ground water for cropping. Also, a lot of patenting is taking place casually and the State Biodiversity Boards etc are involved in facilitating it. If all the Acts are enforced then the seed banks will become illegal. In institutions like CGIAR there is a seed monopoly and later a claim of creating a seed. Indian law did not allow this earlier, now laws have also been borrowed. It is not a question about who should patent, but whether someone should be allowed to do so or not.”

K.N. Rai responded to Ardhendu Chhatterjee by saying that “CGIAR institutions are all in tropical countries and no corporate control of seeds is taking place.” He asserted that there was no way ICRISAT would go into the hands of Multi National Corporations. He remarked that since it was a consultation on millets, he had thought that the discussion would be about technology and how different people could come together to contribute to it.

Responding to this perception, P.V. Satheesh said that “NGOs have wider perspectives, which would feature not only the technical aspects of the food problem, but would encompass social concerns as well.” He further said that the issue was not about ICRISAT per se, but, the larger politics of corporate control over research.

Ruturaj Patnaik emphasized that there was a need for extending credit to millet farmers, and that banks should come forward to formulate this policy.

Vijay Jawandhia added that “the presentation from Orissa and Marathwada have made the point very clear that cotton is replacing millets. It is important to link the entire process of sowing to harvesting of millets to schemes like National Rural Employment Guarantee Act (NREGA). This way we will not be depending on petroleum products.”

K.N. Rai questioned as to what kind of farmers were being discussed in the consultation: “those who have a commercial outlook or those who don’t.” He said that there was a time “when a farmer deemed it an insult to be having to buy grain.”

P.V. Satheesh responded to K.N. Rai and said that “It is not a subsistence economy but a subsistence vision that is being spoken about. Once we go out of it, the millet based system is finished.”

He concluded the session by requesting the participants to think over the declaration scheduled for discussion the following day, and also to come up with their take on the subject. He insisted that if civil societies were to stay with their responsibilities, it was important for them to embrace some amount of sociology and politics while discussing complex issues. They couldn’t be expected to shy away from it.
B. Sesi Keran initiated the session by highlighting the fact that “we are in an era of rediscovering our past glory. People are realizing that what has been ignored all this while is what is going to come to our rescue. Research has indicated that there is an increasing rethinking on millets.” He hoped that the experts taking part in the session would throw light on the nutritional and medicinal aspects of millets.

Creating demand for millet foods

Vijaya Khadir, Formerly DEAN, Home Science, Acharya N G Ranga Agricultural University, Andhra Pradesh

Vijaya Khadir began her presentation by saying that she was happy to share the views and the experimental results of her work. For the last 12 years she had been trying to bring up the agenda of millets at the policy level and also had tried to push it in the PDS system. She also spoke about her efforts towards promoting the importance of millets in human health. She said that she had undertaken two projects, the first being funded by the Indian Council for Agriculture (ICAR), and the second by the Department of Biotechnology. Both the projects were aimed at making use of the traditional base of our diet to prepare healthy and nutritional products for the vulnerable groups of our population. Her experience in this field has strengthened her faith that “there is a need to create a demand for millet foods from production to consumption.”
Millet is one of the oldest foods known to humans. It was grown as early as 2700 BC in China and was the favoured grain before rice usurped its place. They are short-season hardy crops capable of growing on a wide range of infertile soils under extremely harsh climatic conditions in temperate, arid and semi-arid crop regions of the world. Millet is highly nutritious, healthy and versatile. However, Minor Millets account for less than one percent of food grains produced in the world today. According to the Food and Agriculture Organisation (2001), the world production of millets is 26.35 MT (1999) and in India the production is 8.10 MT.”

She advocated giving subsidies to farmers growing millets, and argued for guaranteeing them support prices. Nutrition security implies food grain security and availability of diverse foods to ensure macro and micro nutrient requirements.

She said “people are slowly waking up to the virtues of millets, but there is much that needs to be done to popularize the use of millets. This could be done through education, especially in schools and ashrams.”

Nutritious Sorghum - Health Food

V. Vimala, Formerly Associate DEAN, Home Science, Acharya N G Ranga Agricultural University, Andhra Pradesh

V. Vimala explained that her presentation would deal essentially with sorghum, which was her main field of research. She said that “sorghum has unique nutritional and functional properties which allows for development of healthy nutritious foods as it is gluten free; it has unique phenolic compounds which have medicinal properties and also complements well with lysine rich vegetable and animal proteins to form nutritionally balanced foods.”

“Sorghum also can be considered as a functional food since it is hypocholesterolemic and hypoglycemic in nature. A study on sorghum amongst other things concludes that sorghum biscuits are effective in reducing serum lipid levels in hypercholesterolemic subjects. But long term supplementation studies are required to support this. Further, there has been a strong clinical impression that diabetic patients tolerate Ragi better than rice. Hence it is very essential to study the effectiveness of sorghum recipes on the blood sugar level of diabetic patients.”
The presentation concluded with three points:

- It is possible to develop many products using coarse grain like sorghum using varied processing technologies.

- Among all the processing technologies, fermentation seems to be the better option for deriving maximum nutritional benefits.

- With increase in nutritional awareness among people, it is always advisable to promote sorghum as a health food / functional food since it possesses hypocholesterolemic effects and hypoglycemic effects.

“A study also indicates whole sorghum recipes are better than dehulled sorghum recipes for diabetic patients.”
- V. Vimala

Millets, Orissa and Nutritional Security
Pushpashree Nayak, MASS, Orissa

Pushpashree Nayak asked the participants if they had come across an instance where they had seen a child drink traditionally made wine before he/she went to school? She put this question to explain how each culture evolves its own patterns of food habits, depending on place, time and its collective wisdom. Following this logic, the farmers of Orissa arranged different types of food hierarchically. They categorized food as “Charbya, Choshya and Lehya,” as markers for the kind of nutrients each of them provided to the body. The underlying rationale for this division was their recognition of Nature’s biodiversity. With the introduction of corporate technology, the situation changed drastically, upsetting the traditional, healthy, and nutritive food habits.

Millet, the miracle grain can be grown under harsh conditions, and the poor and marginalized people who live upland, and have no irrigation facility could grow the grain easily without any external input. That is how poor farmers from Dalit and Adivasi communities in Orissa were able to get food from millet crops for eight months and depend on forest produce for the remaining four months. Today, a consciousness of prestige has entered the minds of people, and it has been impacting millet cultivation and consumption. In Western Orissa, more than 40% of women are malnourished. Most people are not consuming millet gruels but cold drinks. Biscuits, mixture, vada and singda (samosa) have taken over all snacks. The nutritional charts in schools do not have millets but only fruits and vegetables that need to be bought from the market.

Despite its advantages, Nayak questioned as to why it is that millets are ranked below other grains. This is because it is considered to be ‘poor man’s grain’ and also because the current, changed food habits don’t support it. The government and other agencies neglect it, so there is no market for it.

However, it is important to push for millets by its inclusion in different programmes and policies of the government, including PDS and Mid-Day Meals. Inclusion of its nutritional, medicinal and other values in course curriculum is also required from the primary level.
Active research is needed on its production, value addition and marketing. Value addition to millet is required through technological intervention by taking care of its nutritional values.

Potential of Pearl Millet for Alternative Food Uses and Nutritional Security

K.N. Rai, Principal Scientist, ICRISAT, Hyderabad, Andhra Pradesh

K.N. Rai initiated his presentation by announcing that he had been involved in millet research, specifically Pearl Millet, for the last 31 years. He is not a nutritionist or a food scientist, but a hard core plant breeder. However, he has been reviewing the nutritional aspects of pearl millet for the past 3-4 years. His interest in the nutritional value of pearl millet was more influenced after his participation in a symposium organized last year in Delhi by the Nutritional Foundation of India. He then shared with the participants a slide which looked at the nutritional values of millets versus that of wheat and maize. As per the literature, the protein content of pearl millet and wheat was almost the same. But he observed that it would be wrong to jump to such conclusions that wheat has as high protein as pearl millet because the grain samples of wheat must have come from fields managed at much higher applied nitrogen fertilizer levels than pearl millet, and nitrogen application increases protein content in pearl millet as in other cereals.

He declared that “one would not be surprised to find that more than 50% of those in attendance in the meeting might be deficient in iron, but don’t realize it till there are clinical symptoms of the same.” He then shared a slide which clearly showed that the iron content of pearl millet and sorghum was much higher than that of wheat.

There are various processing technologies for millets including Milling, Decortication, Malting, Blanching, Heat treatment, Acid treatment, Fermentation and popping. This is to improve the nutritional quality of pearl millet/sorghum as well as the consumer acceptability.

The presentation then spoke about the effect of storage time on free fat acidity of processed and unprocessed pearl millet flour. A graph indicated that the fat acidity of the flour of the unprocessed grains shoots up within seven days. But there are solutions with treatment to control this. Figures were also shared regarding the effect of malting and blanching on polyphenols and phytic acid content of pearl millet (mg/100 g grain).

K.N. Rai showed pictures of how various products could be made out of pearl millet, and said that Haryana Agricultural University, among others was doing that work. He said that India had the dubious distinction of being called the diabetic capital of the world, and highlighted the role that pearl millet could play in handling the problem. He showed figures related to Glycaemic Index of pearl millets, to bring out their health value.

He concluded his presentation by highlighting the various constraints and opportunities for commercialization of sorghum and pearl millet food products. The constraints include misplaced social stigma, subsidized rice and wheat, inconsistent grain supplies, mixed grain marketing, short shelf life of flour, lack of procurement and food technology at the laboratory scale and declining cultivation. “However there are opportunities which emphasize the fact
that millets are highly nutritious and have a health value. Therefore there is a need for a PDS policy for sorghum and pearl millet along with stable, economical commercial production. The production of specialty grains is possible and also the shelf life can be enhanced with the application of available technologies. Both the procurement and food technologies can make millets commercially feasible. It has been reported that pearl millet foods and drinks have both warming and cooling effects, depending on the type of preparation. It is common knowledge that people in north India consume pearl millet chapati believing that it keeps them warm. But in parts of Tamil Nadu, people use pearl millet to prepare a drink which they have in summer for breakfast believing that it keeps them cool!"

**Experiences from Tamil Nadu**

*C. Uma Maheshwar Reddy, NRM Program, Centre for World Solidarity (CWS), Andhra Pradesh*

C Uma Maheshwar Reddy began his presentation by outlining the goals and objectives of CWS which “include ensuring farmers’ self reliance; household food security through encouraging food crop cultivation; ecological farming like NPM-IPM and encouraging crop bio-diversity. It also believes in non-GM (Genetically Modified) agriculture with self reliance of the farmer in the whole agricultural cycle with an organic approach. Such farming also believes in water conservation and water productivity.”

He further presented the profile of the Tamil Nadu millet network and said that there were several groups which were working actively to popularize millet consumption. Farmers were getting loans to buy mobile carts for selling millet porridge: “TRD affiliated farmers got a loan for selling red gram in packets, and Velicham farmers for making “Ragi murukku”; and PPMS is selling energy food made up of all millets and pulses. A recipe booklet of millets and pulses has been published in Tamil.”

He further said that more campaigning was needed to popularize millets.

**Uncultivated Foods - Experiences from Medak District**

*Salome Yesudas, formerly with DDS*

Salome Yesudas, who was formerly with the DDS and worked closely with the women farmers began her presentation by saying that “the discussions till now in the workshop have dealt essentially with issues of availability, accessibility, and absorption. However, this has been part of DDS’s vision for the last twenty years. DDS has done a lot of work towards this by shifting to organic farming, and working with women’s sanghams, which has spread in different parts of the country through networks. Starting out with only 20 varieties, the..."
women farmers have been able to increase the number of varieties saved to 82. Millets have answers to all the food related security issues prevailing today.”

The presentation brought forth the point that “millets are cultivated with oil seeds, grams and also green leafy vegetables. There are several uncultivated foods that farmers get through millet cultivation which includes green leafy vegetables, up to 120 in number. These serve the food, fodder and also the medicinal requirements of the community. They can also be incorporated in the soil as green manure. All these aspects have been analyzed with the help of National Institute of Nutrition (NIN), Hyderabad. The analysis has also been carried out on the nutritional content of red and black soils. The results have revealed that red soils on which millets are essentially cultivated are more nutritious. Red soils also have vitamins and ß-carotene. Most of the red soil samples have high values in Vitamin C and ß-carotene. These studies are all available on the website of DDS.

It was further added that iron-rich food like millets need to be supplemented by Vitamin C which is contained in the green leafy vegetables that the farmers consume. The women sanghams present the same scientific model. However, this was required to be proved. Therefore, in 2003 a scientific study was undertaken with children and pregnant women and lactating mothers along with NIN and McGill University. This study is available on the International Development Research Centre (IDRC) and DDS websites. In the experimental villages where the Alternate PDS model is operational, people are healthy and have a better standard of living. There are also 8-10 varieties of pulses that are available.

She added that there is a need to appreciate the keeping quality of unprocessed millet and work towards processing technologies which will increase consumption.
The presentation concluded by saying that “there is a need for standardizing and fine-tuning these processes”

Open House Discussion

P.V. Satheesh responded to K.N. Rai’s presentation wherein comments had been made on the keeping quality of millets. He said that people had shown several ways through which millets could be stored. “It is important to think of storage through a decentralized manner, through a village or community level. It is important not to get stuck with the Food Corporation of India (FCI) model. This is one issue that the policy makers use to counter the millet agenda, and it is important to give a counter to that.”

T.N. Prakash replied that the point that was made was not about the keeping quality of millet but that of the flour.

P.V. Satheesh responded by saying that “it is important to understand as to which population is using pre-ground grain and what percentage takes it to a flour mill. The major consumers of millets are rural.”

K.N. Rai said that he would like to re-iterate T.N.Prakash’s point. “There is a need to find out which households consume grain (in tribal areas) and which procure flour. A large population requires flour. In urban areas there are practical difficulties in getting to a flour mill and getting the required amount. Sometimes a required amount of an urban household is much less than what a flour mill is willing to grind. To make the government listen, it is important to ensure that millets are the food of the elite.”

T.N. Prakash questioned if “there is a study to compare the keeping quality of indigenous millet with the HYVs. It is quite likely that the indigenous varieties may fare better!”

Another participant responded to this by saying that “we cannot go and grow varieties which have better keeping quality but fewer yields. The reality is that there is less land and more people.”

Vijay Jawandhia stated that “it is important to look at land, water, and energy together in agriculture.”

P.V. Satheesh asserted that “if India needs to be a leader then it needs to lead and not follow another country’s vision.”

Vijay Jawandhia added to Satheesh’s point and stated that “today India is borrowing technology from developed countries. The land holdings in the country are very small and it is a luxury to keep land fallow.”

Salome Yesudas pointed out that “today people are getting rice and wheat through PDS and are taking it to flour mills; the same can be done for millets. The keeping quality will only be a plus point for millets.”

B.Sesi Keran pointed out that “if millets are promoted only in the rural areas they will
never get over the social stigma. It is important to make it a food of the middle class and the elite; otherwise the same mistakes will be repeated.”

P.V. Satheesh clarified that “if millets need to be commercialized using technology, then it needs to be done for urban areas. For many people working in rural areas, the keeping quality of millets is not a problem. The travesty today is that people in urban areas are eating more millets than in rural areas. It is the PDS that is the problem.”

Remarks from the Chair

B. Sesi Keran, Director, National Institute of Nutrition, Hyderabad

The chairperson concluded the session by stating that “nature is giving everyone another chance to save ourselves from disaster. It is important to take it by promoting millets, as we might not get another chance again.”
K. Hanumanta Rao initiated the session by saying that while everybody agreed on the importance of millets in the present food situation, there were divergent views on the ways millets could be helped to regain their prominence. He said that the policy makers are yet to recognize the merits of millets.

“The fact today is that the net sown area for agriculture is declining and millets are the losers. Schemes like NREGA need to be used to encourage millets. The role of technology is not just about enhancing yields but also about farmers having control over its use. There is perhaps also a need for more studies by ICAR and others. The issue of Minimum Guarantee Price also needs to be looked at. The larger question is also that even if there is a support price there is no institutional mechanism to procure the grains. This is happening even with rice. It is important to see this in the context of the millets and whether the procurement should be promoted through community based SHGs or through the government.”

“There is also a need to conduct studies on the impact of state policies on millets. The role of ITC and other private sector companies is important to be able to take advantage of the millet cultivation. Of course this needs to be done without impacting the food sovereignty of the farmer and only to be taken on if the impact is not negative. Also there is a need for more poverty mapping studies and the cultivation of millets in those areas, public awareness, and for creating more advocacy instruments. Finally millets should not be promoted as monocrops.”

**Ecoregion Specific Pearl Millet Cultivars for Increased and Stable Production**

_I.S. Khairwal, project coordinator, All India Co-ordinated Research Project on Agroforestry (AICRP), Rajasthan_

I.S. Khairwal reported that “the cultivated area for pearl millet globally is 26 million hectares (ha) and in India it is 9.8 million hectares, out of which the state of Rajasthan alone claims
4-5 million hectares. It is considered to be bread and butter here. It is both a way of life and also a lifeline for the state. Pearl millet is a very important crop, largely grown by marginal farmers on marginal soils where there is very low rainfall.

He pointed out that “the open pollinated varieties are the local varieties. The hybrid varieties of pearl millets have an advantage over the local varieties and there is data to show this.” This data was shared during the meeting. It was also highlighted that the grain yield under subsistence agriculture was 600-800 kg/ha, while under Improved management it was 4-5 tonnes/ha. The presentation also shared the adaptive features of sorghum and pearl millet on parameters like drought tolerance, water efficiency, heat tolerance and so on.

“When we talk about food security, we need to grow more food. Hybrids have the characteristics of the parent plants and therefore are not deficient in nutrition. Further, it is important to note that pearl millet will always be under cultivation, as the land area where it is grown is much more than that of sorghum. With the help of biotechnology, an improved variety of HHB 67 pearl millet has been developed. This is very popular in Haryana and Rajasthan and can do well in both saline and alkaline soils.”

Farmers grow pearl millet parallel to wheat with the help of irrigation in the summer season. The investment is recovered through fodder and the rest is a profit for the farmer. This is happening in parts of Gujarat also.

Micro Level Experiments in Food Security

A.C. Jena. Formerly Professor, Centre for Agrarian Studies and Disaster Mitigation, NIRD, Hyderabad

A.C. Jena shared the findings of a study on successful micro level experiments in food security that he had carried out over four states with four NGOs. These groups were the Academy of Development Sciences (ADS) in Maharashtra, Rupantar in Chhattisgarh, Deccan Development Society (DDS) in Andhra Pradesh and Prepare in Orissa. Each of these groups had used a different model for achieving food security in their work with farmers using indigenous seeds. The details of these were shared in the presentation.

He then highlighted the various factors responsible for the success of these initiatives which include:

- understanding and analyzing the food insecurity situation of the marginal groups in the specific context.
- examining their vulnerability factors.
- organizing, mobilizing people and involving communities in the process of decision making.
- utilizing the local resources, unifying their collective
strength and contribution.

- enhancing their collective bargaining power, and finally.
- building a community based institution i.e. grain bank to meet the lean-season scarcity situation.

These experiments have had an impact on various aspects including the economic, social and political ones. The details of each of these aspects were presented.

Following this, the presentation highlighted the following points in conclusion:

- The intervention of micro level food security efforts along with grain banks alleviates lean season scarcity of food grain by eliminating the role of moneylenders.
- Once the exploitation of local moneylender/middle men has been dealt with, the vicious circle of poverty breaks.
- The intervention of grain banks protects their purchasing power to repay their loans and proves effective in countering the uncertain food prices in the market.
- The pull away from the moneylenders and the push to repay the grain loan motivates them to invest labour in their own fields. This shift from role of labourer to cultivator is significant.
- Having overcome their preoccupation with survival needs, they look towards meeting larger goals of development in their village, block and district.
- Therefore, this kind of intervention is necessary.

Presentation

T N Prakash, Professor, University of Agricultural Sciences (UAS), Bangalore

T.N. Prakash began his presentation by reiterating that it is important to think of a single and common language. It is also critical to envisage a segregation of policy initiatives based on millet based cropping systems, which is a different paradigm of development. The scientists from ICRISAT have given a counter paradigm in their presentations.

“Several issues have been raised in the meeting and in that light a question needs to be posed to MINI and its partners.” He asked the MINI partners as to “what was their reaction to the market which is a prominent player in the current system.” He added that another important component of securities (other than the six highlighted earlier by P.V. Satheesh) is income security. “Do the millet farmers not expect money in return of their produce?”

He then quoted an example from Karnataka where, in the previous year the groundnut crop gave 20% more yield. “In simple economics when there is more supply the prices should go down. But that did not happen; instead the prices went up by 30%. This goes completely against the demand-supply logic.” He further added that today India is a one trillion dollar economy. “The incomes in the IT sector are soaring. Anything can
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be sold today. The millet crop is an important thing that can go along with the growth of the economy. Today the market cannot be undermined. It is important to get into the market system. What is wrong with millets being available only in supermarkets or five star hotels? At the same time the community initiatives are also very important.”

“The vision of scientists might be different from that of the NGOs, but it is possible to be more sensitive to cultural values. At the same time, the scale of intervention is also very important. An NGO can think at a community level, but a scientist has to think at the state or national level.

In this light, what should be done first is to set up a National Mission for Millets, run not by bureaucrats but by grassroots organizations. Second, while nutrition and health are important, it is also important to deal with the issue of both farmer suicides and the naxalism problem, both of which are linked with the agrarian crisis.”

Presentation

Sanjay K. Rai, FIAN, Delhi

Sanjay K. Rai observed, “In today’s scenario, 46% children are malnourished. The maternal and infant mortality rates are very high in India, according to UNICEF figures. Even though there is a Nutrition Mission, constituted and headed by the Prime Minister, the problem continues to haunt the population. Finally, the role of corporations is increasingly influencing the development agenda. The procurement for PDS/Mid Day Meal /ICDS is a centralized system, and is influenced by the middle class, rich farmers and corporate houses.”

He further said, “While the need for millets has been discussed extensively in the consultation it is important to think of how this can be done. There is a need to lobby with Members of Parliament, and the relevant ministries including Food and Civil Supplies, Human Resource Development and Tribal Affairs. There is also a need for an alliance of peasants, environmental groups (in the context of climate change) and state governments.”

He ended his presentation by highlighting the discussion with one of the Food Commissioners appointed by the Supreme Court under the petition related to the Right to Food Programme. The commissioner had mentioned that the government system was very strong, and that pressure from the ground was required to push millets in the Right to Food Programme.

Observations

P. V. Satheesh, National Convenor, MINI, Millet Network of India

P.V. Satheesh reported that many of his friends from Orissa had complained that the Right to Food Programme had negatively impacted the millets, so the problem needed to be looked into. He said that artificial divisions had been created between cash and food crops, while what was important to talk about was “the whole farm yield and how much nutrition is generated per farm land.” He said that the media had created a corporate-based demand
for food. “Millets are not alternative but original foods. It is time to go back to the basics.” He further clarified that whatever he was saying came not from his own thinking, but from what he had learnt from the women farmers of DDS, who “have a sustainable vision and not a subsistence one. These terms need to be redefined.”

Putting forth his views on the Public Distribution System, he said, “PDS has to be at the level of community procurement. The idea is not about community versus nation, as a nation is a cumulative of communities. But, there is a need to change the paradigm of thinking with regards to storage of grains. Also there is a need for crop insurance for millets. The current vicious financial systems deprive people of their dignity to produce what they want to. Millet farmers should be given an ecological bonus for their ecological services. Today millets do not occupy the highest priority, as they should. There is no problem with the concept of markets. But it is important to remember that it is a spiral and should start from the centre which is the household. Next comes the community, then the local markets and only after that will come the national and international ones. It should not be at the cost of people’s food sovereignty. Farmers should also have the right to dictate their own markets and not depend on one with current speculations.”

Speaking about poverty, P.V.Satheesh said, “It is important to map both poverty and well-being in rural areas. If one is ‘poor’ it does not mean one is living an unhealthy life. NREGA is an invisible destruction which is slowly destroying the farming economy. There won’t be any willingness to till the land when higher wages are being offered to carry on other tasks. NREGA should support ploughing, weeding, harvesting and other farm related tasks as employment activities.”

Open House and Development of Hyderabad Declaration

Vijay Jawandhia asserted that being a farmer himself, he could say with some authority that market forces by themselves would not solve the farmers’ problems. He said, “70% of the people still don’t have the purchasing power.”

The session ended with the participants proposing the following points for inclusion in the declaration:

- Millets be seen as rooted in food culture and community autonomy.
- Millets be looked at as ‘a concept and not just a crop’.
- Comprehensive valuation of millets be done vis-à-vis food security and other ecosystem services.
- Myths surrounding millets be dispelled.
- Like rice and wheat, millets to be included in the PDS system.
• Private, public and community participation be sought to promote millets.
• Millets be sold below the price of rice, i.e., at less than Rs2/- a kilogram.
• Strategies be worked out to promote minor millet cultivation in cotton areas.
• People impacted by the commercial takeover of millets be co-opted for advice.
• Database be created of seed banks in the country.
• Activities like sowing be included in NREGA schemes.
• Millet processing technology be fine-tuned and standardized.
• More studies be done to tap into indigenous knowledge and culture.
• Myths surrounding millets be dispelled.
• Higher and middle income groups be accessed for millet promotion.
• Millet crops be advertised as “nutri-cereals”.
• Interstate cooperation be sought to promote millet cultivation.
• Subsidies and awards be offered to millet growers.
• “Social Forestry” and plantations be prevented from usurping millet lands.
• More millet ‘melas’ be organized.
• Mono-cropping of millets be resisted to enable mixed cropping.
• National Food Security Mission and National Biodiversity Authority be persuaded to be fair to millets.
• Fallacies of “Green Revolution” be exposed.
• Millets as part of integrated farming system be encouraged in all dryland farming systems and tribal areas.
• Resource material be developed for new organisations initiating work on Millets as a concept.
• Farmer Exchanges be organised.

The Hyderabad declaration was read out and changes incorporated after detailed discussions. There were some points like “farmer-led” research versus “farmer-participatory” research which were discussed in detail, and it was decided that a suitable terminology would be used in the revised declaration to incorporate the differences of opinion.
P.V. Satheesh welcomed the Chief Guest, D.Srinivasulu, Agriculture Commissioner of Andhra Pradesh, and the other guests at the concluding session. He said that D. Srinivasulu was an old supporter of DDS, who had helped the dalit women farmers of DDS procure land during the days when he was working as the Joint Collector. And that was the time when the DDS had just begun its work. Recalling those days, P.V.Satheesh invited the Agriculture Commissioner to return to Zaheerabad to see the transformation over the years.

Explaining the purpose of the meeting, he said that it had been called to involve civil society representatives, nutritionists, scientists and activists in popularizing the message of millets. He said, “we do not see millet as a crop but as a concept, which needs to be at the centre of discussion.” One of the goals in that direction was to carry the network, MINI forward. He further said that the participants had put together a declaration incorporating the concerns voiced during the sessions. He read out the declaration, while making it clear that it was just a framework, and that its final version would soon be available to them.

Millets the Miracle Grains
Screening of a film by Community Media Trust

The above film which was screened on the first day was shown again for the benefit of the special invitees of the final session.

Presentation

B.K. Thapliyal, Prof and Head, Centre for Agrarian Studies and Disaster Management, NIRD, Hyderabad.

B.K. Thapliyal regretted that over the years food had been ascribed qualities based on the status of the people consuming it. It was unfortunate, he said, that junk food had pushed traditional food off the table!
Food and water would be the major concerns in future, he said. The FAO has warned that the food prices would go up further in view of the misguided global policies and the rise in population. Prize agricultural land was being taken over for industrial purposes, thus compounding the situation further. He emphasized the need for streamlining the public distribution system, and said that millets had a big role to play in the future, because the irrigated lands had been stretched to their limit, and the country would be depending more and more on the rain-fed lands for food. Millets, which knew how to adapt to harsh conditions would be able to fill the food basket. It would supply both food and fodder, so there was an urgent need to change the mindset of our agricultural policy makers. He was glad that organisations like DDS had been campaigning for food sovereignty through the restoration of indigenous seeds. He expressed his support for the declaration adopted in the meeting.

**Chief Guest’s Address**

*D. Srinivasulu, Commissioner for Agriculture, Government of Andhra Pradesh*

D. Srinivasulu apologized that he could not attend the inaugural session, but was glad that he could at least make it to the concluding session. Extending a welcome to the participants on behalf of the Government of Andhra Pradesh and the Department of Agriculture, he appreciated the crusading spirit of P.V. Satheesh, who, he said, had been championing the cause of millets for the past two decades. He recalled with joy his memories of enjoying the millet foods at DDS, and said that he missed the days when he used to have jowar roti on a regular basis.

He said he was glad that ICRISAT had adopted millets as a crop to be promoted in semi-arid and rainfed areas. And it also pleased him to learn from a scientist that “there is no need to go for varietal improvement in millets, as the traditional varieties are good enough in terms of yields.”

He felt sorry that “dietary habits have changed, and the consumption of millets has come down.” He informed the members that he had recently discussed the issue of introduction of millets in the National Food Security Mission with an official of the central government.

Srinivasulu pointed out that he was a little skeptical about the introduction of millets in the PDS. “There is no point in distributing grain through DR Depots in tribal areas, because of the political situation in these regions.” Procurement, pricing, availability, and affordability were the major concerns in handling the mechanism of the public distribution system.
Finally, he requested that the MINI consultation come out with feasible and practical suggestions for policy makers. Millets should also be a policy friendly crop. He assured the participants that he would definitely put forth the recommendations of the august body at the highest level and also sought the cooperation of Acharya N.G.Ranga Agricultural University for the same. He concluded by saying that he would like to interact much more with the participants of the consultation and hoped that the deliberations would bring in a new era for millets.

**Remarks from the Chair**

**P. Raghava Reddy, Vice Chancellor, A.N.G.R. Agricultural University, Hyderabad**

P. Raghava Reddy opined that while every one is concerned about the fate of millets, the crux of the issue lies in how they can be protected, conserved and made available to the farming community for higher crop production and how they can become accessible to the consumers with much more acceptability in their food habits. He advocated higher remunerative prices to the millets and incentives to millet growing farmers. Imparting awareness to the rural and urban people regarding nutritive values of millets could also rekindle the interest in millets, he suggested. He felt that opportunities be created to the farming community through provision of best management practices of millet cultivation and by supplying the best possible seeds. He hoped that the State Biodiversity Boards would undertake the detailed documentation of millets and their germplasm in the states in co-ordination with the other local agencies / institutes involved in such missions.

He expressed the view that for the millets to take centre stage in the state and country’s nutrition security, (1) they would have to be cultivated through popularisation of their elite lines (varieties) (2) their acceptance has to be increased through value addition, (3) their products have to be marketed in an attractive and acceptable manner and (4) they would have to be introduced as a part of the public distribution system.

**Vote of Thanks**

**Dr Radhika Rani, Asst Professor, CASDM, NIRD, Hyderabad**

The programme concluded with a formal vote of thanks to panelists, resource persons, participants and to all those who made it possible for the workshop to happen.
Declaration

Millet Network Of India [Mini]
Millet Network Of India [Mini]
Millets Can Rescue India From Agrarian, Ecological, Climate Change And Energy Crisis

The Hyderabad Declaration on millets
June 6, 2008

We, representatives from farmer organizations, civil society groups, scientific community and development academics have met at the National Institute of Rural Development, Rajendranagar as members of the Millet Network of India [MINI] on June 5th and 6th in the National Consultation on Millets and resolved that Millets are the future of Indias food and farming and therefore it is time for the policy makers to wake up to this reality.

The two day national consultation organized by the Millet Network of India has confirmed our belief and practice that millets are truly the miracle grains. We have also discussed the various facets of millet based farming systems, and have come to the conclusion that with their capacity for multiple securities such as Food Security, Fodder Security, Health and Nutritional Security, Livelihood Security and Ecological Security, millets are the food and farming future of India. This leads us to suggest the renaming of millets as nutri-cereals.

Besides its long list of credentials, millets can grow under completely rainfed conditions and therefore do not need irrigation for their cultivation. They can be raised in the harshest of environments and therefore can support farming in the most challenged ecological zones. They can earn India energy independence since they can be farmed with either none or very minimum external inputs. This potential of millets has the capacity to make millet farmers food sovereign.

Unfortunately over the last three decades millets have been progressively marginalized from the Indian agriculture and have lost nearly 35% of their cultivated area from 45.9 Mha in 1990 to 31.5 Mha in 2005. A slew of policy measures that have ignored millets, a hostile market and their social undermining by many sectors including media have been the root cause for this marginalization.
Therefore there is an imperative need to reclaim millets into our farming and policy landscape. In order to realize this: we are demanding/urging/exhorting.

1. The first need is to put millets into the Public Distribution System. Different parts of India grow different kinds of millets. Rajasthan along with a large part of Rainfed India cultivates Pearl Millet [Bajra]. Deccan plateau [Marathwada in Maharashtra, Telangana in Andhra Pradesh and North Karnataka in Karnataka] is well known for sorghum. Southern Andhra Pradesh, Tamil Nadu, Orissa and Southern Karnataka are the home of Finger millet [Ragi]. Uttarakhand and other hill and tribal areas cultivate a range of small millets such as Foxtail, Proso, Kodo and Barnyard. The Indian PDS system will be enriched with the high nutritive quality of these millets if they are included in it.

2. A nutritive analysis of millets vis a vis the major grains such as rice and wheat prove that nutrient to nutrient, millets score over the other grains. They have 30 to 300% more nutritional elements such as Calcium, Minerals, Iron, Fibre, and many other micronutrients.

3. The pro millet PDS paradigm must depend on a completely decentralized approach, supported by the government, both in procurement and in storage. This will resolve the question of availability and keeping quality.

4. Government must urgently provide space for millet based foods in the ICDS, Mid Day Meals, Residential schools meals and welfare hostel programmes.

5. All these together will open up new markets for millet farmers and revitalize them.

6. There are a number of institutional mechanisms that needs to be created, nurtured and developed.

**Enabling conditions**

1. Millets need a number of enabling conditions. One of them is to increase livestock which are local breeds and adapted to local ecosystems. This will create a symbiotic relationship between the farming and pastoralism, such as increased organic manure, fodder availability, milk production and increased incomes for farmers.

2. The rainfed lands where millets are grown need urgent attention for their productivity enhancement. This could be achieved through special watersheds on millet lands and dovetailing government’s empowerment programmes such as NREGA to support millet cultivation from sowing to harvesting.

3. Millet farms are intrinsically biodiverse. This aspect must not be overlooked. Therefore farming system development should become the aim and not single crop development. The monitoring, evaluation and research on millet cultivation must be tailored to this special quality of millet farming system.

4. Policy makers and donors must take note of the fact that millets make way for a dynamic diversity on farmers fields.

5. Millets can be cultivated without using groundwater or any irrigated water. Their energy requirement from sources such as chemical fertilizers, pesticides, water and power can be near zero. Therefore this production system must be honored through
offering socio-ecological bonus to millet growing farmers. Appropriate institutional mechanisms must be developed to assess this.

6. Institutional finance and insurance which is offered generously to farmers who cultivate preferred grains such as rice and wheat and non food crops must be extended to millet farmers also.

7. Research institutions must concentrate on a new thrust on millets particularly on areas and issues that involves productivity and nutrition. The research must also take on the agenda of conserving the germplasm and using the diversity in crop improvement programs, particularly for traits related to nutrition and productivity. While such research from formal science is extremely necessary, farmers' involvement must also be brought to the forefront with several people-centered and people-directed studies which are are bound to offer exciting perspectives.

**Markets**

1. Apart from the focus on community-controlled local food security, millets should enter the new and emerging markets for the burgeoning health conscious, urban populations with value addition as health food using appropriate processing and other technologies.

2. A network of NGO-facilitated markets which promote millets from their areas is key to this market promotion. This rescues millets from the trap of the corporate controlled organic markets which have narrow parameters of profit and not the wider concept of millets.

3. This should ultimately lead to an autonomous federation of millet growing farmers markets.

**Education**

1. There is an urgent need to produce a range of educational materials highlighting the health, nutrition and therapeutc values of millets addressing the consumers and ecological values of millets addressing the farmers.

2. Countrywide there are excellent practices and experiences concerning millet farming, processing and cooking. These must be documented and experiences shared and information disseminated.

3. Farmer Exchanges can be key to the revival of millets. Such exchanges should be supported through appropriate funding support in order to build a new confidence and vibrancy among millet farming community.

[Endorsed by farmers, scientists, development academics and civil society activists from the states of Delhi, Rajasthan, West Bengal, Orissa, Tamil Nadu, Karnataka, Andhra Pradesh and Maharashtra, major millet growing states of India].
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1. Millets – future of food and farming in India

*Presentation by Vatturi Srinivas, Independent Researcher, Hyderabad*

**Millets – future of food and farming in India**

*Project: Promoting Food and Food Security by Strengthening Biodiversity-based Livelihoods*

*South Asian Network on Food, Ecology and Culture (SANFEC)*

2006-07

**A research focus on millets**

- The emphasis is on neglected crops such as millets has evolved from the concerns of rural communities in South Asia, especially in the present scenario where globalization has been negatively affecting agriculture and food systems of local communities, world over.

- India: the technological approach (Green Revolution strategies vs agro-biodiversity based approach – localized food production function for consumption function) to food and nutritional security.

- The aim of this work is to document ground-level traditional agricultural practices that demonstrate the art of using biological diversity by people, with a special focus on millet-based cropping systems.

**What constitutes millets?**

- Millet crops primarily constitute a diverse group of small grains.
- They are usually categorized under *Coarse Cereals* in India.
- Millets are classified into Major millets and Minor millets (or Small millets).
- Major millets: *Sorghum* (Sorghum bicolor) and *Pearl millet* (Pennisetum glaucum).
- Minor millets are a group of gristy plants with short slender culms and of smaller grain size, which are spherical to oval shaped with colored seed coats.
- Some of the commonly known Small millets in India are: *Finger millet* (Eleusine coracana), *Foxtail millet* (Setaria italica), *Barbary millet* (Eleusine coracana), *Kodo millet* (Pennisetum americanum), *Little millet* (Panicum miliaceum), and *Proso or common millet* (Panicum miliaceum).

**Study-sites**

- As the indigenous cultivation and consumption of millet crops is widely dispersed across several States in the country, four representative study-sites from three different agro-ecological habitats were selected for a detailed study.

  1. Arid ecosystem: Bopp region in Rajasthan
  2. Semi-Arid:
     - a) Zaheerabad region in Andhra Pradesh
     - b) Satyamangalam Tamil Nadu
  3. Sub-humid: Uppali Nagari region in Uttar Pradesh

**Millet based high diversity cropping systems**

- *Sat and Baranaja* in Himalayan Ghizrak, here traditional rainfed farming is practiced in the hilltops and hill slopes, where along with *Finger millet*, *Foxtail millet*, *Barbary millet* and *Proso millet* are cultivated.
- *Saat chakri* system in Rajasthan, where farmers with their intimate knowledge of soils manage to cultivate sandy and saline soils in this region, where *Pearl millet* based mixed cropping system predominates.
- *Phoomchu penpulu* in the Zaheerabad region of Andhra Pradesh, along with *Sorghum*, several Small millets are cultivated.
- *Padi parizi* in Tamil Nadu, where along with *Finger millet* a range of *Small millets* are traditionally cultivated.
Key findings: Indigenous farming system – a total system

- The indigenous food farming system is an integration of crops, farm animals and wild or uncultivated plants, which as a 'total system', minimises the risks posed by harsh climatic conditions that are common to rainfed regions and ensures that farming families are food and nutritionally secure.

Millet based mixed farming system

- The climatic adaptability of millet is such that about 8 species of millets.
- Sorghum, Finger millet, Pearl millet, Foxtail millet, Barnyard millet, Proso millet, Kodo millet and Little millet are cultivated across different agro-ecological habitats in India, either as Primary or Allied crops in combination with several other crop species/varieties.
Millet species and varietal diversity

- Farming communities have deliberately selected and manipulated a range of millet species, which reflects in a higher degree of genetic variability.

Preferred agronomic characteristics

- The millet landraces have high adaptability and unique properties such as:
  - pest and disease tolerance;
  - drought resistance;
  - grain and fodder yield potential

- enabling farmers to suitably mix crops to minimise the risk of total crop failure during drought conditions, which reflects farmers confidence on Millets for their hardiness and productive capacity.

Storability of millets

- The natural tolerance of millets to storage pests and diseases are considered as an added advantage especially by the women, who ensure that every bit of precious produce is harvested in time, processed and stored properly to keep the produce free from rot, insect pests, and rodents.

Local storage

- Traditionally larger structures were used to store millets, however as the production and consumption has declined in the villages, storage structures of smaller capacity made out as mud pots, brass vessels, small huts made from straw and plastered mud or a bamboo basket is often used in the Semi-arid and Sub-humid regions.

- While in the Arid regions such as Rajasthan most farming families consider stocking of grains as vital and ensure that the storage structures are built-in while constructing a house.

Post harvest and storage

- Farmers in these regions have evolved elaborate techniques for preserving the food grains and have gained incredible expertise with respect to the post-harvest and storage of grains.

- The know-how of post harvest activities is immense among farmwomen, who are frequently found threshing, storing, drying, grinding, impounding or sifting food grains at home throughout the year apart from their work on the farmlands.

Traditional storage structure

- Farmers preferences for various qualities of millets, revealed local criterias which are primarily based on three aspects of local crops/varieties:
  - (i) Agronomic characteristics;
  - (ii) Food and nutritional potential and;
  - (iii) Socio-cultural aspects like rituals and festivals.

Along with food, fodder is given equal importance

- Traditionally, farmers combine millet crops/varieties along with other crop to ensure that alongside food grains good quality fodder is produced, essential for the farm animals that are traditionally an integral part of farming in the rainfed regions.
Seed saving and selection

- More importantly, the seed selection and storing practices are still in practice, which are deeply interlinked with the socio-cultural norms. In fact, the role of rituals and festivals is significant, as in many villages in spite of rampant changes in the traditional cropping patterns several millet landraces continue to remained under cultivation, as they are essential for ritualistic purposes.

Declining millet based cropping system

- A distinct declining trend in the traditional millet based cropping system is observable in the villages, wherein large and medium farmers are overtly inclined towards monocropping of non-food cash crops, while most of the small and marginal farmers continue to sow millet based cropping systems.

Changing farming scenario

- In the recent times, small and marginal farmers are compelled to alter the cropping patterns to make cash benefits over food/fodder benefits due to economic pressures; market conditions; disabling of local livelihoods; dwindling livestock population and; small size of land holding.

Food and habitat

- An interlink is evident between food, culture and habitat in each of the millet-growing region.
- People preferred to eat local millet grains as staple food grain unlike the popular belief that wheat in the Northern India and rice in the Southern States are the staple food grains of India.
- To typify ‘food security’ and restrict it to just two crops (wheat and rice) as in our current public policy (like Green Revolution technologies) would be an error.

An array of millet cuisines

- In India, several cuisines are made out of Millets:
  - Elaborately recipes of various flavoured food items ranging from Porridge/Pottage/Malt Drinks/Sweet/Sour Meals to several Refreshments/ Snacks or;
  - Otherwise made into very simple food by boiling/steaming or baking as unleavened Indian Bread or as plain boiled meal.

Millet based food habits and cuisines

Consumption pattern of millets

- There exists a phenomenal difference in food habits, with stark differences in the constitution of a typical food basket of poor families in contrast to the well-off families: historically, the dietary practices of the poor and marginalized families are such that they have relied on millets 100 percent. They appreciate special food qualities of millets such as:
  - to provide bodily strength;
  - prevent diseases;
  - stomach filling quality;
  - to produce either heat or cold effect on the body as per changing seasons.

Changing food habits and consumption of millets

- In the recent times, the constitution of food among families from different socio-economic sections has changed.
- Today poorer families obtain just about 50% of their daily intake as millets and the rest (wheat, rice, pulses etc) is purchased either from ration shop or local shops.
- While the well-off families consume just about 25% of the daily intake in the form of millets and the rest is either wheat or rice.
**Changing food habits and consumption of millets**

- A decline in the dietary intake in the form of millets is evident among poorer families due to the poor are marginalised families are unable to access sufficient millets.
- They are landless or whatever land they own/lease produces insufficient quantity of food grains.
- The local production of millets has severely decreased as most farmers have changes to farming non-food cash crops.

**In conclusion:**

- It is imperative for a country like India, where a major landmass of 92.3 Mha, of which 59.6 Mha, receives high to medium rainfall and the rest 34.5 Mha receives low rainfall, of cultivable area out of the total 142 Mha of net sown area, constitutes of dry rainfed region, should encourage dryland farming of food crops such as millets.
- A specialised focus on rainfed regions is all the more important as these regions continue to accommodate a large number of people (45% of India's population lives in Semi-arid habitat).

**In conclusion:**

- It is important to note that instead of relying on a habitat-specific decentralised 'agro-diversity based approach' focused towards peoples food and nutritional security at the household-level, the continuance of a strategic policy-focus to rely on a centralised 'technology-based approach' to National Food Security model for India is detrimental to a truer notion of food and nutritional security.

**Broadening concept of food security**

- Today, the concept, meaning and horizon of Food security is broadening that includes policy issues relating to poverty, sustainable agriculture and rural development, food production, stabilisation mechanisms, improved access, etc. refocused during The Rome Declaration on World Food Security, World Food Summit convened by FAO in the year 1996.
  - "When all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life."

**Challenges**

- Challenges that need to be triumph over are:
  - The deterioration of common property resources
  - Drying of water sources from local farming system
  - Weakening of traditional local structures and local initiatives
  - Disruption of eco-sensitive indigenous farming practices
  - Absence of localised resource restoration mechanism
  - Changes in the cropping system and the loss of agro-biodiversity
  - Changes in local food habits and consumption of regional foods

**Opportunities**

- The following are some of the grassroots initiatives and key approaches currently in practice by people-centred organisations, which can show the direction for sustainable and decentralised food security strategy for the communities living in the rainfed regions:
  - Decentralising natural resource management
  - Re-orienting the livestock development programme
  - To revive and strengthen grassroots initiatives
  - Re-orient agricultural research and agricultural extension system
  - To focus on in situ conservation of agro-biodiversity
  - Ensuring in situ conservation of agro-biodiversity
  - The need to build awareness, demand for millets and revive local food habits
2. From Food Security to Sovereignty

Presentation by P.V. Satheesh, DDS, Andhra Pradesh

From Food Security to Sovereignty
The way ahead for Dryland Communities in India

Food Scenario
- Plan for a new green revolution for rainfed areas
- A recipe for a disaster?

Food Scenario
- **FOOD PRODUCTION**
  - Wheat & Rice: 91%
  - Coarse Grains: 9%

Food Scenario
- **1965 - 1995**
  - Sorghum lost 35% of cropping area
  - Little Millet lost nearly 60% of the crop area
  - Finger Millet (Ragi) lost 30%
  - Pearl Millet (bajra) 16%

Food Scenario
- All millets together lost 50% cropping area during the period corresponding to the processes of SAP & globalisation

Food Scenario
Ninth & tenth plan allotment of grain share:
- Rice: 42%
- Wheat: 35%
Coarse grains share: only 14%
**Food Scenario**

- Strangely a major contributor to this problem: P D S

**Food Scenario**

- Concentrates only on two grains:
  - Wheat & Rice
  - Rich soils
  - Subsidised irrigation
  - Ready market
  - Assured prices

**Food Scenario**

- MILLET FARMING
  - No assured irrigation
  - No crop insurance
  - Cheap rice alters food cultures
  - Shrinking markets
  - Nervousness about producing more

**Food Scenario**

- RAINDED AREAS
  - Farming abandoned
  - Large areas turn into fallows

---

**Rice in dryland states**

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>State</th>
<th>Rice distr (1000 tns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Andhra Pradesh</td>
<td>850.00</td>
</tr>
<tr>
<td>2.</td>
<td>Karnataka</td>
<td>510.00</td>
</tr>
<tr>
<td>3.</td>
<td>Gujarat</td>
<td>350.00</td>
</tr>
<tr>
<td>4.</td>
<td>Madhya Pradesh</td>
<td>310.00</td>
</tr>
<tr>
<td>5.</td>
<td>Tamil Nadu</td>
<td>605.00</td>
</tr>
<tr>
<td>6.</td>
<td>Rajasthan</td>
<td>39.20</td>
</tr>
<tr>
<td>7.</td>
<td>Maharashtra</td>
<td>675.00</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>3339.20</td>
</tr>
</tbody>
</table>

---

**Fallows in dryland states**

<table>
<thead>
<tr>
<th>STATE</th>
<th>C F</th>
<th>PC</th>
<th>Excess over PDS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[1000 ha]</td>
<td>[1000 tonnes]</td>
<td></td>
</tr>
<tr>
<td>AP</td>
<td>3392</td>
<td>3392</td>
<td>2542 [79%]</td>
</tr>
<tr>
<td>Karnataka</td>
<td>1671</td>
<td>1671</td>
<td>1161 [72%]</td>
</tr>
<tr>
<td>M P</td>
<td>719</td>
<td>719</td>
<td>409 [13%]</td>
</tr>
<tr>
<td>Rajasthan</td>
<td>1597</td>
<td>1597</td>
<td>1558 [40%]</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>1106</td>
<td>1106</td>
<td>431 [41%]</td>
</tr>
<tr>
<td>TOTAL</td>
<td>10228</td>
<td>10228</td>
<td>6889 [206%]</td>
</tr>
</tbody>
</table>

---

**Rice & Fallows**

- Quantity of rice distributed matches existing fallows
- Correlation between the fallowisation of dryland India and supply of PDS rice.

**Planners Concerns**

- The poor do not have cash to buy 20 kg at a time, and often they are not permitted to buy in instalments
**Planners Concerns**
- Low quality of foodgrains
- Half of FCI’s grain stocks is at least two years old
- 30% between 2 - 4 years old
- Some grain 16 years old

**Towards Food Sovereignty**

**Planners Concerns**
- Weak monitoring
- No transparency
- Inadequate accountability
- Price charged exceeds official price by 10% to 14%

**Food Security to Food Sovereignty**

**STEP III: COMMUNITY GRAIN FUND**

**ACTION**
- Local production, storage and distribution
- Support for manure and timely farming operation

**RESULTS IN 30 VILLAGES**
- Employment Days created per village: 7967
- Employment generated/acre: 90 person days
- Total income for 1000 Ha: Rs. 110 lakhs

**Food Security to Food Sovereignty**

**STEP III: COMMUNITY GRAIN FUND**

**Food Security to Food Sovereignty**

**STEP III: COMMUNITY GRAIN FUND**

- Coarse grains are basic commodities bought by poor.
- Are available to the poor at low prices
- No additional need to supply them through PDS & give them food subsidy.

**Towards Food Sovereignty**

**DECCAN DEVELOPMENT SOCIETY & ITS EFFORTS**
RESULTS IN 30 VILLAGES
- 800,000 Kg extra grains
- 1000 extra meals per family
- Increased fodder
- Increased livelihoods
- Increased wage income

Towards Food Sovereignty
COMMUNITY GRAIN FUND
GAINS
- Extra employment produced
  # Year I  2.39 lakh p/d
  # Year II  2.44 lakh
- Wage income generated
  # Year I  Rs.35.85 lakhs
  # Year II  Rs.36.6 lakhs

Food Security to Food Sovereignty
STEP III: COMMUNITY GRAIN FUND
GAINS
- Decentralised management
- Women’s committees manage the system
- Women rise from the status of receivers of food to providers of food

TABLE OF TWO PDS SYSTEMS
MAINSTREAM P.D.S
- Highly centralised
- Based on only two cereals: rice and wheat

TABLE OF TWO PDS SYSTEMS
ALTERNATIVE P.D.S
- Totally decentralised
- Based on diverse local grains
- Beneficial to rainfed, marginal areas

TABLE OF TWO PDS SYSTEMS
MAINSTREAM P.D.S
- Beneficial to irrigated, resource rich areas
- Women and local communities are Marginalised

TABLE OF TWO PDS SYSTEMS
ALTERNATIVE P.D.S
- Women and local communities are central to it
  they manage the system

NUTRITION CONTENT OF DIFFERENT FOOD CROPS (All values per 100 gm of edible portion)

<table>
<thead>
<tr>
<th>CROP</th>
<th>Protein (gm)</th>
<th>Carbs (100 gm)</th>
<th>Calcium (gm)</th>
<th>Iron (gm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearl Millet</td>
<td>11.6</td>
<td>13.6</td>
<td>42</td>
<td>5.0</td>
</tr>
<tr>
<td>Finger Millet</td>
<td>7.3</td>
<td>2.7</td>
<td>44</td>
<td>6.4</td>
</tr>
<tr>
<td>Sorghum</td>
<td>10.4</td>
<td>1.6</td>
<td>25</td>
<td>5.8</td>
</tr>
<tr>
<td>Wheat</td>
<td>11.8</td>
<td>0.6</td>
<td>23</td>
<td>2.5</td>
</tr>
<tr>
<td>Rice</td>
<td>6.8</td>
<td>0.6</td>
<td>10</td>
<td>3.1</td>
</tr>
</tbody>
</table>
**ALTERNATIVE P.D.S**

ENSURES
- Community level food security
- Fodder security
- Nutritional security
- Livelihood Security
- Ecological Security

**Food Security to Food Sovereignty**

*STEP IV: COMMUNITY GENE FUND*

**ACTION**
- Women supported for enhancement of diversity on their farms through cropping of traditional crops

**RESULTS**
- Emphasis from cash crop to food crop hands back decision making to women
- Forgotten foods return to kitchen
- Increased nutritional security

**Food Security to Food Sovereignty**

*STEP IV: COMMUNITY GENE FUND*

**ACTION**
- Addressed issues like
  - Triple Marginalisation: Crops, lands, women
  - Disappearing traditional landraces

**RESULTS**
- Seed Control returns to women
- Women regain control over family farming economics
- Farming processes are internalised

**Food Security to Food Sovereignty**

*STEP IV: COMMUNITY GENE FUND*

**RESULTS**
- Confronts triple marginalisation
- Women, crops and lands regain original status
- Recover 75 varieties
- Seeds worth 10000 acres in store

**Food Security to Food Sovereignty**

*STEP IV: COMMUNITY GENE FUND*

**RESULTS**
- Women’s intellectual leadership is reestablished
- Prepares community against the new seed colonialism
Presentations From Session - II
Millets, Biodiversity, Ecological farming and livelihood Security

3. Millets in the Nilgiris
Presentation by Robert Leo, Keystone Foundation, Tamilnadu.

Millets in the Nilgiris

Keystone Foundation, Nilgiris
A Group for Eco-Development Initiatives

Traditional millets of the region
- Tenai (Italian millet) Setaria italica
- Samia (Little millet) Panicum sumatrense
- Varagu (Finger millet) Eleusine coracana
- Panivaragu (Panicum miliaceum)
- Guthiravali (Echinochloa colona)
- Kambu (Pearl millet) Sorghum vulgare
- Chollam (sorghum) Sorghum bicolor

Polyculture, vegetables, tobacco, greens, unclassified crops are grown along with millets.
300 metric tonnes of millets grown every year in TN - dry land farming.

Bio-Diversity of the millet region
Ecological diversity
(as pollinators, seed dispersers, soil fertility and crop raiding too)

- Birds : 15
- Mammals : 6
- Insects : 7
- Reptiles : 4

Numerous earth life is also observed

Application of chemical input is zero level
- critically important to mountain ecosystems and watersheds

Livelihood Security
- 17 meals a month
- Millet is consumed for 3 to 5 months at intervals
- Grain is given as wages to labouring relatives
- Grain is offered to deities annual rituals
- Social action during harvesting and threshing
- Traditional land is an asset, inherited, protector from erosion and soil health is maintained
- Resource, uncultivated food

Diversity in traditional seeds, storages and technologies

Promoting mixed cropping practices and preparation of bio inputs to enhance productivity

Indigenous Knowledge & Practices (revival)
- Specific knowledge related to agriculture methods, seed varieties, foods
- Knowledge on Bird and Animal life relation to agriculture is refreshed
- Specific skills & crafts (improvisation)
- Documentation and use

Forward Linkages:
Initiatives taken so far
- Traditional food festivals to revive tastes
- Value additions and recipes to enhance usage
- Posters for information
- Technological interventions for better efficiency
- Green shops and cultural corners for revenues

is a challenge with growing influence of commercial crop vs. the time consuming millet cultivation practice

Plans ahead
- Marketing with PGS labeling (exclusive)
- Incorporate millet supply into PDS for tribal areas; Tamil Nadu
- Promote millet sale as a health food sector initiative
- Improve intake level amongst local people and school children
4. Biodiversity in Millets
Presentation by Dr. H D Upadhyaya, ICRISAT, Hyderabad.

Reasons for loss of biodiversity
- Habitat loss and fragmentation
- Introduction of species
- Over exploitation of plant species
- Global climate change
- New trends in agriculture

Important Millets
- Pearl millet [Pennisetum glaucum (R.) Br.]
- Finger millet [Eleusine coracana (L.) Gaertn.]
- Foxtail millet [Setaria italica (L.) P. Beauv.]
- Proso millet [Panicum miliaceum L.]
- Little millet [Panicum sumatrense Roth. ex Roem. & Schult.]
- Barryard millet [Echinochloa crusgalli (L.) P. Beauv. & Echinochloa colona (L.) Link]
- Kodo millet [Paspalum scrobiculatum L.]
- Teff [Enagrostis tel (Zucc.)]
- Fonio millet [Digitaria exilis Stapf & Digitaria iburu Stapf]

Utilization of millets
- Millets are used in several food preparations:
  - Unleavened flat breads (chapati)
  - Fermented breads (Kisra, injera, dosa etc.)
  - Porridge
  - Mudde or dumpling
  - Biscuits, snacks, malt
  - Opaque beer
- Millet stalks are used as fodder and thatching

Global conservation of biodiversity

Nutritional value of millets

<table>
<thead>
<tr>
<th>Crop/Nutrient</th>
<th>Protein (g)</th>
<th>Fiber (g)</th>
<th>Minerals (mg)</th>
<th>Iron (mg)</th>
<th>Calcium (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearl millet</td>
<td>10.6</td>
<td>1.3</td>
<td>2.3</td>
<td>18.9</td>
<td>38</td>
</tr>
<tr>
<td>Finger millet</td>
<td>7.3</td>
<td>3.6</td>
<td>2.7</td>
<td>3.9</td>
<td>244</td>
</tr>
<tr>
<td>Foxtail millet</td>
<td>12.3</td>
<td>8</td>
<td>3.3</td>
<td>2.8</td>
<td>31</td>
</tr>
<tr>
<td>Proso millet</td>
<td>12.5</td>
<td>2.2</td>
<td>1.9</td>
<td>0.6</td>
<td>14</td>
</tr>
<tr>
<td>Kodo millet</td>
<td>8.3</td>
<td>9</td>
<td>2.6</td>
<td>0.8</td>
<td>27</td>
</tr>
<tr>
<td>Little millet</td>
<td>7.7</td>
<td>7.6</td>
<td>1.5</td>
<td>9.3</td>
<td>17</td>
</tr>
<tr>
<td>Barryard millet</td>
<td>11.2</td>
<td>10.1</td>
<td>15.2</td>
<td>15.2</td>
<td>11</td>
</tr>
<tr>
<td>Rice</td>
<td>6.8</td>
<td>0.2</td>
<td>0.6</td>
<td>0.7</td>
<td>10</td>
</tr>
<tr>
<td>Wheat</td>
<td>11.8</td>
<td>1.2</td>
<td>1.5</td>
<td>5.3</td>
<td>41</td>
</tr>
</tbody>
</table>
## Role of millets in Sustainable Agriculture

- Because of short life cycle and wide adaptability, millets play an important role in sustainable rainfed agriculture.
- Can be used as catch or relay crop.
- Can be grown up to an altitude of 3000 m.a.s.l.
- Because of long storage life, serves as reserve food during food shortage period.

## Reasons for low cultivation of millets

- Not remunerative as other major crops.
- Lack of improved cultivars.
- Non-availability of suitable technology.
- Lack of organized crop improvement programs.
- Socio-economic factors of millet farmers.

### Millets germplasm at ICRISAT genebank

<table>
<thead>
<tr>
<th>Crop</th>
<th>Active collection</th>
<th>Base collection</th>
<th>Source countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearl millet</td>
<td>21,594</td>
<td>17,570</td>
<td>50</td>
</tr>
<tr>
<td>Finger millet</td>
<td>5,040</td>
<td>4,620</td>
<td>24</td>
</tr>
<tr>
<td>Foxtail millet</td>
<td>1,535</td>
<td>1,054</td>
<td>26</td>
</tr>
<tr>
<td>Proso millet</td>
<td>842</td>
<td>576</td>
<td>30</td>
</tr>
<tr>
<td>Little millet</td>
<td>466</td>
<td>364</td>
<td>5</td>
</tr>
<tr>
<td>Kodo millet</td>
<td>650</td>
<td>630</td>
<td>2</td>
</tr>
<tr>
<td>Barnyard millet</td>
<td>743</td>
<td>467</td>
<td>9</td>
</tr>
</tbody>
</table>

### Pearl millet

- Originated in a duffed belt stretching from western Sudan to Senegal.
- Pearl millet was domesticated some 4000 years ago at its place of origin.
- Reached eastern Africa and then spread to India some 3000 years ago and to southern Africa 2000 years ago.
- Staple food in Africa and parts of Asia and fodder in America.

### Finger millet

- Domesticated about 5000 years B.C. in Eastern Africa (Ethiopia).
- Introduced into India about 3000 years ago.
- Staple food in parts of Eastern and Central Africa and India.

### Foxtail millet

- Domesticated in the high lands of Central China.
- Yang-Shao period dating back some 5000 years.
- Grown in southern Europe and in temperate, subtropical, and tropical Asia.

### Proso millet

- Domesticated in Manchuria.
- Introduced into Europe about 3000 years ago followed by near East and India.
- Particularly suited to dry conditions.
- Grows in more varied temperature climates than other millets.

### Little millet

- Domesticated in India.
- Represents weedy progenitor P. psilopodium.
- Grown throughout India.
- Attitudes of 2100 m.
**Kodo millet**
- Domesticated in India almost 3000 years ago
- Found across the old world in humid habitats of the tropics and subtropics
- Minor grain crop in India
- Important in the Deccan plateau

**Barnyard millet**
- *E. crusgalli* domesticated in Japan 4000 years ago
- *E. colona* domesticated in India
- Barnyard millet are fastest growing of all millets
- Produces a crop in 8 weeks

### Characterization of millets germplasm

<table>
<thead>
<tr>
<th>Crop</th>
<th>Percentage characterized</th>
<th>Number of traits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearl millet</td>
<td>97</td>
<td>23</td>
</tr>
<tr>
<td>Finger millet</td>
<td>99</td>
<td>22</td>
</tr>
<tr>
<td>Foxtail millet</td>
<td>99</td>
<td>24</td>
</tr>
<tr>
<td>Proso millet</td>
<td>99</td>
<td>24</td>
</tr>
<tr>
<td>Little millet</td>
<td>98</td>
<td>26</td>
</tr>
<tr>
<td>Barnyard millet</td>
<td>99</td>
<td>22</td>
</tr>
<tr>
<td>Kodo millet</td>
<td>99</td>
<td>22</td>
</tr>
</tbody>
</table>

### Phenotypic diversity in pearl millet

<table>
<thead>
<tr>
<th>Character</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>Var</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to 50% flowering-rainy</td>
<td>33</td>
<td>159</td>
<td>72.8±0.2</td>
<td>56.9</td>
</tr>
<tr>
<td>Days to 50% flowering-postrainy</td>
<td>32</td>
<td>138</td>
<td>71.4±0.1</td>
<td>123.4</td>
</tr>
<tr>
<td>Plant height (cm) - rainy</td>
<td>30</td>
<td>400</td>
<td>246±0.5</td>
<td>4427.8</td>
</tr>
<tr>
<td>Plant height (cm) - postrainy</td>
<td>25</td>
<td>425</td>
<td>190±0.3</td>
<td>113.1</td>
</tr>
<tr>
<td>Total tillers (mm) - rainy</td>
<td>1</td>
<td>35</td>
<td>27.0±0.0</td>
<td>3.1</td>
</tr>
<tr>
<td>Productive tillers (no.) - rainy</td>
<td>1</td>
<td>19</td>
<td>21.5±0.0</td>
<td>1.2</td>
</tr>
<tr>
<td>Panicle insertion (cm) - rainy</td>
<td>-45</td>
<td>29</td>
<td>13.7±0.1</td>
<td>43.3</td>
</tr>
<tr>
<td>Panicle length (cm) - rainy</td>
<td>5</td>
<td>135</td>
<td>25.2±0.1</td>
<td>115.3</td>
</tr>
<tr>
<td>Panicle length (cm) - postrainy</td>
<td>4</td>
<td>125</td>
<td>25.4±0.1</td>
<td>109.6</td>
</tr>
<tr>
<td>Panicle thickness (mm) - rainy</td>
<td>6</td>
<td>58</td>
<td>24.9±0.6</td>
<td>23.7</td>
</tr>
<tr>
<td>Panicle thickness (mm) - postrainy</td>
<td>9</td>
<td>61</td>
<td>23.9±0.6</td>
<td>25.7</td>
</tr>
<tr>
<td>1000-seed wt. (g)</td>
<td>1.5</td>
<td>21.3</td>
<td>6.5±0.0</td>
<td>4.9</td>
</tr>
</tbody>
</table>

### Phenotypic diversity in Finger millet

<table>
<thead>
<tr>
<th>Trait</th>
<th>Range</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to flowering-rainy</td>
<td>50-120</td>
<td>80.41</td>
</tr>
<tr>
<td>Plant height (cm)-rainy</td>
<td>30-240</td>
<td>100.65</td>
</tr>
<tr>
<td>Basal tillers number</td>
<td>1-70</td>
<td>5.19</td>
</tr>
<tr>
<td>Flag leaf blade length (mm)</td>
<td>100-750</td>
<td>355.13</td>
</tr>
<tr>
<td>Flag leaf blade width (mm)</td>
<td>5-70</td>
<td>12.64</td>
</tr>
<tr>
<td>Flag leaf sheath length (mm)</td>
<td>6-230</td>
<td>102.52</td>
</tr>
<tr>
<td>Panicle length (mm)</td>
<td>15-450</td>
<td>215.45</td>
</tr>
<tr>
<td>Panicle insertion (mm)</td>
<td>0-360</td>
<td>113.47</td>
</tr>
<tr>
<td>Inflorescence length (mm)</td>
<td>16-330</td>
<td>93.13</td>
</tr>
<tr>
<td>Inflorescence width (mm)</td>
<td>0-700</td>
<td>78.47</td>
</tr>
<tr>
<td>Longest finger length (mm)</td>
<td>6-250</td>
<td>127.63</td>
</tr>
<tr>
<td>Longest finger width (mm)</td>
<td>2-50</td>
<td>11.68</td>
</tr>
<tr>
<td>Panicle branches number</td>
<td>2-27</td>
<td>7.73</td>
</tr>
</tbody>
</table>

### Diversity for panicle traits of pearl millet

### Diversity for panicle traits in small millets at ICRISAT genebank

### Global distribution of germplasm samples (1974 – 2007)

<table>
<thead>
<tr>
<th>Crop</th>
<th>Number of samples</th>
<th>Recipient countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearl millet</td>
<td>143,107</td>
<td>79</td>
</tr>
<tr>
<td>Finger millet</td>
<td>34,000</td>
<td>49</td>
</tr>
<tr>
<td>Foxtail millet</td>
<td>10,937</td>
<td>46</td>
</tr>
<tr>
<td>Proso millet</td>
<td>5,339</td>
<td>36</td>
</tr>
<tr>
<td>Little millet</td>
<td>2,313</td>
<td>27</td>
</tr>
<tr>
<td>Kodo millet</td>
<td>3,029</td>
<td>25</td>
</tr>
<tr>
<td>Barnyard millet</td>
<td>2,514</td>
<td>23</td>
</tr>
</tbody>
</table>
### Utilization of Germplasm in crop improvement

- Very small proportion of germplasm has been used in crop improvement
- This is mainly due to lack of information on large collections (considering crops)
- Need to reduce size without losing diversity
- Overcome size induced low use of germplasm
- Developing core collection—an option

### Core collections of millets

- Consist of only 10% of entire collection but represent species diversity
- Due to reduced size core collections can be evaluated extensively to identify trait specific germplasm for utilization
- ICRISAT scientists have developed core collections of pearl millet, finger millet and foxtail millet

### Identifying new sources using core collections

#### Finger millet
- Sixteen accessions flowered significantly early (49–57 days) than the earliest control cultivars Kalyani (63 days)
- Nine accessions (2.02–2.151 ha\(^{-1}\)) produced higher grain yield than Kalyani (1.921 ha\(^{-1}\))

#### Foxtail millet
- Twenty-three accessions flowered significantly early (25–40 days) than the earliest control cultivars SIA 326 (47.7 days)
- Nineteen accessions (7.5–13.2 g) produced greater grain yield than SIA 326 (7.4 g)

### Use of mini core collections by NARS to identify new sources of important traits

Promising accessions identified in finger millet core collection, evaluated at MPKV, Kothapur, Maharashtra, India
- Seed yield - 2 accessions
- Fodder yield - 7 accessions
- Early maturity - 2 accessions
- Basal tillers - 1 accession
- High inflorescence length and width - 7 accessions

### Impact of pearl millet germplasm

<table>
<thead>
<tr>
<th>Germplasm source</th>
<th>Variety released</th>
<th>Country of release</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP 17862</td>
<td>MP 124</td>
<td>India</td>
</tr>
<tr>
<td>IP 17862</td>
<td>PCB 138</td>
<td>India</td>
</tr>
<tr>
<td>IP 17862</td>
<td>Okashara 1</td>
<td>Namibia</td>
</tr>
<tr>
<td>IP 17862</td>
<td>Nyanthinumbo</td>
<td>Malawi</td>
</tr>
<tr>
<td>IP 17862</td>
<td>ICMV 0004</td>
<td>India</td>
</tr>
<tr>
<td>IP 17862</td>
<td>Okashara 2</td>
<td>Namibia</td>
</tr>
<tr>
<td>IP 11381</td>
<td>IKMP 3</td>
<td>Burkina Faso</td>
</tr>
<tr>
<td>IP 11317</td>
<td>IKMP 5</td>
<td>Burkina Faso</td>
</tr>
<tr>
<td>IP 6426</td>
<td>Benkadi Nic</td>
<td>Burkina Faso, Mali</td>
</tr>
<tr>
<td>IP 17527 &amp; IP 17531</td>
<td>Kangara and PMV 3</td>
<td>Namibia, Zimbabwe</td>
</tr>
</tbody>
</table>

### Impact of finger millet and barnyard millet germplasm

Varieties directly released from the material supplied by ICRISAT
- Finger millet - 2
- Barnyard millet - 1

### Molecular characterization of germplasm using SSR markers

- Pearl millet 1000 accessions, 20 SSR markers
- Finger millet 1000 accessions, 20 SSR markers
- Foxtail millet 500 accessions, 20 SSR markers

### Genetic diversity in finger millet composite collection

- 1000 accessions genotyped with 20 SSR markers
- 959 accessions analyzed with < 3% missing data
- 231 total alleles (110 rare, 121 common) in composite
- 11.5 alleles per locus in composite ranging from 7 to 12
### Genetic diversity in foxtail millet composite collection

- 500 accession genotyped with 19 SSR markers
- 19 SSR on 452 accessions analyzed with ~3% missing data
- 362 total alleles (170 rare, 192 common) in composite
- 19.1 alleles per locus in composite ranging from 5 to 35

### Conclusions

- Despite their importance, millets remained underexploited and underresearched crops until recently.
- Conservation of biodiversity of millets is an important objective at ICRISAT and important priority in the CGIAR system.
- ICRISAT research on germplasm diversity assessment and core collection development has provided means to enhance the use of genetic resources in pearl millet, finger millet and foxtail millet.
- Crop improvement programs need to be developed for the food security of poorest of the poor.

### Phenotypic diversity in Foxtail millet

<table>
<thead>
<tr>
<th>Trait</th>
<th>Range</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to flowering-rainy</td>
<td>32-135</td>
<td>53.5</td>
</tr>
<tr>
<td>Plant height (cm)-rainy</td>
<td>20-215</td>
<td>132.08</td>
</tr>
<tr>
<td>Basal tillers number</td>
<td>1-180</td>
<td>7.46</td>
</tr>
<tr>
<td>Flag leaf blade length (mm)</td>
<td>30-520</td>
<td>284.73</td>
</tr>
<tr>
<td>Flag leaf blade width (mm)</td>
<td>5-40</td>
<td>20.24</td>
</tr>
<tr>
<td>Flag leaf sheath length (mm)</td>
<td>50-160</td>
<td>138.47</td>
</tr>
<tr>
<td>Peduncle length (mm)</td>
<td>3-100</td>
<td>136.67</td>
</tr>
<tr>
<td>Panicle exertion (mm)</td>
<td>10-160</td>
<td>162.46</td>
</tr>
<tr>
<td>Inflorescence length (mm)</td>
<td>5-150</td>
<td>163.10</td>
</tr>
<tr>
<td>Inflorescence width (mm)</td>
<td>0.35-1.15</td>
<td>0.51</td>
</tr>
<tr>
<td>Weight of 5 panicles (gm)</td>
<td>0.35-1.15</td>
<td>0.51</td>
</tr>
</tbody>
</table>

### Phenotypic diversity in Little millet

<table>
<thead>
<tr>
<th>Traits</th>
<th>Range</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to flowering rainy</td>
<td>39-138</td>
<td>57.98</td>
</tr>
<tr>
<td>Plant height (cm) rainy</td>
<td>50-240</td>
<td>112.39</td>
</tr>
<tr>
<td>Basal tillers number</td>
<td>1-46</td>
<td>14.60</td>
</tr>
<tr>
<td>Calm thickness (mm)</td>
<td>2-18</td>
<td>6.64</td>
</tr>
<tr>
<td>Flag leaf blade length (mm)</td>
<td>60-560</td>
<td>247.12</td>
</tr>
<tr>
<td>Flag leaf blade width (mm)</td>
<td>6-160</td>
<td>39.32</td>
</tr>
<tr>
<td>Flag leaf sheath length (mm)</td>
<td>40-180</td>
<td>102.10</td>
</tr>
<tr>
<td>Peduncle length (mm)</td>
<td>60-400</td>
<td>189.36</td>
</tr>
<tr>
<td>Panicle exertion (mm)</td>
<td>90-200</td>
<td>131.15</td>
</tr>
<tr>
<td>Inflorescence length (mm)</td>
<td>27-500</td>
<td>202.24</td>
</tr>
<tr>
<td>Inflorescence width (mm)</td>
<td>10-400</td>
<td>147.54</td>
</tr>
<tr>
<td>Inflorescence lowest primary branch length (mm)</td>
<td>40-300</td>
<td>154.00</td>
</tr>
<tr>
<td>Inflorescence primary axis node number</td>
<td>2-29</td>
<td>11.07</td>
</tr>
<tr>
<td>Inflorescence secondary branch number</td>
<td>4-65</td>
<td>22.22</td>
</tr>
</tbody>
</table>

### Phenotypic diversity in Proso millet

<table>
<thead>
<tr>
<th>Traits</th>
<th>Range</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to flowering-rainy</td>
<td>26-50</td>
<td>34.50</td>
</tr>
<tr>
<td>Plant height (cm) rainy</td>
<td>20-123</td>
<td>59.25</td>
</tr>
<tr>
<td>Basal tillers number</td>
<td>1-32</td>
<td>3.96</td>
</tr>
<tr>
<td>Flag leaf blade length (mm)</td>
<td>80-380</td>
<td>222.24</td>
</tr>
<tr>
<td>Flag leaf blade width (mm)</td>
<td>6-150</td>
<td>19.39</td>
</tr>
<tr>
<td>Flag leaf sheath length (mm)</td>
<td>30-170</td>
<td>82.09</td>
</tr>
<tr>
<td>Peduncle length (mm)</td>
<td>15-400</td>
<td>180.92</td>
</tr>
<tr>
<td>Panicle exertion (mm)</td>
<td>6-320</td>
<td>99.68</td>
</tr>
<tr>
<td>Inflorescence length (mm)</td>
<td>22-400</td>
<td>193.08</td>
</tr>
<tr>
<td>Number of nodes</td>
<td>2-50</td>
<td>11.32</td>
</tr>
<tr>
<td>Inflorescence primary branches number</td>
<td>5-58</td>
<td>16.11</td>
</tr>
</tbody>
</table>

### Phenotypic diversity in Kodo millet

<table>
<thead>
<tr>
<th>Traits</th>
<th>Range</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to flowering rainy</td>
<td>51-112</td>
<td>77.51</td>
</tr>
<tr>
<td>Plant height (cm) rainy</td>
<td>30-17</td>
<td>54.77</td>
</tr>
<tr>
<td>Basal tillers number</td>
<td>2-48</td>
<td>15.17</td>
</tr>
<tr>
<td>Number of leaves</td>
<td>3-15</td>
<td>5.72</td>
</tr>
<tr>
<td>Flag leaf blade length (mm)</td>
<td>24-440</td>
<td>133.50</td>
</tr>
<tr>
<td>Flag leaf blade width (mm)</td>
<td>3-15</td>
<td>7.69</td>
</tr>
<tr>
<td>Flag leaf sheath length (mm)</td>
<td>50-220</td>
<td>144.73</td>
</tr>
<tr>
<td>Inflorescence length (mm)</td>
<td>20-160</td>
<td>54.33</td>
</tr>
<tr>
<td>Peduncle primary axis length (mm)</td>
<td>10-300</td>
<td>103.33</td>
</tr>
<tr>
<td>Raceme number</td>
<td>1-8</td>
<td>3.92</td>
</tr>
<tr>
<td>Thumb length (mm)</td>
<td>20-110</td>
<td>55.27</td>
</tr>
<tr>
<td>Longest raceme length (mm)</td>
<td>2-75</td>
<td>29.50</td>
</tr>
</tbody>
</table>

### Phenotypic diversity in Barnyard millet

<table>
<thead>
<tr>
<th>Traits</th>
<th>Range</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to flowering rainy</td>
<td>27-90</td>
<td>46.14</td>
</tr>
<tr>
<td>Plant height (cm) rainy</td>
<td>25-235</td>
<td>63.14</td>
</tr>
<tr>
<td>Basal tillers number</td>
<td>1-44</td>
<td>6.53</td>
</tr>
<tr>
<td>Calm thickness (mm)</td>
<td>2-16</td>
<td>5.21</td>
</tr>
<tr>
<td>Flag leaf blade length (mm)</td>
<td>50-420</td>
<td>198.26</td>
</tr>
<tr>
<td>Flag leaf blade width (mm)</td>
<td>5-40</td>
<td>18.40</td>
</tr>
<tr>
<td>Flag leaf sheath length (mm)</td>
<td>40-260</td>
<td>87.70</td>
</tr>
<tr>
<td>Peduncle length (mm)</td>
<td>20-510</td>
<td>151.35</td>
</tr>
<tr>
<td>Panicle exertion (mm)</td>
<td>50-280</td>
<td>64.68</td>
</tr>
<tr>
<td>Inflorescence length (mm)</td>
<td>13-280</td>
<td>144.75</td>
</tr>
<tr>
<td>Raceme number</td>
<td>5-61</td>
<td>24.87</td>
</tr>
<tr>
<td>Number of nodes</td>
<td>3-35</td>
<td>11.45</td>
</tr>
<tr>
<td>Longest raceme length (mm)</td>
<td>5-80</td>
<td>29.50</td>
</tr>
</tbody>
</table>
5. An Overview of Millet Biodiversity

Presentation by Dr. K.S. Varaprasad, NBPGR, Andhra Pradesh

---

### An Overview of Millet Biodiversity-Species

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Botanical Name</th>
<th>Vernacular Names</th>
<th>Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little Millet</td>
<td>Paniceae minutaee</td>
<td>Sama (Telugu, Hindi)</td>
<td>India</td>
</tr>
<tr>
<td>Kodo Millet</td>
<td>Paspalum scrobiculatum</td>
<td>Konnu (Kanuru), Kukki (Hindi)</td>
<td>India</td>
</tr>
<tr>
<td>Black Millet</td>
<td>Setaria italica</td>
<td>Saumpi (Telugu), Kampa (Hindi)</td>
<td>China</td>
</tr>
<tr>
<td>Pear Millet</td>
<td>Paniceae melicaceae</td>
<td>Vavara (Telugu), Bajra (Hindi)</td>
<td>China</td>
</tr>
<tr>
<td>Barnyard Millet</td>
<td>Echinochloa frumentacea</td>
<td>Bhatia (Telugu), Sawma (Hindi)</td>
<td>China</td>
</tr>
<tr>
<td>Finger Millet</td>
<td>Eleusine coracana</td>
<td>Ropu (Telugu), Ropu (Hindi)</td>
<td>Africa</td>
</tr>
<tr>
<td>Pearl Millet</td>
<td>Pennisetum americanum</td>
<td>Oyri (Telugu), Song (Hindi)</td>
<td>Africa</td>
</tr>
</tbody>
</table>

---

### An Overview of Millet Biodiversity-Land races

<table>
<thead>
<tr>
<th>Crop</th>
<th>No. of Landraces</th>
<th>Some Farmers’ landraces/traditional varieties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearl Millet</td>
<td>75</td>
<td>Karupatti, Kondapalli, Kadakampally, Pedda</td>
</tr>
<tr>
<td>Finger Millet</td>
<td>32</td>
<td>Bollapalle, Bollapalle, Palakollu, Puduralu</td>
</tr>
<tr>
<td>Kodo Millet</td>
<td>25</td>
<td>Asu (Korvai), Adal (Hindi), Chana (Korvai), Kudra (Korvai)</td>
</tr>
<tr>
<td>Little Millet</td>
<td>27</td>
<td>Bollapalle (Korvai), Chana (Korvai), Kudra (Korvai)</td>
</tr>
<tr>
<td>Peso Millet</td>
<td>4</td>
<td>Peth (Korvai)</td>
</tr>
<tr>
<td>Bara Millet</td>
<td>6</td>
<td>Dhere (Korvai)</td>
</tr>
<tr>
<td>Kodo Millet</td>
<td>5</td>
<td>Ahu (Korvai)</td>
</tr>
</tbody>
</table>

---

### Nutritional status of millets (Per 100gms of edible portion)

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Little Millet</th>
<th>Kodo Millet</th>
<th>Pearl Millet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein (g)</td>
<td>6.3</td>
<td>7.2</td>
<td>5.5</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>0.3</td>
<td>0.7</td>
<td>0.3</td>
</tr>
<tr>
<td>Fiber (g)</td>
<td>2.2</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>160</td>
<td>190</td>
<td>190</td>
</tr>
<tr>
<td>Phosphorus (mg)</td>
<td>160</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
</tr>
</tbody>
</table>

---

### Conservation of Small millets germplasm

<table>
<thead>
<tr>
<th>Crop</th>
<th>No. of accessions</th>
<th>NGB</th>
<th>MTM</th>
<th>Repatriated from ICARISAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small millets</td>
<td>19/19</td>
<td>1021</td>
<td>3325</td>
<td></td>
</tr>
</tbody>
</table>

---
Issues flagged

- In situ on-farm conservation of millet biodiversity.
- Documentation of traditional and local millet products for possible GI protection and organized marketing.
- Improved farmer’s varieties seed supply chain.
- Procurement price for millet crops.
- Inclusion of millet grains in the PSN.
- Promoting millets as certified organic products.
- Revival of innovative named relay cropping systems.
- Rich gene source exploration and protection.
- Therapeutic foods commercialization.
- Soil health revival and ecosystem sustainability.

Variability in Finger millet

Variability in Italian millet

Variability in Setaria italica

Panicum miliare
4. Biodiversity in Millets

Presentation by Dr. H D Upadhyaya,
ICRISAT, Hyderabad.

Reasons for loss of biodiversity

- Habitat loss and fragmentation
- Introduction of species
- Over exploitation of plant species
- Global climate change
- New trends in agriculture

Important Millets

- Pearl millet [Pennisetum glaucum (R.) Br.]
- Finger millet [Eleusine coracana (L.) Gaertn.]
- Foxtail millet [Setaria italica (L.) P. Beauv.]
- Proso millet [Panicum miliaceum L.]
- Little millet [Panicum sumatrense Roth ex Roem. & Schult.]
- Barnyard millet [Echinochloa crusgalli (L.) P. Beauv. & Echinochloa colona (L.) Link]
- Kodo millet [Paspalum scrobiculatum L.]
- Teff [Eragrostis tef (Zucc.)]
- Fonio millet (Digitaria exilis Stapf & Digitaria iburua Stapf)

Utilization of millets

- Millets are used in several food preparations
  - Unleavened flat breads (chapati)
  - Fermented breads (Kisra, injera, dosa etc.)
  - Porridge
  - Mudde or dumpling
  - Biscuits, snacks, malt
  - Opaque beer
- Millet stalks are used as fodder and thatching

Global conservation of biodiversity

> Over 6 million ex situ germplasm accessions exist and conserved in 1300 genebanks worldwide


Millets

- Millets are hardiest crops
- Serves as food and fodder
- Rich in micronutrients
  - "Nutritious Millets"
- Mainly grown in arid, semi-arid and mountain zones as rainfed crop
- Grown in south Asia, China, Russia & CISs and Africa

Utilization of millets

- Millets are used in several food preparations
  - Unleavened flat breads (chapati)
  - Fermented breads (Kisra, injera, dosa etc.)
  - Porridge
  - Mudde or dumpling
  - Biscuits, snacks, malt
  - Opaque beer
- Millet stalks are used as fodder and thatching

Nutritional value of millets

<table>
<thead>
<tr>
<th>Crop/Nutrient</th>
<th>Protein (g)</th>
<th>Fiber (g)</th>
<th>Minerals (g)</th>
<th>Iron (mg)</th>
<th>Calcium (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearl millet</td>
<td>10.6</td>
<td>1.3</td>
<td>2.3</td>
<td>16.9</td>
<td>36</td>
</tr>
<tr>
<td>Finger millet</td>
<td>7.3</td>
<td>3.6</td>
<td>2.7</td>
<td>3.9</td>
<td>344</td>
</tr>
<tr>
<td>Foxtail millet</td>
<td>12.3</td>
<td>8.4</td>
<td>3.3</td>
<td>2.8</td>
<td>31</td>
</tr>
<tr>
<td>Proso millet</td>
<td>12.5</td>
<td>2.2</td>
<td>1.9</td>
<td>0.8</td>
<td>14</td>
</tr>
<tr>
<td>Kodo millet</td>
<td>8.3</td>
<td>9.2</td>
<td>2.6</td>
<td>0.5</td>
<td>27</td>
</tr>
<tr>
<td>Little millet</td>
<td>7.7</td>
<td>7.8</td>
<td>1.5</td>
<td>9.3</td>
<td>17</td>
</tr>
<tr>
<td>Barnyard millet</td>
<td>11.2</td>
<td>10.1</td>
<td>15.2</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Rice</td>
<td>6.8</td>
<td>0.2</td>
<td>0.6</td>
<td>0.7</td>
<td>10</td>
</tr>
<tr>
<td>Wheat</td>
<td>11.8</td>
<td>1.2</td>
<td>1.5</td>
<td>5.3</td>
<td>41</td>
</tr>
</tbody>
</table>
Role of millets in Sustainable Agriculture

- Because of short life cycle and wide adaptability, millets play an important role in sustainable rainfed agriculture.
- Can be used as catch or relay crop.
- Can be grown up to an altitude of 3000 m a.s.l.
- Because of long storage life, serves as reserve food during food shortage period.

Reasons for low cultivation of millets

- Not remunerative as other major crops.
- Lack of improved cultivars.
- Non-availability of suitable technology.
- Lack of organized crop improvement programs.
- Socio-economic factors of millet farmers.

Millets germplasm at ICRISAT genebank

<table>
<thead>
<tr>
<th>Crop</th>
<th>Active collection</th>
<th>Base collection</th>
<th>Source countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearl millet</td>
<td>21,594</td>
<td>17,670</td>
<td>50</td>
</tr>
<tr>
<td>Finger millet</td>
<td>5,949</td>
<td>4,620</td>
<td>24</td>
</tr>
<tr>
<td>Foxtail millet</td>
<td>1,535</td>
<td>1,054</td>
<td>26</td>
</tr>
<tr>
<td>Proso millet</td>
<td>842</td>
<td>576</td>
<td>32</td>
</tr>
<tr>
<td>Little millet</td>
<td>466</td>
<td>384</td>
<td>5</td>
</tr>
<tr>
<td>Kodo millet</td>
<td>638</td>
<td>630</td>
<td>2</td>
</tr>
<tr>
<td>Barnyard millet</td>
<td>743</td>
<td>487</td>
<td>9</td>
</tr>
</tbody>
</table>

Pearl millet

- Originated in a degum belt stretching from western Sudan to Senegal.
- Pearl millet was domesticated some 4000 years ago at its place of origin, reached eastern Africa and then spread to India some 3000 years ago and to southern Africa 2000 years ago.
- Staple food in Africa and parts of Asia and fodder in Americas.

Finger millet

- Domesticated about 5000 years B.C. in Eastern Africa (Ethiopia).
- Introduced into India about 3000 years ago.
- Staple food in parts of Eastern and Central Africa and India.

Foxtail millet

- Domesticated in the Highlands of Central China.
- Yang-Shao period dating back some 5000 years.
- Grown in southern Europe and in temperate, subtropical, and tropical Asia.

Proso millet

- Domesticated in Manchuria.
- Introduced into Europe about 3000 years ago followed by near East and India.
- Particularly suited to dry conditions.
- Grows in more varied temperature climates than other millets.

Little millet

- Domesticated in India.
- Represents weedy progenitor P. psilopodum.
- Grown throughout India.
- Altitudes of 2100 m.
Kodo millet

- Domesticated in India, almost 3000 years ago
- Found across the old world in humid habitats of the tropica and subtropics
- Minor grain crop in India
- Important in the Deccan plateau

Barnyard millet

- E. crusgalli domesticated in Japan 4000 years ago
- E. colone domesticated in India
- Barnyard millet are fastest growing of all millets
- Produces a crop in 8 weeks

Characterization of millets germplasm

<table>
<thead>
<tr>
<th>Crop</th>
<th>Percentage characterized</th>
<th>Number of traits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearl millet</td>
<td>97</td>
<td>23</td>
</tr>
<tr>
<td>Finger millet</td>
<td>99</td>
<td>22</td>
</tr>
<tr>
<td>Foxtail millet</td>
<td>99</td>
<td>24</td>
</tr>
<tr>
<td>Proso millet</td>
<td>99</td>
<td>24</td>
</tr>
<tr>
<td>Little millet</td>
<td>96</td>
<td>26</td>
</tr>
<tr>
<td>Barnyard millet</td>
<td>99</td>
<td>22</td>
</tr>
<tr>
<td>Kodo millet</td>
<td>99</td>
<td>22</td>
</tr>
</tbody>
</table>

Phenotypic diversity in pearl millet

<table>
<thead>
<tr>
<th>Character</th>
<th>Min.</th>
<th>Max.</th>
<th>Mean</th>
<th>Var.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to 50% flowering-rainy</td>
<td>35</td>
<td>189</td>
<td>72±1-0</td>
<td>549.7</td>
</tr>
<tr>
<td>Days to 50% flowering-postrainy</td>
<td>32</td>
<td>138</td>
<td>71±1-0</td>
<td>123.4</td>
</tr>
<tr>
<td>Plant height (cm) - rainy</td>
<td>30</td>
<td>400</td>
<td>240±0-5</td>
<td>4427.6</td>
</tr>
<tr>
<td>Plant height (cm) - postrainy</td>
<td>35</td>
<td>425</td>
<td>310±0-3</td>
<td>3213.5</td>
</tr>
<tr>
<td>Total tillers mm (cm) rainy</td>
<td>37</td>
<td>37</td>
<td>37±1-0</td>
<td>1.1</td>
</tr>
<tr>
<td>Total tillers mm (cm) postrainy</td>
<td>35</td>
<td>35</td>
<td>35±1-0</td>
<td>1.1</td>
</tr>
<tr>
<td>Productive tillers (no.) rainy</td>
<td>10</td>
<td>10</td>
<td>10±0-0</td>
<td>0.2</td>
</tr>
<tr>
<td>Productive tillers (no.) postrainy</td>
<td>5</td>
<td>10</td>
<td>8±0-0</td>
<td>1.2</td>
</tr>
<tr>
<td>Panicle diameter (cm) rainy</td>
<td>5</td>
<td>125</td>
<td>25±0-1</td>
<td>109.8</td>
</tr>
<tr>
<td>Panicle diameter (cm) postrainy</td>
<td>5</td>
<td>125</td>
<td>25±0-1</td>
<td>109.8</td>
</tr>
<tr>
<td>Panicle thickness (mm) rainy</td>
<td>15</td>
<td>55</td>
<td>35±0-0</td>
<td>22.7</td>
</tr>
<tr>
<td>Panicle thickness (mm) postrainy</td>
<td>9</td>
<td>61</td>
<td>22±0-0</td>
<td>23.7</td>
</tr>
<tr>
<td>1000-seed weight (g)</td>
<td>1.5</td>
<td>24.5</td>
<td>6±1-0</td>
<td>46</td>
</tr>
</tbody>
</table>

Phenotypic diversity in Finger millet

<table>
<thead>
<tr>
<th>Trait</th>
<th>Range</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to flowering - rainy</td>
<td>65-120</td>
<td>90±41</td>
</tr>
<tr>
<td>Plant height (cm) - rainy</td>
<td>30-240</td>
<td>100±66</td>
</tr>
<tr>
<td>Basal tillers number</td>
<td>1-70</td>
<td>5±15</td>
</tr>
<tr>
<td>Flag leaf blade length (mm)</td>
<td>105-750</td>
<td>350±13</td>
</tr>
<tr>
<td>Flag leaf blade width (mm)</td>
<td>5-20</td>
<td>12±64</td>
</tr>
<tr>
<td>Flag leaf sheath length (mm)</td>
<td>6-280</td>
<td>102±52</td>
</tr>
<tr>
<td>Peduncle length (mm)</td>
<td>16-450</td>
<td>21±45</td>
</tr>
<tr>
<td>Panicle ovation (mm)</td>
<td>0-300</td>
<td>113±47</td>
</tr>
<tr>
<td>Inflorescence length (mm)</td>
<td>10-100</td>
<td>50±15</td>
</tr>
<tr>
<td>Inflorescence width (mm)</td>
<td>7-700</td>
<td>75±42</td>
</tr>
<tr>
<td>Longest finger length (mm)</td>
<td>10-250</td>
<td>72±63</td>
</tr>
<tr>
<td>Longest finger width (mm)</td>
<td>2-50</td>
<td>11±56</td>
</tr>
<tr>
<td>Panicle branches number</td>
<td>0-57</td>
<td>7±33</td>
</tr>
</tbody>
</table>

Diversity for panicle traits of pearl millet

Diversity for panicle traits in small millets at ICRISAT genebank


<table>
<thead>
<tr>
<th>Crop</th>
<th>Number of samples</th>
<th>Recipient countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearl millet</td>
<td>143,107</td>
<td>79</td>
</tr>
<tr>
<td>Finger millet</td>
<td>31,400</td>
<td>49</td>
</tr>
<tr>
<td>Foxtail millet</td>
<td>10,937</td>
<td>46</td>
</tr>
<tr>
<td>Proso millet</td>
<td>5,339</td>
<td>36</td>
</tr>
<tr>
<td>Little millet</td>
<td>2,111</td>
<td>27</td>
</tr>
<tr>
<td>Kodo millet</td>
<td>2,023</td>
<td>25</td>
</tr>
<tr>
<td>Barnyard millet</td>
<td>2,514</td>
<td>28</td>
</tr>
</tbody>
</table>
Utilization of Germplasm in crop improvement

- Very small proportion of germplasm has been used in crop improvement
- This is mainly due to lack of information on large collections (considering crops)
- Need to reduce size without losing diversity
- Overcome size induced low use of germplasm
- Developing core collection - an option

Core collections of millets

- Consist of only 10% of entire collection but represent species diversity
- Due to reduced size core collections can be evaluated extensively to identify trait specific germplasm for utilization
- ICRISAT scientists have developed core collections of pearl millet, finger millet and foxtail millet

Identifying new sources using core collections

Finger millet
- Sixteen accessions flowered significantly early (49-57 days) than the earliest control cultivars Kalrani (63 days)
- Nine accessions (2.02-2.15 t ha⁻¹) produced higher grain yield than Kalrani (1.92 t ha⁻¹)

Foxtail millet
- Twenty-three accessions flowered significantly early (25-40 days) than the earliest control cultivars SIA 326 (41.7 days)
- Nineteen accessions (7.5-13.2 g) produced greater grain yield than SIA 326 (7.4 g)

Use of mini core collections by NARS to identify new sources of important traits

Promising accessions identified in finger millet core collection, evaluated at MPKV, Kolhapur, Maharashtra, India
- Seed yield - 2 accessions
- Fodder yield - 7 accessions
- Early maturity - 2 accessions
- Basal tillers - 1 accession
- High inflorescence length and width - 7 accessions

Impact of pearl millet germplasm

<table>
<thead>
<tr>
<th>Germplasm source</th>
<th>Variety released</th>
<th>Country of release</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP 17862</td>
<td>MP 124</td>
<td>India</td>
</tr>
<tr>
<td>IP 17862</td>
<td>PCB 138</td>
<td>India</td>
</tr>
<tr>
<td>IP 17862</td>
<td>Okahshara 1</td>
<td>Namibia</td>
</tr>
<tr>
<td>IP 17862</td>
<td>Nyirembero</td>
<td>Malawi</td>
</tr>
<tr>
<td>IP 17862</td>
<td>ICMV 8804</td>
<td>India</td>
</tr>
<tr>
<td>IP 17862</td>
<td>Okahshara 2</td>
<td>Namibia</td>
</tr>
<tr>
<td>IP 11351</td>
<td>IKMP 3</td>
<td>Burkina Faso</td>
</tr>
<tr>
<td>IP 11317</td>
<td>IKMP 5</td>
<td>Burkina Faso</td>
</tr>
<tr>
<td>IP 8426</td>
<td>Benzadi Nio</td>
<td>Burkina Faso, Mali</td>
</tr>
<tr>
<td>IP 17527 &amp; IP 17531</td>
<td>Kargara and PMV 3</td>
<td>Namibia, Zimbabwe</td>
</tr>
</tbody>
</table>

Impact of finger millet and barnyard millet germplasm

Varieties directly released from the material supplied by ICRISAT
- Finger millet - 2
- Barnyard millet - 1

Molecular characterization of germplasm using SSR markers

- Pearl millet 1000 accessions, 20 SSR markers
- Finger millet 1000 accessions, 20 SSR markers
- Foxtail millet 500 accessions, 20 SSR markers

Genetic diversity in finger millet composite collection

- 1000 accessions genotyped with 20 SSR markers
- 950 accessions analyzed with < 3% missing data
- 231 total alleles (110 rare, 121 common) in composite
- 11.5 alleles per locus in composite ranging from 7 to 12
### Genetic diversity in foxtail millet composite collection
- 509 accession genotyped with 19 SSR markers
- 19 SSR on 452 accessions analyzed with <3% missing data
- 362 total alleles (170 rare, 192 common) in composite
- 19.1 alleles per locus in composite ranging from 5 to 35

### Conclusions
- Despite their importance, millets remained as under exploited and under researched crops until recently.
- Conservation of biodiversity of millets is an important objective at ICRISAT and important priority in the CGIAR system.
- ICRISAT research on germplasm diversity assessment and core collection development has provided means to enhance the use of genetic resources in pearl millet, finger millet and foxtail millet.
- Crop improvement programs need to be developed for the food security of poorest of the poor.

### Phenotypic diversity in Foxtail millet

<table>
<thead>
<tr>
<th>Trait</th>
<th>Range</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to flowering-rainy</td>
<td>32-135</td>
<td>93.95</td>
</tr>
<tr>
<td>Plant height (cm)-rainy</td>
<td>20-213</td>
<td>110.08</td>
</tr>
<tr>
<td>Basal tillers number</td>
<td>1-83</td>
<td>4.46</td>
</tr>
<tr>
<td>Flag leaf blade length (mm)</td>
<td>10-520</td>
<td>204.73</td>
</tr>
<tr>
<td>Flag leaf blade width (mm)</td>
<td>5.40</td>
<td>20.24</td>
</tr>
<tr>
<td>Flag leaf sheath length (mm)</td>
<td>50-263</td>
<td>138.47</td>
</tr>
<tr>
<td>Peduncle length (mm)</td>
<td>80-500</td>
<td>299.57</td>
</tr>
<tr>
<td>Panicle exertion (mm)</td>
<td>10-360</td>
<td>152.46</td>
</tr>
<tr>
<td>Inflorescence length (mm)</td>
<td>10-399</td>
<td>303.10</td>
</tr>
<tr>
<td>Inflorescence width (mm)</td>
<td>5-120</td>
<td>19.19</td>
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<tr>
<td>Weight of % panicles (cm)</td>
<td>0.35-116.5</td>
<td>30.11</td>
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</table>

### Phenotypic diversity in Little millet

<table>
<thead>
<tr>
<th>Traits</th>
<th>Range</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to flowering-rainy</td>
<td>39-138</td>
<td>67.08</td>
</tr>
<tr>
<td>Plant height (cm)-rainy</td>
<td>50-240</td>
<td>112.09</td>
</tr>
<tr>
<td>Basal tillers number</td>
<td>2-46</td>
<td>24.60</td>
</tr>
<tr>
<td>Culm thickness (mm)</td>
<td>2-10</td>
<td>6.04</td>
</tr>
<tr>
<td>Flag leaf blade length (mm)</td>
<td>40-540</td>
<td>247.22</td>
</tr>
<tr>
<td>Flag leaf blade width (mm)</td>
<td>5-150</td>
<td>39.02</td>
</tr>
<tr>
<td>Flag leaf sheath length (mm)</td>
<td>40-180</td>
<td>103.30</td>
</tr>
<tr>
<td>Peduncle length (mm)</td>
<td>60-480</td>
<td>189.86</td>
</tr>
<tr>
<td>Panicle exertion (mm)</td>
<td>40-280</td>
<td>71.15</td>
</tr>
<tr>
<td>Inflorescence length (mm)</td>
<td>27-500</td>
<td>302.24</td>
</tr>
<tr>
<td>Inflorescence width (mm)</td>
<td>20-480</td>
<td>147.64</td>
</tr>
<tr>
<td>Inflorescence lowest primary branch length (mm)</td>
<td>40-300</td>
<td>154.90</td>
</tr>
<tr>
<td>Inflorescence primary axillary node number</td>
<td>2-29</td>
<td>11.07</td>
</tr>
<tr>
<td>Inflorescence secondary branch number</td>
<td>4-95</td>
<td>23.22</td>
</tr>
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</table>

### Phenotypic diversity in Proso millet

<table>
<thead>
<tr>
<th>Traits</th>
<th>Range</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to flowering-rainy</td>
<td>26-160</td>
<td>34.10</td>
</tr>
<tr>
<td>Plant height (cm)-rainy</td>
<td>20-233</td>
<td>59.35</td>
</tr>
<tr>
<td>Basal tillers number</td>
<td>1-93</td>
<td>4.46</td>
</tr>
<tr>
<td>Flag leaf blade length (mm)</td>
<td>80-380</td>
<td>222.34</td>
</tr>
<tr>
<td>Flag leaf blade width (mm)</td>
<td>6-150</td>
<td>19.19</td>
</tr>
<tr>
<td>Flag leaf sheath length (mm)</td>
<td>30-170</td>
<td>92.10</td>
</tr>
<tr>
<td>Peduncle length (mm)</td>
<td>15-400</td>
<td>180.12</td>
</tr>
<tr>
<td>Panicle exertion (mm)</td>
<td>3-320</td>
<td>99.18</td>
</tr>
<tr>
<td>Inflorescence length (mm)</td>
<td>22-400</td>
<td>193.10</td>
</tr>
<tr>
<td>Number of nodes</td>
<td>2-96</td>
<td>11.12</td>
</tr>
<tr>
<td>Inflorescence primary branch number</td>
<td>5-25</td>
<td>10.12</td>
</tr>
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</table>

### Phenotypic diversity in Kodo millet

<table>
<thead>
<tr>
<th>Traits</th>
<th>Range</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to flowering-rainy</td>
<td>51-112</td>
<td>77.61</td>
</tr>
<tr>
<td>Plant height (cm)-rainy</td>
<td>29-97</td>
<td>54.77</td>
</tr>
<tr>
<td>Basal tillers number</td>
<td>2-48</td>
<td>11.17</td>
</tr>
<tr>
<td>Number of leaves</td>
<td>3-15</td>
<td>5.72</td>
</tr>
<tr>
<td>Flag leaf blade length (mm)</td>
<td>15-440</td>
<td>183.50</td>
</tr>
<tr>
<td>Flag leaf blade width (mm)</td>
<td>3-15</td>
<td>7.69</td>
</tr>
<tr>
<td>Flag leaf sheath length (mm)</td>
<td>55-220</td>
<td>144.73</td>
</tr>
<tr>
<td>Inflorescence length mm</td>
<td>28-180</td>
<td>94.33</td>
</tr>
<tr>
<td>Sterile primary axis length (mm)</td>
<td>10-250</td>
<td>101.23</td>
</tr>
<tr>
<td>Raceme number</td>
<td>1-8</td>
<td>3.62</td>
</tr>
<tr>
<td>Thumb length (mm)</td>
<td>21-130</td>
<td>51.27</td>
</tr>
<tr>
<td>Longest raceme length (mm)</td>
<td>2-75</td>
<td>21.50</td>
</tr>
</tbody>
</table>

### Phenotypic diversity in Barnyard millet

<table>
<thead>
<tr>
<th>Traits</th>
<th>Range</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to flowering-rainy</td>
<td>37-90</td>
<td>46.14</td>
</tr>
<tr>
<td>Plant height (cm)-rainy</td>
<td>29-236</td>
<td>83.14</td>
</tr>
<tr>
<td>Basal tillers number</td>
<td>1-44</td>
<td>0.55</td>
</tr>
<tr>
<td>Culm thickness (mm)</td>
<td>2-15</td>
<td>5.21</td>
</tr>
<tr>
<td>Flag leaf blade length (mm)</td>
<td>55-420</td>
<td>198.36</td>
</tr>
<tr>
<td>Flag leaf blade width (mm)</td>
<td>5-40</td>
<td>18.40</td>
</tr>
<tr>
<td>Flag leaf sheath length (mm)</td>
<td>48-260</td>
<td>87.70</td>
</tr>
<tr>
<td>Peduncle length (mm)</td>
<td>25-520</td>
<td>151.35</td>
</tr>
<tr>
<td>Panicle exertion (mm)</td>
<td>55-280</td>
<td>64.68</td>
</tr>
<tr>
<td>Inflorescence length (mm)</td>
<td>17-280</td>
<td>144.75</td>
</tr>
<tr>
<td>Raceme number</td>
<td>5-61</td>
<td>24.67</td>
</tr>
<tr>
<td>Number of nodes</td>
<td>3-25</td>
<td>11.45</td>
</tr>
<tr>
<td>Unusual raceme length (mm)</td>
<td>5.80</td>
<td>26.50</td>
</tr>
</tbody>
</table>
5. An Overview of Millet Biodiversity

Presentation by Dr. K.S. Varaprasad, NBPG, Andhra Pradesh

### An Overview of Millet Biodiversity - Species

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Vernacular Names</th>
<th>Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little Millet</td>
<td>Panicum miliaceum (L.)</td>
<td>Sona, (Telugu, Hindi)</td>
<td>India</td>
</tr>
<tr>
<td>Kodo Millet</td>
<td>Pachyrhizio.</td>
<td>Coorgi (Telugu), Kana (Hindi), Konas (Sanskrit)</td>
<td>India</td>
</tr>
<tr>
<td>Italian Millet</td>
<td>Secale cereale (L.)</td>
<td>Korra, (Telugu), Kana, (Hindi), Konas (Sanskrit)</td>
<td>China</td>
</tr>
<tr>
<td>Persian Millet</td>
<td>Panicum miliaceum (L.)</td>
<td>Vang (Telugu), Chena (Hindi)</td>
<td>China</td>
</tr>
<tr>
<td>Barley Millet</td>
<td>Hordeum vulgare</td>
<td>Barna (Telugu), Moobha (Hindi), Rupka (Sanskrit)</td>
<td>China</td>
</tr>
<tr>
<td>Finger Millet</td>
<td>Eleusine corocoza</td>
<td>Gogur, Jogala (Telugu), Mundha (Hindi), Bajko (Sanskrit)</td>
<td>Africa</td>
</tr>
<tr>
<td>Pearl Millet</td>
<td>Pennisetum americanum (L.)</td>
<td>Ganta, Sugata (Telugu), Pogha (Hindi), Vangara (Sanskrit)</td>
<td>Africa</td>
</tr>
</tbody>
</table>

### An Overview of Millet Biodiversity - Land races

<table>
<thead>
<tr>
<th>Crop</th>
<th>No. of Land races</th>
<th>Some Farmers’ landraces / traditional varieties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearl millet</td>
<td>21</td>
<td>Karuppu, Koogadu, Hoolagudi, Kittiguda</td>
</tr>
<tr>
<td>Finger millet</td>
<td>32</td>
<td>Parvathu, Malh, Muttu mudda, Pedda mudda.</td>
</tr>
<tr>
<td>Italian millet</td>
<td>24</td>
<td>Amthikuru, Hutan boringa, Chivaram, Kondalaram</td>
</tr>
<tr>
<td>Little millet</td>
<td>25</td>
<td>Srilakshmimal, Chinnu maddu, Kreedu maddu, Malla maddu</td>
</tr>
<tr>
<td>Pearl millet</td>
<td>4</td>
<td>Parvandu.</td>
</tr>
<tr>
<td>Denny top millet</td>
<td>6</td>
<td>Dhurum, Chassu, Chinnu maddu, Malu maddu.</td>
</tr>
<tr>
<td>Kodo millet</td>
<td>5</td>
<td>Alle, Meenikaloo.</td>
</tr>
</tbody>
</table>

### Nutritional status of millets (Per 100gm of edible portion)

<table>
<thead>
<tr>
<th></th>
<th>Pearl millet</th>
<th>Little millet</th>
<th>Finger millet</th>
<th>Kodo millet</th>
<th>Kodo millet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein (g)</td>
<td>6.4</td>
<td>9.7</td>
<td>7.4</td>
<td>7.7</td>
<td>9.1</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>2.9</td>
<td>0.9</td>
<td>1.1</td>
<td>0.9</td>
<td>1.1</td>
</tr>
<tr>
<td>Fibre (g)</td>
<td>12.5</td>
<td>7.7</td>
<td>12.3</td>
<td>12.2</td>
<td>12.2</td>
</tr>
<tr>
<td>Phosphorus (mg)</td>
<td>162</td>
<td>64</td>
<td>156</td>
<td>139</td>
<td>159</td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>0.3</td>
<td>0.2</td>
<td>0.4</td>
<td>0.2</td>
<td>0.4</td>
</tr>
</tbody>
</table>

### Conservation of Small millets germplasm

<table>
<thead>
<tr>
<th>Crop</th>
<th>No. of accessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small millets</td>
<td>19,919</td>
</tr>
</tbody>
</table>

G NGB, MTM Repatriated from ICRI SAT.
**Issues flagged**

- In-situ on-farm conservation of millet biodiversity
- Documentation of traditional ethnic products for possible off protection and organized marketing
- Improved farmer's varieties seed supply chain
- Provenance prices for millet crops
- Inclusion of millet grains in the PDS
- Promoting millets as certified organic products
- Pilot trial of innovative mixed relay cropping systems
- Basic gene source exploitation and protection
- Therapeutic foods commercialization
- Soil health revival and ecosystem sustainability

**Variability in Fingermillet**

**Variability in Italianmillet**

**Variability in Setaria italica**

**Panicum miliare**
6. Millets and Health/Nutritional Security
Presentation by Dr. P. Rajyalakshmi, ANGRAU, Hyderabad

Millet is one of the oldest foods known to Humans.
It was grown as early as 2700 BC in China and was prevalent grain before rice became the dominant staple.

Millets are short-season hardy crops capable of growing on a wide range of infertile soils under extremely harsh climatic conditions in temperate, arid and semi-arid trop regions of the world.

Millet is Highly Nutritious, Healthy and versatile grown.

Nutrition security implies food grain security and availability of diverse foods to ensure Macro and Micro nutrient requirements.

Minor Millets account for less than one percent of food grains produced in the world today.

➢ The world production of millets 26.35 MT (1999)
➢ India production 8.10 MT (FAO, 2001)

MILLETS GROWN IN INDIA
MAJOR MILLETS
Sorghum
Ragi

MINOR MILLETS
➢ Finger Millet (Eleusine Coracana) Ragi
➢ Foxtail Millet (Setaria Italica) Korra
➢ Proso Millet (Panicum Miliaceum)
➢ Barnyard Millet (Echinochloa Colona)
➢ Kodo Millet (Paspalum Scrobiculatum)
➢ Little Millet (Panicum Miliare)
NUTRITIONAL SECURITY MUST ADDRESS INTERDISCIPLINARY APPROACH

FOOD SECURITY
- External factors governing -
  - Adequate food supply/availability
  - Awareness creation/popularization
  - Utilization aspects (Cooking, Processing)
  - Market value
  - Purchasing power/affordable price
  - Physical access to food
- Internal factors -
  - Intrafamilial distribution
  - Health & Sanitation
  - Traditions & Customs
  - Attitudes

TARGETING FOOD SECURITY
- Exclusion of genuinely needed person (57% BPL households not covered in Targeted PDS)
- Ineffective delivery system (PDS, Midday meals ICDS)
- PDS should aim at specific food and Nutrition intervention
- Address specific consumption needs of vulnerable groups through food supplementation
- National strategy for Nutrition of children under two years.

Global nutrition security (Swaminathan, 1998)
- Re-focus national priorities in agricultural research to allow for crop diversity as well as the intensity of production.
- Recreate the demand and market for a wide range of crops.
- Develop processed foods based on a mixture of nutritious crops.
- Include minor crops in national food security measures.
- Redesignate ‘coarse cereals’ as ‘nutritious cereals’ in order to alter the image of such micronutrient rich crops in public perception.
- Promote conservation of wide range of food crops.
- Promote breeding efforts designed to increase the micronutrient content of crops like rice, wheat and maize.
- Promote mixed cropping and multiple cropping sequences which provide space in the cropping system for under-utilized but nutritionally desirable crops.

Thank you
7. Creating demand for Millet foods

Presentation by Dr. Vijaya Khadir, ANGRAU, Hyderabad

**PROJECT LEADER AND STAFF**

(a) Leaders
- Principal Investigator: Dr. (Mrs.) Vijaya Khadir
  Dean, Faculty of Home Science
- Co-Investigator: Dr. (Mrs.) K Uma Maheswari
  Associate Professor

(b) Staff involved
- Research Fellow: G. Anitha
- Field Assistants: Md. Naser Ali & Praveen Kumar

**Date of Initiation:** 17-9-2004
**Duration:** 2 Years

**OBJECTIVES**

**General objective:**
- To study the effect of feeding malted food on the nutritional status of vulnerable groups of population.

**Specific objectives:**
- To develop ready to use malted mixes using malted wheat / Ragi and green gram
- To assess the physico-chemical and organoleptic quality characteristics of the developed malted mixes.
- To develop the training manual and education material on malting.

**Initiation of Supplementation:** 12th July, 2005
**Completion of supplementation:** 12th October, 2005

**Selected villages:** 8 villages of Lepakshi mandal, Ananthapur district

**No. of preschool children:** 400
**No. of Pregnant women:** 100
**No. of Lactating women:** 100

Contd...

- Supplementation of the malted food for 3 months to the selected group
- To assess the nutritional status of the subjects before and after the supplementation by:
  - Anthropometry (weight, height, MUAC)
  - Assessment of Hemoglobin
  - Diet survey
  - Clinical assessment
  - Assessment of morbidity
CONTD...

- To train the selected self-help group on the preparation of ready-to-use malted mixes.
- To promote and popularize the use of malted foods.
- To establish small-scale food processing industry for income generation.
- To encourage the consumption of malted mix in government supplementary feeding programmes in A.P.

RESULTS

2 Types of Ready to Use Malted Mixes

- Amylase Rich Ragi Malted Mix (ARRMM)
- Amylase Rich Wheat Malted Mix (ARRMM)

Recipes with ARMMs

- Ragi Porridge
- Ragi Roti
- Wheat Roti
- Kheer prepared with Amylase rich malted mix

Recipes with ARMMs

- Laddu prepared with Amylase rich malted mix

Chemical Composition

- Wheat malted mix has significantly higher (P<0.05)
  - Fat (2.27g)
  - Carbohydrate (98.3g) and
  - Calories (396 kcal)
- Ragi malted mix has significantly higher (P<0.05)
  - Calcium (140 mg)
  - Thiamine (0.7 mg)
  - Riboflavin (0.3 mg)
  - Amylase activity (169 mg/%) and
- Germinated green gram (P<0.05)
  - Protein (8.0g)
  - Fibre (11.3g)
  - Iron (8.6g) and
  - Vitamin C (157.3 mg)

Selection of the villages

1) Manempally
2) Sirivaram
3) Gopindoripally
4) Gourganpally
5) Venkatapararam
6) Tirumaladevaunpally
7) Sudiapally
8) Pulanathil
Selection of subjects

- Preschool children (400) were selected based on degree of malnutrition (<60% to 75%) as per Gomez classification (Jellefee D.B, 1966)
- Pregnant and lactating women with chronic energy deficiency (<16.0 to 17.0) were selected based on BMI classification (James et al, 1988)

Initiation of Supplementation Programme in Selected Villages (12th July, 2005)

No. of beneficiaries trained through the project

- 40 self-help group women were trained under the following aspects
  - General introduction on malted foods
  - Ingredients for ARMMs
  - Steps involved in the preparation of ARMMs
  - Importance of ARMMs to preschool children, pregnant women & lactating women
  - Advantages of ARMMs
  - Requirement of ARMMs for different age groups
  - Recipes
  - Budget proposal to establish small scale malt mix industry

Distribution of ARMMs

- Wheat malted mix was distributed in
  - Mannampally
  - Venkatapuram
  - Gourgampally and
  - Pulanath

- Ragi malted mix was distributed in
  - Tirumaladevarapally
  - Sudipally

Collection of KAP Information in SHG’s and Training

- Knowledge, Attitude and Practices on Malted Mixes of Self Help Groups showed 40-70% improvement after the training programme
Steps taken to sustain the activities after the completion of the project

- Established small scale food processing industry for income generation in two selected villages namely: Manepally and Sribaram.
- Two self help groups comprising 20 members in each group established the preparation of malted milk powder unit at community level.
- A voluntary organization i.e. Sri.Kodi Ranganatha Swamy Seva Trust agreed to donate two ceiling machines.
- The Honorable Minister for Agriculture Dr. Raghunendra Reddy is very keen to introduce these malted milk powder in TCBS Programme.

Promotion of malt based small scale food industry provides

- Entrepreneurship
- Employment
- Food and Nutrition security through income generation
Three Pillars of Food Security

- Food Availability
- Food Access
- Food Utilisation

A number of critical factors affect household food insecurity, including:
- Pressure on agricultural land;
- Low soil fertility;
- Restricted access to wetlands;
- Poor diversity of food crop production;
- Poor post harvest practices;
- Poor access to fertile farmland and fishing areas.
Integrate nutrition education and social marketing:

- Knowledge of the traditional diet
- Seasonal food shortages
- Food storage and cooking practices
- Intra-household food distribution
- Prevailing food taboos

(Will provide invaluable formation for planning an appropriate nutrition communication strategy)

Five main areas need to be addressed in any community-based nutrition effort:

- Eating right for age and gender.
- Improving food production.
- Promoting local foods.
- Processing and preserving food.
- Education about nutrition.

There is no single means for guaranteeing food security.
- It requires a broad range of programmes
- Backed by sufficient national and international commitment to implement them
- Political mechanisms that respond to basic human needs.

Thank you
8. SORGHUM – HEALTH FOODS

Presentation by Dr. V. Vimala, ANGRAU, Hyderabad

NUTRITIOUS SORGHUM – HEALTH FOOD

Dr. V. Vimala

Nutritious sorghum as health food

- Sorghum posses unique nutritional and functional properties which allows for development of healthy nutritious foods
  - It is gluten free
  - Has unique phenolic compounds which has medicinal properties
  - Compliments well with lysine rich vegetable & animal proteins to form nutritionally balanced foods of high B.V.

Processing Technologies

Some of the relevant processing technologies which would result in value addition & increased utilization are:

- Dehulling
- Germination
- Popping / Puffing
- Flaking
- Matting
- Baking
- Extrusion
- Fermentation

Dehulling

- Traditional hand pounding method
  - Time consuming
  - Laborious
  - Inefficient method
- Mechanical dehulling improved
  - Physical appearance
  - Functional properties
  - Better quality grain
  - Reduces drudgery
  - Lower level of bran and broken

Dehulling

As mechanical dehulling improves the quality of grain better quality flour and rawa were obtained. This good quality flour & rawa made it possible to develop commercially viable products.

- Baked foods
- Breakfast foods
- Snack items
- Ready to cook mixes
- Dehydrated foods
- Instant mixes
- Composite rot mixes
Puffing, Popping

Puffed Sorghum – Low bulk density
Good Texture
Appealing flavour
used as a snack food after spicing or sweetening

Popped Sorghum – Infant weaning foods
Snack food products
Breakfast & Specialty foods

Flaking

Flaked sorghum – Excellent
snack food
Flaked sorghum powder – weaning food

For getting a good quality flattened product, the millet grains are to be harvested slightly premature

Malting

Malting / germination – produces maximum fall in the viscosity of gruels.
many nutritional benefits.

Malted sorghum – Weaning foods with low viscosity and high calorie density.

Malted millets – malted vinegar
medicinal preparations
brewing industry

However high oil content and poor keeping quality of millet malt are the constraints for its utilization in brewing industry

Baking

Sorghum flour in combination with wheat flour can be used for the preparation of diversified baked products

Extrusion

Sorghum has been successfully used in the preparation of roller dried extruded products

Products – vermicelli
noodles

Traditional – muruku
products

However a minimum of 36% wheat flour was found to be required to produce an acceptable product

Fermentation

Fermentation helps to preserve the foods since the end products formed, mainly acids and alcohols, are inhibitory to common pathogenic microorganisms
Fermentation – Nutritional implications

- Improvement in starch availability & digestibility
  - Protein digestibility
  - Mineral availability
- Reduction in tannins, phytic acid, fibre & oxalates
- Mycotoxins
- Physico-chemical – reduces the viscosity
- Changes of the product

Nutritional implications - starch

- Starch content in sorghum is comparable to other cereals
  - But has a lower feeding value due to lower starch availability
- Fermentation reduces enzyme resistant starch and decreases the concentration of flatulence causing sugars thus increasing the availability

Shanaz Saldana (1991) has recommended fermentation among all the processing technologies as a good method to improve the nutritional quality of sorghum, specially, protein

Nutritional implications - protein

- Fermentation increases the availability of most limiting amino acids (lysine, methionine, leucine and tryptophan)
- Increases the digestibility of sorghum protein due to inhibition of protein binding effects of polyphenols
- Free amino acids increase
  - Degradation of protein into peptides and amino acids
  - Bacteria synthesizes amino acids from metabolic intermediates during fermentation

Nutritional implications - minerals

- Mineral availability increases during fermentation. It could be due to decrease in
  - Phytic acid
  - Oxalates
  - Tannins

The rate of available iron, manganese, calcium and zinc also increases due to fermentation

Value addition to sorghum

<table>
<thead>
<tr>
<th>Product</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noodles, macaroni, pasta</td>
<td>Desikachar, 1970</td>
</tr>
<tr>
<td>Flakes</td>
<td>Ridley &amp; Satter, 1977</td>
</tr>
<tr>
<td>Tortilla &amp; Tortilla chips</td>
<td>Sema Sadicvar et al., 1988</td>
</tr>
<tr>
<td>Grilled sorghum flour, rice, breakfast food snack, tamales, dairy foods, dehydrated foods, infant mixes, sticky-knot mixes, composite roll</td>
<td>Viner et al., 1993</td>
</tr>
<tr>
<td>Bread</td>
<td>Sema Sadicvar et al., 1994</td>
</tr>
<tr>
<td>Papads</td>
<td>Nakata, 2002</td>
</tr>
<tr>
<td>Baked products like bread, cakes, muffins, cookies and biscuits</td>
<td>Torres et al., 1995</td>
</tr>
<tr>
<td>Ready-to-eat breakfast foods</td>
<td>Singh et al., 2003</td>
</tr>
<tr>
<td>Nutritious bar, cake, biscuits, breakfast foods with fermented sorghum</td>
<td>Cruz et al., 1994</td>
</tr>
<tr>
<td>Grilled snacks</td>
<td>Kamini Devi et al., 2007</td>
</tr>
</tbody>
</table>

Sorghum as functional food

- Functional foods are those that provide specific health benefits beyond the traditional nutrients they contain
- Functional foods are viewed as health promoting and may be associated with a decreased risk for certain diseases
- Sorghum also can be considered as a functional food since it is hypocholesterolemic and hypoglycemic in nature
**Coronary heart disease - sorghum**

- Elevated total or LDL cholesterol level in the blood are major risk factors for CHD
- Diet is primary and most potent treatment for hyperlipidemia
- The possible hypocholesterolemic effects of beta glucan, soy protein, isoflavones, dietary fibre, plant sterols, tocotrienols etc. have attracted much attention
- Millets defatted soy flour, pectin and oat bran can be considered as functional food

The results of the study indicated

- Significant decrease in serum cholesterol (7.5%)
- Significant decrease in serum triglycerides (7.9%)
- Non-significant increase in HDL cholesterol (2.5%)
- Significant decrease in serum LDL cholesterol (10%)
- A marked reduction in VLDL cholesterol (8.2%)

A study conducted on non-insulin dependent diabetic subjects has shown that consumption of whole sorghum recipes (masi roti, upma and dokla) had resulted in significantly

- Lower plasma glucose levels
- Least glycemic response was observed in
  - Whole sorghum upma (74.6 mg)
  - Whole sorghum masi roti (77.8 mg)
  - Whole sorghum dokla (84.5 mg)
  
  Buchilakshmi and V. Vimala, 1992

**Sorghum – Functional food**

Functional food – whole sorghum flour defatted soy flour oat bran pectin

Form of product – biscuit

Subjects

- 20 hypercholesterolemic subjects

Experimental period – 2 months

Chitra purohit and V. Vimala, 2004

**Diabetes Mellitus - sorghum**

- Diet was one of the few factors which could be modified to improve diabetic control
- There has been a strong clinical impression that diabetic patients tolerate ragi better than rice
- Hence it is very essential to study the effectiveness of sorghum recipes on the blood sugar level of diabetic patients

The study also indicates whole sorghum recipes are better than dehulled sorghum recipes for diabetic patients

**Conclusions**

- It is possible to develop many products using coarse grain like sorghum using varied processing technologies
- Among all the processing technologies, fermentation seems to be the better option for deriving maximum nutritional benefits
- With increase in nutritional awareness among people, it is always advisable to promote sorghum as a health food / functional food since it possesses hypocholesterolemic effect and hypoglycemic effects.
9. Potential of pearl millet and nutritional security

Presentation by Dr. K.N. Rai, ICRISAT, Hyderabad

Potential of pearl millet for alternative food uses and nutritional security

Composition of major cereal crops

<table>
<thead>
<tr>
<th>Crop</th>
<th>Protein (%)</th>
<th>Fat (%)</th>
<th>Minerals (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum</td>
<td>10.4</td>
<td>1.9</td>
<td>1.6</td>
</tr>
<tr>
<td>Pearl millet</td>
<td>11.6</td>
<td>5.0</td>
<td>2.3</td>
</tr>
<tr>
<td>Maize</td>
<td>11.1</td>
<td>3.6</td>
<td>1.5</td>
</tr>
<tr>
<td>Wheat</td>
<td>11.3</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Rice</td>
<td>6.3</td>
<td>0.5</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Micronutrient composition of major cereal crops (ppm)

<table>
<thead>
<tr>
<th>Crop</th>
<th>Iron (Fe)</th>
<th>Zinc (Zn)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearl millet</td>
<td>30-146</td>
<td>25-94</td>
</tr>
<tr>
<td>Sorghum</td>
<td>17-76</td>
<td>11-55</td>
</tr>
<tr>
<td>Maize</td>
<td>10-63</td>
<td>13-58</td>
</tr>
<tr>
<td>Wheat</td>
<td>29-57</td>
<td>25-53</td>
</tr>
<tr>
<td>Rice</td>
<td>6-24</td>
<td>14-35</td>
</tr>
</tbody>
</table>

Processing technologies for pearl millet

Various processing treatments like:
- Milling
- Decortication
- Melting
- Blanching
- Heat treatment
- Acid treatment
- Fermentation
- Popping

Improve the nutritional quality of pearl millet/sorghum as well as the consumer acceptability

Effect of storage time on fat acidity (mg KOM/100 g flour) of pearl millet flour

Effect of storage time on free fat acidity of processed and unprocessed pearl millet flour
Effect of malting and blanching on polyphenol and phytic acid content of pearl millet (mg/100 g grain)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Polyphenol</th>
<th>Phytic acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>756.4±4.44</td>
<td>889.5±2.22</td>
</tr>
<tr>
<td>Malting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>48 hrs</td>
<td>429.6±0.41</td>
<td>481.8±1.41</td>
</tr>
<tr>
<td>(41)</td>
<td></td>
<td>(44)</td>
</tr>
<tr>
<td>72 hrs</td>
<td>429.5±0.40</td>
<td>429.5±1.75</td>
</tr>
<tr>
<td>(50)</td>
<td></td>
<td>(50)</td>
</tr>
<tr>
<td>Blanching</td>
<td>529.9±0.05</td>
<td>565.6±1.16</td>
</tr>
<tr>
<td>(50)</td>
<td></td>
<td>(50)</td>
</tr>
<tr>
<td>CD at 5%</td>
<td>2.40</td>
<td>4.96</td>
</tr>
</tbody>
</table>

Value in parentheses indicate percentage change from control

Source: Rokhu (1997)

Percent increase in the in vitro starch digestibility of acid-treated (AT) and heat-treated (HT) pearl millet flour over control

Pearl millet-based baked products

Pearl millet-based supplementary foods

Prevention of diabetes

Health value of pearl millet-based diabetic products

<table>
<thead>
<tr>
<th>Product</th>
<th>Glycaemic index</th>
<th>Pearl millet-based products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biscuit</td>
<td>72.7</td>
<td>58.1</td>
</tr>
<tr>
<td>Chapati</td>
<td>69.4</td>
<td>48.0</td>
</tr>
<tr>
<td>Dhokla</td>
<td>68.4</td>
<td>38.0</td>
</tr>
<tr>
<td>Instant idli</td>
<td>69.8</td>
<td>52.1</td>
</tr>
<tr>
<td>Pasta</td>
<td>71.3</td>
<td>54.1</td>
</tr>
</tbody>
</table>

Constraints and opportunities for commercialization of sorghum and pearl millet food products

<table>
<thead>
<tr>
<th>Constraints</th>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Misplaced social stigma</td>
<td>Highly nutritious, health value</td>
</tr>
<tr>
<td>Subsidized rice and wheat</td>
<td>PDS policy for sorghum and pearl millet</td>
</tr>
<tr>
<td>Inconsistent grain supplies</td>
<td>Stable, economical commercial production</td>
</tr>
<tr>
<td>Mised grain marketing</td>
<td>Specialty grains production possible</td>
</tr>
<tr>
<td>Flour: short shelf life</td>
<td>Shelf-life enhancing technologies</td>
</tr>
<tr>
<td>Precision Lab scale</td>
<td>Commercially feasible</td>
</tr>
<tr>
<td>Food tech—Lab scale</td>
<td>Commercially feasible</td>
</tr>
</tbody>
</table>
10. Pearl millet for increased and stable production
Presentation by Dr. KN Rai and Dr. IS Khairwal  ICRISAT, Hyderabad

### Eco-region-specific pearl millet cultivars

**KN Rai** and **IS Khairwal**

1. Principal Scientist (Breeding), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru
2. Project Coordinator, All India Coordinated Pearl Millet Improvement Project (AICPIMP), Mandor, Jodhpur

### Adaptive features of sorghum and pearl millet

<table>
<thead>
<tr>
<th>Adaptation trait</th>
<th>Sorghum</th>
<th>Pearl millet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drought tolerance</td>
<td>Higher than maize</td>
<td>Higher than sorghum</td>
</tr>
<tr>
<td>Water-use efficiency</td>
<td>Better than maize</td>
<td>Better than sorghum</td>
</tr>
<tr>
<td>Seedling heat tolerance</td>
<td>Higher than maize</td>
<td>Higher than sorghum</td>
</tr>
<tr>
<td>Reproductive heat tolerance</td>
<td>Higher than maize</td>
<td>Higher than sorghum</td>
</tr>
<tr>
<td>Seasonal adaptation</td>
<td>Kharif (rabi)</td>
<td>Kharif (summer/rabi)</td>
</tr>
<tr>
<td>Crop maturity</td>
<td>90-130 days</td>
<td>65-95 days</td>
</tr>
</tbody>
</table>

### Cultivar options in pearl millet

- **Open-pollinated varieties (OPVs)**
- **Hybrids**
  - Single-cross hybrids
  - Topcross hybrids
  - Three-way hybrids
  - Inter-population hybrids

### Performance of hybrids and open-pollinated varieties (OPVs) in AICPIMP's Hybrid and Population trials

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean grain yield (kg/ha)</th>
<th>Highest yield (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hybrid</td>
<td>Percent over OPV</td>
</tr>
<tr>
<td>1996</td>
<td>1775</td>
<td>24</td>
</tr>
<tr>
<td>1997</td>
<td>1676</td>
<td>10</td>
</tr>
<tr>
<td>2000</td>
<td>1117</td>
<td>27</td>
</tr>
<tr>
<td>2001</td>
<td>1916</td>
<td>27</td>
</tr>
</tbody>
</table>

### Pearl millet area, production and productivity trends

- Pearl millet area has declined over years (from about 12 m ha in mid-1960s to about 9 m ha in recent years)
- Increase in the production, especially since mid-1980s
- Production increase due to large number of productive hybrids under cultivation
**DM resistance to multiple pathotype**

- Stable and highly resistant sources
- Most frequent use of DM resistance sources in breeding materials
- Greater use of GH screening facility
- Year-round DM resistance screening
- Large number of breeding lines
- High and consistent disease pressure

**Forage yield and quality of sorghum and pearl millet**

Dry forage yield (t/ha) and crude protein (%) of pearl millet, sorghum and maize varieties under rainfed conditions in 2000 All India Forage Trials

<table>
<thead>
<tr>
<th>Crop</th>
<th>Initial trial</th>
<th>Advance trial</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Forage yield</td>
<td>Crude protein</td>
</tr>
<tr>
<td>Pearl millet</td>
<td>8.5</td>
<td>8.7</td>
</tr>
<tr>
<td>Sorghum</td>
<td>7.7</td>
<td>8.0</td>
</tr>
<tr>
<td>Maize</td>
<td>6.5</td>
<td>5.5</td>
</tr>
</tbody>
</table>

**Dry forage yield of some promising experimental pearl millet hybrids**

<table>
<thead>
<tr>
<th>Hybrid</th>
<th>Dry forage yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCMA 00999</td>
<td>50 d 18.6</td>
</tr>
<tr>
<td>× IF 20485</td>
<td>5.0</td>
</tr>
<tr>
<td>× IF 17215</td>
<td>4.6</td>
</tr>
<tr>
<td>× IF 20555</td>
<td>5.4</td>
</tr>
<tr>
<td>× IF 3616</td>
<td>6.0</td>
</tr>
</tbody>
</table>

**Adaptation to soil salinity**

- Pearl millet is most salt-tolerant cereal (after barley), followed by sorghum
- Several landraces, improved populations and released varieties of pearl millet and sorghum found tolerant to soil salinity
- Large variability for dry matter yield under soil salinity in sorghum and pearl millet
- High positive correlation between dry matter yield under soil salinity and salt tolerance index

**Pearl millet as a productive summer-season crop**

- Cultivation on 0.6 million ha
- Grain yield (4.5 t/ha)
- Good quality grain and fodder

**Grain and fodder yield, time to 50% flower and downy mildew (DM) resistance of HBB 67**

<table>
<thead>
<tr>
<th>Character</th>
<th>HBB 67-2</th>
<th>HBB 67</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield and flowering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Grain yield (kg/ha)</td>
<td>2115</td>
<td>1986</td>
</tr>
<tr>
<td>- Fodder yield (kg/ha)</td>
<td>4560</td>
<td>42.40</td>
</tr>
<tr>
<td>- Time to flower (d)</td>
<td>42</td>
<td>40</td>
</tr>
<tr>
<td>DM incidence (%) in glasshouse</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Jodhpur</td>
<td>2</td>
<td>60</td>
</tr>
<tr>
<td>- Della</td>
<td>0</td>
<td>51</td>
</tr>
</tbody>
</table>

T: Mean of 11 tests from All India trials
11. Re-exploring the Millets of South Konkan, Maharashtra

Presentation by Anuja Krishna, ECONET, Maharashtra

Working towards re-exploring the Millets of South Konkan Maharashtra

Palvi
With support of ECONET
And ADS

The status before we started

- 98% of the farmers has shifted to rice as the mono-crop and that too of the hybrid Varieties of Rice only though it is completely rainfed.
- This region was traditional the source of the best Ragi and Varai Millets along with a variety of species of pulses.
- The region had a linkage in terms of inter-dependency on labour that migrated to Metros.

Growing Fellow land: Specifically where Millets were grown

- 3000 mm rain fall
- 6 inches of av. Soil
- Drinking water shortage
- 2 months every year

Thus the agro bio-diversity was identified area of work

- Grain banks for millets
- Local Vegetable Promotion

The status today after 5 years

- Started with 4 Varieties borrowed from ADS
- 36 Seed bank contributors
- Ragi 6 varieties and Varai, Kang and Harik are the millets varieties of millets and 17 indigenous rice varieties are now available in the organisational seed bank
- A reach up to 10 villages
A film
Milets - The Miracle Grains
by
DDS Community Media Trust