



EXTRUDED SNACKS FROM MILLETS -THE GRAINS OF THE FUTURE

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- ❖ Millets are highly nutritious, non-glutinous, non-acid forming foods; thus, easy to digest.
- ❖ Being gluten free, these are least allergenic and hence, well suited for those suffering from celiac disease.
- ❖ Compared to rice, especially polished rice; millet ingestion results in slower release of glucose over a period of time. In other words, millets have low glycaemic index (GI) and low glycaemic load (GL); and thus, their habitual intake reduces the risk of diabetes mellitus.
- ❖ Millets are high in minerals, particularly iron, calcium, magnesium, phosphorous, zinc and potassium.
- ❖ Millets are often termed as *coarse grains*; however realizing their nutritional value, these are now being referred as '***nutria-millets/nutria-cereals***'.

In Indian agriculture, although millets occupy a relatively lower position among the food crops, these are rather important from the stand point of food & nutrition security of the population at large - both at the national/regional and household levels.



“Millets are one of the oldest foods known to humans”

- ❑ Millets is a collective term referring to a number of small-seeded crops belonging to gramineae family.
- ❑ These are the hardy crops that grow well both in dry zones/rain-fed areas under marginal soil fertility conditions.
- ❑ Due to short growing period, millets are rather unique; and can develop from seeds to the mature, ready to harvest plants in as little as 65 days. Stored properly, whole millets can keep well for two years or beyond.
- ❑ These highly beneficial characteristics of the millets are of grave importance for the heavily populated regions of the world.

India is the largest producer of many varieties of millets.

With regard to Global Hunger Index (GHI), India ranks 64 (among the 81 nations); and in child malnutrition, unfortunately it occupies the second place. This is the scenario despite the PDS/TPDS being there for nearly five decades, which has helped the poor/marginalized households in meeting their food & nutrition needs. However, the focus of PDS/TPDS has been only on wheat/rice distribution while the millets have long been disregarded.

(Michaelraj and Shanmugam, 2013)

Trends in the production (MT) of Rice, Wheat & Coarse Cereals

Years	Rice	Wheat	Coarse cereals
1950-51	20.6	6.5	15.4
1970-71	42.2	23.8	30.4
1980-81	53.6	36.8	29
1990-91	74.3	55.1	32.7
1999-00	89.7	76.4	30.3
2000-01	85	69.7	31.1
2001-02	93.3	72.8	33.4
2002-03	71.8	65.8	26.1
2003-04	88.3	72.1	38.1
2004-05	80.8	72.8	33.2
2005/06	85.1	69.9	30
2006/07	86.7	69.3	28.7
2007/08	90.4	75.8	39.1
2008/09	99	78.7	39.4
Annual growth rate (%)			
1950/51-2000/01	2.77%	5.36%	1.04%
1991/92-2008/09	1.09%	1.99%	-1.22%

Source: Agriculture Ministry of India

Over the last five decades, the area under millet production has been shrinking and more so ever since the Green Revolution in 1960s. During the span of 40 years (1966 and 2006), 44% of the area under millet cultivation was shifted to other crops - an extraordinary loss to the India's food and farming systems.

World Cereal Market						
	2009/10	2010/11	2011/12	2012/13 (estimate)	2013/14 (forecast)	
					Previous (06 Mar 2014)	Current (03 Apr 2014)
Production (MT)	2266.1	2257.4	2354.2	2307.4	2514.8	2521
Utilization (MT)	2233.1	2271.7	2327.9	2327.1	2419.8	2420.7

World Coarse Cereals Market						
	2009/10	2010/11	2011/12	2012/13 (estimate)	2013/14 (forecast)	
					Previous (06 Mar 2014)	Current (03 Apr 2014)
Production (MT)	1123.9	1133.5	1165.5	1156.2	1304.7	1308.3
Utilization (MT)	1129.4	1152.2	1158	1163.1	1240.1	1242

(<http://www.fao.org/worldfoodsituation/csdb/en/>)

TYPES OF MILLETS

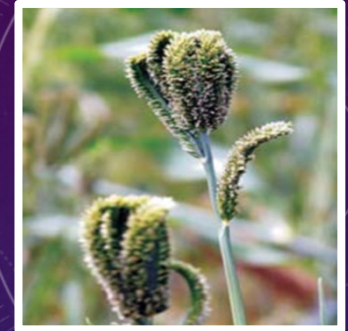
A wide variety of millets are grown all over the world including India - a home to large number of millets. The most important species include pearl millet, sorghum, finger millet, proso millet and foxtail millet.

Pearl millet (bajra) is the most widely grown millet in India.



Sorghum (jowar) due to high photosynthetic efficiency, it can adapt well to climate change, particularly the droughts, soil salinity and high temperature conditions.

Finger millet (*Ragi*) is an important staple food in Asia (India, Nepal) and Eastern Africa. The plant carries several spikes or "fingers" and the grain size is small (Diameter: 1 - 2 mm).



Proso/Common millet (*Barri*) usually grown in temperate climates, can withstand a wide range of temperatures.

Foxtail millet/Italian millet (*Kangni*) is well adapted to moderate climates. Though China ranks first, the crop is also grown in India, Indonesia, Korea and parts of southern Europe.



Teff is a very small-seeded grass which can tolerate heavy soils with poor drainage characteristics.

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White fonio), Black fonio, and Guinea millet are grown in dry lands of Western Africa.

Barnyard millet (*Jhangora*) is grown in the tropic/subtropic regions of India.

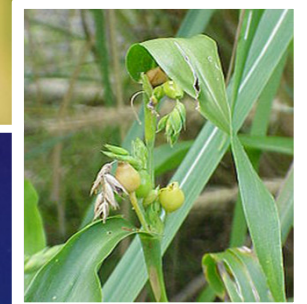
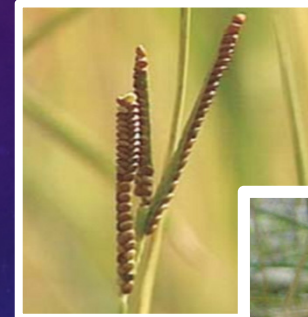
Little millet (*Kutki*) is widely grown in India, Nepal, Pakistan, Sri Lanka, eastern Indonesia and western Myanmar.

Kodo millet (*Kodra*) grows abundantly along paths/ditches and is harvested as a wild crop in India and Western Africa.

Job's tears (*Adlai*) - its production is largely confined to Southeast Asia.

Millets can not only grow in poor soil/climatic conditions, but due to their short growing period, these can very well fit into multiple cropping systems - both under irrigated as well as dry land farming; and can provide nutritious grain/fodder in short span. Their prolonged and easy storability under ordinary conditions has accorded them the status of "**famine reserves**".

In our country, this attribute of the millets is rather important as Indian agriculture suffers from the vagaries of monsoon.



MILLETS: THE FUTURE CROPS

- Millets being drought resistant crops requiring fewer external inputs, can be grown under harsh circumstances of the arid/semi-arid regions and poor soil conditions. Hence, these are also termed as the 'miracle grains' or 'crops of the future'.
- Millets provide food and livelihood security to millions of households, particularly the small/marginal farmers and the inhabitants of rain fed/remote tribal regions.
- Cultivated as dual-purpose crops (food & fodder), millets contributes to the economic efficiency of farming.
- The millet based cropping systems foster agro-biodiversity of the ecosystem. As part of mixed farming, these are frequently cultivated along with pulses, beans, oilseeds and other millets.
- Besides being water efficient, millets help in reducing the atmospheric CO₂. Due to this attribute, these crops may become entitled for benefits under climate change mitigation schemes.
- Paddy is one of the major contributors to climate change through methane emission (*the green house gas emanating from water-drenched rice fields*). Wheat - a thermally sensitive crop, is liable to decreased cultivation with rising temperatures as part of climate change (*With the projected 2^o C rise in temperature, in due course, wheat might disappear from our farms*).

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- Millets having been cultivated for around 3,000 years, have been an integral part of the culture & history of India and other regions.
 - Millet production is not dependent on synthetic fertilizers; the farmers mostly use farmyard manure/household bio-fertilisers. Therefore, these crops can significantly reduce the burden of fertilizer subsidy being borne by the government.
 - Grown by traditional methods, millets do not attract pests; and a majority of them are not affected by the storage pests either. Thus, the pesticides are not needed, making these crops a great boon to the agricultural environment.
 - Millets can withstand the challenges of lesser rainfall, rising temperatures, reduced water availability and soil erosion making them the *Climatic Change Compliant Crops*.
 - Millets are all-season crops whereas wheat is season specific. Further, wheat/rice provide only food security while the millets can provide multiple securities (food, fodder, health, nutrition, livelihood and ecology) making them the crops for our future security.

(Millet Network of India, DHAN FOUNDATION, 2012)


MILLETS FOR FOOD & NUTRITION SECURITY.....

- ❖ Millets are amazing in their nutritive content; these are nearly 3 - 5 times nutritionally superior to rice and wheat - be it in terms of minerals, vitamins, dietary fibre (water soluble/ insoluble) or other nutrients.
- ❖ Finger millet is very rich in calcium; pearl, foxtail and little millet are rather rich in iron. Millets contain appreciable amounts of β - Carotene, niacin, vitamin B₆, folic acid, potassium, magnesium, zinc and dietary fibre. Therefore, these can help to overcome malnutrition among vast majority of the Indian population. These also contain high amounts of lecithin and help in strengthening the nervous system.
- ❖ Millets are good for people suffering from celiac disease (gluten intolerance).
- ❖ Due to their high dietary fibre and low glycaemic index, millets can help in curbing overweight/obesity and reducing the risk of hypertension, CVDs, T2DM, various types of cancers including colon cancer as well as preventing constipation.
- ❖ Sorghum is potentially an important source of nutraceuticals such as antioxidants, polyphenols and cholesterol-lowering waxes.
- ❖ Regular consumption of millets is highly beneficial for post menopausal women suffering from hypertension and hypercholesterolemia (*Millet Network of India*).

Nutrient Content of Various Millets vs Rice and Wheat

Crops	Protein (g)	Crude Fibre (g)	Total Minerals(g)	Iron (mg)	Calcium (mg)
Rice	6.8	0.2	0.6	0.7	10
Wheat	11.8	1.2	1.5	5.3	41
Finger millet	7.3	3.6	2.7	3.9	344
Pearl millet	10.6	1.3	2.3	16.9	38
Foxtail millet	12.3	8	3.3	2.8	31
Kodo millet	8.3	9	2.6	0.5	27
Little millet	7.7	7.6	1.5	9.3	17
Proso millet	12.5	2.2	1.9	0.8	14
Barnyard millet	11.2	10.1	4.4	15.2	11

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- Despite numerous qualities, utilization of millets as food is confined to the traditional consumers esp. the tribal populations. This is mainly due to the non-availability of consumer friendly, ready-to-use/ready-to-eat millet based products. Recently, millets have gained attention and efforts are under way to obtain their convenient and value added processed products (Deshpande and Poshadri, 2011).
 - Although, millets are rich in phytochemicals (polyphenols, tannins, phytosterols) and antioxidants, they also contain some anti nutritional factors that can be minimised by certain processing treatments.
 - Millets (in different proportions) along with rice, wheat and pulses/oilseeds can be used to produce various nutritious food items such as porridges, pastas, biscuits, cakes, cookies, tortillas, bread, probiotic drinks, ladoos, flakes and several fermented foods (Kaur et al, 2012).
 - After dehulling, all millets can be cooked as rice. Millet flour batters with little butter milk (after overnight fermentation) are used to prepare porridge. Italian millet is consumed as unleavened bread/roti. Proso millet flour is used as a substitute for rice flour in various snack foods.
 - Millets and black gram (3:1) batter, after fermentation, can be used for making idli, dosa or uttapam.

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- Studies have shown that the finger millet flour - in various blends (30 to 50%) with refined wheat flour has been used for the preparation of noodles. Sensory evaluations indicate the noodles containing 30% finger millet to be highly acceptable; and these are hypo-glycemic too.

(Shukla and Srivastava, 2014)

- The traditional (popping/flaking) and contemporary (roller drying/ extrusion cooking) methods of cereal processing could be successfully applied to the foxtail millet for preparing ready-to-eat products.

(Singh et al, 2004)

- By suitable processing it might be feasible to produce ready to eat products like flakes, which due to their crisp and friable texture, are highly popular.
- The relatively smaller size and quick hydration of millets make them most suitable for the production of flakes.

(http://agritech.tnau.ac.in/postharvest/pht_millets_sorghum.html)

- Sorghum can be cooked like rice or the flour can be used for making chapaties. From sorghum/other millet blends with wheat can be used for multi-grain flour, baked products like muffins, bread and cakes. Sorghum malt is used in the preparation of infant foods as well as in the fermentation industry for producing alcohol.

NEWER AVENUES IN MILLET PROCESSING

- Most commonly employed conventional millet processing methodologies include milling (decortication/ size grading), popping, malting, fermentation and manual extrusion. In recent years the contemporary food processing technologies such as extrusion cooking, advanced methods of baking are becoming popular.
- In India, in the next few years, 'ready to eat' food market is expected to grow tremendously; therefore, there is a great potential for millet/millet-cereal-pulse blended products.
- Convenience foods are flooding both the urban and rural markets, however, the type depends on demands of the respective consumers.
- In view of the current agricultural scenario and our changing life styles, there is a need to revive production and consumption of millets for bestowing the multiple benefits. If made available in convenient RTE/RTC forms, the nutritional/nutraceutical benefits of the millet can be reaped by the masses.
- Millets have considerable potential as a food and beverage. Cakes, cookies, pasta, parboiled rice-like product and snack foods have been successfully produced from sorghum/some other millets. Sorghum/millet leavened breads (without using wheat) remain a challenge (Taylor et al, 2006).

MILLET BASED FOOD PRODUCTS

Extruded food products:

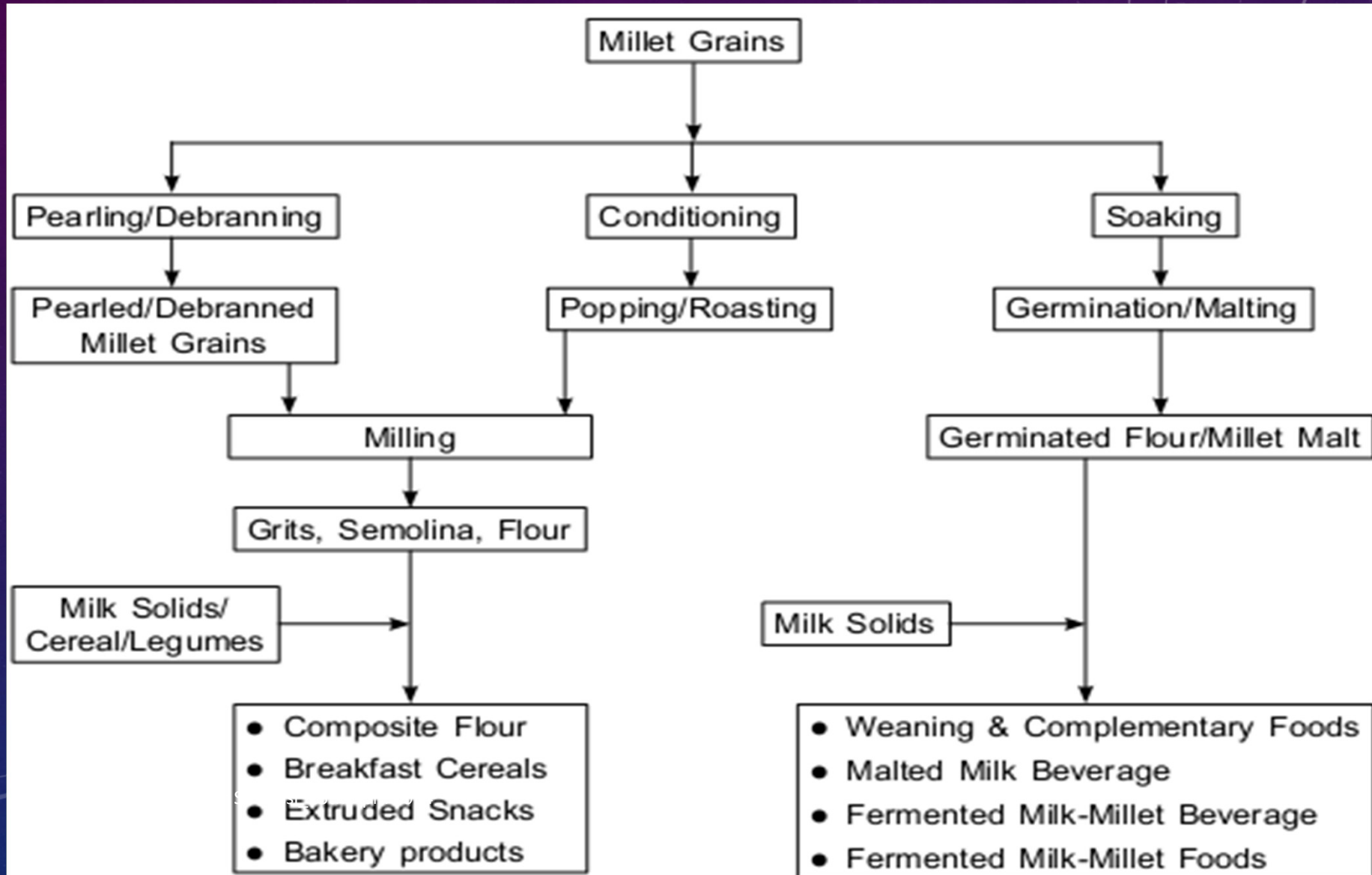
- ✓ Millet flakes/fibre regulated flakes
- ✓ Extruded millet-cereal-pulse snacks
- ✓ Vermicelli, spaghetti, Noodles, Macaroni
- ✓ Extruded RTE/Instant foods
- ✓ Murukus, Vadiyan, *Bhujia*
- ✓ Extruded Health foods
- ✓ Biscuits, cookies
- ✓ Tortilla chips

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Other food products:

- ✓ Bakery products - Muffins, buns, cakes
- ✓ Popped millet products
- ✓ Health foods
- ✓ Breakfast cereals, breads
- ✓ RTE/Instant foods
- ✓ Papads
- ✓ Malted foods
- ✓ Millet and Flax chips, Millet Crunchies
- ✓ Millet milk/millet based milk powder
- ✓ Millet based beverages, non alcoholic beverages brewed from malted millets

Prospective scheme for developing millet based composite health foods



(NAAS, 2012).

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- Breakfast cereals are gaining popularity among the health-conscious populations, however, the traditional processes (roasting/popping/puffing) have seldom been used for millets which could even enhance nutritional quality of the RTEs.
 - Processing technologies like extrusion, flaking and toasting need to be evaluated for their suitability/efficacy in preparing novel foods using millets in combination with other foods (NAAS, 2012).
 - Extrusion processing lowers the anti-nutrients and enhances digestibility of proteins and starches, therefore, it is well suited for the millets. Extruded millets, due to their lower fat content, can be promoted as healthy snacks/ health foods. Multi-grain snacks can be both baked or fried.
 - In extrusion process, the starches are partially solubilised; thus, the extruded products take less time and are convenient to cook. Extruded snacks are now available in different size, shapes and flavours.
 - The leftovers/by products can be used as feed for cattle, pig, fowl and fish.
 - Certain lactobacilli species with phytase activity can effectively reduce the phytates in fermented millet products. There is a substantial scope for innovative products like Bajra lassi (*with nutritional supremacy of the millet, the probiotic and enhanced mineral bio-availability as well as consumer acceptability*). Millets act as the food substrate for probiotics resulting in improve flavour, texture and overall acceptability of the product (NDRI, 2008; Charalampopoulos et al, 2002).
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- Addition of millet or malt components to milk/milk products is another opportunistic window in functional foods.

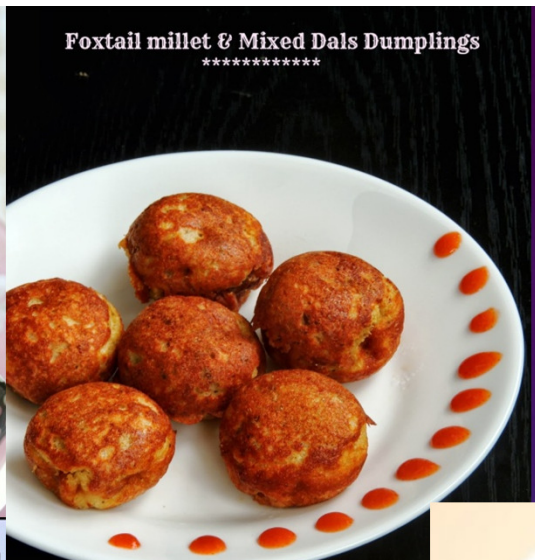


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Ragi Malt



Foxtail millet & Mixed Dals Dumplings



Ragi Rotti



Foxtail Millet Upma

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Bajra Dosa

fondy-buddy.blogspot.com



Ragi ladoo



Ragi Chakli



Kodo Millet/Varagu Arisi Dosai



Raagi Ambali

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Millet Cookies



Ragi Chocolate Shake
© cooklikepriya



Millet puffs



RAGI VADA

www.almpolindianrecipes.com

DIFFICULTIES IN THE PROCESSING OF MILLETS

- 
- Absence of appropriate primary and secondary processing technologies to prepare ready-to-eat/ready-to-cook products.
 - Poor popularity and limited adoption of the millet based foods among the non-traditional urban populations.

Efforts are needed for increasing the popularity and wider adoption of the millet based food products for diversified utilization among the non-traditional urban populations.

WAY FORWARD....

- ❖ Developing millet based low cost weaning foods for the poorer sections of our society (to meet nutritional needs of the infants/children), should be accorded an extremely high priority.
- ❖ Various challenges - both at production and processing level, need to be addressed. R & D initiatives are needed for storage/processing of raw food materials, novel food product development, fabrication of indigenous processing equipment, appropriate packaging materials/ techniques and rapid/reliable quality control methods.
- ❖ 'Diversification' is the key for sustainability, however, for viability, it needs to attain commercial significance. There is a wide scope for optimizing the technologies for processing millets, especially the novel foods with unique nutritional/therapeutic value.
- ❖ Considering the increasing popularity of millets, the major task is to develop products that can alleviate child malnutrition as well as appeal the health conscious consumers. Newer technologies can be developed and the existing ones can be tested/ fine tuned.
- ❖ The current trends in Indian food market offer opportunities for developing health foods containing judicious blend of millets with other cereals/pulses/milk & milk products. Malted flour/malt extract from millets can be incorporated in a wide range of processed health foods.
- ❖ Millets serve as a suitable base for gluten-free food products including bakery items.
- ❖ Our Government has recognized the role of millets in the food chain. Under the NFSM (12th Plan), preliminary targets to enhance food grain production by additional 25 MT includes 2 MT of millets.

Policy measures/programmes on millets

Currently, millets have been almost disappearing from our food basket.....

- ❖ Declining State support (crop loans/crop insurance) has significantly contributed to the decline/poor status accorded to millets in Indian agriculture. Unless halted urgently, over the next fifty years, millets might disappear from the agrarian landscape of India. This will not only cost our food and farming systems, but may be a ecological disaster. Thus, there is an urgent need for Indian policy makers to refocus their attention towards millet farming systems and enact policies to create enabling environment for the farmers (Millet Network of India).
- ❖ Limited policies and schemes explicitly include millets. For small millets , there are no exclusive Government schemes/projects/ programmes. Some of the available schemes include:
 - ❑ Initiative for Nutritional Security through Intensive Millets Promotion (INSIMP) - a part of Rashtriya Krishi Vikas Yojana” (RKVY);
 - ❑ Rainfed Area Development Programme (RADP) - again a part of Rashtriya Krishi Vikas Yojana” (RKVY); and
 - ❑ Integrated Cereals Development Programmes in Coarse Cereals based Cropping Systems Areas (ICDP-CC) under Macro Management of Agriculture (MMA).

INSIMP is the only comprehensive initiative to support millet production.

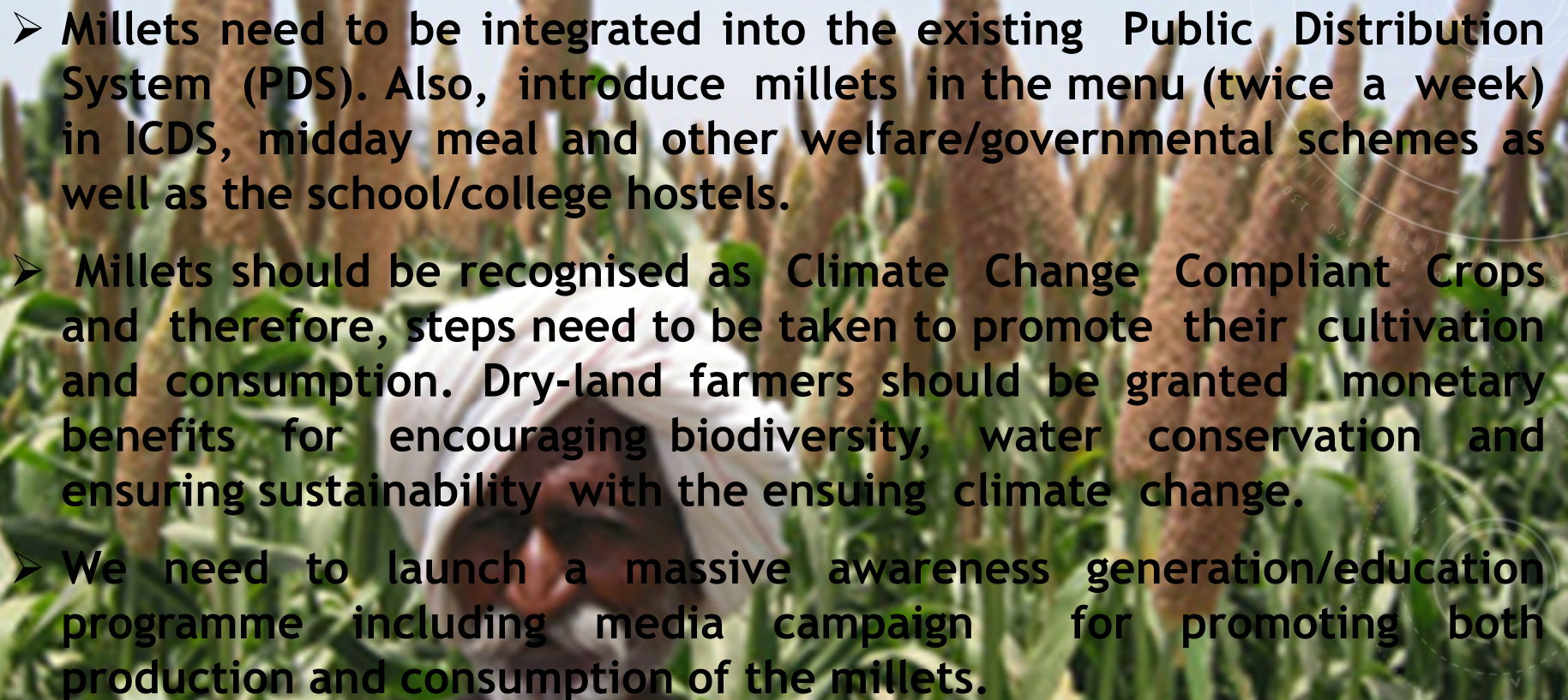
- ❖ For promoting millets, there is a lot of variation in the utilisation of these opportunities at the state level. Most of the states usually focus only on sorghum, pearl millet and finger millet; ignoring the small millets during implementation of these schemes (DHAN Foundation, 2012).

Suggestions for improving the millets cultivation

As millets are predominantly grown in marginal/sub-marginal dry lands by poor farmers, the fluctuations in production bring hardship to farmers and create instability in the total production.

Therefore, for improving the millets cultivation:

- Efforts through mini-kit demonstrations/State Level Training Programmes can help in popularizing the newly released varieties among the farmers; and these can be supplied free of cost or at subsidized rates.
- Agronomic research should bring out efficient low-cost technologies which are within the means of farmers and easy to adopt.
- Increased use of small millets in various ready-to-eat food products should be encouraged as it enhances their nutritive value at low cost.
- Millets should be accorded highest priority in the National Food Security Bill; the Government should allocate at least 40% of the food security budget to millet based farming and food systems using millets as the major food component.

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- Millets need to be integrated into the existing Public Distribution System (PDS). Also, introduce millets in the menu (twice a week) in ICDS, midday meal and other welfare/governmental schemes as well as the school/college hostels.
 - Millets should be recognised as Climate Change Compliant Crops and therefore, steps need to be taken to promote their cultivation and consumption. Dry-land farmers should be granted monetary benefits for encouraging biodiversity, water conservation and ensuring sustainability with the ensuing climate change.
 - We need to launch a massive awareness generation/education programme including media campaign for promoting both production and consumption of the millets.

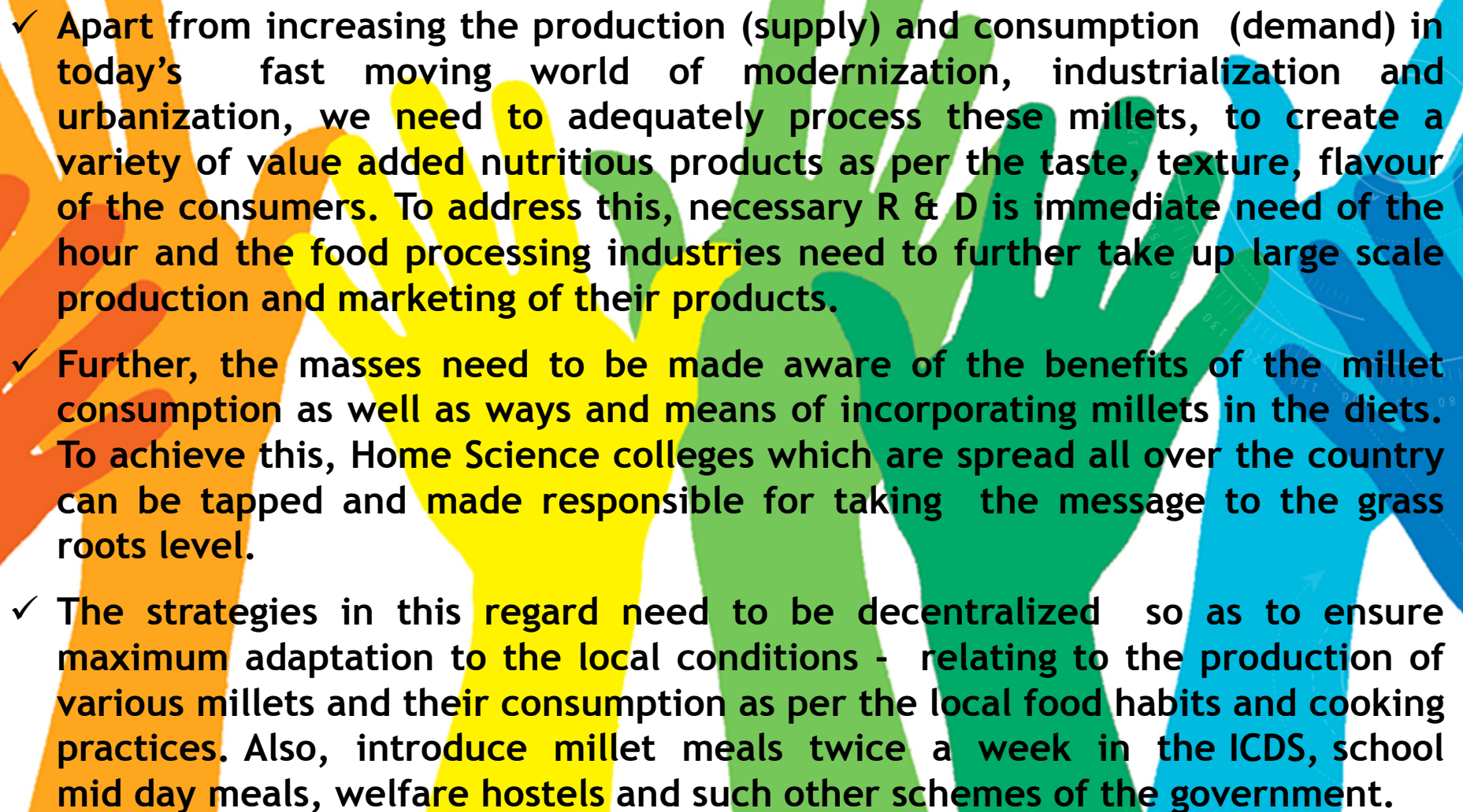
(Michaelraj and Shanmugam, 2013)

To Conclude....

For having safe earth, safe climate, safe and nutritious food and, above all, an agricultural future that will keep our planet cooler, poison-free and full of happiness for all of us.

- ✓ We, the citizens of India need to grow more and more of the millets on our farmlands, since these are the future of food and farming for our country.
- ✓ In view of the ensuing global warming, only millets can keep the planet cool. With the worsening climatic changes, millet farming will make it possible to continue our agriculture systems. Also, in the event our population faces severe malnutrition, millets can help us to overcome the crisis. Millets can be grown even by the poorest farmers of India, without the facilities of irrigation and technological advancements.

In view of all the benefits and advantages conferred to us by millets, our farmers should take necessary steps to grow millets; and we as the consumers, should include millets in our daily food basket; and as citizens of our country, we should strive to bring more and more people under the ambient of millet family.

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- ✓ Apart from increasing the production (supply) and consumption (demand) in today's fast moving world of modernization, industrialization and urbanization, we need to adequately process these millets, to create a variety of value added nutritious products as per the taste, texture, flavour of the consumers. To address this, necessary R & D is immediate need of the hour and the food processing industries need to further take up large scale production and marketing of their products.
 - ✓ Further, the masses need to be made aware of the benefits of the millet consumption as well as ways and means of incorporating millets in the diets. To achieve this, Home Science colleges which are spread all over the country can be tapped and made responsible for taking the message to the grass roots level.
 - ✓ The strategies in this regard need to be decentralized so as to ensure maximum adaptation to the local conditions - relating to the production of various millets and their consumption as per the local food habits and cooking practices. Also, introduce millet meals twice a week in the ICDS, school mid day meals, welfare hostels and such other schemes of the government.

Public awareness needs to be generated about the benefits of including millets in our daily diets for combating the ill effects of a more westernized, sedentary lifestyle, so that our people can achieve healthy living.

THANK YOU

A photograph of a woman, Ms. Akanksha Jain, smiling and holding a large bundle of harvested grain, likely sorghum, in front of her. She is wearing a light-colored headscarf and a plaid shirt. The background shows a rural landscape with fields and trees under a clear sky.

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Ms Akanksha Jain's contributions are gratefully acknowledged.