INSTITUTION OF AGRICULTURAL TECHNOLOGISTS,

BENGALURU

EVALUATION OF RKVY PROJECTS

OF

UNIVERSITY OF AGRICULTURAL SCIENCES,

RAICHUR

"PROCESSING AND VALUE ADDITION TECHNOLOGY OF MILLETS FOR NUTRITIONAL SECURITY IN HYDERABAD KARNATAKA REGION"

INSTITUTION OF AGRICULTURAL TECHNOLOGISTS,

#15, QUEENS ROAD, BENGALURU 560 052

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PROCESSING AND VALUE ADDITION TECHNOLOGY OF MILLETS FOR NUTRITIONAL SECURITY IN HYDERABAD KARNATAKA REGION

EXECUTIVE SUMMARY

Global food security has been increasingly narrowing down to a handful of crops. Over 50% of the global requirement for proteins and calories are met by just three grains, maize, wheat and rice. Only 150 crops are commercialized on a significant global scale, while humankind over time, had used more than 7,000 edible species. The narrowing base of global food security is limiting livelihood options for the rural poor, particularly in marginal areas. Addressing their needs requires that we broaden the focus of research and development to include a much wider range of crop species, as one of the options.

Minor millets, a group of small-grained grass cereals, are of importance as food and fodder in the semi-arid regions of the world. Millets are the most viable option in the dryland conditions as they require minimum water and can withstand in adverse weather conditions. These crops were cultivated in wide ranges of climatic conditions and marginal conditions of soil and moisture. In India, minor millets have traditionally been cultivated in the drylands from ancient times, predominantly by poor and marginal farmers and in many cases by tribal communities.

There is a growing interest in reviving millets in the country owing to their ability to survive in changing climatic conditions while providing high nutrition and better health. Millets provide nutritious food as compared to others cereals with high fibre content, minerals and slow digestibility. The millets can constantly help to meet out the needs of our animal feed and fodder and will continue to be grown by dryland and resource poor farmers in the foreseeable future. The millets are one of the cheapest sources of energy, high content of digestive fibre, protein, vitamins and minerals.

Difficulty in processing is the key challenge that hinders consumer demand and upscaling potential for minor millets. Several interventions can be made to facilitate access by value chain actors to processing plants on the one end and by consumers to processed millet products on the other. The lack of suitable processing units close to millet fields forces local producers to take their produce to distant places (Panwar Hema Yogendra Singh, 2015).

More specifically, there is a critical need to optimise technology for de-hulling of different small millet species, which have different seed sizes. More research is needed for improving the separation mechanism in hullers to reduce removal of grits and other usable

materials along with the husk. Improving the sieving efficiency of graders is also needed. Large-scale equipment is available for this operation but equipment tailored for the community level and the small and medium enterprise level is needed and would be most relevant for supporting development of farmer enterprises.

Keeping the above in view, **"PROCESSING AND VALUE ADDITION TECHNOLOGY OF MILLETS FOR NUTRITIONAL SECURITY IN HYDERABAD KARNATAKA REGION"** was taken up by University of Agricultural Sciences, Raichur with Rashtriya Krishi Vikas Yojana funding. The project was implemented from 2013-14 to 2016-17. The details of the project are as under:

1.	**Title of Project**	**:**	**PROCESSING AND VALUE ADDITION TECHNOLOGY OF MILLETS FOR NUTRITIONAL SECURITY IN HYDERABAD-KARNATAKA REGION**
2.	**Nodal officer and Principal Investigator**	**:**	**Dr. Udaykumar Nidoni, Head, Dept. of Processing and Food Engineering, College of Agricultural Engineering, University of Agricultural Sciences, Raichur.**
3.	**Implementing Institution (S) and other collaborating Institution (s)**	**:**	Departments of Processing and Food Engineering, College of Agricultural Engineering, Raichur
4.	**Date of commencement of Project**	**:**	2013-14
5.	**Approved date of completion**	**:**	2016-17
6.	**Actual date of completion**	**:**	2016-17
7.	**Project cost**	**:**	Rs. 175 lakhs

The objectives of the project are as follows:

1. Development of selected primary millet processing equipment for establishment of state-of-art millet processing complex at UAS Raichur.
2. Standardization of process technology for preparation of millet-based value-added products.
3. Adoption of developed processing and value addition technologies in the millets production catchments.
4. Imparting technical know-how on processing and value addition technologies among different stake holders.

The focus of Evaluation is:

i. To evaluate the primary millet processing equipment developed by the University.
ii. To examine the sstandardization of process technology for preparation of millet-based value-added products finalized by the University and its utility.
iii. To evaluate the effectiveness of developed processing and value addition technologies in the millets production catchments
iv. To evaluate the efforts made at imparting technical know-how on processing and value addition technologies among different stake holders.

Development of selected primary millet processing equipment for establishment of state-of-art millet processing complex at UAS Raichur.

Development of dehusker for foxtail millet

Millets are neither ready to eat nor ready to cook grains and need some kind of processing invariably for human consumption. Difficulty in processing is the key challenge that hinders consumer demand and upscaling potential for minor millets. Several interventions can be made to facilitate access by value chain actors to processing plants on the one end and by consumers to processed millet products on the other. The lack of suitable processing units close to millet fields forces local producers to take their produce to distant places. More specifically, there is a critical need to optimise technology for de-hulling of different small millet species, which have different seed sizes. More research is needed for improving the separation mechanism in hullers to reduce removal of grits and other usable materials along with the husk. Improving the sieving efficiency of graders is also needed.

In this direction, a prototype of the millet dehusker has been developed under the project. The prototype has been tested for efficiency and it has been observed that the dehusking efficiency of dehusker for foxtail millet was found to be 81%. that the dehusking efficiency of dehusker for foxtail millet was found to be 81%. The head yield of dehusked grains was 97.33%. The cleaning efficiency of the grader/separator was found to be 81.66%. The broken yield of dehusked grains was 2.66%. Malathi Durairaj et al., 2018 reported dehulling efficiency of 95-96% and broken yield of dehusked grains of 4-5% with the double chamber centrifugal dehuller developed at Department of Post-Harvest Technology Centre, Tamil Nadu Agricultural University, Coimbatore, India.

The dehusker and polisher developed by Department of Processing and Food Engineering, College of Agricultural Engineering, University of Agricultural Sciences, Raichur has been installed at Agricultural Research Stations, Bidar, Hagari, Lingsugur, Gangavathi and Raichur.

Standardization of process technology for preparation of millet-based value added products has been taken up under the project and preparation flow charts have been prepared for various millet-based bakery products. Indian Institute of Millets Research, Hyderabad has already brought out Technologies of Millet Value added products detailing the methods of preparation of various products from millets. Similar efforts have been done by Central Food Technology Research Institute, Mysuru and Tamilnadu Agricultural University, Coimbatore also. There is need to bring out the literature in local language.

The bakery established in the University campus is being used for commercial production of millet-based bakery products and sale in the University Sales counter. This is a good move and helps in popularizing the millet products.

Memorandum of Understanding has been signed with two private entrepreneurs, viz., Mr. Millet and M/s. Farm Bandi for commercial production of millet-based bakery products and units have been started to manufacture millet bakery products of 500 kg/ hour. These are being marketed in Ballari, Davanagere and Raichur.

Training programmes have been conducted for training entrepreneurs in making various millet-based bakery products. Totally 390 entrepreneurs during 2012-14, 212 beneficiaries during 2015-16 and 376 beneficiaries during 2016-18 have been trained at in Raichur. Similar programmes were held in Hagari, Lingsugur and Huvina Hadagali where 289, 38 and 71 beneficiaries were trained. There is need to evaluate the impact of these training programmes.

REFLECTIONS AND CONCLUSIONS

1. Efforts made in design and development of millets dehusker are praiseworthy. The University should obtain patent for the machinery developed and also take up commercial production of the machinery under PPP mode by tieing up with a commercial agricultural machinery manufacturer.
2. Standardization of process technology for preparation of millet-based value added products has been taken up under the project and preparation flow charts have been prepared for various millet-based bakery products. There is need to bring out the literature in local language.
3. The bakery established in the University campus is being used for commercial production of millet-based bakery products and sale in the University Sales counter. This is a good move and helps in popularizing the millet products.
4. Training programmes have been conducted for training entrepreneurs in making various millet-based bakery products. There is need to evaluate the impact of these training programmes.

ACTION POINTS

1. The outcome of the projects is very good. However, there is a need of working model with support of private participation or as per Farmer Producer Organization principles/ model.
2. Nutritional status of millet products and their digestibility need to be worked out in collaboration with food scientists and medical practitioners.
3. Keeping quality of millet products, i.e., shelf life of products and their economics need to be worked out in detail.
4. Comparative keeping quality of dehusked and nondehusked products may be tested with economics.
5. Economics of by-products and products may be worked out in addition to value addition and nutrition quality.
6. Efforts made in design and development of millets dehusker are praiseworthy. The University should obtain patent for the machinery developed and also take up commercial production of the machinery under PPP mode by tieing up with a commercial agricultural machinery manufacturer. Effort may be made include this machine under mechanization subsidy scheme.
7. Efforts made in development of the millet de-husker increases the quality input of the processed product of millets, enables the farmers to fetch more price in the market (Approximately 1000 farmers benefitted using this unit).
8. Standardization of process technology for preparation of millet-based value added products has been taken up under the project and preparation flow charts have been prepared for various millet-based bakery products. There is need to bring out the literature in local language.
9. The bakery established for commercial production of millet-based bakery products and a sale counter at UAS RAICHUR under this project enables the farmers of this Hyderabad Karnataka region as a market facility to sell their value-added product to get notable price for enhancing economic conditions of the farmers
10. Training programmes have been conducted for training entrepreneurs in making various millet-based bakery products. There is need to evaluate the impact of these training programmes.
11. Already Two Enterprises Mr. Millet and M/s. Farm Bandi (Memorandum of Understanding with UAS Raichur) has started bakery more private Enterprises are to be attracted to popularize this technology and extend the benefits to the farmers.
12. A core team of experts at the Institution level may be identified to identify suitable equipment/ technology developed to recommend and initiate for patent registration and policy formation at university level/ transfer of this technology to

other Agricultural Universities in the state for adopting / popularization among farmers through frontline demonstration and series of training programmes involving farmers, manufacturers etc.

RESEARCHABLE ISSUES

1. Rice husk is abundantly available. Hence, there is need for research on value addition to rice husk and straw (ethanol production) and their by products in PPP mode.
2. Integrated and multi-disciplinary approach for integration of indigenous technology knowledges (ITKs) in agro climatic zones and patenting.
3. Establishment of millet quality testing techniques.
4. Need for research on product development/ technology for millets keeping in view their nutritional and antinutritional status.
5. Initiate farmers use of incubation facilities on campus to enhance use of millets.

PROCESSING AND VALUE ADDITION TECHNOLOGY OF MILLETS FOR NUTRITIONAL SECURITY IN HYDERABAD KARNATAKA REGION

INTRODUCTION

A significant increase in food grain production in recent times made India a potential exporting country besides maintaining a buffer stock of 60 million tonnes. It was achieved through green revaluation. The major driving forces in achieving this was; introduction of high yielding production technologies like, high yielding variety (HYV) seeds, chemical fertilizers and intensive irrigation, improved pest and disease management, input subsidization and incentives to farmers through remunerative pricing policies for some crops, public investment in agricultural research and education, and institutional reforms. These reform measures have paid back significantly to increase the agricultural production in the country and resulted in 45% increase in per capita food availability.

Global food security has been increasingly narrowing down to a handful of crops. Over 50% of the global requirement for proteins and calories are met by just three grains, maize, wheat and rice. Only 150 crops are commercialized on a significant global scale, while humankind over time, had used more than 7,000 edible species. The narrowing base of global food security is limiting livelihood options for the rural poor, particularly in marginal areas. Addressing their needs requires that we broaden the focus of research and development to include a much wider range of crop species, as one of the options. Many of these species occupy important niches, adapted to the high risk and fragile conditions where significant sections of the rural communities practice marginal farming (Bhagmal et al., 2010).

Dryland/rainfed farming is the practice of cultivating land, which derives water only through rains. Hence, an understanding of rainfall patterns and land characteristics is crucial for optimizing the use of available water for dryland crops. The productivity of dryland crops is still very low because of low and erratic rainfall and poor adoption of improved technologies. To bridge yield gap, the crop diversification is required for increasing the productivity and profitability per unit area. Intercropping is also an efficient strategy that can be followed with suitable options in the present climatic scenario. Apart from rainfall, two other important elements include, moisture availability to crops and availability of suitable production technologies. Priority needs to be given on conservation of soil moisture and crop management practices. The productivity of dryland crops is very low because of low and erratic rainfall and poor adoption of improved technologies. To bridge this gap, the crop diversification is required for increasing the productivity and

profitability per unit area and per unit time. Intercropping is also an efficient strategy that can be followed to get desirable outcomes (Rajendra Chapke et al., 2018). Minor millets, a group of small-grained grass cereals, are of importance as food and fodder in the semi-arid regions of the world. Millets are the most viable option in the dryland conditions as they require minimum water and can withstand in adverse weather conditions. These crops were cultivated in wide ranges of climatic conditions and marginal conditions of soil and moisture. In India, minor millets have traditionally been cultivated in the drylands from ancient times, predominantly by poor and marginal farmers and in many cases by tribal communities.

The small millets comprising six species, namely, finger millet (Eleusine coracana), little millet (Panicum sumatrense), Italian or foxtail millet (Setaria italica), barnyard millet (Echinochloa crusgalli), proso millet (Panicum miliaceum) and kodo millet (Paspalum scrobiculatum) are grown in about 2 million ha area in India. India is the largest producer of millets, producing about 33-37% of a total of 28 million tonnes of the world produce. Among these, finger millet is the most important and occupies about 60% of the area and contributes 70 % of small millet production and the rest is by kodo millet, foxtail millet and little millet (Pradhan et al., 2010). The world total production of millet grains was 7,62,712 metric tons and the top producer was India with an annual production of 3,34,500 tons (43.85%) (FAO, 2012).

These crops are hardy and quite resilient to varied agroclimatic adversities and play important role in marginal agriculture more common in hilly and semi-arid regions as important source of food grain as well as highly valued fodder. Many kinds of traditional foods and beverages are made from these grains in different regions and hence have important role in the local food culture (Chandrasekara and Shahidi 2011). Nutritionally, they have high micronutrient content, particularly calcium and iron, high dietary fibre, higher amount of essential amino acids and low glycemic index and thus play an important role in the food and nutritional security of the poor.

The area under millets cultivation is decreasing. Despite the fact that, area under millets cultivation has been drastically reduced over the years in India, it is one among the major producers of millets in the world. Growing interest to revive millet cultivation in this country is driven by nutrition, health and resilience considerations. There is a growing interest in reviving millets in the country owing to their ability to survive in changing climatic conditions while providing high nutrition and better health. Millets provide nutritious food as compared to others cereals with high fibre content, minerals and slow digestibility. The millets can constantly help to meet out the needs of our animal feed and fodder and will continue to be grown by dryland and resource poor farmers in the foreseeable future. The millets are one of the cheapest sources of energy, high content of digestive fibre, protein, vitamins and minerals.

Millets are hardy crops and can grow under less favorable conditions and have potential to bridge the gap between demand and supply to ensure nutritional security. While, the population pressure continues, the area under arable land is decreasing. In spite of a wider climatic adaptability, cultivation of diverse millet species/varieties is gradually decreasing in the recent past. Lack of institutional support for millet crops in contrast to rice and wheat continue to shrink the millet growing area. In spite of this, several communities in the dry/rain fed regions having known the food qualities of millets over generations continue to include a range of millets in the traditional cropping patterns and recognize millet as an essential part of the diet. Unlike in other parts of the world, almost all the millets are grown in rainy season while a few like, sorghum and pearl millet are grown in post-rainy season in India, and used for human consumption, livestock feed, and raw materials for industries. Thus, millets are the key for the sustenance of human and livestock population in an era of perceptible climatic changes.

However, their presence in the Indian food basket had been declining over the years primarily due to wheat and rice being available at subsidized rates. Key factors behind the declining trend of millet production include low crop productivity, high labour intensity, difficult post-harvest operations and lack of attractive farm gate prices. Easy availability of rice and wheat through the Public Distribution System (PDS) has contributed to a shift in food consumption patterns in millet producing regions. With the exception of finger millet for which technology has made faster advances, drudgery relating to hulling of small millets is still discouraging local producers. Other disabling factors include inadequate investment in product development and commercialization and the persisting perception of low social status associated with their consumption. Lack of knowledge on ways to use the small millets in the daily diet is widespread. The poor availability of millet foodstuffs in local market coupled with high prices for their products are also limiting their popularization (Leisa India, 2018).

Nutrient composition of millets

Millets are highly nutritious, non-glutinous and non-acid forming foods. Hence, they are soothing and easy to digest. They are considered to be the least allergenic and most digestible grains available. Millets contain about 8 per cent protein and 4 per cent fat. They are rich source of vitamins and minerals. Millets are especially rich in calcium. The dietary carbohydrate content of millets is also relatively high. Although a considerable portion of nutrients is concentrated in the seed coat, the bioavailability of the nutrients present in the endosperm is higher than the seed coat nutrients. Anti-nutritional factors such as phytate and polyphenols are also present in millets but they are mostly confined to the seed coat and the milled millets are generally free from the anti-nutritional factors (Kumar, 2010).

The nutritional composition of the millets is comparable with that of rice and wheat (Saleh et al 2013). The protein content of foxtail millet, proso millet and pearl millet are comparatively higher than the protein content in wheat.

Pearl millet is high in fat content (5.00 gm /100 gm). The carbohydrate content of small millets is lesser than that of rice and wheat. The carbohydrate content ranges between 307.00 gm to 361.00 gm per 100 gm of grains. The fibre content of kodo, little, foxtail and barnyard millet is higher. Finger millet has a remarkable amount of calcium 344.00 mg / 100gm. Millets are also rich sources of iron. The iron content of little and pearl millet is 9.30 and 8.00 mg /100 gm respectively.

Little millet protein contains amino acids in balanced proportions and is rich in methionine, cysteine and lysine. Little millet is a good Source of iron. It has highest soluble p-coumeric acid among the millets. Its iron chelating activity is high compared to other millets. It helps to prevent constipation and heals all the problems related to stomach. It improves the semen counts of men. It also helps for women with irregular periods problems. Its high fiber helps to reduce the fat depositions in the body. The little millet contains 8.7 gm protein, 75.7gm carbohydrate, 5.3 gm fat and 1.7 gm mineral per 100 gm.

Kodo millet is rich in B vitamins, especially niacin, B6 and folacin, calcium, iron, potassium, magnesium and zinc. Kodo millet contains comparatively high amount of lysine, (3.0-3.5 gm/ 100gm). It also contains phenolics, tannins. It has good antioxidant potential, highest DPPH quenching activity among millets (Edge and others 2005). It is hypoglycemic in nature and reduces cholesterol levels. The grain contains 8.3 % protein, 1.4 % fat, 65.6 % carbohydrates and 2.9 % ash. The grain is recommended as a substitute for rice to patients suffering from diabetes disease.

Barnyard millet is most effective in reducing blood glucose and lipid levels compared to other millets and rice. It contains antioxidant compounds and serotonin derivative and has anti-inflammatory activity. The flavonoid-luteolin and tricin present in Barnyard millet are cancer preventive.

Foxtail millet has good nutritive value and it is a good source of carbohydrate. It is also a rich source of calcium. It is rich in dietary fiber and minerals such as copper and iron. It helps us to keep our body strong and immune. It helps to control blood sugar and cholesterol levels. Foxtail millet contains ferulic and p-coumeric acids and has good antioxidant potential. It contains carotenes and tocopherols and accumulates gamma aminobutyric acid on germination, GABA regulates cardiovascular functions. Foxtail grain contains 10% to 12% Protein, 4.7% fat, 60.6 % carbohydrates 2.29% to 2.7% Lysine and 0.59 (mg) Thiamin.

Finger millet is an excellent source of natural calcium which helps in strengthening bones for growing children and aging people. Regular consumption of finger millet is good for bone health and keeps diseases such as osteoporosis at bay and could reduce risk of fracture. Finger millet's phytochemic slowing digestion process. This helps in controlling blood sugar level in condition of diabetes. It has been found that finger millet-based diet helps diabetics as it contains higher fibre than rice and wheat. The study found that diet based on whole finger millet has lower glycemic response, lower ability to increase blood sugar level. This is due to presence of factors in finger millet flour which lower digestibility and absorption of starch (Rishov Sircar et al., 2019). Due to its high nutritional content, ragi is preferred in southern parts of India. It is a good source of natural iron, which helps in recovery of Anaemia. Ragi base products are recommended for expectant mothers because of high calcium and iron content.

Table: Nutrient composition of various millets in comparison with other cereals

Food	Protein (g)	Fat (g)	Ash (g)	Crude fibre (g)	Carbohy-drate (g)	Energy (kcal)	Ca (mg)	Fe (mg)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)
Rice (brown)	7.9	2.7	1.3	1.0	76.0	362	33	1.8	0.41	0.04	4.3
Wheat	11.6	2.0	1.6	2.0	71.0	348	30	3.5	0.41	0.1	5.1
Maize	9.2	4.6	1.2	2.8	73.0	358	26	2.7	0.38	0.2	3.6
Sorghum	10.4	3.1	1.6	2.0	70.7	329	25	5.4	0.38	0.15	4.3
Pearl millet	11.8	4.8	2.2	2.3	67.0	363	42	11.0	0.38	0.21	2.8
Finger millet	7.7	1.5	2.6	3.6	72.6	336	350	3.9	0.42	0.19	1.1
Foxtail millet	11.2	4.0	3.3	6.7	63.2	351	31	2.8	0.59	0.11	3.2
Proso millet	12.5	3.5	3.1	5.2	63.8	354	8	2.9	0.41	0.28	4.5
Little millet	9.7	5.2	5.4	7.6	60.9	329	17	9.3	0.3	0.09	3.2
Barnyard millet	11.0	3.9	4.5	13.6	55.0	300	22	18.6	0.33	0.10	4.2
Kodo millet	9.8	3.6	3.3	5.2	66.6	353	35	1.7	0.15	0.09	2.0

*N × 6.25

Source: Hulse et al., 1980

Finger Millet (Eleusine coracana L.) has low protein content, but nutritionally superior because protein present in ragi compared to other cereals is high. Millets are having higher ash content which indicates the presence of minerals is high, finger millet is in-rich in iron and phosphorus, even it has the highest calcium content (300-350 gm/100g). High fibre content and lower digestibility of nutrients is the other characteristic feature of millet grains. Finger millet has good source of vitamin and minerals, it has high amount of calcium. Calcium is an important ingredient for our body and daily need is around 250-350 mg. Amino acid Lecithin Methionine help to cut down the cholesterol levels by eliminating extra fat from liver.

Millet processing

Processing requirements of finger millet and other millets are different. Finger millet, including its malt, is largely milled directly into flour and the products are made from sieved and whole flour. Little and Italian millets are largely consumed as rice and this requires de-husking and polishing. No village level machinery is available for such quality polishing and hence trade on these millets and profit from processed rice are inaccessible to farmers. There is a need for designing efficient mini-hulling-cum-polishing machinery to benefit farmers growing little and Italian millets and such village-based processing facility has great potential to make a huge difference to farmers both on their household consumption and income generation capacity (Bhagmal et al., 2010).

Difficulty in processing is the key challenge that hinders consumer demand and upscaling potential for minor millets. Several interventions can be made to facilitate access by value chain actors to processing plants on the one end and by consumers to processed millet products on the other. The lack of suitable processing units close to millet fields forces local producers to take their produce to distant places (Panwar Hema Yogendra Singh, 2015).

More specifically, there is a critical need to optimise technology for de-hulling of different small millet species, which have different seed sizes. More research is needed for improving the separation mechanism in hullers to reduce removal of grits and other usable materials along with the husk. Improving the sieving efficiency of graders is also needed. Large-scale equipment is available for this operation but equipment tailored for the community level and the small and medium enterprise level is needed and would be most relevant for supporting development of farmer enterprises.

A number of initiatives are being promoted by various agencies towards enhancing millet cultivation and marketing. Integrated approaches and networking among key players are found to be crucial for wider impact. These cereals grow well in drylands and at high temperatures; they have been supporting millions of poor and marginal women and men farmers struggling with poor soil, low moisture and scarce external inputs. Thanks to their hardiness and good nutritional profile, they are in fact important assets for adapting to climate change.

Government initiatives

Government of India initiatives for popularizing millets in the country are covering various facets of millet production, processing and marketing. Scheme on Initiative for Nutrition Security through Intensive Millets Promotion has been formulated by Government of India. The scheme aims to demonstrate the improved production and post-harvest technologies in an integrated manner with visible impact to catalyze increased production of millets in the country. Besides increasing production of millets, the Scheme

through processing and value addition techniques is expected to generate consumer demand for millet-based food products.

The districts with large crop area under millets (more than 10,000 ha area under sorghum and pearl millet, or more than 5,000 ha under finger millet or more than 2,000 ha area under small millets namely; barnyard, kodo, kutki, foxtail and proso) but with productivity less than that of the National Average Yield could be taken up for active promotion of production technologies through block demonstrations. However, in case of small millets, which have low productivity in general and are taken by resource poor tribal farmers in remote interior areas, production programme would be organized in all the identified districts irrespective of their productivity levels.

Three commodity-wise national demonstrations cum training centres would be set up at the Directorate of Sorghum Research (DSR), Hyderabad for sorghum; University of Agriculture Sciences, UAS, Bengaluru for finger millet and small millets and CCS Hisar Agriculture University, Hisar for pearl millet with the following objectives:

- Refinement of technology, retrofitting and their demonstration.
- Providing entrepreneurship development and training.
- Facilitate market linkages between processors and producers.

Each of these centres would function as a Centre of Excellence for the designated crop for the purpose of technology demonstration and capacity building for increasing production, processing unit for product development and value addition.

One processing unit along with the services of one Technical Assistant purely on contract basis would be set up in selected 100 KVKs to serve as demonstration cum training centres for furtherance of post-harvest technologies. To utilise the full capacity of these processing unit, KVKs may levy nominal charges. A single complete post-harvest processing cluster/unit at a total cost up to Rs 4.00 lakh will comprise of both primary processing (3-in-one destoner cum grader cum cleaner + Pearling machine) costing up to Rs. 2.0 lakhs and secondary processing machines ((Rava / Flaking machine – Jowar; Popping roaster-Ragi; Parboiling unit- Pearl millet) costing up to Rs 2.0 lakhs.

Keeping the above in view, **“PROCESSING AND VALUE ADDITION TECHNOLOGY OF MILLETS FOR NUTRITIONAL SECURITY IN HYDERABAD KARNATAKA REGION”** was taken up by University of Agricultural Sciences, Raichur with Rashtriya Krishi Vikas Yojana funding. The project was implemented from 2013-14 to 2016-17. The details of the project are as under:

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3. Adoption of developed processing and value addition technologies in the millets production catchments.
4. Imparting technical know-how on processing and value addition technologies among different stake holders.

HYPOTHESIS

The context of the evaluation arises from the following facts:

1. Millets are hardy crops and can grow under less favorable conditions and have potential to bridge the gap between demand and supply to ensure nutritional security. While, the population pressure continues, the area under arable land is decreasing. In spite of a wider climatic adaptability, cultivation of diverse millet species/varieties is gradually decreasing in the recent past.
2. Difficulty in processing is the key challenge that hinders consumer demand and upscaling potential for minor millets. Several interventions can be made to

facilitate access by value chain actors to processing plants on the one end and by consumers to processed millet products on the other.

3. More specifically, there is a critical need to optimise technology for de-hulling of different small millet species, which have different seed sizes. More research is needed for improving the separation mechanism in hullers to reduce removal of grits and other usable materials along with the husk. Improving the sieving efficiency of graders is also needed. Large-scale equipment is available for this operation but equipment tailored for the community level and the small and medium enterprise level is needed and would be most relevant for supporting development of farmer enterprises.

OBJECTIVES AND ISSUES FOR EVALUATION

The scope of evaluation is to study the impact of scheme, **"PROCESSING AND VALUE ADDITION TECHNOLOGY OF MILLETS FOR NUTRITIONAL SECURITY IN HYDERABAD KARNATAKA REGION" IMPLEMENTED** by University of Agricultural Sciences, Raichur from 2013-14 to 2016-17.

1. Stake Holders

a) University of Agricultural Sciences, Raichur – Sponsorer
b) Rashtriya Krishi Vikas Yojane – as Monitoring Authority
c) Institution of Agriculture Technologists – as Consultant
d) Farmers / beneficiaries as target group of evaluation

2. Purpose of Evaluation

Evaluation Framework

The focus of Evaluation is:

i. To evaluate the primary millet processing equipment developed by the University.
ii. To examine the sstandardization of process technology for preparation of millet-based value-added products finalized by the University and its utility.
iii. To evaluate the effectiveness of developed processing and value addition technologies in the millets production catchments
iv. To evaluate the efforts made at imparting technical know-how on processing and value addition technologies among different stake holders.

LOG FRAME/THEORY OF CHANGE/PROGRAM THEORY

The intention of the project is to study the impact of **"PROCESSING AND VALUE ADDITION TECHNOLOGY OF MILLETS FOR NUTRITIONAL SECURITY IN HYDERABAD KARNATAKA REGION"** project on development and use of processing technologies to meet the needs of various stake holders viz., farmers, researchers, students, scientists, food and processing industries, food grain packers and exporters.

EVALUATION DESIGN

Evaluation design has a rationale of requirement of field level data (primary) that is required to study evaluation objective with respect to beneficiary farmers on one part and the projects taken up for study per se on the other part. The evaluation requires analysis of administration obligations under the two heads and hence a secondary data analysis becomes important and accordingly formats were designed to procure secondary data. The third obligation under evaluation is opinion of stake holders with respect to improvement of the schemes, which require group discussions and exchange of views both in the form of

a format, as well as group discussions with the stake holders. The entire evaluation process required a central administration of all activities.

A core team of experts at the Institution level considered three methods to bring a meaningful evaluation of the subject, keeping in mind the scope, evaluation questions and sub-questions duly keeping its focus on the purpose of evaluation. The three methods are:

a. Accessing and analysis of secondary data from the implementing department.
b. Interaction with Principal Investigator and his team.
c. Actual visit to the project site to study and obtain necessary information to elicit answers to the evaluation questions.

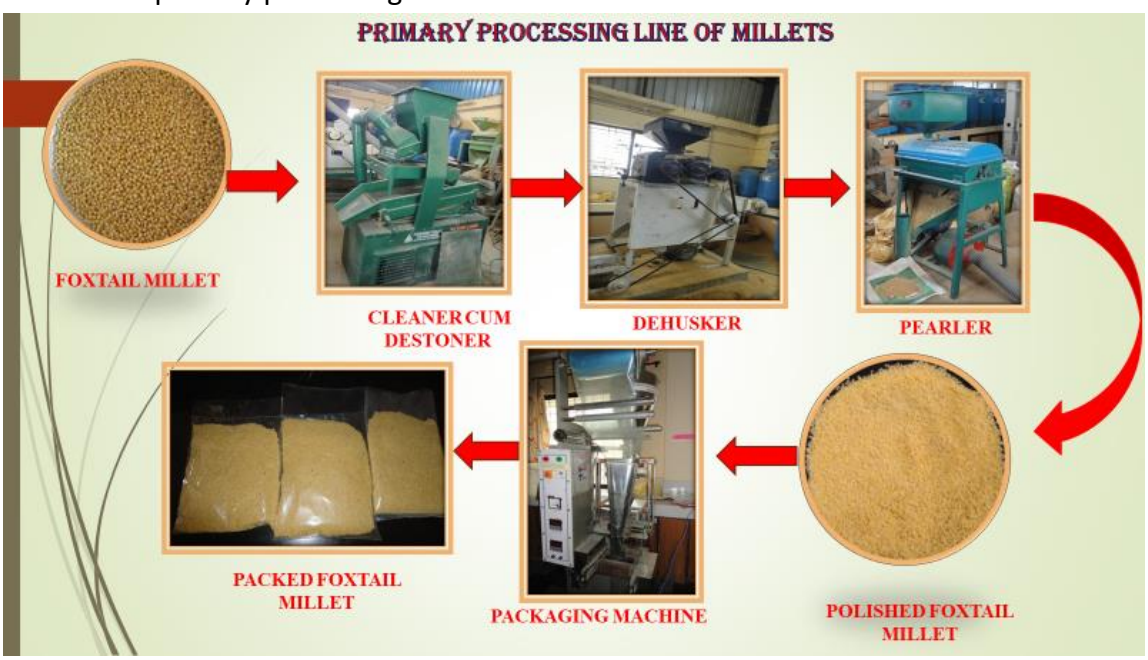
DATA COLLECTION AND ANALYSIS

Development of selected primary millet processing equipment for establishment of state-of-art millet processing complex at UAS Raichur.

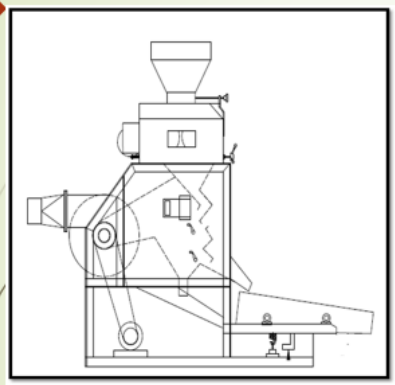
Development of dehusker for foxtail millet

Millets are neither ready to eat nor ready to cook grains and need some kind of processing invariably for human consumption. Difficulty in processing is the key challenge that hinders consumer demand and upscaling potential for minor millets. Several interventions can be made to facilitate access by value chain actors to processing plants on the one end and by consumers to processed millet products on the other. The lack of suitable processing units close to millet fields forces local producers to take their produce to distant places. More specifically, there is a critical need to optimise technology for de-hulling of different small millet species, which have different seed sizes. More research is needed for improving the separation mechanism in hullers to reduce removal of grits and other usable materials along with the husk. Improving the sieving efficiency of graders is also needed.

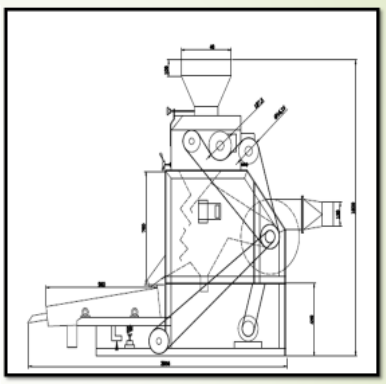
The primary processing line of millets is detailed below:



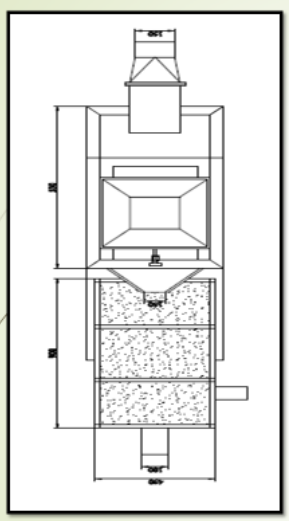
In line with the primary processing line, a study to design the foxtail millet deshusker was taken up. Power required for the dehusker was arrived at based on husk thickness of 0.40 mm. The force (compress force) required to remove of husk from grains was considered for designing the processing components. The components included hopper, rubber bolls, impeller, blower, grader and separator. The sieve was designed based on the parameters size of openings (mm), rate of movement (ms^{-1}), slope (degree) and width of the screen. The width of screen was designed based on the width of dehusker (James, 1983).



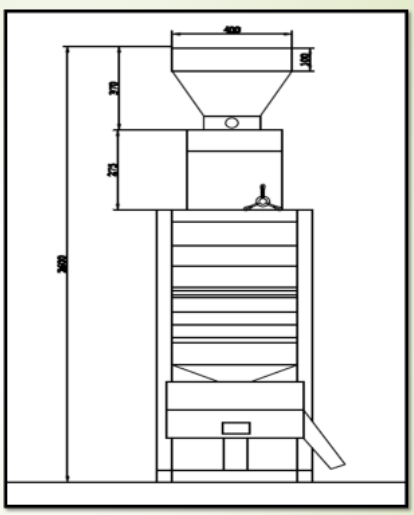
Left side view of dehusker



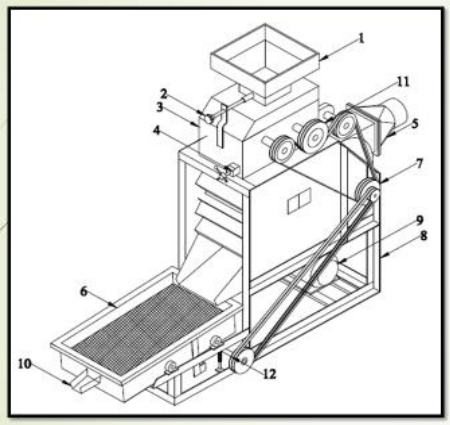
Right side view of dehusker



Top view of dehusker for foxtail millet



Front view of dehusker for foxtail millet



Parts list	
Sl. No.	Part name
1	Hopper
2	Feed controller
3	Dehusking zone
4	Roller clearance adjustor
5	Air blower
6	Grader
7	Main pulley
8	Supporting frame
9	Motor
10	Chute
11	Rubber roller pulley
12	Oscillator

Isometric view of dehusker for foxtail millet

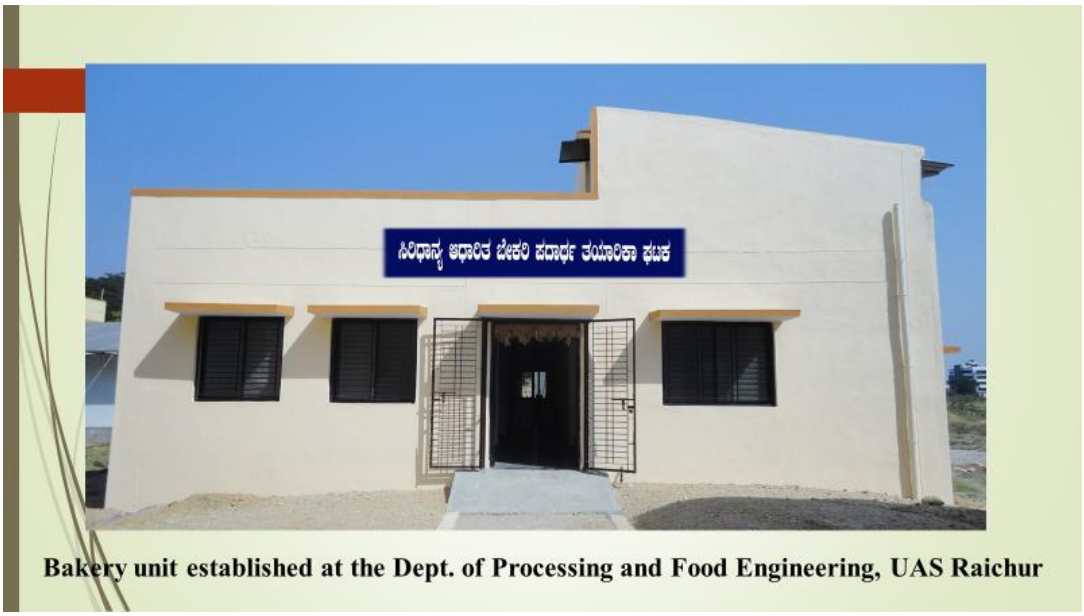
Assembled dehusker for foxtail millet

Performance of millet dehusker and polisher

- Unhulled Millet : 100 kg
- Brokens: 4 kg
- Husk: 24 kg
- Head Rice: 72 kg

The performance of the dehusker and polisher was evaluated and it was observed that the dehusking efficiency of dehusker for foxtail millet was found to be 81%. The head yield of dehusked grains was 97.33%. The cleaning efficiency of the grader/separator was found to be 81.66%. The broken yield of dehusked grains was 2.66%. Malathi Durairaj et al., 2018 reported dehulling efficiency of 95-96% and broken yield of dehusked grains of 4-5% with the double chamber centrifugal dehuller developed at Department of Post-Harvest Technology Centre, Tamil Nadu Agricultural University, Coimbatore, India.

The dehusker and polisher developed by Department of Processing and Food Engineering, College of Agricultural Engineering, University of Agricultural Sciences, Raichur has been installed at Agricultural Research Stations, Bidar, Hagari, Lingsugur, Gangavathi and Raichur.



Bakery unit established at the Dept. of Processing and Food Engineering, UAS Raichur

Standardization of process technology for preparation of millet-based value added products

In this present era, consumers prefer high-quality foods with longer shelf life. They also look for products which are convenient to prepare as people are too busy in their daily schedule. Moreover, people have increased their tendency to eat a greater variety of foods both traditional and conventional. Efforts are being made to create awareness on the potential health benefits of millets which are recommended for obese, diabetic, celiac and other lifestyle diseases. In order to make millet value chain sustainable, the production and promotion of various products in the market is very much essential (Dayakar Rao et al., 2016).

Millet Bread

Bread is a ready to eat product which is prepared by mixing a mixture of flour, water, fat, salt and yeast until the mixture gets converted into dough, which is followed by

baking the dough into a loaf. Millet breads have been prepared replacing wheat in bread with pearl millet, finger millet or foxtail millet flour of varied proportions and adding superior quality yeast, trans-free fat, salt and sugar. The dough is proofed and then baked in oven to get bread. Round balls of the dough are made and baked to get bun. Millet bread is fiber rich and beneficial for all age groups. Utility as breakfast food. It is rich in magnesium, zinc, iron, dietary fiber and protein. It has a shelf life of 6 days when packed in LDPE packets. Nutrient composition for Millets Bread (per 100 gm) - Protein 7.4 %, Fat 12.3 % and dietary fibre 0.8 gm.

In preparation of millet bread, up to 75% of wheat flour was replaced by millet flour and 25% maida was used to make the dough. After preparation of the bread, quantitative descriptive analysis was conducted to evaluate sensory parameters of the developed products. The Millet Bread is well received in the market and was found to be very good by most of the consumers. The bread is being prepared daily by the bakery unit and sold commercially through the outlet opened in the University campus.

Millet flour (75%) + Maida (25%) + Sugar (7 kg) + Salt (350 g) +Yeast (500 g) + Oil (3.5 kg)

↓

Mixing (10 min)

↓

Addition of water (18 Lit)

↓

Dough preparation (10-15 min)

Proofing (3 h)

↓

Baking (210°C 30 min)

↓

Cooling (-2 h)

↓

Packing

Millet cookies/ Biscuits/ Muffins

Millets were incorporated indifferent variations from 10% to 50% levels to standardize cookies (100%), bread/bun (50%) and cake (100%) by replacing refined wheat flour or using 100% millet flour. Cookies are popular ready-to-eat product consumed by different age groups in a family. Cookie of 100% millets is prepared using a planetary mixer, automatic cookie making machine and rotary oven.

Cookies are prepared using the formulation pearl millet, finger millet and foxtail millet flour of superior quality with addition of sugar, milk solids, trans free-fat, salt and nature identical flavoring substances. Cookie – 92%; By-product yield – 8% (Dough left in the machine, Broken cookies or unbaked).

Pure Millet biscuits are fiber rich and beneficial for all age groups. Low sugar and low fat compared to the market products. It is rich in magnesium, zinc, iron, dietary fiber and protein. It has a shelf life of 6 months.

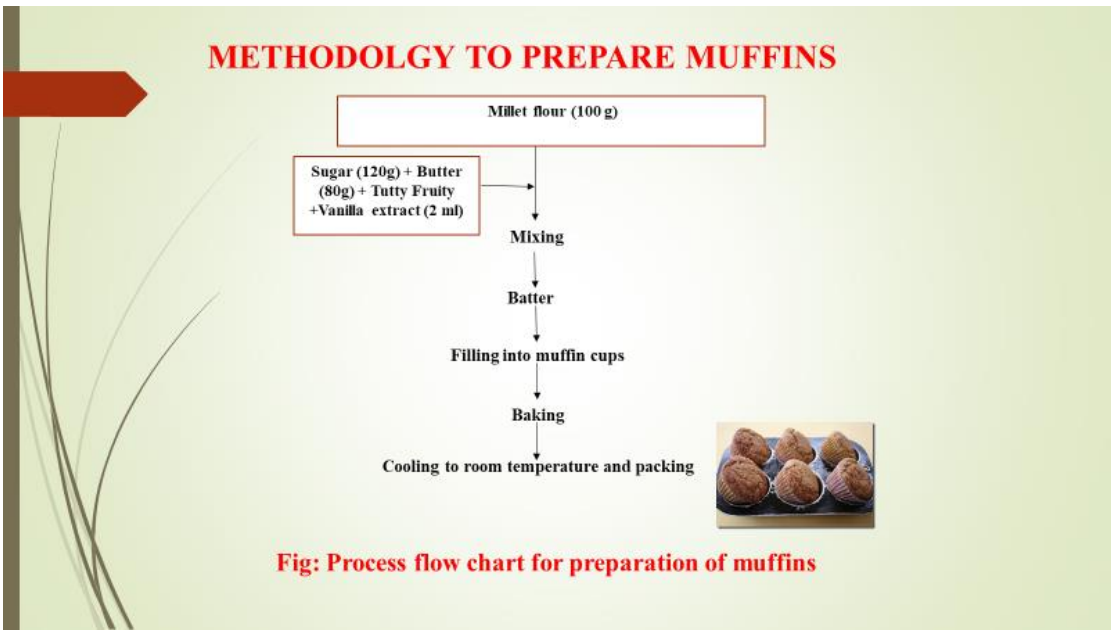
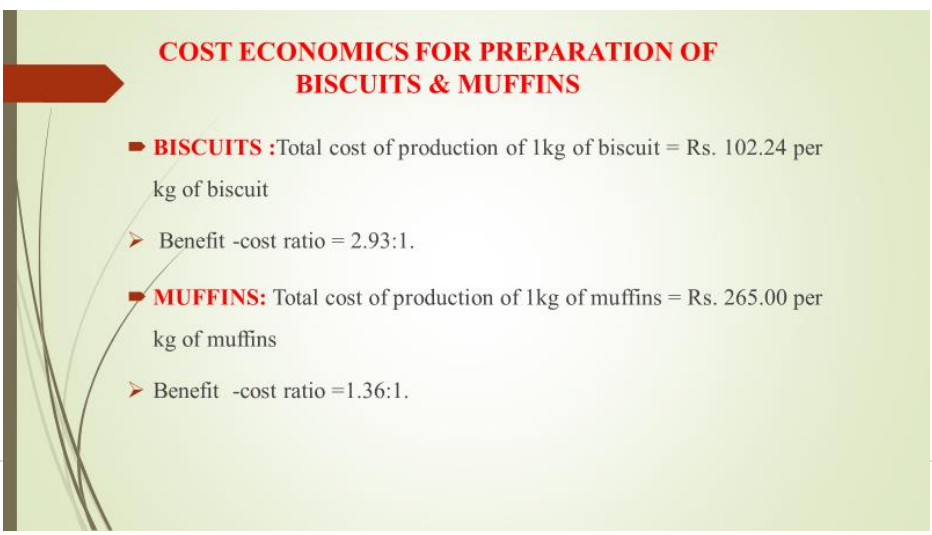


Fig: Process flow chart for preparation of muffins



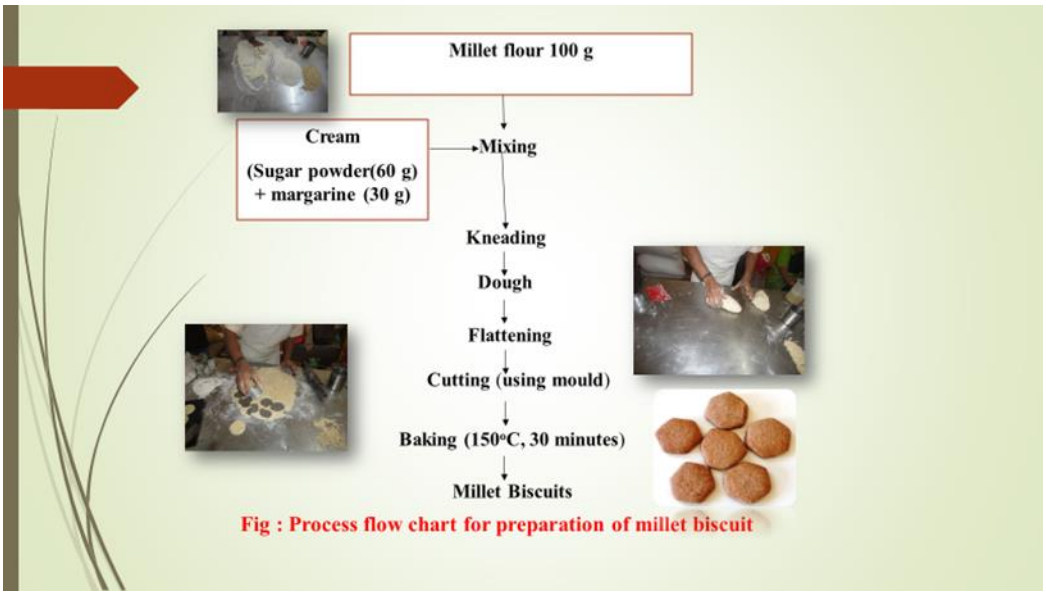


Fig : Process flow chart for preparation of millet biscuit

Millet cookies, biscuits and muffins are also regularly prepared and sold through the outlets in the University campus.

Chilly biscuits

Trials were carried out to select a best formulation by altering margarine (50 and 30 g) and kept foxtail millet as a base material. The formulation with 30 g margarine was found to be best based on sensory characteristics. Formulation of foxtail/kodo/ragi (50, 60, 70, 80 and 100 g) millet based chilly biscuit was carried out. Among the different formulations, biscuit prepared with 50 g millet flour was found to be best based on sensory evaluation.

The Cost Benefit analysis of various products was undertaken and it was found that all the products had very high and healthy cost benefit ratios which established their viability.

Adoption of developed processing and value addition technologies in the millets production catchments and Imparting technical know-how on processing and value addition technologies among different stake holders

After testing the prototype of the millet dehusking unit in the Department of Processing and Food Engineering, College of Agricultural Engineering, Raichur millet processing facilities have been established at Krishi Vignana Kendra, Kalaburgi and Bidar, Agricultural Research Station, Hagari and Gangavathi. These facilities are being used by more than 1,000 millet growing farmers and more than 5,000 consumers across the four districts. One commercial organic millet processing unit has been started at Sindhanur.

The bakery established in the University campus is being used for commercial production of millet-based bakery products and sale in the University Sales counter.

Memorandum of Understanding has been signed with two private entrepreneurs, viz., Mr. Millet and M/s. Farm Bandi for commercial production of millet-based bakery products and units have been started to manufacture millet bakery products of 500 kg/ hour. These are being marketed in Ballari, Davanagere and Raichur.

Training programmes have been conducted for training entrepreneurs in making various millet-based bakery products. Totally 390 entrepreneurs during 2012-14, 212 beneficiaries during 2015-16 and 376 beneficiaries during 2016-18 have been trained at in Raichur. Similar programmes were held in Hagari, Lingsugur and Huvina Hadagali where 289, 38 and 71 beneficiaries were trained.

A series of three trainings were conducted at Lingsugur to popularize the value-added products from millets. Under the banner of vocational training six weeks training programme for the upcoming entrepreneurs was organized to demonstrate various products of millets. This training provided them a hands-on-experience in preparing the sweets, and bakery products with the incorporation of millet flour.

The produce of millet was taken to the processing and food engineering laboratory where a millet processing unit sponsored to Krishi Vigyan Kendra Raichur under INSIMP was established. The processing included sorting, dehusking, polishing and sealing and branding the processed produce in the name of KVK along with coordinating groups. The groups were facilitated with sealing machine, printing label and information about the nutritional importance of millets. There was about 60- 65% recovery of millets after processing. Meantime a group by name Nagar Yellamma SHG from Deosugur, Raichur was trained to produce a sweet from millet in the form of pedha, a local name to the sweet which is prepared with the roasted millet flour, ghee and sugar powder. There was demand created for this product. This in turn enhanced their income as well as self-confidence.

In addition, pearl millet which grown in large area under Lingasugur taluk was also selected for value addition. Wherein, sprouting of pearl millet was tried and malt preparation was carried out. This malt was fortified with malted ragi flour, popped rajkeera, soya flour and condensed milk powder. Developed malt powder utilized in preparation of porridge. Demonstration of this beverage preparation was carried out for Asha workers at government hospital, Mudugal to enhance their knowledge which in turn they can disseminate to many farm women at villages.

These efforts have yielded good results and more entrepreneurs are expected to take to production and marketing of millet-based products in the near future.

Date	Title	No. of trainees
2/01/2012 - 4/01/2012	Importance of millets and their nutrients	50
28/01/2014	Importance of millets and their nutrients	42
28/01/2014	Importance of millets and their nutrients and the processed products prepared by using millets	44
29/01/2014	Preparation of different processed products by using millets	25
8/12/2014	Value addition of millets	28
5/08/2014 - 6/08/2014	Processing and value addition of minor millets for food security in Hyderabad-Karnataka region	55
15/12/14	Processing and value addition of minor millets for food security in Hyderabad-Karnataka region	61
25/12/2014	Value addition of millets	61
31/12/2014	Value addition of millets	24
5/01/2015	Value addition of millets	61
2/02/2015	Processing and value addition of Minor millets	24
3/02/2015	Processing and value addition of minor millets	49
4/02/2015	Value addition of millets	34
3/03/2015	Processing and value addition of minor millets	44
22/2/2016 -	Millet based bakery products	44
7/06/2017	Popularized millets	55
16/06/2017	Millet awareness	59
18/06/2017	Importance and value addition of millets	33
21/06/2017	Importance and value addition of millets	45
28/06/2017	Importance and value addition of millets	38
7/08/2017	Millet awareness programme	29
10/09/2017	Millet awareness programme	30
20/08/2017	Millet awareness programme	43

Training programmes conducted at Agricultural Research Station, Hagari

Date	Title	No of trainees
20/03/2017	Food preservation and processing of millets and their value addition	15
22/03/2017	Processing of foxtail millet and their value addition	18
20/06/2018	Value addition of millets	25
25/6/2018	Processing of millets and their value addition and cultivation of nutrient rich kitchen garden	16
26/12/2018	Value addition of foxtail millets cultivation of nutrient rich kitchen garden	48
4/07/2018	Processing of millets	65
19/07/2019	Practical's on processing of millets	36
20/11/2019	Processing of millets	45
22/11/2019	Processing of millets	21

Training programmes conducted at Lingsugur

Date	Title	No. of trainees
27/08/2012 to30/08/2012	Income generation activities for farm women (value addition)	17
8/08/2017 to 10/08/2017	Training on cultivation, practices, processing and value addition of millets	21

Training programme conducted at Huvina Hadagali

Date	Title	No. of trainees
11/08/2014 to 12/08/2014	Training programme on processing and value addition of minor millets for food security in Hyderabad-Karnataka Region	71


Training conducted on processing and value added products from millets during 27-01-14 to 02-02-14 at Dept. of PFE, CAE, Raichur
Creating awareness to trainees about the millets


Preparation of value added products from millets
Value added products from millets


Training programme for Preparation of millet biscuits


Sensory evaluation by staff


Training programme for preparation of Millet biscuits


Training programme for preparation of millet based puffs

Training programme for preparation of fruit cake





Training programme for preparation of muffins








FINDINGS AND DISCUSSION

Millets are neither ready to eat nor ready to cook grains and need some kind of processing invariably for human consumption. There is a critical need to optimise technology for de-hulling of different small millet species, which have different seed sizes. More research is needed for improving the separation mechanism in hullers to reduce removal of grits and other usable materials along with the husk. Improving the sieving efficiency of graders is also needed.

In this direction, a prototype of the millet dehusker has been developed under the project. The prototype has been tested for efficiency and it has been observed that the dehusking efficiency of dehusker for foxtail millet was found to be 81%. The head yield of dehusked grains was 97.33%. The cleaning efficiency of the grader/separator was found to be 81.66%. The broken yield of dehusked grains was 2.66%. Malathi Durairaj et al., 2018 reported dehulling efficiency of 95-96% and broken yield of dehusked grains of 4-5% with the double chamber centrifugal dehuller developed at Department of Post-Harvest Technology Centre, Tamil Nadu Agricultural University, Coimbatore, India.

The dehusker and polisher developed by Department of Processing and Food Engineering, College of Agricultural Engineering, University of Agricultural Sciences, Raichur has been installed at Agricultural Research Stations, Bidar, Hagari, Lingsugur, Gangavathi and Raichur.

The University should obtain patent for the machinery developed and also take up commercial production of the machinery under PPP mode by tieing up with a commercial agricultural machinery manufacturer.

Standardization of process technology for preparation of millet-based value added products has been taken up under the project and preparation flow charts have been prepared for various millet-based bakery products. Indian Institute of Millets Research, Hyderabad has already brought out Technologies of Millet Value added products detailing the methods of preparation of various products from millets. Similar efforts have been done by Central Food Technology Research Institute, Mysuru and Tamilnadu Agricultural University, Coimbatore also. There is need to bring out the literature in local language.

The bakery established in the University campus is being used for commercial production of millet-based bakery products and sale in the University Sales counter. This is a good move and helps in popularizing the millet products.

Memorandum of Understanding has been signed with two private entrepreneurs, viz., Mr. Millet and M/s. Farm Bandi for commercial production of millet-based bakery

products and units have been started to manufacture millet bakery products of 500 kg/ hour. These are being marketed in Ballari, Davanagere and Raichur.

Training programmes have been conducted for training entrepreneurs in making various millet-based bakery products. Totally 390 entrepreneurs during 2012-14, 212 beneficiaries during 2015-16 and 376 beneficiaries during 2016-18 have been trained at in Raichur. Similar programmes were held in Hagari, Lingsugur and Huvina Hadagali where 289, 38 and 71 beneficiaries were trained. There is need to evaluate the impact of these training programmes.

REFLECTIONS AND CONCLUSIONS

1. Efforts made in design and development of millets dehusker are praiseworthy. The University should obtain patent for the machinery developed and also take up commercial production of the machinery under PPP mode by tieing up with a commercial agricultural machinery manufacturer.
2. Standardization of process technology for preparation of millet-based value added products has been taken up under the project and preparation flow charts have been prepared for various millet-based bakery products. There is need to bring out the literature in local language.
3. The bakery established in the University campus is being used for commercial production of millet-based bakery products and sale in the University Sales counter. This is a good move and helps in popularizing the millet products.
4. Training programmes have been conducted for training entrepreneurs in making various millet-based bakery products. There is need to evaluate the impact of these training programmes.

ACTION POINTS

1. The outcome of the projects is very good. However, there is a need of working model with support of private participation or as per Farmer Producer Organization principles/ model.
2. Nutritional status of millet products and their digestibility need to be worked out in collaboration with food scientists and medical practitioners.
3. Keeping quality of millet products, i.e., shelf life of products and their economics need to be worked out in detail.
4. Comparative keeping quality of dehusked and nondehusked products may be tested with economics.
5. Economics of by-products and products may be worked out in addition to value addition and nutrition quality.
6. Efforts made in design and development of millets dehusker are praiseworthy. The University should obtain patent for the machinery developed and also take up commercial production of the machinery under PPP mode by tieing up with a commercial agricultural machinery manufacturer. Effort may be made include this machine under mechanization subsidy scheme.
7. Efforts made in development of the millet de-husker increases the quality input of the processed product of millets, enables the farmers to fetch more price in the market (Approximately 1000 farmers benefitted using this unit).
8. Standardization of process technology for preparation of millet-based value added products has been taken up under the project and preparation flow charts have been prepared for various millet-based bakery products. There is need to bring out the literature in local language.
9. The bakery established for commercial production of millet-based bakery products and a sale counter at UAS RAICHUR under this project enables the farmers of this Hyderabad Karnataka region as a market facility to sell their value-added product to get notable price for enhancing economic conditions of the farmers
10. Training programmes have been conducted for training entrepreneurs in making various millet-based bakery products. There is need to evaluate the impact of these training programmes.
11. Already Two Enterprises Mr. Millet and M/s. Farm Bandi (Memorandum of Understanding with UAS Raichur) has started bakery more private Enterprises are to be attracted to popularize this technology and extend the benefits to the farmers.
12. A core team of experts at the Institution level may be identified to identify suitable equipment/ technology developed to recommend and initiate for patent registration and policy formation at university level/ transfer of this technology to other Agricultural Universities in the state for adopting / popularization among

farmers through frontline demonstration and series of training programmes involving farmers, manufacturers etc.

Researchable issues on Post-harvest Technology of Millets (Processing, Storage, Packaging and Value Addition)

Millet Processing	Standardization of screens/sieves for efficient separation of unhulled and dehulled millets after dehulling
	Development of appropriate technologies to enhance milling efficiency or dehusking efficiency through proper pre-treatments
	Studies on preservation of nutritional components in the millet flour
	Studies on pre-treatments for reducing tannin content in millets (bitter taste specially in Barnyard millet)
Storage and Packaging	Enhancement of shelf-life of dehulled millets through appropriate treatments/ packaging/ storage technologies
	Application of ITK for packaging and storage of dehulled millets
	Development of cattle feed using millet husk
	Developing biodegradable packaging material by using millet husk
Value addition	Palatability studies for improving the flavour profile of small millets
	Development of millet based weaning foods
	Development of exotic foods using millets
	Shelf life of millet value added semi perishable products
Policy issues	Millet farmers should be given incentives for increasing the production Suitable platform for marketing/export of millet rice and its value added products

OTHER RESEARCHABLE ISSUES

1. Rice husk is abundantly available. Hence, there is need for research on value addition to rice husk and straw (ethanol production) and their by products in PPP mode.
2. Integrated and multi-disciplinary approach for integration of indigenous technology knowledges (ITKs) in agro climatic zones and patenting.
3. Establishment of millet quality testing techniques.
4. Need for research on product development/ technology for millets keeping in view their nutritional and antinutritional status.
5. Initiate farmers use of incubation facilities on campus to enhance use of millets.

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TERMS OF REFERENCE

FOR EVALUATION OF THE PROJECT ENTITLED "PROCESSING AND VALUE ADDITION TECHNOLOGY OF MILLETS FOR NUTRITIONAL SECURITY IN HYDERABAD-KARNATAKA REGION" IMPLEMENTED DURING THE PERIOD 2013-14 BY THE UNIVERSITY AGRICULTURAL SCIENCES, RAICHUR AT THE DEPARTMENT OF PROCESSING AND FOOD ENGINEERING, COLLEGE OF AGRICULTURAL ENGINEERING, UAS, RAICHUR

1. **Title of the Study:**

   Processing and Value Addition Technology of Millets for Nutritional Security in Hyderabad-Karnataka Region

2. **Department/Agency implementing the Scheme:**

   Department of Processing and Food Engineering, College of Agricultural Engineering, UAS, Raichur

3. **Project Approval No.: KA/RKVY-MRKT-2013/450**

   Year of Start : 2013-14
   Year of conclusion : 2016-17
   Total budget of the project: Rs. 175.00 Lakhs

4. **Background of the context:**

   Millets are the important ingredient of household food security and nutrition particularly in draught years as the millets are harvested well even in the substantial low rains. Millets play very specific role in human nutrition because of their multiple qualities. They have high content of calcium and are suitable for diabetic patients due to low glycemic index. Millet is gluten-free and safe to eat for those who suffer from Celiac disease or for those who experience gluten sensitivity.

   The minor millets namely, finger millet (*Ragi*, *Eleusine coracana*), foxtail millet (*Navane*, Italian millet, *Etaria italica*), Little millet (*Savi/Samai/Kutki*, *Panicum miliare*), Barnyard millet (*Oodahe/Banti*, *Echinocloa frumantacea*), Proso millet (*Baragu*/Cheena/French millet, *Panivum miliacium*) and Khodo millet (*Haraka/Varagu, Paspalum scrobiculatum*) are cultivated in the areas where a more dependable harvest is produced compared to any other crop. This has been largely responsible for the continued presence and cultivation in many parts of the

world. These crops provide good nutrition and compete very well with rice or wheat.

Further, small millets are superior in protective nutrients such as vitamins, minerals, dietary fibre, essential amino acids and phyto-chemicals. In recognition of this, these grains are now considered as nutritious grains and are the main sources of energy as these contribute about 70-80% of daily energy intake of Indian diet. Since cereals/millets are the cheapest source of energy, their contribution of energy intake is highest among the poor income families. Cereals contain protein, calcium, iron and B-complex vitamins and provide more than 50% of daily protein intake. Cereal grains also act as inexpensive binding agent in pelleted feeds.

Millets being small seeds, contain large proportions of husk and bran, which require dehusking and debraning prior to consumption (Hulse *et al.,* 1980). Despite their nutritional superiority, utilization of millets is restricted due to non-availability of processed millets in ready to eat form. Hence, millets are confined to traditional consumers and to the people of lower strata. Although, a majority of the millet production (80%) is used for human food, it is also used for feeding cage birds. On global basis, small millets are cultivated in an area of 36.79 million ha, with annual production of 29.20 million tonnes indicating the productivity of 1 tonne/ha. (Prasada and Wet, 2009). In India, they are cultivated in an area of 18-19 million ha. producing 18 million tonnes per year with the productivity of 789 kg/ha. In Karnataka, small millets are cultivated on an area of 1.25 million ha producing 1.54 million tonnes with a productivity of 1230 kg/ha. Millet ranks as the sixth most important grain in the world, sustains 1/3 of the world's population and is a significant part of the diet in Northern China, Japan, Manchuria and various areas of the former Soviet Union, Africa, India, and Egypt (Karen, 2011).

Keeping the above facts in view, the present investigation on **"Processing and value addition technologies of millets for nutritional security in Hyderabad-Karnataka region"** was sanctioned during 2013-14 under RKVY grants.

5. The objectives:

The objectives of the project are as follows:

i. Development of selected primary and secondary millet processing equipments for
establishment of state-of-art millet processing complex at UAS Raichur
ii. Standardization of process technology for preparation of extruded snacks, vermicelli, pasta, biscuits, muffins, pro-biotic value added products
iii. Adoption of developed processing and value addition technologies in the millets production catchments

iv. Imparting technical know-how on processing and value addition technologies among different stake holders

6. Present status of the project:

The above project was implemented during 2013-14 to 2016-17 at the Department of Processing and Food Engineering, College of Agricultural Engineering, UAS, Raichur.

- The processing unit established during the implementation of the said project is being in operation and the facility is being used for conducting the trainings and demonstration on millet processing and value addition to the farmers, NGOs, SHGs, traders, aspirant entrepreneurs, and to the students of the farm universities as well.
- The millets processing facilities have been created in different campuses of UAS Raichur namely, KVK, Kalaburgi; ARS, Hagari; KVK, Bidar; and ARS, Gangavathi and about 1000 No. of millets growing farmers of respective production catchments and more than 5000 consumers across four districts are benefited.
- The bakery unit established under the said project is being used for producing the millet based bakery products, namely, bread, muffin, cake, rusk, biscuits on commercial scale and sold in the University sale counter through the revolving fund project.
- The facilities namely, millet processing unit and the millet based bakery unit are being used for providing technical know-how on processing millets and value addition technologies to the different stake holders.
- The project has encouraged the startup entrepreneurs and one firm has already entered MOU with the University for selling the bakery products outside the university campus and one more enterprise in the pipeline.

7. Outcome of the project:

- Physico-chemical properties of different millet grains were determined.
- Developed a rubber roll type millet dehusker for processing of the millets.
- Performance evaluation of millet dehusker was carried out in comparison with commercially available dehusker.
- Established a complete line of millet processing unit at UAS Raichur and extended the developed millet dehusker to different campuses of UAS Raichur for promotion of millets cultivation in this region.
- Established a full fledged bakery unit for production of millet based value added bakery products on commercial scale.
- Developed different value added products namely, millet based bread, muffins, biscuits and extruded products.

- Training programmes on preparation of valued added millet based bakery products
  wetre organized to the different stake holders (520 No.) at UAS Raichur

8. Assets: Including building, equipments – all the assets purchased under the project.

Sl. No.	Name of the asset	Date of purchase	Quantity (Nos.)	Total cost (Rs.)	Purpose of purchase
1	Civil works-Millet based Bakery laboratory (2690 Sq.ft.).	2014-15	01 No.	40,00,621	accommodate different bakery equipments for standardize recipe of millet based value added products and to conduct the training programmes for promotion of millet based foods to different stake holders
2	Digital weighing machine	18.12.2013	01 No.	5,496	weigh the raw materials for preparation of bakery products
3	Bakery Unit	19.03.2014	01 No.	48,88,975	establish the bakery for production of millet based value added products
4	NIR grain Analyzer	21.03.2014	01 No.	16,15,950	analyze the proximate composition of millets
5	Stomacher	28.03.2014	01 No.	4,10,000	homogenize the samples for microbial studies of developed millet based foods
6	Millet Husker	28.03.2014	05 No.	8,25,000	dehusk the millets for development of millet based foods
7	CO_2 new fire Extinguisher	06.08.2014	03 No.	14,427	prevent electrical fire risks
8	RF Dryer	10.01.2015	01 No.	22,33,575	remove the surface moisture from the developed bakery products

9. Where the project is undertaken:

Places to visit to evaluate the project: **Dept. of Processing and Food Engineering, College of Agricultural Engineering, UAS, Raichur - 584104**

10. Evaluation questions and minimum expectations:

i. Whether the solution for mechanical processing of millets was resolved?
The physico-chemical properties of the different millets were determined and based on the results of this study, the rubber roll type millet dehusker was developed and the evaluated its performance.

ii. Whether the millet processing unit was established at UAS Raichur?
A complete line millet processing unit comprising a millet cleaner cum grader, destoner, centrifugal dehusker, rubber roll type dehusker, specific gravity separator, and a pearler was established at UAS Raichur

iii. Any effort was made to extend the millet processing facility other than the Head quarter?
The efforts were made to create the facility for processing of the millets at different campuses of UAS Raichur namely, KVK, Kalaburgi; ARS, Hagari; KVK, Bidar; and ARS, Gangavathi.

iv. Whether the millet growing farmers in Kalyan Karnataka region are benefited?
The millet processing facilities created in different campuses of UAS Raichur benefitted about 1000 farmers across six districts of Kalyan Karnataka region and they have been supported for the processing of their millet produce and marketing of the processed products.

v. Whether the bakery unit fully equipped for production of millet based bakery products?
The bakery unit comprising all the necessary equipments was established for commercial production of millet based bakery products and sold in the University sale counter through the revolving fund project..

vi. What are the millet based valued added products developed?
The millet based valued added products developed are namely, bread, muffin, cake, rusk, biscuits.

vii. Whether the infrastructure created has been used for promotion of the millet cultivation and value addition in the region?
The facilities namely, millet processing unit and the millet based bakery unit created under the project are being used for providing technical know-how on processing millets and value addition technologies to the different stake holders through trainings and demonstrations.

viii. Whether the project has achieved nutritional security in Kalyan Karnataka region?
The nutritional security in Kalyan Karnataka region is being achieved through establishment of millets processing facilities in different campuses of UAS Raichur namely, KVK, Kalaburgi; ARS, Hagari; KVK, Bidar; and ARS, Gangavathi and about 1000 No. of millets growing farmers of respective production

catchments and more than 5000 consumers across four districts are benefited. The bakery unit is being used for producing the nutritious millet based bakery products on commercial scale and sold in the University sale counter. The project has encouraged the startup entrepreneurs and one firm has already entered MOU with the University for selling the bakery products outside the university campus and one more enterprise in the pipeline.

11. Evaluation Methodology and sampling:

i. Interaction with the Co-ordinator and the Principal Investigator of the scheme to seek the information
ii. The evaluation should be undertaken at the Department of Processing and Food Engineering, College of Agricultural Engineering, UAS Raichur
iii. The millet processing unit and the millet bakery unit may be visited and necessary information may be obtained for the evaluation
iv. The training and demonstration facilities available in the department may be visited
v. The interaction with the entrepreneurs associated with the millet processing and value added products to seek the information

12. Deliverables:

A detailed report of the facilities created for processing and value addition in millets for nutritional security in Kalyan Karnataka region through the post project activities being carried out at the University of Agricultural Sciences, Raichur may be submitted.

13. Duration and time schedule for the study:

The task should be completed in three months of time

- Visit to the Department of Processing and Food Engineering, CAE, UAS Raichur for inspecting the millet processing unit and the millet bakery unit
- Discussion with the Co-ordinator and the Principal Investigator of the scheme
- Visit to the university sale counter of the millet based value added products
- Preparation of the draft report
- Presentation of the draft report
- Final report to be submitted before the end of the stipulated time of three months

14. Quality Expected from the Evaluation report:

The report should highlight the following;

- The importance of millet cultivation in Kalyan Karnataka region

- The importance of the facilities created for millet processing and value addition
- The impact of millet processing unit on farmers of this region
- The impact of millet bakery unit on nutritional security in Kalyan Karnataka region
- The quality of the expertise developed in the Dept. of Processing and Food Engineering at UAS Raichur
- The training facilities available for providing know-how on millet processing and value addition to the different stake holders namely,
- The farmers, SHGs, NGOs, startups and aspirant entrepreneurs

15. Recommendations:

Specific recommendations leading to the policy making in providing more financial grants for further strengthening the research and training facilities at the Dept. of Processing and Food Engineering at UAS Raichur towards establishment of the Centre of Excellence in Millet Processing and Value Addition at UAS Raichur for the benefit of the farmers of Kalyan Karnataka region shall be useful

16. Cost and Schedule of budgets:

The budget would be released as follows

- The first installment of consultation fee of 30% of the total fee shall be paid as advance to the consultant after the approval of the inspection report, but only on execution of a bank guarantee of a scheduled national bank valid for a period of at least one month from the date of receipt of advance.
- Second installment of consultation fee of 50% of the total fee shall be payable to the consultant after the approval of the draft report.
- Third and final installment of consultation fee amounting to 20% of the total fee shall be payable to the consultant after the receipt of the hard and soft copies of the final report in the format and the number as prescribed in the agreement along with all original documents.
- Tax will be deducted from each payment as per the rates in force; in addition to this the evaluator is expected to pay the statutory taxes at their end.

17. Minimum qualification of the consultant

Consultant should provide the details of the evaluation team members having the technical qualification/capability as below;

- Post graduate in Agricultural Engineering/Food Processing and allied sectors having knowledge in Agricultural Processing, Food Processing, Food Technology, Food Science and Nutrition.
- Research Assistant with good data processing skills

- Additional such members that the evaluation is completed within three months of the scheduled time prescribed by in the TOR. Consultant not having these members and kind of personnel will ot be considered as competent for evaluation

18. Providing Oversight:

Karnataka Evaluation Authority will provide the funds and oversight for the study. All technical aspects of the study are subjected to their approval.

19. Contact persons:

Dr. Udaykumar Nidoni,
Professor and Head,
Dept. of Processing and Food Engineering,
College of Agricultural Engineering,
UAS, Raichur-584104
Mob: 9008688430
Email: udaykumarnidoni@yahoo.co.in will be the contact person for giving information and the details for this study.

The entire process of evaluation shall be subject to and conform to the letter and spirit of the contents of the Government of Karnataka Order No. _____ dated _____ and orders made under

EVALUATION TEAM MEMBERS

Sl. No.	Name	Designation
1	Dr. B. C. Suryanarayana	Principal Investigator
2	Dr. M. A. Shankar	Associate Investigator
3	Sri. Siddaraju	Associate Investigator
4	Dr. H. B. Shivaleela	Subject Matter Specialist
5	Dr. M. Ananthachar	Subject Matter Specialist

Dr.Suryanarayana, B.C. is a doctorate in Agriculture with specialization in Agronomy and is a Certified Associate of Indian Institute of Banking (CAIIB), Fellow of Indian Institute of Valuers. He worked in State Bank of India from the year 1981 to 2014 as a Technical Officer and retired as Asst. General Manager (Rural Development). He is a practicing consultant in the field of Agriculture, Horticulture, poultry, dairy, fisheries and plant tissue culture and covered cultivation. He has about 35 years of experience in the field and has prepared several project reports for financial institution, written books in vanilla cultivation, anthurium, medicinal and aromatic crops, minor irrigation, poultry and dairy farming. He has appraised more than 6,000 proposals in agriculture and related fields for funding by the Bank and has also been involved in many studies relating to development of Agriculture and allied activities. He has served as a General Manager in a bio-fertilizer, bio-pesticides and organic manures manufacturing company and is also a Technical Director in a company involved in manufacture of agricultural implements and equipment.

Dr. M. A. Shankar is a doctorate in Agriculture with specialization in Agronomy. He is former Director of Research, University of Agricultural Sciences, Bengaluru and presently the Executive Member of Institution of Agricultural Technologists, Bengaluru and Co-Chairman of Agribusiness Consultancy Subcommittee. He has implemented 51 research projects for the University funded by International organizations, Central and State governments, Private firms. He has guided 6 Ph. D. students and 15 M. Sc., (Agri) students. As Dean of College of Agriculture, Hassan, he has, with his administrative skills, streamlined accounting, financial, academic and administrative issues. He has been involved in review and evaluation of Technical Reports of 32 All India Co-ordinated Research Projects (AICRP) spread all over India. He has also evaluated 11 operational research projects for the technical feasibility and implementation. He has published 173 peer reviewed research

papers. He has also penned 54 booklets and books for the University. He has vast experience in evaluation studies of projects.

Sri. Siddaraju is a Graduate in Agriculture with more than 35 experience in the field of Agriculture. He has served in the Karnataka State Department of Agriculture (KSDA) as Asst. Agricultural Officer in Farmers' Training and Education Centre, Soil Testing laboratory and as Subject Matter Specialist. He was Deputy Director of Agriculture (Commercial Crops) for 6 years, District Watershed Development Officer for 2 years. He has also been Joint Director of Agriculture (Inputs) for 5 years. He was involved in preparation of Annual Programme Planning booklets pertaining to Agricultural Inputs in Department of Agriculture. After retirement, he is serving as Chairman, Agriculture Consultancy Subcommittee, Institution of Agricultural Technologists, Bengaluru and has been actively involved in evaluation studies of projects.

Dr.H.B.Shivaleela has a post graduate degree in food and nutrition from Mysore University and a Ph. D. on Sports Nutrition from Bangalore University and is a honorary Registered Dietecian. She has over 41 years of teaching and research experience having worked in Mysore University and University of Agricultural Sciences and has also worked as a Dietecian in Mallige Medical Centre, Bangalore for five years. She has handled over 32 research projects as Investigator and co-investigator. These include 4 international and 28 national, state, institutional and industry level projects. She has two patents in her name, viz., Wheat Based Chocolate Bar for sustained Energy release, A Process for the manufacture of tomato (S*olanum lycopersicum*) bread. There are 9 patents pertaining to various food products and processes pending approval in her name. She is a Life member of IDA, AFSTI.-India, Nutrition Society of India, Organic Foods-GOK, Home Science Association of India. She has 20 books (English & Kannada), 86 Research papers, 68 research Abstracts, 52 Popular articles, 35 Information Folders, 16 Training Manuals, 8 Education Games –(Snake & ladder, Play Cards), 20 Radio Programs, 26 T.V. Programmes and 2 Live Satellite Programmes to her credit.

Dr. M. Anantachar has a mechanical engineering degree from Karnataka University, Dharwad, a post graduate degree in Farm Power and Machinery from Tamilnadu Agricultural University and a Ph. D. in Mechanical Engineering Sciences from Vishveshwaraya Technological University, Belgaum. He is a Fellow of Institution of Engineers (India) and a life member of Indian Society of Agricultural Engineers. He has over 35 years' experience in teaching and research in Farm Machinery and Power. He has authored four books and published 23 research papers on Farm Power and Machinery is International and National research journals. He has also published 12 international papers, 42 national papers, 52 papers in other research journals and conducted/ participated in 72 national level seminars. He also has 98 popular articles and 37 teaching manuals/ extension bulletins and e-resources to his credit. He has been a Technical

Committee member in Mechanization Scheme of Department of Agriculture, Govt of Karnataka from 2006 to 2017, Krishi Yantra Dhare Scheme in Raichur district, SMAM Meeting from 2013 to 2017, for establishment of RFMSC (Rural Farm Machinery Service Centres) in Karnataka during 2016-17 and a member for preparation of technical specification for Farm Machinery Tender document from 2008 to 2017. He was also Principal Investigator of Farm Implements and Machinery (Mechanization scheme of ICAR) project from 1996 to 2017.