Project Title

Enhancing food security of rural families through production, processing, and value addition of regional staple food grains in India

IDRC Project Number 106314

Partner Research Institutions
McGill University, Bioresource Engineering Department - McGill
University of Agricultural Sciences Dharwad, Home and Food Science - UASD
M.S. Swaminathan Research Foundation – MSSRF

Third Party Partner Organization
Himalayan Environmental Studies and Conservation Organization - HESCO

Joint Technical Final Report : October 2010 – March 2013

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Abbreviations:

PVS, participatory variety selection
PDS system, public distribution system
SHG, self help groups

Location of Study:

Location map : Area of influence under programme in India

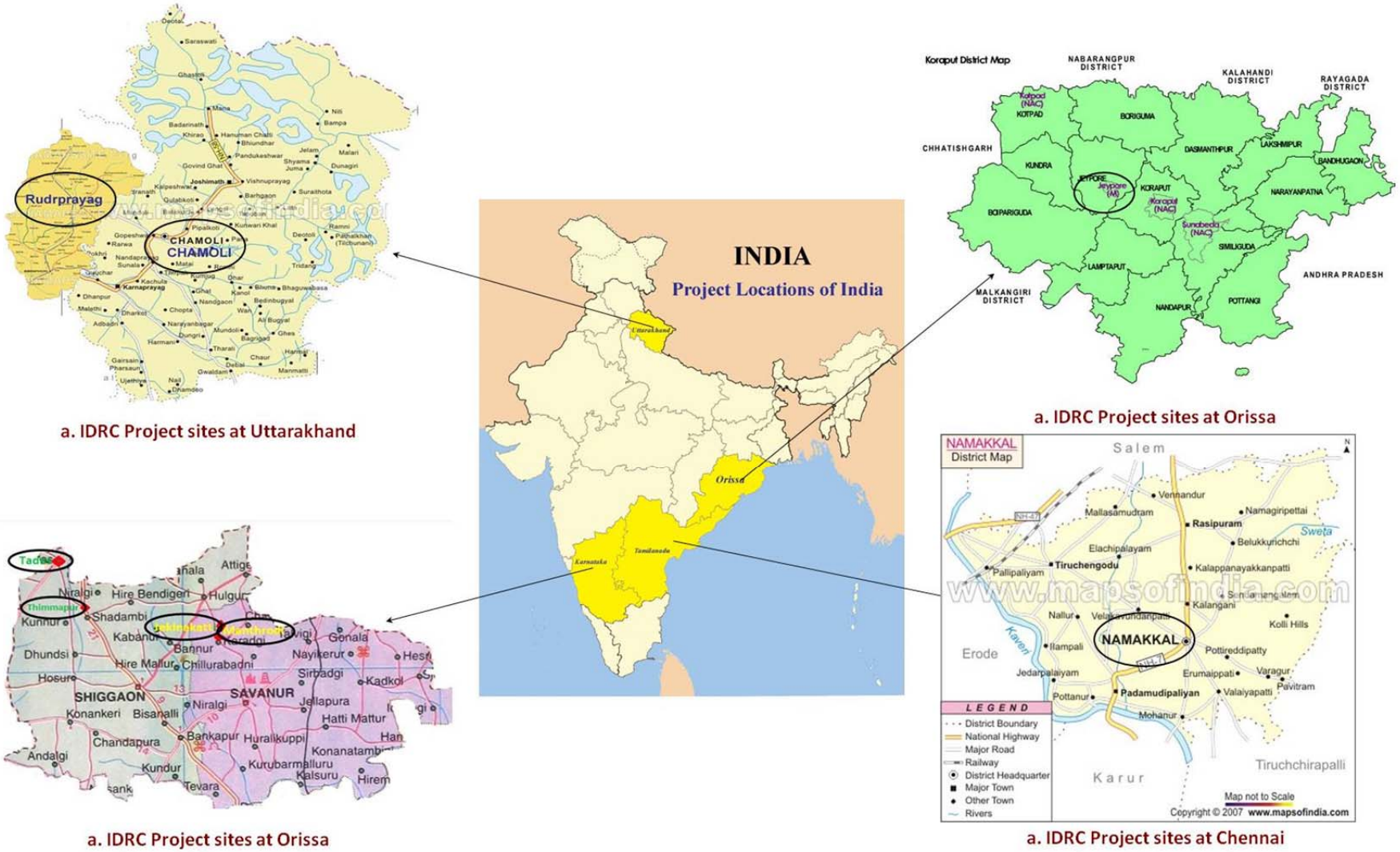


Fig I : IDRC Project sites in different states of India

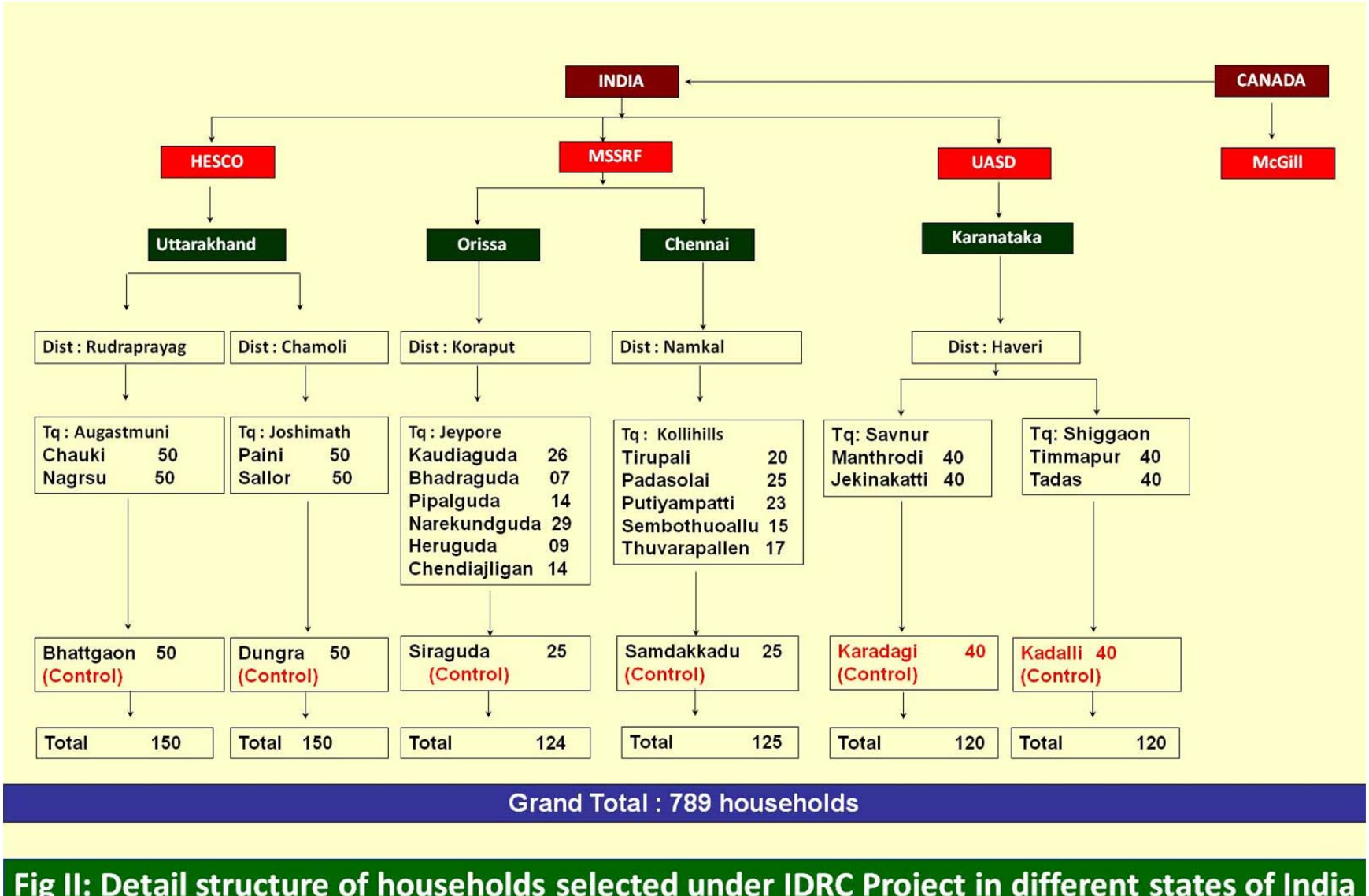


Fig II: Detail structure of households selected under IDRC Project in different states of India

Names of Researchers/Members of Research Teams: *Please refer to Annex 2 for the list of participants*

1. Executive Summary: October 2010-March 2013

Millets are one the most ancient crops, which were domesticated about 10000 years ago (Bagdia et al., 2011). They are important crops in semiarid and tropical regions of the world especially Africa and Asia (Nithya and Krishnamoorthy, 2006) because of their resistance to pests and diseases, their short growing season, adaptation to grow under hardy, drought and low fertile soils (Palanisamy Bruntha Devi et al., 2011). They are generally fast growing, early maturing grains, ready to harvest plant in as little as 65 days which can perform well in marginal environments (Chaturvedi et al., 2011). The small seeds have a long shelf life and can be stored for long period without insect damage, which makes them good reserves for famine-prone areas (Rengalakshmi 2005). Millets have an excellent nutritional profile with high vitamin levels especially B vitamins, niacin, B6, folic acid, pro-vitamin A, and micronutrients particularly calcium, iron, potassium, magnesium, copper and zinc (Obilana 2003). The mineral elements of millets, such as iron and calcium, are higher than in rice and wheat (Murugesan et al., 2012).

However, millet seeds have a seed coat which gives a darker color, chewy texture and musty odour (Shobana 2007). These characteristics reduce the applicability of millet in the food industry. The seed husk of millet is an excellent source of phytochemicals (polyphenols up to 3%) and dietary fiber (Palanisamy Bruntha Devi et al., 2011; Ramachandra et al. 1977). In addition, certain parts of the seed contain anti-nutritive compounds such as phytates (0.48%), polyphenols, tannins (0.61%), tripsin inhibitory factors, hydrochloric acid which require processing for the promotion of millets for nutritional and organoleptic acceptance (García-Estepa 1999; Jingju 2007; Shobana 2007; Bagdia et al., 2011).

This project had for objective to increase the productivity and consumption of minor millets for improved nutritional security, to reduce the drudgery of women in processing and harvesting and to enhance their income and social status. The local staple food grains targeted were the minor millets, found in all over India, represented largely by finger millet and to lesser extent by little millet, foxtail millet and their companion crops such as black gram, pigeon pea and grain amaranth in the hilly regions of the north of India. The project finalized its contribution agreements in October 2010 and had its inception workshop hosted by UAS-Dharwad between Dec 13-15th, 2010. All the Indian and McGill partners attended the workshop. Project activities started with identifying millet growing villages and the selection of interested farmers towards millet production in all project sites (Fig 1 and 2).

Interventions on increasing food security of households have components such as (1) increasing food availability and income through enhanced productivity and production of local staple food grains, (2) increasing income from value chain of these crops, (3) reducing the drudgery arising from certain traditional production and post-harvest operations and (4) influencing household nutrition through nutrition education. Strategies used for increasing productivity are (i) promotion of superior and quality seed, (ii) technology interventions to promote productivity and income (largely by agronomic practices modifications), and (iii) improved and drudgery free postharvest processing to achieve higher quality grain recovery and reduce the burden on the women labourer.

In Uttarakhand, four villages were selected, two from the Chamoli district (Saloor, Paini) and two villages from the Rudraprayag district (Chauki, Nagrasu), covering 157 volunteered families. In the first phase, men and women farmers were selected for participatory demonstration of improved seeds and production technology for enhancing productivity and increased food availability. Improved varieties of finger millet (VL-149, VL-146, VL-315), barnyard millet (PRJ-1 and VL-172) and grain Amaranth (PRA-3, VL-44 and Durga), along with their respective local varieties were distributed.

In Karnataka, four villages were selected along with 2 control villages of Haveri District in Karnataka state. Entry point activities were completed through organization of training programmes at the village level.

Productivity enhancement was attempted through a combination of participatory methods involving women and men farmers.

Eleven project villages were selected in Kundra (Koraput, Orissa) and Kolli Hills (Namakkal, Tamil Nadu) targeting to increase production and consumption of local staple food grains. Two villages in both locations were identified as no-intervention villages for comparing the impact of the projet's interventions.

The UASD centre organized interventions for improved agronomic practices . Pure and intercrop interventions were implemented in little millet. Comparative assessment of genotypes like CO(Sa)-4, OLM-203, JK-8 and local Mallige was made in four locations of the project area. The results of the large scale demonstration spread across Haveri district revealed on average about 19.1% increase in grain yield in CO (Sa)-4 over local cultivar followed by Sukshema (5.4%). Similarly, increase in fodder yield was to the tune of 60% and 15% in CO (Sa)-4and Sukshema respectively. In another demonstration, use of the recommended dose of fertilizers revealed that grain and fodder yields of little millet increased to an extent of 17.68% and 10.25% respectively. Following field demonstrations for adequate seed rates, it was revealed that the use of recommended seed rate (10kg/ha) resulted in 18.6% increase in grain yield and 9% increase in the fodder yield. Furthermore there was an increase in the net returns up to 61 to 76 % for intercropping systems over that of sole little millet.

In Tamil Nadu and Orissa, superior and quality seeds were promoted through farmer participatory variety selection (PVS) activities and the propagation/production of quality seeds of selected varieties among farmers was encouraged. Trials were conducted deploying 28 varieties of finger millet (9 improved and 9 traditional), seven varieties of little millet (3 improved and 4 traditional) and three varieties of foxtail millet (all traditional). This resulted in the selection of three best finger millet varieties, two and one such varieties of little millet and foxtail millet, respectively. The increased productivity potential of the best selected finger millet variety over the best traditional variety was around 50%. The project activities promoted new quality seed in conjunction with research interventions using an improved agronomic technique (intercropping) to increase productivity. These agro-techniques were demonstrated over two growing seasons in 2011 and 2012. The yield enhancement achieved in these trials over farmers' traditional practice using local varieties, on an average, ranged between 86% and 40 %.

With the encouraging response of the first year of this project, farmers automatically came forward during the second year, interested in benefiting from new technical inputs and practices. Women were highly motivated for the value addition of the products and for the development of new market linkages.

The drudgery associated with millet production and processing is often the burden of women. Hence it is interesting to note that women participation was over 60% in the project activities related to improved production and postharvest processing practices. Village level interactive discussions were organized on gender related concerns and accordingly interventions on drudgery reducing technologies during sowing, harvesting and processing were included and demonstrated to ease the labour intensive tasks of women. Drudgery reducing equipment were identified and demonstrated during production, post harvesting and value addition for millets in all project villages. The sowing equipment (line markers), seed-cum-fertilizer drill has substantially reduced the drudgery and time and has helped to maintain vigorous plant population. The inter-cultivation equipment, cycle weeder and double hoe weeder and konoweeder were found suitable and time-savers by the marginal farmers. An improved sickle for cutting of millet crop has substantially reduced the women drudgery especially in bending.

Based on the survey report of existing millet processing units and their constraints, McGill University took the challenge of designing a small scale dehulling unit. A first prototype for millet dehulling was built and tested in India, then further modified at McGill University in collaboration with UASD and technical guidance from SDM Engineering College (Sri Dharmasthala Manjunatheshwara), Dharwad. This small-scale machine was designed to run in single phase with ½ HP motor with a dehulling capacity of 5-6 kg per hour. One machine was installed at Timmapur for regular use and two machines were duplicated and supplied to project partners for evaluation. Multiple units are being manufactured locally on order.

Since the newly designed rubber roller mill uses shearing force rather than abrasive force, like in the emery mill, the bran remains on the grain which provides increased nutrition when compared to millet that has gone through the emery mill which ends up being polished providing less fiber and micronutrients which concentrate in the bran. While the de-hulled millet is not considered locally acceptable to be consumed as rice, since it remains a bit crunchy, there is a wide variety of products that can be made with the dehulled millet further processed into flour. Using the rubber roller mill to de-hull millet can help in improving the livelihoods and food security of rural families by freeing some time, by cleaning and availing more grain which can then be processed into value-added products which will provide ready to eat foods with improved nutrition (Chin & Orsat 2012).

Meanwhile local millers of Haveri District also showed interest in the modification of their existing emery mill to improve milling efficiency and reduce drudgery of cleaning of grains which is usually done by women. A millers' meet was organized to create an awareness of the need for adjustment of the emery clearing space for milling of millet with less breakage. Modification of the existing emery mill for clearance, size and attachment of blower improved the milling efficiency of head rice yield by 9% and reduced the drudgery of cleaning milled grain by 80%. This modified machine can also be popularized at village level for enhancing consumption of millet.

Totally 32 vermi-compost units were installed in the project villages of UASD, in Karnataka. 100 vermi-compost units were installed in the project villages in Uttarakhand, whereas 132 individual units (size of 8' or 10' x 3' x 3') and seven group units (each group units have 5 to 6 pits) were installed in the project villages of Orissa and Tamil Nadu. 71 % of the vermi-compost pit holders stated that it they found it to be an interesting activity. Almost all have used the compost for application as fertilizer to their own fields, and 50% per cent of them have used it for millet cultivation. Three unit holders have developed a small business this activity and have started selling the vermi-worms. Almost all have reduced the use of chemical fertilizer by 50 % while 25 % of them have stopped purchasing farm-yard manure.

Numerous women from all project sites underwent certificate training and skill-oriented training on the preparation of value added millet products (flatbreads, fried snacks, etc.). Specifically interested and trained women were exposed to larger scale production and marketing of value added millet products through participation in various exhibitions organized under the project. A large number of value added millet products were branded, labeled and released locally. A few of the developed food formulations, selected as per the site specificity and local preferences, are considered most suitable and have been adopted as profitable processed foods for the development of value-added businesses for women entrepreneurs.

For the promotion of value addition, two processing centers (common facility centre), one in Khemada and the other in Paini were established in Uttarakhand where all members of the associated women SHGs were trained on value addition and product development.

The establishment of three processing units (with primary processing units like de-stoning and grading machines) in three villages in Karnataka has given an opportunity to successfully promote entrepreneurial activities by providing start-up facilities and equipment. Women entrepreneurs have gained self confidence in enhancing the supply value chain and improving their family nutrition security by including value added millet products regularly (58.3%) and occasionally (41.7%) at the household level. Millet products were fetching 20-30 % profit even though the cost of millets was high. Over the duration of the project, in Karnataka alone, the women entrepreneurs have produced 1100 Kg of millet products and raised a profit of Rs 71,000. Statistics of the presence of these local processing units within 8 to 10 months duration have shown that there is an improvement in the consumption of millet by 7 and 13% per household in Manthrodi and Timmapur villages respectively.

A sale outlet in Kolli Hills is being managed by the Confederation of SHGs called Kolli Hills Agro-biodiversity Conservers' Federation, where all value added products are marketed. During the project period, the sales turnover of the various value added millet products represented a total value of Rs. 657 634.

In all the project villages, rural women were initially assessed for their nutrition knowledge, attitude and practice towards consumption of millets. Along with the women, school children were also tested for

their baseline nutrition knowledge. Later, millet nutrition information was provided to women and school children. At the end of the project an impact assessment was done in the target groups and it was observed that approximately 69 per cent of them are now including millets as value added products or staple food for consumption. The frequency of consumption of millet has increased in all project sites.

Millet processing research in the area of value addition has extended its scope to promote millets to become a mainstream food ingredient in health foods, snack, fermented breakfast food and bakery products. The research projects conducted at McGill and UASD have demonstrated that processing of millet has an advantage to extend the shelf life of grains along with improved nutritional benefits (digestibility and bioavailability of the nutrients). Processed millet can be formulated as therapeutic foods in designing health foods based on the specific functional properties of millet. Processed millet grain can be recommended for the PDS system (public distribution system) /school feeding programmes/hospital catering systems thanks to the grains' enhanced nutritional benefits.

The project also extended collaborative services in organizing workshops, symposium, demonstrations, lectures, and trainings to other institutions (Govt. and non Govt) with millet activities. This brought awareness to an additional 986 stakeholders (including 529 female and 457 male). The project activities and out puts were promoted through presentation in numerous workshops, symposium, annual and mid review meets, publications, broadcasted programmes in radio, telecasted in local TV Channels, published books in local languages and in English, released one international proceedings, several posters, blowups and folders, reported on case studies, photos and video documentation.

The completion of the project was marked by the organization of an International workshop on "Promoting small millets for improved rural economy and food security", which took place February 8-9th, 2013 in Dharwad, to share the knowledge and experience of millet research activities among the national stakeholders including scientists, NGO representatives, students, farmers, farm women, field level workers, who participated as delegates, technical speakers, poster presenters, members of interactive session with millet growers and as entrepreneurs in exhibition stalls. Around 200 delegates representing six states were present. 20 oral papers were presented in technical sessions along with 90 poster presentations.

Sustainable changes in production, processing, value addition and consumption practices were brought among stakeholders of project villages through the organization of: certificate trainings on value addition and seed production, production enhancing technologies, awareness and management of vermi-compost units to improve the soil fertility, introduction to drudgery reducing technologies, creation of grain cleaning and processing infrastructure facilities, demonstrations, and nutrition education. The identified outputs and outcomes were the localized empowerment of the trained men and women on production, processing and value-added marketing, increased productivity of millet with improved millet based cropping system and enhanced nutritional knowledge resulting into increased consumption for better health of the community.

References cited:

Bagdia A, B. G., Schmidtb J, Szatmária M, Schoenlechnerb R, Berghoferb E, Tömösközia S (2011). "Protein Characterization and Nutrient Composition of Hungarian Proso Millet Varieties and the Effect of Decortication." Acta Alimentaria 40(1): 128-141.

Beltona, P.S., and J.R.N. Taylor (2003). Sorghum and millets: protein sources for Africa. Trends in Food Science & Technology. 15: 94-98.

Chaturvedi et al. (2011). "Cereals Nutraceuticals, Health Ennoblement and Diseases Obviation: A Comprehensive Review." J. Applied Pharmaceutical Science 1(07): 06-12.

Chin, R and V. Orsat (2012). Optimization of a Rubber Roller Mill for Little Millets (Panicum sumatrense). NSERC-USRA Poster presentation, September 2012. McGill University.

García-Estepa RM, G.-H. E., García-Villanova B (1999). " Phytic acid content in milled cereal products and breads." Food Res. Int 32: 217–221.

Jingju NL, Z. C., Huiyuan Y, Ying X (2007). "Optimization of stress medium enhance hydroxyl radical inhibition by water-soluble protein from germinated millet." LWT – Fd Sci. Technol 40: 1630–1636.

Kumari, PL and S. Sumathi (2002) Effect of consumption of finger millet on hyperglycemia in non-insulin dependent diabetes mellitus (NIDDM) subjects. Plant Foods for Human Nutrition, 57(3-4):205-213.

Murugesan, R., V. Orsat, N. Yenagi and Bala Ravi (2012). Millet products for food security. Global Food Security Conference. October 2012, McGill University.

Nithya KS, R. B., Krishnamoorthy VV (2006). "Assessment of anti-nutritional factors, minerals and enzyme activities of the traditional (Co7) and hybrid (cohcu-8) pearl millet (Pennisetum glaucum) as influenced by different processing methods. J. App. Sci. 2(12): 1164-1168.

Obilana, A. (2003). "Overview: Importance of millets in Africa. -in: AFRIPRO Proceedings of workshop on the Proteins of Sorghum and Millets: Enhancing Nutritional and Functional Properties for Africa." Pretoria, South African Journal of Agricultural Research: 26–43.

Palanisamy Bruntha Devi, R. V., Sathyaseelan Sathyabama, Nagappa Gurusiddappa Malleshi, Venkatesan Brindha Priyadarisini (2011). "Health benefits of finger millet (Eleusine coracana L.) polyphenols and dietary fiber: a review." J Food Sci Technol.

Ramachandra, G., T. K. Virupaksha, et al. (1977). "Relation between tannin levels and in vitro protein digestibility in finger millet (Eleusine coracana Gaertn.)." J. Agricultural & Food Chemistry 25(5): 1101-1104.

Rengalakshmi, R. (2005). "Folk biological classification of minor millet species in Kolli Hills, India." Journal of Ethnobiology 25(1): 59-70.

Saleh, A.M.S., Q. Zhang, J. Chen and Q. Shen (2013). Millet Grains: Nutritional Quality, Processing, and Potential Health Benefits. Comprehensive reviews in food science and food safety.

Shobana S (2007). " Preparation and functional properties of decorticated finger millet (Eleusine coracana)." J. Food Engng 79: 529–538.

2. The Research Problem:

More than 35 % of the population in rural India suffers from poverty and malnutrition while around 60% of the Indian population lives in rural communities. India has the largest number of poor and malnourished people than any other country or even region in the world. The majority of the rural poor belong to the farming community constituted by the small and marginal farmers and landless agricultural labourers. The rural women and children bear the brunt of this economic deprivation. According to the UNDP, malnutrition and associated anaemia affect 79 % of children below the age of three, 56 % of women and 24 % of men. Despite this inequality and socio-economic disadvantage, rural poor women have to bear the double burden of earning a daily income and providing food and nutritional security to their family, at whatever level it may be possible. Several socio-economic studies on household consumption pattern and distributive equity of food within family have revealed that whenever the food supply is inadequate for reasons of low access or availability, there is no distributive equity for food within the family, the most affected being women and the female children. Agriculture is a major component of food security especially for rural women. To increase the availability of food worldwide, the approach of improving crop yields through cultivation practices and higher yielding cultivars may not be enough and rural communities have to recognize the importance of their food choice selections and the food processing that can make these foods widely available, affordable and nutritious.

Indian poverty and malnutrition are more rampant in regions of rain-fed agriculture, more particularly the arid and semi-arid, hilly and mountainous areas. The reach and penetration of modern production technologies are low and not readily welcomed due to cost and lack of skills. The natural resource base of this production system, soil, water and biodiversity, under continuous resource mining is getting heavily stretched.

Nonetheless, these regions compared with the irrigated region, have richer agro-biodiversity in terms of crop species, crop varieties and cropping systems. One important cropping system in the semi-arid, hilly and mountainous regions is based on small millets, legumes, and other under-utilized crops such as grain amaranth and oilseeds (Saleh et al., 2013). India grows six species of small millets on about 2 million ha, largely comprising fragile agricultural regions. These species are finger millet (*Elusine coracana*), little millet (*Panicum sumatrense*), Italian or foxtail millet (*Setaria italica*), barnyard millet (*Echinochloa crusgalli*), proso millet (*Panicum miliaceum*), and kodo millet (*Paspalum scrobiculatum*). Among these, finger millet takes the lead position, occupying 60 % of the area and contributing 70 % of production. The legumes associated with the small millet-based cropping system are pigeon pea (*Cajanus cajan*), horse gram (*Macrotyloma uniflorum*), Dolichos (*Lablab purpureus*), black gram (*Vigna mungo*), and green gram (*Vigna radiate*). Among these, the pigeon pea is more predominant. Grain amaranth (*Amaranth sp*) is cultivated in the higher elevations of mountain sides.

Prior to the Green Revolution, eight millets comprising pearl millet, sorghum and the six small millets used to occupy about 39 % of grain producing area and contributed 30 % to the total grain produced in India. Currently, their cultivation has declined to 18 % of the total food grain producing area with their share to the national grain pool shrinking to 15.5 %. These grains were traditionally the cheapest and more easily accessible to the poor and the initial reduction in millet production has had a phenomenal impact on the grain diversity and availability in the rural food basket, significantly affecting the food and nutritional security of the rural poor, particularly in agriculturally fragile regions (Beltona and Taylor 2003).

Owing to the recent government policies on grain production and distribution, the food basket in rural and urban India is getting increasingly filled with only two major grains, rice and wheat. Rice and/or wheat contribute 70-80% of daily energy to a majority of people. Millets, traditionally considered as an ideal food for agricultural/manual workers are missing, despite their food value and their recognized nutritional health benefits. Availability of rice and wheat through the public distribution system (PDS) at subsidized prices, which are lower than the farm gate prices of small millets, is reducing further the contribution of the latter. Also due to the non-availability of proper post-harvest processing technologies, small millets are looked down as inferior or as a poor man's food. Therefore, improved availability and processing of small millets should push for their re-introduction in to the local distribution system and the promotion of small millets will play an important role in augmenting the food and nutritional well-being of the poor in rain-fed, hilly and mountainous regions where they grow particularly well.

In these regions, farmers traditionally grow small millets in a cropping system that includes other crops, which are also notable for their hardiness to adverse agro-climatic conditions such as low soil fertility, monsoon rains, decreased precipitation and biotic stress. This is a traditional strategy to distribute the risk of unpredictable weather and potentially offer a great means to adapt to the changing climate. In their traditional regions, these crops present an impressive genetic variability for some of the components of climate resilience. Hence, in the context of climate change they have earned the name of "crops of the future". With the decline in cultivated area under these crops, their genetic diversity is at risk of being lost. In the era of climate change, their special adaptive traits are very valuable and this demands urgent intervention to stop and reverse the genetic erosion in the larger interest of humanity. Promotion of their cultivation and associated food culture and creating economic stake in their cultivation is the best way to conserve them. This project has aimed at local selection and promotion of improved and heritage cultivars.

The small millets, in comparison with rice and wheat, are known to have better nutritional profile (Beltona and Taylor 2003). This is notable for dietary nutrients such as protein quality due to the increased amount of essential amino acids, soluble fiber, minerals such as calcium, iron and phosphorus, and vitamins such as B complexes, niacin and folic acid. On account of this nutritional superiority, small millets have earned the title of "nutritious grains". They are widely recognized for their value in combating hidden hunger, particularly among the poor. They also possess certain nutraceutical or functional properties, which could be leveraged to create a portfolio of health foods. Grain amaranth is also an excellent source of high quality dietary protein with high potential for mitigating protein-calorie malnutrition at lower cost.

Thus these groups of under-utilized crops have a unique agro-climatic regime where they could be effectively leveraged for addressing local food and nutritional security with the methodologies, handling practices and processes to be developed during this project.

3. Progress towards milestones

During this reporting period (October 2010-March 2013), all project milestones have been completed:

- **The administrative set up of the project was established and is working effectively, while all the research staff and students have been recruited and assigned tasks:**

In all the project sites, a local administrative structure for the implementation of the project work was established and started working effectively from January 2011.

- **A gender specialist was hired to conduct the preliminary social and gender assessment**

Village level discussion meetings were organized on gender related concerns with UASD, HESCO and MSSRF and accordingly few interventions addressing social and gender issues were identified and integrated in the project activities. Interventions on drudgery reducing devices, labour intensive activities, post harvesting of millet for consumption and value addition were included to reduce physical drudgery, cost of production, income generation with value addition marketing and generation of employment to empower rural women.

- **Benchmark survey of grain processing technologies completed**

A survey of the existing technologies for the processing of millets was conducted and it directed subsequent activities to improve the existing emery mills and to design a new roller dehuller.

- **Benchmark survey on food and nutritional status of project villages, including controls, designed, pre-tested, conducted and analysed**

All project sites conducted a benchmark survey following a standardized questionnaire.

- **Inception workshop with all partners**

UASD hosted the Inception workshop during Dec 13-15th, 2010 where discussions took place and decisions were made on the administrative set-up for this project. All the Indian (UASD, MSSRF and HESCO) and McGill partners attended the workshop. The inception workshop report was duly submitted.

- **Project communication strategy finalised and outreach communication initiated**

The project communication strategy was discussed at the annual meeting in September 2011 in Orissa. Overall, it was agreed that all partners would make every effort to publicize the activities of the project to their fullest capacity in a variety of forms (pamphlets, poster, short communications, local newspaper, local radio, scientific print, etc.) in order to reach the widest audience possible. UASD took on the responsibility to launch a project website.

- **First joint technical progress report submitted by McGill to IDRC (at 7 months)**

First progress report was duly submitted at 7 months.

- **Cost effectiveness of different agronomic practices to be tested completed**

Different interventions in enhancing ragi, little millet and other minor grains planting area and production, increasing consumption, improvement in processing, value addition & scientific marketing were established are initiated and the cost effectiveness of the different activities were analysed.

- **Value added product and marketing strategies developed**

Undergraduate and Graduate students of McGill and UASD were selected and formulated their research proposals on value addition to millet for diversified utilization and commercialization. Some students visited collaborative international institutions and interacted with staff and students and conducted part of their research abroad.

- **Design and testing of grain processing machinery and progress made in improving their function**

Design considerations were streamlined for de-hulling equipment. Existing millet processing units have been evaluated for milling quality and their constraints which were considered while designing a centrifugal de-hulling equipment at UASD with McGill personnel in summer 2011.

- **Community level value addition units established and functioning effectively**

Production lines for preparation of few selected and popular value added products were established in all the centres.

- **Certificate training for women's self help groups in millet value addition by UAS-D and certificate training on quality seed production for farmers by MSSRF**

Certificate training courses were developed on value addition and seed production and were delivered to various target groups in all the project sites.

- **Improved grain processing equipment developed and first prototype tested in a village**

Two new prototypes of the millet dehuller (roller dehuller) were delivered at UASD in spring 2012. They have been tested at the University and in a Village setting by Ms. Rebecca Chin in summer 2012. The roller dehuller is being locally duplicated and sold on order.

- **Evaluation of local grains for thermal processing and industrial applications**

Studies of millet grains have been conducted to determine their nutritional and techno-functional properties in the research laboratories of McGill University and UASD.

- **Development of diversified novel millet-based products and their commercial potential assessed**

A variety of millet based products were developed, such as millet based breakfast muffin, fried snacks such as Chakali and Nippattu, traditional fried sweets, millet ladoo, papads and malts.

- **Evaluation of income generation and improvements in food and nutritional security against benchmark survey**

Study of income generation is presented briefly in the next section on synthesis of results. Further details can be found in the reports of each of the Indian partners in Appendices.

- **Production and dissemination of project outputs and results through a variety of media, including project website, policy briefs and fact sheets for decision-makers, researchers, practitioners and the media in India/South Asia and Canada**

Project website was created by UASD and is being fed by all project members.

- **Publication of joint, peer-reviewed papers in relevant technical and policy journals with outreach in India/South Asia and Canada**

Presentations were made and will be made in various venues. Publications have been prepared and are submitted for publication consideration.

- **Research work at McGill**

Ms. Deepa Madalgeri (UASD student) worked in summer 2011 on millet substitution in paddu.
Ms. Mamata Manuramath (UASD student) completed research work at McGill in summer 2012 on little millet substitution in bread.
Ms. Kim Singson (UASD student) conducted research work at McGill in summer 2012 on millet substitution in chakli.
Ms. Uma Ballolli (UASD student) conducted research work at McGill in summer 2012 on foxtail millet substitution in bread.
Ms. Veeda Padamsi (McGill student) conducted research work at McGill University with Ms. Deepa Madalgeri (UASD student) in summer 2011 on millet substitution in paddu.
Mr. Ramesh Murugesan (McGill student) is pursuing his PhD research work on minor millets substitution in bakery products.
Mr. Siddhartha Joshi (McGill student) is completing his MSc research work on oil extraction from grain amaranth.
Ms. Priyanka Kapoor (McGill student) is completing her MSc research work on little millet popping and its effect on nutritional and techno-functional properties.
Ms. Sara Najdi Hejazi (McGill student) is continuing her PhD research work on malting and fermenting of finger millet and grain amaranth.

- **Production and sharing of project results in local languages (four states in India) and in accessible format for neo-literate rural population**

Pamphlets, display, brochures have been prepared by all partners in India in English and local languages.

- **October 2012 to March 2013 milestones since the Project was extended to 30 months from the commencement date of October 1, 2010**

UASD developed a questionnaire for the impact assessment of production, PVS, drudgery reduction analysis and value addition, nutrition and food security. This was circulated among project partners for feedback and later for implementation (Dec 2012-March 2013). Gender impact analysis of the project was evaluated from all the project villages and control villages along with the participatory assessment of cost benefit aspect of interventions in different cropping systems and evaluation of drudgery in agricultural operations (harvesting and threshing).

The millet dehuller design was given to one of the manufacturers at Belgaum for multiplication. Till now four machines have been duplicated. Two machines were installed at project

villages for evaluation and farmers feedback. Two machines were distributed to project partners for testing with other millets. Getting the similar type of rubber for the rollers as those supplied by McGill was one of the major hurdles in multiplying the machine (McGill supplied additional rollers which were delivered in India in June to complete the current orders for the roller-dehuller).

4. Synthesis of research activities and results

This research project was implemented in: Jeypore of Odisha (Orissa) covering 243 tribal households; Kolli Hills of Tamil Nadu covering 345 tribal households; Manthrodi, Timmapur, Jekinakati and Tadas in Karnataka covering 240 households; and Nagrasu, Chauki, Paini and Sallor in Uttarakhand covering 300 households.

Thematic Area 1: Benchmarking of status

The impact assessment survey was conducted this winter 2013 and results are integrated in the report for the activity specific thematic areas that follow.

Thematic Area 2: Research and Development for productivity enhancement

The project areas in Karnataka received very different rainfall in both testing periods. Field demonstrations were carried out in the farmers' fields of selected villages during the *kharif* seasons of 2011 and 2012. Monthly mean rainfall in both the Taluks during the experimental year 2011 and 2012 was monitored. In Savanur Taluk, about 575 mm of rainfall was received from April to October 2011, against 338 mm in 2012. There was a shortfall of 58.73 % of rainfall in 2012 in Savanur taluk. Similarly, there was a reduction of 177 mm rainfall in 2012 in Shiggaon Taluk. The crop season in both locations was better in 2011 compared to 2012 due to reduced rainfall in 2012.

Description of millet varieties selected

In Karnataka, the participatory rural appraisal showed that the main considerations for the little millet growing farmers were grain and fodder yields. Based on grain yield, the cultivar Sukshema was found significantly superior to all other tested cultivar. This variety was preferred by the farmers because of its relatively early maturity (85 days), high tillering, non-lodging and drought tolerance. Pre- and post-harvest group discussions with farmers, considered some of the important characteristics such as crop duration, ear-head type and size, disease resistance, drought tolerance and grain and fodder yields, revealed that the little millet cultivars Sukshema and CO (Sa)4 were found to be closest to the farmers' choice and requirements. The farmers of the test villages were satisfied with the performance of these varieties and were keen to plant more area under these varieties in the ensuing crop season. For each demonstration, the farmers were given 4 kg seeds of improved variety and were asked to grow selected variety along with local variety in an area of 0.8 ha (improved and local variety) by adopting prevailing cultivation practices. Regular visits were made during the crop growth period to have continuous interaction with the farmers.

<u>Varietal preferences</u>

For little millet, grain chaffiness was least noticed in 'Sukshema' (5%) and was maximum with local 'Mallige' cultivar. Further, the weight of 1000 grains was moderate in 'Sukshema' (2.72 g) in

comparison with other genotypes such as local (2.87 g), CO (Sa)-4 (2.65 g) and JK-8 (2.26 g). The per cent immature grains were least (5.5%) in local, while it was maximum in CO (Sa)-4 (15.7 %). In whole grains the farmers/farm women preferred local variety (M*allige)* followed by Sukshema and then CO (SA)-4. Among decorticated rice the farmers best ranked Sukshema followed by CO (SA)-4 and then local variety. The Sukshema variety maintains full grain (rice) and the percentage of broken is much less. With regard to the cooked millet rice, the farmers ranked Sukshema first followed by CO (SA)-4 and local variety. It was agreed that the texture, taste and appearance of Sukshema and CO (SA)-4 varieties were very good. The local variety tastes bland whereas the CO (SA)-4 variety taste is sweet and the Sukshema variety rice is softer with good flavour.

Participatory varietal selection in Kundra and Kolli Hills was conducted in 2011 and 2012 to facilitate and demonstrate to farmers the choice of millet varieties available to them targeting increasing productivity, improved culinary property and other agronomic attributes of local importance. For this purpose, 12 finger millet varieties, 5 little millet varieties and 3 Italian millet varieties (total 20) including local varieties (four finger millet and three each varieties of little and Italian millets) were selected for the trials. At the stage when all the varieties were at maturity farmers were required to select best two varieties of finger and little millets and one best variety of Italian millet from each replication. At the end of the selection, each farmer was quizzed on why he/she selected the specific varieties. The reasons most farmers mentioned for their selection were better panicle size, larger panicles and high estimated yield. Based on two years results, finger millet variety GPU 28 was far superior than the rest and the second best comprised of three varieties including a local variety followed by GPU 67 and MR 6.

Participatory interventions for productivity enhancement

The participatory demonstrations were conducted for sole cropping and intercropping.

Sole cropping (**2011 & 2012)**

Among the genotypes tested during *kharif* 2011 & 2012, CO(SA)-4 performed better in both grain and fodder yield compared to other cultivars including local cultivar *Mallige*. Averaging over both years, CO(SA)-4 recorded 19 and 60% increase in grain and fodder yield over the local variety (Table 1).

Table 1: Mean grain yield of little millet genotypes (2011 and 2012)

Cultivar	Grain yield (q ha^{-1}) across locations		Mean Yield	% increase in yield over local	Fodder Yield (t ha^{-1})		Mean Yield	% increase in yield over local
	2011	2012			2011	2012		
CO(SA)-4	22.0	18.44	20.22	19.1	12.52	19.25	15.90	55.9
Sukshema	20.1	15.68	17.90	5.4	6.41	17.06	11.74	15.1
Local	19.8	14.16	16.98	-	8.80	11.59	10.20	-
JK-8	14.2	-	14.20	-28.3	4.76	-	4.76	-46.0

The analysis on the economics of sole cropping of little millet varieties indicated that the variety CO (SA)-4 had a higher B:C ratio of 4.66 and 5.04 in 2011 and 2012 respectively (Table 2). This was followed by Sukshema (4.06 and 4.48 in 2011 and 2012 respectively).

Table 2: Gross returns (Rs./ha), net returns (Rs./ha) and B:C ratio of sole-cropping (2011 & 2012).

Little millet varieties	Economics							
	Gross returns (Rs./ha)		Cost of cultivation (Rs./ha)		Net returns (Rs./ha)		B:C ratio	
	2011	2012	2011	2012	2011	2012	2011	2012
CO(SA)-4	45860	54151	9850	10750	36010	43401	4.66	5.04
Sukshema	39385	46162	9700	10300	29685	35862	4.06	4.48
Local	38044	39779	9500	10300	28544	29479	4.00	3.86

Market price : Grains Rs. 1800/q, (2011) and Rs. 2400/q (2012); Straw: Rs. 500/t

Intercropping **(2011 & 2012)**

In both 2011 and 2012, the intercropping of popular variety Sukshema with pigeon pea increased the overall yield of production over monocropping (Table 3) and thus should be encouraged.

Table 3: Grain yield (q/ha) and straw yield (t/ha) of little millet as influenced by intercropping.

Treatments	2011				2012			
	Grain yield (q/ha)		Fodder/Straw yield (t/ha)		Grain yield (q/ha)		Fodder/Straw yield (t/ha)	
	Little millet	P.pea	Little millet	P.pea	Little millet	P.pea	Little millet	P.pea
T_1-Demon-stration (4:2)	12.12	3.04	5.88	0.85	10.50	2.30	5.6	0.80
T2-(Sole crop)	11.21	-	5.35	-	9.25	-	6.0	-

Intercropping of little millet Sukshema with pigeon pea recorded higher little millet grain equivalent yield and higher net returns over sole cropping of little millet (Table 4).

Table 4: Assessment of economics [gross returns Rs./ha), net returns (Rs./ha) and B:C ratio] as influenced by intercropping of little millet with pigeon pea in 4:2 row proportion.

Practices	Little millet grain equivalent yield (q/ha)		Economics							
			Gross returns (Rs./ha)		Cost of cultivation (Rs./ha)		Net returns (Rs./ha)		B:C ratio	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
T_1 - Demonstration	16.51	13.18	29720	31632	11500	11750	18220	19882	2.58	2.69
T_2–Farmers practice	11.21	9.25	20178	22200	9850	9850	10328	12350	2.05	2.25
% increase over check	47.28	42.48					76.41	60.98		

Market price during 2011 : Grains 1) Little millet Rs. 1800/q, 2) pigeon pea Rs. 2600/q
Market price during 2012 : Grains 1) Little millet Rs. 2400/q, 2) pigeon pea Rs. 2800/q

Part of the productivity enhancement of crops is linked with the adoption of improved varieties. As the spread of high yielding varieties has been limited in little millet, the true genetic potential available in high yielding varieties has not been exploited. Hence, large scale demonstration has been conducted to demonstrate the full potential of selected variety “Sukshema” in project

villages by adopting improved sustainable agronomic practices such as the use of balanced fertilizer doses, the use of biofertilizers and the use of proper seed rate.

Following studies of the soil fertility at representative villages, UAS Dharwad has made a general recommendation of application of 30:15:15 N:P:K for little millet. However, the farmers are not adapting this recommendation, either by disinterest or ignorance. The present intervention was planned with the objective of motivating the farmers to adopt balanced use of fertilizers. To achieve this, in the identified farmers' fields the adequate fertilizers were distributed. The results of the field demonstrations indicated that the average yield of little millet was increased by up to 17.68 %.

Farmers in the project villages were using higher seed rates (between 20 and 25 kg ha^{-1}) than the UAS Dharwad recommended seed rate of 10 kg ha^{-1}. Higher seed rates were preferred by the farmers for obtaining more fodder (Table 5).

Table 5: Performance of recommended seed rate versus Farmer's seed rate in sixteen farmer's fields.

N=16	Average yield		% yield increase
	Recommended seed rate (10 kg ha^{-1})	Farmers' seed rate (20-25 kg ha^{-1})	
Grain yield (q ha^{-1})	18.50	15.60	+18.60 %
Fodder yield (t ha^{-1})	12.80	14.00	- 9.00 %

It was observed that the overall grain yield was higher to an extent of 18.6 % with recommended seed rate while the decrease in fodder was acceptable.

Yield enhancement in Kundra and Kolli Hills

A total of 295 farmer participatory demonstrations took place, comprising of 136 demonstrations in Kundra and 159 in Kolli Hills. The plots were separated in millet monocropping or millet intercropping with black gram, pigeon pea and tapioca under controlled treatments. These treatments were traditional varieties grown with traditional or farmers' practices and improved seeds grown with improved agronomic practices. Improved practices included optimum seed rate, row planting instead of broadcast sowing, modest application of farmyard manure and fertilizers and weeding with intercultivation using semi-mechanized konoweeder.

The grain yield across these demonstrations varied both in the improved practice and farmers' practice due to variable management followed by each farmer. However, over all, in all cases, the improved agronomic practices led to higher grain yield, significantly higher than the farmers' practice. For example i n Kolli Hills, the mean yield from improved practice of mono crop was 16.37q/ha, while the mean yield from farmers' practice was 13.60q/ha. In case of intercrop with other pulses, mean yield of improved method was 15.88q/ha, while the mean yield from farmers' practice was 13.33q/ha. This represented 20 % increase in yield under improved practice vis-à-vis the farmers' practice. Yield improvements in Kundra are presented in figure 3.

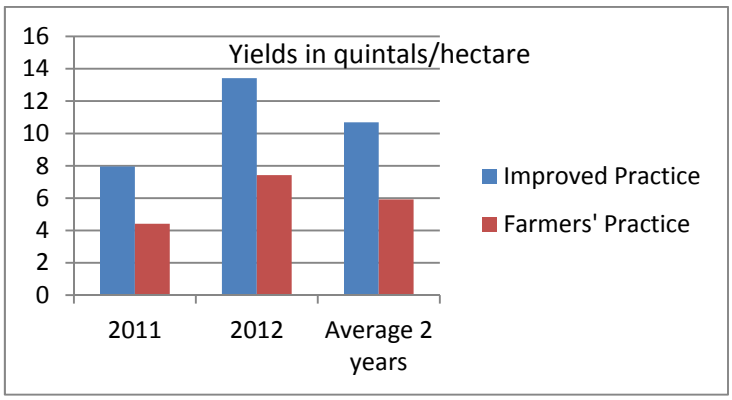


Figure 3: Yield of monocrops following improved or farmers' practices (yield in quintal/hectare) for Kundra.

While the farmers' practice offered a marginal profit of Rs 4976 /ha with a wide range of reported results for all farmers, including a few farmers reporting a loss, the profit from the improved practice was estimated at an average Rs 6712/ha. This represented 25.87 % increase in return under improved practice vis-à-vis the farmers' practice.

In Uttarakhand, the selected millet varieties were sown, leveling off the field for better and uniform irrigation, seed treatment, application of compost, better crop management with row planting, optimum seed rate, better application of farm yard manure, regular thinning and weeding were major improved practices. In Chauki, the productivity of improved varieties of finger millet was found to be almost three times better than the local variety. The improved varieties VL 149, 315 and 146 had a significant improvement in grain and straw yield, further improvements were obtained with adequate seed treatments, line sowing and timely weeding. For the barnyard millet trials in Nagrasu, the yield increased from 9.6 to 12.0 q/ha in local varieties whereas the improved varieties PRJ 1 and VL 172 significantly produced higher yield with 25.12 and 21.03 q/ha respectively. At the same time, with line sowing, the plants got proper nutrition and air, resulting in a straw yield increase from 30 q/ha to 70 q/ha. The increased straw yield is appreciated for animal feed (which benefits the family with increased dairy production). Similar increased yields were obtained in the other villages for other millet trials (finger millet and grain amaranth) following the adoption of improved cultivars and improved agronomic practices.

Seed production

Quality seeds of improved varieties along with other production inputs (such as fertilizers) enhance the productivity of small millets. The farmers are using seeds saved from the crop they had grown during the preceding season and currently there is little organized system in place for seed production and supply of improved varieties.

In view of the extreme shortage of millet seeds and the somewhat poor quality of seeds being used, production and supply of quality seeds were identified as an important project activity for increasing productivity. This activity involved the training of farm women and men on quality seed production including practical lessons on variety characteristics, rouging in each variety, and handling of seed during harvest, threshing, drying and storage.

A seed production programme of Sukshema CO(Sa)4 and JK-8 was organized in nine farmers' fields in Karnataka. About 80 quintals of CO(Sa)4 truthful seeds were made available for ensuing

season and about 200 quintals of certified and truthful label seeds were made available for further distribution by UASD.

Establishment of Community gene-seed-grain bank:

To conserve these important nutritious small millets, quality seeds should be available to all farmers. For this purpose, six community seed banks were established in Kolli Hills and Kundra. It will help farmers to access quality seeds for cultivation. The local women self-help groups and farmers' club members will hold the responsibility of managing the seed bank. All local landraces and selected improved varieties were made available through the seed bank.

Vermi-compost

With a view to enhance the productivity of the millet crops and to provide economic benefits to the farmers, 32 pits were installed in the four project villages of UASD. Prior to the installation of the pits the farmers/farm women were invited to visit an organic farm for a demonstration of a vermi-compost pit. Later the farmers voluntarily came forward to get a pit installed at their place. A total of 16 pits were installed in all the four project villages during the first year while during the second year another 16 pits were installed. The farmers were given training in the preparation of the vermi-compost. And now the farmers are harvesting the compost and are using it for the cultivation of their own fields.

An impact assessment was carried out to collect data on the average production of compost, its utilization, its benefits and overall feedback from the beneficiaries of the vermi-compost pits. The preparation of the vermi-compost is the equal responsibility of both men and women and around 71% of them agreed that the preparation of vermi-compost is an interesting activity and it consumes less than ½ hr of time per intervention. It was interesting to note that 99% percent of the farmers have utilized the compost for their own fields. Around 50% of them have applied it for little millet crop, followed by 34% of them have used it for mango plantations, flowering plants and coconut plantation and around 25% of them have also used it for maize and groundnut crops. Some of the beneficiaries are selling the worms at the rate of 200 Rs per kg at the nearby market. Regarding the overall benefits of the vermi-compost around 90% of them have reduced the use of chemical fertilizer by 50 to 70% and 25% of them have completely stopped using the farm yard manure which is a saving of around Rs 1100.

In Kundra, farmers preferred group vermi-compost systems due to shortage of water during the dry period of year, while Kolli Hill famers preferred individual compost units. Accordingly, 132 individual units (size 8' or 10' x 3' x 3') of compost and seven group units (each group units having 5 to 6 pits of mentioned sizes in cluster) were constructed in Kolli Hills and Kundra, respectively. All farmers are harvesting the compost and are mostly using it for their own cultivation needs. To date about 8352 kg of compost has been harvested and used for different crops.

In the selected villages of Uttarakhand, 100 vermi-compost systems have been constructed among all adopted villages followed by the training of farmers on composting practices. Major improvements are seen in the productivity of all the millet crops for which the compost is used as a soil fertilizer.

The farmers from all project sites have agreed that the production and use of vermi-compost has a great impact in terms of cost saving and maintenance of soil fertility and plant productivity.

Thematic Area 3: Reduction of drudgery

Majority of agricultural operations in India are carried out manually and in certain areas with the use of bullocks. Tractor and machineries are used mostly during land preparation and threshing of the crop. The benchmark study conducted in the project villages revealed that women participate in over 60 per cent of the activity related to production and postharvest crop handling. Most of the practices carried out by women involve labour, time and drudgery (bending and repetitive movements). Hence the issue of drudgery and gender mainstreaming was addressed with the help of a gender consultant, Dr. Nitya Rao who visited the project sites and made recommendations, such as the need to focus on drudgery related interventions to save women labour time.

Table 6: Drudgery from farm work & suggested solutions

Sl.No	Area/Field	Drudgery	Suggestion
1.	Sowing operation	Women are strained to place the seeds and apply fertilizer in bending posture	Seed cum fertilizer drill to reduce the labour time/strain.
2.	Inter cultivation	Bullock drawn implement covering one row at time require more time and energy to women	Inter cultivation hoe Variable size spades
3.	Weeding	Done manually by women in a squatting posture which is strain full.	Cycle weeder Double hoe weeder Konoweeder
4.	Crop cutting	Solely done by women with traditional sickle resulting in more stress on hands and back	Improved sickle with extended arm and serrated cutting edges
5.	Sieving and winnowing of harvested produce	Traditionally done on the road side/yard resulting in contamination by foreign material and microbial load. More strenuous to subsequently clean	Use of tarpaulin to reduce the cleaning and separation of foreign material. Tarpaulin has multiple use of protecting grains and fodder from dirt/sand
6.	Post harvest Processing	Done manually by separating the stones, then by hand pounding and winnowing	Processing equipment including destoner, grader for cleaning , emery mill and roller dehulling

In the benchmark assessment, it was observed that women devoted 1/3rd of their time to agricultural production, while 2/3rd of their time was devoted to family maintenance. Women were found to influence purchase and crop selection but in general they did not have control and access to the marketing of the produce. Based on the analysis, it was planned to introduce interventions that would help reduce women labour time and drudgery in production and postharvest processing activities. As there was no equipment specifically available for small millet crops, suitable equipment/tools available with research institutes/ private firms were selected and modified to suit a variety of millet crops and the equipment/tools were demonstrated in the project villages.

Field drudgery reduction: Sowing operation

In the conventional method of sowing little millet, the seeds are sown by standard drill with a separate application of fertilizers. A labour and time saving device, a seed cum fertilizer drill was demonstrated to farming groups. This enabled the adoption of different row spacings so as to maintain optimum plant population and production. In order to reduce the drudgery from weeding in the field, it is required to plant the millet in rows.

Inter cultivation and weeding operations

The project introduced cycle weeder, double hoe weeder and konoweeder equipment to benefit small and marginal farmers in inter cultivation and weeding operations. The men and women were trained on using the new equipment which significantly reduced back breaking drudgery.

Weeding in tapioca fields is done by women using a spade, which is about 9 cm wide. Introduction of finger millet between rows of tapioca caused problems to women in using the wide spade for weeding. This was addressed by the project by modifying the spade width to about 6 cm.

Harvesting/ crop cutting equipment

Another important drudgery, related to crop production, is the harvesting of little millet. Around 80 per cent of the harvesting activity is carried out by women. Farm women use locally made sickles. The project demonstrated improved sickles for cutting the little millet crop. The sickles were tested with farm women during harvest. The immediate response of the farm women was that the sickle reduced the drudgery of bending.

Primary processing of little millet (Cleaning and grading)

Cleaning and de-stoning of the millets has traditionally been practiced manually by the women, causing time drudgery. Mechanized destoner and grader machines were demonstrated at project villages. This was conveniently accepted and used by the farming community.

Threshers were procured from VPKAS Almora and feasibility trials were undertaken. The threshers were effective at separation, unfortunately it fractionated the straw into very small pieces. The small straw pieces are acceptable in the Uttarakhand region but found unacceptable in Karnataka.

Secondary processing of little millet grains (Dehulling)

Secondary processing involves the decortication of little millet for consumption which is traditionally done by women through hand pounding and stone grinding. Emery mills have been introduced in the past for the preparation of millet rice, which is a mixture of hull, broken and flour. Milling efficiency was in general not good and for this purpose modified emery mill use were introduced for dehulling operation.

Roller dehuller

Existing mills include the traditional stone mill and the emery mill both of which can result in a significant amount of broken grains which is undesirable. These existing mills also entail a lot of drudgery for the women who further clean the de-hulled grain from the hulls. In response to these concerns, a centrifugal mill was designed and prototyped in Dharwad, India in 2011. The mill was then re-configured in Montreal, Canada in 2011-2012 to use rubber rollers which resulted in fewer broken grains as compared to the centrifugal mill (Figure 4). The original centrifugal portion was therefore used as a fan as a means to separate the cleaned grain from the hulls which decreases women's drudgery associated with cleaning the grains.

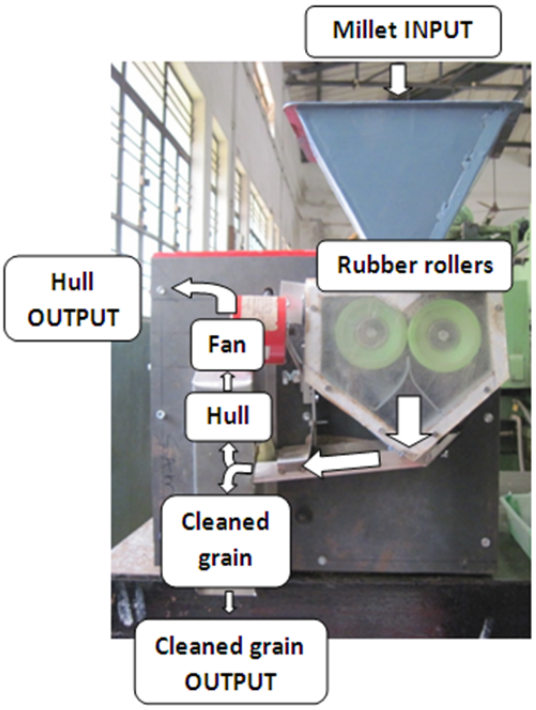


Figure 4: Roller dehuller designed at McGill University

The efficiency of the rubber roller mill is 99% and is advantageous as compared to the currently used emery mill since the former doesn't cause as many broken grains as the latter. The rubber roller mill has been shown to decrease women's drudgery by eliminating the time required for winnowing since it separates the de-hulled grain from the hulls.

The rubber roller mill has a capacity of about 6kg/h which is adequate for village use at the household level. The rubber roller mill with 0.5HP motor is more appropriate and accessible for household level use than the electric powered emery mill since the former uses single-phase electrical power, while the latter uses 3-phase electrical power which is not standard at the household level and also costs more per kWh of electricity, making the cost of operation cheaper for the rubber roller mill.

Since the rubber roller mill uses shearing force rather than abrasive force like in the emery mill, the bran remains on the grain which provides increased nutrition as compared to the millet that has gone through the emery mill. While the de-hulled millet is not acceptable as rice (consumers do not like its harder texture), there is a wide variety of products that can be made using the millet as a flour. Using the rubber roller mill to de-hull millet can help in improving the livelihoods and food security of rural families through value-added products and improved nutrition.

Flour mill

The project staff from MSSRF identified small electrically operated flour mills for drudgery free grain processing into flour. Seven flour mills were procured and distributed; four to four villages in Kundra (Bhadraguda, Chendiajhilligaon, Narakenduguda and Siraguda) and three to three villages in Kolli Hills (Thiruppuli Oorupuram, Sembuthuvalavu and Sundakkad). The respective farming communities of these villages donated land to house the mill shed and jointly constructed the shed structure including providing its electrification. Two persons volunteering from each village to

operate the mills were trained on the mill operation, regular maintenance and account keeping. These mills created considerable interest among the whole village community, in particular the women, because of their great contribution to their food processing operation. The management of these mills is entrusted to the women self help groups (SHGs). They are levying milling charges on every quantity processed and the monthly proceeds are used to meet the electrical cost and charges to the mill operator. Where ever, there is collection in excess of the mentioned expenses, the saving is mobilized to the fund of the SHG. The SHG is responsible for maintenance of the mill including replacement of components.

Impact of drudgery reducing methods:

Weeders

The inter cultivation/weeding equipment were tested by many farmers in their millet fields. The results indicated that the developed weeders were found to be most suitable for marginal farmers as the initial investment is very low (Rs 1200-1600) when compared with the traditional hoe (Rs 60000). Furthermore, the farmers agreed that the crop is less damaged with the use of these tools compared to the inter cultivation operation using bullocks.

Improved sickle for harvesting of little millet crop

The improved sickles were experimented in the fields of 14 millet growing farmers. It was observed that the improved sickle was found to be most effective among the older age (>50yrs) and younger age (<35 yrs) women workers with noticeable increase in productivity.

Processing centre: Destoner/ Grader and Electric Powered Emery mill

The processing devices such as de-stoner, grader and de-hulling machines were found to be highly efficient and drudgery reducing methods compared to traditional methods of processing. The results highlighted that the processing machines, de-stoner and grader required less time for cleaning and de-stoning i.e. 0.8 hrs as compared to 18 hrs per 100 kg grains in case of traditional methods, which means a saving of 2.15 man days per 100 kg of grains (Table 7). Similarly milling with the electric powered emery mill reduced time to 1.7 hrs per 100 kg with saving of man days of 6.03 per 100 kg. There has been substantial reduction in processing cost (Rs. 200 to 25 per 100 kg grains) for grading and de-stoning as well as de-hulling (Rs. 150 to 2 per 100 kg grains).

These improved methods have resulted in increased consumption due to easier access and ease of operation, as well as low cost in processing of grains which otherwise would have involved more time and drudgery. The processing units are also being used for other grains and the service has attracted nearby villagers who are now also taking advantage of the processing units (Table 8).

Table 7 : Efficiency of processing machines in comparison with traditional method

Activities	Time/quintal (in hrs)		Difference in time	Cost (in Rs.)		Drudgery	
	Tradi-tional	Improved method		Tradi-tional	Improved	Traditional method	Improved method
De-stoner	18	0.5	17.2 hrs (2.15 man days)	200	25	High	No
Grader		0.3			25	High	No
Hulling	50	1.7	48.3 hrs (6.03 man days)	150	02	High	No

Table 8: Impact of installation of de-stoning and grading machine in project villages

Particulars	Manthrodi	Timmapur	Use of machine by surrounding villages
Date of installation	9th July 2012	12th February 2012	
# households	450	420	
Evaluation of usage of Machine	9th July 2012- 4th March 2013	8th November 2012 - 17th January 2013	
No. of households	56	30	25 (10 villages)
% households using the machine	13.33%	6.67%	
Quantity used in the machine (kg)	3 to 100	2.5 to 200	
Quantity grains cleaned(kg)	559	1135	
Millet cleaned, decorticated and milled (kg)	549	2077	
Type of millets	Little millet, Foxtail millet, Ragi,	Little millet, Foxtail millet, Ragi,	
Other grains used for cleaning	Jowar, Red gram, Horse gram, Niger seeds, sunflower seeds, wheat		

The recovery of head rice yield of little millet in existing emery flour mill was 65% with admixture of husk and flour. Modification of the machine for clearance size and attachment of blower improved the milling efficiency of head rice yield by 9% with reduced mixture of husk and flour. It also reduced the drudgery of cleaning the milled grains by 80%. The study reveals that the existing electric powered emery flour mill can be popularized for little millet with the attachment of blower for yield of ready to use little millet rice. This may enhance the consumption of little millet by the farming community.

Thematic Area 4: Value Chain

Extension of women centric farm to market linkage was adopted with the objective of building a value chain based on local crops and empowering rural women for economic security through home based food processing activities. Women are home makers, feed the family and dedicate their life to the welfare of the family. Since women know the art of cooking, this character was focused on to strengthen and explore their skills for commercial enterprise. Introduction of food processing units encouraged women for active participation in processing, value addition and marketing.

Training lectures and demonstrations on importance of millets in foods, processing, value addition, standard recipe preparation, large scale production, maintenance of personal and environmental hygiene and food safety for quality production, packaging, nutrition labeling, pricing and marketing aspects were covered.

From the UASD training, 23 millet products were standardized. All twenty three standardized millet products have been marketed/ introduced to market under the brand name 'Samvardhika'. Suitable, attractive and eco-friendly packaging materials such as cotton bag and card boxes have been designed with nutrition labelling along with their health benefits and multiplied (decorticated little millet rice, little millet based –chakli, nippattu, khara papad, palak tomato, tomato papad, foxtail millet based hurakki holige and besan laddu and finger millet based malt and papad).

Attractive and informative detachable mobile marketing stalls were developed and provided to the women entrepreneurs to install in fairs, exhibitions, near schools premises, bus stands and market venues for the display and commercialization of their food products.

Following the standardization of specific recipe preparations and their larger scale production, per day profit analysis for each product was done. The results showed that one woman entrepreneur can earn a profit between Rs. 80-400 from storable products and between Rs. 485- 1775 from fresh foods apart from her wages and providing employment to one more woman. Food processing units were established in three project villages of Timmapur, Manthrodi and Jekinkatti in February and March 2012, where trained women are now actively involved in entrepreneurial activities. Processing utensils and machines were provided to each processing units for quality larger scale production and marketing.

Cost of expenditure of selected value added millet products which are being commercialized were analyzed. Cost of expenditure included cost of raw ingredients, processing, fuel, packaging and labour. It was observed that highest profit was found in foxtail millet based hurakki holige and ragi and little millet papad. Sweet products had highest cost of production, hence they were sold at a higher price (Rs. 200/-).

The success of Krishimelas 2011 and 2012, organized by UAS-Dharwad, indicated that the selling of millet products can earn Rs. 37,440/- by selling 103 kg. For example, Ms. Hazratbi, a woman entrepreneur of Manthrodi has secured the order of supplying 2 kg of Ragi malt weekly to the boys' hostel of Veerabhadreshwara temple which is situated just 3 km from her village. Till now she has supplied 60 kg of ragi malt in 30 weeks and earned Rs. 3,000 profit. Similarly Ms. Iramma Jolad is another active entrepreneur from Timmapur village who has ventured to produce millet snacks, supplying to Rock Garden at Gotagodi village which is a tourist place situated around 10 km from her village.

The difficulty in marketing the processed products with at times leftover unsold items, has had the advantage of raising the household consumption of the millet products. The mill owner Manju Bagade, revealed the fact that, this has become the common scenario for various farming families who end up consuming the unsold prepared millet products.

The movement of production and sale of value added products at Timmapur, Jekinakatti and Manthrodi villages has generated interest among other women towards entrepreneurship and among villagers towards the consumption of these products at household level.

Initially the women entrepreneurs started the activity in groups. Later when the demand for the value added products increased, this had an impact on the family management. Immediately they took the bold step to run the business at household level with the help of one lady assistant and started accepting orders at their capacity, a challenge that empowered them all. The movement of production at the household level has allowed them to "multitask".

Production in Karnataka for marketing started from October 2011 and was monitored till February 2013 for a total production around 1103.74 kg. The distributed products ranged from little millet chakli (311.15 kg), little millet nippattu (216.75 kg), ragi malt (167.7 kg), hurakki holige (141.8 kg), millet papad (117.7 kg) and foxtail millet besan laddu (81.1 kg). This 1100 kg of total production created 222 days of employment for 14 women entrepreneurs from 4 project villages earning Rs.1,90,140/- with Rs. 71,000/- profit. Highest production was from women entrepreneurs of Timmapur (610.9 kg) followed by UASD (197.6 kg) and Manthrodi (193.7 kg). At Jekinakatti (101 kg) only one woman entrepreneur is involved in continuous production of little millet chakli.

During summer season production was increased. Four women entrepreneurs were actively involved in papad production. The group leader got employment in an NGO through her experience and knowledge about entrepreneurial activities obtained from the project. This made her to move out from production activity which weakened the group and off season (rainy season) production was reduced.

Empowerment of women entrepreneurs

The earnings of the women entrepreneurs are being used toward the children's education, family expenditure and also towards fulfillment of their entrepreneurial aspirations. They have purchased essential materials for large scale production. The newly self-confident women entrepreneurs have demonstrated that food processing business in rural areas not only creates employment, but also provides food and nutrition security. However there is a need to address the following problems or constraints they are faced with for sustainable entrepreneurial activity:

1. Management of family along with food processing business.
2. Food business demands women to spend majority of time outside the family. But the family members are not encouraging of such activities.

3 Shortage of electricity and transport facilities are hurdles for fulfilling more orders from the urban consumer.

4. Unavailability of fuel at their village leading to purchase of fuel from nearby cities at higher price.
5. The proper market chains towards the sale of food products are not easily created from the villages.

Nutrition Security

- SHG members involved in value addition activities have included ragi malt drink in their children's diet, hence improving their overall nutrition.
- The millet project activities in the villages have increased awareness for the consumption of millet, which is contributing to the improved nutrition security.

Results of impact assessment of value chain

Value chain impact was assessed from women entrepreneurs involved in value addition activities in project villages. 58.3% of women entrepreneurs are consuming their value added millet products regularly and 41.7% women are consuming occasionally. All women entrepreneurs prepared a variety of products: little millet chakli, nippattu, papad, ragi malt and foxtail millet based hurakki holige and besan laddu for sale. Majority of them have sold most of their products (66.7%) on the UASD campus; to their neighbours (41.7%); others (33.3%); and to relatives and petty shops (25%). 25% of women are only recently involved (0-1 years) in value addition activities, 41.7% are involved since 1-3 years and 33.3% women who had trained under previous projects were involved since the past 5 years. Even though the majority of women are producing products individually (91.7%), majority of women prefers group production (58.3%). Apart from it, 50% of women sell in exhibitions, 16.7% sell at their village and 8.3% women sell their products through a supply chain network. Majority of women (91.7%) finds chakli as a product in demand and 25% of women find an important demand for papads. Most of the women (66.7%) find more profit in ragi malt. Whereas, 33.3% find profit with chakli, 16.7% with hurakki holige and papad and 8.3% women find profit with nippattu production (Tables 9-10). 75% of women can devote 2-5 hours for value addition activities and 25% of them can devote only for 1-2 hours.

Shops for purchasing the required raw materials were situated between 5-15 km away. Majority of women (33.3%) had participated in 3-5 exhibitions, 16.7% have participated in 1-3 exhibitions, 25% women in more than 5 exhibitions and 25% women had not participated in any exhibitions. Most of the women entrepreneurs have their family's support. Only 8.3% of women felt that some of the villagers think negatively about their activity. Majority of women (58.3%) are ready to take up value addition as a regular activity and spend at upto 5 hours a day without disturbing their family's work. All women entrepreneur managed time for value addition by reducing their leisure time and at times their field work.

Table 9: Per day profit analysis of value added millet products

Sl. No	Name of the product	Quantity of production per day (Kg)	Cost of expenditure (Rs.)	Hired labour charge (Rs.)	Selling price per Kg (Rs.)	Total amount earned (Rs.)	Total Profit (Rs.)
1	Little millet Chakkali	9	846	100	150	1350	404
2	Little millet Nippattu	7	700	100	150	1050	250
3	Ragi Malt	4	200	100	100	400	100
(A) (B)	Ragi Malt Drink	5	1470	100	1250 / 100 cup	6250	4680
4	Foxtail besan Laddu	7	1120	100	200	1400	180
5	Hurakki Holige	5	715	100	200	1000	185
6 (A)	Little millet Papad	3	270	100	150	450	80
(B)	Little millet Papad	3	270	100	150	450	80
(C)	Little millet Papad	3	270	100	150	450	80
7	Ragi Papad	3	249	100	150	450	101
8	Little millet Paddu	5	715	100	260	1300	485
9	Foxtail Bisibelebhat	5	1250	100	480	2400	1050
10	Little millet Curd rice	6	600	100	250	1500	800
11	Little millet Upama/mix	5	500	100	400	2000	1400
12	Foxtail payasam	5	1875	100	750	3750	1775

Table 10: Production, profit and employment generated from value addition to millets activities

Sl.No	Particulars	UASD	Timmapur	Jekinkatti	Manthrodi	TOTAL
1.	Total No. of women	02	07	03	02	14
2.	Total days of employment	45	103	19	55	222
3.	Total Production (Kg)	198	610	101	194	1103
4.	Net Profit (Rs.)	12,926	38,718	6,614	12,684	70,942

The major value chain activities in Kolli Hills and Kundra consisted of developing a variety of millet products such as finger millet (FM) malt, finger and Italian millet (IM) laddu and FM murukku (chakkli), all of which were determined to have market potential both locally and externally. In addition, Italian and little millet products such as flour, upma mix, bajji mix, payasam mix, and rava mix were prepared and sold in Kolli Hills. The sale outlet in Kolli Hills is being managed by the Confederation of SHGs called Kolli Hills Agro-biodiversity Conservers' Federation. Finger millet malt is being produced by the Padasolai Farmers' Club together with Mullai magalir Suyaudhavikuzhu, Padasolai (local women SHG). One notable feature of this production during last several months is that it has not been able to expand the production beyond 90-100 kg malt/month. This stagnation is largely due to the restricted marketing network. We found out that for the millet malt there are at least four competing other branded products, some of them priced higher than the retail price of the Kolli Hills malt. There is demand for this product, but there is strong competition from other brands. The FM murukku is being produced by the Iyyanar Porulatharav Munnetra Sangam (women's SHG), Thuvarappallam. This product is newly launched after its standardization for quality. As of now the SHG is supplying the product to local shops. Initial pricing of Rs.18 for packs of 10 pieces (75 g) was found to be high for consumers. Hence, the cost of production was reviewed and price revised to more acceptable Rs 15/ pack of ten.

The FM and IM laddu have been standardized and produced by the Kannimarmagalir Suyaudhavikuzhu (SHG of women), Sembuthuvalavu. Current formulation of the product and cost of ingredients offers only marginal profit to the group. Further studies and trials are being made to cut the cost of production of the laddus, while maintaining the quality and consumer preference.

At the marketing outlet in Kolli Hills, during the project period, the sales brought a total value of Rs. 657 634. Out of these the net income to the groups has been Rs. 135 735 across 27 months. The peak sale was recorded during December 2012 with a record sale of Rs 82 336.

The established outlets on Yatra marg of Badrinath (Uttarakhand) are earning good income. The details are presented in Table 11.

Table 11: Cost benefit analysis from the value addition of the produce for 2011 and 2012.

Center Villages	Products	Input (Rs) 2011	Input (Rs) 2012	Output (Rs) 2011	Output (Rs) 2012	Profit (Rs) 2011	Profit (Rs) 2012	Women in group	Income per woman (Rs) 2011	Income per woman (Rs) 2012
Kameda Nagrasu +Chauki	Ladoo	110546	156000	186230	269950	75684	113950	18	4205	6331
	Biscuits	28650	38500	47510	77890	18860	18860	18	1048	1048
	Namkeen	12225	16450	19810	32410	7585	7585	18	421	421
Paini Paini+ Saloor	Ladoo	130200	180000	224110	289410	93910	93910	20	4696	4696
	Biscuits	35890	45500	58750	71790	22860	22860	20	1143	1143
	Namkeen	18750	22000	27410	39400	8660	8660	20	433	433
	TOTAL	**336261**	**458450**	**563820**	**780850**	**227559**	**265825**			

Thematic Area 5: Promotion of consumption via nutrition education

Promotion of millets for household consumption and improving the nutritional status of the farming community is one of the important activities of this project. 40 households from four project villages of Haveri district were assessed by UASD for their initial knowledge, attitude and practice towards consumption of millets through interviews using a developed questionnaire. The nutrition survey revealed that the women had some knowledge (64.45%) about millet consumption. Attitude towards millet consumption appeared positive whereas, the practice of millet consumption was poor which may be due to processing difficulties, and the availability of cereals like rice and wheat at lower cost through the PDS (public distribution system). The survey results also revealed that millets are being consumed only during special occasions such as festivals in all the project villages.

To reintroduce millets in the diet of the rural families in the villages of UASD, a nutrition awareness programme was given to 131 farm women and 410 school children and 12 farming families who participated in the field demonstration for the kharif season 2011.

Furthermore, 151 volunteer high school children who participated in the nutrition awareness programme were assessed for their nutritional knowledge through a quiz. The nutrition education booklet was distributed and the post assessment was carried out after 3 months. The initial knowledge about the nutritive value of millet ranged from 29.40 to 47.40 per cent and it was increased to 33 to 51 per cent following the nutritional awareness program.

Similar results were obtained in Uttarkhand where nutritional education about the value of millets was delivered to school children and women of the four villages with the help of charts, live models, demonstration, literature and written/oral quiz. Following the education programs on nutrition and value addition, the nutrition knowledge increased by approximately 7% and 8% in children and women respectively.

Impact assessment:

An impact assessment was carried out to know if the nutrition education programs have influenced the consumption of millets at the household level. The assessment was carried using a questionnaire with the women/farming community and the school children who participated in the

nutrition education programme. The survey was carried out with 81 households covering around 60 per cent of the total sample. The results indicated that out of 81 families, 56 families have started consuming millets on a regular basis, which means that around 69% of families are consuming millets in the project villages Table 12.

Table 12: Total consumption of millet among women/farming community

Sl.No	Village (N=81)	Women/farming community	Consumption		
			Little millet	Finger millet	Both
1.	Timmapur (n=35)	18(51.42)	02 (11.11)	06 (33.34)	10 (55.55)
2.	Tadas (n=11)	09 (81.81)	04 (44.44)	02 (22.22)	03 (33.34)
3.	Jekkinkatti (n=21)	20 (95.23)	04 (20.00)	05 (25.00)	11 (55.00)
4.	Manthrodi (n=14)	09 (64.28)	-	07 (77.78)	02 (22.22)
	Total	**56 (69.13)**	**10 (12.34)**	**20 (24.69)**	**26 (32.09)**

Note: Figures in parenthesis indicate percentage

The frequency of consumption of millet varied from regularly, to weekly, monthly and occasionally. It was also observed that 32 per cent of the families were consuming millets on a monthly basis followed by weekly (30.35%), regularly (26.78%) and occasionally (10.71%). The consumption of millet was around nil or 1kg per month earlier and it increased to 2.13 kg per month. Earlier millets were consumed only as festival foods, but now most of the families have started including millets in their regular diet.

Millet Food Exhibition and Millet Food Mela

To improve awareness on millet foods to rural farmers, a millet based food mela was conducted at Semputhuvalavu village in Kolli Hills. Nearly 400 community members from nearby villages participated and enjoyed the millet based foods. In this mela, both traditional foods as well as modern food prepared with millet were displayed and their nutritional value highlighted. As a part of the food mela, a millet traditional food competition was organized for women farmers to share their traditional food preparation skills.

Thematic Area 6: Training and Capacity Building:

Training & Capacity Building to stake holders of project villages:

Project activities were initiated in all project sites through entry point activities. Drudgery issues related to women were studied through interaction with farm women and men in all project villages. Certificate training on seed production was given to farmers in various sessions during the project period to ensure continuity in the supply of good quality seeds.

Innovative technologies were demonstrated with respect to productivity enhancement of millet crop cultivation with intercropping interventions and the assessment of different millet genotypes through participatory demonstrations.

Members of the women SHGs were trained in value addition using millet flour following recipes optimized by all project partners (UASD, MSSRF and HESCO).

Training and demonstrations on the use of a variety of simple agricultural implements for saving time, energy and money were organized and delivered to the selected farming stakeholders.

Fuel saving and drudgery reducing technologies were also introduced. Installation of postharvest processing units and their functioning were demonstrated to local village people. Neighbouring villages visited the units and acquired additional information. Installation of processing units at the village level has increased the utilization of millet for household consumption and the marketing of millet at a higher price.

De-hulling machine was introduced in a farmer's house and it was demonstrated to local farmers to encourage consumption of local crops. Nearly 1000 local farmers have seen a demonstration on the use of the new de-hulling machine. Awareness on evaluation of grains for processing quality was done in the project villages.

Rural women entrepreneur participated in training to strengthen their self confidence and to become leading women entrepreneurs.

Farmers and community of farmers received vermi-compost units and realized the importance of vermi-compost for improving the soil fertility of their own lands and have reduced the use of chemical fertilizers.

Training and Capacity Building to Project Staff

The project brought together the participation of NGO's (MSSRF and HESCO), Dept of Agriculture, Dept of Women and Agriculture, UASD staff and students and McGill University staff and students.

All the project staff for all Indian partners obtained training at a staff orientation workshop, conducted at the M.S. Swaminathan Research Foundation (MSSRF) for 4 days on 24-27 January 2011. The participants were given a full overview of the project objectives, methodologies, project activities, milestones and the environmental and human subject ethics guidelines of the donor organization. The salient aspects of the project, particularly its emphasis on gender, empowerment of women with skills and the development of a value chain with nutritional literacy were emphasized. The developed questionnaires for benchmark and nutritional surveys were presented and discussed with all the participants, with an emphasis put on the art of conducting field survey to obtain quality data. Project staff also received a one-day training on participatory demonstrations.

Project staff participated in a 2-days workshop to exchange on success stories of project stakeholders, organized at UASD, on the 21st and 22nd August 2012.

Graduate students from UASD and McGill University interacted together and developed research methodologies for the advancement of knowledge on the functional and nutritional characteristics of millets. McGill students were exposed to the Indian agricultural processing context where they adapted technology for the development of a roller dehuller, adjustable for use for an array of different small millets. UASD students were exposed to North American practices in food formulations and analytical tools.

4 UASD graduate students (Ms. Madalgeri in summer 2011, and Ms. Mannuramath, Ms. Singson and Ms. Ballolli, in summer 2012) visited McGill University for part of their graduate research work. The project research activities have involved directly 4 McGill graduate students (Murugesan, Hejazi, Joshi and Kapoor) on thesis projects pertaining to millet and have involved the laboratory collaboration of an additional 2 graduate students (for data collection). For equipment design, the project has involved three senior Engineering students, two of which Mr. Kristian Swan and Mr. Nick Matlashewski have spent 2-3 months in India in the summer 2011. The third student Ms. Rebecca Chin spent the summer 2012 at UASD for equipment testing. Another undergraduate McGill Student, Ms. Margot Roux (Major in International Agriculture), provided a helping hand to the UASD team on

the analysis of the productivity enhancement of local grains during a few weeks internship during the summer 2012.

Capacity building through exhibitions

UASD organized around 30 exhibitions within the campus and also outside the campus thus helping to create awareness to the public covering approximately 5 lakhs people. In general, exhibitions were the best forum for capacity building of a larger number of stakeholders from villages and the general public.

Thematic area 7: Research Highlights

Millets are appreciated for their content in dietary fibre, trace elements and antioxidant components. Scientific studies have demonstrated that millet products have a high satiety value, low digestibility, low glycaemic value and have been considered as therapeutic foods in the management of diabetes (Kumari and Sumathi, 2002). However color and taste are the hindering factors for wide acceptability among the consumers.

Millet research was extended for sustainable market development of millet products produced by women entrepreneurs and development of novel foods in the following areas:

- ✓ Extension of storage stability of milled millets for distribution in PDS System
- ✓ Quality changes in thermally processed millets
- ✓ Hydrothermal treatment to millet for extended use
- ✓ Extraction of oil from grain amaranth
- ✓ Functional properties of millets and their application in commercialization of millet in bakery industries, papad industries, breakfast items, etc., and for the food service industries.
- ✓ Millet flour in bakery products
- ✓ Development and evaluation of foxtail millet based vermicelli
- ✓ Nutrient composition of dehulled millet in comparison with decorticated millet of emery mill and sensory evaluation of products prepared from deglumed grain and flour
- ✓ Storage stability of deglumed grain and flour
- ✓ Popping quality (nutritional and techno-functional) of little millet
- ✓ Malting and fermentation of millet and amaranth

5. Synthesis of results towards AFS Outcomes

a. New technologies and / or farming systems and practices

The project aimed at technological transfer of adapted technologies for the production, handling and processing of minor millets. The benchmark survey established the current village level use of technology and their basic nutrition knowledge of millets. The project interventions have promoted new technologies and farming practices which have helped in improving production yields, reduce drudgery and increased millet consumption.

The adoption of improved agronomic practices has certainly enhanced the crop yields of the individual farmers thereby enhancing the food production of families and villages. Introduction of different genotypes has helped the farmers to identify specific seed cultivars most appropriate for their specific location and preferred use, a compromise between seed and fodder. Through the participatory approach, the performance

of different genotypes was assessed directly in the farmers' fields and a planned farmer-to-farmer seed distribution system was organized. Seeds produced will be used to distribute to the farming community in the next crop years. With the help of the project, it has been possible to promote the importance of sustaining the millet crops and their cultivar diversity. The interventions were focused mainly on the under-utilized or crops vanishing from cultivation and consumption. So it has direct impact on sustaining these crops for the benefit of local community involved and the global community in the long term.

The introduction of intercropping and relay cropping in millets has helped farmers to diversify their production compared to mono-cropping while it has also increased the fertility status of the soils and the overall yields. Line sowing has also been encouraged and small tools and implements have been locally adopted to promote this production practice. Use of agricultural inputs, as per recommendations provided on the seed package, has helped in reducing the cost of cultivation by reducing over-fertilization.

In drudgery reduction, the introduction of seed cum-fertilizer-drill and weeders have helped the farmers in the reduction of the labour cost while the timely operations have yielded higher productivity thereby making millets a viable crop. The tools helped reduce the drudgeries being experienced by the farming community and women in particular. Simple implements were introduced to simplify line sowing; better sickles were introduced to improve harvesting; threshers were purchased and installed for processing barnyard millet and grain amaranth; emery mills were evaluated to improve their working parameters in the decortication of little millets (to improve their milling efficiency and improve the ease in their adjustments); while a prototype roller dehuller was designed, built and tested which will offer durability and flexibility in use and operation as it can be adapted to various grain sizes while it reduces broken grains in comparison to an emery mill.

b. Dietary diversity and nutrition

The project helped to improve the production of millets and grain amaranth, which are local traditional crops, that when consumed, confer better nutrition to the local community than rice or wheat alone. The project efforts on nutritional education and value addition have promoted the consumption of these grains and improved bioavailability of the nutrients. In addition, awareness building activities, with a focus on women and children, on the nutritional importance of these crops have contributed to the dietary diversity as well as towards improved/balanced nutrition for women and children.

Many stakeholders have received training in value-addition of the millet grain. At times they are experiencing some difficulty in the marketing/selling of their production. These value-added millet products are then returned home where they are consumed by the household. This downturn of marketing has significantly increased the consumption of millet products by the families in the project villages.

c. Engagement of Canadian researchers

The longstanding knowledge of Canada in agricultural and food has been useful to the project in many areas from field production, grain processing and formulation of value added millet products. For example in grain processing, experts from McGill University have designed a new machine to effectively de-hull the millet grains while keeping the bran intact, and reducing the broken grains.

The research laboratories of McGill effectively served the research needs of the UAS-D graduate students (4 of them came to Canada) for conducting high-end research and analytical experiments. Research scientists at McGill have also been actively participating in the determination of R&D priorities for all the graduate students involved in this project at both UASD and McGill.

The information from the newsletters of IDRC/CIDA has proven to be very helpful in the integration and focusing of the project activities, especially in the analysis of some of the cross cutting themes.

d. Research groups

The research collaboration between all partner institutions, HESCO, MSSRF, UAS-D and McGill is substantially contributing to accessing productivity enhancing technologies, processes which are effective in technology transfer, learning on the role of gender in the production and consumption of these crops, and approaches to reduce the drudgery of women in production and processing. We also gained knowledge on policy aspects as well as in developing a broader vision on the impacts of the project.

e. Food distribution

The areas chosen for this project are socio-economically backward with vast majority of local population classified by the government as Below Poverty Line (the BPL poverty line is 0.35 US $ income/person/day). Increased productivity and production of millets, as important and nutritious food crops, will improve access to nutritious food to these people at relatively lower cost. The production technologies being promoted are less intensive on agricultural chemicals, more sustainable and more environmental friendly as well as energy-efficient. Efforts for inclusion of little millet and other millets in the public distribution system, at least in the millet growing areas, and also in the mid-day meal programme are made, as it will facilitate reaching equitable food distribution and environmentally sustainable food security.

During 16-17th October 2011 a National Convention of Millets farmers was organized at Dharwad with Joint venture of UAS, Dharwad, Millets Network of India, Hyderabad, SIRI Dhanya Kriya Sameti, Dharwad. At the end of this convention an important document the “Dharwad declaration” emerged for consideration of policy makers, administrators, scientists, farmers and civil society groups in India. The important recommendations of the “Dharwad declaration” are i) Millets are to be introduced in the public distribution system; ii) to encourage production, storage and distribution of millets at the local level; iii) to ensure use of millets in schools, Hotels, Welfare hostels, Govt. Canteen and during State celebrations so as to increase market potential and to develop a millet food culture; and iv) to support awareness activities on the nutritional values among school children’s by incorporating the importance of cultivating and consuming of millets in the school syllabus.

f. Food processing and storage

To reduce the drudgery involved in processing millets, the improved processing equipment, like destoner, aspirator, blower and milling equipment are being established in the project’s selected villages. This is motivating farmers towards better practices of processing with least cost and higher returns. Specific research activities assessed grain quality and fodder quality in storage over varying periods of time. Project also concentrated on post-harvest processing practices, addressing the drudgery of women associated with the traditional processing methods, and training women on production of value added products which have better nutritional value, higher consumer acceptability and commercial potential. These processing technologies are community based, low energy demanding, simple to operate, cost-effective, environment friendly and sustainable. These processing methods can contribute towards achieving food security.

The project has not directly addressed the issue of land tenure. Improved productivity and profitability were demonstrated and it is expected to promote leased cultivation for these crops by marginal and landless farmers. The project has offered direct technology and input extension to the community.

g. Risk-mitigation

Instead of maintaining mono-cropping, efforts have been made to promote intercropping practices and mixed cropping systems to overcome risk-mitigation under adverse agro-climatic situations. Furthermore, millets are a reasonable choice in risk mitigation as millets are relatively tolerant to drought conditions and poor soil quality.

h. Access to resources

To improve access to marketing strategies, a market link has been established for the village level products produced by the women entrepreneurs through the creation of sale points at village level and linkages for distribution at market windows at city level and that for all project sites.

i. Income generation

Post harvest technologies, especially threshing and dehulling, are given importance so as to get better quality produce enabling them to get better prices in the market leading to better income generation. Similarly the production of value added products has resulted into additional income for women SHG members. Realising the opportunities and potentiality in the rural areas for the production and marketing of value added products, the formation of commodity interest groups are being encouraged at the project villages, especially in production of value added millet products. Establishment of processing production units such as milling, manufacturing of ragi malt powder, millet snacks, breakfast foods, bakery products and nutritious papads is continuing.

The increased productivity is causing virtual rise in income although the increased production at household level does not necessarily turn into additional cash income as most of the families do not sell the increased production, but rather use for home consumption leading to better overall nutrition. To that extent, their cash requirement to buy food from the market is reduced. The commercialization of value added products are slowly bringing additional income to women groups.

j. Policy options

The study of minor millets, these underutilised and nutritious crops, has profound policy implications in the current Indian context of narrowing food basket of rural and urban population at the behest of the Product Distribution System (PDS) driven food supply. Distribution of millet seeds on subsidy and millet grain under PDS system must be considered as a policy option in order to increase the area and consumption of millets in general. Many farmers consider that the inclusion of these nutritious grains in PDS system, at least at local level, will have huge benefit for their production, food diversity and nutritional well being. The "Dharwad declaration" conveyed the same points. The development of appropriate processing machinery will also have policy implications in promoting wider consumption of these grains with considerably reduced drudgery.

k. Information communication technologies (ICTs)

The entry point activities followed by other awareness and educational activities in the villages have increased the knowledge level of the farmers towards structured production, processing and consumption of millets. Information on better practices and technologies was promoted via radio tips and programmes and disseminated through mass media like newspapers, pamphlets, webpage and training manuals, making a wide and varied access to information.

l. Gender

Considering the need for tackling the gender issues, our activities have focused on the use of improved agricultural implements, and the establishment of improved processing equipment which are provided locally and which are helping the farm women to increase their work efficiency through reduced drudgery, the potential to generate additional income with surplus production and value addition through grain processing.

m. Environment

In general, growing of millets, especially with intercropping, is helping farmers in using less chemical fertilizers and pest management chemicals thereby encouraging environmentally friendly crop production. The

cropping systems introduced will maintain the fertility of the soil and the diversified cropping systems will help the farming families meet different needs towards sustainable food security and adequate nutrition.

6. Problems and challenges

To bring all the members of the community and to motivate them to work together and share the knowledge with each other was a major challenge faced in the selected villages for the project interventions. During the project implementation, the major challenges were to convince the locals for change and shift in agricultural practices, i.e. new varieties, line sowing instead of broadcasting of the seeds, etc. Regular irrigation at appropriate time was another issue with the farmers. Unavailability of improved variety of seeds, unawareness about the seeds and their quality and the seed treatment needed for better yield were the major points of their unwillingness for change.

Farmers and farm women are not willing to participate in 'on campus' trainings of more than one day, especially women, which are more reluctant to leave their villages for more than one day due to involvement in diversified farm activities and family commitment. Small and marginal farmers and farm women are busy with agricultural activities each day, and it is a very important task for earning that day's bread. Therefore, most of the project activities were planned in the evening hours to encourage attendance.

Providing facilities to a selected and limited amount of farmers in a village can sometimes create friction and unhealthy atmosphere in the village and it is very difficult to convince farmers to adopt new technologies within such a short time period.

Formation of SHG/commodity interest groups forms a basis for implementation of the project but the formation of these groups needs sufficient time and efforts which has presented challenges on the given timescale.

Nutrition awareness programmes have slow impact on the consumption of millet at household level as food habits and existing social system play a crucial role in the change of dietary pattern among the consumers.

Major Challenges:

With the existing social system, life style and dietary food habits, the major challenges are:

1. Distribution of millets under PDS system along with other major cereals.
2. Construction of community threshing yards to produce quality grains for home consumption, value addition and marketing. Extension of storage life of decorticated grains and distribution at home level and PDS.
3. Little millet farmers of Karnataka are growing little millet specifically for fodder purpose. At the same time there is a strong market linkage for supply of grains. As such there is a need for identification of suitable genotypes to meet both the requirements. Regular basic research is essential to identify suitable package of practices to enhance productivity of millets.

Constraints faced: Majority of the farmers complained of scanty rainfall and they all feared that both grain and fodder yield would be low

- One farmer at Manthrodi has reported of total loss of little millet crop (both local and demonstration plots) due to delayed sowing
- Rain fed conditions - Problem associated with the vagaries of monsoon failure in South India sites
- Obstacles/barrier in adopting new technology associated with poverty in many project sites
- Some farmers have sown pigeon pea in the sole crop plots. They reported that it was needed for their household consumption.
- Rainfall was reported during harvesting of Sukshema and local mallige crop affecting quality and storability.

7. Recommendations

Harvesting, threshing and storage of grains are crucial stages for procurement of quality grains for consumption as well as marketing. This presents a new dimension of study and attention to promote the production of nutritious grains for household consumption. In certain regions of India, millets are also considered as fodder crops. Therefore attention to this is essential for adequate seed selection and for the adequate handling of the fodder for its intended final use, which may require some research in terms of characterization. Farmers will decide to go for millet or alternate crops based on economic viability, hence to increase areas on millet production, it is essential to declare a support price as it is customary for other crops.

Commodity interest groups are to be encouraged to multiply, procure and redistribute among the community or if necessary outside by bringing the concept of seed bank. A well established seed bank system would facilitate popularisation of improved genotypes. As the government supplies many crop seeds at a subsidised rate, it is essential to include millet seeds under the subsidy chain. It will enhance the area under millet production. It is essential to distribute millet grains at least periodically under PDS system so as to encourage general consumption of millets in a community, to increase awareness and to create a supply and demand market.

As a recommendation to the funding agency IDRC/CIDA, there should be at least one day dedicated to project management during the inception meeting of any new project. This project management workshop/training should effectively define the expectations and identify clearly the reporting requirements with a clear assignment of reporting responsibilities among the project leaders/stakeholders.

We are thankful to IDRC for the 6-month duration extension which allowed us the time to wrap up the second year of field trials and look back on our activities.

Annexes

Annex 1: Monitoring AFS Outcomes
Annex 2: List of participants
Annex 3: Research Output Titles and Abstracts

Appendices

Appendix 1: McGill final progress report
Appendix 2: M.Sc. Thesis of Priyanka Kapoor. Thesis title: *Nutritional and functional properties of popped little millet*
Appendix 3: M.Sc. Thesis of Hoitinkim Singson. Thesis title: *Physico-chemical and sensory evaluation of commercial chakli and developed little millet chakli*
Appendix 4: M.Sc. Thesis of Prabhu Y. Iliger. Thesis title: *Production and post-harvest management practices of minor millets by farmers of Haveri district of Karnataka*
Appendix 5: International workshop booklet
Appendix 6: International workshop book of abstracts
Appendix 7: Sample of Certificate Trainings
Appendix 8: Recipe booklet
Appendix 9: Newspaper cuttings
Appendix 10: Presented Posters
Appendix 11: Nutrition education booklet
Appendix 12: Project Photos
Appendix 13: UASD final progress report
Appendix 14: MSSRF final progress report
Appendix 15: HESCO final progress report

ANNEX 1 –MONITORING AFS EXPECTED OUTCOMES

The quantitative and quality evidence of the outcomes are listed below:

1. New technologies and / or farming system and practices

- Introduction of different genotypes has helped the farmers to identify specific seed cultivars most appropriate for their specific location and preferred use between seed and fodder.
- Planification of farmer-to-farmer distribution seed distribution system was organized along with some seed banks in certain locations.
- Seeds produced will be used to distribute to the farming community in the next crop year. With The introduction of intercropping and relay cropping in Millets (with pigeon pea, black gram, tapioca, etc) has helped farmers to diversify their production compared to mono-cropping while it is increasing the fertility status of the soils and overall product yields.
- Line sowing has also been encouraged and small tools and implements (simple row markers) have been locally adopted to promote this production practice.
- Use of agricultural inputs, as per recommendations provided on the seed package, has helped in reducing the cost of cultivation by reducing losses.
- Introduction of seed cum-fertilizer drill and weeders have helped the farmers in the reduction of the labour cost while the timely operations have yielded higher productivity.
- Better sickles were introduced to improve harvesting; threshers were purchased and installed for processing little millet barnyard millet and grain amaranth; emery mills were evaluated to improve their working parameters in the decortication of little millets (to improve their milling efficiency and improve the ease in their adjustments);
- A newly designed roller dehuller was tested and is being duplicated on order for widespread distribution.

2. Dietary diversity and nutrition

- Improvement of production of millets and grain amaranth (which have better nutrition than rice or wheat)
- Increased local awareness on the benefits of consuming millets through nutritional education.
- Organization of small enterprise through self help groups which have developed a variety of value added products promoting the consumption of these grains and improved bioavailability of the nutrients.
- The interesting processed products have increased household and village level interest in consuming millet food products.
- Extra production of value-added foods which are not successfully sold are ultimately consumed at the household for the nutritional benefits of all its members.

3. Engagement of Canadian researchers

- 4 UAS-D graduate students benefited from the McGill research facilities to conduct part of the thesis research work.
- The new roller dehuller was designed by Canadian researchers and first built in Canada.
- Research scientists at McGill have also been actively participating in the determination of R&D priorities for all the graduate students involved in this project at both UASD and McGill.

4. Research groups

The research collaboration between all partner institutions, HESCO, MSSRF, UAS-D and McGill is substantially contributing to accessing productivity enhancing technologies, processes which are effective in technology transfer, learning on the role of gender in the production and consumption of these crops, and approaches to reduce the drudgery of women in production and processing. We also gain in learning on policy aspects as well as in developing a broader vision on the impacts of the project.

5. Food distribution

- Increased productivity and production of millets, as important and nutritious food crops, will improve access to nutritious food to these people at relatively lower cost.
- The production technologies being promoted are less intensive on agricultural chemicals, more sustainable and more environmental friendly as well as energy-efficient.
- Efforts for inclusion of little millet and other millets in the general public distribution system at least in the millet growing areas and also in the mid-day meal programme have been made.

6. Food processing and storage

- Destoner, aspirator, blower, dehuller and milling equipment have been established in the project's selected villages.
- Value addition activities have taken up as entrepreneurial activities supported by numerous marketing outlets. The scope is still modest though.
- For commercial scale potential, at which point, the community will require support and financial assistance to manage larger scale marketing and adequate storage.

7. Risk-mitigation

- Instead of maintaining mono-cropping, efforts are made to introduce intercropping practices and mixed cropping systems to overcome risk-mitigation under adverse agro-climatic situations.
- Millets themselves represent a target crop for climate change adaptation of agriculture.

8. Access to resources

- To improve access to marketing strategies, a market link has been established for the village level products produced by the women entrepreneurs through the creation of sale points at village level and linkages for distribution at market windows at city level.

9. Income generation

- Post harvest technologies, especially threshing and dehulling, is given importance so as to get better quality produce enabling them to get better prices in the market leading to better income generation.
- Similarly the production of value added products has resulted into additional income for women SHG members.
- The formation of commodity interest groups are being encouraged at the project villages, especially in production of value added millet products.
- Establishment of processing production units such as milling, manufacturing of ragi malt powder, millet snacks, breakfast foods, bakery products and nutritious papads has showed some levels of success.
- The increased productivity is causing virtual rise in income although the increased production at household level does not turn into additional cash income as most of the families do not sell the increased production, but rather use for home consumption leading to better overall nutrition.

10. Policy options

The study of minor millets, these underutilised and nutritious crops, has profound policy implications in the current Indian context of narrowing food basket of rural and urban population at the behest of the Product Distribution System (PDS) driven food supply. Distribution of millet seeds on subsidy and millet grain under PDS system must be considered as a policy option in order to increase the area and consumption of millets in general. Many farmers consider that the inclusion of these nutritious grains in PDS system, at least at local level, will have huge benefit for their production, food diversity and nutritional well being. The "Dharwad declaration" conveyed the same points. The development of appropriate processing machinery will also have policy implications in promoting wider consumption of these grains with considerably reduced drudgery.

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The entry point activities followed by other awareness and educational activities in the villages have increased the knowledge level of the farmers towards structured production, processing and consumption of millets.

Information on better practices and technologies has been promoted via radio tips and programmes and disseminated through mass media like newspapers, pamphlets, and training manuals, making a wide and varied access to information.

12. Gender

Considering the need for tackling the gender issues, our activities have focused on the use of improved agricultural implements, and the establishment of improved processing equipments which are provided locally and which are helping the farm women to increase their work efficiency through reduced drudgery, the potential to generate additional income with surplus production and value addition through grain processing.

13. Environment

- In general, growing of millets, especially with intercropping, is helping farmers in using less chemical fertilizers and pest management chemicals thereby encouraging environmentally friendly crop production.
- Improved agronomic practices will maintain the fertility of the soil and the diversified cropping systems will help the farming families to meet different needs towards sustainable food security and adequate nutrition.
- Similarly use of vermin-compost to fields can reduce by at least 50% the application of chemical fertilizers while helping in maintaining soil fertility.

List key members of ALL applicant research teams (add more tables and rows as needed). For type of organization, indicate: government, university, private sector, NGO (national), NGO (international), or other.

Organization 1: McGill University, Educational and Research Organization, Canada						
Family name	Given name	Male (M) / Female (F)	Job title	Address (mailing address, phone number, fax, email)	Project role/responsibility (please indicate if lead PI and identify if consultant)	% of time committed on this project
Orsat	Valérie	F	Principal Investigator	Bioresource Engineering Department, McGill, 1-514-398-7680, Valerie.orsat@mcgill.ca	Project implementation and overall management and reporting	25%
Raghavan	Vijaya	M	Co-investigator	Bioresource Engineering Department, McGill, 1-514-398-8731, vijaya.raghavan@mcgill.ca	Project activities, visit of field sites in India, discussion with local stakeholders	10%
Prasher	Shiv	M	Professor and Chair	Bioresource Engineering Department, McGill, 1-514-398-7775, shiv.prasher@mcgill.ca	Meeting with visitors and introduction to research activities conducted at McGill. Use of lab facilities.	2%
Madramootoo	Chandra	M	Professor and Dean	Bioresource Engineering Department, McGill, 1-514-398-7778, Chandra.madramootoo@mcgill.ca	Meeting with visitors and introduction to research activities conducted at McGill	1%
Ngadi	Michael	M	Professor	Bioresource Engineering Department, McGill, 1-514-398-7779, Michael.ngadi@mcgill.ca	Meeting with visitors and introduction to research activities conducted at McGill. Use of lab facilities.	1%
Lefsrud	Mark	M	Professor	Bioresource Engineering Department, McGill, 1-514-398-7967, mark.lefsrud@mcgill.ca	Meeting with visitors and introduction to research activities conducted at McGill. Use of lab facilities. Discussions with students and visitors	2%
Sotocinal	Sam	M	Professional Associate	Bioresource Engineering Department, McGill, 1-514-398-7740, Samson.sotocinal@mcgill.ca	Laboratory training of students, supervision of metal machining, building and testing of millet processing equipment.	15%
Manktelow	Scott	M	Technician	Bioresource Engineering Department, McGill, 1-514-398-7740, scott.manktelow@mcgill.ca	Shop operation, training and supervision of students working on equipment design	5%
Gariépy	Yvan	M	Professional Engineer	Bioresource Engineering Department, McGill, 1-514-398-7785, yvan.gariepy@mcgill.ca	Laboratory safety and supervision of laboratory manipulations. Experimental design, data analysis and statistics.	10%
Murugesan	Ramesh	M	PhD Student	Bioresource Engineering Department, McGill, ramesh.murugesan@mail.mcgill.ca	Patent search for equipments and study of the thermal processing of millets	100%
Anekella	Kartheek	M	MSc student	Bioresource Engineering Department, McGill, kartheek.anekella@mail.mcgill.ca	Laboratory manipulations and help in the machine shop	2% (left)
Kapoor	Priyanka	F	MSc student	Bioresource Engineering Department, McGill, priyanka.kapoor@mail.mcgill.ca	Popping quality of millets	100%
Joshi	Siddhartha	M	MSc student	Bioresource Engineering Department, McGill, Siddhartha.joshi@mail.mcgill.ca	Study of grain amaranth	100%
Najdi-Hejazi	Sara	F	PhD student	Bioresource Engineering Department, McGill, sara.najdihejazi@mail.mcgill.ca	Review of the nutritional quality of millets	100% (onto a separate project now)
Routray	Winny	F	PhD student	Bioresource Engineering Department, McGill, winny.routray@mail.mcgill.ca	Laboratory manipulations and establishment of research protocols for quality analysis	50% (onto a separate project now)
Nemes	Simona	F	PhD student	Bioresource Engineering Department, McGill, simona.nemes@mail.mcgill.ca	Data collection and statistical analysis support	25% (left)

Padamsi	Veeda	F	B.Eng. student	Bioresource Engineering Department, McGill, veeda.padamsi@mail.mcgill.ca	Laboratory help, data collection, support to Indian visitors	10% (left)
Swan	Kristian	M	B.Eng. student	Bioresource Engineering Department, McGill, kristian.swan@mail.mcgill.ca	Machining and construction of new equipment. Testing of equipment	15% (onto a separate project now)
Matlashewski	Nicholas	M	B.Eng. student	Bioresource Engineering Department, McGill, Nicholas.matlashewski@mail.mcgill.ca	Machining and construction of new equipment. Testing of equipment	15% (onto a separate project now)
Chin	Rebecca	F	B.Eng. student	Bioresource Engineering Department, McGill, Rebecca.chin@mail.mcgill.ca	Machining and construction of new equipment. Testing of equipment	15% (onto a separate project now)
Roux	Margot	F	International Agr Student	Animal Science Department, McGill University, margot.roux@mail,mcgill.ca	Evaluation of agronomic practices in agricultural development	1% (onto a separate project now)

Organisation 2: University of Agricultural Sciences, Dharwad, Karnataka, India

Family name	Given name	Male (M) / Female (F)	Job title	Address (mailing address, phone number, fax, email)	Project role/responsibility (please indicate if lead PI and identify if consultant)	% of time committed on this project
Yenagi	Nirmala	F	Principal Investigator	IDRC Millet Project, Dept. of Food Science and Nutrition, RHSc, UAS, Dharwad, Karnataka- India. 9880417046, niryenagi@yahoo.co.in.	Overall implementation and supervision	60%
Handigol	Jayashree	F	Co-Principal Investigator	IDRC Millet Project, Dept. of Agril. Economics, UAS, Dharwad, Karnataka- India. 9449074268,	Economic Analysis	20%
Dolli	Shrishail	M	Co-Principal Investigator	IDRC Millet Project, Dept. of Agril.Extn., UAS, Dharwad, Karnataka- India. 9845142796, ssdolli@yahoo.com	Drudgery Activities	20%
B.N.	Aravindkumar	M	Co-Principal Investigator	IDRC Millet Project, Dept. of Agronomy, UAS, Dharwad, Karnataka- India. 9980251914, bnakumar@gmail.com	Crop Production	20%
Budihal	Rajashekhar	M	Project Manager	IDRC Millet Project, Dept. of Food Science and Nutrition, RHSc, UAS, Dharwad, Karnataka- India. 9900922600, rab.budihal@gmail.com	Management of Project Activities	100% **(left)**
Joshi	Rajarajeshwari	F	Project Technical Assistant	IDRC Millet Project, Dept. of Food Science and Nutrition, RHSc, UAS, Dharwad, Karnataka- India. 9480189642, rajeshwari65@gmail.com	Management of Project Activities	100%
Nadagoudar	Vanitha	F	Senior Research Associate	IDRC Millet Project, Dept. of Food Science and Nutrition, RHSc, UAS, Dharwad, Karnataka- India 9481725637 Email:	Activities relating to the milling research work	100%
U	Roopa	F	Senior Research Associate	IDRC Millet Project, Dept. of Food Science and Nutrition, RHSc, UAS, Dharwad, Karnataka- India., 9845769346 E-mail: roopsu.08@gmail.com	Teaching and Assisting in report writing	100%
B.	Josna	F	Senior Research Associate	IDRC Millet Project, Dept. of Food Science and Nutrition, RHSc, UAS, Dharwad, Karnataka- India. 7829482143, jothsnasachu2008@gmail.com	Overall activities realating to the creating awareness,production, value addition and scientific marketing of millet based products	100%
Bhat	Rajeshekhar	M	Research Associate	IDRC Millet Project, Dept. of Food Science and Nutrition, RHSc, UAS, Dharwad, Karnataka- India. 9886574167, rajuyellapur@gmail.com	Processing and Crop production and Field level activities	100% **(left)**

B.	Nagendra	M	Research Associate	IDRC Millet Project, Dept. of Food Science and Nutrition, RHSc, UAS, Dharwad, Karnataka- India. 9483475100,	Activities realating to the creating awareness,production, value addition and scientific marketing of millet based products	100% **(left)**
Naik	Shalmali	F	Research Associate	IDRC Millet Project, Dept. of Food Science and Nutrition, RHSc, UAS, Dharwad, Karnataka- India. 9481277821, naikshalu@gmail.com	Activities realating to the creating awareness,production, value addition and scientific marketing of millet based products	100% **(left)**
Byadagi	Sumalatha	F	Research Associate	IDRC Millet Project, Dept. of Food Science and Nutrition, RHSc, UAS, Dharwad, Karnataka- India 8792379862 Email:	Activities realating to the creating awareness,production and nutrition awareness	100%
Dargad	Saira	F	Research Associate	IDRC Millet Project, Dept. of Food Science and Nutrition, RHSc, UAS, Dharwad, Karnataka- India 9483475043 Email:	Activities realating to the Threshing experiments, Impact assessment	Dargad
G K	Nethra	F	Field Assistant	IDRC Millet Project, Dept. of Food Science and Nutrition, RHSc, UAS, Dharwad, Karnataka- India. 9731326409	Nutrient analyses of developed millet products at laboratory	
Veeraghanti	Ms. Shweta S	F	Field Assistant	IDRC Millet Project, Dept. of Food Science and Nutrition, RHSc, UAS, Dharwad, Karnataka	Monitoring timmapur field activities and maintining finance	100% **(left)**
Galagali	Ms. Chandramati	F	Field Assistant	IDRC Millet Project, Dept. of Food Science and Nutrition, RHSc, UAS, Dharwad, Karnataka	Monitoring Tadas field activities and maintining finance	100% **(left)**
Patil	Ms. Rajata A	F	Field Assistant	IDRC Millet Project, Dept. of Food Science and Nutrition, RHSc, UAS, Dharwad, Karnataka	Monitoring Manthrodi field activities and maintining finance	100% **(left)**
Patil	Ms. Sharanabasamma	F	Field Assistant	IDRC Millet Project, Dept. of Food Science and Nutrition, RHSc, UAS, Dharwad, Karnataka	Assisting marketing of women entrepreneurs activities	100% **(left)**
Galigoudar	Manjunath	M	Field Assistant	IDRC Millet Project, Dept. of Food Science and Nutrition, RHSc, UAS, Dharwad, Karnataka	Monitoring Jekinakatti field activities	100% **(left)**
Gadag	Shashidhar	M	Field Assistant	IDRC Millet Project, Dept. of Food Science and Nutrition, RHSc, UAS, Dharwad, Karnataka	Monitoring Manthrodi field activities	100% **(left)**
Mahale	Bharathi	F	Field Assistant	IDRC Millet Project, Dept. of Food Science and Nutrition, RHSc, UAS, Dharwad, Karnataka- India. 8951545722,	Assistance in Millet based Value added product development, training and Finance management	100%
Shaikh	Md. Rafik	M	Field Assistant	IDRC Millet Project, Dept. of Food Science and Nutrition, RHSc, UAS, Dharwad, Karnataka- India. 9902670193, mohammadrafik2020@gmail.com	Documentation of project activities	100%
Hazari	Mamata	F	Field Assistant	IDRC Millet Project, Dept. of Food Science and Nutrition, RHSc, UAS, Dharwad, Karnataka- India.,	Assisting in lab research work	100%
Nadaf	Shehnaz	F	Field Assistant	IDRC Millet Project, Dept. of Food Science and Nutrition, RHSc, UAS, Dharwad, Karnataka- India. 7795247181,	Production, Marketing and popularization of Value added Millet products	100%
Hebballi	Prabhavati	F	Field Assistant	IDRC Millet Project, Dept. of Food Science and Nutrition, RHSc, UAS, Dharwad, Karnataka- India., 9686791880	Assisting RAs, data entry and finance	100% **(left)**
Kundgol	Gangadhar	M	Field Assistant	IDRC Millet Project, Dept. of Food Science and Nutrition, RHSc, UAS, Dharwad, Karnataka- India. 9740378880,	Gross root project staff in mobilizing communities	100%
Pawar	Vidya	F	Field Assistant	IDRC Millet Project, Dept. of Food Science and Nutrition, RHSc, UAS, Dharwad, Karnataka- India.	Data entry of project activities	100%
Hiremath	Jayashree	F	Field Assistant	IDRC Millet Project, Dept. of Food Science and Nutrition, RHSc, UAS, Dharwad, Karnataka- India	Assisting in Threshing and Cooking quality	100%

Organization 3: MS Swaminathan Research Foundation, MSSRF, Research and NGO organization, India

Family name	Given name	Male (M) / Female (F)	Job title	Address (mailing address, phone number, fax, email)	Project role/responsibility (please indicate if lead PI and identify if consultant)	% of time committed on this project
King	I Oliver	M	Project Leader	MSSRF, Chennai	Project implementation and management of resources	25%
Bala Ravi		M	Project Leader	MSSRF, Chennai	Project implementation and management of resources	Retired
Nagalakshmi	R.M.	F	Senior research fellow	MSSRF, Kolli Hills	Research project implementation and result analysis	25%
Kumar	N.	M	Junior research fellow	MSSRF, Kolli Hills	Research project implementation and result analysis	25%
Chinnathambi	S.	M	Field technician	MSSRF, Kolli Hills	Field experimentation and data collection	25%
Gowrisankar	R.	M	Field technician	MSSRF, Kolli Hills	Field experimentation and data collection	25%
Mallik	Ms. Deeptimayee	F	Senior research fellow	MSSRF, Jeypore	Research project implementation and result analysis	25%
Das	Biswa sankar	M	Junior research fellow	MSSRF, Jeypore	Research project implementation and result analysis	25%
Taraputia	Trinath	M	Field technician	MSSRF, Jeypore	Field experimentation and data collection	25%
Suchen	Benudhar	M	Field technician	MSSRF, Jeypore	Field experimentation and data collection	25%

Organization 4: Himalayan Environmental Studies and Conservation Organization, HESCO, NGO organization, India

Family name	Given name	Male (M) / Female (F)	Job title	Address (mailing address, phone number, fax, email)	Project role/responsibility (please indicate if lead PI and identify if consultant)	% of time committed on this project
Kumar	Rakesh	M	Principal investigator	HESCO, Dehradun, Rudraprayag, rakeshkumar_hesco@rediffmail.com	Project implementation and management	50%
Negi	Kiran	F	Co-investigator	HESCO, Dehradun, Chamoli, kirannegi_hesco@rediffmail.com	Technology adoption in postharvest	50%
Chandola	Richa	M	Research assistant	HESCO, Dehradun	Data collection and analysis	20%
Khati	Vinod	F	Research assistant	HESCO, Dehradun	Data collection and analysis	20%
Rawat	S.S.	M	Research assistant	HESCO, Chamoli	Crop Sowing and Trainings	20%
Rawat	Laxmi	F	Research Assistant	HESCO, Rudraprayag	Crop sowing, data collection and training	20%

LIST OF STUDENTS INVOLVED - 2011-2012

Surname	Given name	Gender	Institution	Department	Country of research	Degree pursued/ing	Title of Thesis	Date expected
Murugesan	Ramesh	M	McGill	Bioresource Engineering	Canada	PhD	Techno-functional properties of minor millet grains for bakery applications	December 2013
Padamsi	Veeda	F	McGill	Bioresource Engineering	Canada	B.Eng.	Study of the physical properties of paddu batter containing millet	September 2011
Kapoor	Priyanka	F	McGill	Bioresource Engineering	Canada	M.Sc.	Effect of popping on the nutritional quality of little millet	April 2013
Joshi	Siddhartha	M	McGill	Bioresource Engineering	Canada	M.Sc.	Extraction of oil-based compounds from grain amaranth	June 2013
Najdi-Hejazi	Sara	F	McGill	Bioresource Engineering	Canada	Ph.D.	Millet flour as an ingredient for infant weaning foods	December 2014
Swan	Kristian	M	McGill	Bioresource Engineering	Canada (3 months in India)	B.Eng.	Design and construction of a centrifugal de-huller	April 2012
Matlashewski	Nicholas	M	McGill	Bioresource Engineering	Canada (2 months in India)	B.Eng.	Design and construction of a centrifugal de-huller	April 2012
Chin	Rebecca	F	McGill	Bioresource Engineering	Canada (3.5 months in India)	B.Eng.	Design of roller decorticators	December 2012
Roux	Margot	F	McGill	International Agriculture and Food Security	Canada (4 weeks in India)	B.Sc.	Millet production and cost-benefit analysis of millet adoption	December 2012

Garwad Hiremath	Ashwini	F	RHSc, UAS, Dharwad	Dept. of Food Science and Nutrition	India	MSc	Enriched Foxtail Millet Breakfast muffin	July 2011
Patil	Sharanabasamma, S.	F	MBA student KUD/UASD	Dept. Food Science UASD	India	MBA	Marketing of millet-based value added products	July 2011
Madalageri	Deepa	F	RHSc, UAS, Dharwad	Dept. of Food Science and Nutrition,	India (3 months in Canada in 2011)	MSc	Fermented products of Little Millet & application of this food formulation to catering and evaluation for commercial use	June 2012
Mannuramath	Mamata	F	RHSc, UAS, Dharwad	Dept. of Food Science and Nutrition,	India (3 months in Canada in 2012	Ph.D	Development of suitable processing technology for diversified utilisation of little millet	June 2013
Singson	Hoitin Kim	F	RHSc, UAS, Dharwad	Dept. of Food Science and Nutrition,	India (3 months in Canada in 2012)	MSc	Physico Chemical and sensory evaluation of Little Millet based Fried Snacks	June 2012
Ballolli	Uma	F	RHSc, UAS, Dharwad	Dept. of Food Science and Nutrition,	India (3 months in Canada in 2012)	Ph.D	Management of teenage obesity through nutrition education and millet based low calorie food.	June 2013
Pandey	Pragya	F	RHSc, UAS, Dharwad	Dept. of Food Science and Nutrition,	India	MSc	Evaluation of foxtail millet based vermicel	Sept. 2012

ANNEX 3 –AFS RESEARCH OUTPUTS

1. Biodiversity Based Cultural Traditions and Religious Belief of Little Millet as Fasting Food and Studies on Cooking Quality for Development of Therapeutic Foods for Management of Diabetes

N.B. Yenagi, P. S. Sawant, Y. Gariepy, V. Orsat and G.S.V. Raghavan

Report Type: Research report

Date: September 2011

IDRC Project Number, and component number (if applicable): 106314

IDRC Project Title: ***Enhancing food security of rural families through production, processing, and value addition of regional staple food grains in India***

Country/Region: *Canada and India (Karnataka)*

Full Name of Research Institution: McGill University and University of Agricultural Sciences Dharwad

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Name(s) of Researcher/Members of Research Team: ***N.B. Yenagi, P. S. Sawant, Y. Gariepy, V. Orsat and G.S.V. Raghavan***

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This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.

Abstract: *Small millets like little millet (Panicum sumatrense) are regionally important food and feed crops in India. The nutrient composition of little is comparable to other cereals. It contains about 8.7g protein, 4.7g fat and 12.2g dietary fibre/ 100g. It contributes good amount iron (9.3mg), and also exhibits antioxidant properties because of the presence of polyphenols, carotenoids, tocopherols and tocotrienols. Little millet also exhibit an hypoglycemic effect due to the presence of a higher proportion of unavailable complex carbohydrates. Therefore millets are suitable in diabetic diet to improve metabolic control of diabetes. Traditionally, little millet is consumed as rice in millet growing areas and as fasting food in several northern states of India. Research on millet and its food value is in its infancy and its potential vastly untapped. Hence the study was undertaken to better understand the traditional foods and religious beliefs towards consumption of little millet and their application in the fabrication of therapeutic foods for the management of metabolic disorders. Varied methods of preparation of traditional and culturally accepted fasting foods with little millet such as millet-rice and upama can be applied in developing therapeutic foods. A pre-treatment of dry or moist heating yields millet-rice that has better and more desirable properties for subsequent cooking.*

Keywords: Millet fasting food. Thermal pretreatments.

2. Properties of Paddu Batter and Paddu Prepared from Little Millet

By: Deepa Madalageri, Nimala Yenagi, Veeda Padamsi, Yvan Gariepy and Valérie Orsat

Report Type: *Preliminary research report*

Date: *September 2011*

IDRC Project Number, and component number (if applicable): 106314

IDRC Project Title: Enhancing food security of rural families through production, processing, and value addition of regional staple food grains in India

Country/Region: *Research project was carried in Canada*

Full Name of Research Institution: McGill University and University of Agricultural Sciences - Dharwad

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This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.

Abstract:

Production of fermented foods is one of the oldest food processing technologies known to man. The diversities of the population of India has given rise to a large number of traditional fermented foods, among which paddu is one of the famous fermented shallow fat fried product in southern parts of India which is generally consumed as a breakfast or as a snacks item. Paddu is prepared traditionally by soaking rice, black gram dhal and Bengal gram dhal for about 6-8 hours, after which it is grinded and kept for fermentation overnight at room temperature after which the fermented batter (salt added) will be dispended in a special paddu skillet for shallow fat frying. Being a mixed cereal-legume based fermented product, it has an improved nutritive value as evidenced from the higher PER and increased amino acid and vitamin contents. The study conducted here revealed that little millet could be used successfully to replace rice in the paddu formulation has millets can offer better nutrition than rice. Texture of paddu prepared with little millet was softer, spongy, light, and shiny when compared to rice in all proportions. The increase in volume of batter after fermentation of 12 hours was higher in Little Millet compared to Rice with excellent batter flowability.

Keywords: Millet breakfast, fermented food, rice replacement.

3. Development of foxtail millet based breakfast muffin

By: Ashwini Garwad Hiremath and Nimala Yenagi

Report Type: *Preliminary research report*

Date: *September 2011***IDRC Project Number, and component number (if applicable):** 106314

IDRC Project Title: Enhancing food security of rural families through production, processing, and value addition of regional staple food grains in India

Country/Region: *Research project was carried in India*

Full Name of Research Institution: University of Agricultural Sciences - Dharwad

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This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.

Abstract: Development of foxtail millet based muffins was standardized for optimum incorporation of foxtail millet flour, fat, sugar, egg and baking powder and were evaluated for physical and organic characteristics by standard procedures and semi-trained panellists respectively. Locally available Beta-carotene rich papaya fruit was selected for enrichment in the form of dehydrated pulp powder without affecting the textural quality of muffin. Nutritional quality of enriched muffin was assessed for its proximate composition, trace minerals in comparison to refined wheat flour by standard procedures. The enriched muffin was evaluated for consumer acceptability in food service centre. The storage quality of muffin was also evaluated for changes in moisture, free fatty acid (FFA) and organoleptic qualities. Organoleptically acceptable muffin, with incorporation of 50% foxtail millet flour with sensory score of 8.08, was selected as an optimum level for foxtail millet based muffin. 10 g of dehydrated papaya powder to 120 g flour mix 1:1 preparation of foxtail millet flour and refined wheat flour was organoleptically accepted. Enriched foxtail millet flour based muffins provide higher protein (15.33%), crude fiber (1.24%) ash (0.49%), copper (0.99 mg), zinc (1.94 mg) and iron (34.11 mg) as compared to refined wheat flour muffins. The product was well accepted organoleptically upto 4 days of storage period. The enriched foxtail millet based muffin was highly acceptable by the consumers. Around 88 per cent of consumers expressed as excellent and very good. Enrichment enhanced the trace elements and ß-carotene content in foxtail millet based breakfast muffin. About 88% of consumers scored the enriched breakfast muffin as excellent and very good. Shelf-life of the enriched foxtail millet muffins was five days. Breakfast muffins prepared from foxtail millet are more nutritious as compared to muffins prepared from refined wheat flour alone. It can be recommended that using composite flours should be encouraged among food industries to make economic use of locally available raw material and to produce highly nutritious products for consumers. This will in turn help to increase the production of locally available, nutritious and underutilized millets.

Keywords: Finger millet breakfast, wheat flour replacement.

4. Marketing of Millet-Based Value Added Products

By: Sharanabasamma Patil and Nimala Yenagi

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Date: *September 2011*

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IDRC Project Title: Enhancing food security of rural families through production, processing, and value addition of regional staple food grains in India

Country/Region: *Research project was carried in India*

Full Name of Research Institution: University of Agricultural Sciences - Dharwad

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This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.

Abstract:

The objectives of this study were to assess consumer awareness towards less familiar millets. The study looked at the market potential for little millet and its value added products; the development of penetration strategies to introduce little millet and its products; finding out the satisfaction level of millet and its products from the respondents; finding out effective strategy to be built for the promotion and sale of little millet products; and formulate suggestion strategies to adopt towards enhancing the sale of little millet products.

Ragi is very well known millet among the millets on which this survey was conducted followed by Little millet, foxtail millet & Barnyard millet. So there is a need for developing an awareness for the millets namely, Little millet, foxtail millet & Barnyard millet. Hubli – Dharwad area is best suited for marketing of Little millet and its products. To penetrate into the market the best channel for marketing is door to door selling. Small package size (100gms to 200gms) with low economic price is most preferable for the promotion and sale of Little millet and its products. In order to enhance the sales of Little millet and its products, it is suggested to promote them through various campaigns, by participating in food melas and other health related activities. The consumers are very health conscious and the products produced must highlight and give value added benefits towards health. The Little millet and its products must be marked with 'safety and healthy logos' which ensures the quality and nutritional importance of the product.

***Keywords:** Millet, marketing, health.

5. Knowledge, Attitude and Practice of Farm Women of Millet Growing Areas Towards Millet Consumption

Yenagi N B[*1], **Shalmali Naik[1]**, Josna B.[1],

Report Type: Poster presentation

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Location: Dharwad

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Country/Region: *India (Karnataka)*

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This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.

Abstract: Cereals and millets provide the cheapest source of calories in people's diet, but unfortunately the support for production and consumption of rice and wheat through PDS system has resulted in neglect of significant number of small rain fed farmers engaged in cultivation of various small millets. This has led to reduction in conservation, cultivation and consumption of these crops. An attempt was made to assess the nutrition knowledge, attitude and practice towards consumption of millets in growing areas. The study was conducted in one of the major little millet growing districts of Karnataka state, Haveri. Four adopted and two control villages from two talukas were selected for the fulfilment of project objectives of IDRC millet project, UAS Dharwad. Totally 240 farmers were selected for bench mark survey and assessed the grain consumption pattern as one of the objectives. Further sub sample of 40 farm women of marginal and small little millet growing farm families from four adopted villages (10 from each) were selected for assessment of nutrition knowledge. The nutrition questionnaire was developed covering areas like knowledge of nutrition, processing and therapeutic value of millets, importance of different types of foods, attitude towards millet consumption, their acceptability, distribution of cereals through PDS, practice related to type, quantity and frequency of consumption of cereals, millets and pulses. The results from the study revealed that rice and jowar were the most common grains consumed in the form rice and *roti* respectively but only 1.93 per cent was consuming little millet in their daily diet. Rice and wheat were purchased from the PDS system at subsidised prices. Knowledge of farm women towards millet consumption was 64.45 per cent and had positive attitude towards millet consumption. But the practice of millet consumption was very poor (2.5 %). However 100% utilisation of little millet and foxtail millet was observed during special occasions and festivals. Commonly consumed pulses were red gram dhal, green gram, cowpea and moth bean. Baking and boiling were the common cooking methods followed. The study concludes that nutrition awareness is an important part of the solution for enhancing the dietary diversity and for addressing the current nutrition issues of the rural community.

Keywords: Millet, Nutrition Knowledge, attitude, consumption

6. Batter Properties of Little Millet in Comparison to Rice and its Effect on Physical and Textural Qualities of *Paddu* - An Indian Fermented Breakfast Food

D.M.Madalageri, N.B.Yenagi, Y. Gariepy, V.Orsat and G.S.V. Raghavan and V.Padmasami

Report Type: Oral presentation

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***IDRC Project Title:** Enhancing food security of rural families through production, processing, and value addition of regional staple food grains in India

***Country/Region:** *India (Karnataka) and Canada*

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***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

***Abstract:**

Objectives: To study the physico-chemical characteristics of batter prepared with addition of different proportion of little millet and to study the physical and textural quality of *paddu* in comparison to rice.

Methodology: *Paddu* is one of the fermented shallow fat fried foods in southern part of India which is generally consumed as breakfast. In the present study *paddu* was prepared with little millet and mixture of pulse and spice (blackgram dhal, Bengal gram dhal and methi seeds) in the proportion of 2:1,3:1,4:1,5:1 and 6:1. Ingredients were soaked for about 6-8 hours, ground to fine paste and kept for fermentation overnight(12h) at room temperature. The fermented batter was poured and shallow fat fried in a special *paddu* skillet. Batter properties and physical qualities of cooked paddu were studied for increase in volume during fermentation, pH, viscosity and colour and weight, colour and texture respectively in comparison with rice.

Results and Discussion: The optimum proportion of addition of little millet and rice to pulse was 6:1 and 4:1 respectively with respect to volume of batter, colour and viscosity. The colour and textural quality of paddu prepared from little millet was comparable to the quality of rice paddu. Thus, a novel food prepared from little millet can be popularized as micronutrient rich fermented food for food and nutrient security in millet growing areas.

***Keywords:** Little millet, Paddu, Texture, breakfast food

7. Promotion of Culturally Accepted Traditional Fermented Breakfast of Little Millet *Paddu* as Novel Food in Catering Centers for Enhancing Nutrition and Economic Security Through Local Cereals

N.B.Yenagi,

Report Type: *Poster presentation*

Date: December 15-16, 2011

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Location : Mysore,

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***Abstract:**

Objective: To explore the feasibility of introduction of little millet as value added traditional fermented breakfast, *paddu* in catering centres of educational institution and rural canteen and evaluation of fermented foods for large scale production and economic analysis.

Methodology: One trained and active women entrepreneur each from urban and rural areas were selected for initiation of fermented break fast food of little millet as value added product in the premises of college of Rural Home Science, Dharwad and in one of the canteens of millet growing village of Jekinakatti, of Haveri district, Karnataka . The product was introduced once in a week to college students, staff and rural customers for a period of six months and evaluated for acceptability and market sustainability. Net profit was calculated by excluding the cost of food ingredients, fuel, packaging and labour.

Results and Conclusion: Women entrepreneurs could introduce 1-2 kg little millet every week as a fermented healthy breakfast food for around 25-50 customers in urban as well as rural areas. The process of supply is continuous and customers have highly accepted traditional fermented food. The percentage of regular visitors was 80-90%. The net profit was around 80%. The locally grown micronutrient rich little millet has good market potential in introducing healthy fermented breakfast food item in catering centres through enhancing the economic security of women entrepreneurs as well as nutrition security of the urban and rural population.

Key words : Little millet, women entrepreneur, paddu, empowerment,

8. Nutritional Quality and Sensory Attributes of Millet Recipes Designed for the Management of Diabetes

Yenagi N. B*[1] , **Josna B[2]**, Shalmali Naik[3],

Report Type: Poster presentation

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Location: Dharwad

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Country/Region: *India (Karnataka)*
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This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.

***Abstract:**

Millets are appreciated for their content of dietary fibre, trace elements and antioxidant components. Scientific studies have proved that millet products have high satiety value, low digestibility, low glycaemic value and has been considered as therapeutic foods in management of diabetes. However color and taste are the hindering factors for wide acceptability among the consumers. Hence the present study was conducted to make use of the therapeutic quality of millets in developing acceptable recipes for the cost effective management of diabetes. Ragi flour, decorticated little millet and foxtail millet were used as whole grains. Recipes were developed with addition of other functional food ingredients and application of suitable traditional cooking methods such as steaming, fermentation, roasting and boiling to improve the color, taste, flavour to enhance the satiety value. Totally 16 therapeutic recipes of millets were developed and evaluated for nutritional quality. Sensory attributes were evaluated by 19 trained panelists of Department of Food Science and Nutrition, UAS, Dharwad by using nine-point hedonic scale. Per serving of millet recipes contributed energy and protein in the range of 102 to 499 Calories and 3.0 to 11.0 g respectively. It was observed that mean scores for color, appearance, texture, flavour, taste and overall acceptability ranged from 7.0 to 8.11, 6.44 to 7.72, 6.56 to 7.89, 6.44 to 7.89, 6.67 to 7.94 and 6.94 to 8.06. Most of the recipes were rated as 'moderately accepted'(87.5%). Among all the recipes foxtail millet steamed *methi kadabu* was highly accepted (8.06) followed by little millet steamed *kotte kadabu* (7.94) and little millet vegetable pulav (7.79). Thus therapeutic millet recipes can be recommended in planning of diabetic diet and also in hospital catering department.

***Keywords:** Millet recipes, sensory attributes, diabetic

9. Nutritional Quality and Shelf-Life of Foxtail Millet Breakfast Muffin

GarwadHiremath A, Yenagi N.B and **Sharada G.S.**,

Report Type: Poster presentation

Date: Januaury 20-21, 2012

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Location: Pune

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***Abstract:**

Breakfast is the power meal of the day and should be well balanced with energy, body building and protective nutrients. urban consumers are interested in convenient foods and prefer usually bakery products for breakfast. Muffins are popular bakery products and generally fit in the palm of an adult and are intended to be consumed by an individual in a single sitting. Foxtail millet as a coarse grain is a good source of protein, micronutrients, phytochemicals and dietary fiber. It blends very well with refined wheat flour in preparation of diversified cookies. Foxtail millet incorporated cookies are rich in protective nutrients and fibre and are highly acceptable by the consumers. In the present study foxtail millet was used in designing breakfast muffin and evaluated for nutritional and storage quality. Muffins were prepared by using whole grain flour of foxtail millet and refined wheat flour in the ratio of 50:50 and control which contains 100% refined wheat flour. Further millet muffin were enriched with papaya powder. The moisture, protein, fat, ash, crude fiber and carbohydrate contents of control muffin were 24.95, 12.87, 24.80, 0.67, 0.11 and 36.59 g/100g respectively. Replacement of foxtail millet flour increased the nutrient composition of breakfast muffin significantly. The protein, crude fibre and mineral contents increased by 12.5, 90 and 28 per cent respectively. Copper zinc and iron contents increased by 34.5, 24.5 and 49.9 per cent respectively. Further, enrichment of muffins significantly increased the copper, zinc, and iron by 30, 5 and 41 per cent respectively. The total carotene content increased by 93% (291.36µg/100g). The shelf life of control and millet muffin was 5 and 4 days respectively based on sensory evaluation. Thus, locally grown staple millets can be incorporated to enhance the nutritional quality of convenient food products.

***Keywords:** Breakfast, Foxtail millet, Muffin

10. **Evaluation of *Chakkli* Available in Local Market for Fat Content and Sensory attribute**

Singson Hoitinkim, Yenagi N. B. and Sharada G.S

Report Type: Poster presentation

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Location: Pune

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***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

***Abstract:**

Chakkli, a deep fat fried product is one of the favoured savoury item in South Indian market. An investigation was undertaken to evaluate the *chakkli* available in Dharwad local market for the fat content and sensory attributes. Totally 23 *chakkli* samples from different shops in different areas of Dharwad were collected randomly. Fat estimation was done for 10 random samples by using standard AOAC procedure and sensory evaluation by using 9 point hedonic scales with 10 panel members. 70% of samples collected from the market were home-made. The fat content varied from 17.6- 42.3% with a mean of 31.71 % and there was a significant difference between each samples, and the sensory scores varied from 4-7.9, 4-7.56, 3.1-7.6, 3.8-7.7 and 3.2-7.8, respectively for appearance, colour, texture, taste and overall acceptability. Only 34% of market samples fell in the category of 'like slightly' and 'like moderately' in context with overall acceptability. The study indicates that there is a wide variation in the fat content and sensory attributes. There is a need to improve the sensory attributes of chakkli prepared at household level to maintain the quality at the market level.

***Keywords:** Millet, Chakali, Sensory attributes

11. **Promotion of Home Based Food Processing Micro Enterprises through Technological Empowerment of Rural Women for Household and Nutrition Security**

N.B.Yenagi,

Report Type: Oral presentation

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Location: New Delhi

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***Country/Region:** *Canada and India (Karnataka)*

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***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

***Abstract:** Food processing is an integral part of agriculture production and utilization system. It also plays a key role in value addition, thereby increasing the income of the farmers, creating employment opportunities, diversifying the economy and foster rural industrialization. The processed food sector is expected to reach newer dimensions in future for providing better 'ready to use' and 'ready to eat' health foods, ethical foods, and traditional festival foods for better food and nutrition security. Further, well managed food processing units ensure that the producer gets remunerative price for his product and the consumer pays for higher and assured quality. Department of Food Science and Nutrition of the University of Agricultural Sciences, Dharwad has done a commendable research on innovative technologies on value addition to regional staple cereals, which are highly suitable for fragile and vulnerable agro ecosystems, suitable for sustainable agricultural contribution to food and nutrition securities and incomes of the poor. This was done in collaboration with international developmental agencies like CIDA and IFAD during 2003-2010. Developed technologies such as therapeutic foods for management of diabetes, supplementary foods for anemia, novel bakery foods, standardized traditional foods, millet based fermented breakfast foods and papads, value added millet snacks and ragi based health foods were demonstrated to rural women entrepreneurs through trainings. More than one thousand women entrepreneurs were trained along with nutrition awareness programme by covering five districts of Northern Karnataka. The lower consumption of energy, protein and mild deficiency of iron revealed the poor nutritional status and physical efficiency among the members of women organization. Nutrition awareness improved the knowledge to the extent of 25% in three months of duration. Inclusion of processed foods developed by women entrepreneurs in feeding programmes to rural adolescent girls, school children and farm women laborers revealed better impact on nutrition security. The home based food processing activities were found to be positive and highly remunerative. The technological interventions showed potential improvement in socio-economic conditions and food

security status. Further promotion of indigenous and value added millet products through demonstrations, trainings, exhibitions, cooking competitions and messages through radio, magazines and daily news papers have enhanced the knowledge and readiness to incorporate millets in the daily diet to improve nutrition security. Awareness campaigns have improved the market structure with respect to availability of millets in retail shops other than weekly *mandis.* Several training programs organized under international project-IFAD in collaborative institutions like MSSRF, Chennai, UAS-Dharwad, and UAS-Bangalore on value addition to millets, packaging, marketing of products and management of accounts and exposure visits contributed substantially to the knowledge level of the farmers, changing their outlook on the agricultural practices and the over all self confidence of the individuals, in particular the women and the community. The role of youth in these processes deserves special attention. They were in the forefront and showed high interest in learning new technologies, capturing new opportunities and changing to the better. But there was low rate of adoption technologies due to non availability of suitable processing units, infrastructure constraints, lack of power availability, lack of transport, lack of communication and marketing facility. Emphasis needs to be given on developing linkages and co-ordination among different agencies responsible for marketing.

***Keywords:** Home industry, Food processing, Women empowerment, Food security and Nutrition security

12. **Effect of Hydrocolloids on the Properties of Little Millet (*Panicum sumatrense*) *Chakli***

Hoitinkim Singson[1], Nirmala Yenagi[1], Valerie Orsat[2] and Yvan Gariepy[21]Department of

Report Type: *Oral presentation*

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***IDRC Project Number, and component number (if applicable): 106314**

***IDRC Project Title:** Enhancing food security of rural families through production, processing, and value addition of regional staple food grains in India

***Country/Region:** *Canada and India (Karnataka)*

***Full Name of Research Institution:** McGill University and University of Agricultural Sciences Dharwad

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***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

***Abstract:** A study was conducted to evaluate the physical characteristics and sensory attributes of little millet *chakli* modified with addition of hydrocolloids to reduce the fat content. Different hydrocolloids viz. Xanthan, Carboxymethylcellulose (CMC), K4M-Hydroxypropylmethylcellulose (HPMC) and E4M-Hydroxypropylmethylcellulose (HPMC) were added at 0.25, 0.50 and 1.00 % for little millet *chakli* flour mix. The oil uptake and moisture content were evaluated by standard AOAC(1984) methods and texture by Instron-4502, colour by Minolta chromometer and sensory evaluation by 15 semi-trainedpanellist.Additionof hydrocolloids at 0.25, 0.50 and 1.00 % decreased the oil uptake to 8.91, 14.72 and 29.65 % respectively with Xanthan, 0.24, 45.71 and 59.10% respectively with CMC, 10.22, 21.86 and 27.77 % respectively with K4M (HPMC), 10.54, 18.57 and 24.96 % respectively with E4M (HPMC). The moisture content increased with increasing percentage of the hydrocolloid addition. The hardness of the texture also increased with increase in hydrocolloid percentage. Thecolour of the *chakli* turned slightly lighter with hydrocolloid addition.The sensory evaluation revealed that the control *chakli* scored highest and that the overall acceptability of the *chakli* decreased with increase in hydrocolloids percentage. Addition of Xanthan and E4M upto 0.50 % had no effect on the sensory scores and K4M (HPMC) had no effect up to 1.00 % on the sensory scores. However for CMC the addition of hydrocolloids even at 0.25 % had a significant effect on the sensory scores. The study thus supports the addition of hydrocolloids to decrease the oil uptake of fried *chakli.*

***Keywords:** Little millet, hydrocolloids

13. **Acceptability of Flaxseed and Samai Incorporated Low Fat Baked Products**

B.Josna, Nirmala Yenagi and V. Vijayalakshmi

Report Type: *Oral presentation*

Date: 20-22ndSeptember 2012

Location :ICBPN,2012 at Kottayam, India

***IDRC Project Number, and component number (if applicable):** 106314

***IDRC Project Title:** Enhancing food security of rural families through production, processing, and value addition of regional staple food grains in India

***Country/Region:** *Research project was carried in India*

***Full Name of Research Institution**: University of Agricultural Sciences - Dharwad

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***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

***Abstract:** Flaxseed (*Linum usitatissimum*) is basically used for production of industrial linseed oil. It is not widely used as an edible grain in many countries. Whereas, samai (*Panicum summatrense*) or little millet is considered as minor millet which is generally used as a bird feed. Flaxseed is the richest source of α-linolenic acid and n-3 fatty acid and also contains other components like dietary fiber, mucilage, lignans and phenolic compounds. Samai also has beneficial nutrients like protein, high amounts of fiber, B-complex vitamins, essential amino acids minerals and phytochemicals including phytate. The nutrient components of flaxseed and samai are potentially beneficial for maintaining good health and reducing incidence of various diseases like coronary heart diseases, cancer, rheumatoid arthritis and hypertension. They have also shown hypocholesterolemic effects. However, the health benefits of flaxseed and samai are not fully utilized because the consumption of flaxseed and samai are low due to lack of knowledge of the consumers and limited availability in the market. Since, the existing generation is interested and consume more of bakery products, the present study was designed to incorporate flaxseed and samai in baked products where both are rich in fiber and many health beneficial properties and to determine the acceptability of products. Bakery products viz., bread, muffin and masala biscuit were developed by incorporating flaxseed at 10, 20 and 40 per cent levels. In all the products a combination of 50 per cent refined flour and 50 per cent of samai flour were used as the base. Muffins and masala biscuits were evaluated by sensory evaluation trials. Bread was excluded due to its poor attributes and poor end product. Among different levels of flaxseed incorporated muffins and masala biscuits, 20 and 40 per cent flaxseed incorporated masala biscuits were highly accepted by obtaining high overall acceptability scores.

***Keywords:** Flaxseed, little millet, low fat, medicinal properties, bread, muffin, masala biscuit

14. **Project review: Enhancing Food Security of Rural Families Through Production, Processing and Value Addition of Regional Staple Food Grains in India**

Murugesan, R and V. Orsat

Oral presentation

Date: October 17th 2012

Location : Global Food Security Conference

***IDRC Project Number, and component number (if applicable):** 106314

***IDRC Project Title:** Enhancing food security of rural families through production, processing, and value addition of regional staple food grains in India

***Country/Region:** *Canada-India*

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***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

Abstract:

A summary of the project activities was presented for improvements in agronomical practices, harvesting, postharvest handling and value addition of minor millets.

15. Himalayan Food Security Past, Present and Future

Anil P. Joshi and V. Orsat

Report Type: *Poster presentation*

Date: October 17th, 2012, Global Food Security Conference

Location : McGill University, Montreal, Canada

IDRC Project Number, and component number (if applicable): 106314

IDRC Project Title: ***Enhancing food security of rural families through production, processing, and value addition of regional staple food grains in India***

Country/Region: *Canada and India*

Full Name of Research Institution: McGill University

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This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.

16. **Rejuvenation of minor millets for ecological,**

economic and nutrition security

Dolli S.S. , Arvindkumar B.N., Yenagi N.B., Suma B., Josna B., Handigol J. and V. Orsat

Report Type: *Poster presentation*

Date: October 17th, 2012, Global Food Security Conference

Location : McGill University, Montreal, Canada

IDRC Project Number, and component number (if applicable): 106314

IDRC Project Title: ***Enhancing food security of rural families through production, processing, and value addition of regional staple food grains in India***

Country/Region: *Canada and India (UASD)*

Full Name of Research Institution: McGill University

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This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.

17. **Value chain addition for the promotion of millets for nutritional and food security**

Yenagi N.B., Josna B., Dolli S.S. , Suma B., Handigol J. , Arvindkumar B.N. and V. Orsat

Report Type: *Poster presentation*

Date: October 17th, 2012, Global Food Security Conference

Location : McGill University, Montreal, Canada

IDRC Project Number, and component number (if applicable): 106314

IDRC Project Title: ***Enhancing food security of rural families through production, processing, and value addition of regional staple food grains in India***

Country/Region: *Canada and India (UASD)*

Full Name of Research Institution: McGill University

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This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.

18. Extraction from grain amaranth

Siddhartha P Joshi and Valerie Orsat

Report Type: *Poster presentation*

Date July, 2012, Joint meeting of NABEC/CSBE

Location : Lakehead University in Orillia, Ontario, Canada

IDRC Project Number, and component number (if applicable): 106314

IDRC Project Title: ***Enhancing food security of rural families through production, processing, and value addition of regional staple food grains in India***

Country/Region: *Canada and India (Karnataka)*

Full Name of Research Institution: McGill University

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Abstract:

There is renewed interest in the grain amaranth which grows in many tropical, subtropical as well as temperate countries. Amaranth produces good yields of cereal-like seeds under arid conditions and in poor soils where conventional cereal crops do not grow well. Approximately 60 species of amaranth are recognized, in which several species are considered as weed. The oil content of amaranth seed is low varying between 6-9%, so usually oil would not be extracted from the seed, but there may be possibilities when it would be advantageous to extract oil from its byproducts. This research developed methodologies to extract oil from amaranth byproduct using microwave assisted and conventional extraction methods, to characterize the various bioactive components of unsaponifiable fraction of its oil.

19. Effects of popping on the nutrient availability of little millet

Priyanka Kapoor and Valerie Orsat

Report Type: *Poster presentation*

Date July, 2012, Joint meeting of NABEC/CSBE

Location : Lakehead University in Orillia, Ontario, Canada

IDRC Project Number, and component number (if applicable): 106314

IDRC Project Title: ***Enhancing food security of rural families through production, processing, and value addition of regional staple food grains in India***

Country/Region: *Canada and India (Karnataka)*

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This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.

Abstract:

Food industries are directing their focus towards the development of functional foods and food ingredients. Several ancient grains such as kamut, millet and sorghum are being reintroduced as a source of functional nutrients. Millets are minor cereals which have high nutritional value, are non-glutinous and are easily digestible. In spite of this, their consumption is limited. This could be attributed to their non-availability in ready-to-eat or ready-to-use foods. Processing of millets to incorporate them in ready-to-eat foods can increase their nutritional value, availability and economic value. Thermal processing can improve the bioavailability of certain vitamins and minerals and also help in lowering the water activity thus, preventing the growth of microorganisms. Thermally processed foods also have better organoleptic properties. One interesting method of thermal processing is popping. Popping enhances the carbohydrate and protein digestibility by inactivating some of the enzymes and enzyme inhibitors. Popping also improves the color, appearance, aroma and taste of the processed food commodity. In the current research, the popping quality of little millet (*Panicum sumatrense*) and the effect of popping on the nutrient composition and the functional properties of the millet have been studied.

20. Water absorption characteristics of Millets

Ramesh Murugesan and Valerie Orsat

Report Type: *Oral presentation*

Date July, 2012, Joint meeting of NABEC/CSBE

Location : Lakehead University in Orillia, Ontario, Canada

IDRC Project Number, and component number (if applicable): 106314

IDRC Project Title: ***Enhancing food security of rural families through production, processing, and value addition of regional staple food grains in India***

Country/Region: *Canada and India (Tamil Nadu)*

Full Name of Research Institution: McGill University

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This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.

Abstract:

Water absorption characteristics of various millets, i.e. Foxtail millet, Barnyard millet and Little millet were investigated. Millets were soaked in water for various durations at different water temperature to study the water absorption property of millets. The millets were soaked for 4, 8 & 12 hours at different water temperature such as 30, 40 & 50° C. The water absorption character of millets was correlated with the physiological properties of millet. Millet's density, hardness, color change, water intake and change in length, breath and width were calculated in the experiment.

21. Physical Properties and Sensory Evaluation of Little Millet Incorporated Bread

Mamata Mannuramath, Nirmala Yenagi, Valerie Orsat and Yvan Gariepy

Date: Presented in November 2012

Location : 44th National Conference of NSI, Tirupati, India

***IDRC Project Number, and component number (if applicable): 106314**

***IDRC Project Title:** Enhancing food security of rural families through production, processing, and value addition of regional staple food grains in India

***Country/Region:** *Canada and India (Karnataka)*

***Full Name of Research Institution:** McGill University and University of Agricultural Sciences Dharwad

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***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

***Abstract:**

Bread is a bakery product priced for its taste, aroma and texture. Wheat is the grain of choice in bread preparation due to its high gluten level. There are several attempts at partial substitution of wheat flour with flour from readily available, cheap, indigenous ingredients like millets. An attempt was made to incorporate little millet in the preparation of bread as a good source of dietary fiber and trace elements. Decorticated little millet flour was incorporated at 10, 30 and 50 percent and compared with control bread. Developed breads were evaluated for physical dimensions, texture, crumb colour and for sensory attributes. The weight and height of breads ranged from 111.6 to 116.30 g and 4.20 cm to 6.70 cm respectively. Increased addition of little millet flour decreased the height significantly, whereas length and breadth of the breads did not differ much. The hardness values of the millet breads were higher when compared to wheat bread. Cohesiveness and adhesiveness did not differ significantly. L, a, b values of the color differed significantly. Wheat bread was whiter than millet bread. Millets breads were more yellowish in color. Sensory evaluation revealed that there was no significant difference found between control and breads prepared with 10 and 30 percent millet flour. Considering the health benefits of little millet, it can be recommended to incorporate millet flour up to 30 percent without affecting sensory quality of the bread.

***Keywords:** Bread, little millet

22. Evaluation of Little Millet *Paddu* for Functional, Nutritional, Microbiological and Sensory Attributes as Compared to Rice *Paddu*

Deepa M. Madalageri[1], Nirmala B. Yenagi[1] and Geeta Shirnalli[2]

Report Type: *Oral presentation*

Date: Presented in November 2012

Location : 44th National Conference of NSI, Tirupati, India

***IDRC Project Number, and component number (if applicable):** 106314

***IDRC Project Title:** Enhancing food security of rural families through production, processing, and value addition of regional staple food grains in India

***Country/Region:** *Research project was carried in India*

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***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

***Abstract:** The present study was undertaken to evaluation of little millet paddu for functional, nutritional, microbiological and sensory attributes as compared to rice paddu . The standardized proportion of ingredients (Cereal to pulse mix) ie., 6:1and 4:1 was used for the preparation of little millet *paddu* and rice paddu respectively. Keeping the other processing conditions constant like, soaking the ingredients for 6 h and fermenting the batter for 14 h and using this batter paddu were prepared. Significant difference in the increase in the volume, bulk density, specific gravity, pH and titratable acidity of little millet batter was observed when compared to rice batter. The changes in physical characteristic of *paddu* with respect to total volume, average volume and bulk density of *paddu* were significant for little millet and rice *paddu* , whereas the total number, total weight of *paddu* and average weight of *paddu* did not show significant changes. Little millet paddu was highly nutritious than rice *paddu* and did not show significant difference in the scores of sensory attributes. Significant difference in the microbial population was observed between little millet and rice with irrespective of the duration of fermentation of batter. *Leuconostoc mesenteroides, Lactobacillus spp.* and yeast dominated the fermentation process among all the microorganisms. In little millet *paddu* yeast were observed whereas in rice *paddu* bacteria were present.

Keywords:** ***Paddu , little millet

23. Nutritional Quality and Sensory Attributes of Little Millet*(Panicum sumatrense)Chakli* Compared with Rice *Chakli*

Hoitinkim Singson, NirmalaYenagi and G.S. Sharada

Report Type: *Poster presentation*

Date: Presented in November 2012

Location : 44th National Conference of NSI, Tirupati, India

***IDRC Project Number, and component number (if applicable):** 106314

***IDRC Project Title:** Enhancing food security of rural families through production, processing, and value addition of regional staple food grains in India

***Country/Region:** *Research project was carried in India*

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***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

***Abstract:** Little millet is a locally accepted staple cereal of northern Karnataka. In the present day there is not much positive reaction from the farmer to grow and consume this staple cereal as rice is replaced under public distribution system. Value addition is one of the strategies for commercial exploitation of little millet in diversified form. Fried snacks as convenient foods occupy a major share in the national and international market. In the present study, the optimized recipe of *chakli* prepared from little millet was evaluated for nutritional and sensory attributes as compared to rice *chakli*. The results of the nutrient composition of little millet *chakli* revealed that fat (32.89 %), protein (12.75 %), crude fibre (2.62 %) and ash (3.49 %) contents were significantly higher than rice *chakli* (32.92, 11.16, 1.32 and 3.19 % respectively). The sensory scores of little millet *chakli* for appearance and colour, texture, flavour, taste and over all acceptability were 8.1, 7.5, 7.7, 7.7 and 7.5 respectively and were within the acceptable range. The stored little millet *chakli* was sensorily acceptable up to 2 months when packed in 150 gauge polyethylene cover and stored at ambient temperature. Per serving (50 g) of little millet *chakli* contributes 16 % energy, 21 % protein, 65 % fat, 6 % calcium and 37 % iron to meet the RDA adequacy of pre-school children. This newly designed novel *chakli* of little millet can be commercially popularized as nutri-snack in millet growing areas.

***Keywords:** Little millet, *chakli*

24. Physico-Chemical Changes of Batter and *Paddu* of Little Millet during Progress of Soaking and Fermentation

Deepa M. Madalageri, Nirmala B. Yenagi and Kasturiba B.

Report Type: *Research report*

Date: Presented in November 2012

Location : 44th National Conference of NSI, Tirupati, India

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***Country/Region:** *Research project was carried in India*

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***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

***Abstract:** The present study was undertaken to evaluate the physico-chemical changes of batter and *paddu* of little millet during progress of Soaking and fermentation. For optimization, soaking and fermentation the optimized proportion of ingredients (cereal: pulse mix) ie., 6:1 was taken. The variation in duration of soaking hours from 4 to 8 and fermentation of 12 h increased the volume of batter significantly. Significant decrease in the bulk density, specific gravity, pH and increase in titratable acidity in the fermented batter was observed during progress of soaking and also fermentation hours. The changes in physical characteristics of *paddu* with respect to total weight and volume of *paddu*, average weight and volume of *paddu* and bulk density was observed with variation in duration of soaking and fermentation, however this was non significant. The soft texture with acceptable taste was observed in *paddu* prepared from 6 h soaked grains and considered as optimum condition for *paddu* preparation. The variation in duration of fermentation hours from 8 to 24 h by 6 h soaking of grain increased the volume of batter significantly. The *paddus* prepared from 14 and 16 h of fermented batter were softer, had good expansion, acceptable sour taste and had higher overall acceptability. The optimum duration of soaking and fermentation was 6 h and 12 to 16 h respectively.

***Keywords:** little millet, *paddu,* batter

25. Nutritional Evaluation of De-Hulled Little Millet in Centrifugal Sheller and Milled in Existing Emery Flour Mill and Development of Products for Household Consumption

Nirmala B. Yenagi, Roopa U, Josna B and Mamata Hazare

Report Type: *Oral presentation*

Date: Presented in November 2012

Location : 44th National Conference of NSI, Tirupati, India

***IDRC Project Number, and component number (if applicable):** 106314

***IDRC Project Title:** Enhancing food security of rural families through production, processing, and value addition of regional staple food grains in India

***Country/Region:** *Research project was carried in India*

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***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

***Abstract:** Conventionally the millets are milled in existing emery flour mill. But the major problems encountered are separation of husk, more breakage, poor recovery of whole polished grains and over polishing of grains. Drudgery reducing processing equipments is very essential for reintroduction of nutritious millets in the regular diet of millet growers. A Centrifugal sheller designed for de hulling of little millet at household level operating under single phase by McGill University, Canada in collaboration with UAS Dharwad under IDRC Millet project was used to de-hull little millet which removes only the hull. The nutrient composition of de-hulled little millet was compared with grains milled in existing emery flour mill. Eleven recipes were prepared from de hulled and polished little millet grain and flour for regular household consumption. Products were evaluated for sensory attributes by 30 semi trained panel members using 9 point hedonic scale. The nutrient composition showed that de hulled little millet had significantly higher fat, ash, crude fibre, energy and iron than polished little millet in emery mill. The results of sensory evaluation revealed that the scores were significantly higher in most of the products prepared from polished little millet grains than de hulled grains for color, appearance, texture and overall acceptability. The sensory scores of different products prepared from de hulled grains were ranged from 5.53 to 7.57. Since de hulled little millet products were within the acceptable range, these products can be popularized for regular consumption at household level for better nutrition security.

***Keywords:** little millet, de hulling

26. Sensory Attributes of Fibre Enriched Low Fat Masala Biscuits from De Hulled Little Millet Flour

Josna B, Nirmala B Yenagi and Mamata Hazare

Report Type: *Poster presentation*

Date: Presented in November 2012

Location : 44th National Conference of NSI, Tirupati, India

***IDRC Project Number, and component number (if applicable):** 106314

***IDRC Project Title:** Enhancing food security of rural families through production, processing, and value addition of regional staple food grains in India

***Country/Region:** *Research project was carried in India*

***Full Name of Research Institution:** University of Agricultural Sciences - Dharwad

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***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

***Abstract:**

Little millet (*Panicum summatrense*) is a minor millet which is generally used as bird feed. Even though it has got beneficial nutrients, it has disappeared from the food basket of both rural and urban population. Moreover, influence of western diet and sedentary life style has resulted into a number of health disorders. Hence an effort was made to reintroduce little millet as fibre and micronutrient rich product to the population. Since, biscuit is one of the most popular crispy snack items enjoyed by all age groups. In the present study low fat salt biscuits were prepared by incorporating 50, 60 and 75 per cent levels of de hulled little millet flour and evaluated for sensory attributes by 30 semi trained panel members using 9 point hedonic scale. 50 and 60 per cent incorporated salt biscuits were accepted though they had a slight bitter after taste. Hence, biscuits were modified to masala biscuits by incorporating omum and cumin seeds, characterised by medicinal properties which masked the after taste. Both 50 and 60 per cent levels were highly accepted and obtained high overall acceptability scores. Since there was no significant difference in 50 and 60 per cent levels, acceptability of 60 per cent incorporated de hulled little millet masala biscuit was preferred. The study also revealed that there was no significant difference for sensory attributes of biscuits prepared from de hulled and polished grains.

***Keywords:** Little millet, biscuit

27. Impact of Nutrition Awareness Programme of Millet and Value Addition on Knowledge Level of Rural High School Children from Millet Growing Areas of Karnataka

Nirmala B. Yenagi, Shalmali Naik, Josna B and Sumalata Byadgi

Report Type: *Poster presentation*

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Location : 44th National Conference of NSI, Tirupati, India

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***Full Name of Research Institution:** University of Agricultural Sciences - Dharwad

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***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

***Abstract:**

Millets are the major staple food grains of the farming community as they provide both food and nutrition security. However processing and value addition to major cereals such as wheat and rice have changed the dietary pattern of the people. But millets are re- gaining nutritional importance in urban community as therapeutic foods in the management of metabolic disorders. The present study was an attempt to create nutrition awareness for younger generation to accept millets as nutritious and easily accessible staple food at low price for better nutritional status. Nutrition awareness programme on millets was given to 410 high school children of age 13-15yrs from three villages of millet growing district of Haveri. 151 children were assessed for their initial and post knowledge. Nutrition awareness programme was conducted in ten sessions through lectures, charts, blow-ups, live models and demonstration of millet recipes. Millet snacks were also distributed during sessions for taste and acceptability. Millet book was given to children at the end of awareness programme and after three months post nutrition knowledge was assessed. Initial knowledge level of girls and boys was 39.25 and 36.38% respectively. Nutrition awareness programme had a positive impact on the knowledge of millets and the post knowledge was 47.65 and 44.13% in girls and boys respectively. Nutritional knowledge among school children significantly increased (t value-8.39**) at the end of awareness programme. Most of the children revealed that they have not at all tasted millet, even though they are growing. Children are interested to have millet snacks and health drinks in school feeding programmes. Such nutrition awareness programmes should be organized regularly in schools for promotion of nutritious millets in the daily diet for better nutrition and health.

***Keywords:** Millets, Nutrition awareness

28. Little Millet Milling System of Small Capacity for Value Addition

Nirmala Yenagi, Mamatha Hazari, Rebbecca[1], Roopa U and Kiran Shindhe[2]

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Date: Presented in December 6th 2012

Location: CFTRI Mysore, India

***IDRC Project Number, and component number (if applicable): 106314**

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***Country/Region:** India (Karnataka)

***Full Name of Research Institution:** University of Agricultural Sciences, Dharwad

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***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

ABSTRACT:

In Karnataka Little millet is produced in 20 thousand hectare area with production of 13 thousand tones. The crop is processed for commercial use at Maharashtra. Due to a lot of drudgery associated with cleaning, de-hulling, and de-cortication women are not utilizing for home consumption and growers have reduced the area of cultivation. Promotion of consumption of millet is one of the important thrust areas for improving the physical efficiency and nutritional status of farming community. These grains have been recognized as therapeutic grains for management several metabolic disorders as these are rich source of dietary fiber , phyto-chemicals and antioxidants. In the present study a machine developed for milling of little millet under CIFSRF, IDRC was evaluated. This machine was designed to run in single phase with ½ HP motor. It was optimized to improve the de-hulling efficiency of 2 varieties of little millet(local and improved variety) for space between 2 rollers, feed rate, and number of passes. The results showed the variation in de hulling efficiency between the varieties. The local variety- malli savi showed maximum de-hulling of 83.59% at 0.330mm spacing, feed rate 2, with 3 passes. Whereas in improved variety -CoSa4 showed 86.29% de- hulling at 0.312mm spacing, feed rate 2, with 3 passes. In one hr the out - put of de-hulling was 5kg and electricity consumption of 0.36 units. The de-hulled grains were intact with bran and found suitable for preparation of fermented foods, upama, roti, and thaalipattu . Value added fiber enriched biscuits, and bread were also acceptable. The shelf life of de-hulled grains and flour were 2 and 1 months respectively.

29. Response of Hydrothermal Treatment on Milling Quality of Little Millet Rice

Mamata Mannuramath , Nirmala Yenagi,

Report Type: Poster presentation

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Location: CFTRI Mysore, India

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***Country/Region:** India (Karnataka)

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ABSTRACT:

Little millet (*Panicum sumatrense*) is one of the staple foods in millet growing areas of Northern Karnataka, Haveri District. The farmers are not interested to grow the little millet as there are no suitable processing equipments. The main objective of the hydrothermal treatment is to reduce the levels of breakage as there is high breakage was observed in the milled grains which are milled in the existing emery mill for flour. The Government is interested introduce the millet rice in the public distribution system but once milled grains have shorter life hence it was studied whether the parboiled grains are feasible to introduce in public distribution system. In this study whole little millet grain was soaked at different soaking temperatures of 60, 70 and 80°C. The soaking time was 3 and 4h followed by steaming at temperatures 100 and 110 °C for 15, 20 and 25 min. After drying, milling was done. Head rice yield and broken percentage was measured. As the increase in temperature of soaking and steaming temperature has head rice yield. But increased time of steaming decreased the head rice yield. However increased temperature of soaking and steaming affected color of the grains. The broken percentage was high at 60°C soaking temperature followed by 80 and 70 °C. Breakage was reduced as the steaming temperature and increased with steaming time. The optimum conditions for hydrothermal treatment for better yield was found at 70 °C soaking for 3h at 110 °C steaming for 20 min steaming time resulted in 92.397 % head rice yield with 0.987% breakage. Raw little millet grains yielded 75.303 % head rice yield and 13.313 % broken .

30. Participatory Yield Enhancement Demonstrations of Little Millet Cultivars in Northern Karnataka.

B N Aravinda Kumar, Nirmala B, Sumalatha B, Dolli S S and Rajarajeshwari Joshi

Report Type: Poster presentation

Date: Presented in February 2013

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***Full Name of Research Institution: University of Agricultural Sciences, Dharwad**

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ABSTRACT:

The improved genotypes of little millet *(Panicum sumatrense)* with recommended package of practices were assessed under various demonstrations in north Karnataka, India during *kharif* seasons of 2011 and 2012 as a part of study in an IDRC funded project on 'Enhancing food security of rural families through production, processing, and value addition of regional staple food grains in India'. A total of 79 interventions covering 16 ha (in 2011) and 42 interventions in 8 ha (in 2012), were implemented. UAS, Dharwad centre has identified different genotypes of short/long duration available with different research centres. Comparative assessment of genotypes like CO (Sa)4, LM-203, JK-8 and local Mallige was made in four locations of the project area. The four locations were chosen purposively for demonstration/interventions in the major little millet growing district of Haveri. In Haveri district, Savannur taluka (villages Jekinakatti, Manthrodi) and Shiggoan taluka (villages Thadas, Thimmapur). From each village, farmers were randomly chosen for yield demonstrations. The results of the large scale demonstration spread across Haveri district revealed that on an average about 19.1% increase in grain yield in CO (Sa)-4 over local cultivar followed by Sukshema (5.4%). In another demonstration, conducted on ten farmers' fields, covering 2 ha area, on the use of recommended dose of fertilizers revealed that grain and fodder yields of little millet increased to an extent of 17.68% and 10.25% respectively. As regards to varietal preferences indicated by the farmers-Sukshema variety has profuse tillering ability. However, its grains shatter if not harvested timely. CO (Sa)-4 is a non-shattering type and has good quality fodder besides more biomass. JK-8, a non-shattering type, has succulent biomass and has responded well to applied fertilizers. Local variety *Mallige* produced more dry matter and has more tillers. Farmers prefer both CO (Sa)-4 and Sukshema. The parameters of grain/straw were assessed and suitable location specific genotypes were identified in the course for all test sites.

31. Field Demonstrations on Adoption of Recommended Seed Rate and on Use of Biofertilizers in Little Millet Production in Northern Karnataka.

B.N.ARAVINDA KUMAR, NIRMALA B. YENAGI, DOLLI, S.S. AND SUMALATHA

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***Full Name of Research Institution: University of Agricultural Sciences, Dharwad**

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ABSTRACT

Field demonstrations on enhancing the yield of little millet through recommended seed rate as well as on the use of biofertilizer were carried out during *kharif* 2011 as a part of study in an IDRC funded project 'Enhancing food security of rural families through production, processing, and value addition of regional staple food grains in India'. These demonstrations were conducted in four adopted villages namely Jekkinkatti, Manthrodi, Tadas and Timmapur of Savanur and Shiggaon taluk. Most of the farmers in these areas grow millets for the fodder purpose and they use higher seed rates ranging between 20 and 25kg ha^{-1}. Hence the field demonstrations were conducted in 16 farmers' fields covering 4 ha area during the *kharif* 2011 to observe the yield performance of cultivars with UASD recommended seed rate of 10kg ha^{-1}. Use of recommended seed rate resulted in 18.6% increase in grain yield and 9% increase in the fodder yield. The overall yield was found better in demonstration plots compared to the control plots. The field demonstrations on the use of biofertilizers covering 3 ha area indicated that Azospirillum and Phosphorus solublising bacteria applied at 4kg/ha as plough sole placement while sowing has resulted in 3.1% increase in grain yield and 12.6% increase in fodder yield over farmers practice.

32. Comparative Studies on Intercropping in Little Millet with Pigeonpea in Northern Karnataka.

B.N.Aravinda Kumar, Nirmala B. Yenagi, Sumalatha, Dolli, S.S., and Rajeshwari Joshi

Report Type: Poster presentation

Date: Presented in February 2013

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***Country/Region:** India (Karnataka)

***Full Name of Research Institution: University of Agricultural Sciences, Dharwad**

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ABSTRACT

Little millet is often intercropped with pigeon pea in the row ratio of either 5:1 or 6:1 as a traditional practice by farmers in Haveri district of Karnataka, India. The recommended row ratio of 4:2 was advocated to sample farmers with a view to convince and spread this technology in millet growing areas. Field demonstrations were carried out during *kharif* 2011 and 2012 as a part of study in an IDRC funded project 'Enhancing food security of rural families through production, processing, and value addition of regional staple food grains in India'. These demonstrations were carried out in the fields of 13 farmers of Jekkinkatti, Manthrodi and Timmapur village of Savanur and Shiggaon taluk. The inter-crop of popular little millet variety Sukshema with Pigeonpea in 4:2 proportion resulted in increased grain and fodder yield. The mean grain yield of little millet and redgram were 12.12 q/ha and 3.04 q/ha respectively, when compared to farmer practice of little millet monocrop (11.21 q/ha). The fodder yield of little millet, and redgram were 5.88 t/ha and 0.85 t/ha respectively, when compared to farmer practice of moncropping of little millet (5.35t/ha). A higher little millet grain equivalent yield (16.51 q/ha) and higher net returns of Rs.18220/- were realized over farmers practice. The study revealed that there was an increase in net returns to the tune of 76.41 per cent in 4:2 intercropping system over that of sole little millet.

33. Appropriate Agronomic Interventions for Increasing Productivity in Nutritious and Underutilized Millets

E.D.Israel Oliver King[#], Aravinda Kumar B.N[*.], Rakeshkumar[$], Kumar. N[#]., Nirmala Yenagi[*]., Sumalata Byadgi[*].,Mishra C.S.[#], Kalaiselvan N.N [#]

Report Type: Oral presentation

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ABSTRACT

In India, poverty and malnutrition are more rampant in regions of rain-fed agriculture particularly in the arid and semi-arid, hilly and mountainous areas. The agriculture of these regions is traditional and marginal with dominance to many locally adapted crops, some of them classified as under-utilized. These crops are normally grown with low input and cost, more often deploying traditional knowledge and practices. The reach and penetration of modern production technologies are low and usually acceptance of such technologies is low in view of high cost and skill required to use them.

The farming practice being followed causes continuous resource mining leading depletion and degradation of natural resource base of production system, particularly soil and water. However, these regions compared with the irrigated region, have richer agro-biodiversity in terms of crops, varieties and cropping system diversity. One such important cropping system in the semi-arid, hilly and mountainous regions is based on small millets and legumes, and grain amaranth in mountain region.

Promotion of locally grown under-utilized and nutritious food crops offers better option for addressing sustainable food and nutritional security solution in many parts of the developing world. This approach is more desirable and relevant to remotely placed regions like hilly and mountainous as well as certain semi-arid regions in the hinder lands of the country where mobilization of huge quantities of food on regular basis is energy intensive.

It is also appropriate that promotion of such local production systems and local crops can put to better use of the traditional knowledge and skill of local farmers, particularly women, and their natural

productive assets to provide them employment during crop seasons. This will also promote the local food culture for ensuring better household nutrition.

With this view, A research study is carried out during 2010 to 2012 in four regions of India namely, Kolli Hills in Tamil Nadu, Jeypore in Odhisha, Chamoli and Rudrapravag in Uttrahand and Dharwad in Karnataka using participatory approaches; to strengthen rural household food and nutritional security and increasing income generation through promoting improved agronomic cultivation practices of locally important under-utilized food crops like small millets and grain amaranth by;

- Using quality seeds and suitable varieties of locally important underutilized small millets by appropriate trainings for getting good productivity
- Conducting improved agronomic demonstrations with people participation for their food and nutritional security
- Reducing drudgery of farm families through development and introduction of simple, affordable and workable technological solutions to the tedious crop management

Current paper examines key intermediary results of techniques such as quality seed production, participatory varietal selection, different types of yield enhancement trials, Vermi composting technologies, introducing farmers' friendly technologies for reducing drudgery; row maker, kono weeder, inter-cultivator-appropriate spade and also related training for capacity building for rural women and men.

34. **Evaluation of Little Millet Varieties for Nutritional and Processing Qualities**

Mamata Mannuramath and Nirmala Yenagi,

Report Type: Poster presentation

Date: Presented in February 2013

Location: International Workshop UAS Dharwad, India

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***Country/Region:** India (Karnataka)

***Full Name of Research Institution:** University of Agricultural Sciences, Dharwad

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ABSTRACT

Little millet (*Panicum sumatrense*) is one of the coarse cereal consumed in the form of rice. There is also a traditional practice to use as fasting food in most of the Northern states of India. Recent research studies have shown that little millet can be promoted commercially for preparation of fried fermented and whole grain based bakery food items. In the present study Local cultivars (Malli savi and Kari savi) and high yielding varieties(Sukshema, JK-8 and Co(Sa)4) were evaluated for their grain characteristics, nutrient composition, milling and cooking quality to know suitability for specific end use. Significant difference ($p \geq 0.05$) was observed for all the quality parameters among the traditional cultivars and high yielding varieties. Traditional cultivar Malli savi was found to be significantly superior for 1000 kernel weight, whole grain density, colour, hardness, milling quality, protein and cooked volume. . Cooking time ranged from 7.1 min to 9.13 min. The maximum time taken for cooking was observed in Sukshema (9.13min) followed by Local variety Malli savi (8.27min). Quality characters of Sukshema resembled to Malli savi with respect to milling, nutritional and cooking quality. Kari savi performed poor in most of characters compare to other varieties. JK-8 and Co(Sa) 4 were better than the Kari savi. Sensory evaluation revealed that is no significant difference among the varieties. The study concludes that the inherent quality characteristics of Malli savi are found to be suitable for milling. Breeder can use these inherent characteristics for development of high yielding varieties for suitable processing.

35. Nutritional Evaluation of *Roti* Prepared from Finger Millet Genotypes in Konkan Region of Maharashtra

POOJA SAWANT*[1] and NIRMALA YENAGI[2]

Report Type: Poster presentation

Date: Presented in February 2013

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***Country/Region:** India (Karnataka)

***Full Name of Research Institution:** University of Agricultural Sciences, Dharwad

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ABSTRACT

An investigation was undertaken to evaluate the nutritional quality of *Roti* prepared from the two finger millet genotypes ,viz. Dapoli 1(Brown) and Dapoli Safed 1 (white) released by Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, grown with the application of only organic manure and only inorganic fertilizers. Rice is the main agricultural crop of Konkan and finger millet is cultivated as a major *Kharif* crop next to rice. It is also taken as a *Rabi* crop where irrigation facilities are available. *Roti* is the popular traditional way of consumption of finger millet in the region. The white genotypes had significantly higher protein, crude fibre, iron, manganese and zinc content than brown genotypes while the amount of carbohydrate, energy, calcium and phosphorus was significantly high in brown genotypes. Significantly higher contents of protein, energy and phosphorus were observed in both the genotypes grown with the application of organic manure than the genotypes grown with inorganic fertilizers . It was found that the amounts of ash, calcium, phosphorus and all the micronutrients were more in *rotis* than their raw flours. Organoleptic evaluation revealed that the *rotis* made from organically grown white finger millet were better in appearance,texture and colour, but the *rotis* made from brown finger millet were significantly better in taste.

36. Effect of Hydrothermal Treatment on Milling Quality of Little Millet (*PANICUM SUMATRENSE*)

Mamata Mannuramath and Nirmala Yenagi,

Report Type: Poster presentation

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ABSTRACT

Millet processing is laborious and tedious and it has become the major constraint for promotion of value added products. There is a need for introduction of newer processing technologies. One of the main objectives of the hydrothermal treatment is to improve quality of milling. Little millet samples had been parboiled using different regimes of soaking time, soaking temperature, steaming time and steaming temperatures were analyzed for milling quality and colour. A significant improvement was observed on head rice yield and breakage. It was observed that broken percentage drastically reduced when compared to raw millet millng. It was found that parboiling of millet for soaking 3h at 70°C and steaming at 110°C for 20 min could yield higher head rice and lesser brokens (92.39 % head rice yield with0.98% breakage). Lightness of the colour value of the grains ranged from 54.22 to 63.86, a* and b* value of the colours ranged from 4.22 to 5.99 and 17.68 to 20.51 respectively. It indicates that hydrothermal treatment significantly affected the colour of the grains when compared to raw millet (L- 72.25, a*-3.167, b*-17.87). The increase in temperature of soaking and steaming enhanced the head rice yield, whereas increased temperature of soaking and steaming affected color of the grains. Hydrothermal treatment brought significant positive changes in the milling quality of little millet.

37. Versatile Foxtail and Little Millet Composite Flour

Itagi S. K., Naik R. K., Yenagi N. B, and Bharati P. C.

Report Type: Poster presentation

Date: Presented in February 2013

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ABSTRACT

Composite flour stimulated domestic agriculture by utilizing local food grains and helped in improving nutritional quality of vulnerable group. It also aided in exploitation of natural health component of traditional foods such as millets and reduced economic drain due to encouragement for consumption of indigenous grain products in regular diet. The present study was done with the objective to expand the utility of foxtail/*navane (Sateria italica*) and little millet/*save* (*Panicum miliare*), by value addition through composite flour preparation and its characterization. The millet composite flour blend was prepared by mixing foxtail and little millet in major proportion (80%) along with wheat (10%) and black gram *dal* (10%) and selected spices such as coriander, cumin, fenugreek seeds and black pepper upto 8%. Value added products from composite flour are economic to consumer and producer. The composite flours are rich in protein, total dietary fiber and minerals but low in fat. The nutritional parameters included the determination of proximate principles by AOAC methods. The recipes from composite flour were prepared and presented trained judges for organoleptic evaluation. The blood glucose response curves were plotted for both Glucose and the carbohydrate test meal. The mean GI values for the mixes ranged from 63.07for foxtail millet to 64.51 for little millet composite flour. The protein content of the recipes were ranged from 4.08 to 6.07 g and total dietary fiber from 8.28 to 9.20 g per serving size (40g mix) in little and foxtail millet recipes. The developed millet composite flour conveniently substituted staple cereals *viz.,* rice and wheat flour in preparations like *chapathi, roti, pancake, mudde* (dumpling) and *thalipatti* and even in snack items like *chakali, nippattu shev* and *laddus*. The preparations using the little millet composite mix were more acceptable than the foxtail millet composite mix as shown by the sensory scores of the products. The easy availability and familiarity of the millets helped to exploit the natural and nutritional component of the millet and provided clinical benefits to the diabetics. Inclusion of millet based composite flour in regular diet adds variety and exhibit several neutraceutical benefits. Production of such millet blends at commercial level might be a feasible and remunerative enterprise for farmers.

38. Development and Quality Evaluation of Little Millet Noodles

Uma Ballolli[1], Usha Malagi[1], Nirmala Yenagi[1] and Pushpa Khadi[2]

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***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

ABSTRACT

Little millet (*Panicum sumatrense)* is one of the important minor millets indigenous to Indian subcontinent. Little millets are nutritionally superior to rice and wheat provide protein, minerals and vitamins and contain higher proportion of dietary fiber. The demand for ready to use foods is ever increasing due to the technological, industrial and economical advances of the developing societies of the world including India. Among the ready to use foods noodles are the novel food items of choice especially across the younger population. Hence an attempt was made to develop little millet based noodles. Optimization trials were conducted to develop highly acceptable little millet noodles by substituting wheat flour with steamed little millet flour at different levels ranging from 0 to 45 per cent levels by keeping bengal gram flour (10%) and gaur gum (3%) constant. Control noodles were prepared with 100 per cent wheat flour. Sensory evaluation scores revealed that 35 per cent little millet incorporated noodles were on par with control noodles with smooth surface, firm and non sticky strands. Further trials were conducted to enhance the nutritional and functional quality of highly accepted little millet noodles by incorporating curry leaf powder at 1, 2 and 3 per cent level. One per cent curry leaf powder incorporated noodles gave better sensory scores and provided 351 K cal energy and 10.98 g of protein and 14.04 g of dietary fiber. Thus, developed little millet based noodles are highly acceptable and may be used as health food.

39. Development of Value Added Foxtail Millet Vermicelli

Pragya Pandey[1] ,Usha Malagi[1] and Nirmala Yenagi[1]

Report Type: Poster presentation

Date: Presented in February 2013

Location: International Workshop UAS Dharwad, India

***IDRC Project Number, and component number (if applicable): 106314**

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ABSTRACT

Foxtail millet (*Setaria italica*) is the second-most widely planted species of millet. It is nutritionally superior to conventional food grains and exhibits hypoglycaemic effect due to presence of higher proportion of unavailable complex carbohydrate, resistant starch and release sugar slowly. Vermicelli is a popular instant food product which is tasty and easy to make, liked by people of all walks of life, irrespective of age and changing lifestyles. Hence, an attempt was made to develop foxtail millet based value added vermicelli. Standardization trials indicated that acceptable foxtail millet vermicelli could be developed by substituting 50 per cent processed foxtail millet flour in the standard vermicelli recipe. Further different trials were conducted by replacing wheat semolina with black gram dal flour at 5, 10, 15 and 20 per cent levels in the standard foxtail millet vermicelli in which the proportion of foxtail millet flour was kept constant (50%). Among all the trials, vermicelli from 20 percent black gram dal flour was found to be highly acceptable for its overall acceptabilty. To improve nutritional quality of developed vermicelli, fenugreek seed powder was incorporated at level of 1, 2 and 3 percent, among which vermicelli from 1 percent fenugreek seed powder was found to be acceptable as compared to other samples. Developed vermicelli were evaluated for overall acceptability. The sensory score for designed foxtail millet vermicelli was 7.6 in comparison to control which scored 8.40 .This developed vermicelli was highly acceptable and could be a healthy snack food for people of all age group

40. Value Addition of Foxtail Millet in Bellary District – An Economic Analysis

Kusuma, D.K[1]., J.A.Handigol[2]., Nirmala Yenagi[3]

Report Type: Poster presentation

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ABSTRACT

Foxtail millet **(***Setaria italica***)** was considered as an inferior millet, oflate is considered as an nutrient millet. Foxtail millet is used in indigenous medicine and it is mainly used in snake poisoning. Indigenous products of millets viz, mudde, ambali, rice, halva and fried products posses unique nutritional processing qualities. Diabetic patients can replace certain cereal grains in their diets by consuming millets in various forms including breakfast cereals. The focus of the present study was an economic analysis on value addition in foxtail millet in Bellary district. A sample size of 60 farmers for value addition of foxtail millet was selected using multiple stage random sampling method. Field level data were elicited for the agriculture year 2009-10 through personal interview method. For analyzing the data collected during the study, budgeting technique and tabular analysis were employed. In the preparation of papad, the total cost of production worked out to be Rs.7000, gross returns realized were Rs.11880 and net returns were Rs.4880. In preparation of tambittu, gross returns were Rs. 14250 and net returns were Rs. 5960 after deducting total cost of Rs. 8290 from gross returns. The major problems faced by the farmers were lack of technical guidance, non-availability of quality seeds, lack of marketing information, standardization of value added products and tough competition with existing products. The study concluded that value added products of foxtail millet brought more returns to the farmers than the foxtail millet grains. Hence, the study suggested the farmers to involve in value addition of foxtail millet and get better returns rather than selling it in raw form.

41. Nutrition Educational Intervention Regarding Consumption of Whole Grain in The Management of Diabetes

Soumya Beranje and Nirmala B Yenagi

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ABSTRACT

The study on Nutrition Educational Intervention regarding consumption of whole grains in the management of Diabetes was conducted in Dharwad city in 2009-2010. The booklet on the use of whole grains in the management was developed in local language as self management programme. Thirty five purposively selected subjects were included for intervention for a period of three months. Totally eight education sessions were conducted during the intervention for three months. Most of subjects were the age of 51 to 60 years (62.90%) followed by 61 and above age group, (22.90%). Most of the subjects were graduates (40.51%), majority of subjects were suffering from diabetes since 5-10 years duration (48.60%). Onset of diabetes in subjects was maximum between the ages of 41 to 50 years (37.10%). Mean knowledge level of diabetic subjects before the educational intervention was 11.20 and after the intervention 15.09. The mean gain in knowledge of diabetic subjects after the intervention was 3.88. From the't' value it could be inferred that the difference in knowledge level obtained from pre and post exposure was significantly high indicating that the respondents had gained knowledge as a result of their exposure to the nutrition intervention. The knowledge level improved by 20 percent in subjects who had high level of knowledge. The mean scores related to whole grains in the management of diabetes had shown an improvement after the nutrition intervention. The gain in knowledge of different aspects of whole grains viz., structural part, distribution of nutrient, nutritional and therapeutic significance, processing dietary fiber have shown significant difference before and after the intervention at one percent level. The impact of education intervention was 42.90 percent among subjects who had high level of knowledge where in before intervention it was 22.90 percent. The improvement in dietary practice of including whole grains was 8.80%. Consumption of brown rice, millets and use of soy flour increased by 14.28% to 42.86%, 6.00% to 62.86% and 42.86% to 60.00% respectively. Use of functional ingredients such as fenugreek seeds, bengal gram flour increased by 48.56% to 62.86% and zero percent to 8.57% respectively. Use of developed booklet as self management programme was found to be effective.

42. Value chain based on local crop (millet) and empowering of rural women.

Nirmala Yenagi*1, E.D.Israel Oliver King*2, and Rakesh Kumar*3

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ABSTRACT

Millets have been considered as life support crops since times immemorial due to their nutritional value and being consumed at large scale being the part of daily diet of the people of the country. However, with the advancement of new scientific era, the production and consumption of these staple/nutritional crops have decreased drastically as these crops are replaced by the other cash crops mainly wheat and paddy as the result of which the nutritional security of the people has come down. Keeping this in view an attempt was made to enhance the consumption of these staple crops in the rural India, where the nutritional deficiency is a major problem.

The present work is based on the research work of three years during 2010 to 2012 in four states of India covering Chennai, Karnataka, Orissa and Uttarakhand by HESCO Dehradun, MSSRF Chennai & UAS Dharwad. The technical parameters like value addition (Protocol development), practices, post harvesting technologies and marketing strategies of these were the major aspects of this study. The crops chosen for the activities were Finger Millet, Barnyard Millet, Little Millet, Proso Millet, Kodo Millet and Grain Amaranth. The value addition in target crops has been initiated to promote consumption and income generation for rural families of India. In this study, Women Groups, SHG's, were identified for value addition practices and production technology for enhancing productivity and increased food availability. On the value addition front, protocols were developed in value addition simultaneously. Barnyard Millet *Flour Laddoo, Halwa, Chachera, Kheer,* Finger Millet Flour biscuits, Namkeen, Popped amaranth, *Ragi chakli, Ragi Malt, Barnyard Yard Maisur Pak*, Popped amaranth mixed health drink, Barnyard Millet mix *Dosa, Papad, Idli* were produced and taught to the beneficiaries.

At MSSRF, market linkages were established for these millet value added products by involving various self help groups and farmers club members there was distributed which was helping to the tribal groups by distributing to different outlets in various urban areas.The average net income at Kolli Hills was found Rs.732/month, while at Jeypore the average income was Rs.938/month.

At UASD, total twelve standardized quality maintained convenient millet products were introduced for commercialization and twelve women entrepreneurs who were involved regularly saving rupees 400 to 500/month apart from their daily wages.

At HESCO, implementation of this study has led to increase in income of women groups by Rs. 1720/month. The total earned income of women was Rs.6995.40.Resulting to it total 145 days (8 hours/day) were created for the employment.

The research work was done at the field level to improve the knowledge and skills of the farmers. Women groups were trained on value addition, packaging, labelling and product presentation. Implementation of this study has led to increase in income of farmers and women groups and SHG's. The consumption at village level also increased four times as compared previously. This will make them more independent and encourage them to open to adopt new technologies and practices. Apart from this, it can help to set an example for nearby communities, women groups, SHG,s to engage them in such income generation activities and production of value added product accrues superior financial gains for the producers and ensure better life for them.

43. Evaluation of Commercial Production of Little Millet Paddu and its Economic Analysis

Nirmala B Yenagi, Deepa M Madalageri, Josna B and Jayashree Handigoal

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Date: Presented in February 2013

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Abstract

Paddu is a fermented breakfast food item of Southern India, commonly consumed at household level. It is a golden brown, round and soft shallow fried product of rice and mixture of pulses. In millet growing areas of Karnataka, traditionally paddu is also prepared from little millet. The present study was planned to enhance the economic value of little millet produce through evaluation of commercial value added products of millets and its economic analysis. Optimized little millet paddu preparation was studied for its feasibility in introduction in catering centers for a period of 6 months and evaluated for consumer acceptability. Economic analysis of production of little millet paddu was assessed by taking into consideration of variable cost and fixed cost. Return per rupee invested was calculated by gross return, net return and price of the main return. Totally 600 consumers were evaluated the products and 44 percent of them rated the products very good followed by 28 percent as excellent and 28 percent as good, around 60percent consumers were regular customers. The variable cost accosted for 92.60 percent of the cost of little millet paddu production. Variable cost included two components viz. raw material input and labour cost. The share of raw material input cost was 74.47percent of the total cost of production. Among the material input cost, the cost of rice (17.14%) was highest followed by oil (9.14%), tender coconut and paper plates (8.57%), roasted Bengal gram dhal (6.86%), black gram dhal (6.64%) and electricity (3.43%). On the other hand labour cost accounted for the more share in the total cost of production (17.14%). Labour cost included procurement of raw materials, preparation of little millet paddu and selling. Per 100kg total cost of production of little millet paddu worked out to be 17504.20. The gross returns was Rs.26, 000 per 100kg with a returns of Rs.1.49 per rupee spent on little millet paddu production. Thus the study provides an opportunity for alternate substitution for making a popularly consumed traditional paddu.

44. Performance Evaluation of Thresher for Threshing of Little Millet(*PANICUM SUMATRENSE*)

Satish R. Desai1, Nirmala B. Yenagi[2], B. N. Aravind Kumar[3]and Vanita N [2],

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***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

Abstract:

Little millet is one of the minor crops grown in regions of north Karnataka covering an area of about 15650 ha and annual production is 10732 tons. It in mainly grown in district of Haveri, Bellary, Belgaum, Raichur, Chitradurga, Davangere, Gulbarga, Koppal and Dharwad of Karnataka. Little millet is being used for human consumption, which is rich in iron and fiber content and gaining importance due to its nutritional value especially for diabetic patients. A radial flow thresher is used for threshing of the crop. The thresher was operated by 2.28KW petrol start diesel engine. The threshing drum has a length of 300mm and diameter of 150mm. A blower, having a length of 225mm and diameter of 150mm has been provided. The threshing drum and blower are rotated by the engine using V-belt pulley and the size of chaff outlet is 100mm X 225mm. Inlet chute of size 100mm X 225mm has been provided for feeding the crop to the thresher. The average moisture content of crop during threshing was 6.81 percent and the chaff seed ratio of the crop was 7:3. The threshing efficiency of the thresher was in the range of 93 to98 percent. It was observed that due to high chaff to grain ratio, some part of the chaff was collected along with the seeds in the seed outlet. The output capacity of the thresher was 6.54 kg of grains per hour and feed rate was 21.81 kg of plant material. The overall performance of thresher was found satisfactory.

45. Impact of Improved Equipments on Drudgery Reduction of Women in Little Millet Production and Processing

S.S.Dolli, Nirmala B.Yenagi, Sumalata B, Arvindkumar B.N, and Rajeshwari Joshi

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Abstract:

Women participation in production and post harvest activities of millet is over 60 per cent and most of these activities involve drudgery. Hence an effort was made to introduce the drudgery reducing, labour and cost saving equipments in the cluster of villages of Haveri district of Karnataka state during kharif 2011-12. The demonstrations included, weeding equipments (double-hoe weeder and cycle weeder), improved sickle for harvesting, de-stoner, grader and emery mill for processing of millet. The double-hoe weeder and cycle weeder were found to be most suitable for marginal farmers as the initial investment is very low (Rs 1200-1600) compared to traditional method (Rs 60,000). Even in case of hiring of the equipment, the cost of inter-cultivation by use of bullocks is higher (Rs. 2000/ha) compared to the double-hoe/cycle weeder (Rs. 375/ha). Though the traditional sickle has relatively higher efficiency, the improved sickle used by women workers was found to reduce the drudgery especially among the old age (>50 yrs) and young age (up to 35yrs) women workers with same efficiency. The women workers expressed that the improved sickle tested in the field need to be improved to enhance its efficiency, so that it can be used by majority of them. The processing machines, de-stoner and grader required less time for cleaning and de-stoning i.e. 0.8 hrs as compared to 18 hrs per 100 kg grains in case of traditional methods, which means saving of 2.15 man days per 100 kg of grains. Similarly milling by emery mill has reduced time to 1.7 hrs per 100 Kg with saving of man days of 6.03 per 100 Kg. There has been substantial reduction in processing cost (Rs. 200 to 25 per 100 kg grains) for grading and de-stoning as well as de-hulling (Rs. 150 to 2 per 100 kg grains). These improved methods have resulted in increased consumption due to easy access at village level, as well low cost in processing of grains which otherwise would have involved more time and drudgery.

46. Nutrition Education Programmes on Consumption of Local Staple Millets for Enhancing Food and Nutrition Security

Nirmala B. Yenagi, Ed. Oliver King Israel, Rakeshkumar, Sumalata B, Josna B, Sairabanu D and Vanita

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***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

Abstract:

A study was conducted with an objective to enhance the food security of rural families through nutrition education programmes. The sample for the study was from three major millet growing areas i.e. mountain region, hilly areas and semi-arid regions of Uttarkhand, Orissa, Tamil Nadu and Karnataka states respectively. Prior to intervention study, benchmark survey was conducted on consumption pattern of staple cereals from 789 households covering 25 villages of five districts of four states. The knowledge, attitude and practice of 260 women towards consumption of millet was also assessed. Nutrition awareness programme on millets reached around 962 school going children and 426 house wives through lectures, demonstration, essays and quiz competitions. Education materials like blow-ups, charts, booklet and literature relating to nutritional and therapeutic value of millets were developed and used for giving nutrition education. The benchmark survey results revealed that majority of households are consuming rice and wheat as major staple cereals whereas consumption of millet was only 1 to 5 kg/month. The nutrition knowledge of housewives varied widely from 35-99 per cent and the attitude towards consumption was found positive in all the three regions. However the practice of consumption of millet was very poor. The nutrition knowledge of 80 housewives enhanced by 5 to 13 per cent after the nutrition education. Similarly the consumption of millet increased in 69.13 per cent households. The overall quantity of consumption of millet, which was almost nil or 1kg per month before the nutrition education was increased to 2.13 Kg per month. Finger millet was introduced in 25 per cent of households and 32 per cent of the households were consuming both little millet and finger millet in the form of staple as well as value added products. It was also observed that 32 per cent of the families were consuming millets on monthly basis followed by weekly (30.35%), regularly (26.78%) and occasionally (10.71%). The most common value added millet products introduced for consumption were ragi malt, *chakli, nippattu, paddu* and papad in semiarid region. In case of school children, the initial knowledge which ranged from 29.40 to 47.40 per cent was increased to 35 to 51 per cent at post nutrition knowledge assessment after three months. Children were interested to have millet snacks and health drinks in school feeding programme and in regular meals. Though nutrition awareness has enhanced the knowledge and consumption, the drudgery involved in cleaning and non-availability of processed grains in local market are the major constraints for not including the millets in regular diet. Hence there is a need to develop linkage between awareness programmes and availability of millets in public distribution system.

47. A Case Study of Hajratbi Belagali

Nirmala B. Yenagi, Josna B and Rajarajeshwari G. Joshi

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Abstract:

Hajratbi Belagali is a 55 years old widow staying in village Mantrodi of Haveri district in Karnataka. After the death of her husband she was left alone struggling to meet both the ends. She continued to work as an agricultural labourer. She also has partial responsibility of her grand children as her daughter died at a younger age. When millet project approached the village with training programme on value addition Hajratbi was quick to enrol herself for the training programme. After the training programme Hajaratbi has selected Ragi Malt & varieties of Millet Papads for production and sale. Though hesitant in the beginning to approach customers and sale her products, her participation in several exhibitions, krishi melas and fairs has given her confidence in tackling customers, understanding them, convincing them and market her products. Presently she is selling her products at village Kharadagi close to her place, where most of the people visit for the temple on new moon day. She is visiting the village every week and is successful in selling her products. Hazratbi has also trained her daughter-in-law in millet papad preparation. Both the women are happy to have engaged in this entrepreneurial activity. Her initial entrepreneurial venture started with a production of 4 Kg per month and now it has increased to 25 Kg per month with a net income of Rs.1,800/-. While the school hostel in Kharadagi village is a regular buyer of ragi malt prepared by Hazratbi, the households of the village have developed the liking for the millet mudde papads that she prepares. Though it involves little bit of extra work, Hajaratbi prefers preparation and sale of millet products than working as agricultural labour under the hot sun. She thanks the project for this opportunity.

48. Case Study of Iramma Jolad

Nirmala B. Yenagi, Josna B and Rajarajeshwari G. Joshi

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Abstract:

She is uneducated but open to learn new things. A versatile cook by herself but had no opportunities. 40 year old polio stricken Iramma was finding it difficult and tiring to work as agricultural labourer. So when the project approached the village with a training programme on value addition to millets. Iramma was quick to use this opportunity. Iramma started her career as an assistant in the group of four women entrepreneurs. The group worked together for a year. Due to some major constraints like inconvenience in fixing a common time for production activity and combined investment, the members preferred to continue the production individually. Iramma selected production of little millet chakli and nippattu and started production at her home. Iramma was not an expert yet to start the production independently. After a few trials and errors and with little more coaching from her colleagues and project staff, her production could reach the required standard. Iramma's husband supports her by getting raw ingredients, assisting in preparation and taking the ready products to the consumers. Iramma's customers include pity shop owners, school teachers, neighbours, water shed department and a milk parlour in the university campus. Her latest venture is supply of her products to Utsav Rock Garden, a tourist place depicting rural life and culture situated around 10 Kms away from her village. That the chaklies and nippatus prepared by Iramma are made of millets is a matter of uniqueness and goes well with concept of Utsav Rock Garden. Apart from this, she also participates in exhibitions and melas organised by different Institutions, NGOs etc. Her average monthly production has reached 20-25 Kg of little millet chakli and 10 Kg of little millet nippattu which fetches her an average income of Rs. 1,700/- to Rs.2,000/- per month.

49. Successive Woman Smt. Champavathi N Mahantshettar

Nirmala B. Yenagi, Josna B and Rajarajeshwari G. Joshi

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Date: Presented in February 2013

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***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

Abstract:

Champavathi, a 55 year widow from Jekinkatti village runs a small canteen for her sustenance. Her interest in preparing a variety of snack items encouraged her to attend the training programme on value addition to millet products. Champavathi has used her marketing skills in introducing little millet chaklies to her regular canteen customers. While her regular canteen customers relish little millet chaklies along with a cup of tea, some carry for domestic consumption or for family functions. Petty shop owners from the nearby villages also buy millet chaklies from her. During the installation of wind mills in the village the labourers would visit her hotel every 15 days and buy chaklies to carry to their native home. She began her sale of chaklies with half kilo per week which gradually increased to the extent of 3-4 Kg of sale per week. Presently with an increased demand for millet chaklies, Champavathi is finding it difficult to meet the demand as she is alone. Her age factor also contributes to her inability to meet her customer demands regularly. A chance to attend training on 'Market Oriented Value Enhancement' however, has motivated Champavathi and her SHGs colleagues to plan to start an entrepreneurial activity on value added millet products in one of the rooms of her house. Now Champavathi is slowly preparing herself to move in this direction with a fresh zeal and strengthened confidence.

50. Active Women Entrepreneurs of Timmapur

Nirmala B. Yenagi, Josna B and Rajarajeshwari G. Joshi

Report Type: Poster presentation

Date: Presented in February 2013

Location: International Workshop UAS Dharwad, India

***IDRC Project Number, and component number (if applicable): 106314**

***IDRC Project Title** Enhancing Food Security of Rural Families Through Production, Processing and Value Addition of Regional Staple Food Grains in India.

***Country/Region:** India (Karnataka)

***Full Name of Research Institution:** University of Agricultural Sciences, Dharwad

***Address of Research Institution:** Rural Home Science College, UAS Dharwad

***Name(s) of Researcher/Members of Research Team:** Nirmala B. Yenagi, Josna B and Rajarajeshwari G. Joshi

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***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

Abstract:

The four active women of Timmapur *viz*. Shivaleela, Renuka, Iramma, and Manjula, are a team involved in production and sale of value added minor millet products. They were trained under the millet project on preparation of value added millet products *ragi* malt, foxtail millet *laddus*, millet *papads, chaklies* and *nippattu*. Initially they started with production of 1kg for successive batches to expertise themselves. Later the group reached large scale production of 5-10kg per batch. In a month the group could supply an average of 10 to 15kg of each product to the University. Additional preparation was done if there was a demand in the university and village. The value addition activity has added income to their respective families and has given them a kind of freedom in spending the money as per their desire. All the four have used the income both for personal and for family purpose. They have even managed to save some amount. The group members intend to expand the value addition activity and make it a regular means of their livelihood. However being placed in a village, marketing of products is not an easy task for them. Due to household schedule and improper transport facilities women find difficulty to carry the finished products to the nearby cities like Hubli and Dharwad. Due to constraints pertaining to time and investment, the members have now opted for individual production. While three women entrepreneurs have opted different items for production with mutual consent, one woman has quit the group because of her illness. However, she assists her colleagues whenever possible. As the products are being prepared in their own houses their family members also extend their helping hand to the women entrepreneurs. Individual production even in a small scale is profitable to them. Given a proper market linkage, they are capable of adopting this millet based entrepreneurial activity in future.

51. Cost Analysis of Processed Small Millet Products for Home Based Industries

Nirmala B. Yenagi, Josna B and Jayashree Handigol

Report Type: Poster presentation

Date: Presented in February 2013

Location: International Workshop UAS Dharwad, India

***IDRC Project Number, and component number (if applicable): 106314**

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***Country/Region:** India (Karnataka)

***Full Name of Research Institution:** University of Agricultural Sciences, Dharwad

***Address of Research Institution:** Rural Home Science College, UAS Dharwad

***Name(s) of Researcher/Members of Research Team:** Nirmala B. Yenagi, Josna B and Jayashree Handigol

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***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

Abstract:

Small millets are nutritious and therapeutic grains and comparable to other cereals. Value addition has an extensive scope for enhancing the economic value of the agriculture produce. In this context, a study was conducted to evaluate the cost analysis of processed small millet products for better market potential. Seven processed products of small millets such as *ragi* malt, *ragi papad,* little millet *chakli, nippattu, papad*, foxtail millet *besan laddu* and *hurakki holige* were selected for cost analysis for production and marketing through rural women entrepreneurs. Cost of ingredients for 1 Kg standard recipe, fuel, labour, packaging and miscellaneous were the major items included for cost analysis. The total yield of different items ranged from 800g to 2 Kg. Ingredients cost was more in sweet products *viz.,* foxtail millet based *hurakki holige* (Rs.140/-) and *besan laddu* (Rs.330/-) and also had highest market price (Rs.200/- per Kg). The labour cost was high for *hurakki holige* and millet *papads*. There was a wide variation in the per cent of profit of the products. It ranged from 25 to 60 per cent. The highest profit was seen in *ragi* malt (60%) followed by little millet *chakli* (59%) and millet papads (58%). The cost benefit ratio of little millet *chakli* and *nippattu*, foxtail millet *besan laddu* and *hurakki holige*, *ragi* malt and millet *papad* was 1.59, 1.49, 1.25, 1.40, 1.60 and 1.58 respectively. The study reveals that marketing of processed small millet products have potential for commercial marketing. Women entrepreneurs can adopt this as a subsidiary activity for enhancing their household income.

52. OPPORTUNITIES AND CONSTRAINTS IN HOME BASED MILLET PROCESSING UNITS – A CASE STUDY

Nirmala B. Yenagi, Josna B and Sumalata Byadgi

Report Type: Poster presentation

Date: Presented in February 2013

Location: International Workshop UAS Dharwad, India

***IDRC Project Number, and component number (if applicable): 106314**

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***Country/Region:** India (Karnataka)

***Full Name of Research Institution:** University of Agricultural Sciences, Dharwad

***Address of Research Institution:** Rural Home Science College, UAS Dharwad

***Name(s) of Researcher/Members of Research Team:** Nirmala B. Yenagi, Josna B and Sumalata Byadgi

***Contact Information of Researcher/Research Team members:** uasd.idrc2011@gmail.com

***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

Abstract:

The present study was designed to promote and strengthen value chain of millets through production and marketing of indigenous festival and value added millet products through home based units. Three trained active women entrepreneurs were studied in detail. The analysis of four value added millet products such as little millet based *chakli* and *nippattu* and foxtail millet based *hurakki holige* and *besan laddu* was carried out. In addition, festival snacks of deepavali prepared from wheat (*karchikayi*) and rice (*tengolu* and seasoned *rice flakes)* were also studied. As a project intervention women entrepreneurs were motivated to take orders from the staff of University of Agricultural Sciences, Dharwad and to distribute quantity of production among themselves. At the end of the festival the sales and profits were analysed and feedback of women entrepreneurs and customers were collected. It was observed that 29 customers placed orders for festival foods. Women entrepreneurs prepared different products batch-wise to maintain the quality. The total production of festival foods was about 71 Kg. the minimum production was seasoned rice flakes (6 Kg) and the maximum was little millet chakli (14 Kg). Initial investment was Rs.400/- to 500/- towards labour charge and miscellaneous. Women entrepreneurs took 3-4 days (8 Hrs/day) to complete the assigned production with one woman assistance. Total expenditure and gross return were Rs.8,000/- and Rs.12,000/- amount respectively. The profit amount was utilized for celebration of deepavali festival, household requirements and continuation of value addition activities. Women entrepreneurs also prepared these products, around 2 to 2.5Kg each, for their household consumption. Almost all customers accepted the products and they were interested to give orders for other festivals also. All the three women entrepreneurs showed interest to continue the business of food processing. However, the huddles to take up the activity were non availability of gas cylinders for commercial use and time constraints to deliver the products. Still home based millet processing is a challenging business to break the potential barrier of millet consumption which also creates employment and empowers women entrepreneurs technically, socially, economically and nutritionally.

53. Drudgery Reducing Interventions in Millet Cultivation and their Impact

S.S.Dolli[1], Nirmala Yenagi[1], E.D. Israel Oliver king[2], Rakeshkumar[3], Sumalata B.[1] Kiran Negi[3], N. Kumar[2] and C.S.Misra[2]

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***IDRC Project Title:** Enhancing Food Security of Rural Families Through Production, Processing and Value Addition of Regional Staple Food Grains in India **.**
***Country/Region:** India (Karnataka)
***Full Name of Research Institution:** University of Agricultural Sciences, Dharwad
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***Name(s) of Researcher/Members of Research Team:** S.S.Dolli[1], Nirmala Yenagi[1], E.D. Israel Oliver king[2], Rakeshkumar[3], Sumalata B.[1] Kiran Negi[3], N. Kumar[2] and C.S.Misra[2]
***Contact Information of Researcher/Research Team members:** uasd.idrc2011@gmail.com
***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

Abstract:

Women's participation in millet crop production and processing is higher than the men farmers and the activities carried out by women involve drudgery, hence interventions to reduce drudgery were demonstrated in three different regions of India which includes hilly, mountain and semi-arid regions under the Canadian International Food Security Research Fund (CIFSRF) funded project on Millet. The impact was assessed in cluster villages of Orissa, Tamil Nadu, Uttarakhand and Karnataka states. Double-hoe weeder, cycle weeder, improved sickle, de-stoner, grader and emery mill were the drudgery reducing equipments introduced in the semi-arid regions of Karnataka. Improved sickle was found to be effective among old age (>50 years) women farmers in terms of reducing drudgery as well as improving efficiency. The experience of women workers indicated that improved sickle requires less bending and it is easy to handle compared to traditional sickle. Double-hoe weeder and cycle weeder were found to be suitable for marginal farmers as the initial investment was very low (Rs 1200-1600). The processing of grains using de-stoner and grader was found to save 2.15 man days per 100 kg. Similarly milling by emery mill has reduced processing time to 1.7 hrs per 100 kg with saving of 6.03 man days per 100 kg.
Similarly, row marker, kono weeder, improved spade, pulverizer flour mill were introduced in mountain and hilly areas of Tamil Nadu, Odisha (Orissa) and Uttarakhand. Usually, farmers practice broad casting method of sowing, manual weeding and manual grinding of millet crops which are carried out by women. Use of row marker has resulted in maintaining lines and also plant population. The time saved was six times compared to that of making lines using hand hoe, while kono weeder helped women members to take weeding effectively with minimum drudgery and modified spade with the size of 6 inches of width and 9 inches length for weeding in millet has reduced the time by almost 40 per cent. The grain pulverizer (flour mill) managed by women groups have resulted in significant reduction of drudgery as well as time (10 times less) and also generated income to women farmers. In hilly areas of Uttarakhand, thresher for harvesting and processing of barnyard millet and grain amaranthus was introduced to reduce the drudgery and generate income to the women. The improved equipments have not only reduced the drudgery but also increased productivity and consumption at the local level.

54. Evaluation and Modification of Existing Emery Flour Mill for Improving Milling Efficiency of Little Millet (*Panicum Sumtrense)*

Nirmala B. Yenagi, Vanita N, Mamata Mannuramath and Josna B

Report Type: Poster presentation

Date: Presented in February 2013

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***Country/Region:** India (Karnataka)

***Full Name of Research Institution:** University of Agricultural Sciences, Dharwad

***Address of Research Institution:** Rural Home Science College, UAS Dharwad

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***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

Abstract:

In Northern Karnataka, Haveri district is the major little millet growing area. Traditionally little millet was processed mainly by hand pounding by farm women, which was laborious and time consuming. Introduction of ready to eat rice in public distribution system in cheaper rate has resulted in replacement of little millet from regular diet of the farming community. The existing emery flour mills are being used for processing of little millet to reduce the drudgery. An attempt was made to evaluate the milling efficiency of little millet in existing and modified emery flour mill for promotion of little millet consumption in rural communities. Modifications made were, clearance adjustment according to the grain size and blower attachment. The study revealed that the recovery of head rice yield in existing flour mill was 65.8 and percentage of broken grains was 5.5. After clearance adjustment and blower attachment the head rice yield was 68.06 and 73.5 percent respectively and broken grains were 5.24 and 4.21 percent respectively. The head rice yield increased by 3.48 percent with the adjustment of clearance and 11.70 percent by blower attachment. With the attachment of blower the cleaning time reduced from 22 min to 5 min. It was also observed that the complete de hulling process takes minimum two passes. The drawback of processing in emery mill was an admixture of head grains, broken grains, flour and husk, the separation of which is again a time consuming drudgery activity for women. Further, modification of this emery mill with additional attachment of blower reduced the drudgery of separation of grains and also increased head rice yield. The study reveals that existing emery flour mill can be popularised for little millet with attachment of blower for yield of ready to use little millet rice. This may enhance the consumption of little millet by farming community.

55. Promotion of Ethnic and Novel Foods using the Genetic Diversity of Small Millets

Nirmala Yenagi and Mamata Mannuramath

Report Type: Poster presentation

Date: Presented in February 2013

Location: International Workshop UAS Dharwad, India

***IDRC Project Number, and component number (if applicable): 106314**
***IDRC Project Title:** Enhancing Food Security of Rural Families Through Production, Processing and Value Addition of Regional Staple Food Grains in India **.**
***Country/Region:** India (Karnataka)
***Full Name of Research Institution:** University of Agricultural Sciences, Dharwad
***Address of Research Institution:** Rural Home Science College, UAS Dharwad
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***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

Abstract:

Appropriate food processing technologies can stimulate agricultural production to ensure availability of quality product, value addition and help in creating jobs and thus play crucial role in the economic progress and industrial development. This study was undertaken to explore the inherent technological opportunities for better utilization of resources in designing value added and sustainable foods. The traditional fermented breakfast *paddu* made with little millet has light and fluffy textural quality, highly acceptable for taste and texture which is nutritious and comparable with rice. Small seeded little millet showed an advantage over rice due to several technological features like less water uptake, less soaking, grinding, cooking and baking time and high product yield. Introduction of *paddu* in restaurants was acceptable to the consumers and found sustainable in hotels. Indigenous *papads* prepared from millets without any addition of chemical additive enhanced the characteristic aroma and sour taste with good expansion of fried *papad.* This natural fermented food which is harmless to health, cost effective preparation and requires less laborious technology. When taken as home based food industry by women entrepreneurs, it was found profitable as compared to black gram dhal *papad*. Muffins developed from foxtail millet were light puffy highly acceptable and incorporation of millet flour increased protein, fiber and micronutrient contents. Incorporation of decorticated little millet flour in cookies increased the bioavailability of iron and zinc compared to deglumed little millet cookies. Millet based products showed good potential to enter bakery industries especially in rural sector as nutritious snack item for school children. Parboiling of little millet has improved the milling efficiency and also enhanced the bioavailability of iron and zinc. Fried snacks prepared from little millet were comparable with rice and found to be suitable home based food industry by women entrepreneurs. Similarly a traditional festival food prepared from foxtail millet such as *hurakki holige* and *besan laddu* proved to have good scope for marketing and income generation of rural community particularly women. Thus value addition has shown to be highly strategic intervention in the popularization of nutritionally and technologically rich crops which are currently largely neglected and underutilized. The research has demonstrated that the success and sustainability of efforts in this domain are largely dependent upon and synergistically effective among highly complementary disciplines including crop improvement nutrition, food technology, marketing, education, public awareness and policies.

56. Mineral Composition of Little Millet Food Products and Bioavailability of Iron And Zinc in Different Processing Methods

Mamata Mannuramath and Nirmala Yenagi

Report Type: Poster presentation

Date: Presented in February 2013

Location: International Workshop UAS Dharwad, India

***IDRC Project Number, and component number (if applicable): 106314**

***IDRC Project Title:** Enhancing Food Security of Rural Families Through Production, Processing and Value Addition of Regional Staple Food Grains in India **.**

***Country/Region:** India (Karnataka)

***Full Name of Research Institution:** University of Agricultural Sciences, Dharwad

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***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

Abstract:

Little millet (*Panicum sumatrense*) is small seeded grain used as food, feed, and fodder which is most popular as fasting food because of its high satiety value and better mineral composition. Parboiling, fermentation and baking are the suitable processing technologies for development of consumer acceptable value added products. In the present study, the mineral content of raw and parboiled little millet, fermented products prepared from little millet and rice*(paddu*), bread prepared from refined flour and little millet substitution, and biscuits prepared from dehulled and decorticated little millet were analyzed for the mineral composition. The bioavailability of iron and zinc of the products was analyzed. The significant difference was found in mineral contents of the samples (P≤0.05). The total ash content in the products ranged from 1.33 to 2.73 percent. The highest ash was found in little millet *paddu*(2.73%) and lowest was found in the parboiled little millet (1.33%). The iron, zinc, copper and manganese content in products ranged from 2.48 to 10.87mg/100g, 0.48 to 2.06 mg/100g, 0.15 to 1.96 mg/100g and 0.45 to 4.59mg/100g respectively. Little millet bread was found to be rich in iron, copper and manganese content and millet *paddu* was high in zinc content. The percent bioavailability of iron was found to be high in rice *paddu* followed by decorticated little millet. The per cent bioavailability of zinc was found to be high in refined flour bread followed by decorticated little millet biscuit. Compared to raw little millet, parboiling, baking and fermentation have increased bioavailability of iron and zinc by 7.4 to 40.11 per cent and 11.83 to 34.45per cent respectively. Even though dehulled little millet biscuit, little millet bread and little millet *paddu* have high mineral content the bioavailability of minerals was found to be low when compared to decorticated little millet biscuit, refined flour bread and rice *paddu* respectively It can be concluded that processing methods play an important role in enhancing the bioavailability of mineral in little millet products.

57. Development of a millet dehuller

Valérie Orsat, S. Sotocinal, K. Swan, R. Chin, N. Matlashewski, V. Raghavan, N. Yenagi.

Report Type: Conference Presentation

Date: February 8-9, 2013

Location: International Workshop UAS Dharwad, India

IDRC Project Number, and component number (if applicable): 106314
IDRC Project Title: Enhancing Food Security of Rural Families Through Production, Processing and Value Addition of Regional Staple Food Grains in India
Country/Region: Canada
Full Name of Research Institution: McGill University
Address of Research Institution: Bioresource Engineering Department, 21111 Lakeshore Rd, Ste-Anne-de-Bellevue, QC, H9X 3V9
Name(s) of Researcher/Members of Research Team: and Valérie Orsat
Contact Information of Researcher/Research Team members: Valerie.orsat@mcgill.ca
This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.

Abstract:

Renewed efforts are being made to encourage the cultivation of the minor millets in South East Asia in an attempt to empower rural communities through increased food security and reduced malnutrition. In order to encourage the cultivation of millets, efficient post-harvest processing machines are quintessential. Minor millets are minor grains with a near spherical shape, an average axial length of 1-1.5 mm and encased by an indigestible single layer hull. The removal of this hull along with the separation of the hull from the edible grains is essential before consumption. The goal of this project was to design an efficient machine that can accomplish effectively the dehulling while remaining affordable and easily operable for the layman in rural communities in India. Existing mills include the traditional stone mill and the emery mill both of which can result in a significant amount of broken grains which is undesirable. These existing mills also entail a lot of drudgery for the women who further clean the de-hulled grain from the hulls. In response to these concerns, a centrifugal mill was designed and prototyped in Dharwad, India in 2011. The mill was then re-configured in Montreal, Canada in 2011-2012 to use rubber rollers which resulted in fewer broken grains as compared to the centrifugal mill. The original centrifugal portion was therefore used as a fan as a means to separate the cleaned grain from the hulls which decreases women's drudgery associated with cleaning the grains. The efficiency of the rubber roller mill is 99% and is advantageous as compared to the currently used emery mill since the former doesn't cause as many broken grains as the latter. The rubber roller mill has been shown to decrease women's drudgery by eliminating the time required for winnowing since it separates the de-hulled grain from the hulls. The rubber roller mill has a capacity of about 6kg/h which is adequate for village use at the household level. The rubber roller mill with 0.5HP motor is more appropriate and accessible for household level use than the emery mill since the former uses single-phase electrical power, while the latter uses 3-phase electrical power which is not standard at the household level and also costs more per kWh of electricity, making the cost of operation cheaper for the rubber roller mill. Since the rubber roller mill uses shearing force rather than abrasive force like in the emery mill, the bran remains on the grain which provides increased nutrition as compared to the millet that has gone through the emery mill. While the de-hulled millet is not acceptable as rice, there is a wide variety of products that can be made with the millets. Using the rubber roller mill to de-hull millet can help in improving the livelihoods and food security of rural families through value-added products and improved nutrition.

58. Microwave Assisted Extraction of the lipid fraction from Grain Amaranth

Siddhartha Joshi and Valérie Orsat

Report Type: Conference Presentation

Date: February 8-9, 2013

Location: : International Workshop UAS Dharwad, India

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***Country/Region:** Canada

***Full Name of Research Institution:** McGill University

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***Name(s) of Researcher/Members of Research Team:** and Valérie Orsat

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Abstract:

There is renewed interest in grain amaranth which grows in many tropical, subtropical as well as temperate countries. Amaranth produces good yields of cereal-like seeds under arid conditions and in poor soils where conventional cereal crops do not grow well. Approximately 60 species of amaranth are recognized, in which several species are considered as a weed. The oil content of amaranth seed is high varying between 6-9%, compared to other grains.

The present study optimized the methodology using microwave for extracting high value lipid from grain amaranth, which is a rich source of squalene, phytosterols, tocopherol & polyphenols and has an application in nutraceutical & cosmetic based industries.

The method used microwave energy to enhance the extraction diffusion processes and to release oil from the grain amaranth at reduced extraction time and reduced solvent consumption as compared with conventional extraction methodologies. Statistical designs were used to identify the process factors – sample to solvent ratio, solvent mixture ratio and extraction time at constant microwave power, which governed the oil yield & preserved the best quality of its high value constituents. The second half of the study focussed on comparing the yield and quality of these high value lipids with conventional extraction methodology under optimized conditions.

59. Use of millets for partial wheat replacement in bakery products

Ramesh Murugesan and Valérie Orsat

Report Type: Conference Presentation

Date: February 8-9, 2013

Location: : International Workshop UAS Dharwad, India

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***Country/Region:** Canada

***Full Name of Research Institution:** McGill University

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***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

Abstract:
Bakery products account for a major part of the processed food market and this industry is rapidly changing with advancements in nutraceuticals and new product developments. Wheat is the most important cereal in bakery industry and the demand for wheat is growing year by year as the processing of wheat into variety of products propagates. The protein quality of wheat is inferior when compared to certain other cereals, and this is primarily attributed to lower lysine, methionine, and threonine content of wheat proteins. This has significant health impact, especially in the vulnerable population with diabetes patients and people with gastro-intestinal and colo-rectal problems. The main objective behind replacing wheat flour with millets in bakery products is to add more functional and nutritional value to the bakery products. Millet replacements will affect the baking quality and in-turn the overall consumer acceptance. Identifying the right proportion of such replacement products in the baking industry has always been a major challenge and it is not possible without conducting multiple research studies and also it is strenuous to integrate the results of such studies to develop a unified model for future product development. Three minor millets varieties i.e. little millet, foxtail millet, barnyard millet, which are grown in India are being used in this research and two major bakery products i.e. bread and cake are considered in this study. Composite flours are made by using different combinations of wheat and millet flour (i.e. 9:1 to 1:9) and baking quality of the composite flours was evaluated by conducting various baking trails. The bread and cake which are made by using different proportions of composite flours are tested in terms of color, physical characteristics of baked product such as loaf height, volume, and various textural properties such as crumb texture, softness, sponginess etc. These quality parameters will be correlated with the rheological properties of dough or batter such as dough resistance, extensibility, smoothness of batter, dough preparation time, dough stability, etc. Sensory evaluation of the baked products was carried out to determine the overall acceptability of the baked products prepared from millet and wheat combinations. The sensory evaluations were done based on consumer preferences on taste, appearance, color, flavor, mouth feel, texture, and overall acceptability of the baked product. The outcome of sensory evaluation expressed that consumers preferred millet based baked products over wheat only bakery products due to its different pleasing taste and texture profile.

60. Weaning Infant Foods from Minor Millets

Sara Najdi-Hejazi and Valérie Orsat

Report Type: Conference Presentation

Date: to be presented in June 2013

Location: NABEC conference, Altoona, PA, USA

***IDRC Project Number, and component number (if applicable): 106314**

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***Country/Region:** Canada

***Full Name of Research Institution:** McGill University

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***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

Abstract:

Finger millet is a gluten-free nutritious pseudo-cereal grain. It is an excellent source of protein, starch, minerals, and dietary fibers. Although these characteristics make it a proper choice to be used as weaning products, the presence of anti-nutrient components restricts its usage. We hypothesised that germination and fermentation may be employed as effective treatments to increase the bioavailability of proteins and carbohydrates while reducing ant-nutrients. This hypothesis is investigated through a thorough experimental study of process parameters.

61. Effects of popping on the nutrient availability of little millet (*Panicum sumatrense*)

Priyanka Kapoor, Yvan Gariépy and Valérie Orsat

Report Type: Conference Presentation

Date: to be presented in June 2013

Location: NABEC conference, Altoona, PA, USA

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***IDRC Project Title:** Enhancing Food Security of Rural Families Through Production, Processing and Value Addition of Regional Staple Food Grains in India **.**

***Country/Region:** Canada

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***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.**

Abstract:

In the present research, the popping quality of little millet (Panicum sumatrense) and the effects of popping on the nutrient availability and the functional properties of the millet have been studied. Table salt was used as the heated particulate medium for popping. The popping conditions were optimized with respect to the temperature of the particulate medium and the moisture content of the millet. Thereafter, the effect of popping was observed on the proximate components, namely total phenolics, swelling power and solubility, hot and cold oil absorption, viscosity and the pasting characteristics of millet flour. It was found that both the temperature of the popping medium and the moisture content of the millet determined the yield of the popped millet. The protein content of the popped millet was almost equal to that of the native millet thus showing the popped millet to be as good a source of protein as native millet. Popping increased the non-resistant starch content of little millet, thereby increasing its digestibility. There was a negligible difference between the fat and the total ash content of the popped and the native millet. The availability of total phenolics increased from 225 mg gallic acid/100g sample (db) in the native millet to 661.462 mg gallic acid/100g sample (db) in the popped millet. Popped millet flour had a higher tendency of oil absorption at room temperature as well as at 140°C and also exhibited higher swelling power and solubility than native millet flour. It was also observed that while the cold paste viscosity of the native millet was 5.359 X 10-3 Pa s, that of popped millet varied from 1.5 to 7.5 Pa s. A similar trend was observed for the hot paste viscosity (HPV). Native millet had a HPV of 0.1908 Pa s whereas the HPV of popped millet was in the range of 1.9 to 7.5 Pa s. Popped millet flour has a higher water absorption capacity and forms a thicker paste than native millet flour with the same volume of water. This could be attributed to the higher availability of starch in popped millet flour. Thus, it can be concluded that popping little millet to incorporate it in ready-to-eat foods can increase its nutritional value, availability and economic value.

62. Optimization of Microwave Assisted Extraction of High Value Industrial Lipid from Grain Amaranth

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Abstract:

This study optimized the methodology for extracting high value lipid from grain amaranth, which is a rich source of squalene, phytosterols, tocopherol & polyphenols and has an application in nutraceutical & cosmetic based industries.

The method used microwave energy to enhance the extraction diffusion processes and to release oil from the grain amaranth at reduced extraction time and reduced solvent consumption as compared with conventional extraction methodologies. Statistical designs were used to identify the process factors – sample to solvent ratio, solvent mixture ratio and extraction time at constant microwave power - that governed the oil yield & preserved the best quality of its high value constituents.