

Scaling up Small Millet Post-harvest and Nutritious Food Products Project

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DHAN Foundation (DHAN), India



McGill University (McGill), Canada



Tamil Nadu Agricultural University (TNAU), India

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India

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Acronyms

CFTRI	Central Food Technological Research Institute
CIFSRF	Canadian International Food Security Research Fund
CRS	Community Radio Station
CSMP	Community Scale Small Millet Processing
DHAN	Development of Humane Action Foundation
FACHIG	Farmers' Association of Community self-Help Investment Groups
FPO	Farmers Producer Organisation
FSSAI	Food Safety and Standards Authority of India
GAC	Global Affairs Canada
GIZ	Gesellschaft für Internationale Zusammenarbeit
GST	Goods and Services Tax
ICAR	Indian Council of Agricultural Research
ICCOA	International Competence Centre for Organic Agriculture
IDRC	International Development Research Centre
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IGKV	Indira Gandhi Krishi Vishwavidyalaya
IIMR	Indian Institute of Millets Research
KVK	Krishi Vigyan Kendra
MAVIM	Mahila Arthik Vikas Mahamandal
McGill	McGill University
MoU	Memorandum of Understanding
MSMEs	Micro, Small and Medium Enterprises
MSP	Minimum Support Price
MSSRF	M S Swaminathan Research Foundation
NABARD	National Bank for Agriculture and Rural Development
NGO	Non-government organization
NSIC	National Small Industries Corporation
PDS	Public Distribution System
PI	Principal Investigator
PMPV	Pushcart Millet Porridge Vendor
R&D	Research and Development
RESMISA	Revalorising Small Millets in Rainfed Regions of South Asia
SHG	Self Help Group
SMEs	Small and Medium Enterprises
SMPU	Small Millet Processing Unit
TNAU	Tamil Nadu Agricultural University
ToT	Training of Trainers

1. Executive summary

An action research project titled “Scaling up Small Millet Post-harvest and Nutritious Food Products” was implemented by DHAN Foundation, India and McGill University, Canada, along with Tamil Nadu Agricultural University, India between December 2015 to April 2018. Its main objective is to develop and apply ways for scaling up small millet processing and value addition technologies to reduce drudgery of women and improve the nutritional (and diet-related health) security in India. This project builds upon the results of two previous CIFS RF projects viz. i) Revalorizing Small Millets in Rainfed Regions of South Asia, 2011-2014 and ii) Strengthening of Rural Families Through Empowerment by Introducing Food Security Through Production, Processing and Value Addition of Regional Staple Food Grains, 2010-2012. The project has taken initiatives to scale up two innovations namely (i) appropriate scale small millet processing machines and (ii) appealing small millet food products.

For scaling up processing technologies, a ‘commercialization business model’ referred to as ‘on-site business incubation’ of equipment manufacturers, and a ‘knowledge transfer business model’ to revive the defunct processing units were explored. Six equipment manufacturers were supported for product improvement, business development and improving visibility. Their products were promoted in Central and Northern India and at national and international fairs. AVM and Victor improved their product designs and started supplying a huller model with a capacity of 500 kg/hr to meet the requirement of medium scale enterprises. AVM and Perfura took part in government bidding and secured the work order. Perfura and Agromech started offering small millet centrifugal huller as part of their product portfolio. All manufacturers widened their contact base and reach. Since the start of the project, 173 processing units have been supplied for the processing of small millets in 54 districts in 10 States. Nineteen processing units were revived in Tamil Nadu and Odisha. Of the target of 200 processing units, 192 were reached and about 1015 tonnes of millet rice and grits have been produced, reaching 288,500 consumers across 10 states.

For scaling up appealing small millet food products, the project explored a ‘commercialization business model’, which included ‘on-site business incubation’ of micro, small and medium enterprises (MSMEs) and customised capacity building of cottage enterprises and FPOs. A ‘knowledge transfer business model’ was explored for scaling up the reach of ‘method/recipes’, mainly through individuals, consumer organisations and food service providers. Customised on-site incubation support was offered to 66 micro, small and medium sized food enterprises in Tamil Nadu for scaling up of their operations. Benefiting from the project support, the food enterprises in Tamil Nadu were improved in the following aspects: (i) standardisation of foods products (22), (ii) introduction of new products (28), (iii) improvement in packaging (21), (iv) improvement in hygienic practices (35), (v) improvement in production capacity (14), (vi) increased visibility (42) and (vii) increase in marketing links (28). Furthermore, the sales volume of 30 enterprises increased by more than 15% and, in addition to their existing markets, their geographical reach increased to nearby districts and states. Furthermore, twenty-seven entrepreneurs started commercialising small millet food products. Support was given to Pushcart Millet Porridge Vendors (PMPVs) in Tamil Nadu, an existing channel serving nutritious millet foods to the low-income sector of the population. As a result, 152 PMPVs have adopted customised food hygiene practices, 76 have registered with FSSAI, 75 got biometric card and most of them have improved their image through display of a name board, oaths and do’s and don’ts of hygienic food handling. Focused efforts were taken for dissemination of small-millet-value-addition technologies to Eastern, Central and Northern India by orienting and building the capacity of 391 potential adopters and promoters such as NGOs and government entities. As a result, 26 cottage enterprises, two micro enterprises and 14 NGOs have begun production and marketing of small-millet-based food products. Since the beginning of the project, 210 tonnes of value-added products have been produced, thereby reaching 278,000 additional consumers.

Considerable progress was made through need based research related to scaling up small millet processing and value addition technologies on: (i) market research in India, (ii) development of the hulling and processing assemblies to meet varying operating requirements at the village, micro enterprise and SME levels, (iii) studies on health benefits of small millet foods, and (iv) working models on scaling up. The initiatives to address technology gaps in primary processing of small millets resulted in (i) generation of valuable data on grain parameters; (ii) improvement of existing processing equipment in terms of performance, ease of use and safety; (iii) development of additional equipment: (a) an improved model centrifugal huller with higher performance and energy efficiency, (b) a household scale and an enterprise scale rubber-roller type hullers, (c) a pneumatic cleaner, and (d) a vibro-grader; and (iv) identification of storage methods for enhancing shelf life of hulled grains and flour. Studies on (i) nutritional comparison of millets with other super foods, and (ii) anti-diabetic and bioavailability studies of small-millet-based food products, were taken up to position small millets as a health food category. Lessons learnt from implementing scaling up business models were synthesised into (i) on-site incubation model for supporting equipment manufacturers, (ii) working model to facilitate adoption of processing technology, (iii) on-site incubation model for supporting MSMEs and cottage enterprises, and (iv) working model for promoting consumption of small millets.

The learning acquired from the project activities for scaling up was synthesised into three policy documents, seven academic papers covering overarching findings of the project, 26 papers on specific research results, one output on gender, six video/ audio/ slide shows, four protocols/ guidelines, four technical bulletins, and three study reports. These outputs were widely shared through a national seminar, a national policy workshop, and a “Project Dissemination Workshop” and through participation in 10 national and international conferences. The project contributed to policy discussion on mainstreaming small millets in the regular diets by bringing to attention the policy support needed for developing local and regional value chains, particularly for (i) establishing decentralised processing infrastructure, (ii) establishment of MSMEs and cottage industries in the millet sector, and (iii) addressing supply chain constraints. The document on strategic directions and specific policy action points for (a) scaling up production, (b) processing infrastructure development, (c) market development, and (d) increasing household consumption was shared with the Ministry of Agriculture and Farmers Welfare, Delhi, to feed in to the “Millets Mission” being contemplated by the central government and some state governments. Furthermore, a suggestion was made for having a “sub-mission focusing on small millets” within the broader “Millets Mission”. A short note on “Sub-Mission on Promoting Small Millets in Tamil Nadu under Mission on Sustainable Dryland Agriculture” was submitted to the Agriculture Production Commissioner in Tamil Nadu. The project team participated in a consultation meeting of the “Comprehensive Revival of Millets Project”, Andhra Pradesh and “Special Programme for Promotion of Millets in Tribal Areas in Odisha”, to help choose appropriate processing equipment, and given advice on sound procurement and installation procedures. On invitation by the government of Tamil Nadu, technical inputs were given on modalities of inclusion of small millets in the existing public food programs. A detailed document was shared with NABARD, the national level body that is managing climate adaptation fund, on promoting millet-based cropping systems as a climate change adaptation strategy. A skill exchange program on small millet processing and value addition was organised between FACHIG Trust, Zimbabwe and DHAN with the support of the Agricultural Biodiversity Community.

For facilitating adoption of small millet processing equipment, demonstrations of processing equipment were organised in 20 locations in Odisha, Tamil Nadu and Andhra Pradesh, Uttarakhand, Telangana, Maharashtra, Madhya Pradesh, and Rajasthan with the support of partner NGOs (14) and Indian Institute of Millet Research. Demonstrations were also organised at 10 national and international exhibitions and events. The capacities of 33 village level processors, 25 small scale processors, three medium scale processors, seven FPOs, three food companies, 198 prospective buyers and 62 promoters were built up

on processing of small millets in Southern, Eastern and Central India. Through these efforts, a sound beginning for the development of decentralised small millet processing infrastructure was created in Eastern and Central India. Awareness posters, a monthly calendar with message on millets, a music album, radio programs, and short films on cooking demos of small millet traditional recipes and modern value-added small-millet-based food products were developed and shared widely through the DHAN website, YouTube and by sales. In Tamil Nadu, Andhra Pradesh, Karnataka, New Delhi, Odisha, Chhattisgarh, and Kerala, 72,490 persons, mainly women, farmers, and school children, were educated about the health benefits of small millets through 84 local and district level promotional events and 21 international, national, provincial and local exhibitions. Youths were reached through a novel recipe competition organised for Catering, Hotel Management and Home Science students and through a short film contest on the theme of 'Small Millets- Our Food: Our Pride'. Furthermore, the message of small millets reached more than 200,000 persons through programs aired on community radio stations, telecasted on local television channels and by SMS audio messages. The capacity of 829 persons including 725 women and 104 men working in 85 women/farmer federations (29 urban and 49 rural and 7 tribal) in Tamil Nadu, Andhra Pradesh and Odisha was built on organising recipe demonstrations for end users. The knowledge and skills of 15,838 persons (12,993 women, 1,719 men and 1,126 children) on inclusion of small millets in their diets were built through recipe demonstration in 334 habitations. About 300 tonnes of small millet rice was supplied by different FPOs and by Kalanjiam Thozhilagam Limited, most of which was supplied to members of women/ farmers organisations who fall in the lower middle class and low-income categories, at a price far lower than the market price. Through these efforts, the attempt to transform small-millet-based food products from the 'elite food' category towards the 'mass food' category was achieved to an extent.

The development of appropriate small millet technologies and scaling up of their adoption by strengthening existing value chain actors and facilitating entry of new actors with the support of two CIFSRF projects since 2011, played an instrumental role in the transformation of local and regional value chains in the Tamil Nadu region. These developments have provided valuable expertise and knowledge for other regions that produce millets. The project resulted in processing equipment with women friendly design that reduce women's drudgery in processing operations. It also resulted in additional income and employment for women in many small millet processing units and 191 food enterprises and capacity building of 72 women organisations. The project also provided training for five Masters and PhD students on development of processing equipment for small millets and of millet based products.

The work completed so far by the project partners has contributed to a body of knowledge/ technologies/practice, and working models on scaling up small millet processing and value addition technologies and set direction for mainstreaming small millets in regular diets in India and in other countries and regions. Broadly, the project has thrown light on (i) what scaling up approaches work for neglected and underutilized nutritious plant species such as small millets for improving nutrition security of the masses, and (ii) how markets can be made to adapt for ensuring nutrition security of the masses. There is considerable need and scope for scaling up the learning from the project in India, particularly in Central and Northern India and in other South Asian and African countries with millets.

2. The research problem

Many developing countries are facing the triple burden of undernourishment, micronutrient deficiency, and obesity. In India, there is large-scale prevalence of stunted growth among children, and anaemia among pregnant women (IFPRI, 2015). Obesity is also fast increasing across rural and urban areas (Kalra et al. 2012). Furthermore, chronic and non-communicable diseases are on the rise. For example, the prevalence of Type-II diabetes mellitus and impaired glucose tolerance were affecting, at an alarming

rate, both rural (2.4%) and urban (11.6%) populations (Mohan et al. 2009). Increasing research and epidemiological evidence links the lack of dietary diversity to these health issues (Khoury et al. 2014). Small millets which include finger millet, kodo millet, little millet, foxtail millet, proso millet, and barnyard millet, are one of the important traditional food groups that have been moved out of the food basket in recent times (Ramachandran, 2007). Small millets offer better nutrition with various micronutrients like vitamin B complex, calcium, iron and sulphur, high dietary fibre and low glycemic index when compared to mainstream cereals like rice and wheat (Saleh et al. 2013). They are known as both preventive and curative foods. Small millet crops also have the ability to adapt to a wider range of growing environments. Despite these advantages, small millets cultivation and consumption have declined across India. This project addresses this research problem.

One of the important reasons for this decline is the drudgery related to the hulling of the small millets. Hulling is the process of removing the outer husk from the grains, which is vital for obtaining grain-rice, so that it can be further processed for consumption. Traditionally, small millets were hulled manually by women, as there was no local processing infrastructure in the villages. This process was time consuming and involved significant drudgery for women. Due in part to this reason, the consumption of small millets had drastically declined in the production regions. The few large-scale mills available in Maharashtra and Tamil Nadu produced highly polished grain-rice. In this process most of the bran, which contains fibres, minerals and many phytonutrients, is removed, leading to considerable reduction in the nutritional quality of the resulting small millet grain rice. Small-scale small millet processors faced difficulty in removing extraneous matter and separating hulled and unhulled grains and had lower head-rice recovery. Then available huller models did not effectively meet the village and regional level processing requirements. The earlier CIFS RF projects addressed this gap in technology by developing three centrifugal huller prototypes and one rubber roller prototype.

Consumption is also restricted due to inadequate availability of affordable ready-to-cook and ready-to-eat small millet products in local markets. The small millets were consumed in production regions mainly in traditional preparations such as porridge and rice. Consumption has declined significantly in these regions. Some of the important reasons are: i) social stigma attached to millet foods (food of poor and lower caste), and ii) lack of appeal of traditional food preparations, particularly to younger generations. There was a need for small millet recipes that are on par with mainstream rice/wheat recipes, so as to be attractive to younger generations in order to increase small millet consumption in the production regions. In the non-production regions, where small millets are less known, there was a requirement for recipes and products that are familiar (instead of very new food products), convenient to use, and attractive to younger generations in order to promote consumption. Food products that incorporated small millets in significant proportion into commonly consumed traditional breakfast items, meals, snacks and sweets and in modern food products like cookies, vermicelli, bread, etc. were developed in the earlier CIFS RF project to address the needs and tastes of different categories of consumers. These products made small millets acceptable and appealing to them. These products also provided a business opportunity to food enterprises who want to promote healthier alternatives to conventional foods.

A related research problem was how to scale up these two innovations, namely (i) appropriate scale small millet hulling equipment, and (ii) appealing small millet food products to large number of end users. The main objective of the project is to 'develop and apply ways for scaling up small millet processing and value addition technologies to reduce drudgery of women and improve the nutritional (and diet-related health) security in India'.

3. Progress towards milestones

3.1 Project team hired and established, and mechanisms for project integration and coordination, and roles and responsibilities of project team members well defined (DHAN, McGill): *Achieved*

a) Recruitment of personnel: The key positions with respect to this project in DHAN, TNAU and McGill were filled. SAS Technologies, a Canadian company, was engaged by McGill to provide technical support for improving small millet processing equipment.

b) Project integration and coordination mechanism: A Memorandum of Understanding (MoU) was signed between DHAN and McGill and a grant agreement was signed between DHAN and TNAU. These documents spelled out the terms of collaboration between the project partners and served as the foundation for project integration and coordination. The roles and responsibilities of the project partners developed during proposal preparation were refined and firmed up during the Inception Workshop.

3.2 Project Inception Workshop held and report finalized (DHAN, McGill): *Completed*

The inception workshop for the project was organized by DHAN with the support of project partners from 4th to 7th of April 2016 at Heritage Madurai Hotel, Madurai, Tamil Nadu, with a focus on (i) the public launching of the project, (ii) team building, (iii) bringing a common understanding among the team members, and (iv) planning for the first six months. The meeting brought together 69 participants, which included staff from the project partners (DHAN, TNAU, and McGill), and program officers from the International Development Research Centre (IDRC), policy makers from the Indian government, the Consulate General from the Canadian High Commission, manufacturers of small millet processing equipment, food processors, owners of food enterprises and restaurants that are marketing small millet products, scientists from the Indian Council of Agricultural Research (ICAR) and academic institutions, representatives from non-government organizations, and media personnel. The workshop was attended by Kevin Tiessen and Alvaro Paz of IDRC. The Inception Workshop provided an excellent opportunity for the main actors of the project and members of their respective teams to meet face to face, and to re-examine and discuss openly how the objectives are to be realized while addressing the guidelines of IDRC and Global Affairs Canada (GAC). The inception workshop brought visibility to the project with other stakeholders involved in the promotion of small millets. The proceedings of the inception workshop were given in Annex 2.1 of the first technical report.

3.3 Outline of the communication strategy for the project (DHAN, McGill): *Prepared*

The project partners through consultation developed an outline of the communication strategy describing specific audiences and ways to reach them. The communication strategy document for the project was given as Annex 2.2 of the first technical report.

3.4 Scaling up strategy (McGill, DHAN): *Prepared*

A scaling up strategy document for the project was prepared by the project partners, which benefitted from the deliberations and insights obtained from both the *Scaling Up Food Security Innovations in Asia* workshop that took place in Cambodia and the Inception Workshop. The scaling up strategy document covered the description of the two innovations that the project will scale up (*i. appropriate scale small millet dehulling equipment, and ii. appealing small millet food products*), potential developmental effects of scaling up, possible business models and delivery mechanisms, impact projections, key factors that may play in favor or against these projections, gap analysis and

implementation plan. The scaling up strategy document for the project was attached as Annex 2.3 of the first technical report.

3.5 Outline of the gender strategy for the project (McGill): *Prepared*

An outline on how the project will integrate gender considerations into the project was prepared by the project partners and was attached as Annex 2.4 of the first technical report. The project benefited from the gender workshop organised by IDRC in early June 2016 in Nairobi, Kenya.

3.6 Action plan to support equipment manufacturers developed and initiated (McGill, TNAU & DHAN) : *Undertaken*

An action plan was prepared and initiated for equipment development, business development and improving visibility of the product for AVM Engineering (AVM), VICTOR AGRO SALES (Victor), Perfura Technologies Private Ltd. (Perfura), Agromech Engineers (Agromech) and KMS Industries (KMS) in Tamil Nadu, and Vishwa Agro Tech and Bio-tech in Karnataka, by DHAN. Expert assessment of the equipment was organised by DHAN with the involvement of SAS Technologies and of TNAU. This helped in capacity building of the manufacturers on technical design and equipment standards, identification of areas for improvement, and preparation of an action plan.

3.7 Action plan to support small and medium enterprises (SMEs) developed and initiated (McGill, TNAU & DHAN): *Undertaken*

A working relationship was established with 66 small millet food enterprises and 152 Pushcart Millet Porridge Vendors (PMPV) in Tamil Nadu, and with 26 cottage enterprises and two enterprises in Eastern India. After assessing their requirements on a one-to-one basis, action plans were prepared with them. These action plans were further firmed up in the post-training sessions organized on product development, food hygiene and safety, packaging, and Government protocols to be followed.

3.8 Assessment of market potential for an array of hulling and other processing equipment/assembly for small millets (McGill, TNAU & DHAN): *Completed*

Visits were made to Odisha, Andhra Pradesh, Madhya Pradesh, and Uttarakhand (provinces with considerable area under cultivation of small millets) by DHAN to understand prevalence of centrifugal small millet processing equipment. It was observed that except in Andhra Pradesh, there was very limited penetration of centrifugal and other technologies of small millet processing at both the village and regional levels, indicating potential for promotion. The market segments for small millet processing equipment are: (i) village level custom hiring services, (ii) micro processing enterprises, and (iii) medium processing enterprises. In terms of different types of processing units, the estimated market size was 6,350 for village level users, and 585 for micro and medium processing enterprises. This figure was arrived at by taking into account the existing area under cultivation, with assumptions for self-processing and processing by centralised large-scale units; the market potential will increase further if there is increase in area under cultivation. More details are shared in Annex 2.1.

3.9 Development of the huller assembly to meet the varying operating requirements depending on the type of millet at the village, microenterprise and SME levels completed (McGill & TNAU): *Undertaken*

Assessment of machines pertaining to small millet processing line offered by manufacturers in the market was carried out by DHAN and McGill. This assessment indicated that considerable efforts are needed for improving the existing machines and for developing additional machines to improve the processing assembly for getting quality output at a reduced cost of processing. A detailed

review of implementation of mechanized post-harvest processing technologies of millets was undertaken by McGill student (Annex 2.2). With this background, the following activities were taken up in the project to improve the processing assembly and to address the issues related to low shelf life:

- (i) **Generation of data on grain parameters:** Data were generated by TNAU for small millets with husk on (a) force required to split the husk, (b) hardness of the grain and (c) terminal velocity. These parameters will help in improving the design of processing equipment.
- (ii) **Improvement of existing machines:** Joint R&D was organised with equipment manufactures to improve performance, ease of use, safety and energy efficiency of existing units. These efforts resulted in (a) improvement of existing centrifugal small millet huller with increased head rice recovery, reduced footprint, weight, and height, improved ease of use and safety, particularly for women, (b) improvement in versatility of grader by using interchangeable sieves to serve for pre and post-hulling activities, and for processing different small millet crops, (c) improvement in process flow to enhance the quality of output, (d) improvement in the versatility of the processing assemblies in terms of scale of operation varying from 50 kg/hr to 500 kg/hr to meet requirements at the village, micro enterprise, and SME levels, and (e) improvement in segregation of post-hulling fractions through use of a specific gravity separator.



Figure 1: Improved impact hullers for processing small millets developed in the project

- (iii) **Testing of equipment designed for other crops/commodities for hulling small millets**
- (iv) **Development of additional equipment to fill the gaps in the processing line:** The project developed (a) an improved centrifugal huller with significant higher performance and energy efficiency than the existing centrifugal hullers, (b) a household scale and an enterprise scale rubber-roller type huller prototype, (c) a pneumatic cleaner to remove unfilled chaffy grains, dust, and large impurities from the grains, and (d) a vibro-grader for improving segregation of pre and post-hulled fractions, and
- (v) **Evaluation of different storage methods for enhancing shelf life of dehulled grains and flour of small millets:** Vacuum packaging, modified atmosphere packaging, hermetic storage and flexible package methods were evaluated; and hermetic storage was found to give the best results followed by flexible package.

3.10 Market research on appealing small millet products in India (McGill, TNAU & DHAN):

Undertaken

Market research was carried out in three phases as described below:

An exploratory market study was done by DHAN in different districts of Tamil Nadu, Bangalore in Karnataka, Vizianagaram and Visakhapatnam of Andhra Pradesh and Jeypore, Bhubaneswar and Koraput of Odisha to understand the presence and demand for different appealing small millet products. This study focused on the type of products, market channels, market actors and positioning of the product. This study found that while there is considerable small millet value chain development in Tamil Nadu and Bangalore, there was meagre presence of small millet products in the Visakhapatnam of Andhra Pradesh and Jeypore, Bhubaneswar and Koraput of Odisha, indicating that differential strategies were needed for scaling up across the geographical regions.

A second market research on appealing small millet products in Tamil Nadu was carried out by DHAN with the following objectives: (1) to understand the consumer acceptance of value-added product of small millets, (2) to understand the constraints faced by different actors in the small millet market chain, and (3) to suggest suitable marketing strategies for small millet food products that can be used by the entrepreneurs. The main small millet market chain actors namely, consumers, small millet food enterprises, distributors, retailers and restaurants were selected for the study. This study was informative about the products and package size preferred by the consumers and the issues faced by food enterprises.

A third study that was wider in scope was taken up by McGill. Indianet Marketing Services was hired to do a research study in different urban centres (Delhi, Kolkata, Mumbai, Bengaluru, and Chennai) and rural areas (Ambala, Ranchi, Hubli-Dharwar, Salem) across India on the habits and attitudes with respect to the consumption of millets. This study was done to understand (1) the awareness levels and perception of different millets; (2) consumption patterns for the different millets (e.g. consumers, frequency of consumption/purchase, purchasing habits: volume and cost); and (3) attitudes and preferences with respect to different types of millets in different areas of India. The study was accomplished through personal interviews of consumers of millets and of other cereals, and of retailers, traders, and wholesalers. The results showed that awareness of millets is low and is consumed primarily in middle class and educated households. The consumption of millets is gaining popularity in urban cities primarily for health-beneficial reasons. The full report from Indianet can be found in Annex 2.3.

These studies informed the approach of project interventions on disseminating the small millet value addition technologies across India.

3.11 Nutritional education campaign developed and initiated (in progress) (McGill & DHAN):

Undertaken

Promotional materials were prepared and widely used, namely: (i) awareness posters in Tamil, Telugu and English, (ii) Community Radio programmes in Tamil and Telugu, (iii) short films on recipes in Tamil, Telugu, Odiya, and Hindi, and (iv) a music album of motivational songs in Tamil on health benefits and other virtues of small millets. The content included: (a) introduction to the crops, (b) positioning small millets as 'food for all', not just for patients and appealing as any other mainstream food, (c) highlighting culinary heritage, (d) health benefits, (e) ease of cooking, (f) ways of cooking and tips for integration into regular diets, (g) need to eat less polished millet rice, and (h) advantages of parboiled millet rice. Using these materials, nutrition education campaigns were carried out through (i) value addition demonstrations at the community level, (ii) folk arts campaign, (iii) promotional events, (iv) wall paintings, and (v) media campaign in Tamil Nadu, Odisha, Andhra Pradesh, Telangana and Uttarakhand.

3.12 Customized support to micro enterprises being offered under progress (DHAN & TNAU) : *Undertaken*

One hundred and fifty two Pushcart Millet Porridge Vendors (PMPVs) were identified in Madurai, Krishnagiri, Salem, and Harur in Tamil Nadu. Customised support was offered to stabilize and enhance their livelihood and to improve the quality of their food services to urban poor in terms of food hygiene and additional millet products. PMPVs were motivated and supported to adopt appropriate food hygiene and safety practices, for FSSAI registration, getting biometric card, improving visibility, improving infrastructure, and exploring diversification to other millet snack items. In Odisha and Andhra Pradesh, 58 micro enterprises and 15 NGOs were offered customised training on product development.



Figure 2: Short films on cooking demos of small millet recipes in Hindi

3.13 Evaluation of adoption and impact of village level hulling equipment on the largely female users and entrepreneurs (McGill, DHAN & TNAU): *Undertaken*

High drudgery in manual processing of small millets is considered as one of the important reasons for the fast decline in their consumption in the production regions. To address this issue, Small Millets Processing Units (SMPUs) are being promoted at the village level in these regions, as availability of local processing infrastructure is expected to reduce drudgery in processing, which in turn is expected to increase consumption of small millets. However, there is inadequate understanding of the utilization and the consequent outcomes of the promotion of SMPU. In this backdrop, an assessment study of SMPUs was undertaken in i) Jawadhu Hills, Tamil Nadu, ii) Peraiyur, Tamil Nadu, and iii) Semiliguda, Odisha. These areas vary in cultivation intensity and socio-economic background. The main objectives of the study were: (i) to understand why some families used and why some families did not use SMPU within the zone of usage, (ii) to identify the benefits realised by the families who used the SMPU; (iii) to understand the reasons for difference in utilisation within the site and within the region; and (iv) to suggest ways to optimize the use of SMPUs. This explorative study relied more on qualitative research method. Interview schedules were administered to users and non-users (mostly families consuming small millets but not using SMPU) of six SMPUs. Key informant interviews were done with SMPU operators or owners and with a few opinion leaders, wherever possible. Focus group discussion with men and women was undertaken to understand the drudgery reduction and change in gender role in processing of small millets. Results indicated that most of the users viewed reduction in drudgery and time taken for processing as the main benefit of using the SMPUs, realized mainly by women. However, the extent of this benefit varied depending on the user, the SMPU and the site. The existence of SMPUs did not result in changes in decision making by women on the quantity of grains to be processed and the role of women in preparatory works before processing grains in SMPU. But, it has resulted in sharing of roles between men and women related to processing using SMPUs. Not shifting from 'non-eater' to 'eater' of small millets by families around SMPU was a main reason for its low utilisation. There was a critical need for improving the quality of output, mainly by improving the skills of operators and for complementary efforts, along with promotion of SMPUs for motivating

non-eaters to consume small millets. The reasons for non-utilization varied across the SMPUs. The study recommended specific action plan to optimize utilization of SMPU for each site.

While this is the case of functioning SMPUs, the survey of all the village SMPUs in Jawadhu Hills, Tamil Nadu, indicated that the major part of them were not functioning due to factors related to the quality of machines, agency, lack of a support system for technical assistance, etc. Anecdotal evidences in Andhra Pradesh and Madhya Pradesh also indicated the same status. These results point to the need for fine tuning of the processing technologies to this market segment, and for a package of support that is needed for establishing village level SMPU as a custom hiring service. The results of these studies will feed into the modalities for implementing Government schemes pertaining to establishing new village level SMPUs.

3.14 Studies to assess the health benefits of selected small millet products (TNAU & McGill): *Undertaken*

i) Development of multi small millet value-added products

TNAU has developed 14 multi millet-based therapeutic foods and 42 multi small-millet-based foods (including 26 traditional foods [8 breakfast foods, 6 sweets, 5 lunch foods and 7 snacks], six bakery products, two extruded and flaked products, and eight ready-to-cook mixes) by substituting small millets for fine cereals. The developed products were found to be rich in protein, calcium and iron. Results of the sensory evaluation showed that the developed products were 'highly acceptable'. Use of a combination of small millets gave new tastes and improved acceptability. These multi small millet food products helped to satisfy the individual preferences and have the advantage of improved nutrient content at a lower cost.

ii) Anti-diabetic activities of multi millet instant food mixes

The anti-diabetic activities of ten multi-small-millet-based instant therapeutic food mixes developed in the project were evaluated in rats. The results showed significant reduction in the blood glucose level seven hours after feeding of multi-millet-based instant mixes in diabetic rats when compared to normal rats. Among the ten products, glycemic index was lowest in drumstick leaves *chappathi* mix, followed by fenugreek leaves rice mix, *upma* mix and *adai* mix. These mixes were found to be suitable for diabetics.



Figure 3: Bioavailability studies of small millet recipes

iii) Bioavailability study of instant multi millet-based therapeutic mixes

The bioavailability of the multi millet instant mixes was evaluated in the Wistar albino rats at 0, 1, 2, 4, 8, 12 and 24 hours of the post dose period. Delayed absorption of carbohydrate in the blood stream and significant absorption of minerals (calcium and iron), vitamins (thiamine and riboflavin) were observed as compared to control rats. This result showed that the developed multi-millet

products were highly suitable for diabetics and for patients with cardiovascular problems. More information is shared in Annex 2.4.

McGill has undertaken following studies on the health benefits of millets: (i) Nutritional comparison of millets with other superfoods (Annex 2.5), (ii) [Development of innovative probiotic weaning products from finger millets and amaranth](#), and (iii) Study on microwave-assisted extraction (MAE) of phenolic antioxidants from Kodo millet hulls (*Paspalum scrobiculatum*) and evaluation of antioxidant activity 'in vitro'.

3.15 Preparation of case studies (McGill & DHAN): *Completed*

Case studies on equipment manufacturer, SMPU, small millet food enterprises, and women federation promoting small millets were prepared. These case studies throw more light on what is happening in the chain, as small millets are an emerging food category in the market. They are expected to help value chain actors and other stakeholders like Government bodies, support institutions, NGOs, and funding agencies to understand the overall micro and macro scenarios that the different small millet value chain actors are facing, how it influences their performance, how the challenges faced by them for sustaining and scaling up of their operations are being met, and what support can be offered to strengthen them.

3.16 Organize at least 3 state level policy consultation meetings (DHAN & McGill): *Undertaken*

A national policy workshop was organised by DHAN on 'Mainstreaming Small Millets in Our Diets' at the India Habitat Centre, New Delhi on 1st June, 2017. The main objective of the policy workshop was to discuss and develop concrete policy support needed for mainstreaming small millets at the State and Central Government levels in the following spheres: (i) improving production, (ii) development of decentralized processing infrastructure, (iii) market development and (iv) promoting household consumption. Shri B Rajender, IAS, Joint Secretary (Crops), Ministry of Agriculture and Farmers Welfare, gave a keynote address. Representatives from Farmers Producer Organisations (FPOs), small millet processors, food entrepreneurs, and eminent persons from the Governments of Tamil Nadu, Odisha and Andhra Pradesh, NGOs, research organisations and funding agencies participated in the workshop and shared their views on the policy support needed for mainstreaming small millets in our diets. [The presentations of the workshop are shared on the project web link](#). The workshop resulted in a set of comprehensive recommendations that was

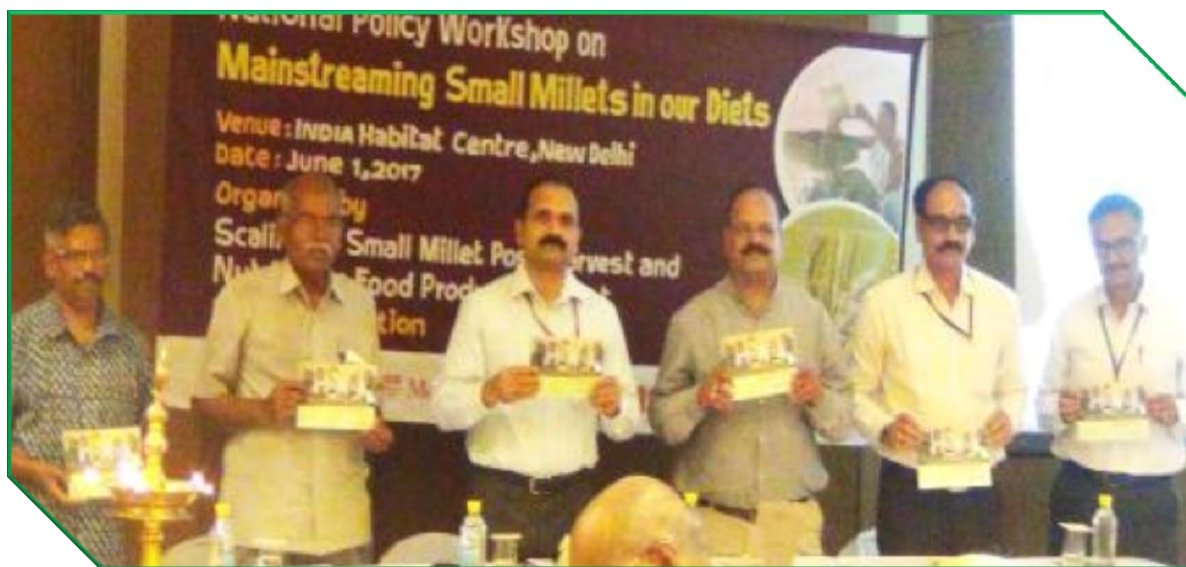


Figure 4: National policy workshop on Mainstreaming Small Millets in Our Diets, New Delhi.

shared with the Joint Secretary (Crops), Ministry of Agriculture and Farmers Welfare, Delhi, for feeding into the upcoming “Mission on Millets”. A sub-mission for small millets with the “Mission on Millets” was also advocated, as this would aid in getting necessary attention and exclusive fund allocation. Policy consultation meetings were organised with Agriculture Production Commissioners in Tamil Nadu and Odisha; the District Administrator in Dantewada district, Chhattisgarh, and Nandurbar District, Maharashtra, and the Madhya Pradesh State Rural Livelihoods Mission (MSRLM).

3.17 Conduct training on utilization of hulling and processing equipment (McGill & DHAN): *Undertaken*

Inadequate knowledge and skills for efficient use of the processing machines to get optimum quantity and quality of output have been important reasons for non-functioning and sub-optimally functioning of SMPUs. These reasons were also one of the underlying factors behind the high cost of production and poor quality of small millet rice and grits, which affected the viability of SMPUs and demand for small millets from the consumers. DHAN organised ten training sessions and exposure visits on the processing of small millets focusing on skill and knowledge building in Tamil Nadu, Odisha, Andhra Pradesh, Uttarakhand, Maharashtra, Madhya Pradesh, and Chhattisgarh for 33 village level processors, 25 small scale processors,



Figure 5: Training on small millet processing at Dantewada, Chhattisgarh

three medium scale processors, seven FPOs, and three food companies. In four training sessions, two experienced successful processors, one equipment manufacturer cum processor, and one expert shared their tacit learning from years of practice (which is opaque to the outsiders). All the training sessions covered the following aspects: (i) overview of small millet processing, (ii) assessing quality of small millet grains, (iii) steps in processing small millets, (iv) pre-hulling, cleaning and grading, (v) hulling and post-hulling operations, (vi) pest management, (vii) maintenance and basic repair of processing machines, (viii) storage of raw material and processed outputs and (ix) purchasing suitable machines. ‘Learning by doing’ approach and clarifying day-to-day issues were given focus to ensure effective utilisation of skills gained from the training. Furthermore, these training sessions served as an effective tool to disseminate small millet processing technologies in Eastern, Central and Northern India, the major small millet production regions of the country. As a result, 15 SMPUs in Tamil Nadu (three SMPUs in Madurai district and nine in Jawadhu Hills, Tiruvannamalai district), four in Odisha, and one each in Visakhapatnam district, Andhra Pradesh; Nandurbar, Maharashtra; Mandla, Madhya Pradesh; and Dantewada, Chhattisgarh have improved the quality of their final products. For the promoting/facilitating organisations, the avenues for promoting small millets have opened up with these events and they have come to know how promoters in other states are doing the same. The training sessions were widely covered by the news and television media, thereby taking the message of small millet promotion to the wider public. Through these efforts, a good base *for the development of decentralised small millet processing infrastructure was created in Eastern and Central India.*

3.18 Demonstration of hulling and processing equipment in strategic locations (DHAN): *Completed*

Demonstrations of processing equipment were organised by DHAN in 10 locations in Odisha, three each in Tamil Nadu and Andhra Pradesh, and one each in Uttarakhand, Telangana, Maharashtra, Madhya Pradesh, and Rajasthan with the support of partner NGOs (14) and the Indian Institute of Millet Research. Demonstration were also organised in various national and international exhibitions and events by DHAN and TNAU along with equipment manufacturers. These events included: (i) Krishi Unnati Mela 2016, a national level Agriculture Fair-cum-Exhibition in New Delhi, (ii) CODISSIA Trade Fair 2016, Coimbatore, (iii) AGRI EXPO 2016 at the Vellore Institute of Technology, Vellore, (iv) Tamil Nadu Agri Expo 2016, Madurai, (v) MADISSIA Food Tech, 2016, (vi) Agricultural Machinery & Engineering Mela, Coimbatore, 2017, (vii) Grain Tech 2017, Bangalore, (viii) CODISSIA Trade Fair 2017, (ix) Madurai Symposium 2017, and (x) Organics & Millets 2018, Bangalore. The Otake huller was demonstrated at Virudhunagar, Salem, and Krishnagiri, Tamil Nadu, for Agribusiness Department of District Administration Office, AVM, Victor, earth360 Eco Ventures Pvt. Ltd. (processor) and BIGSTAMP Technologies (P) Ltd. (machine designer). More details are given in Annex 2.6.

3.19 Increased capacity of up to five equipment manufacturers to meet varying hulling/processing equipment requirements at the village, microenterprise and SME levels: *Achieved*

The project has engaged five equipment manufacturers in Tamil Nadu (AVM, Victor, Perfura, Agromech and KMS), and one in Karnataka (Vishwa Agro Tech and Bio-tech). The capacities of these manufacturers have increased in the following ways:

- (i) Ability of Perfura and Agromech to commercialise small millet centrifugal huller in their product line.
- (ii) Exposure of AVM and Victor to design standards and practices for grain processing equipment that are being followed by leading equipment manufacturers, such as (a) designing the equipment based on grain characteristics, (b) ensuring energy efficiency, and (c) considering the tolerance level and compatibility of machine components. They had the opportunity to take part in joint R&D involving technology developers (research institutions), technology adopters (manufacturers), and end users (processors).
- (iii) Improvement of the design of small millet processing equipment by AVM and Victor in terms of hulling efficiency, safety, ease of operation, and compactness; and in terms of varied capacities ranging from 50 kg/hr to 500 kg/hr to meet requirement at the village, micro and SME levels (earlier they offered equipment with only 50 to 100kg/hr capacity); and improvement in the design of grader and destoner by KMS and Agromech.
- (iv) Increased ability of AVM, Victor, and Perfura to serve distant markets beyond Southern India
- (v) Positioning as providers of appropriate small millet processing equipment throughout India through training sessions, advertisements in print media, web presence (on-line market platforms and own website), and use of social media like WhatsApp and Facebook.
- (vi) Increased ability of AVM and Perfura to liaise with government entities involved in procurement.
- (vii) Widening of contact base and reach of all manufacturers.

- (viii) Increase in production capacity by AVM that was achieved by increase in floor space and number of regular staff, and by reorganising the manpower in the production line.
- (ix) KMS and Agromech have started producing three deck interchangeable sieve graders.

3.20 Increased capacity of 10 SMEs, 150 micro enterprises and 3 FPOs to expand their market for appealing ready-to-eat small millet products by 15%: *Achieved*



Figure 6: New small millet-based food products introduced by food enterprises

The project has engaged with 66 food enterprises, 152 Pushcart Millet Porridge Vendors (PMPVs), and three FPOs in Tamil Nadu; and 10 micro enterprises, 15 NGOs and one FPO in Odisha, Andhra Pradesh and Uttarakhand. In Tamil Nadu, the project engagement resulted in increased capacity of these food enterprises with respect to: (i) standardisation of foods products, (ii) development of new products, (iii) packaging, (iv) food hygiene and safety, (v) improvement in production capacity, promoting their products, (vi) visibility, and (vii) marketing and business linkages. The sales volume has increased by above 15% for 30 enterprises and these enterprises have increased their reach to nearby districts and states, in addition to their existing markets. The capacity of 152 PMPVs was built up for (i) food safety and hygienic practices for food vending carts, (ii) importance of FSSAI registration and its procedures and (iii) social

security schemes of government. Twenty-six cottage enterprises, two micro enterprises and fourteen NGOs gained capacity in production and marketing of small-millet-based food products in Odisha, Andhra Pradesh, Chhattisgarh, and Madhya Pradesh. The four FPOs in Tamil Nadu and Odisha supported in the project have gained capacity in supplying seeds, trading grains, and selling processed millet rice, and have improved their understanding of the market.

3.21 Linkage development with relevant stakeholders to create a converging platform for product development involving millets and millet ingredients in their product portfolio: *Achieved*

Linkage was facilitated for food enterprises with the “Technology Business Incubator” and “Food Processing Incubator” of TNAU, Indian Institute of Food Processing Technology, Indian Institute of Millets Research, and Tamil Nadu Veterinary and Animal Sciences University for building their capacity on development of small-millet-based food products. In Tamil Nadu, the project organised 18 training sessions on product development for 269 entrepreneurs, 3 training sessions on improving packaging for 51 enterprises, and 2 training sessions on improving food safety and hygiene for 39 enterprises. Furthermore, 11 training sessions were organised in Odisha, Andhra Pradesh, Madhya Pradesh, Chhattisgarh, Maharashtra and Delhi for disseminating small millet value addition technologies benefiting 391 interested entrepreneurs, NGOs, FPOs, and promoting organisations. Interfacing was facilitated with support organisations such as the International Competence Centre for Organic Agriculture (ICCOA), Confederation of Indian Industry, National Small Industries Corporation, and Entrepreneurship Development and Innovation Institute (EDII) at Chennai, and regulating institutions such as the Food Safety and Standards Authority of India

(FSSAI). Furthermore, the food enterprises were supported to participate in national and international food processing exhibitions for building relevant linkages with other stakeholders.

3.22 Publications on scaling up of processing and value addition technologies of small millets: *Undertaken*

The document on “Top communications output from project” that is attached as Annex 2.7 provides comprehensive information on communications output from the project. The project has contributed four policy documents, seven academic papers covering overarching findings of the project, 26 papers on specific research results related to small millet processing and food product development, one output on gender issues, six video/ audio/ slide shows, two outcome stories, two protocols, one National seminar abstract book, two guidelines, four technical bulletins, and two study reports. While nine papers have been published, eight more papers were submitted to reputed journals for review and possible publication.

3.23 Development of policy briefs on the lessons learned from the project and policy interventions needed for effectively supporting value chain actors to increase consumption of small millets: *Undertaken*

The lessons learnt from the project interventions and policy suggestions from the different small millet value chain stakeholders were synthesised and converted into the following policy documents:

- (i) Small millets in mainstream diets: Establishing decentralized processing infrastructure
- (ii) National Policy Workshop on Mainstreaming Small Millets in Our Diets- A Synthesis of Policy Recommendations
- (iii) A policy paper on comprehensive support package for MSMEs in the millet sector

3.24 Increased awareness (on functionality, nutrition and health) and improved capacity of end users such as women groups, micro enterprises, SMEs, civil society groups, and the general public, on the use and benefits of small millets processing equipment and appealing value-added millet-based food products: *Achieved*

The capacities of end users of processing equipment were improved in the following ways:

- (i) Families, particularly women in the production regions: Awareness events were organised for 730 men and 840 women in Tamil Nadu and Odisha. They understood the need to revive consumption of small millets, the advantages of using the processing equipment over manual methods and the less polished nutritious output that can be obtained
- (ii) Existing small millet processing units (SMPUs): Hands-on training programs and exposure programs were organised for 33 village level processors, 7 FPOs, 25 small scale processors, three medium scale processors and three food industries in Tamil Nadu, Karnataka, Andhra Pradesh, Odisha, Uttarakhand, Madhya Pradesh, Chhattisgarh, and Maharashtra. They learnt about (i) assessing the raw material, (ii) process flow to be followed to improve rice recovery and quality of output, and how to hull different small millets, (iii) maintenance of the equipment, and (iv) reducing pest infestation.
- (iii) Prospective buyers: Orientation program was organised for 198 prospective buyers of various kinds in Tamil Nadu, Karnataka, Andhra Pradesh, Odisha, Uttarakhand, Madhya Pradesh, Chhattisgarh, and Maharashtra. They learnt about (i) choosing appropriate equipment for their processing line from the ones available on the market, (ii) equipment

manufacturers, (iii) site selection and layout, and (iv) the skill sets required to run the processing unit.

- (iv) **Promoters of SMPU:** Orientation was given to 62 promoters namely government entities including KVKs, NGOs, funding agencies, etc. in Chhattisgarh, Odisha, Madhya Pradesh, Maharashtra, Tamil Nadu, and Karnataka. They learnt how to integrate promotion of small millets as part of their development interventions and the modalities involved in promoting SMPU, including the funding support needed.

The capacities of end users of food products were improved in the following ways:

- (i) **Food enterprises and NGOs:** In Tamil Nadu, Odisha, Madhya Pradesh, Chhattisgarh and Maharashtra, the capacities of 814 food enterprises and NGOs were built up for product development, food safety and hygiene, packaging, compliance with government protocols, and accounts maintenance.
- (ii) **Farmers Producer Organisations (FPOs):** A three months course and exposure visit was offered to Chief Executive Officers and Board of Directors of each FPO on organisation management, compliances with statutory procedures, and business development.
- (iii) **Consumer organisations:** The capacities of 695 women and 103 men social workers from 49 rural, 29 urban and 7 tribal women/ farmers organisations from 16 districts of Tamil Nadu, Odisha, and Andhra Pradesh were improved with respect to the health benefits of small millets and the demonstration of small millet recipes.
- (iv) **Consumers:** In the above-mentioned regions, recipe demonstrations were organised for 12,993 women, 1,719 men and 1,126 children. They have improved their knowledge and skills on inclusion of small millets in their diets. Awareness on the health benefits of small millets and knowledge on their utilisation were built-up for 72,490 persons, including farmers. Furthermore, the capacities of more than 200,000 consumers were built-up through Community Radio Programs through 34 radio stations in Tamil Nadu and Andhra Pradesh, telecasting of recipe films and through voice SMS in Madurai district.



Figure 7: Walkathon 2016, Krishnagiri, Tamil Nadu

- 3.25 a) Increased availability of easy to use dehulling/processing equipment of various capacities to meet the requirements at the village, micro enterprise an SME levels across India. b) Improved processing infrastructure at village and regional levels, and increased capacity of SMEs, micro enterprises and FPOs to market hygienic and nutritious small millet products in India. c) Increased availability of small millets ingredients and millet-based food products: Achieved**

Increased availability of easy to use dehulling/processing equipment

Before initiation of the project only two manufacturers AVM and Victor, Salem were manufacturing 20 to 30 small millet dehulling equipment each per year, and this was based on orders. By the end

of this project period AVM has increased their annual production capacity to 100 processing units/year and Victor to about 50 units. Furthermore, Perfura now has a double chamber impact huller as part of their product line. Agromech and KMS have started supplying more units of improved small millet destoners and graders of various capacities. All six equipment manufacturers have widened their contact base and reach across India; AVM, Victor, and Perfura have increased their ability to serve distant markets beyond Southern India. Furthermore, AVM, Victor and Perfura have improved the design of their products and have started manufacturing higher capacity (100-500 kg/hr) small millet processing equipment to cater to the demand from medium scale processors and food enterprises. DHAN has developed a 300 kg per hour capacity portable small millet huller prototype, which on initial trials has shown better hulling efficiency, rice recovery, and energy efficiency than existing commercial hullers. Sensing the emerging market demand, new players like Borne Technologies, Coimbatore; Bhavani Industries, Mysore; and BIGSTAMP, Bangalore have started manufacturing small millet processing machineries. Borne Technologies has developed a one tonne per hour capacity processing equipment. In these ways, there has been an increased availability of easy to use small millet processing equipment of various capacities across India.

Improved processing infrastructure at village and regional levels

With the supply from the equipment manufacturers supported by the project, small millet processing units have been established in 158 places in 49 districts of 10 states. Of the 158 new units, 56 were community level processing units, 60 were regional level processing units, and 42 were demo cum community units. Furthermore, 19 defunct/sub-optimally functioning units in Odisha and Tamil Nadu have been revived by giving additional equipment, training on operation and maintenance and exposure visits to successfully running units.

Table 1: Reach of small millet processing equipment across the country

Sl. No.	State	No. of districts	No. of new processing units
1	Tamil Nadu	14	43
2	Andhra Pradesh	7	37
3	Chhattisgarh	10	25
4	Karnataka	7	11
5	Maharashtra	1	1
6	Madhya Pradesh	3	20
7	Odisha	4	12
8	Telangana	1	5
9	Uttarakhand	1	3
10	Rajasthan	1	1
Total		49	158

Increased availability of small millet ingredients and millet-based food products.

Since the start of the project, 1,015 tonnes of millet rice and grits have been produced, reaching 288,500 consumers across 10 states. In Tamil Nadu, the sales volume of value-added food products was increased by above 15% for 30 enterprises and 10 to 15 % for 16 enterprises. These enterprises have increased their reach to nearby districts and states, in addition to their existing markets. Since the beginning of the project, 210 tonnes of value-added products were produced and served to 278,000 additional consumers.

3.26 Positioning small millets as a health food category to increase the reach of small millet products in rural and urban areas completed: *Undertaken*

On the one hand, research was undertaken to prove the health benefits of small millets. Studies such as (i) nutritional comparison of millets with other super foods, (ii) comprehensive nutritional



Figure 8: Assessment of the novel small millet recipes by the jury

analysis of millets in comparison with major cereals, and (iii) anti-diabetic and bioavailability studies of small-millet-based value-added products were taken up as part of the project. On the other hand, large nutritional education campaigns were carried out through (i) value addition demonstrations at the community level focusing on awareness of health benefits of small millets, and on knowledge and skill building on its utilisation, (ii) promotion

through folk arts (3 locations), (iii) promotion through events (84) and exhibitions (21), (iv) promotion through wall paintings (171 in 24 locations), (v) promotion through media namely community radio (34), SMS campaigns (11 locations in one district), and television programmes (3), (vi) promotion through novel recipe competition and short film contest, and (vii) promotion through project website. The first four activities were carried out with the engagement of 85 consumer organisations - women and farmer organisations. Value addition demonstrations on small millet were done in 334 habitations in 29 urban, 49 rural and 7 tribal locations in 16 districts in Tamil Nadu, Andhra Pradesh, and Odisha, reaching 12,993 women, 1,719 men and 1,126 children. About 200,000 persons were reached through these campaigns in India.

3.27 Evidence of business, market development and service provision approaches across the small millets value chain, needed for scaling up of adoption of small millets processing equipment and appealing small millet food products to a large number of end users: *Achieved*

The following are the evidence of results of the business, market development, and service provision approaches adopted in the project:

- (i) The Government of Karnataka has listed three of the supported equipment manufacturers (AVM, Victor and Perfura) on [their website](#) for contact by interested buyers.
- (ii) Two equipment manufacturers supported by the project, AVM and Perfura received purchase orders from the “Comprehensive Revival of Millets in the Farming Systems and in Household Consumption Project”, of the Andhra Pradesh Government.
- (iii) The Directorate of Agriculture and Food Production, Government of Odisha, has invited three of the supported equipment manufacturers (AVM, Victor, and Perfura) and DHAN to a consultative meeting on millet processing machinery on 19th April 2018 for “Special Programme for Promotion of Millets in Tribal Areas of Odisha”.

- (iv) Perfura received a purchase order for 12 processing units under the Tamil Nadu Innovation Initiatives Project supported by the State Planning Commission, Tamil Nadu; this purchase order included the double chamber centrifugal huller developed as part of the earlier CIFSRF project.
- (v) Of the 66 food enterprises enrolled for project support in Tamil Nadu, eight expanded sales outside the state, and three within the state; three initiated food outlets and retail shops, and five expanded their production infrastructure.
- (vi) In Eastern and Central India, 26 micro enterprises and 14 NGOs have started marketing bulk and value-added products.
- (vii) Eighty-five women and farmers federations have started promoting small millets consumption among their members and have supplied 130 tonnes of small millet rice.
- (viii) On witnessing the project initiatives, Madhya Pradesh State Rural Livelihoods Mission (MPSRLM) and Indira Gandhi Krishi Viswavidyalaya (IGKV), Chhattisgarh have come forward for collaborative initiatives for scaling up small millet cultivation and consumption in their states.

3.28 Proceedings of policy consultation events and seminars: Completed

The proceedings of the national policy workshop on 'Mainstreaming Small Millets in Our Diets' organised at the India Habitat Centre, New Delhi on 1st June, 2017, were widely shared with various small millet stakeholders across the country. The proceedings were attached as Annex 2.4 in the Third Technical Report.

3.29 Policy makers and other important stakeholders (academia, government, Para-governmental, NGOs and industry) will be informed about the best practices and policy interventions needed for scaling up the adoption of small millets processing and value addition technologies: *Undertaken*

The policy actors who were considered included senior bureaucrats and elected representatives in the Ministries of Agriculture and Food Processing and other relevant departments of state and central governments, senior bureaucrats in the districts, and large NGOs and funding agencies playing the role of promoters and policy advocates. The following mechanisms were adopted by the project to inform the policy actors: (i) setting up direct meetings, (ii) representing in their meetings, (iii) organising joint events, (iv) exposure to working models, (v) collaboration for creation and implementation of working models, (vi) dissemination through national and international exhibitions, and (vii) sharing of policy documents.

Direct meetings were set up with policy makers in the federal government at New Delhi, the provincial governments of Tamil Nadu, Odisha, Chhattisgarh, and Madhya Pradesh, and district administrations in Dantewada and Nandurbar. The synthesis on policy support needed for mainstreaming small millets in regular diets generated from the policy workshop on 'Mainstreaming Small Millets in Our Diets' held at New Delhi on 1 June 2017, was shared in person with the Joint Secretary (Crops), Ministry of Agriculture and Farmers Welfare, Delhi. It covered (i) the need for government intervention, (ii) important pointers for policy on small millets, and (iii) focus areas for policy action. Furthermore, strategic directions and specific policy action points were shared for four specific focus areas, namely (a) scaling up production, (b) processing infrastructure development, (c) market development, and (d) increasing household consumption. It is expected that these recommendations will feed into the "Millets Mission" being contemplated by the central government and some of the state governments. Furthermore, a suggestion of having a "sub-mission focusing

on small millets” within the broader “Millets Mission” was made. The DHAN team met the Agricultural Production Commissioner and Principal Secretary to the Government of Tamil Nadu, to impress on the focused interventions needed for promoting small millets in Tamil Nadu. As a follow up, a short note on “Sub-Mission on Promoting Small Millets in Tamil Nadu under Mission on Sustainable Dryland Agriculture” was submitted for consideration. With the support of GIZ, a detailed document was shared with NABARD, the national level body managing the climate adaptation fund, on promoting millet-based cropping systems as a climate change adaptation strategy. The district officials of Virudhunagar district in Tamil Nadu and of Dantewada district in Chhattisgarh were informed about the advancements made in the processing of small millets and they plan to integrate the same in their support to FPOs.

Representation was made in policy consultations organised by the Indian Institute of Millet Research, the Karnataka Government, the Confederation of Indian Industry, the Andhra Pradesh government project on millets, and the Odisha government project on millets. The project team participated in the “National Workshop on Millets” organised by the Indian Institute of Millets Research and Sahaja Samrudha to discuss and evolve an action plan for reviving millets, and the team shared the initiatives needed for promoting a decentralised processing infrastructure, which is the key to the development of the small millet value chain. The project team participated in a consultation meeting of the “Comprehensive Revival of Millets Project”, Andhra Pradesh, and “Special Programme for Promotion of Millets in Tribal Areas in Odisha”, to help these projects in choosing appropriate processing equipment, and to give advice on sound procurement and installation procedures. On invitation by the government of Tamil Nadu, TNAU has suggested modalities of inclusion of small millets in the existing public food programs in Tamil Nadu, which is being actively considered by the government. The policy lessons from the project on the development of local and regional value chain and for scaling up the reach of nutrition-dense small millets were shared in (i) Global Agri Connect, New Delhi; (ii) Nutricereals for farmers', environment and consumers' security, INTERNATIONAL TRADE FAIR 2018 - ORGANICS & MILLETS, Bangalore; and (iii) Dialogue on Millets, Monsoon and Market, 2018 held at MSSRF, Chennai.

A national level policy workshop on ‘Mainstreaming Small Millets in Our Diets’ was organised with the involvement of the federal government and three state governments at New Delhi on 1 June 2017. Capacity building events were organised in Central India, with the support of Madhya Pradesh State Rural Livelihood Mission, Indira Gandhi Krishi Viswavidyalaya of Chhattisgarh, and Mahila Arthik Vikas Mahamandal (MAVIM) of Maharashtra. They were informed about the small millet processing and value addition technologies and about the modalities of promoting them; they have come forward to initiate millet promotion projects in the near future. To aid this, a pre-proposal note was shared with Madhya Pradesh Rural Livelihood Mission and Indira Gandhi Krishi Viswavidyalaya. The lessons from the project were shared with funding agencies, namely IFAD, GIZ, Axis Bank Foundation and SWISSAID for their engagement in small millet promotion in various capacities.

Policy makers in Odisha and Tamil Nadu have been exposed to various small millet value chain initiatives through their participation in the Inception Workshop, promotional events and the Project Dissemination Workshop. DHAN is working with the government of Odisha in the capacity of Facilitating Agency in two blocks for the “Special Programme for Promotion of Millets in Tribal Areas of Odisha”. This collaboration is serving as a platform for sharing of lessons learnt in the project with state level agencies and implementing NGOs.

Participation in the “World Food India 2017” at New Delhi has helped in positioning millets as health foods in need of promotion by state and central government ministers and senior bureaucrats. The Deputy Chief Minister of Tamil Nadu visited the project stall at Food Pro 2017, Chennai. In these

ways, the dissemination of project lessons in 10 national and international exhibitions served as a channel for informing policy makers. The three policy documents prepared by synthesising policy lessons from the project and other relevant experiences were widely shared among policy makers and other stakeholders.

4. Synthesis of research results and development outcomes

Objective 1: To scale up the reach of de-hulling and processing equipment and appealing small millet food products.

Business models for scaling up appropriate small millet processing equipment

Two principal business models were explored to scale up new hulling equipment by the project to reach 200 end users by the end of the project period. These 200 end users are expected to serve 30,000 plus consumers. For this target to be achieved, a 'commercialization business model' referred to as 'On-site business incubation' of equipment manufacturers was adopted to aid them in enhancing their scale of operations. In addition to this, the project adopted a 'knowledge transfer business model' to revive the defunct processing units. By this effort, the project attempted to bring into use sunken investments.

On-site incubation support to equipment manufacturers

4.1 Identification of and agreements with interested equipment manufacturers

As mentioned in milestone 3.19, the project has identified six equipment manufacturers namely AVM, Victor, Perfura, Agromech and KMS, and Vishwa Agro Tech and Bio-tech as suitable partners for joint work on product improvement and scaling up appropriate scale small millets processing equipment. AVM and Victor were involved in developing and field testing centrifugal huller prototypes in the past CIFS RF project and have expressed interest in scaling up of their operations in collaboration with the project. MoUs were signed with these partners for firming up their collaboration. Besides these six equipment manufacturers, relationships have been developed with BK Agencies, Coimbatore; SGM Technologies, Hosur; and BIGSTAMP Technologies Pvt. Ltd., Bangalore.

4.2 Preparation of action plan for on-site incubation support to equipment manufacturers

The approach followed for on-site incubation support to equipment manufacturers is shared in Figure 9. The following specific aspects were identified as requiring support through multiple interactions with equipment manufacturers and through an assessment study of the products offered by them:

1. *Equipment development*- Support for improving existing models, and preparation of operation and maintenance manuals.
2. *Improving visibility of the product*- Support in development of communication materials for advertising, such as brochures, and support for participating in exhibitions and fairs.
3. *Business development*- Support for building of

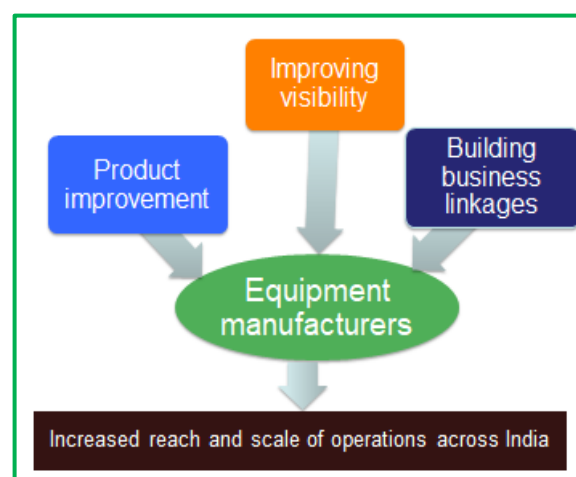


Figure 9: On-site incubation model attempted with equipment manufacturers

linkage with potential buyers, and initiating online sales.

4.3 Implementation of action plan to support equipment manufacturers

The following efforts were made as part of on-site incubation support to equipment manufacturers in order to scale up their operations:

i) Product improvement

Structured assessment of small millet processing machineries of AVM Engineering and Victor Agro Sales was organised by DHAN, involving a retired grain technology scientist from Central Food Technology Research Institute (CFTRI) and experts from McGill, earth360 Eco Ventures (P) Ltd. and TNAU. Observations on their strengths, areas of improvement of equipment, and possible ways for improvement were shared with the equipment manufacturers for validation, learning, and follow-up action. Furthermore, the project channelled the feedback from processors and followed-up with equipment manufacturers for product improvement. Similar efforts were taken with other four equipment manufacturers for improving their millet processing equipment. As a result, the capacity of manufacturers for equipment design was improved and they made the following design modifications:

(i) AVM Engineering, Salem

1. The huller footprint and weight were reduced by realigning the components as per recommendations.
2. The height of the machine was reduced, making it user friendly for women.
3. Impeller design of the huller was fine-tuned so that different small millet crops could be processed.
4. Stability was improved by reducing the overhang load on the pillow block.
5. The hopper size of the huller was increased.
6. In the huller, instead of one motor, two motors were used - one for hulling and the other for aspirator and blower; this modification helped to save power and increases flexibility in its use.
7. A centrifugal huller prototype with four chambers and with a capacity of 500 kg/hour was developed and marketed for medium size processors.
8. Safety was improved by reducing the space between moving parts and the outer guard, and by having starter, emergency switch and MCB switch together on a compact panel; the latter also improved the ease of use by making the equipment 'ready to plug in' during installation.
9. In the grader and destoner, the footprint and weight were reduced by realigning the components as per recommendations.

(ii) VICTOR AGRO SALES, Salem

1. The outflow channel from the hulling chamber was widened for smooth flow of hulled materials.
2. The grain flow control mechanism was improved in the huller hopper.
3. A damper was reintroduced in the aspirator blower of the huller.
4. Stability was improved by reducing the overhang load on the pillow block.
5. The impeller rotation was made smoother, thereby reducing energy consumption.

6. Hulling quality was improved by sticking rubber on the one side of the impeller dome.
7. The impeller design of the small-scale huller was improved to increase hulling capacity from 50 kg/hr to 100 kg/hr, and to improve versatility to hull different small millet crops, without an increase in price.
8. Huller prototypes with capacities of 300 kg/hour and 500 kg/hr were developed to meet the requirement of medium size enterprises.
9. Destoner performance pertaining to segregation of hulled rice from grits was improved by fitting a divider on the exit of the bed mesh, thereby improving the cost efficiency of the hulling operation.
10. Safety was improved by adding an outer guard for moving parts.



Figure 10: Improvement of existing processing equipment by VICTOR AGRO SALES

(iii) Agromech Engineering, Coimbatore

1. In the single chamber model, the motor was mounted between the aspirator and the hulling chamber, so that the two pulleys are directly on the motor shaft driving the two sub-systems. This also helped in reducing the overall height of the machine.
2. In the huller hopper, a grain level indicator was added.
3. In the destoner, a sliding door was provided to facilitate ease of cleaning the covered base.
4. Grader with interchangeable sieves across the decks was developed for flexibility in using different set of sieves for different small millet crops.

(iv) Perfura Technologies Private Ltd., Coimbatore

1. The double chamber centrifugal dehuller developed as part of the “Revalorising Small Millets in Rainfed Regions of South Asia (RESMISA)” project has been licensed to Perfura by TNAU and it has been rolled out for sales.

(v) KMS Industries, Coimbatore

1. Grader with interchangeable sieves across the decks was developed.

2. Destoner motor box size was increased with provision for opening on one side for ease of cleaning, better segregation, and for reducing the heating of motor; and a grain flow inflector was introduced.

ii) Improving visibility of the equipment manufacturers

The following activities were taken up for improving visibility:

1. Website creation and listing in Indiamart was facilitated for AVM and advertising in Google was facilitated for Victor and Agromech. The profile of four manufacturers was uploaded in the project web link. Online advertisement and ad posting was taken up for AVM and Victor.
2. Support for advertisement in newspapers was given to AVM and Victor for improving their visibility in states where their supply was meagre namely, Odisha, Madhya Pradesh, Chhattisgarh, and Andhra Pradesh.
3. A flyer covering the processing equipment offered by five manufacturers was shared with potential buyers by mail, and in national and international exhibitions: (i) CODISSIA 2017, Coimbatore, Tamil Nadu; (ii) Grain Tech 2017, Bangalore, Karnataka; (iii) Tamil Nadu Millet Meet, organised by Confederation of Indian Industries; (iv) Organics and Millets 2017, Bangalore, Karnataka, (v) World Food India 2017, Delhi; (vi) Food Pro 2017, Chennai, Tamil Nadu; (vii) Global Tribal Entrepreneurship Summit, Dantewada, Chhattisgarh; (viii) MADITSSIA FOOD TECH 2017, Madurai, Tamil Nadu, (ix) Uzhavar Kalanjiam at Vellore Institute of Technology, Vellore, Tamil Nadu; (ix) Madurai Symposium 2017, (x) Organics and Millets 2018, Bangalore, Karnataka, and (xi) Food Tech Kerala 2018, Cochin. These flyers were shared with potential buyers and promoters in Odisha, Tamil Nadu, Maharashtra, Chhattisgarh, and Madhya Pradesh during the orientation workshops.
4. Support was given to Victor for participating in i) Agri Expo 2016 Madurai, ii) CODISSIA 2017, Tamil Nadu, iii) Grain Tech 2017, Bangalore and iv) World Food India 2017, Delhi. Perfura. was supported for participating in the (i) 'MADITSSIA FOOD TECH 2017', and (ii) Organics & Millets 2018. KMS was supported for participation in (i) CODISSIA 2017, Tamil Nadu, and (ii) World Food India 2017, Delhi.
5. Support was given for preparing product brochure for KMS.
6. Perfura and Victor shared information about their products at the National Seminar on "Emerging Trends in Processing & Value Addition of Small Millets" and interacted with national level delegates.

iii) Business development

Efforts were made to link the equipment manufacturers with potential buyers namely, Comprehensive Revival of Millets Project, Andhra Pradesh; Krishi Vigyan Kendra, Chitradurga, Karnataka; College of Agriculture, Dhule, Maharashtra; and a few enterprises. TNAU has facilitated a purchase order for 12 millet-processing units worth Rs. 6,000,000 to Perfura from the "Tamil Nadu Innovation Initiatives Project" supported by the State Planning Commission. Purchase orders were received by AVM and Perfura from the "Comprehensive Revival of Millets Project", Andhra Pradesh. Furthermore, as a result of guidance given to new entrants, small millet processing machines were purchased by 1) KVK in Hirayur, Chitradurga, 2) KVK in Hardanahalli, 3) KVK in Nandurbar, 4) VSRF, Virudhunagar, 5) Grace Food, Odisha, 6) NIRMAN, Odisha, and 7) Sahaja Samrudha, Karnataka. An order was placed by the College of Agriculture, Bhubaneswar. AVM, Victor and Perfura were listed by the Government of Karnataka in its

flagship website on 'Organics & Millets' and they were invited by the Government of Odisha for a consultative meeting on millet processing machinery for "Special Programme for Promotion of Millets in Tribal Areas of Odisha".

Information from the business incubator of TNAU was shared with manufacturers pertaining to (i) design impact awards, (ii) Entrepreneurship fest RENAISSANCE, (iii) 10th Agri Tech India-2018, (iv) BIEC, Bangalore, (v) Agri Tech South-2018, (vi) Workshop on Design Thinking, Bangalore, and (vii) exhibition for manufacturing start-ups at Karnataka. AVM, Victor and Perfura were supported for making operation manual for the buyers given along with the equipment, which gives instructions and guidance on testing the equipment, processing unit layout, foundation laying, and installation.

AVM annual sales of equipment during the second year (53), was improved by more than 100% when compared to the first year (25). This was mainly due to the improvement in the product design and intensive efforts to get orders from the government departments of Chhattisgarh, Madhya Pradesh, and Andhra Pradesh. AVM has standardised their equipment and started to offer a new product – a huller with a capacity of 500 kg/hour. It has improved its ability to liaise with government officials in different states for getting purchase orders. The manufacturer changed from being primarily a diversified agriculture machinery producer to chiefly a small millet machinery producer. AVM has improved its workshop infrastructure, streamlined production, and increased its workforce.

Victor has improved the annual sales of equipment by more than 24% during the second year (31), when compared to the first year (25). This was mainly due to improvements in the product design, and relatively lower product price. It has standardised its equipment and started offering a new product – a huller with a capacity of 300 kg/hour. It has improved the workshop infrastructure. AVM and Victor realised increase in income in the range of 24 to 100%. Perfura has rolled out a double chamber huller as one of its product lines and Agromech has rolled out a single chamber centrifugal huller. Furthermore, the project facilitated testing, demonstration, and promotion of the portable Otake rice huller.

4.4 Reviving existing small millet processing units in Tamil Nadu and other parts of India

Mapping of existing SMPUs: Information on existing SMPUs was collected for Tamil Nadu from various sources and a survey was undertaken to determine their present status. This survey indicated that many of the processing units were functioning sub-optimally and many were defunct. Efforts were taken to understand the reasons for lack of functioning of defunct units, to assess the performance of sub-optimally functioning units, and to revive/improve them with the support of the project.

Assessment of performance of village level small millet processing unit (SMPU): A protocol was developed for assessing the performance of the SMPU using parameters such as (i) machine and infrastructure, (ii) hard skills (ability to use machines), (iii) soft skills (understanding of the grains and coming up with ways to deal with real world challenges), and (iv) utilization of SMPU. [This protocol](#) was used for assessing SMPUs in different parts of Tamil Nadu and Odisha.

Support to SMPUs: Based on the assessment, support was given by DHAN for 16 small millet-processing units in Tamil Nadu and three in Odisha for improving the functionality of the existing machineries, and for obtaining additional machineries. Structured capacity building was offered through training of operators on equipment operation and maintenance to improve quantity and quality of output. Sets of test sieves were given to seven SMPUs in Tamil Nadu and Odisha.

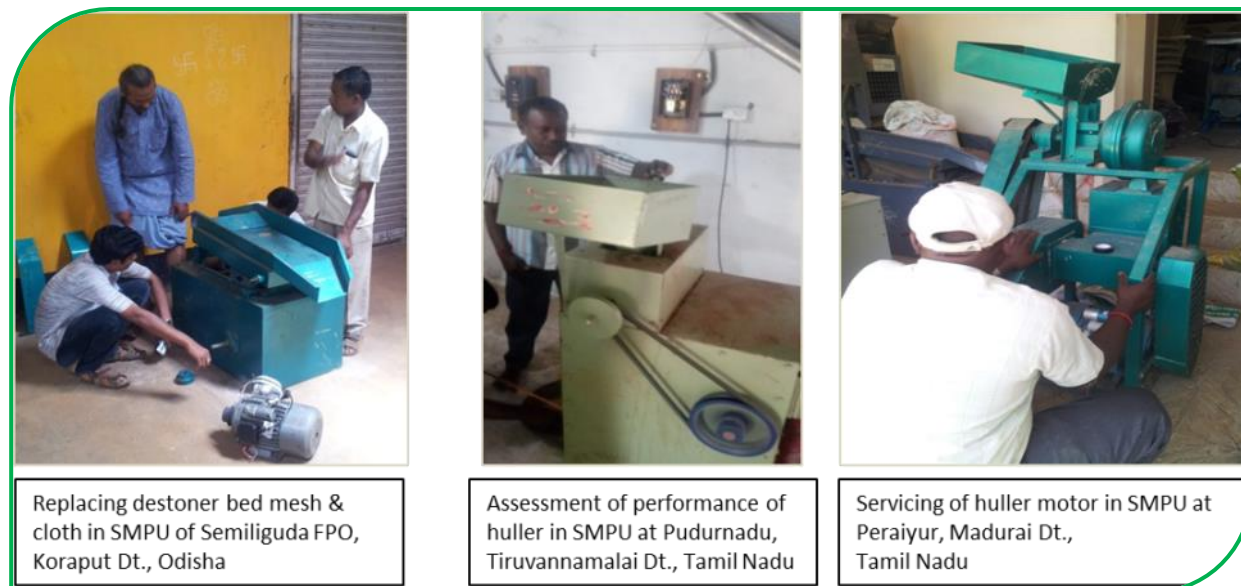


Figure 11: Support given for revival of small millet processing units

During the project period, 89 processing units were sold by AVM, 58 by Victor, 18 by Perfura, three by Agromech and five by Otake, covering 54 districts in 10 states across India. Processing equipment were supplied by the manufacturers to 56 community level processing units, 60 regional level processing units, 15 demonstration units, and 42 demo-cum-community level processing units. Out of the target of 200 units for the project, 192 were reached by the end of the project period. Through the processing equipment supplied by the equipment manufacturers and the existing SMPUs, about 1,015 tonnes of millet rice and grits have been produced, reaching 288,500 consumers across 10 states.

Business models for scaling up appealing small millet food products

Two principal business models were attempted to scale up small millet food products to reach 150,000 consumers on a sustainable basis by the end of the project period. The appealing small millet food products can be seen as a 'product' on the one hand and 'method/ recipe' on the other hand. The project has adopted a 'commercialization business model' for scaling up of 'products' through private channels. The project focused on providing on-site incubation support to MSMEs dealing with value added food products and established within the last five years and customised support and training to millet porridge vendors, an existing pro-poor millet food channel. A 'knowledge transfer business model' was used for scaling up 'method/recipes' mainly through individuals, consumer organisations and food service providers (such as caterers, canteen, etc.). It involved mainly skill building through recipe demonstration and cooking workshop and capacity building of consumer organisations in rural and urban areas and shared in Objective 4 section (see 4.39 to 4.46).

Onsite incubation support to small millet food enterprises

4.5 Identification of interested small and medium private / public food enterprises

A survey of private small millet food enterprises belonging to micro, small, and medium enterprises (MSMEs) was taken up in Tamil Nadu and in the millet production zones of Odisha and Visakhapatnam (Andhra Pradesh). This included companies that produce ready-to-cook and ready-to-eat food product, restaurants, and processors. Among the 129 enterprises surveyed in Tamil Nadu, Pondicherry and

Bangalore, 66 expressed interest to be part of the project for joint initiatives for stabilising and scaling up. Customised MoUs were prepared and signed with them. Similarly, efforts were made to find interested Pushcart Millet Porridge Vendors (PMPVs), an existing channel serving nutritious millet foods to the poor families in the urban and semi-urban areas. As a result, 152 PMPVs were identified and working relationship was built. In Eastern and Central India, 26 cottage enterprises, two micro enterprises and 14 NGOs were identified.

4.6 Preparation of action plan to support small and medium food enterprises

An interface meeting was organised by TNAU and DHAN at the Post Harvest Technology Centre of TNAU on 27 April 2016 to showcase various small millet processing equipment and food products, and to give orientation on the rules of the Food Safety and Standards Authority of India (FSSAI), scope for bank credit linkage, and available linkage with government schemes. Further detailed exploration was made with 36 food enterprises regarding the details of status of operations, plans for scaling up in the next two years, critical initiatives to be taken for achieving scaling up, the possible ways in which the project could support in their scaling up. Marketing support in an emerging market for small millets was a key felt requirement of most of the food enterprises. Though improvements in food hygiene, packaging and business management were equally important, they were not considered to be as important requirements by the food enterprises. The approach followed for on-site incubation support to food enterprises is shown in Figure 12.

The following specific aspects were identified as possible areas of support for food enterprises:

1. *Product development*- Support for improving existing food products and introducing new products
2. *Improving food safety and hygiene*
3. *Improving packaging*
4. *Improving visibility of the product*- Supporting in development of communication materials for advertising their products such as brochures, and support for participating in exhibitions and fairs.
5. *Business development*- Support for building business linkages, marketing, and online sales.
6. Building linkages to access credit and government schemes.
7. Education on FSSAI rules, food hygiene and safety procedures (Hazard analysis and critical control points -HACCP) and labelling with health benefits of small millets.
8. Linking with Farmers Producer Organisations (FPOs) and processors for getting quality raw material at better terms on a regular basis.

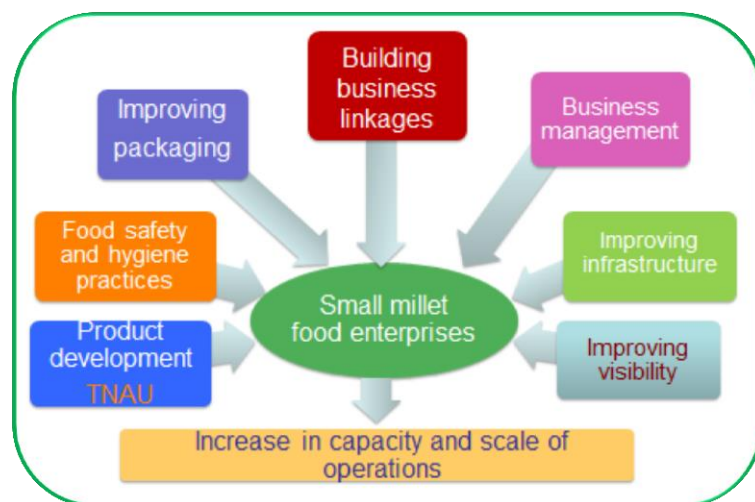


Figure 12: On-site incubation support for small millet food enterprises attempted in the project

Work done on business models by McGill has generated one publication with open access: Ademola Adekunle, Darwin Lyew, Valérie Orsat, Vijaya Raghavan. 2018. Helping agribusinesses – small millets value chain – to grow in India which is shared as Annex 2.8.

4.7 Supporting micro, small and medium food enterprises

The food enterprises identified for support in the project varied in terms of size and business operations, with the majority of them being small enterprises. While some of the areas needing improvement were common (like improving food hygiene and safety, and packaging), some requirements were specific to the enterprise. Common training sessions were organized for the first type of requirement, while for the second type of requirement, a case-by-case approach was followed to meet the needs of the individual enterprise for stabilizing and scaling up. The details are shared below:

i) Support for compliance of government protocols

All the enterprises were informed about the importance and procedures for registering with FSSAI (a mandatory requirement for being in the food business), National Small Industries Corporation (NSIC), and registering as Micro, Small and Medium Enterprises (MSME). The project motivated 15 food enterprises to get FSSAI registration and one to get an MSME certificate.

ii) Product development

Most of the entrepreneurs engaged with the project have a strong flair for product development and have developed many products on their own through trial and error. To standardize the products of the food enterprises, the following support was offered:

- (i) Seventeen training sessions on preparation of four kinds of small-millet-based food products namely, bakery products, instant food mixes, pastas, and traditional snacks were offered by TNAU as part of on-site incubation support to 269 entrepreneurs. During the training session, the prepared products were evaluated for acceptance, and the participants reflected on their own experience and clarified doubts. An exclusive training session was offered for 27 entrepreneurs on millet-based therapeutic food products. Furthermore, four training sessions were organised for 31 entrepreneurs on innovative millet-based food products like millet puffs, millet ice cream, noodles, etc. with the support of Amma Parampariyam, Coimbatore, a small millet food enterprise with expertise on innovative millet products, Indian Institute of Millet Research (IIMR), Indian Council of Agricultural Research (ICAR), Hyderabad, and Tamil Nadu Veterinary and Animal Sciences University for the enrolled enterprises.
- (ii) Nutritional analysis for 71 food products from 23 food enterprises was supported by the project, which helped in product improvement and labelling of products.
- (iii) Sensory evaluation test for 80 food products from 23 food enterprises was done by TNAU. The majority of the products fell in the range of 'acceptable' to 'highly liked' categories, and rankings ranged from 7.9 to 8.8. Specific suggestions were given when products needed improvement.



Figure 13: Small millet puffs

More details of all the three activities mentioned above can be seen in Annex 2.9. As a result, 23 food enterprises standardised their 49 food products in terms of moisture content of the raw materials,

composition, addition of herbs and vegetables, use of natural preservatives and reduction of oil content. In these ways, they improved the taste, flavour and shelf life of their products. Furthermore, 28 food enterprises introduced 137 new products, hoping that it will improve their sales. The majority of the new products belonged to 'instant food mixes' category, as these products are easy to prepare without investment in new machinery and were readily accepted by the consumers. Innovative products such as small millet energy bar and instant porridge mix were developed by a few of the enterprises. More details are given in Annex 2.10.

iii) Food hygiene and safety

Inadequate adoption of food hygiene and safety practices is a general problem across small millet food enterprises supported by the project, and this is a generic issue across small-scale food enterprises. Capacity building on appropriate but affordable food hygiene and safety practices is needed. Two training sessions on food hygiene and safety was organized for 39 food enterprises by TNAU and DHAN covering (i) food safety and quality control practices in food industries, (ii) food safety issues and challenges faced by small entrepreneurs, (iii) Hazard Analysis and Critical Control Points (HACCP), and (iv) FSSAI norms. Furthermore, an expert visit was organised to observe hygiene status in the production unit and customised suggestions were given for improvement. Seventeen food enterprises were supported for the microbial analysis of 52 food products, to help understand food safety. Out of the 52 samples, only six from four enterprises were found contaminated and it was insisted that they improve by following hygienic practices for food preparation. More details are given in Annex 2.9. Five enterprises were supported for improving the hygiene and safety of their food products through use of metal trays for drying and aluminium drums for storage.

iii) Improving packaging

Most of the small food enterprises were using aluminium foil based covers and standing pouches, mainly due to lack of knowledge of other options for attractive low cost packaging. Furthermore, the labelling on the packs did not follow the statutory and standard procedures specified by FSSAI. Barcode and batch coding were not provided on the label by most of the enterprises. Due to these reasons, the food products were less attractive and not welcomed by supermarkets. There was a need for revamping of packaging and labelling, to improve functionality and appeal. Three training sessions on packaging was organized for 51 food enterprises by TNAU and DHAN. The content of the training included (i) functions and classification of packaging, (ii) packaging materials, (iii) packaging with flexible films and multilayer films, (iv) partition packaging, and (v) labelling. Demonstrations of packaging equipment like vacuum packaging, gas flushing, cans, bottle closure, form fill and sealing machines were carried out for better understanding of packaging processes. Furthermore, specific suggestions were given on analysis of the label pattern of each of the food enterprises during the expert visit by TNAU on following FSSAI standards. Support was given for barcoding sticker for seven enterprises, batch coder for 10 enterprises, batch coder cum barcoding equipment for three enterprises and for improving label for five enterprises to improve saleability of their food products in supermarkets and shopping malls. While support was given to six enterprises for improving packaging, a few enterprises improved packaging on their own to improve saleability of their products.

iv) Improving visibility

Support was given to food enterprises to participate in the following national and international exhibitions for showcasing their products to improve their visibility, build business linkages, and to sell their products: (i) Agri Tech 2016 at Madurai, Tamil Nadu (4 enterprises), (ii) Organics & Millets 2017, Bangalore, Karnataka (3), (iii) MADITSSIA FOOD TECH 2017, Madurai, Tamil Nadu (5), (iv) CODISSIA 2017, Tamil Nadu (8), (v) Agri Tech 2017 at Madurai, Tamil Nadu (5), (vi) Food Pro 2017, Chennai (6), (vii) World Food India 2017, Delhi (8), (viii) Madurai Symposium, 2017 (2), (ix) Organics & Millets 2018, Bangalore,

Karnataka (9), and (x) Food Tech Kerala 2018, Kerala (5). Enterprises benefited from these efforts by sales totalling Rs. 798,000 and enquiries from over 100 distributors and dealers. Participating in exhibition/ trade fair was found to be a good way for building business-to-business linkages for the food enterprises.

Support was given to nine enterprises for advertising on television, to 13 enterprises for making brochure/pamphlet and to six enterprises for bus/auto advertisement. Similar support was offered to three enterprises for display board/banner, and to one for advertisement in popular magazines. One enterprise was supported for developing a website for online sales, and the profiles of 46 enterprises was showcased in the project web link to help improve their visibility.

v) Expert visit

Expert visits were organised by TNAU for 29 food enterprises in Tamil Nadu. It was observed that the visited enterprises were aware of the importance of food safety and hygienic practices, and of labelling standards after their participation in the training programmes conducted by the project. A few mistakes in the labels were pointed out and suggestions were given on complying with the government norms. The visited enterprises raised queries on product improvement based on the feedback from their customers, which were addressed by the experts. A visit by business development and marketing expert was organized for eight enterprises for identifying areas for improvement.

vi) Improving infrastructure

Twelve food enterprises were assisted for purchasing of machinery to improve their production capacity and control over production process, viz. Pulveriser (5), Roaster (1), Packing machine (1), Kneading machine (1), Blender (2), Slicer (1) and Oil dryer (1). One enterprise each was supported for billing machine, weighing machine, sealing machine, and sewing machine.

Two enterprises were supported for mini stall for increasing direct sales.

Atchaya Foods, Madurai, was

supported for initiating a food outlet. Uzhavan Unavagam, a millet food outlet at Madurai, was supported for improving its infrastructure. Sri Vari Foods was supported to set up a quality-testing lab for its wide range of food products.

vii) Supporting for marketing

Linkage of 21 food enterprises with FPOs and small scale processors for sourcing quality raw materials was facilitated, since accessing quality raw materials throughout the year at an acceptable price was found to be an important constraint to many food enterprises. Six food enterprises were linked with the 16 distributors from Krishnagiri, Madurai, Trichy, and Tanjore in Tamil Nadu; Bangalore in Karnataka; Visakhapatnam in Andhra Pradesh, and Pune in Maharashtra.



Figure 14: New millet outlet initiated by Atchaya Foods at Madurai, Tamil Nadu

viii) WhatsApp group for small millet enterprises

DHAN has been managing a WhatsApp group wherein 81 participants including entrepreneurs, organic shop owners and supermarket owners from four states were interacting with each other. The broad contents communicated include (i) product introduction, (ii) expression of interest to buy/sell, (iii) sharing of information on government schemes, taxes and new developments, and (iv) sharing details about upcoming events.

ix) Other support

- (i) Five enterprises were supported in preparing documents for accessing credit from banks for further investment.
- (ii) Information on relevant government schemes (Micro Units Development Refinance Agency (MUDRA), National Small Industries Corporation Limited (NSIC), The New Entrepreneur-Enterprise Development Scheme (NEEDS), Unemployed Youth Employment Generation Programme (UYEGP)) for supporting new and existing food enterprises was shared with all the enterprises.
- (iii) Support was given to eight enterprises to participate in two meetings on business development and one on accessing finance from Central Government schemes for enterprises registered under the Companies Act organised by the Directorate of Agribusiness Development of TNAU.
- (iv) Training on basic business management and compliance of government protocols was organised by DHAN for nine enterprises.
- (v) Support was given to Sri Vari Foods to participate in the workshop on 'Setting Up Organic Companies & Doing Business', organised by ICCOA on 20-22.07.2017 at Bangalore.
- (vi) *Capacity building on digital marketing*: Support was given to Ammirdham Foods to participate in a workshop on digital marketing organised by EDII at Chennai and to six enterprises to a short training program on digital marketing organised by Kumaraguru College of Technology. A short lecture was organised on digital marketing by a practitioner involved in online marketing of food products.
- (vii) The information on relevant call for proposals /events/ workshops /exhibitions from Technology Business Incubator, TNAU, were communicated to the collaborating food enterprises, including (i) Entrepreneurship Fest RENAISSANCE 2018, (ii)preneur, Global Start up challenges –Fintech 2017, (iii) TiE –Global Summit, and (iv) Global start up awards from SAARC. Green Happy Cookies from Aruppukottai has applied for an innovation award fund.

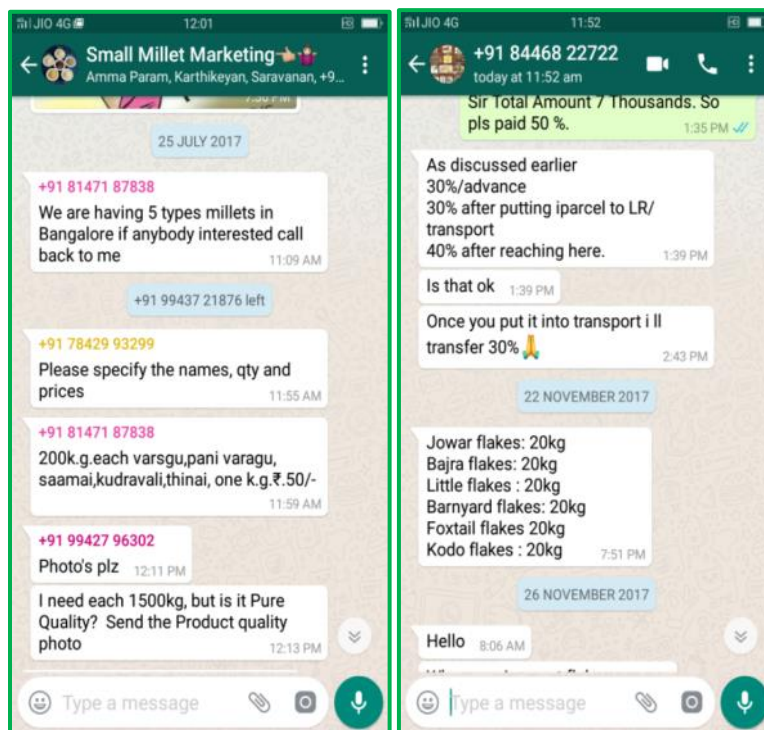


Figure 15: WhatsApp group on small millet marketing

Box 1: Century Foods, a model small millet food enterprise

Mr. Sahul Hameed (45 years old), the proprietor of Century Foods, started small millet based food enterprise as home based business in 2013 at Abiramam in Ramanathapuram District of Tamil Nadu. He was producing and marketing health mix (grain), flour mix items, pearl millet *laddu*, finger millet *laddu*, and sprouted health mix (flour). He marketed his products through the retailers in the region. He enrolled as a collaborator in the project by March 2016. Since then, DHAN has given support for (i) capacity building on product development, package improvement, food safety and hygiene, and record keeping, (ii) nutritional and sensory analysis of food products, (iii) purchase of SS pulveriser and aluminium containers, (iv) package and label improvement, (v) batch coder, and (vi) building business linkages. Besides trainings and exposure visit, regular visits were made by the project team for motivating and offering timely suggestions to convert the learning into day-to-day practice.

Capitalising on the trigger support from the project, Mr. Sahul Hameed expanded the production capacity by installing an urli roaster and SS pulveriser, and improved product delivery capacity by investing in a van. He also improved food safety and hygiene practices by reorganizing the workspace by allocating exclusive space for washing, drying, frying, milling and packing; by making raw material storage hut rat-proof; and by using aluminium containers for storing and cooling of flour items. He introduced new products namely *adai* mix, *puttu* mix, *dosa* mix, *venpongal* mix, porridge mix and *kozhukkattai* mix and parboiled small millet rice, based on the feedback from the retailers and buyers. Packaging was improved by opting for carton boxes, better designed label, barcoding and batch coding. He started marketing a few small millet food products produced by other food enterprises. He also started keeping proper records and ensured timely compliance to government protocols. His sales volume has increased substantially from 1,200 kg/year to 12,000 kg/ year, along with increase in the number of customers and in the geographical area served.

Facilitating adoption of food products in Central and North India

A short survey in Visakhapatnam and Bhubaneswar at the beginning of the project brought to light the differences in value chain development of small millets between Tamil Nadu region and Eastern India region. While more than 140 value chain actors have entered and become active in the Tamil Nadu region, not many actors were present in the Eastern India region. Further explorations indicated that this is also the case with respect to Central and Northern India. Given this context, efforts were made to identify and orient the potential adopters and promoters of small-millet-based value-added food products in these regions. Local partners were identified and with their support, workshops were organised in Madhya Pradesh, Chhattisgarh, Maharashtra, Odisha, New Delhi and Andhra Pradesh. TNAU served as the technical resource agency for organising most of these workshops. The details of the workshops organised and their participants are given in Table 2.

Table 2: Details of capacity building events on preparation of small millet value-added food products

Sl. No.	Location of training	Local partners	Private sector individuals	Members of civil society organizations	Extension staff	Policymaker	Other academics	Other	Total
1	Vizianagaram, Andhra Pradesh	Agriculture Research Station, ICAR	15	16					31
2	Koraput, Odisha	Spread	48	2	4				54
3	Koraput, Odisha	Women federations	34	20					54
4	Lamtaput, Odisha	Asha Kiran	19	19	3				41
5	Deoghati, Odisha	Women federations	39	3			2		44
6	Raipur, Chhattisgarh	Indira Gandhi Krishi Viswavidyalaya	14	27	5	1	2	2	51
7	Mandla, Madhya Pradesh	Madhya Pradesh Rural Livelihood Mission	25	15	5	1	2		48
8	Bhubaneswar, Odisha	CYSD & NIRMAN	19	4	2	2	4		31
9	KVK, Nandurbar, Maharashtra	MAVIM	22		3				25
10	New Delhi	Millet for Health & SOUDH	12		0				12
Total			247	106	22	4	10	2	391

Based on the local culture and food habits, value-added millet-based food products such as *adai*, *kitchadi*, *payasam*, *pakoda*, noodles, biscuit, cake, *sambar* rice mix, *biriyani* mix, health mix, *pongol*, and *paniyaram* were demonstrated during the training programme. The participants in these workshops include food industries, FPOs, NGOs, cooks at educational institutions, cooks of canteens, and SHG members who were eager to enter the small millets food segment. Furthermore, these workshops helped to forge collaborations and in building the capacity of promoting organisations, namely the Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur; Chhattisgarh Aajeevika Mission, Madhya Pradesh State Rural Livelihoods Mission (MPSRLM); KVK and Maharashtra Arthik Vikas Mahamandal (MAVIM), Nandurbar, Maharashtra; and Millets for Health, New Delhi. In all the six regions, the workshops were well received, as this was the first time such a training event was organised in these parts of the country on value-added small-millet-based food products. Many of the participants expressed their plans to take up production and marketing of small-millet-based food products in their region.

In Tamil Nadu, the project engagement resulted in the following improvements: (i) standardisation of foods products (22), (ii) new product introduction (27), (iii) improvement in packaging (22), (iv) hygiene improvement (35), (v) production capacity improvement (20), (vi) visibility (42), and (vii) marketing and business linkage improvement (28). Furthermore, the sales volume increased by above 15% for 30 enterprises and 10 to 15 % by 16 enterprises. These enterprises have increased their reach to nearby districts and states, in addition to their existing markets. Benefiting from the training on small millet value added food products and guidance from the project team, twenty-seven entrepreneurs have initiated small millet food enterprise. In Eastern India, where millet value chain is just emerging, NIRMAN, Living Farms, CYSD, Asha Kiran, Ahinsa Club, SPREAD, NIRMAAN and Sabala have started selling small-millet-based food products. Lakshmi Agro Foods and Grace Food Processing Industry Ltd. have started selling value-added small millet food products. In Visakhapatnam and Koraput, 26 cottage enterprises initiated preparation and supply of small-millet-based food products. NIRMAN is in the process of setting

up an exclusive millet bakery unit in Bhubaneswar, Odisha, the first of its kind in the region. In Chhattisgarh and Madhya Pradesh, six NGOs have intensified their initiatives on selling millet food products. Since the beginning of the project, 210 tonnes of value-added products were produced and served to 278,000 additional consumers. In these ways, new income generation opportunity was created for 55 entrepreneurs and they realised annual income in the range of Rs. 36,000 to Rs. 50,000.



Figure 26: Training session on Recipe demonstration at Raipur, Chhattisgarh

4.8 Offering of customized support to Pushcart Millet Porridge Vendors (PMPVs)

In Tamil Nadu, 152 PMPVs serving affordable foods to the 'bottom of the pyramid' population were identified by DHAN in Madurai, Krishnagiri, Salem and Dharmapuri districts. The following efforts were taken to stabilize and enhance their livelihood:

1. Fifteen training sessions were organised by DHAN with the support of TNAU, FSSAI, and city administration on the themes of (i) food safety and hygienic practices for food vending carts, (ii) importance of FSSAI registration and procedures, (iii) social security scheme provided by the Government of Tamil Nadu, and (iv) registering with the city administration for a biometric card. Good food hygiene and safety practices being followed by some of the porridge vendors was shared with the other participants.
2. Appropriate food hygiene and safety practices for pushcart porridge vendors (ex. using water can with a tap, long handled ladle, lids for covering side dishes, etc.) were identified, and 152 vendors were motivated and supported to adopt them.
3. Seventy-six vendors were supported for FSSAI registration, and 75 for getting biometric card from the city administration. Biometric registration helps the vendor in legitimising their occupation within the city limits.
4. Sixteen vendors were supported to enrol in the labour welfare scheme for unorganised workers; this scheme offers support for education of children, accident insurance cover, widow pension, etc.
5. One hundred and twenty-three PMPVs were supported for improving visibility through use of name board and charter for following food hygiene and safety practices.

6. Six PMPVs were supported for improving infrastructure.
7. Fourteen PMPVs were supported for exploring diversifying to other millet snack items.

Box 2: Transformation of a Pushcart Millet Porridge Vendor



Mrs. Kalaiselvi, 30 years, is a Pushcart Millet Porridge Vendor located at Sathyasai Nagar, Krishnagiri. She has been serving nutritious finger millet porridge and buttermilk at affordable prices (Rs. 15 per cup) for around 100 customers on a daily basis for the past five years. She took part in the training organized for millet porridge vendors by DHAN in collaboration with FSSAI during April 2017, wherein the need and importance for hygienic food handling, personal hygiene, and cleanliness of the food premises were stressed. Understanding the importance of food safety and hygiene, she took the following measures to transform her business with the guidance and support of DHAN: i) Providing drinking water using a water can with tap instead of the pot, ii) Covering the side dishes to protect from dust and flies and serving to the customers by herself instead of self-serving by them, iii) Using long handled scoop to avoid contact of hand with porridge while serving, iv) Cleaning the used vessels away from the food serving place, v) Registering with FSSAI, vi) Investing in the repair of the push cart and painting it, and vii) Displaying of name board, and oaths on hygienic food handling. Her customers appreciated her initiatives to improve hygiene and cleanliness. She feels proud that her image has improved and customers of all age groups visit her pushcart regularly.

A photo essay on interventions to support PMPV is given in Annex 2.11. As a result of these initiatives, many millet porridge vendors have improved their image, consumer acceptability, and increased their sales, thereby offering hygienic millet porridge and other millet products to about 17,610 persons per day.

4.9 Identification of interested Farmers Producer Organizations (FPOs) and preparation of action plan

Four FPOs were identified based on type of small millets and their geographic distribution. They are located in Jawadhu hills, Tiruvannamalai District (little millet); Peraiyur, Madurai district (kodo and barnyard millets); Anchetty, Krishnagiri District (finger millet); and Semiliguda, Koraput District (finger and little millets). An action plan was prepared for these FPOs for production initiatives and setting up a processing unit for production of small millet rice and grits (*rava*).

4.10 Supporting FPOs for effectively engaging in small millet value chain

Three FPOs were supported for establishing a processing unit for value addition of their members' produce and for selling small millet products in the region. The FPOs engaged in local procurement of small millet produce for trading to small millet food enterprises, and in seed supply to its members.

DHAN offered intensive capacity building support for FPOs and organised a special three-month course, which was offered to Chief Executive Officers and Board of Directors of FPOs on organisation management, compliances with statutory procedures, and business development. Exposure visit was organised to learn from successful FPOs. These four FPOs had a membership of 1,629 farmers and had mobilised a total share capital of Rs. 1,404,900/-. They have taken up business activities related to backward and forward linkages in the small millet value chain such as the supply of small millet seeds, grain and rice worth 4.6 million. Business relationship was built with buyers, including consumer organisations.

Objective 2: To test different business, market development and service provision approaches across the small millets value chain for their effectiveness to improve availability, choice and consumption of small millets in rural and urban areas.

4.11 Assessment of market potential for an array of dehulling and other processing equipment for small millets at the village, micro enterprise and SME levels, and end user profiling

Details are given in Milestone 3.8

4.12 Development of the hulling and processing assemblies to meet varying operating requirements at the village, micro enterprise and SME levels

Assessment of existing small millet processing machineries

Concerted efforts were taken for assessment and improvement of existing small millet processing machineries during the project period with the following objectives: (i) to improve the quantity and quality of output, (ii) to reduce drudgery in processing, (iii) to improve ease of use, maintenance, safety and stability, and (iv) to reduce footprint and cost of the machineries and improve energy efficiency. A structured assessment was conducted by DHAN in the facility of equipment manufacturers (AVM and Victor) in Salem, Tamil Nadu, between June 22nd and 24th, 2016 with a team of experts: Dr. Malleshi, a retired Grain Science and Technology expert, CFTRI; Dr. Samson Sotocinal of SAS Technologies, Canada, an engineer with considerable expertise on building of agricultural machineries, and Mr. Dinesha Kumar, an experienced processor of small millets from earth 360 Eco Ventures Ltd. The team assessed the equipment with reference to (i) structure and frame, (ii) safety and maintenance features, (iii) drive: motor, pulleys and belts, (iv) material flow and transfers, (v) grading and cleaning operations, (vi) feed hopper, and (vii) fan box and aspirator. The team extensively interacted with equipment manufacturers actively involved in equipment design. Further focused interactions with processors using these machineries were carried out for getting users' perspective for improvement. A second set of trials was organised by DHAN with SAS technology for understanding the internal operation of centrifugal dehuller and to fine-tune the same for different small millets by using VFD (variable frequency drive). [A detailed report on areas for improvement and possible measures for improvement for each processing equipment and for the process line](#) was prepared. The summary of the areas in need of improvement is shared below.

1. Optimising the hulling technology to process different small millet crops based on scientific principles.
2. Improving the separation mechanism in hullers to reduce removal of grits and other usable materials along with the husk.
3. Improving the grader in terms of its sieving efficiency to meet pre- and post-hulling segregation requirements of different small millet crops and its footprint.

4. Improving the post hulling machinery to separate unhulled from the hulled grains and to remove finer stones and mud balls similar in size and weight as rice and grits.



Figure 17: Assessment of centrifugal dehuller

5. Optimising the 'process line' for improving the versatility, head rice recovery, and product quality, for minimizing the cost of processing, and for reducing pest incidence; this in turn will increase the viability of the processing enterprise.
6. Reduction of the cost of the machines in the process line by reducing the footprint, height, weight and energy requirements; this will help in making them more affordable.
7. Improving the ease of use, ease of maintenance and servicing, and safety, considering the power requirements, skill requirements, and gender concerns, to reduce the downtime and to reduce the pest infestation.
8. Improving the capacity of the huller and other processing equipment to meet the processing requirements at the SME level.
9. Research on multi-product process line: Currently only small millet 'rice' is considered as the primary output of the processing unit; as the market develops further, there can be requirements for more than one type of rice, grits and flour, which are differentiated in terms of quality, use and price. Research is needed for improving the 'process line' to deliver multiproduct outputs.

A detailed review of implementation of mechanized post-harvest processing technologies of millets was undertaken by McGill student (Annex 2.2). As a follow-up of the assessment of existing small millet processing machines by the experts, the following initiatives to improve the processing assembly and to address the issues related to low shelf life were taken up:

- i) Generating basic data related to processing of small millets

The force required for splitting the husk plays a major role in the hulling efficiency and in the reduction of un-hulled and broken millets in the case of centrifugal hulling process of the millet. Similarly, the hardness of the grain decides the force required for hulling. Data was generated by TNAU for little, proso, barnyard, foxtail and kodo millets pertaining to the force required for hulling using Newton's second law of motion and the hardness of the grain using the Kiya hardness tester (shared in Table 3). This crucial data will help the equipment manufacturers in improving the design of the huller in terms of feed flow rate, rpm and impeller size and will assist the processors in fine-tuning their process line to improve rice recovery and versatility of the equipment. Similarly, data on terminal velocity were generated, which will be useful for improving the post hulling aspiration in the huller.

Table 3: Data on critical parameters related to processing of small millets

Small millet	Hardness (N)	Force required (F) to split the husk	Terminal velocity m/s
Kodo millet	25.5	18.5	3.75
Barnyard millet	23.8	17.3	3.08
Little millet	22.8	16.4	2.73
Foxtail millet	21.5	16.0	2.94
Proso millet	18.5	14.3	2.45

(ii) Improvement of existing machines

For improving the existing processing equipment, two strategies were followed: a) Joint R&D was organised with equipment manufactures: The results are shared as part of product development section in 4.3. b) Undertaking specific research to improve the functionality of the existing equipment. The results are shared below:

Developing grader prototypes with interchangeable sieves

In order to improve flexibility of the grader to process different small millet crops and to meet pre-hulling and post-hulling requirements, efforts were taken to modify the existing graders to have interchangeable sieves across the decks and have the flexibility of using different sets of sieves. Three prototypes with slight variations were developed with different equipment manufacturers.

(iii) Testing of equipment designed for other crops/commodities for hulling small millets

Testing of Otake centrifugal rice huller for processing small millets

During the assessment of existing equipment available in the market for processing small millets, it was found that the centrifugal hullers are not energy efficient as they were disproportionately heavy and large when compared to the quantum of hulling. Since then, a search has been made to identify hullers that are designed using scientific principles for ensuring performance in terms of rice recovery and hulling efficiency along with being energy efficient, compact, lightweight and most importantly user friendly. The explorations led to Otake impeller pickpocket unit FSE28G-M working on the centrifugal principle. Many trials of this rice huller were conducted by DHAN- on its own, with earth360 Eco Ventures Pvt. Ltd. and with SAS Technologies, Canada. It was found that the Otake huller fared well on two aspects: (i) performance and (ii) improved design features. The performance data from trials with earth360 Eco Ventures Pvt. Ltd. are shared in Table 4. The hulling efficiency ranged from 90 to 95 % and rice recovery varied from 66 to 77%. Otake huller performed quite well for foxtail millet, little millet and proso millet. In terms of design features, it is relatively light, produces low noise, required only a small motor, compact, portable and has a low hopper that makes it easier to operate. Using a one horsepower motor and weighing 85 kg, it was able to process 200kg (kodo millet) to 470kg (little millet) per hour. The hullers

available in the market use 5 to 7 HP for the same performance and weigh more than 300 kg.

Table 4: Performance of Otake huller for processing small millets

S. No.	Millet used	Moisture (%)	Hulling efficiency (%)	Avg. rice recovery (%)	Husk (%)	Broken (%)	Avg. output Kg/hr.	No of pass required for 90-95% hulling
1	Foxtail Millet	11.7	95	75	19	< 5%	420	1
2	Little Millet	11.1	95	77	17.7	< 5%	470	1
3	Proso Millet	11.3	90-95	73	18.3	Between 7-10%	407	1
4	Kodo Millet	8.9	90-95	66	25	8%	200	3
5	Barnyard Millet	11.1	90-95	66	21	10%	250	2

The observations made by the team of experts from the trials conducted with earth360 Eco Ventures Pvt. Ltd. include,

1. The Otake dehuller design holds promise for the efficient small scale dehulling of different types of small millets.
2. It is easy to operate and to clean in between batches.
3. The efficiency of the huller is superior to all other Indian hullers with a higher rate of rice recovery and less share of broken grains.
4. The power consumption is minimal compared to the current design of hullers available in India.



Figure 18: Trials with Otake rice huller at earth360 Eco Ventures Pvt Ltd.

The design features of this huller are considered as a benchmark for designing huller for small millets. Efforts were taken to share the design and performance advantages of this huller with equipment manufacturers and potential buyers. Demonstrations were organised at Grain Tech 2017, Madurai Symposium, at Salem (for AVM), Organics & Millets 2018, Bangalore, at Krishnagiri (for Victor and BIGSTAMP (machine designer)) and at Virudhunagar (for government departments and FPOs). The lessons learned were shared at the national seminar on “Emerging Trends In Processing & Value Addition of Small Millets”. Convinced by the performance of the Otake rice huller for small millets, Tumkur Organic Farmers Federation, Udupi Organic Farmers Federation and Anandam Enterprises from Virudhunagar have purchased it for their processing units. More details are given in Annex 2.12.

Trials on using specific gravity separator for removal of unhulled grains from rice and grits

Trials using the specific gravity separator from Westrup were taken up by TNAU, using dehulled output of kodo, foxtail, barnyard, proso and little millets. A Response Surface Methodology was used with the Box

Behnken Method. It was found that the separator was effective in removing impurities like dust and stones from hulled small millets. It also aided in the grading of grains with identical particle size. Hence, it can be used to get good quality grade small millet rice. It is better than traditional cleaning methods viz. air, screen, and indented cylinder. More details are given in Annex 2.12.

iv) Development of additional processing equipment to fill the gaps in the processing line:



Figure 19: Pneumatic grain cleaner

The project developed the following equipment:

Improved centrifugal huller for small millets:

Benefiting from the lessons learnt from the testing of the Otake huller, efforts were made to develop an improved enterprise-scale centrifugal huller for small millets. The preliminary results were much better than those for hullers currently on the market, in terms of hulling efficiency, rice recovery, energy efficiency, and user friendliness. Efforts will be made for fine-tuning and commercialising of the prototype in the near future. More details are given in Annex 2.12.

Developing a pneumatic grain cleaner prototype

The presence of unfilled chaffy grains considerably increases the difficulty in processing and there are difficulties in removing chaffy grains completely using size and weight based segregation in vogue now. To address this issue, DHAN with SAS technologies have developed a pneumatic grain cleaner prototype. In the

trials with little, kodo and foxtail millets, this equipment was found effective in removing hollow or unfilled chaffy grains and dust from the source grains. The capacity of the machine ranges from 70 kg/hr to 125 kg/hr. Efforts will be made for fine-tuning and commercialising in the near future. More details are given in Annex 2.12.

Design, construction, and testing of a hand-operated huller at McGill

In his M.Sc. project, Mr. Subhash Palaniswamy designed and constructed the prototype of a hand-operated huller using rubber rollers. The performance of the huller was tested using little, foxtail, and kodo millets, and modifications were made to improve the milling efficiency and safety features of the initial design. These modifications included the choice of the type of blades for the impeller, use of a compound gear train assembly instead of a sprocket arrangement for transmitting power to the blower for husk separation, and enclosure of the centrifugal impeller. The final version of the prototype was completed, and brought to India for full testing. The maximum capacity of the hand-operated dehuller was 300 to 350 g/hr, which was too low for purposes of commercialization. More work needs to be done on this to improve the performance and to increase the capacity of the machine. The value of a hand-operated dehuller is for ready use at the household level for rapid processing of the millets by women and youths. The machine does not require electricity or gasoline to drive the motor. Mr. Palaniswamy's MSc Thesis on his work on the hand-



Figure 20: Hand operated rubber roller type huller

operated dehuller and on extraction of antioxidants from the waste hull has been accepted. The thesis abstract is given in Annex 2.12 & 2.13. He is preparing manuscripts for publication with open access in peer-refereed journals.

Design, construction, and testing of an enterprise scale rubber roller type huller at McGill

The rubber roller huller designed and constructed by Dr. Samson Sotocinal of SAS Technologies was shipped to India for full testing. This huller has a processing capacity of 175 kg per hour, which will meet the needs of an enterprise scale operation. Reconstruction and testing at Krishnagiri by Dr. Samson Sotocinal, SAS Technologies, indicated that refinement needs to be done further to improve the performance of this prototype.

Development of vibro-grader

To improve the performance of the grader and to reduce the footprint and cost of the same, DHAN has developed a vibro-grader prototype with the involvement of SAS Technologies, Canada. While the equipment is performing to an extent, considerable improvements need to be made.

4.13 Comparison of nutrient content of small millet processed using different processing methods

It is known that manual processing and centrifugal dehuller offers more nutritious product than existing large-scale mills through better retention of bran-fibre and micronutrients. A comparison of the nutrients of little millet processed using the centrifugal dehuller, and manual dehulling with little millet available in the market that were processed using emery mill and cone polishers was done in the project period to understand the differences. The results are shared in Table 5. It can be seen that both grade 1 and 2 rice processed using centrifugal dehuller fared better or are on par in terms of nutrient content with the one processed manually. Both of them fared much better than the market sample, particularly with respect to fat, ash content, antioxidant and protein content.

Table 5: Comparison of nutrient content of little millet rice obtained by different processing methods

Nutrient	Centrifugal - Grade 1	Centrifugal - Grade 2	Manual hulling	Large scale mill*
Carbohydrate (%)	76.60	76.84	81.10	80.90
Protein (%)	10.35	10.35	9.79	8.91
Fat (%)	3.54	3.52	1.87	0.36
Crude Fibre (%)	0.48	0.40	0.41	0.32
Ash (%)	0.96	0.95	0.72	0.23
Moisture (%)	7.96	7.94	6.30	9.19
Energy (kcal/100g)	380.06	380.44	378.59	362.48
Antioxidant (mg/g)	173.70	212.38	107.95	27.60
Calcium mg/100g	47.53	47.21	45.30	25.55
Iron mg/100g	10.61	8.48	5.79	7.30

Source: TNAU, 2016 * Sourced from market

4.14 Storage trials on enhancing the shelf life of hulled small millets

The short shelf life of dehulled small millets (two to three months) is a great constraint for commercialization of small millet products. Poor keeping quality of small millet grains is attributed to presence of higher amounts of fat than other cereals and deterioration of its triglycerides through lipolysis and subsequent oxidation of de-esterified unsaturated fatty acids. The lipase enzyme, which is concentrated in the pericarp, aleurone layer and germ, accounts for the hydrolysis of the triglyceride,

which results in off odour and taste in the flour and its products. In order to increase the shelf life, storage trials involving three different environments namely vacuum packaging, modified atmosphere packaging, and hermetic storage were taken up by TNAU. The moisture, starch, proteins, free fatty acid, dietary fibre and phenolic contents of stored samples were analysed at 10 days interval for 120 days of storage in four different storage methods. At the end of the storage period, moisture and free fatty acid content had increased, while protein, starch, dietary fibre and phenolic contents had decreased. Hermetic storage gave the best results followed by storage with flexible packaging. More details are shared in Annex 2.12.

4.15 Evaluation of adoption and impact of village level dehulling equipment on the largely female users and entrepreneurs

The details are given in Milestone 3.13.

4.16 Assessment of the effectiveness of business incubator approach for improving the performance of the equipment manufacturers supported by the project in India

At the beginning of the project, the small millet processing equipment manufacturing sector was in its nascent stage and was yet to have an effective manufacturing zone ecosystem (involving 'Production' and 'Research & Development (R&D)' components) and the utilization zone ecosystem (involving marketing, spares provision, and maintenance service provision). This was a reflection of relatively low market demand. The manufacturing of small millet processing equipment suffered from all the typical problems of a small-scale unregulated industry. Only four small-scale manufacturers were supplying small millet machineries as part of their business portfolio, based on orders. All of them were located in Southern India. The huller design was not standardised and the design varied slightly from one order to another. The grader, destoner and huller manufactured for processing small millets were improvised versions of paddy processing machineries. There was limited investment on promotion of their products across India. Most of the manufacturers did not have institutional arrangements for long distance sales on a scale and for after sales service. Inadequate competition, poor research input, and lack of a system for enforcement of standards contributed to the above-mentioned situation. In this context, an on-site incubation approach was considered appropriate to build the capacities of these small-scale manufacturers, and for scaling up of the reach of centrifugal impact huller technology developed in the earlier project.

The incubation support offered to these equipment manufacturers through the project mainly involved on-site support for (i) equipment development through joint R&D, (ii) improving visibility of the products and (iii) building business linkages. As mentioned earlier, the incubation support aided AVM and Victor (the two manufacturers who have been offering centrifugal impact huller technology for more than five years) to considerably improve their equipment design in terms of safety, reduced footprint, and the versatility to meet varying scales of operation, to reach distant markets, and to position themselves as providers of appropriate equipment. AVM was transformed from a generic manufacturer to a one specialising in small millet processing equipment. AVM took part in government bidding and secured a work order. Furthermore, AVM made additional investments to increase production capacity and marketing ability. Perfura and Agromech started offering small millet centrifugal huller as part of their product portfolio. The destoner and grader of KMS and Agromech were introduced to Northern and Central India. All manufacturers widened their contact base and reach. Purchase order was secured by AVM and Perfura from Andhra Pradesh project on millets. AVM, Perfura and Victor were enlisted by Karnataka government in their website and invited by government of Odisha for consultation meeting on millet machineries. These results indicated the appropriateness of the on-site incubation approach for improving the performance of small-scale equipment manufacturers for commercialisation and scaling up of small-scale

agro-processing technology. The approach followed was found to be suitable for both small-scale manufacturers (Victor, Salem) and medium scale manufacturers (AVM, Salem).

While the incubator approach was found suitable, the performance of equipment manufacturers was limited by internal and external factors. On the internal side, they were limited by their inadequate ability to invest in significant modifications in the design of their equipment, to enhance their production capacity, to market their products in distant markets and to invest in capacity building of manpower. The design of the incubation approach should take into consideration the activities needed to address these areas of weaknesses. There is need to support access to capital at convenient terms. Externally, they were limited by the slow growth of the demand for processing equipment, entry barriers pertaining to large-scale government bids, and a lack of support to meet R&D costs and for improvement of production capacity. The segregation of the sale of 173 equipment over the last two years showed that, while 30% of equipment were purchased by regional processors, indicating the emergence of the market for small millets across India, this market segment was still growing slowly. In this situation, equipment manufacturers were hesitant to invest substantially on (i) production capacity improvement, and (ii) building a marketing network. This showed the need to generate more demand for the processing equipment on the one hand by creating large-scale demand for small-millet-based food products, and on the other hand by putting more efforts into dissemination of the technology in potential markets like Madhya Pradesh, Chhattisgarh, and Uttarakhand. More focused investment is needed on developing the utilisation ecosystems in these regions through (i) local demonstration of SMPU, (ii) capacity building on equipment operations, (iii) facilitating access to quality equipment, and (iv) building local cadre of mechanics, to bring about a bigger change. There is also need for government intervention for (i) promoting local consumption of small millets as is done for paddy and wheat to generate bulk demand for small millet processing equipment, and (ii) for creating a favourable tax regime.

4.17 Market research on appealing small millet products covering consumer acceptance, profiling, segmentation, and communication and marketing strategies

Market research was carried out in three phases and details are given in Milestone 3.10. More details on the results of market research are shared for Tamil Nadu and all India study below:

Marketing research on appealing small millet products in Tamil Nadu

Small millet food products are an emerging food category. There have not been many research studies to understand the market potential and consumer acceptance pertaining to small-millet-based food products, and segmentation, communication and marketing strategies followed by the MSMEs involved in production and marketing of small millet food products. In this backdrop, the main objectives of the research study were: (i) to understand the consumer acceptance of value-added products of small millets, (ii) to understand the constraints faced by different actors in the small millet market chain, and (iii) to suggest suitable marketing strategies for small millet food products that can be used by entrepreneurs. The primary data were collected from 60 consumers of restaurant and 50 consumers of retailers to identify the factors influencing consumer preference towards small millet products/food purchase. Primary data were also collected from five owners of restaurant, 15 food enterprises, 10 retailers and five distributors in the small millet value chain in the selected districts of Tamil Nadu. Furthermore, an online survey was made with regard to purpose, quantity preferred and brand preferred in relation to purchase of small millet food products and attracted 50 respondents. The study indicated that information about restaurant was received mainly from word of mouth (56.66%) followed by newspaper (26.67%); television (8.33%); and other sources (8.34%). Some of the recommendations pertaining to the restaurants are: (i) the restaurants should impress existing customers with better quality food, price and service, so that they can act as their brand ambassadors, and (ii) the restaurants should be opened on Sundays and can

focus on breakfast food items along with chat items. It is evident from the research study that 54 per cent of the customers of retail shop studied visited retail shop weekly and 28%, 12% and 6% visited monthly, fortnightly and daily, respectively. The important recommendation with regard to retailers is: the instant mix products and health mix products have better consumer acceptance and can be focused more. According to the consumers, more than 50% preferred to buy 250-500g packages and they are price sensitive. Therefore, enterprise can go for 250-500g packages in all products at a reasonable price. The selected food enterprises used different channels in marketing of their products namely, direct retailing, relationship marketing, distributor and retailer. The issues that the food enterprises faced include: (i) competition, (ii) high cost on raw materials, (iii) lack of promotional activities, (iv) lack of awareness on small millet products to the people, (v) financial problem, (vi) problem in package, (vii) difficulties in getting the necessary licenses, (viii) poor quality raw materials, and (ix) no growth in the business. Some of the recommendations from the study are: (i) sales promotions should be made by the retailers since their influence on the consumers has been significant and these can lead to an increase in daily and weekly consumers, (ii) demand for small millet products must be created so that distributors may have very effective expansion plan to reach and rural consumers on a scale, (iii) sustained improvement in product features of small millet food products, (iv) loan provision from banks to food enterprises to sort out the financial problems they face and to increase the production capacity, (v) consumer segmentation approach needs to be followed and bulk marketing of small millet food products needs to focus on B2B (Business to Business) possibilities.

Marketing research on appealing small millet products in India by Indianet Marketing Service Pvt. Ltd
Details given in Milestone 3.10 and Annex 2.3.

4.18 Studies to assess the health benefits of selected small millet products

The details of development of small-millet-based therapeutic and regular food products and studies on anti-diabetic activities and bioavailability for small millet food products is given in Milestone 3.14. More details on the multi millet-based therapeutic foods are shared below.

Development of multi millet-based therapeutic foods and assessing consumer acceptance by TNAU
Therapeutic foods suitable for breakfast – (Drumstick leaves/ Fenugreek *dosa*, Drumstick leaves/ Fenugreek *chappathi*, Vegetable *rotti*, *Kitchadi*, *Palak dosa*, *Upma*, *Idiyappam*, and *Adai*) and lunch (*Palak rice* and *Methi rice*) were selected. Instant mixes of these therapeutic food products with the incorporation of multi millets (kodo millet/ little millet/ barnyard millet/ foxtail millet) were standardized. In the selected food products, wheat flour and rice, which were major ingredients, were replaced with multi millets. The proportion of the rest of the ingredients in the instant mixes were maintained the same as that in traditional methods of preparation. The recipes were evaluated for their organoleptic properties. The therapeutic foods prepared using multi millets were found to be acceptable. More details on the 14 multi millets based therapeutic foods and 42 multi small millet value-added products developed and their anti-diabetic and bioavailability studies are shared in Annex 2.4.

At McGill, Ms. Sara Najdi Hejazi has completed her doctoral thesis on the development of innovative probiotic weaning products from finger millets and amaranth. The main goal of her doctoral studies was to explore the suitability of using these grains as alternatives to wheat and rice grains that are currently being used by the weaning food industry. This objective was achieved by studying the impact of malting, fermentation, and drying on the biochemical properties of these grains and on their effect on health-beneficial gut bacteria, namely *Lactobacillus rhamnosus*, *Bifidobacterium longum*, and *Bifidobacterium infantis*. The results are useful for the development of nutritious gluten-free millet-based weaning food products. This research project has generated several publications. McGill student has taken a study on

microwave-assisted extraction (MAE) of phenolic antioxidants from Kodo millet hulls (*Paspalum scrobiculatum*) and evaluation of antioxidant activity 'in vitro'.

4.19 Preparation of technical bulletin covering scientific data on health benefits of small millets and scientific standards for the small millet food products

The following technical bulletins were prepared on small-millet-based food products by TNAU and shared widely through training sessions and on the website:

- (i) [A technical bulletin on 56 small millet food products such as breakfast recipes, sweet recipes, snacks, puffed products, pasta products, bakery products, instant millet mixes, ready to cook sweet mixes, and ready to cook snack mixes](#)
- (ii) [A technical bulletin on 14 multi small-millet-based instant therapeutic food products](#)
- (iii) [The technical manual on 42 multi small-millet-based food products](#)

4.20 Study of gender aspects in small millet food enterprise development

In general, food enterprises that focus on small millet products are in need of support to run the business profitably and grow in a sustainable manner. This is more so in the case of women entrepreneurs, as many of them still struggle more than their male counterparts in managing their enterprises successfully. There have not been many research studies on small millet food enterprises and the related gender aspects. In line with the research problem, the main objectives were: (i) to analyse the factors that influence the performance and scaling up of women-led, men-led, and women-and men-led small millet food enterprises and (ii) to suggest customized support to these three kinds of enterprises. This explorative study relied more on qualitative data collected through administering semi-structured interview schedule with the three kinds of food entrepreneurs. To elicit opinions from the experts who had involved in supporting food enterprises, key informant interviews were done with four of them. The study covered 20 factors associated with individual entrepreneur and eight factors associated with a business environment. The performance of the three kinds of food enterprises was measured by using a Likert scale and categorized as *a) below average, b) average, c) good, and d) very good*. In the measurement scale, none of the 'women-led entrepreneurs' was categorised as "very good", while enterprises from 'men-led' and 'women and men-led' scored in that category. It was found that four influencing factors need attention in all three types of food enterprises namely, (i) ability to promote their products, (ii) accessing finance, (iii) managing procurement of raw materials, and (iv) accessing relevant information. In addition to these above-mentioned four factors, women-led enterprises needed attention on the following factors: (i) attractive packaging, (ii) ability to market, (iii) using information and communication technologies and (iv) accessing professional advice and business development services. The study results informed the project initiatives on the support to small millet food enterprises. It will also feed into efforts of government and other stakeholders on promoting women entrepreneurs in the millet value chain and in any emerging food market in developing countries.

4.21 Assessment of the business incubator approach for improving the performance of private / public small millets food enterprises of various sizes

The market for small millet food products was in the nascent stages and was growing at a good pace at the beginning of the project. Most of the small millet enterprises were catering to the demand from health conscious elite and middle class. In this market situation and considering the food cultures in the pertaining regions, the development of local or regional small millet food enterprises was deemed necessary. The enterprises dealing with small-millet-based food products fell mostly in the cottage, micro,

and small enterprise categories; very few were medium scale enterprises. Most of the micro and small enterprises were family-run operations, with limited investment and manpower. The majority were first generation entrepreneurs and only a few were registered as companies. Their products were competing with other cereal products and other health food products, which had price and product advantages and were offered by big companies. Under these circumstances, an on-site business incubation approach was considered suitable for improving their performance and to scale up their operations.



Figure 21: Food enterprises supported for participation in Organics & Millets 2018, Bengaluru

The project has engaged with 66 MSMEs in Tamil Nadu. The on-site incubation approach offered as part of the project under the above-mentioned context went beyond technology transfer and beyond incubator based support. Onsite incubator support was offered, covering various dimensions related to food business besides product development such as (i) compliance with government protocols, (ii) improving the hygiene of the production environment, (iii) improving packaging to meet the expected standards by the distributors and retailers, (iv) product promotion, and (v) building marketing linkages. The support offered was customized to the needs and circumstances of the individual enterprise to an extent. It was focused more on capacity building and trigger support to bring about significant improvement.

In Tamil Nadu, the on-site incubation support resulted in improvement of food enterprises in the following aspects: i) standardisation of foods products (23), development of new products (28), improvement in packaging (22), improvement in hygienic practices (35), improvement in production capacity (20), visibility (42) and increase in marketing links (28). They were exposed to the wider food processing sector, developed contacts and soft skills, and received moral support on associating with fellow entrepreneurs and support organisations as part of the project. Furthermore, the volume of sales was increased more than 15% for 30 enterprises. Of the 66 food enterprises, eight expanded sales outside the state, and three within the state; and three initiated food outlet and retail shop. The income of the 30 enterprises increased above 10% and another 16 enterprises by 5 to 10%. From these results, it can be inferred that the on-site incubation approach to commercialise nutrition-dense appealing foods is working to a large extent in improving the performances of micro, small and medium food enterprises.

Important lessons learnt are:

1. On-site business incubation support is needed for small millet food MSMEs (in general, for MSMEs dealing with nutrient-dense neglected foods) that is beyond the incubator centred support, which focuses mainly on technology transfer, as they face all the issues faced by small scale food enterprises related to registration, packaging, food hygiene, poor access to capital, inadequate ability to market, etc., besides issues specific to small millet food enterprises like marketing of lesser known products with limited demand.
2. Nevertheless, the presence of technology transferring organisations plays a crucial role and they act as the bridge between the technology developers (research institutions) and technology adopters (food enterprises); the in-house training organised by TNAU served as an essential early step for the enterprises to explore this business option besides building their capacity on small-millet-based food products development.

3. Access to relevant information, support for small-scale machinery, market linkages and moral support from fellow enterprises and support organisations makes a significant difference for the growth of MSMEs.
4. The success of the incubation approach depends a lot on the initiatives taken by the enterprises to utilise the opportunities generated; it must be a demand based initiative rather than a supply based one.
5. The involvement of MSMEs has made it possible to transform small-millet-based food products from the 'elite food' category towards the 'mass food' category, due to the market channels adopted by them and their focus on reaching all types of local consumers.
6. Growing market for small millets as part of the expanding market for 'health foods' helped in scaling up sales volume; but a big leap in consumer demand for small-millet-based foods is needed for regularising production and significant growth of the enterprises.
7. Small millet food MSMEs are yet to emerge as an important category in the small millet value chain in Central, Eastern and Northern India, as is happening in Tamil Nadu and Karnataka. In these regions, support schemes are needed for entry of new food enterprises and for inclusion of small-millet-based food products in the product portfolio by existing food enterprises.

Improvement has been limited on (i) production capacity improvement, (ii) credit linkage, (iii) expanding marketing network beyond the region where they are located, and (iv) accessing government schemes. The design of the incubation approach needs to take into consideration the activities needed for addressing these areas of weaknesses. Ways of accessing credit at convenient and subsidised terms, such as through specific financial schemes and mechanisms like credit guarantee are needed to meet working and fixed capital needs. The MSMEs face major problems in overcoming and managing entry barriers in to the mainstream food market such as supermarkets, and suffer from relatively higher taxes in the new tax regime. So, creating an enabling environment by the government through (i) promotion of exclusive millet markets in urban and semi-urban centres, (ii) supportive tax regime involving simple and transparent taxation and exemption for small millet food products under GST for five years, and (iii) single window system for compliance to government protocols, would help a lot. Furthermore, government support for developing and ensuring product standards and for promoting small millets as a 'health foods' on a large scale is needed.

4.22 Assessment of the customised support and training approach for improving performance of small millet micro-enterprises.

Pushcart Millet Porridge Vendors (PMPVs) are informal street food service providers in the cities and small towns in Southern India. They provide nutritious millet porridge to the poor sections and floating population. While they provide a valuable service at affordable prices, they are not recognised for their role in the society. They have an image of providers of unhygienic food and are harassed by city authorities. Stabilising and strengthening these informal entrepreneurs can go a long way towards providing nutrition-dense millet foods to 'bottom of the pyramid' population.

Support was given to the PMPVs located in Madurai, Krishnagiri, Salem and Harur in Tamil Nadu to (i) build their capacity for voluntary adoption of hygienic practices for handling of food, (ii) register with FSSAI, (iii) enable them to access relevant Government schemes, (iv) improve the image and visibility of their food business and (v) diversify millet products. As a result, 152 PMPVs have adopted customised food hygiene practices, 76 have registered with FSSAI, 75 have gotten biometric card, six have improved infrastructure, and 123 have improved their image through display of name board, and oaths, and dos

and don'ts on hygienic food handling. Most of the PMPVs involved in the project realised an increase in monthly income in the range of Rs. 2,000 to Rs. 3,000. Above all, these poor entrepreneurs, mostly women, received moral support due to the attention they got as part of the project, as up to now no agency has touched their lives. A working model of supporting pushcart millet porridge vendors was developed from these experiences for extending such support in other regions. These interventions throw light on innovatively reaching poor with nutrition-dense foods through market channels with a lower development investment.

Improvements have been limited on (i) diversification of millet products and (ii) improvement of infrastructure, (iii) credit linkage, and (iv) accessing government schemes. The design of the incubation approach must take into consideration the activities needed to address these areas of weaknesses. Furthermore, enabling support is needed from city/local administration for provision of space and for access to clean water.

4.23 Implement supply chain interventions involving FPO and value chain actors

FPOs have started their business activities related to backward and forward linkages in the small millet value chain such as supply of small millet seeds, grain and rice. The Peraiyur FPO undertook Rs. 3.4 million worth of transactions including small millet grains procurement, grains sales and rice sales. Similarly, Jawadhu Hills FPO, Anchetty FPO and Deomali Farmers' Producer Organization (Odisha) transacted Rs. 329,375, Rs. 62,000 and Rs. 52,000, respectively. The Peraiyur FPO supplied 17,035 kg kodo millet grains and 533 kg kodo millet rice, 610 kg barnyard millet rice and 427 kg foxtail millet rice. It procured 9900 kg kodo millet grains. The FPO of Jawadhu Hills supplied little millet grain, little millet rice, foxtail millet rice, and kodo millet rice to the tune of 4,250 kg, 1680 kg, 375 kg, and 150 kg, respectively. It supplied 950 kg of little millet seeds and procured 430 kg proso millet. The Anchetty FPO supplied 440 kg seeds. The Deomali FPO in Odisha has started organizing farmers for seed production and has sold processed rice of little millet and foxtail millet at the state level festival called *Paraba*. It has sold 550 kg finger millet seeds of GPU series varieties to FES, MSSRF and farmers at three DHAN locations. While the grain was supplied to small scale processors, millet rice was mainly supplied to consumer organisations namely federations of women self-help groups and farmers federations, thereby considerably shortening the value chain and reduction in consumer price. Twenty-six women/ farmers organisations in six districts of Tamil Nadu were facilitated to purchase of 30,685 kg of small millet rice for supply to their members, mainly from FPOs, to the value of Rs. 1,687,675.

4.24 Assessment of the support and training approach for improving performance of FPOs for scaling up small millet food products.

Support was given to four small millet FPOs, three in Tamil Nadu and one in Odisha, for building capacity of office bearers and Chief Executive Officer, establishing processing unit, and initiating supply chain interventions. As mentioned above, the FPOs have started supplying seeds to farmers in their working area, trading grains and selling processed millet rice, and during the project period they were able to do transactions worth Rs. 4.6 million. These transactions have resulted in the shortening of the value chain by connecting FPOs with consumer organisations, building business linkages, and, more importantly, gaining an understanding of the market. The support given was effective in setting up FPOs and initiating supply chain interventions. However, the FPOs faced difficulties in competing in the small millet rice market. Intensive financial and capacity building support is needed to enable FPOs to take up the activities on a scale in the enterprise mode for reaching a viable scale of operations, and to cover the cost of operations.

Objective 3: To inform policy makers and other important stakeholders on the best practices and policy interventions needed for increase the awareness, availability and consumption of small millets

4.25 Study of introduction of millets in Public Distribution System in Karnataka

Despite the high potential contribution of millets to food and nutritional security, there has been a drastic decline in the production and consumption of millets in India. In order to promote millets, the Karnataka Government has introduced millets under its on-going “*Anna Bhagya*” scheme, following the recommendation to introduce millets in the Public Distribution System (PDS) by the Food Security Act, 2013. In 2014, finger millet was introduced in 14 southern districts, and sorghum in 2 northern districts, based on the prevalence of production and consumption. The study aimed to understand the ground level implementation of millet supply in the *Anna Bhagya* scheme and its effects on producers and consumers, and to identify areas for improvement. Both primary and secondary data were collected. Data were collected from 72 respondents (36 producers and 36 consumers) each in Belagavi district (Gokak and Savadatti taluks) and Tumkur district (Tumkur taluk). In addition to this, key informant interviews were done with PDS distributors, managers of Karnataka Food and Civil Supply Corporation, and managers of Karnataka Agriculture Producers Marketing Federation. In the first year, the state government faced difficulties in the procurement of grains due to unattractive Minimum Support Price (MSP). The MSP for finger millet was raised to Rs.2100 per quintal during 2015-16, keeping in view of the higher labour and input costs. Farmers participated in the *Anna Bhagya* scheme by selling their produce during 2015-2016. Sorghum was not distributed regularly; it was distributed only three times in Gokak Taluk. The beneficiaries were happy with the quality of sorghum and demanded for the continuity of sorghum distribution. There was no issue with the periodicity of supply of finger millet and the majority of the respondents had received it. However, there was an issue with the quality of the grains supplied. The present allocated quantity of sorghum and finger millet (5 kg/ month/ family) were found to be inadequate by the respondents and suggested that the quantity should be increased. Long distances as well as delay in payment were the main hindrances in local grain procurement in this scheme. Producers were demanding for local level procurement centres and suggested that *Raithu Mitra Kendras* (local farmer service centres) can be used for the procurement process. In 2016-17, again the state government faced difficulties in procurement due to low production and as MSP was far lower than the grain prices in the local market. The initiative of Karnataka for improving nutrition by supplying millets in PDS offers important lessons on the possibilities and modalities of such initiatives, and the practical problems to be surmounted for successful implementation. These lessons can be used by other states.

4.26 Policy study of Comprehensive Support Package for MSMEs in Millet Sector

The development of small millet value chains in Tamil Nadu region has demonstrated the dynamic role played by MSMEs in the processing and marketing of bulk and value-added products. Given this and given the role of small millets in addressing malnutrition and climate change, the Government of India and various state governments need to establish a vibrant millet-based MSME sector that can help in making



Figure 22: Small millet processing unit set up by Peraiyur FPO

millet available to a wide range of consumers. A study was taken to identify comprehensive policy support needed to promote vibrant MSMEs in the millet sector by the central and state governments. The study approach comprised secondary research and interaction with millet industry including millet enterprises, millet consumers, incubators, and government institutions involved in millet sector. The study was completed and the report is shared in Annex 2.14.

4.27 National Seminar on Emerging Trends in Processing and Value Addition of Small Millets

To address the issues pertaining to processing and value addition of small millets, many researchers, research agencies, equipment manufacturers and enterprises have been attempting to develop appropriate technologies in the recent past. However, constructive sharing and interactions between research agencies, equipment manufacturers (adopters) and food enterprises (users of the technologies) have been limited. Therefore, there is need for informing and facilitating systematic interactions among the stakeholders on new developments pertaining to small millets processing and value addition technologies. With these focus areas in mind, TNAU and DHAN organised a two-day national seminar on “Emerging Trends in Processing and Value Addition of Small Millets” on 22nd & 23rd September, 2017, as part of the Madurai Symposium, a biennial large-scale development event organized at Madurai, Tamil Nadu, by DHAN, on the theme of “Building Resilience for Sustaining Development”.

A wide range of participants namely, researchers, equipment manufacturers, processors, food entrepreneurs, marketing experts, and representatives from FPOs and NGOs participated in the event. There were five technical sessions: (i) health and nutritional benefits of small millets, (ii) machineries used in primary and secondary processing, (iii) value-added small millet products, (iv) innovation and promotion of small millets food products, and (v) marketing strategies for small millet products. In each technical session, there was a lead paper presentation followed by three to five oral presentations. In addition, there was a poster session in which selected posters were presented. In total, 79 papers were received for the seminar, of which 30 were presented orally.

This seminar also served as a platform for sharing small millet processing and value addition technologies developed by the project partners with other stakeholders, and for offering inputs to food enterprises on marketing and storage. The following project research works were presented in the seminar:

1. M. Balakrishnan, K. G. Ishwarya and N. Varadharaju. “Studies on enhancing the shelf life of de-hulled millets”. Technical Session 1. Health and nutritional benefits of small millets.
2. Subhash Palaniswamy, Samson Sotocinal, Valérie Orsat, Vijaya Raghavan. “Fabrication of hand operated dehuller”. Presented by Dr. Orsat in Technical Session 2. Machineries used in primary and secondary processing.
3. Saravanan Panaiyuran. “Experimenting with Otake huller for processing of small millets-Learning and insight for improving hulling equipment for small millets”. Technical Session 2. Machineries used in primary and secondary processing.
4. Malathi D., Lilia-Baby, Subbulakshmi B., Gokhal Seetha R. and Suganya N. “Standardisation and evaluation of small-millet-based drumstick leaves chappathi mix”. Technical Session 3. Value-added small millet products.
5. Malathi D., Suganya N. Lilia-Baby, Subbulakshmi B. and Gokhal Seetha R. “Development of multi millet vegetable rotti mix”. Technical Session 3. Value-added small millet products.

6. Malathi D., Gokhal Seetha R., Lilia-Baby, Subbulakshmi B. and Suganya N. “Development and evaluation of small-millet-based palak leaves dosa mix”. Technical Session 3. Value-added small millet products.
7. Malathi D., Subbulakshmi B., Lilia-Baby, Gokhal Seetha R and Suganya N. “Development of fenugreek leaves incorporated multi millets instant rice mix”. Technical Session 4. Innovation and promotion of small millet food products.
8. Vijaya Raghavan. “Millets – Shrouded Gold”. Technical Session 4. Innovation and promotion of small millet food products.
9. Ademola Adekunle, Darwin Lyew, Valérie Orsat, Vijaya Raghavan. “Marketing models for small millets”. Presented by Mr. Adekunle in Technical Session 5. Marketing strategies for small millet products.

[The key presentations made in the seminar and the abstract book](#) were shared on the project website for wider reach.

Another seminar on “Promotion of small millet post-harvest and nutritious food products” was organised at Centurion University, Paralakhemundi, Odisha, on 17th June 2017, by DHAN, in which 69 female and 52 male students participated.

4.28 Project dissemination workshop

A two day Project Dissemination Workshop was organized on 15th and 16th February 2018 at The Gateway Hotel, Pasumalai, Madurai, by DHAN with the support of TNAU and McGill. The main objectives of the workshop were:

1. To disseminate the learning on scaling up of small millet processing equipment and food products;
2. To strengthen the existing partnerships and establishing new partnerships; and
3. To explore the next steps for further scaling up.

The workshop had five major sessions: (i) inaugural session, (ii) technical sessions, (iii) free rolling discussion, (iv) recognition and appreciation of small millet stakeholders, and (v) concluding and way forward session. Mr. M. Karthikeyan, Principal Investigator, DHAN, welcomed the participants and gave an introduction about the workshop. Mr. M.P.Vasimalai, Executive Director, DHAN, made opening remarks and Dr. A. Seetharam, President, Society for Millets Research, delivered the keynote address. The following project outputs were released by the delegates: (i) short films on cooking demonstration of small millet recipes in Hindi and Odiya, (ii) short films on preparation of modern value-added small-millet-based food products, and (iii) “A Synthesis of Policy Recommendations of National Policy Workshop on Mainstreaming Small Millets in Our Diets”.

The technical session was divided into five, namely (i) scaling up appropriate processing equipment, (ii) scaling up appealing small millet food products, (iii) promoting household consumption, (iv) local and regional value chain development for small millet Consumption; and (v) informing policy actors for favorable policy environment for mainstreaming small millets. In these sessions, the project partners – DHAN, TNAU and McGill shared the progress made with respect to the objectives of the project, the learning and insights gained, and the possibilities for further scaling up. Furthermore, the value chain actors and the NGO partners involved in the project shared their experiences, support received, improvements made, and future plans. The project results were also shared with the participants as a

Project Update, and through posters, small millet processing equipment, and small millet food products displayed in the exhibition as part of the workshop. Dr. Malleshi, Former Director Grade Scientist and Head, Department of Grain Science & Technology, CFTRI, Mysore; Mr. Dinesha Kumar, Founder, earth_360 Eco Ventures Ltd.; Dr. Vijaya Raghavan, Professor, Bioresource Engineering, McGill; Dr. Varadharaju, Professor & Head, Post Harvesting Technology Center, TNAU; Dr. Valérie Orsat, Professor & Head, Bioresource Engineering, McGill; Mr. K. Palaniswamy, Deputy General Manager, NABARD; Dr. Oliver King, Senior Scientist, M.S. Swaminathan Research Foundation; and Mr. M. Palanisamy, Programme Leader, DHAN, were among the panel members for the sessions of the workshop. Small millet value chain actors such as farmers, processing equipment manufacturers, food entrepreneurs, government officials, and representatives of NGOs from across the country participated in the workshop.



Figure 23: Participants of Project Dissemination Workshop

[The key presentations made in the Project Dissemination Workshop](http://www.dhan.org/smallmillets2/smnews.html) were shared on the project website for wider reach. The press coverage of the event can be seen at <http://www.dhan.org/smallmillets2/smnews.html>.

4.29 Publications

Details are given in Milestone 3.22.

4.30 Preparation of case studies

Details are given in Milestones 3.15

4.31 Preparation of policy brief

Details are given in Milestones 3.23

4.32 Sharing the lessons from the project

The results and learning from the project were shared in the following national/international seminars/conferences:

1. Functional foods to achieve nutrition and health security, Home Science College & Research Institute in Madurai, 2016
2. ASABE Global Initiative Conference, Stellenbosch, South Africa, 2016 on Engineering and Technology Innovation for Global Food Security

3. National Symposium on Trends in Agricultural and Bio-systems (TAB 17), India
4. International Conference on Food and Nutrition 2017, USA.
5. Global Food Security Conference, 2017, South Africa.
6. Global Agri Connect 2017, New Delhi
7. Annual General Meeting and Technical Conference of the Canadian Society for Bioengineering (CSBE)
8. [Nutricereals for farmers', environment and consumers' security, INTERNATIONAL TRADE FAIR 2018- ORGANICS AND MILLETS, Bangalore](#)
9. [Dialogue on Millets, Monsoon and Market, held at MSSRF, Chennai during April 15-17, 2018](#)

The summary of learning from two CIFSRF projects and ways for scaling up was shared in a multi-stakeholder consortium meeting on supporting mainstreaming of small millets in India organised in collaboration with IDRC at New Delhi on 17 August 2017 for sounding with potential funders and to seek their engagement. The meeting was attended by International Fund for Agricultural Development (IFAD), Axis Bank Foundation and GIZ. Similar presentations were made to IDRC and Global Affairs Canada (GAC) by mid-March, 2018.

Project website

The project activities are shared through the [web link](#) hosted on the website of DHAN. The [web link](#) is designed as a resource website on small millet processing, value addition, policy, and promotion. The project activities and outputs such as protocol, training manuals, promotion materials, and policy briefs were all shared on the project web link. Since its initiation in April 2016, this web link was visited globally by a large number of persons with a total 1,563,340 hits and 62,533 monthly hits.

The following project initiatives were covered by national and local media, thereby reaching a wider audience:

1. Inception workshop
2. National seminar on “Emerging Trends in Processing and Value Addition of Small Millets”
3. Novel and innovative small millets recipe contest, Madurai, Tamil Nadu (Tamil)
4. Training on value-added food products from small millets at Mandla, Madhya Pradesh
5. Training on small millet processing at Mandla, Madhya Pradesh and Dantewada, Chhattisgarh
6. Inauguration of SMPU at Visakhapatnam district
7. Project Dissemination Workshop

[A newspaper article was published in Daily News and Analysis \(DNA\) on small millets](#) carrying the message from project partner. The news items on the project can be accessed at <http://www.dhan.org/smallmillets2/sm-news.html>.

Some of the project outputs were shared via YouTube. The project interventions were also shared in national and international exhibitions mentioned earlier.

4.33 Organizing policy consultation meetings

Details are shared in Milestones 3.16 and 3.30.

4.34 Organising cross learning events

A skill exchange program on small millet processing and value addition was organised between FACHIG Trust, Zimbabwe and DHAN with the support of the Agricultural Biodiversity Community, a network of organisations and individuals striving to scale up people-centred and agricultural biodiversity rich food systems. This program indicated the potential for productive exchange of skills and knowledge on promoting small millets between India and different countries in Africa, including Zimbabwe, Kenya, Uganda and Botswana.

Objective 4: To build the awareness and capacity of end users and consumers of small millets processing equipment and value-added millet-based food products.

4.35 Identification of partners in predominantly small millet cultivating zones, where project partners do not have a presence

Exploration was made for identification of potential partners for disseminating appropriate small millet processing and value addition technologies in Eastern, Central and Northern India. By the end of the project period, partnerships had been developed with 20 organisations. The list of partners identified in Odisha, Andhra Pradesh, Uttarakhand, Madhya Pradesh, Chhattisgarh, Rajasthan and Maharashtra are shared in Annex 2.15.

Capacity building of end users of appropriate small millet processing equipment

4.36 Demonstration of hulling and processing equipment in strategic locations

Details are shared in Milestone 3.18.

4.37 Advertising on the equipment

Advertisements were placed in newspapers in Maharashtra, Madhya Pradesh and Uttarakhand on the availability of processing equipment. DHAN organised an exhibition stall at the Global Tribal Entrepreneurship Summit, Dantewada, Chhattisgarh, wherein the processing and value addition technologies of small millets and their commercialisation was shared with 500 participants including local Members of the Legislative Assembly, District Administrators and government officials. A presentation was given on the “Impact type small millet huller” at Global Agri Connect 2017, New Delhi, an event organised by the National Skill Development Foundation of the Government of India. This event explored promising climate change adaptation technologies for scaling up and published the technology profile of impact type small millet huller. Exploratory visits were undertaken for promotion of small millet processing equipment to Raipur, Gariyaband, Dantewada and Rajnandgaon in Chhattisgarh; to Rewa, Mandla and Seoni in Madhya Pradesh; and to Nandurbar, Maharashtra.

4.38 Capacity building on small millet processing

Given the challenges in processing small millets due to the small size of the grains, variations in the raw materials, and the short shelf life of the processed rice, building adequate knowledge and skills of the



Figure 24: Interaction with small-scale equipment manufacturer in Zimbabwe

operators for effectively using processing machines is critical for increasing head rice recovery and quality of the output. The project has taken up the following initiatives to address the above-mentioned concerns:

Preparation and dissemination of training materials on small millet processing

1. A training manual on Community Scale Small Millet Processing (CSMP) was prepared by DHAN in both written and audio-visual format in English, keeping in mind the training needs of the operators of village level and small-scale processing units, and of potential buyers. The topics covered in the film clips of the CSMP manual are:

1	Introduction to the CSMP manual	6	Hulling and post-hulling operations
2	Assessing quality of small millet grains	7	Products of CSMP
3	Steps in CSMP	8	Pest management in CSMP
4	Machines and tools used in CSMP	9	Maintenance and basic repair of CSMP machines
5	Pre-hulling, cleaning & grading	10	Summary and conclusion

[Audio-visual manual](#) was uploaded onto YouTube for wider dissemination.

2. [A flyer on how to choose the set of equipment based on need](#) and available small millet processing equipment in the market was prepared and widely disseminated.
3. [Guidelines for setting up a small millet-processing unit](#) covered small millet processing equipment available on the market, how to choose the set of equipment based on need, the testing of the equipment at the manufacturer site, the floor plan and installation steps to be followed, and the testing of the equipment after installation was prepared. It was released in the national policy workshop on Mainstreaming Small Millets in Our Diets, New Delhi and shared with 90 interested buyers and promoters.
4. Poster on process flow for improving quantity and quality of output in SMPUs (in English and Tamil)

ii) Training on utilization of hulling and processing equipment

Details are shared in Milestone 3.17

Guidance to new entrants to small millet processing

The entrepreneurs and organisations who are interested in getting into small millet processing or supporting small millet processing were reached through newspaper advertisements, flyers distribution at exhibitions, and communications with development organisation networks and government departments. The interested actors were offered guidance in the purchase and establishment of processing units, and exposed to the realities of running a processing unit. Visits were organized by DHAN for the following potential buyers: (i) Krishi Vigyan Kendra and FPO from Chitradurga, Karnataka, (ii) INHERE, Uttarakhand, (iii) officials from MAVIM and representatives from FPO in Nandurbar, Maharashtra, (iv) entrepreneurs/FPOs from Dindigul, Salem, Dharmapuri, Tirunelveli and Trichy -Tamil Nadu; Bangalore - Karnataka; and Hyderabad - Telangana.

Training to develop a local cadre of mechanics

Long downtime for servicing and repair of small millet processing equipment due to lack of mechanics in the local area, and the inability of manufacturers to offer timely service are the major reasons for poor functioning of processing units. To address these critical issues, a training session to develop local cadre of mechanics, the first of its kind, was organised by DHAN with VICTOR AGRO SALES on their premises in Salem, Tamil Nadu. Eight participants from Tamil Nadu and Odisha participated in the training. This training session covered: (i) installation of grader, destoner and huller, (ii) addressing frequent and less frequent repairs, (iii) spares and tools needed and (iv) identification of the right sieve sizes.



Figure 25: Training of local cadre of mechanics by VICTOR AGRO SALES, Salem, Tamil Nadu

Promotion of consumption of appealing small millet food products through capacity building of end users

4.39 Preparation and dissemination of small millet promotion materials

i) Awareness posters

[A set of informative and motivational posters on small millets](#) was prepared in regional languages and English, and disseminated as a flip chart and as a Power Point presentation. Four posters on small millets and one brochure on barnyard millet were developed in Hindi for promotion in Uttarakhand.

ii) Calendar with the message on small millets

[A monthly calendar for 2018 with motivational messages on small millet consumption in Tamil and Kannada](#) languages as one of the content was developed for promotion of small millets. The motivational messages and images were displayed at the bottom of the calendar. These calendars were distributed to 200,000 poor families in Tamil Nadu and 75,000 families in Karnataka, who have been organised in to SHGs in rural, coastal, and urban areas by DHAN.

iii) Radio programme

DHAN has prepared and released ten episodes of radio programme on promoting cultivation and consumption of small millets, in the name of [“Puthayal \(Treasure\) - An Effort to Revive Lost Food Habits”](#). Each episode is 30 minutes in duration. Details of the content are given in the table below:

Episodes	Content	Communication method
1	History of small millets, health benefits and recipes	Drama involving visit of a family to Traditional Food Festival
2	Kodo millet - health benefits and recipe preparation	Song, drama, lecture and cooking instructions
3	Foxtail millet - health benefits and recipe preparation	Song, drama, lecture and cooking instructions

4	Small millet health benefits, Recipe preparation, cultivation practices, value-added products	Drama involving sharing of old memories by elder women, lecture and experience sharing by a farmer on cultivation and housewife on utilisation
5	Finger millet - health benefits and recipe preparation	Song, drama, lecture and cooking instructions
6	Proso millet - health benefits and recipe preparation	Song, drama, lecture and cooking instructions
7	Little millet - health benefits and recipe preparation	Song, drama, lecture and cooking instructions
8	Barnyard millet - health benefits and recipe preparation	Song, drama, lecture and cooking instructions
9	Cultivation practices	Lecture by an expert
10	The need for reviving small millets, motivating consumption and preparing recipes	Lecture, cooking instructions

Forty-five short episodes were prepared for Community Radio programs in Telugu, covering the importance of small millets, their nutrition values and different recipes that can be prepared with them.

iv) Music album

'Small Millet Music Treat', a music album of motivational songs covering the health benefits and other virtues of small millets was developed in Tamil, and released on the occasion of the 20th Foundation Day of DHAN. It was disseminated widely through the website and by direct sales.



Figure 26: Short films on modern value added small millet-based food products

v) Short films on cooking demos of 28 small millet recipes

Short videos of cooking demos were developed in [Telugu](#), [Odiya part 1](#), [Odiya part 2](#) and [Hindi part 1](#), [Hindi part 2](#) for reaching a large consumer base in the states where these languages are spoken. They were disseminated through YouTube, the website, and by distribution. They can be accessed at:

vi) Short films on preparation of modern value-added small-millet-based food products

DHAN and TNAU have developed these short films in English for dissemination to potential manufacturers in and beyond India. They were disseminated through YouTube, the website, and by distribution.

Promotion with different consumer groups

The reasons related to consumption were different for consumers in the production regions from that of consumers in the non-production regions. So differentiated efforts were taken for promotion. The following viewpoints were embedded in the promotional efforts:

Consumption of small millets as meals, tiffin or in any form involving substantial quantity as it will make a difference on the nutrition

Building on prevailing local/ regional food cultures

Building on available functional knowledge and skills on recipes and health benefits

Targeting wider section of the society, with the focus on poor families

The broader approach shown in Figure 25 was followed for promoting consumption.

4.40 Promotional events

A total of 84 local and district level promotional events were organised in Tamil Nadu, Odisha, and Andhra Pradesh for promoting small millet consumption with a focus on women, farmers, and schoolchildren. The Annual General Body Meetings and special events of federations and clusters of women federations served as a platform to promote small millets. Small millet food festivals were organised in Uttarakhand, Andhra Pradesh, and Tamil Nadu. Through these events 36,190 persons were educated about the health benefits of small millets. In most of the events the participants were given the opportunity to taste appealing small-millet-based food products. The details of some of the flagship events are shared below:

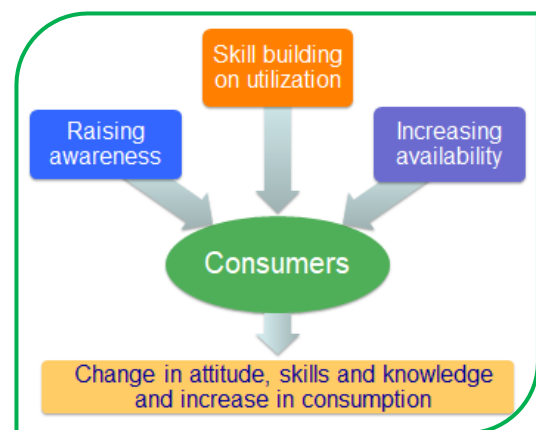


Figure 27: Approach followed for promoting consumption of small millets

1) Walkathon 2016, 2017 and 2018

Small millet promotion was a component of the 'Walkathon', a large-scale awareness event organised at the district level in Tamil Nadu, Andhra Pradesh and Odisha, for three years. This event was organised with the focus on schoolchildren, women SHG members and members of farmers group. As part of Walkathon, a series of awareness events including orientation and competitions in 60 government schools, awareness rally, and seminars were organised. Besides coming to know the health benefits of small millets, the participants had the opportunity to relish a variety of small millet recipes.

2) Celebration of National Nutrition Week in Visakhapatnam

National Nutrition Week, which was observed during 1-7 September 2017, was used by women SHG federations in the Visakhapatnam region to promote millets among students and the public. About 170 and 80 students from five schools participated in essay writing competition and elocution competition, respectively. Recipe contests were organised in five federations, in which 55 members displayed 72 small millet recipes, proving their avid interest and rich knowledge and skills. An awareness rally was organised at Vaisakhi wherein women members and officials of the Greater Visakhapatnam Municipal Corporation and health department participated. The event evoked good response among the students, the general public, and the media.

3) Promoting small millet recipes at schools

Considering children as the gateway for change in food habits at the family level, small millets exhibition cum awareness events were organised in Salem, Krishnagiri, Madurai in Tamil Nadu; and in Chittoor and Visakhapatnam in Andhra Pradesh. The panicle, grain and rice of different small millet crops and value-added products were displayed, and snacks made from small millets were introduced to school students.

4.41 Promotion as part of national and international exhibitions

The display of small-millet-based food products and sharing of recipe booklets were taken up in three international, 10 National, two provincial and six local exhibitions in Tamil Nadu, Karnataka, New Delhi, Odisha, Chhattisgarh, and Kerala, thereby reaching 36300 persons.



Figure 28: School awareness event in progress at Krishnagiri, Tamil Nadu

4.42 Novel and innovative small millet recipe competition for college students

Students from Catering, Hotel Management and Home Science who are taking training to be future Chefs, Restaurant Managers and Dieticians, respectively, can play a significant role in taking appealing small-millet-based foods to the wider public. A novel recipe competition was organised for these students on 4th December, 2017 at Madurai with the twin objectives of (i) generating novel and innovative small millet recipes and (ii) creating awareness. Students from three colleges in and around Madurai participated in this competition. Twenty-two novel recipes using small millets were generated, and displayed with ingredients and health benefits. Based on taste, appearance, ease of preparation, presentation of the recipe, and oral explanation of its health benefits, the participants were assessed by the jury consisting of experienced women entrepreneurs and the prizes were awarded to the participants of the event. Recipes that won an award included (i) foxtail millet pancake, (ii) seven-in-one *biryani* and (iii) foxtail millet badam nuts milk rice.

4.43 Short film contest on promoting small millets

Short film contest was organised by DHAN on the theme of 'Small Millets - Our Food: Our Pride' as part of the Madurai Symposium at Madurai, Tamil Nadu, with the twin objectives of (i) creating awareness among students and the public by engaging them on the theme of small millets, and (ii) generating effective short films for promoting small millets. Among the short film entries, three short films were selected for first, second and third prizes in line with the guidelines provided to the contestants. Based on the content, format and presentation, a short film titled "*Appuchi*" was selected for the first prize of the contest. The selected short films will be used for disseminating awareness on small millets among the students and the public.



4.44 Nutrition education and campaign through media, folk arts and wall painting

i) Promoting small millets through community radio

"*Puthayal* (Treasure)-An Effort to Revive Lost Food Habits", a radio programme with ten episodes on promoting cultivation and consumption of small millets, was broadcasted by 33 Community Radio Stations (CRSs). Most of the broadcastings were done in the morning, which is a suitable time slot for women. Out of 33 CRSs, seven have repeated broadcasting for more than two times between January and June 2017. The CRSs and the listening community have given positive feedback about the episodes. The CRS at Kotagiri, which is run by the Keystone Foundation, a NGO, was approached by local women after listening to the episodes for supply of small millet rice and it facilitated the sales. Another CRS at Kottampatti, Madurai district, in addition to broadcasting had organised a cooking competition on small millet foods at Kalaour village, where 22 women participated. At the end of the programme, participating women took an oath to use small millets in their regular diets. Following the broadcasting of the programme, Vayalaga vanoli organised a speech competition at Managalampatti Girls Higher Secondary School on the topic of "Small Millets and Nutritious Food Practices". Twelve girls participated in the programme. At the end of the programme, a demonstration on small millets recipe preparation was organised by the radio team for the adolescent girls. The Vayalaga vanoli CRS also facilitated participation of six listeners in training programme on preparation of small millet recipes organised by the Home Science College, Madurai. Vayalaga vanoli CRS has organised 12 health camps during the reporting period with the support of the Department of Science and Technology, New Delhi, in which participants were made aware of the nutritional benefits of small millets through posters and display of food products. Promoting small millets through the community radio platform was extended to Chittoor, Andhra Pradesh. Episodes on the importance of small millets, their nutrient content and different recipes preparations were broadcasted for 45 days for a duration of 10 to 40 minutes per day.

ii) Promoting small millets through telecasting short recipe films

Small millet recipe films were telecasted in three locations in Tamil Nadu for popularising appealing small millet recipes and building cooking skills.

iii) Promoting small millets through voice SMS campaign

A novel media campaign for promoting small millets through voice SMS was piloted by DHAN by engaging Vayalaga vanoli, a Community Radio platform. This initiative was done from 23rd November 2017 to 31st March, 2018. One hundred voice SMS messages have been broadcast to 1,042 persons at the frequency of one message per day. The voice SMS covered the nutrient content of small millets,

proverbs related to small millets, the preventive and curative medicinal properties of small millets, and nutritional and medicinal benefits specific to foxtail, barnyard, and finger millets. Monitoring the listening pattern indicated that out of 93,356 SMS sent, 60,093 were listened and of that 38,460 were fully listened. Of the 1,042 persons reached, 43% listened for 75 to 100 days and 38% listened for 50 to 75 days. As a result, 359 women learnt to prepare small millet recipes, 254 renewed cooking small millets and 140 women introduced small millets in their diets, thereby indicating the efficacy of this method of promotion. A detailed report is shared in Annex 2.16.

iv) Facebook group on millets

A public Facebook group by name 'Millets' was facilitated by DHAN team member, in which 791 millets and organic food enthusiasts, equipment manufacturers, small and medium scale millet processors, chefs, millet enterprises, NGOs, scientists, millet farmers, and government officials from 100 cities in 16 countries were participating. This group besides providing useful information on millet cultivation, processing machinery, value addition, interesting recipes, and marketing, helped the members in knowing the latest developments in the field.

v) Folk arts campaign

Campaigning to motivate consumption of small millets was taken up by DHAN through cultural programmes deploying folk music, songs, dance, and skits in Jawadhu Hills and Anchetty, Tamil Nadu, and in Chittoor, Andhra Pradesh. Sixteen events were organised reaching 5,814 persons including school students.

vi) Promoting small millets through wall paintings

Motivating messages on small millets were shared through wall painting in 171 spots in 24 locations in 5 districts.

4.45 Value addition demonstration in rural areas

Training of Trainers (ToT) programs on the health benefits of small millets and on the demonstration of small millet recipes was organized for staff and office bearers of women/farmers' organisations hailing from 85 locations in 16 districts including 29 urban, 49 rural, and seven tribal locations in Tamil Nadu, Andhra Pradesh and Odisha. Through these ToT programs, the capacities of 829 persons including 725 women and 104 men were built up. In these three states, 128,000 recipe booklets; 77 cooking kits; 97 DVDs with cooking demos on small millet recipes and 107 poster sets were distributed to the women/farmer federations to aid them in organising recipe demonstrations and promoting consumption of small millet food products among their members.

Recipe demonstrations were organised by the participants of ToT in 334 habitations in 85 locations in Tamil Nadu, Andhra Pradesh and Odisha to build the knowledge and skills of 15,838 persons on inclusion of small millets in their diets. Of these, 12,993 were women, 1,719 were men and 1,126 were children. Both 'meal type' and 'snack type' recipes suitable for each region were demonstrated.

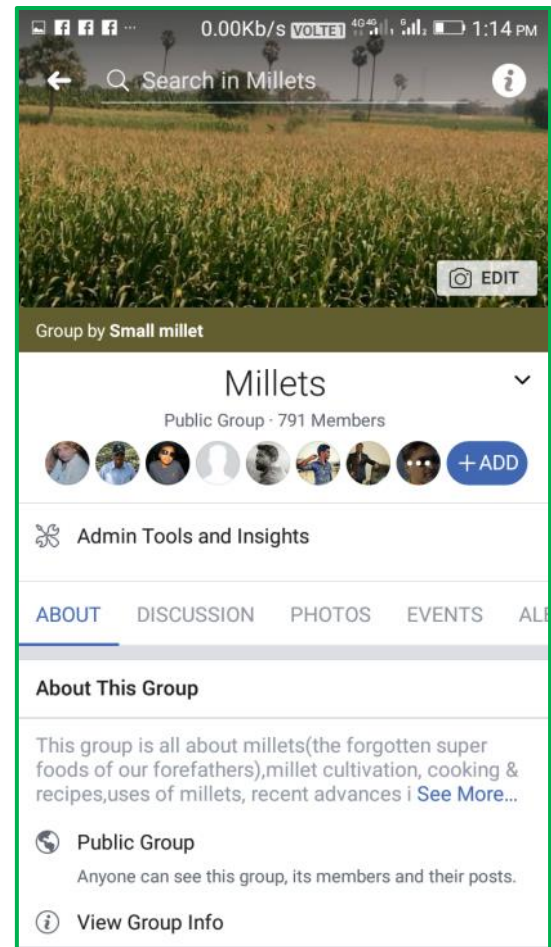


Figure 29: Facebook group on Millets

4.46 Supply of small millet food products



Figure 30: Distribution of small millet rice by women federations at Salem

Given the constraints in access to small millet food products at affordable prices and the need for a 'nudge' at the household level to include small millets in the regular diets, efforts were made to combine initiatives for knowledge and skill development on small millet utilisation with sustainable supply of small millet food products at affordable prices. Towards this end, working relationships were facilitated among consumer organisations, FPOs, and small millet food enterprises. It was envisaged that these efforts will serve as large-scale demonstrations at the household level leading to consumption by the families on their own. Kalanjiam Thozhilagam Limited (KTL), the business division of DHAN, supplied 248 tonnes of small millet rice worth

Rs. 11.2 million (CAD 0.22 million) during the project period, at an affordable price. From KTL, FPOs and open markets, women and farmers federations have organised a supply of 130 tonnes of small millet rice worth Rs. 6.08 million. A large part of this was supplied to the women federations of Salem region, Tamil Nadu, which has initiated two outlets for supplying healthy foods to its members. The women federations of Visakhapatnam region, Andhra Pradesh, have linked with Sabala, one of the local partner in Andhra Pradesh, for supplying nine tonnes of finger millet to its members. The farmers and women federations in the Chittoor region, Andhra Pradesh, have initiated two outlets at Punganur and Chittoor where 2,000 kg of finger millet flour and grains, pearl millet flour, little millet rice, foxtail millet rice, and millet biscuits were supplied in five months.

Important development outcomes

Improving access to resources, and/or markets and income (Accessibility)

Micro and small enterprises are often constrained by factors such as limited infrastructure, less capacity for product positioning, limited manpower, limited access to capital, etc. This was more so in the case of MSMEs active in the emerging small millet market. In this backdrop, customised on-site business incubation support has been offered to 66 food enterprises and 152 PMPVs in Tamil Nadu for scaling up of their operations. In Tamil Nadu, the project engagement resulted in the improvement of food enterprises in: (i) standardisation of foods products (22), (ii) introduction of new products (28), (iii) improvement in packaging (22), (iv) improvement in hygienic practices (35), (v) improvement in production capacity (20), (vi) visibility (42) and (vii) increase in marketing links (28). Furthermore, the sales volume increased above 15% for 30 enterprises. The income of the 30 enterprises increased above 10 % and another 16 enterprises by 5 to 10%. Twenty-seven entrepreneurs have initiated small millet food enterprise. Capacity building events on product development in Eastern and Central India has resulted in initiation of production and marketing of small millet food products by 26 cottage enterprises, two micro enterprises and 14 NGOs. In these ways, new income generation opportunity was created for 55 entrepreneurs and they realised annual income in the range of Rs. 36,000 to Rs. 50,000.

Pushcart millet porridge vendors (PMPVs), one of the important actors in the small millet value chain, serve nutritious millet food to urban and semi-urban poor. These, family owned enterprises, are generally

run by poor people, with women playing important roles. These enterprises needed support for stabilising their operations. Support was given to PMPVs in Tamil Nadu to help build their capacity on adopting appropriate food hygiene and safety practices such as using water can with a tap, long handled ladle/scoop, lids for covering side dishes, and wearing an apron, hand gloves and head cover. As a result, 152 PMPVs have adopted customised food hygiene practices, 76 have registered with FSSAI, 75 got biometric card, and most of them have improved their image through the display of a name board, oaths, and do's and don'ts on hygienic food handling. Most of the PMPVs realised an increase in monthly income in the range of Rs. 2,000 to Rs. 3,000. More importantly, these entrepreneurs, mostly poor women, received moral support due to the attention they got as part of the project.

The manufacturing of small millet processing equipment was in its nascent stage. Small-scale manufacturers were supplying small millet processing equipment only based on orders. They suffered from limited infrastructure, inadequate product quality, limited research inputs, limited investment for promotion, and limited access to capital. They needed support to stabilise and scale up their operations. Six equipment manufacturers were supported for product improvement, business development, and improving visibility. As a result, (i) Perfura and Agromech introduced small millet centrifugal huller in to their product line; (ii) the ability of AVM and Victor to design grain processing equipment was enhanced, and they have improved their product design with respect to hulling efficiency, safety, ease of operation, and compactness and in terms of varied capacities ranging from 50 kg/hr to 500 kg/hr to meet requirements at the village, micro, and SME levels; (iii) KMS and Agromech have improved their grader and destoner design; (iv) the ability of AVM, Victor and Perfura to serve distant markets beyond Southern India has increased; and (v) all the manufacturers have widened their contact base and reach. AVM and Victor realised increase in income in the range of 24 to 100%. Since the start of the project, 173 processing units have been supplied to processors of small millets in 54 districts in 10 States. During the project period, 60 new regional level processors have entered the value chain and they realised annual income in the range of Rs. 100,000 to Rs. 240,000.

Efforts were made to strengthen the local and regional value chains in Tamil Nadu and to promote the same in Central, Eastern and Northern India, where the market for small millets was just emerging. Efforts were made to facilitate entry of many actors in to the small millet value chain including MSMEs, NGOs, and FPOs. Furthermore, efforts were made to reach out to the promoters of small millet such as state government entities and larger NGOs. As illustrated below, the value chain of small millets (other than finger millet) in Tamil Nadu region (covering Tamil Nadu and Bangalore) has been transformed in the last decade. This transformation is a result of many local actors, including the government. The interventions taken for strengthening existing value chain actors, and for facilitating the entry of new actors, with the support of two CIFSRSF projects since 2011, have played an instrumental role in this transformation. The equipment manufacturers, food enterprises, technology transferring institutions associated with the project have also significantly contributed to this transformation. The project strengthened the farmers by organising them into Farmers Producer Organisations (FPOs). Village level processors have entered the value chain. FPOs have started playing roles in the supply chain. The development and marketing of small scale processing equipment through the capacity building of equipment manufacturers has resulted in entry of new regional processors who cater to the regional markets. Similarly, the large number of training sessions on value-added products by TNAU have resulted in the entry of more than 100 MSMEs engaged in production and marketing of value-added products. The role of Pushcart Millet Porridge Vendors was strengthened. Shortening of the value chain has led to retaining produce that used to go out of the region to Maharashtra for local consumption. Consumer organisations have entered the value chain for facilitating consumption. The market network has widened and intensified, leading to significant improvement in the availability of bulk and value-added products in major cities and towns. These developments bring high learning value to other regions with millets. Scaling up the proven 'working

models on local/ regional small millet value chain development' available in few states to other parts of the country holds promise.

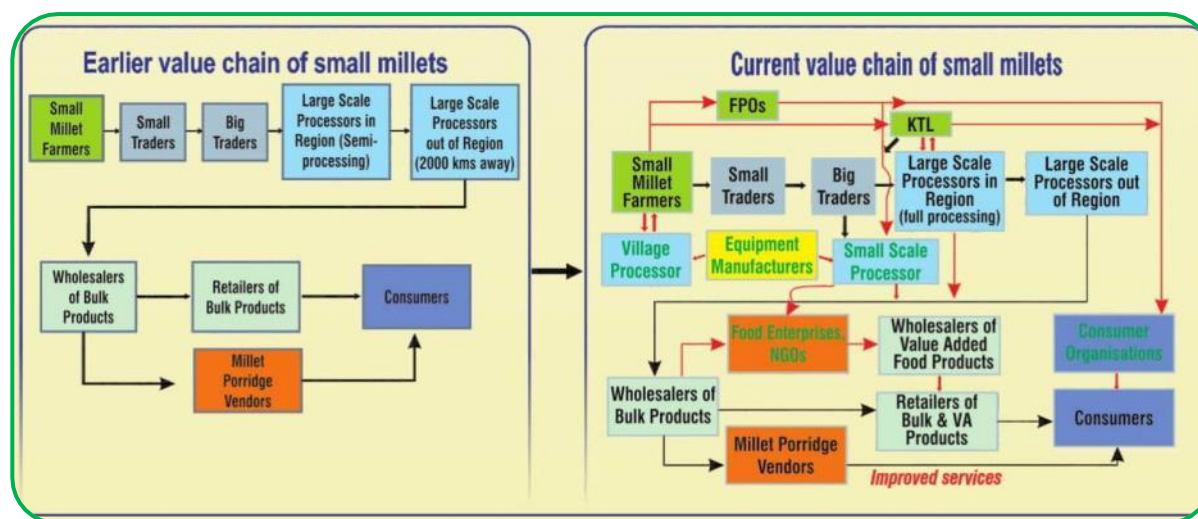


Figure 31: Transformation of local and regional value chains in Tamil Nadu region

A working model of strengthening small millet value chain actors has been developed from these experiences, which can be extended to other regions. These experiences have thrown light on the process of scaling up of the reach of nutrition-dense but neglected foods like small millets to the wider public through market channels.

Improving nutrition (Utilization)

During the project period, 14 multi-millet-based instant therapeutic food products and 42 multi-small-millet-based food products were developed. Transfer of these technologies to food enterprises was done through training sessions for their commercialisation. The activities for stabilising and scaling up of the operations of micro, small and medium small millet food enterprises, the setting up of new processing units, and the reviving of existing processing units were undertaken during the project period. Small millet processing technologies and value addition technologies were transferred from Southern India to various major production regions such as Odisha, Chhattisgarh, Madhya Pradesh, Maharashtra, and Uttarakhand, where small millet value chains were just emerging. These activities have resulted in the additional production of 1015 tonnes of bulk products (rice and grits) and 210 tonnes of value-added products in 10 states, which were consumed by around 550,000 persons. The capacities of 829 persons including 725 women and 104 men from women/ farmers organisations in 85 locations (29 urban, 49 rural and 7 tribal locations) in Tamil Nadu, Andhra Pradesh and Odisha were built on organising recipe demonstration at the grassroots level. The knowledge and skills of 15,838 persons (12,993 women, 1,719 men and 1,126 children) on inclusion of small millets in their diets was enhanced through recipe demonstrations. Popularising small millet products was undertaken through demonstrations at national and international fairs, and at promotional events of the women/farmers organisations, thereby reaching 72,490 persons. Furthermore, the message of small millets reached more than 200,000 persons through programs aired on community radio stations, telecasted on local television channels, and by Voice SMS messages. About 300 tonnes of small millet rice was supplied by different FPOs and by Kalanjiam Thozhilagam Limited, of which a large share was supplied to members of women/ farmers organisations

who fall in the lower middle class and low-income categories. Through these efforts, the attempt to transform small-millet-based food products from the 'elite food' category towards the 'mass food' category was accomplished to an extent.

Informing policy

There is critical need for government intervention in mainstreaming small millets in the regular diets to (i) improve the nutritional status, (ii) address climate change related issues, and (iii) develop the markets for small millets to create a level playing field as a food category when compared to other food grains. Furthermore, promoting millets offers a chance to correct the imbalances created by past agriculture and food policies. There were large differences in millet promotion among the states, with some states such as Andhra Pradesh, Karnataka and Odisha taking comprehensive initiatives for revival of millets. In this context, the project has attempted to inform policy actors about the lessons learnt from the project and from various other small millet promotion interventions in the country on production, processing, marketing, and household consumption. It was expected that these lessons will help the policy actors to improve existing programmes to promote millets, integrate millets promotion in the existing development programmes, and to formulate new programmes.



Figure 32: Recipe demonstration in progress in Chittoor

The learning on scaling up from the project activities was synthesised into three policy documents, eight academic papers covering overarching findings of the project, 25 papers on specific research results, one gender output, six video/ audio/ slide shows, four protocols/ guidelines, four technical bulletins and three study reports. These outputs were widely shared through a national seminar, a national policy workshop and Project Dissemination Workshop and in 10 national and international conferences. The project contributed to policy discussion on mainstreaming small millets in the regular diets by bringing into attention on the following aspects:

1. Policy support needed for developing local and regional value chains, particularly for (i) establishing decentralised processing infrastructure, (ii) establishment of MSMEs and cottage industries in the millet sector, and (iii) addressing supply chain constraints.
2. Policy support needed for establishment of supporting institutions like technology transferring organizations, incubators offering on-site support, common service centres for packaging, nutritional analysis, etc.
3. Exclusive policy support needed for scaling up of operations of equipment manufacturers.
4. Twin policy strategy of (i) supporting market development and (ii) implementing 'what market will not do' to be followed to,
 - o increase consumption among the "BOP" population.
 - o strengthen the roles of women, farming communities and marginalised communities (STs and SCs) in the emerging millet value chains.
5. Policy related to product standards and regulations needed for vibrant growth of small millet value chains.
6. Policy lessons from small millet value chain development in Tamil Nadu region and their relevant to other regions in the country.

The voices of various stakeholders in the small millet value chain are pooled and shared in the policy documents. The document on strategic directions and specific policy action points for (a) scaling up production, (b) decentralised processing infrastructure development, (c) regional market development and (d) increasing household consumption was shared with the Ministry of Agriculture and Farmers Welfare, Delhi to feed in to the "Millets Mission" being contemplated by the central government and some state governments. Furthermore, a suggestion was made for having a "sub-mission focusing on small millets" within the broader "Millets Mission". A short note on "Sub-Mission on Promoting Small Millets in Tamil Nadu under Mission on Sustainable Dryland Agriculture" was submitted to the Agriculture Production Commissioner in Tamil Nadu. The project team participated in a consultation meeting of the "Comprehensive Revival of Millets Project", Andhra Pradesh and "Special Programme for Promotion of Millets in Tribal Areas in Odisha", to help choose appropriate processing equipment, and to advice on sound procurement and installation procedures. On invitation by the government of Tamil Nadu, TNAU has suggested modalities of inclusion of small millets in the existing public food programs in Tamil Nadu. A detailed document was shared with NABARD, the national level body managing climate adaptation fund, on promoting millet-based cropping systems as a climate change adaptation strategy. A pre-proposal note was shared with Madhya Pradesh State Rural Livelihood Mission and Indira Gandhi Krishi Viswavidyalaya, Chhattisgarh to initiate millet promotion projects in the near future. A skill exchange program on small millet processing and value addition was organised between FACHIG Trust, Zimbabwe and DHAN with the support of the Agricultural Biodiversity Community.

5. Project outputs

Important lessons from the project

The work done so far by the project partners has contributed to a body of knowledge/ technologies/practices and working models to address various constraints related to small millets and the ways for scaling up small millet processing and value addition technologies in India and in other countries and regions. Broadly, the project has thrown light on (i) what kind of scaling up approaches work for

production and consumption of neglected and underutilized nutritious plant species like small millets for improving the nutrition security of the masses, and (ii) how markets can be made to adapt for ensuring nutrition security of the masses.

The specific learning from the project are:

1. Integrated interventions at the local/regional level covering production, processing, market development and household consumption by multiple actors, including government, hold promise.
 - In the Indian context setting up decentralized processing infrastructure and local market development deserve more attention by the policy makers.
2. For scaling up adoption of appropriate small millet processing equipment, exclusive support is needed for two aspects: (i) improving production ecosystem and (ii) facilitating technology adoption.
 - On-site incubation approach was found appropriate for improving the performance of small scale equipment manufacturers
3. Though the small millet market is in the nascent stage, a differentiated approach is needed for development of the small millet value chain across different regions of India, as in South India value chain are developed better than in other parts of the country.
4. Local or regional small millet food enterprises are potential channels for reaching the common people with small millet food products as they will take into consideration the local food cultures in the pertaining region; but they still need focused support.
 - On-site incubation approach was found appropriate to a large extent in improving the performances of micro, small and medium food enterprises.
 - Strengthening millet porridge vendors, the existing pro-poor channel, holds much promise.
 - Institutional markets must be explored.
5. Supply chain constraints need to be addressed with priority through (i) promoting and strengthening small millet FPOs, (ii) offering assured prices, and (iii) procurement by government, as is done for other commodities.
6. Promoting consumption of millets as part of local/regional food cultures needs i) sustained and wider media and event based campaigns to generate interest and demand and ii) shortening of millet food chains to supply small millet foods at affordable price.
7. Promoting consumption through member-based organisations like women/ farmers organisations holds promise.

Important outputs from the project

The following were the important outputs from the CIFSRRF initiatives on small millets:

1. Technologies, working models and practices

1. Location specific packages of production interventions for conserving and improving viability of cultivation of small millet crops.
2. Hulling and processing assemblies to meet varying operating requirements at the village, micro, small and medium enterprise levels.

3. On-site incubation model for supporting equipment manufacturers.
4. Working model to facilitate adoption of processing technology in regions where it is less known.
5. Appealing nutritious small millet value-added food products.
6. On-site incubation model for supporting micro, small, and medium size food enterprises.
7. Working model for promoting consumption with different consumer groups.

2. Research partnership and working relationship

1. Collaborative relationship was established with Indian Institute of Millet Research, Indira Gandhi Krishi Vishwavidyalaya and College of Home Science College and Research Institute, Madurai.
2. Research partnerships were strengthened between South Asian and Canadian organisations, aiding in sharing of Canadian expertise on processing equipment development to Indian agencies.
3. Partnership was established for joint R&D involving technology developers (research institutions), technology adopters (manufacturers), and end users (processors).
4. Partnerships were established with FPOs, equipment manufacturers, processors and food enterprises in the small millet value chain in different parts of the country.
5. Partnership was established with 20 NGOs located in 10 states in India, with FACHIG Trust, Zimbabwe and with Agricultural Biodiversity Community.
6. Functional relationships were established with Government entities in provincial and federal governments.
7. Initiation of Small Millet Foundation was done to ensure institutional continuity of these partnerships and working relationships, for long term scaling up of the lessons from the project.

The details of various types of partners are shared in Annex 2.15.

3. Gender outputs and outcomes

Scaling up appropriate small millet processing equipment:

- Improving the design of the small millet processing equipment for ease of operation and safety for women;
- Reduction in women's drudgery in processing operations ranging from 75 to 120 minutes;
 - The project resulted in setting up of 98 new and reviving 21 old village level processing units;
- Additional income and employment for women;
 - Employment was offered for women by many of the processing units.
 - Women managed processing units were set up by women SHG and FPOs with women farmers as significant share of members in Tamil Nadu and Odisha.

Scaling up appealing small-millet-based food products:

- Increase in the capacities and performances of 18 women run food enterprises and 21 food enterprises in which women play key roles;

- Increase in the capacities of 152 millet porridge vending units in which women played key roles;

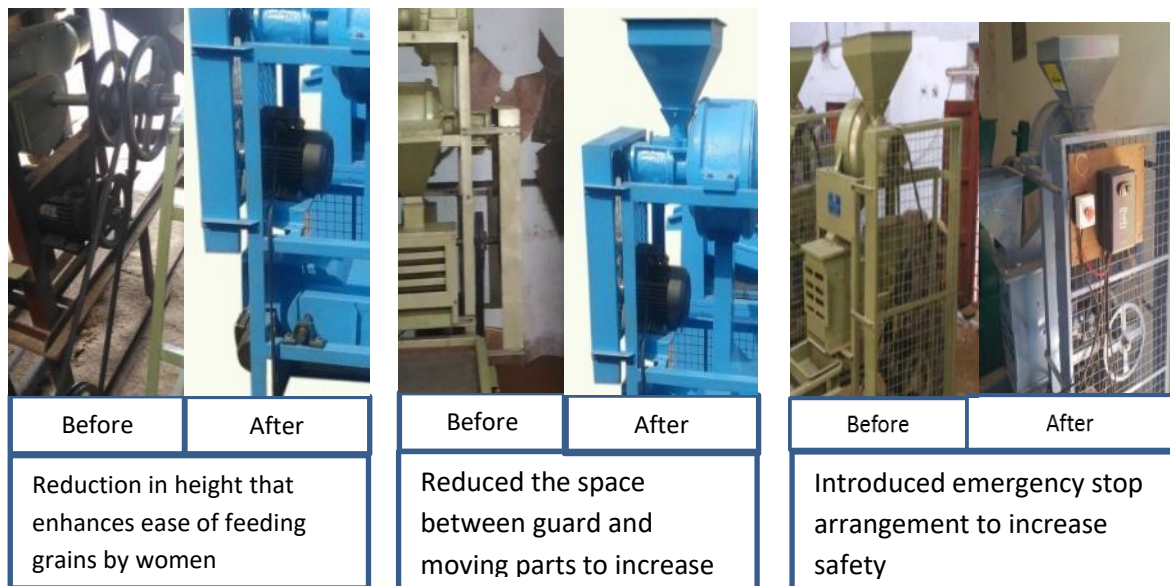


Figure 33: Women friendly design of small millet processing equipment

- Building on the knowledge and skills of women for promoting household consumption of small millets, leading to revalorising of knowledge of women on utilising millets;
- The capacities of 72 women organisations were built up to promote the reach of small millet food products among their members; About 130 tonnes of small millet rice were supplied by women organisations to their members, who fall in the lower middle class and low-income categories.

4. Five Masters and PhD students were trained on development of processing equipment for small millets and of millet based products

5. Publications

The learning and knowledge generated in the process of scaling up of processing and value addition technologies of small millets were converted into the following guidelines, bulletins, and scientific papers:

Small millet processing equipment

1. Protocol for assessment of the existing small millet processing units (SMPUs)
2. Assessment of existing small millet processing equipment in India
3. Implementation of mechanized post-harvest processing technologies of millets: A review
4. Guidance note on purchasing small millet processing equipment
5. Audio-visual and written training manual for community scale small millet processing (CSMP)
6. Guidelines for setting up a small millet processing unit in English and Tamil
7. Master thesis on 'Development of a millet dehuller (hand-operated) to reduce drudgery in processing and utilization of millet waste (hulls) in antioxidant extraction'
8. Five research papers on processing of small millets

Small-millet-based food products

1. Technical Bulletin on Value-added Products from Small Millets
2. Technical Bulletin on Multi Small-millet-based Instant Therapeutic Foods
3. Protocol for ToT on small millet recipe demonstration
4. Technical Manual on Multi Small Millets Based Food Products
5. Comprehensive nutritional analysis of millets in comparison with major cereals
6. Nutritional comparison of millets with other superfoods
7. Local and regional value chain development for small millets
8. Helping agribusinesses – small millets value chain – to grow in India
9. Twenty research papers on development of small-millet-based food products

Policy papers

1. Small millets in mainstream diets: Establishing decentralized processing infrastructure
2. National Policy Workshop on Mainstreaming Small Millets in Our Diets- A Synthesis of Policy Recommendations
3. A policy paper on Comprehensive support package for MSMEs in millet sector

Others

1. Four small millet recipe films, one radio program, one set of songs and a set of awareness posters
2. A National seminar abstract book
3. Fifteen news clips on project activities

Scope for scaling up of the learning from the project for mainstreaming small millets in regular diets

The last three CIFSRF projects have created the necessary grounds and set the direction to scaling up research-for-development interventions for mainstreaming small millets in regular diets. In India, millets have received considerable attention in the last decade from all stakeholders, mainly for their nutrition related features and climate resilience. The appalling performance of the country with respect to nutrition related indicators (National Nutrition Strategy, 2017), such as the rising incidence of diabetes and other non-communicable diseases and increasing intensity of climate change related issues have brought back millets to the policy agenda. The Government of India is contemplating a large-scale millet promotion program. It has announced that 2018 will be the “National Year of Millets” and millets were to be considered as “Nutricereals”. So, there is a favourable situation exists for transition of millets from ‘*niche foods*’ to ‘*mass foods*’. But, for mainstreaming of small millets in the regular diets, the following challenges still remain:

Regional differences in the level of small millet value chain development across the country - While regional value chains are fast growing in South India (Tamil Nadu, Karnataka and Andhra Pradesh), they

are slowly emerging in Central, Eastern, Western and Northern India. There is considerable scope for transfer of technologies and learning from the former to the latter

In all the regions, the following aspects need to be addressed:

1. Making small millet production viable for the farmers, given their low productivity, fluctuating farm gate price and lack of marketing infrastructure
2. Stopping further erosion and increasing the area under cultivation significantly to address supply chain constraints
3. Development of a decentralized processing infrastructure in the production regions
4. Bringing about change in dietary habits of a large population for inclusion of small millets in the regular diets to the extent of 5 kg per family per month; this change will act as a strong demand pull on production. The major challenges in this sphere are:
 - i) Increasing consumption among the producing population
 - ii) Increasing consumption among the poorer sections, given the higher price of small millets other than finger millet
5. Ensuring availability of quality small millet food products at affordable prices to the consumers

So, sustained and well-coordinated interventions at appropriate scale for a considerable period involving many actors is needed for mainstreaming small millets in regular diets.

Small millets are an important crop to ensure food and nutrition security in South Asian countries such as Nepal and Sri Lanka and in African countries such as Zimbabwe, Zambia, Malawi, Uganda and Kenya. Though there are country specific factors, there are many similarities in context between these countries and India in terms of (i) decline in production and consumption of millets, (ii) decline in cereal diversity in the diets, (iii) significant presence of triple burden of malnutrition and rising incidence of non-communicable diseases, and (iv) Increasing intensity of climate change related issues. There is need for medium and long-term development efforts for bringing back the neglected millets in the farms and plates in these countries.

In these emerging contexts, there is considerable scope for scaling up the learning from the project for mainstreaming small millets in the regular diets to improve nutrition security on a scale.

6. Problems and Challenges

The key challenges faced in the project and the efforts made to address them are shared below:

Key challenge 1: Small scale and informal nature of operation of most of the equipment manufacturers and food enterprises.

Action taken to address this challenge

Assistance was given for registration of enterprises under the appropriate Government mandatory systems and for maintaining proper records. Further assistance was given for building business and market linkages, improving visibility, and improving production capacities to scale up the operations.

Key challenge 2: Poor yield realisation by the small millet farmers in 2016 due to a long dry-spell after sowing, which affected the supply of small millets to the value chain actors.

Action taken to address this challenge

Processing units were supported to source from previous year harvest to continue their activities.

Key challenge 3: Small millet food enterprises were not able to display the health benefits of small millets on their labels as per FSSAI norms despite their main selling point being the healthful nature of small millet foods.

Action taken to address this challenge

Ways of circumventing this issue were explored with enterprises and experts. Simultaneously, exploration with research organisations was done for addressing this issue.

Key challenge 4: Small scale food enterprises faced entry barriers to sell in supermarkets in terms of labelling, batch coding and barcoding requirements, and the high margins demanded.

Action taken to address this challenge

Needy enterprises were supported for batch coding and barcoding of their products. Efforts were taken for building linkages with different market actors and exploring different marketing channels.

Key challenge 5: Small millet food enterprises faced reduced orders and/or delay in getting orders due to higher tax for value-added food products in the new Goods and Services Tax regime implemented by the government.

Action taken to address this challenge

Food enterprises were supported for exploring wider markets through their participation in national and international fairs. Suggestion for reducing GST for small millet value-added products was made to the policy makers.

Key challenge 6: Many small millet food enterprises focused on health mix products, which resulted in high competition in the local market and drop in sales.

Action taken to address this challenge

Efforts were taken to build the capacity of the food enterprises in product development to diversify their product portfolio; furthermore, they were supported for exploring distant markets.

Key challenge 7: Equipment manufacturers were facing slow growth of the demand for processing equipment.

Action taken to address this challenge

Efforts were taken for technology transfer and to raise demand in major production regions in Central India, namely Chhattisgarh, Madhya Pradesh, and Maharashtra. Furthermore, information about the processing technology was disseminated at national and international exhibitions.

Key challenge 8: The small scale processors and FPOs were finding it difficult to compete with large scale mills, due to the lower prices offered by the latter by the virtue of large scale of operations.

Action taken to address this challenge

Efforts were taken to raise awareness among the consumers on the nutritional advantage of less polished small millet rice from small scale processors and FPOs, due to retention of bran. Furthermore, efforts were made to link small-scale processors to consumer organisations to reduce the price spread and thereby to reduce the end consumer price.

Besides these challenges, the project faced the risk arising from strict approval procedures of Indian government pertaining to project supported by foreign agencies in the beginning.

7. Administrative Reflections and Recommendations

1. Various initiatives taken in the project to scale up appropriate small millet processing equipment and appealing food products indicate that though considerable progress was made during the project period, the duration of the project was found to be limited for scaling up. While the stage was set and a momentum was built, another 2 to 3 years is needed for scaling up on significant scale. Therefore, it is recommended that duration for scaling up projects can be increased to at least 36 to 48 months.
2. A significant amount of fund was retained in the last reporting period for reimbursement after accomplishment of project activities with own funds and submission of final technical and financial report. This procedure has posed difficulties for the project partners, who have not institutional flexibility to spend large amount of funds in advance. Considering the importance of participation of wide variety of project partners in IDRC funded projects, it is recommended that the amount retained to be reduced substantially.

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Annex 1.1

Title: *Strengthening value chain actors for scaling up the reach of nutrition-dense small millets*

Subtitle:

By: *M. Karthikeyan, V. Vedyappan and T. Paramasivam*

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Full Name of Research Organizations: *DHAN Foundation*

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This report is presented as received from project recipient(s). It has been subjected to peer review or other review processes.

***Abstract:**

In India, declining cereal diversity in diets is one of the key factors behind malnutrition and the prevalence of non-communicable diseases such as diabetes. Bringing back or inclusion of small millets in the mainstream diets could contribute to an answer. Performing well in marginal environments, small millets have superior nutritional properties, including high micronutrient and dietary fibre content, and low glycemic index than mainstream food crops- rice and wheat. However, there has been a drastic decline in production and consumption of small millets in the last few decades. Given their health and ecological benefits, it is important that small millets consumption be revived.

Entry and establishment of significant number of micro, small and medium food enterprises in the small millets value chain is the key for sustained and dynamic growth of consumption of small millets. However, these enterprises are in need of customised support to thrive in the context of nascent market development for small millets. Incubation approach of offering customised business development support was followed by DHAN Foundation under Scaling up Small Millet Post-harvest and Nutritious Food Products Project in India.

Support was offered to 40 food enterprises for compliance of government protocols, product development, building their capacity on food hygiene, safety and packaging, promoting small millet products, and building business-to-business linkages. Training and exposure was organised for interested new entrepreneurs. As a result, twenty four enterprises in Tamil Nadu have introduced new food products, six improved packaging and twenty increased scale of production. Ten enterprises initiated producing small millet food products in Eastern India. The production of small millet products has increased by 42000 kgs and 72000 additional consumers were reached. This model of developing value chain development centred on local micro and small enterprises can be replicated for promoting other nutrition dense neglected and underutilised species.

Keywords: *Food Enterprises, Small Millets, Incubation, Value Chain, Underutilised species*

Annex 1.2

Title: *Millet Incorporated Bakery Foods*

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By: *D. Malathi*

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Full Name of Research Organizations: *Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu*

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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 India, over 80 per cent of the agricultural produced is being used for preparation of traditional food. . The term baking also includes the preliminary steps to get a baked product, such as selection of ingredients, weighing, preparing and baking. Although there is many bakery products which grade one into another in terms of their formulas, methods of preparation and product characteristics, it is possible to classify bakery products according to the way in which they are leavened. Composite flour technology initially referred to the process of mixing wheat flour with cereal and legume flours for making baking products like bread and biscuits. However, the term can also be used in regard to mixing of non-wheat flours, roots and tubers, legumes or other raw materials. Non wheat cereals like oats, corn, and other coarse cereals can be blended with wheat flour to produce acceptable bakery products with better mineral and fibre content. Wheat flour is the basic ingredient in bakery products and its protein properties are crucial in the production of bakery products. High protein and calorie biscuits could be prepared from millets (sorghum, bajra, samai and ragi) substituted with 30 per cent full fat soy flour. Biscuits made from millet flour were heavier and of larger diameter than those made from the blends. Biscuits from sorghum flour, wheat flour, soy flour and groundnut had a good source of energy and protein. High quality nutritional biscuits were produced using local raw materials such as wheat, ragi, jowar, corn, soy, groundnut and sesame. The products had 17 to 19.6 g protein, 18 to 20 g fat with 450 to 500 kcal of energy per 100 g. The lysine content of the product was 0.4 to 0.7 g compared to 0.01 to 0.05 g/100 g material in the commercial wheat biscuits. The development of composite flours for bakery industry will create a new avenue to utilize tropical raw materials. This in turn will enhance the economic value of the native crops. Bakery products are no longer considered as fancy and luxury teatime snacks, but an essential and significant component of the dietary profile of the population. There exists considerable scope for introduction of newer bakery products.

Keywords: *Bakery products, cookies, millets*

Annex 1.3

Title: *Effect of parboiling (thermal treatment) on de-hulling and cooking qualities of little millet (*Panicum sumatrense*) and foxtail millet (*Setaria italica*)*

Subtitle:

By: *N. Varadharaju and S. Ganesan*

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Full Name of Research Organizations: *Tamil Nadu Agricultural University*

Address of Research Organizations: *Post Harvest Technology Centre, Tamil Nadu Agricultural University, Coimbatore-641003, India*

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***Abstract:**

*Millet grains are considered to be one of the most important sources of dietary proteins, carbohydrates, vitamins, minerals and fibre for people all over the world. The nutrient composition of millets compares well with other cereals. These tiny "grains" are gluten-free and contains nutrients such as magnesium, calcium, manganese, tryptophan, phosphorus, fibre and antioxidants. De-hulling of little millet (*Panicum sumatrense*) and foxtail millet (*Setaria italica*) is a cumbersome process since husk and bran layers are bound tightly on the endosperm and their removal needs a special treatment. To ease the milling process, these millets were subjected to hydrothermal treatment at different levels of soaking temperature (60, 70, 80°C), soaking time (6, 7, 8h) and steaming periods (10, 15, 20 min.), and shade dried and milled in a centrifugal de-huller. The milled samples were analysed for hulling efficiency, head rice recovery, degree of parboiling, hardness, colour, cooking time, water uptake and swelling index using standard procedures. Increase in hulling efficiency (20.8 - 26.5%) was recorded over control in little millet and foxtail millet (20.5 – 25.3%) and the head rice recovery enhanced by 26.7% and 24.8 % in little millet and foxtail millet, respectively, over the range of experiments conducted. The increase in temperature of soaking, soaking time and steaming period increased the degree of parboiling, hardness (30.8 – 34.2 N in little millet and 32.6-34.5 N in foxtail millet) and cooking time (10.4-10.8 min.) for both millets. Water uptake and swelling index decreased appreciably due to hydrothermal treatment. The treated samples were dark in colour compared to raw grains and the change in L*, a*, b* values were highly significant. The parboiling treatment increased the hulling efficiency and enhanced the head rice recovery in little millet and foxtail millet.*

Keywords: *Parboiling, de-hulling, small millets*

Annex 1.4

Title: *Development and quality evaluation of multi-millet cookies*

Subtitle:

By: *D. Malathi, A. Padma and B. Subbulakshmi*

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Full Name of Research Organizations: *Tamil Nadu Agricultural University*

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This report is presented as received from project recipient(s). It has been subjected to peer review or other review processes.

***Abstract:**

*Millet is one of the oldest foods known to mankind and possibly the first cereal grain used for domestic purposes. Today millet ranks as the sixth most important grain in the world and sustains 1/3 of the world's population. India is the largest producer of many kinds of millets, which includes sorghum (*Sorghum vulgare*), pearl millet (*Pennisetum americanum*), finger millet (*Eleusine coracana*), and other small millets like little millet, foxtail millet, kodo millet, proso millet and barnyard millet. India accounts for 40% of global millet production. Millet grain is highly nutritious with good quality protein, minerals, dietary fibre, phytochemicals and vitamins. Small millets have potential benefits to mitigate or delay the onset of complications associated with diabetes. Millets, being high fibre foods contribute to wellbeing in various ways by reducing the risk of cardiovascular diseases, constipation, diabetes mellitus and cancer. They are also valued for their natural antioxidants and minerals and are gaining importance as complete nutrient source. The present study focused on standardizing cookies incorporated with four different millet flour viz., kodo millet, little millet, foxtail millet and finger millets with wheat flour at different levels (20 - 80 percent) and organoleptically evaluated using nine point hedonic scale. The cookies prepared from wheat flour, kodo, little, foxtail and finger millet flour at each 20 per cent level were found to be highly acceptable. Moisture, carbohydrate, protein, fat, fibre, calcium and iron content of the standardized cookies were found to be 2.99 (%), 61.55g, 5.88g, 28.22g, 0.44 g, 51.22mg and 4.65 mg/100g, respectively. Millet thus is an amazing grain offering great opportunities for diversified utilization and value addition.*

Keywords: *Millets, Sensory evaluation*

Annex 1.5

Title: *Development of prebiotic bakery products from millets and xylo oligosaccharides*

Subtitle:

By: *D. Malathi, B. Subbulakshmi and A. Padma,*

Report Type: *Journal article*

Date: *2017*

Published by: *Journal of Nutrition and Food Sciences*

Location: *Las Vegas, USA*

Series Name: *ISSN: 2155-9600*

Number of Series part: *Vol.7, Issue 3*

IDRC Project Number and component number (if applicable): *108128-002*

IDRC Project Title: *Scaling Up Small Millet Post-Harvest and Nutritious Food Products*

Country/Region: *India*

Full Name of Research Organizations: *Tamil Nadu Agricultural University*

Address of Research Organizations: *Post Harvest Technology Centre, Tamil Nadu Agricultural University, Coimbatore-641003, India*

Name(s) of Researcher/Members of Research Team: *Dr. D. Malathi*

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This report is presented as received from project recipient(s). It has been subjected to peer review or other review processes.

***Abstract:**

Prebiotics are defined as non-digestible food ingredients that beneficially affect the host by selectively stimulating the growth of one or a limited number of bacterial species in the colon such as Bifidobacteria and Lactobacillus, which have the potential to improve host health. XOS, a class of non-digestible food ingredients having low degree of polymerization are produced during the hydrolysis of xylan and have been generally recognized as safe by Food and Drug Organization. Millets are recognized as important substitutes for major cereal crops to cope with food shortage and to meet the demands of increasing population of developing countries. Development of low cost nutritious foods using millet will go a long way in combating the malnutrition. The shift from millet based diet to refined wheat and rice diets contributed to increased prevalence of diabetes and other health ailments. Xylo oligosaccharides extracted from rice bran and finger millet seed coat was used in the preparation of bread & cookies. The Xylo oligosaccharides was used as a replacement for sugar both in bread and cookies made out of refined wheat flour (50%) and millet flour (50%). The nutrient content and sensory attributes of developed products were analysed. The nutritional analysis indicated that products with Xylo oligosaccharides from finger millet seed coat (FXOS), to the level of 30% in cookies (millet cookies and refined wheat flour cookies) and to the level of 10% in bread (millet bread and white bread), were having higher amount of slowly digestible starch and resistant starch. Xylo oligosaccharides enriched bread and cookies gives prebiotic functional foods to the consumer.

Keywords: *Prebiotics, Xylo oligosaccharides, Small millets*

Annex 1.6

Title: *Effect of de-hulling process on milling and nutritional quality of millets*

Subtitle:

By: *N. Varadharaju and S. Ganesan*

Report Type: *Journal article*

Date: *2017*

Published by: *Journal of Nutrition and Food Sciences*

Location: *Las Vegas, USA*

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Country/Region: *India*

Full Name of Research Organizations: *Tamil Nadu Agricultural University*

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This report is presented as received from project recipient(s). It has been subjected to peer review or other review processes.

***Abstract:**

Millet grain is highly nutritious with good quality protein, rich in minerals, dietary fibre, phytochemicals and vitamins. The milling characteristics and retention of nutrients in the de-hulled millets depends on the process of de-hulling and the type of machinery employed. De-hulled millets obtained from the abrasive type mill and centrifugal de-huller were analysed for recovery, broken, nutritional quality and shelf life under ambient conditions. The study reveals that the recovery of de-hulled millet was around 10% more in centrifugal type (where the bran is retained) with 95 % de-hulling efficiency compared to abrasive mill. The breakage was 4-5% in centrifugal type and there was only 1-2% in abrasive type. The nutritional content (carbohydrate, protein, fat, ash, calcium, phosphorus, iron and fibre) of the all five de-hulled millets (little millet, proso millet, foxtail millet, barnyard millet and kodo millet) tested were resulting in superior quality in centrifugal de-huller. The shelf life of de-hulled millets obtained from the abrasive mill was four times more than that of centrifugal type due to lesser amount of fat presence.

Keywords: *Centrifugal, Abrasive, Small millets*

Annex 1.7**Title:** *Dehuller for millets***Subtitle:****By:** *N. Varadharaju, D. Malathi and S. Ganesan***Report Type:** *Indian Farming (Journal -full paper)***Date:** *March 2016***Published by:** *Indian Council of Agricultural Research, New Delhi***Location:** *New Delhi***Series Name:** *65(12)***Number of Series part:** *65(12): 77-78***IDRC Project Number and component number (if applicable):** *106506***IDRC Project Title:** *"Scaling up of small millet post-harvest and nutritious food products"***Country/Region:** *India***Full Name of Research Organizations:** *Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu***Address of Research Organizations:** *Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu***Name(s) of Researcher/Members of Research Team:** *Dr. D. Malathi***Contact Information of Researcher/Research Team members:** *nvaradharaju@yahoo.com***This report is presented as received from project recipient(s). It has not been subjected to peer review or other review processes.*****Abstract:**

Preliminary studies were conducted for three millets at three different moisture contents, viz. 10, 12, 14 % moisture content (w.b.) using three types of machines available namely rubber roll de-huller, abrasive de-huller and centrifugal de-huller. The maximum de-hulling efficiency of 86.75, 81.56 and 87.50 % was recorded for little millet, foxtail millet and proso millet with a centrifugal de-huller. The abrasive machine and rubber roll de-huller gave poor results in terms of broken grain percentage in the outlet. Three passes were required for all the millets. The capacity of the machine was decided as 75 kg/hr since there was no machine available to process materials in that range. Based on the results obtained with a centrifugal de-huller and to reduce the number of passes a double chamber centrifugal de-huller was developed.

Keywords: *Centrifugal de-huller, Abrasive*

Annex 1.8

Title: *Formulation of multi millet cookies and evaluate its hypoglycaemic effect in albino rats*

Subtitle:

By: *D. Malathi and B. Subbulakshmi*

Report Type: *Journal Article*

Date: *2017*

Published by: *Journal of crop and weed*

Location: *Madurai, Tamil Nadu, India*

Series Name: *ISSN: 2349-9400*

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IDRC Project Title: *Scaling Up Small Millet Post-Harvest and Nutritious Food Products*

Country/Region: *India*

Full Name of Research Organizations: *Tamil Nadu Agricultural University*

Address of Research Organizations: *Post Harvest Technology Centre, Tamil Nadu Agricultural University, Coimbatore-641003, India*

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This report is presented as received from project recipient(s). It has been subjected to peer review or other review processes.

***Abstract:**

Multi millet cookies was standardized by incorporating with four different millet flour viz., kodo millet, little millet, foxtail millet, finger millets and wheat flour at different levels (20 - 80 per cent) and organoleptically evaluated using nine point hedonic scale. The sensory score revealed that cookies prepared from wheat flour, kodo, little, foxtail and finger millet flour at each 20 per cent level was highly acceptable. Moisture, carbohydrate, protein, fat, fibre, calcium and iron content of the standardized cookies were found to be 2.99 (%), 61.55g, 5.88g, 28.22g, 0.44 g, 51.22mg and 4.65 mg per100g respectively. Hypoglycemic effect of the multi millet cookies evaluated on Wistar albino rats and the results showed that reduction in the blood glucose levels was high in the rats fed with multi millet cookies than the rats fed with control cookies. Millet thus is an amazing grain offering great opportunities for diversified utilization and value addition.

Keywords: *Multi millet cookies, Hypoglycaemic effect in rats*

Annex 1.9

Title: *Helping agribusinesses – small millets value chain – to grow in India*

Subtitle:

By: *Ademola Adekunle, Darwin Lyew, Valérie Orsat, Vijaya Raghavan*

Report Type: *Journal article*

Date: *2018*

Published by: *Agriculture*

Location: *NA*

Series Name: *NA*

Number of Series part: *11 pp*

IDRC Project Number and component number (if applicable): *108128-001*

IDRC Project Title: *Scaling Up Small Millet Post-Harvest and Nutritious Food Products*

Country/Region: *India*

Full Name of Research Organizations: *McGill University*

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This report is presented as received from project recipient(s). It has been subjected to peer review or other review processes.

***Abstract:**

Small millets, a group of highly nutritious food, have taken a back seat in the Indian agriculture landscape in recent years, due to government policies and failings in the value chain. In this commentary, the unusual decline of small millets in comparison to its substitutes, and the repercussions thereof, were first presented as context. Thereafter, based on analysis of data from literature, survey, and stakeholder contributions, a cluster map for the Indian small millets value chain was designed, and its competitive state presented. This information was used to conceptualize an open innovation driven business model, and an ecosystem for the proposed model was discussed. This commentary provides the first cluster map analysis of small millets value chain in India, and a business model-based approach to stimulating its agribusinesses growth through a synthesis of stakeholders' contributions and market data.

Keywords: *Small millets, Value chain, Open innovation model*

Annex 1.10

Title: *Evaluation of nutritive quality and sensory attributes of mushroom powder fortified millets cookies*

Subtitle:

By: *A. Padma, R. Rajendran and D Malathi*

Report Type: *Proceedings*

Date: *2017*

Published by: *National Symposium- Trends in Agricultural and Biosystems engineering*

Location: *Coimbatore, India*

Series Name: *NA*

Number of Series part: *NA*

IDRC Project Number and component number (if applicable): *108128-002*

IDRC Project Title: *Scaling Up Small Millet Post-Harvest and Nutritious Food Products*

Country/Region: *India*

Full Name of Research Organizations: *Tamil Nadu Agricultural University*

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This report is presented as received from project recipient(s). It has been subjected to peer review or other review processes.

***Abstract:**

Dried mushroom powder fortified with multi millets in cookies production were evaluated for their nutritive and sensory quality. Nutritive content and sensory characteristics in cookies of floured Calocybeindica and its blends were examined. Wheat flour and Barnyard millet flour was partially replaced by mushroom flour in ratios of 2, 4, 6 and 8% in cookies blends. Protein content of cookies increased in mushroom flour with increasing the level from 6% to 8%. Sensory evaluation showed that flavour had higher score (8.43 and 8.62) for 4 and 6% of mushroom flour providing good quality of cookies. But with 8% of Mushroom flour showed lesser score compared to 6%. Cookies showed higher scores for sensory attributes, colour (8.14 and 8.18), appearance (8.64 and 8.62), crispiness (8.81 and 8.71), flavor (8.54 and 8.48) and overall acceptance (8.84 and 8.76) comparatively in 6% and followed by 4% fortification of mushroom flour. The present study suggested that incorporation of mushroom flour up to 8% to replace multi millet composite flour for improved crispiness and flavor, increased concentration of protein content of cookies.

Keywords: *Mushroom cookies, Organoleptic evaluation, Proximate analysis*

Annex 1.11

Title: *Standardisation and evaluation of small millet based drumstick leaves chappathi mix*

Subtitle:

By: *D. Malathi, Lilia-Baby, B. Subbulakshmi, R. Gokhal Seetha and N. Suganya*

Report Type: *Seminar book of abstracts*

Date: *22nd and 23rd September, 2017*

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Country/Region: *India*

Full Name of Research Organizations: *Tamil Nadu Agricultural University*

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***Abstract:**

Millets are nutritionally rich and occupy an important place in the diet of people in many regions of the world. Although millets are nutritionally superior to cereals their utilization as a food is still mostly confined to the traditional consumers and population of lower economic strata. Millets have received attention for their potential role as functional foods due to health promotive phytochemicals. Beneficial uses of millets and health consciousness of the consumer have made food scientists to develop various millet based food products. One possible way of extending their utilization could be by blending them with wheat flour by appropriate processing. In the present study attempts have been made to develop millet based drumstick leaves chappathi mix. In order to prepare multi millet chappathi mix, flours of foxtail millet, kodo millet, little millet and barnyard millet were mixed with wheat flour in different proportions (25:75, 50:50 and 75:25). From the sensory evaluation it was found that fifty per cent incorporation of multi millet flour with wheat flour was highly acceptable. Multi millet based drumstick leaves chappathi mix was standardized by incorporating dried drumstick leaves at different per cent levels (1 to 10 %). Drumstick leaves incorporated chappathi was evaluated for sensory attributes using nine point hedonic scale by a panel of members. Chappathi prepared by incorporating two per cent drumstick leaves scored the maximum. The prepared chappathi mix was analysed for nutrient content using standard procedures. The protein, fat, carbohydrate and crude fibre content of the prepared mix were 10.08g, 2.36g, 64.07g and 4.64g per 100 g respectively. Millet based drumstick leaves chappathi mix also contained 41.76 mg of calcium, 4.21 mg of iron and 125.57µg of beta carotene. Millet based foods can be used to combat health issues.

Keywords: *Phytochemical, Incorporation, Wheat flour, Hedonic scale*

Annex 1.12

Title: *Development of multi millet vegetable rotti mix*

Subtitle:

By: *D. Malathi, N. Suganya, Lilia-Baby, B. Subbulakshmi and R. Gokhal Seetha*

Report Type: *Seminar book of abstracts*

Date: *22nd and 23rd September, 2017*

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Country/Region: *India*

Full Name of Research Organizations: *Tamil Nadu Agricultural University*

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This report is presented as received from project recipient(s). It has been subjected to peer review or other review processes.

***Abstract:**

Millet grains are nutritionally comparable and even superior to major cereals with respect to protein, energy, vitamins and minerals. These are also rich sources of phytochemicals and micronutrients. Although millets are nutritionally superior to cereals, their utilization is not wide spread. Hence attempts have been made to develop Multi millet vegetable rotti mix by using multi-grain flour. Flours of foxtail millet, kodo millet, little millet and barnyard millet were incorporated with rice flour in different proportions mixed (10 to 100 per cent) to standardize rotti mix. While preparing vegetable rotti mix, other ingredients like onion, beans, carrot, green chilli, curry leaves, asafoetida and cumin seeds were also added to the mix. Dehydrated vegetables were used for the same. Vegetable rotti prepared by incorporating 70 per cent multi millet flour obtained highest acceptability on sensory evaluation. The protein, fat, carbohydrate, crude fibre, calcium, iron and beta carotene content of the developed multi millet vegetable rotti mix were 6.13 g, 1.171g, 51.22g, 4.05g, 64.73g, 2.69g, and 262.75g per 100g respectively.

Keywords: *Multigrain, Dehydrated vegetables, Sensory evaluation, Multi millet rotti*

Annex 1.13

Title: *Development and evaluation of small millet based palak leaves dosa mix*

Subtitle:

By: *D. Malathi, R. Gokhal Seetha, Lilia-Baby, B. Subbulakshmi and N. Suganya*

Report Type: *Seminar book of abstracts*

Date: *22nd and 23rd September, 2017*

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Country/Region: *India*

Full Name of Research Organizations: *Tamil Nadu Agricultural University*

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This report is presented as received from project recipient(s). It has been subjected to peer review or other review processes.

***Abstract:**

Small millets with rich source of nutrients are widely cultivated in India and are considered as the crops of food and nutrition security owing to its sustainability in adverse agro-climatic conditions. Millets were found to have high nutritional value and comparable to that of major cereals such as wheat and rice. Millets are highly nutritious crop that help to prevent the increasing life style diseases. Millets are accepted as functional food and nutraceuticals because they provide dietary fibres, energy, proteins, minerals, vitamins, vitamins and antioxidants required for human health. In the present study millet based dosa mix was developed from flours of multi millets (Foxtail millet, little millet, kodo millet and barnyard millet) along with black gram dhal flour, fenugreek seed flour and rice flour. For standardising millet based dosa mix, millet flours and rice flour were combined in different ratios (25:75, 50:50, 75:25, 100). The developed mix was highly acceptable at 100 per cent incorporation of millet flour. In order to enrich the therapeutic value of the mix dried palak leaves was added at different levels (1 – 10%) and standardized dosa mix. The developed mix was evaluated for their organoleptic quality using nine point hedonic scale. Among the different levels, two per cent of palak leaves incorporation was found to be highly acceptable. The carbohydrate, protein, fat, crude fibre, calcium, iron, β -carotene content of developed palak leaves dosa mix were 58.59g, 12.70g, 2.67g, 5.67g, 77.39mg, 3.87 mg, 191.97 μ g per 100 g respectively.

Keywords: *Multi millet, Therapeutic, Sensory evaluation, Nutraceuticals*

Annex 1.14

Title: *Development of fenugreek leaves incorporated multi millets instant rice mix*

Subtitle:

By: *D. Malathi, B. Subbulakshmi, Lilia-Baby, R. Gokhal Seetha and N. Suganya*

Report Type: *Seminar book of abstracts*

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Full Name of Research Organizations: *Tamil Nadu Agricultural University*

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Name(s) of Researcher/Members of Research Team: *Dr. D. Malathi*

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This report is presented as received from project recipient(s). It has been subjected to peer review or other review processes.

***Abstract:**

Millets were one of the important cereals, grow in hot, dry areas and used to be a major food for sources for millions of people. Millets has high protein, crude fibre, calcium and also rich in micronutrients. Despite numerous qualities, utilization of millets as food is confined to the traditional consumers due to the non-availability of consumer friendly, ready to eat millet based products. In the present study focused to standardized fenugreek leaves incorporated multi millets instant rice mix. The dried fenugreek leaves was incorporated at different levels (1 to 10 %) with the multi millets viz., foxtail millet, kodo millet, little millet and barnyard millet of equal proportions (25 per cent each) and prepared the instant rice mix with other ingredients. The prepared mix was evaluated for sensory attributes using nine point hedonic scale by a panel of members. The mix prepared by incorporating two per cent fenugreek leaves scored the maximum. The prepared rice mix was analysed for nutrient content using standard procedures. The protein, fat, carbohydrate and crude fibre content of the prepared mix were 6.82g, 7.54g, 54.76g and 4.74g per 100 g respectively. With respect to micro nutrients content, the mix also contained 105.56 mg of calcium, 3.14 mg of iron and 395.02 µg of beta carotene. Thus, the availability of nutritious products in the market enhances the millet consumption.

Keywords: *Instant mixes*

Annex 1.15

Title: *Formulation and development of instant food mixes based on millets*

Subtitle:

By: *D. Malathi and B. Subbulakshmi*

Report Type: *Seminar book of abstracts*

Date: *2018*

Published by: *Emerging Synergies in Agriculture, Food Processing Engineering and Biotechnology*

Location: *Karunya University, Coimbatore,*

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IDRC Project Number and component number (if applicable): *108128-002*

IDRC Project Title: *Scaling Up Small Millet Post-Harvest and Nutritious Food Products*

Country/Region: *India*

Full Name of Research Organizations: *Tamil Nadu Agricultural University*

Address of Research Organizations: *Post Harvest Technology Centre, Tamil Nadu Agricultural University, Coimbatore-641003, India*

Name(s) of Researcher/Members of Research Team: *Dr. D. Malathi*

Contact Information of Researcher/Research Team members: *deemala58@gmail.com*

This report is presented as received from project recipient(s). It has been subjected to peer review or other review processes.

***Abstract:**

Rapid urbanization, industrialization and consequent changes in eating habits of people have led to development of instant mixes and ready-to-eat convenience foods. Instant mixes of several traditional Indian foods have gained worldwide popularity. Popular choices of most of these products have been wheat and rice. Awareness about the health benefits on small millets create a demand on development of instant food mixes based on millets. With this background an attempt has been made to formulation and standardization of dried fenugreek/palak leaves incorporated multi millet mixes. The instant multi millet rice mixes were formulated using grains of kodo millet, little millet, foxtail millet, barnyard millet and finger millet with other ingredients. The proximate composition of the multi millet fenugreek leaves rice mix and multi millet palak leaves rice mix were contain 244.61, 240.15 Kcal energy, 37.76, 37.16 g carbohydrate, 6.82, 6.36g protein and 7.54, 7.50 g fat respectively. The mixes were stored in three different packaging materials viz. High Density Poly Ethylene (HDPE- P₁), Aluminium foil (P₂) and Metallised polyester polyethylene laminate pouches (MPP- P₃) and its physico chemical, microbial changes were observed with an interval of 30 days during storage period of 180 days at ambient temperature. The effect of packaging materials revealed that instant mixes stored in the metallised polyester polyethylene laminate pouches (MPP- P₃) retained the nutrient content and sensory score compared to other two packaging materials. With respect to microbial load, the mixes exhibited within the safer limit. The developed multi millets instant mixes can help to increase the food availability and adding variety to the diet.

Key words: *Multi millets, Instant mix, Sensory score, Packaging materials*

Annex 1.16**Title:** *Glycemic index of selected small millets***Subtitle:****By:** *D. Malathi and B. Subbulakshmi***Report Type:** *Seminar book of abstracts***Date:** *2018***Published by:** *Emerging Synergies in Agriculture, Food Processing Engineering and Biotechnology***Location:** *Karunya University, Coimbatore***Number of Series part:** *Pg: 254***IDRC Project Number and component number (if applicable):** *108128-002***IDRC Project Title:** *Scaling Up Small Millet Post-Harvest and Nutritious Food Products***Country/Region:** *India***Full Name of Research Organizations:** *Tamil Nadu Agricultural University***Address of Research Organizations:** *Post Harvest Technology Centre, Tamil Nadu Agricultural University, Coimbatore-641003, India***Name(s) of Researcher/Members of Research Team:** *Dr. D. Malathi***Contact Information of Researcher/Research Team members:** *deemala58@gmail.com***This report is presented as received from project recipient(s). It has been subjected to peer review or other review processes.*****Abstract:**

Glycemic index is a useful concept for the management of blood glucose in diabetes and it acts as a scale which ranks the carbohydrate in foods depending on how they affect blood glucose levels in a span of 1 to 2 hours after a meal. Foods with a low GI helps to prevent large swings in blood glucose, which helps diabetics to have better blood sugar control. Low GI foods may also prevent cancer and heart disease. The study was undertaken to assess glycemic index (GI) of five parboiled millets grain flour viz., finger, kodo, little, foxtail and barnyard millet in six non diabetic and healthy volunteers aged between 18 and 20 years of sedentary life style without any medication. The test food was given in the form of porridge and upma and compared with the reference carbohydrate (glucose) at an interval of one week for each millet. During the test, 50 g available carbohydrate of test food was given to volunteers. The blood samples were collected at fasting and also every 30 minutes interval during 2½ h period. The blood glucose level was assessed by using glucometer and calculated the glycemic index. The result revealed that the glycemic indices of both upma and porridge were found to be lower than glucose (reference food). Among the two form preparation, millet upma was found to be lower GI value than the millet porridge in all millets. The GI upma of finger millet (56.13), kodo millet (43.91), little millet (41.42), foxtail millet (41.04) and barnyard millet (45.30) relatively lower than reference food. The study indicated that GI values of small millets in form of solid consistence are recommended in a diet for the regular management of diabetes mellitus.

Key words: *Small millets, Glycemic index, Upma, Porridge*

Annex 1.17**Title:** *Multi millets based traditional food mixes***Subtitle:****By:** *D. Malathi and B. Subbulakshmi***Report Type:** *Seminar book of abstracts***Date:** *2018***Published by:** *International conference on Bridging innovation in sports, education and nutrition,***Location:** *Avinashilingam University, Coimbatore.***Series Name:** *NA***Number of Series part:** *NA***IDRC Project Number and component number (if applicable):** *108128-002***IDRC Project Title:** *Scaling Up Small Millet Post-Harvest and Nutritious Food Products***Country/Region:** *India***Full Name of Research Organizations:** *Tamil Nadu Agricultural University***Address of Research Organizations:** *Post Harvest Technology Centre, Tamil Nadu Agricultural University, Coimbatore-641003, India***Name(s) of Researcher/Members of Research Team:** *Dr. D. Malathi***Contact Information of Researcher/Research Team members:** *deemala58@gmail.com***This report is presented as received from project recipient(s). It has been subjected to peer review or other review processes.*****Abstract:**

People of India consume most of their foods in traditionally processed forms. However their preparation is time consuming and laborious with result that convenience foods based on traditional processing has entered the market with huge success. Small millets have high nutrient content which includes protein, essential fatty acids, dietary fibre, vitamins, and minerals. It helps in rendering health benefits like reduction in blood sugar level, blood pressure regulation, cardiovascular and celiac diseases. Processing of small millets based instant food mixes would be successful strategy to promote millet utilization. Hence, the present investigation was undertaken to standardized nutritious instant breakfast mixes from small millets with other ingredients. Multi millet grain mix was formulated using grains of kodo millet, little millet, foxtail millet and barnyard millet. These formulated mixes was substituted with different proportions in traditional instant food mixes viz., Idli, Dosa, Puttu, Adai, panyaram, chappathi and Venpongal. Which were organoleptically evaluated with 50 volunteers using 9 point hedonic scale. The result revealed that the standardized products obtained overall acceptability scores of Idli (8.5± 0.14), Dosa (8.6±0.14), Puttu (8.4±0.46) and Adai (8.7± 0.23), Panyaram (8.6±0.21), chappathi (8.8±0.25) and Venpongal (8.8±0.20) and the entire products were maximum acceptability. With respect to nutrient content the standardized products contains high amount of protein, dietary fibre and iron content. This contributes food and nutritional security by meeting energy and protein needs of consumer. The instant mixes from multi millets can help in increasing food availability, adding variety to it and make the diet rich in micronutrients and satisfy the demand of small millets processed foods.

Key words: *Multi millets, Instant mix, Sensory score*

Annex 1.18**Title:** *Nutrients dense multi millets health mix***Subtitle:****By:** *D. Malathi and B. Subbulakshmi***Report Type:** *Seminar book of abstracts***Date:** *2018***Published by:** *International conference on bridging innovation in sports, education and nutrition,***Location:** *Avinashilingam University, Coimbatore,***Series Name:** *NA***Number of Series part:** *NA***IDRC Project Number and component number (if applicable):** *108128-002***IDRC Project Title:** *Scaling Up Small Millet Post-Harvest and Nutritious Food Products***Country/Region:** *India***Full Name of Research Organizations:** *Tamil Nadu Agricultural University***Address of Research Organizations:** *Post Harvest Technology Centre, Tamil Nadu Agricultural University, Coimbatore-641003, India***Name(s) of Researcher/Members of Research Team:** *Dr. D. Malathi***Contact Information of Researcher/Research Team members:** *deemala58@gmail.com***This report is presented as received from project recipient(s). It has been subjected to peer review or other review processes.*****Abstract:**

Nutrition is an important part of sport performance for young athletes. A well-balanced diet containing appropriate amounts of macronutrients (protein, carbohydrates and fat) and micronutrients (vitamins and minerals) is essential to provide enough energy for growth and activity. Fluids are also essential for hydration to support growth and athletic performance. Millets are known for several health benefits and it is mainly attributed to its nutritional composition. Millets provide a good source of energy, protein, vitamins and minerals including trace elements. The edible component of millet kernel is the rich source of phytochemicals, such as dietary fibre and polyphenols. Millets have great potential for being utilized as health drink/food by virtue of their nutritional qualities. The present study was conducted to formulate and evaluate the health mix by using small millets. Millets (kodo millet, little millet, foxtail millet) were soaked for 8 hours and pack loosely in a cloth and allowed for germination. The germinated grains are dried in cabinet drier at 60°C for six hours; sprouts were removed, roasted and ground into flour using Pulverizer. Multi-millet health mix was formulated using these millets flours with other ingredients viz., pulses, nuts, sugar and cardamom powder. The formulated was organoleptically evaluated and their nutritional composition also analysed using standard procedures. The organoleptic evaluation result showed that the health mix was highly acceptable and the mix contains 65.45g carbohydrate, 11.46g protein, 4.94g fat, 4.94g fibre, 4.07g iron, 112mg calcium, 268.52mg phosphorus and 349 calorie of energy per 100g. Since the developed health mix providing adequate amount of micro nutrients which helps to meet the needs of sports personnel

Key words: *Multi millets, Health mix, Value added products*

Annex 1.19

Title: *Hypoglycemic effect of drumstick leave incorporated multi millets dosa mix in diabetic induced rats*

Subtitle:

By: *D. Malathi and B. Subbulakshmi*

Report Type: *Seminar book of abstracts*

Date: *2018*

Published by: *2nd International conference on Innovative food and nutrition technologies for public health care,*

Location: *Peraiyur University, Salem*

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IDRC Project Number and component number (if applicable): *108128-002*

IDRC Project Title: *Scaling Up Small Millet Post-Harvest and Nutritious Food Products*

Country/Region: *India*

Full Name of Research Organizations: *Tamil Nadu Agricultural University*

Address of Research Organizations: *Post Harvest Technology Centre, Tamil Nadu Agricultural University, Coimbatore-641003, India*

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This report is presented as received from project recipient(s). It has been subjected to peer review or other review processes.

***Abstract:**

India is the top most producers of millets which are commonly cultivated under rain fed conditions Millets are also rich in health promoting phytochemicals and functioning as antioxidants, immune modulators, detoxifying agents etc. and hence protect against age-related degenerative diseases like cardiovascular diseases, diabetes, cancer etc. The present study evaluated the hypoglycemic effect of drumstick leaves incorporated multi millets dosa mix in diabetic induced rats. Female Westar rats were fasted overnight for 16 hrs. prior to the experiment and the anti-diabetic activity measured in terms of blood glucose level. Diabetes was induced in rats by a single dose of 120 mg/kg body weight of alloxan by intraperitoneal route. After a period of 2 days blood glucose levels were more than 300 mg/dl is taken into the study. The diabetes induced rats were grouped in to three (6 rats per group). The group I fed glucose orally (2g/kg) served as control, group II rats fed glucose orally (3g/kg) with glibenclamide (600µg/kg) which was used as reference standard and group III rats fed drumstick leaves incorporated multi millet dosa mix (1000mg/kg) for 21 days. The blood glucose levels were measured on 0, 7th, 14th and 21st day of treatment period at 0, 1, 3, 5, 7, and 15th hrs after administration. The result showed that administration of alloxan increased the blood glucose level in control (group I). The glibenclamide had anti-diabetic activity and reduced the blood glucose level of diabetic rats (group II). Similarly group III fed with the single dose of drumstick leaves incorporated multi millet dosa mix on had a significant decrease in blood glucose levels and showed the anti-diabetic activity when compared to control and reference standard group. The study concluded that drumstick leaves incorporated multi millets dosa mix had a hypoglycemic activity in diabetic induced rats. Hence the study suggested that the developed mix suitable for the dietary management of metabolic disorders such as diabetes and hyperlipidemia patients.

Key words: *Small millets, Anti diabetic activity, Dosa mix, Diabetic rats*

Annex 1.20**Title:** *Standardization and evaluation of multi millet based food products***Subtitle:****By:** *D. Malathi and B. Subbulakshmi***Report Type:** *Seminar book of abstracts***Date:** *2018***Published by:** *2nd International conference on Innovative food and nutrition technologies for public health care,***Location:** *Peraiyur University, Salem***Series Name:** *NA***Number of Series part:** *NA***IDRC Project Number and component number (if applicable):** *108128-002***IDRC Project Title:** *Scaling Up Small Millet Post-Harvest and Nutritious Food Products***Country/Region:** *India***Full Name of Research Organizations:** *Tamil Nadu Agricultural University***Address of Research Organizations:** *Post Harvest Technology Centre, Tamil Nadu Agricultural University, Coimbatore-641003, India***Name(s) of Researcher/Members of Research Team:** *Dr. D. Malathi***Contact Information of Researcher/Research Team members:** *deemala58@gmail.com***This report is presented as received from project recipient(s). It has been subjected to peer review or other review processes.*****Abstract:**

Now-a-days people are very conscious about their healthy living practices to overcome metabolic disorders and life style diseases. Small millets has high nutrient content which includes protein, essential fatty acids, dietary fibre, B-Vitamins, minerals such as calcium, iron, zinc, potassium and magnesium. It helps in rendering health benefits like reduction in blood sugar level (diabetes), blood pressure regulation, thyroid, cardiovascular and celiac diseases. With this background an attempt has been made to formulation and standardization of multi millet based value added products. Multi millet grain mix was formulated using grains of kodo millet, little millet, foxtail millet, barnyard millet and finger millet with other ingredients. These formulated mixes was substituted with different proportions in traditional foods (Idli, Dosa, Puttu and Adai), instant mixes (tomato rice, bisbellabath, tamarind rice, biriyani, venpongal and palak rice) and snack foods (murukku, omapodi, seedai and pakoda) which were organoleptically evaluated with 50 volunteers using 9 point hedonic scale. The result revealed that the standardized products obtained overall acceptability scores of Idli (8.5 ± 0.14), Dosa (8.6 ± 0.14), Puttu (8.4 ± 0.46) and Adai (8.7 ± 0.23), Tomato rice (8.5 ± 0.12), Bisbellabath (8.6 ± 0.16), Tamarind rice (8.5 ± 0.12), Biriyani (8.6 ± 0.14), Venpongal (8.8 ± 0.20) Palak rice (8.6 ± 0.21), Murukku (8.5 ± 0.26), Omapodi (8.3 ± 0.02), Seedai (8.5 ± 0.18) and Pakoda (8.4 ± 0.08) and the entire products were maximum acceptability. With respect to nutrient content the standardized products contains high amount of protein, dietary fibre and iron content. This contributes food and nutritional security by meeting energy and protein needs of consumer. Value added products prepared from multi millets can help in increasing food availability, adding variety to it and make the diet rich in micronutrients with affordable price and helps to satisfy the demand of small millets processed foods.

Key words: *Multi millets, Instant mix, Sensory score*

Annex 1.21**Title:** *Integrated local and regional value chain development for small millets***Subtitle:****By:** *M. Karthikeyan***Report Type:** *Presented in the Dialogue on Millets, Monsoon and Market, 2018, MSSRF, Chennai***Date:** April 15-17, 2018**Published by:****Location:** *India***Series Name:** *NA***Number of Series part:** *NA***IDRC Project Number and component number (if applicable):** *108128-002***IDRC Project Title:** *Scaling Up Small Millet Post-Harvest and Nutritious Food Products***Country/Region:** *India***Full Name of Research Organizations:** *DHAN Foundation***Address of Research Organizations:** *1A, Vaidyanathapuram East, Kennet Cross Road, Madurai-625016, Tamil Nadu***Name(s) of Researcher/Members of Research Team:** *Mr. M. Karthikeyan***Contact Information of Researcher/Research Team members:** *karthikeyanrfd@gmail.com***This report is presented as received from project recipient(s). It has been subjected to peer review or other review processes.*****Abstract:**

In India, declining cereal diversity in diets is one of the key factors behind 'triple burden of malnutrition' and the increasing prevalence of non-communicable diseases such as diabetes. Bringing back or inclusion of nutrient-dense millets in the mainstream diets could contribute to an answer. For this to happen, millets need to be consumed in any form involving substantial quantity – as bulk foods- by large section of the population and millets have to transform from "niche foods" to "mass foods". Efforts of DHAN Foundation and its partners since 2011 towards this end indicate that this "transformation" can happen only if the multiple constraints faced by different millet value chain actors are addressed in an integrated way, and local/regional value chains for millets are created/ strengthened. The experiences of small millet value chain development in Tamil Nadu region indicate that integrated interventions at local/regional level for reviving millets in local food cultures and farming systems covering production, processing, marketing and household consumption by multiple local actors hold promise. A wide range of local actors viz. R&D organisations, farmers organisations, civil society actors, equipment manufacturers, processors and food enterprises of various scales, media, government actors, and consumer organisations have a significant role to play. Still there are many concerns related to less remunerative and fluctuating farm gate price, supply chain constraints, higher consumer price and lack of standardization of bulk and value added products, and inadequate consumption by producers and poorer sections, which need to be addressed on priority.

There is need for medium to long term regional level strategy for advancing the millet value chains in the Tamil Nadu region. Support and active role of government in the long term is crucial. The critical technology gaps, that restraint the value chain development, need to be addressed. The experience indicates that a twin strategy of (i) supporting market development and (ii) implementing 'what market will not do' needs to be followed by public and non-private agencies, to ensure increase in millet consumption among the "bottom of the pyramid" population and to strengthen the roles of women, farming communities and marginalized communities like ST and SC in the emerging millet value chains. There are large regional differences in millet value chain development across India and scaling up the proven 'working models' available in few states to other parts of the country can be a way forward.

Keywords: *Enterprises, Small Millets, Incubation, Value Chain, Policy, Underutilised species*

Annex 1.22**Title:** *Millets promotion: Perspective of DHAN Foundation***Subtitle:****By:** *M. Karthikeyan***Report Type:** *Presented in the Nutricereals for farmers', environment and consumers' security, INTERNATIONAL TRADE FAIR 2018 - ORGANICS & MILLETS, Bangalore, 2018***Date:** *January 19-21, 2018***Published by:****Location:** *India***Series Name:** *NA***Number of Series part:** *NA***IDRC Project Number and component number (if applicable):** *108128-002***IDRC Project Title:** *Scaling Up Small Millet Post-Harvest and Nutritious Food Products***Country/Region:** *India***Full Name of Research Organizations:** *DHAN Foundation***Address of Research Organizations:** *1A, Vaidyanathapuram East, Kennet Cross Road, Madurai-625016, Tamil Nadu***Name(s) of Researcher/Members of Research Team:** *Mr. M. Karthikeyan***Contact Information of Researcher/Research Team members:** *karthikeyanrfd@gmail.com***This report is presented as received from project recipient(s). It has been subjected to peer review or other review processes.*****Abstract:**

In India, declining cereal diversity in diets is one of the key factors behind 'triple burden of malnutrition' and the increasing prevalence of non-communicable diseases such as diabetes. Bringing back or inclusion of nutrient-dense small millets in the mainstream diets could contribute to an answer. For this to happen, millets need to be consumed in any form involving substantial quantity –as bulk foods- by large section of the population and millets have to transform from a "niche food" to a "mass food". Efforts of DHAN Foundation since 2011 towards this end indicate that this "transformation" can happen only if the multiple constraints faced by different actors in the millet value chain are addressed in an integrated way, and a local/regional value chain for millets are created/ strengthened. Integrated interventions at local/regional level covering production, processing, marketing and household consumption by multiple actors including government hold promise. Developing appropriate technologies through joint R&D and scaling up their reach/adoption involving market actors and non-market actors has given promising results. The experience indicates that a twin strategy of (i) supporting market development and (ii) implementing 'what market will not do' needs to be followed by public and non-private agencies, to ensure increase in millet consumption among the "bottom of the pyramid" population and to strengthen the roles of women, farming communities and marginalized communities like ST and SC in the emerging millet value chains. Scaling up the proven 'working models' available in few states to other parts of the country can be a way forward.

Keywords: *Mass foods, Small Millets, Incubation, Value Chain, Policy, Local, Regional*

Annex 1.23

Title: *Dehulled small millets: A potential food for improving the nutrition of children*

Subtitle:

By: *D. Malathi, G. Gurumeenakshi, N. Varadharaju, M. Karthikeyan and B. Subbulakshmi*

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This report is presented as received from project recipient(s). It has been subjected to peer review or other review processes.

***Abstract:**

A child's early years are important for its future health and wellbeing, and good nutrition during this time lays a healthy foundation for all of life. But in India, there is widespread prevalence of undernourishment of under-five children. Small millets have great potential for being utilized as health food by virtue of their nutritional qualities in the Indian context. However, the prevailing processing technology had many problems and the presence of value added products was minimal. Assessment of existing processing machinery in millet was undertaken. This led to the development of double chamber centrifugal dehuller, which had higher recovery of dehulled unpolished millets and met requirements at the village and enterprise levels. To demonstrate the health benefits of consuming small millets, a study of supplementation of multi-millet health mix on the nutritional status of primary school children was done in Thondamuthur Block of Coimbatore District, India. Health mix was formulated from millets wheat, kodo millets, little millet, foxtail and finger millet with the inclusion of pulses. The formulated multi-millet health mix contained 65.45g carbohydrate, 11.46g protein, 4.94g fat, 4.94g fibre, 4.07g iron, 112mg calcium, 268.52mg phosphorus and 349 calorie of energy per 100g. The study indicated that there was a significant increase in height, weight and haemoglobin level of the school children who were fed with the formulated millet health mix. The improved huller and multi-millet health mix developed can be disseminated for improving nutrition security and livelihoods.

Keywords: *Multi-millet, Processing equipment, Supplementation, Anthropometric, Nutritional status.*

Annex 1.24

Title: *Development of traditional based sweet recipes from little millet*

Subtitle:

By: *G. Sindumathi and D. Malathi*

Report Type: *Seminar book of abstracts*

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This report is presented as received from project recipient(s). It has been subjected to peer review or other review processes.

***Abstract:**

*Little millet (*Panicum sumatrense*) is a native of South Eastern Asia, grown throughout India to a limited extent. It is rich in fat; iron and niacin content. Little millet contains amino acids in balance proportions and is rich in methionine, cysteine and lysine. They are especially beneficial to vegetarians who depend on plant food for their protein nourishment. The use of little millet in traditional products would increase their utilization. Halwa and Kesari was prepared using little millet at various proportions Based on the sensory evaluation of the halwa and kesari prepared 100 per cent little millet flour was highly acceptable and the overall acceptability scores obtained for halwa was 8.8 and in kesari was 8.9. The standardized halwa and kesari was evaluated for its nutritional quality. The nutrient content of halwa and kesari were 52.15 g and 65.14 g of carbohydrate, 4.45g and 3.82 g of protein, 36.10g and 14.17 g of fat, 2.41 g and 2.40g of fibre, 3.41 mg and 3.52 mg of iron 13.70 mg and 28.75mg of calcium 111.30 mg and 80.46 mg of phosphorous respectively were observed. These value added products from little millet could compete successfully in the emerging markets as functional foods and have relevance to health needs of targeted group.*

Keywords: *Halwa mix, Nutrient content, Millets*