Indian J. Plant Genet. Resour. 35(3): 100–106 (2022)
DOI 10.5958/0976-1926.2022.00050.X

Building Value Chains for Enhanced PGR Utilization and Sustainable Food Systems

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Introduction

The World Food System is characterized by a high level of concentration and dependency. It is estimated that out of the above 5500 plant-known edible species, only 12 makeup of more than 75% of what we eat. Cereals provide the highest share in terms of calorie intake, with only three crops – rice, wheat, and maize – providing more than 50% of calorie intake. This impressive concentration on a few staple crops exposes the agricultural production system and their markets to vulnerability. Furthermore, recent UN report on World Population Prospects–2022 has made the whole World worry especially the countries like India where the population by 2050 would cross 1.66 billion and surpass the population of China (WPP, 2022). In such circumstances meeting the Sustainable Goals and providing healthy and nutritious food to increasing population would be a big challenge. Ensuring food and nutritional security side by side reducing pressure on natural resources, mitigating climate change and controlling price volatility due to conflicts and other disturbances is also a matter of deep concern for developing world.

Diversification of the production base could incorporate local landraces/cultivars/farmers varieties which however needs policy shift and investing in developing value chains. India is endowed with vast diversity of plant genetic resources with 167 cultivated species and 329 wild relatives of crop plants (Arora, 1991). In India around 1000 wild edible plant species have been exploited by native tribes and these include 145 species of roots and tubers, 521 of leafy vegetables/ greens, 101 of buds and flowers, 647 of fruits and 118 of seeds and nuts (Arora and Pandey, 1996). Large number of land races about 30,000-50,000 of various crops, fruits and vegetables like rice, wheat, maize, millets, pseudo cereals, pigeon pea and other legumes, cucurbits, mango and other fruits, turmeric, ginger, sugarcane etc. are exiting in India. Several of these landraces were grown by the farmers for their own consumption, however, era of green revolution and commercialization of agriculture led to the diversion of farmers to high yielding newer technologies. Several of these landraces are still being cultivated by the small and marginal farmers for their special attributes in India.

In the era of hybrid technology, gene transformation and gene editing one can think how the local landraces of crop plants nurtured, conserved and utilized by the native farming communities for centuries are even highly relevant today. These local landraces are not only rich in nutritional attributes but also have several genes tolerant to biotic and abiotic stresses (Duc *et al*., 2010; FAO, 2019) These farmers landraces or varieties were the integral rather major part of agricultural production system in the past. Invention and spread of hybrid technology to increase productivity and income of farmers changed the scenario of farms especially small and marginal farms. It is the earnest fact that in indirect way farmers were involuntarily diverted from their traditional crops and local cultivars. This practice led to the erosion of several of indigenous landraces from the farmers' field and many local crops that were previously common in some areas, today are hard to find. However, still in remote, hilly terrains and fragile areas farmers with small land holdings prefer to grow some of these traditional crops especially small millets, pseudocereals, indigenous vegetables and other important crops for local use Bajracharya *et al.,* 2010

Need for Building Value Chains

In India agriculture provides livelihood to about 58% of population and contributes about 20% to the total economy of India as per the data released in 2021

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(MoAFW, 2021). Food and grocery market of India is also very large and stands at sixth position in the World. This is the position where more than 80% of the farmers are having less than 2 Hectares of land holding and agriculture is mostly for self-sufficiency. During the green revolution our emphasis was just on increasing the agricultural production to meet the food security, however, self-sufficiency in most of the food commodities has now led to the greater emphasis on nutritionally rich crops and value added products. There has been drastic increase in demand for the healthy food, and an expansion of the demand for fruits and vegetables. In India, for instance, food grain production in 2020-21 reached to 296 MT while horticultural production has crossed 330 MMT (MoAFW, 2021). Major initiative of government of India on food processing through Kisan Sampada Yojana where farmers are encouraged to cultivate processing varieties of fruits/vegetables and emphasis on organic agriculture has prompted increased investment of private players and also investment through foreign sources.

Farming community and consumers are now realizing the importance of local landraces. Many of them are rich in nutrients required systematic production, value addition and market value chain to reach to the peri-urban and urban markets. Small and marginal farmers growing these landraces sometimes lack skills to add value, resources and accessibility to the market for their product. Intervention of NGO's, Governmental agencies and corporate houses is often required to systemically achieve these goals (Gauchan *et al.,* 2020). Value chain has been defined as a set of activities that are linked to adding value to the product at each stage by bringing all the actors on a common platform to deliver a high-quality product and also generating more income among the participants. Agricultural value chain comprises farmers and farming inputs-seeds, planting material and other inputs; preharvest operations-crop and farm management, harvest; supply chain-processing, storage, packaging, transport and marketing and consumers. In the agri-value chain farmer the prime factor is having no visibility and not rewarded for his major contribution. However, when we talk of value chain for local landraces farmers, farming community and demography is at the centre along with trait may be nutritional value, taste, culinary attribute or any other specificity of the produce. Systematic development of value chain leads to sustainable food system and adds to the livelihood of farmers and recognition to the area. Local landraces, farmers varieties and cultivars have been awarded or could qualify for Geographical Indicator (GI) have specificity for some trait and link to the territory as well as local traditions. GI Tags to local commodities could help in preserving genetic diversity, indigenous knowledge and enhancing farmers livelihood by recognizing their specificities and increasing their value added and contributing to increase awareness.

In India there are several examples of successful value chain development with the farmers participation besides commercial agri-value chains developed and acquired by the food companies and Agri-start-ups. Some of the successful case studies are given below:

Rice Value Chain SuccessStory of GEF Project

Several Indian rice-eating states have vast diversity of local rice varieties/landraces rich in nutrition, flavour, taste and texture that have been grown for centuries. These landraces were being cultivated using traditional methods caring for soil health also and sustain for future generations. The Kola Joha or Black Husked is rich in nutrients such as protein, minerals and contains high levels of antioxidants that protect cells, tissues, and vital organs. Traditionally this type of rice is cooked for pregnant women to full fill nutritional needs.

Under the GEF-UNEP project on "Mainstreaming agricultural biodiversity conservation and utilisation in the agricultural sector to ensure ecosystem services and reduce vulnerability", 24 heritage rice varieties including Kola Joha were identified and selected, after nutritional profiling, for revival across Assam under the Native Basket brand by Guwahati-based NGO Foundation for Development Integration (FDI). These traditional rice landraces are being marketed since December 2020, traditional rice growers are now targeting the increasing share of health-conscious Indian middle and upper class as their clients. Some of these rice landraces native to Assam has been revived from an almost-lost status to being currently farmed by hundreds of smallholders. Successful value chain has been developed for these highly nutritious landraces and products are available in the urban markets. In Assam, under the Native Basket brand, farmers have learnt to not just grow their rice but to independently handle market linkages after the Alliance, ICAR-NBPGR and FDI aided in registering a new brad to protect intellectual property rights (Fig. 1).

Similar efforts have been made by a group of 20 indigenous women farmers in Surguja district of Central-eastern Indian state Chhattisgarh realising the threats to the survival of their traditional rice variety called Jeeraphool by local name, translating to 'Cumin-Flower' taking its name from its small cumin-shape and pleasant aroma. After registering Jeeraphool with Plant Varieties and Farmers' Rights Authority of India, with technical support of the Alliance, it has also been awarded a Geographical Indication tag as the Jeeraphool variety is primarily grown only in Surguja district. The heritage rice has now found its place on India's food export list. The women self-help groups are striding ahead with their success, linking up with companies and local-level government offices to produce and market alternate products from the rice. From 120 hectares and 180 tonnes of Jeeraphool grains in 2005 they have more than tripled cultivation to 400 hectares harvesting over 1,000 tonnes in 2020 in Surguja district. The agricultural heritage has traversed a long journey to victorious survival.

The small and marginal farmers have also been organised into Farmer Producer Organisation and a new brand was registered. The rice demand and brand recognition increased, price fetched 50 percent more at 1,550 rupees ($22) per quintal. Their aromatic rice brought in up to 20 percent higher. Over 2,000 farmer families are benefiting the whole gamut of activity from production to processing and sale. In the eight different locations where the Alliance is working, 19 community seed banks currently conserve, maintain and provide farmers ready access to over 2,000 traditional varieties of different crops.

Millets Value Chain – ICAR-IIMR Success Story

Millets are generally grown in 131 countries of the World (https://milletadvisor.com/ importance-of-millets-in-india/). Millets are the traditional food of approximately 590 million people of Asia and Africa. India may be treated as the home of Millets with the production of >170 lakh ton which is the 80% production of Asia's and about 20% of global production. In India, these millets are represented by six species, namely, finger millet (*Eleusine coracana*), kodo millet (*Paspalum scrobiculatum*), foxtail millet (*Setaria italica*), little millet (*Panicum sumatrense*), proso millet (*Panicum miliaceum*) and barnyard millet (represented by two species, viz., *Echinochloa crusgalli* and *E. colona* latter domesticated in India)

ICAR-Indian Institute of Millet Research (ICAR-IIMR) is the premier institute undertaking the research, development, extension and value chain development of millets. ICAR-IIMR through its several projects and initiatives promoted not only the cultivation of millets but several innovative interventions in value chain building have led to development of nutritious products meeting consumers' demand. These efforts have led to the millet revolution in India and given new life to the rather elapsed crops. ICAR-IIMR through its Nutrihub (https://www.nutrihubiimr.com/about-nutrihub) is sharing and demonstrating processing Infrastructure facilities for entrepreneurs incubated along with 60+ value added technologies for millet value added products backed by extensive research and Centre of Excellence. The Agribusiness Incubator (ABI) and Technology Business Incubator (TBI) are providing lot of support to entrepreneurs and farming community. More than 175 Stratups have been supported and above 190 technologies related to millets have been transferred to industries and entrepreneurs (https://www.nutrihubiimr.com/about-nutrihub; Rao and Tonapi, 2021). ICAR-IIMR is also supporting 31 FPOs to undertake and promote millets and their value-added products. These FPOs are of great help in supporting millet farmers in cultivating, processing and marketing of their produce. These efforts are helping in popularising millet products and liking of these nutri-rich foods is increasing in health-conscious rural and urban population. These efforts are also adding to livelihood of small farmers by increasing their disposable income and providing them better nutrition. Study undertaken as a part of global project on NUS species amply demonstrated that currently marginalized crops, such as minor millets, can in fact contribute to the nutrition security of rural and urban poor people in India, while at the same promoting economic development and the empowerment of women and other vulnerable groups (Padulosi *et al.,* 2015).

Jackfruit Value Chain and Benefit Sharing (https://www.iihr.res.in/linking-biodiversity-livelihood-security-jackfruit**)**

There are several examples where farmers and community have been benefited by conserving varieties or cultivars having some special traits and higher economic value due to special liking by the consumers. In most of the

cases farmers are unable to recognise this or do not have capacity to gain extra benefit out of these elite germplasm or farmers cultivar. Vast genetic diversity of crops and horticultural species is available in the backyard gardens and farmer's field. Such farmers or community holding unique diversity have been recognised by PPVF&RA, ICAR, SAUs and other governmental agencies and NGOs as "Custodian Farmers" during last two decades. ICAR-Indian Institute of Horticulture Research (ICAR-IIHR), identified two superior jackfruit genotypes with attractive coppery red coloured flakes in the traditional jackfruit growing tracts of Southern Karnataka. These varieties were given wide visibility through a combination of media advertisement and fairs. This cultivar received tremendous response for the planting material by farmers. Hence, ICAR-IIHR created a model for commercialization in 2017, after recognising and honouring the farmers for conserving this variety as "Custodians of Genetic Diversity". Revenue generation was also shared between the Licensor (jackfruit farmer) in such a way that 75% of the earning would go to the farmer and 25% would go to the Institute, if the price per sapling is Rs 150 then Rs 112 would go to the farmer and Rs. 38 for the Institute. The model is well established and custodian farmers are profiting through benefit sharing and also the elite germplasm is conserved and utilized. Such innovative models of linking biodiversity with livelihood security are helping farmers in increasing their income.

Custard Apple Value Chain in Rajasthan (NAIP Project Report, 2013 and Shailza et al., 2020)

Development of custard apple value chain is a successful example where a wild fruit of the tribal areas of Rajasthan could be benefited. This fruit is widely growing particularly in the tracts of Udaipur, Chittorgarh, Jhalawar, Dungarpur, Bhilwara and Rajsamand districts. Freshly harvested fruits by tribals were sold at very less price due to difficulty in transport and also the perishable nature of fruits. There were several common issues tribal farmers face in handling and marketing most of the underutilized fruits. Some of these are harvest and post-harvest losses, lack of processing technologies and value addition and unorganized market (Kaushik, 2013). These challenges have been successfully addressed in custard apple and various processing options, value added products and marketing channels were established. The processing of raw fruit into various innovative products like pulp, powder, etc. promotes market acceptability and gives the products high economic value (Kaushik, 2013). These innovations of value addition greatly helped in post-harvest management of fruits, income and employment generation of tribal farmers. All this started with the training of farmers on harvesting, standardized rejuvenating technology, pulp extraction equipment development and adopting browning free technology for the processing of custard apple, which helped in increasing the shelf life of finished product from a few days to more than a year. It involved the establishment of collection centre at village level, processing unit, a storage unit and marketing network to promote sale of the produce (Shailza *et al.,* 2020). Interventions involving improved cultivation practices and reduction in post-harvest losses would increase the production level by 50 per cent and 20 per cent, respectively, whereas value addition activities through processing would give better returns to the processors as well as to the tribal harvesters (Shailza *et al.,* 2020). Technology has been transferred and successfully adopted by many start-ups and tribal farmers, and all farmers, particularly women, are benefited by earning additional livelihood (Fig. 2).

Challenges in Building Value Chains

Value chain development encompass significant challenges at farm, pre- and post-harvest, supply chain, and consumer level. Building successful value chains especially for landraces depends upon success at all these levels. Encouraging farmers to grow the local landraces on their farm and developing value chains need concerted efforts by all the stakeholders involved, and political will. There are several examples where such successful attempts have been made and through community participation conservation and use of indigenous landraces and local vegetables and fruits have been ensured. Several value chains have been developed and demonstrated under various projects involving NGOs and result of studies have been published showing substantial gains and benefits, however, practically these value chains have not been successfully implemented or adopted by the farmers and consumers. Value chains developed by the private business houses where ample investment and able backstopping with deep market studies are involved have shown the good success. Innovations in food retailing has increased the involvement of the private sector in agriculture and also an emphasis on development and refinement in agriculture value chains. However, value chain development starting from the scratch and involving small farmers

Fig. 1.

Fig. 2

face enormous challenges. Supporting farmers in the cultivation, access and use of landrace, improve market linkages and prices, through value added and mitigate losses in productivity. Bringing farmers in to the FPO fold and taking advantage of various governmental schemes is beneficial to some extent but needs greater involvement. The recent initiative by Government of India like promotion of Millets through "Initiative for Nutritional Security through Intensive Millets Promotion (INSIMP)", 'Poshan Abhiyaan 2018-22', Poshan Month, including celebrating 2018 as Year of Millet and UN would observe 2023 as International Year of Millets due to Indian spearheading. Inclusion of millets and other nutri-foods in the Midday Meal programme and PDS would also promote the cultivation of these crops leading to enhanced farmers income.

Plant Genetic Resources Conservation and Utilization

Genetic diversity in the form of diverse landraces belonging to cereals, millets, pseudo cereals, pulses, vegetables, and indigenous fruits needs urgent conservation. The genetic diversity of landraces is an important part of global crop biodiversity and is considered of paramount importance for future world production (Wood and Lenne, 1997). The utilization of local crop landraces is intensely entangled into the food habit, socio-religious, traditional and cultural dynamics of most of the rural and tribal communities of the World. Most of these local landraces and their uses are limited to small area and native population. Mostly landraces are dynamic populations of genetically diverse, locally adapted cultivated plant species that have historical origin, distinct identity, no formal crop improvement, and are often times associated with traditional sustainable farming systems (Camancho *et al*., 2005). Most of the indigenous landraces being grown by the small and marginal farmers have now been either vanished from the farmers field or only being grown for domestic consumption. The reduced use of landraces can be traced back to the beginnings of the "Green Revolution" (Walters, 2018). Landraces possess vast genetic diversity and due to limited use by the farmers and market value are fast disappearing, their use and continued cultivation is critical near the primary and secondary centres of diversity due to alleles present and evolved during the centuries of evolution at these habitats (Brush, 1994). During the last two decades concerted efforts are being made to protect these indigenous landraces by not only conserving in the Genebank but also promoting their use by adding value to these to enable small farmers to remain with these crops. Although attempts have been made during last 3-4 decades to collect, characterise and conserve these genetic resources in seed genbanks, in vitro repositories, cryogenebanks and field genebanks. However, in situ on farm conservation is now preferred to conserve these genetic resources with the farmers participation. Some of the landraces of major cereals like wheat, rice, maize, barley, pulses and millets are still widely grown and used by local communities. This effort of farmers to grow these important landraces in the farmers field would also protect and conserve the valuable genetic resources. Establishing Community Seed Banks (CSBs) at Panchayat or Block level may be of great advantage in facilitating farmers in conserving, utilizing and selling their produce. CSBs also can be elevated to the status of small training hub for value addition marketing activities of local products. This

practice of conservation through use of landraces would require handholding of farmers to enable them to get suitable value of their produce. This would only be possible by developing successful and reliable value chains for these landraces or their value-added products.

Sustainable Food Systems

The global food system is, at present, based on extremely low genetic diversity, this is impacting dietary quality of vast population especially in the developing world. Beyond their relevance to diets and nutrition, food systems also play an important role in promoting environmental sustainability (climate change adaptation and mitigation, biodiversity, soil and water degradation), inclusivity (viability for smallholder farmers, indigenous peoples, gender equity), livelihood and productivity (increased production of nutritious foods, economic development). The Sustainable Development Goals support making the food system more productive, environmentally sustainable and resilient.

Almost half of the calories consumed by humans come from just four crops, namely wheat, rice, sugar and maize (FAO, 2018); consumed food is becoming more energy-dense and nutrient-poor (Khoury *et al.,* 2014); and fruits and vegetables are under-consumed in all regions of the world, except for China, Japan and South Korea (Berners-Lee *et al.,* 2018). Low intake of fresh fruits, vegetables, nuts and seeds and whole grains is associated with an increased risk of disease, especially cardiovascular disease, type II diabetes and cancer, and affects the poorest populations in particular (Afshin *et al.,* 2019). Reversing these trends requires a redesign of the global food system, which in turn necessitates a thorough understanding of which foods have the potential to simultaneously deliver environmental, nutritional and livelihood benefits at local and global levels.

Extreme climate events are going to impact our food security and in turn resilience of existing food systems. Traditional food system which was more robust and were climate resilient have largely disturbed due to the changing demand for food and policies of governments to grow more. There is a deep contradiction among the policy makers, one side there is an advocacy for the production centric agriculture to meet the increasing food demand and another side need for resilient and sustainable food systems to ensure environmental and nutritional security is picking up the momentum. Transforming food systems for improved resilience has been discussed by the Committee on World Food Security at the UN, IPES-Food, International Assessment of Agricultural Knowledge, Science and Technology for Development, and the UN Food Systems Summit (UNFSS), however, still opinions are divided (Mehrabi *et al.,* 2022). However, the demand for the more proteinaceous food now even in the developing markets due to high rate of obesity is changing the farm priorities. Diversification of food would enhance number of crops in the farm and would provide opportunity to farmers for crop rotation, incorporation of native crops in farming system and also the enhanced income.

In the 21st century agriculture is going under immense transformation entry of educated and tech-savvy youth entrepreneurs in to an attractive vast agricultural economy to grasp some share through modern tools is evident. The wave of start-ups coming in the Agri-sectors and vast investment coming from domestic and foreign investors in farmers as well as consumers centric business is changing the entire landscape of agri-business. During 2017 to 2020, India received ~US$ 1 billion in agritech funding. With significant interest from the investors, India ranks third in terms of agritech funding and number of agritech start-ups. By 2025, Indian agritech companies are likely to witness investments worth US$ 30-35 billion (IBEF, Report, 2022). Substantial investment is going in to the value chain development benefiting small and marginal farmers. There is a great opportunity for farming community to encash upon this trend and diversify to the nutri-rich, climate resilient crops to meet the market demand and to strengthen sustainable agriculture and food systems. Diversification of production base and developing value chains for indigenous landraces of food and horticultural crops is the only answer to meet the food and nutrition demand of increasing population.

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