

Developing value chains for rainfed production systems

K. Narsaiah*

Indian Council of Agricultural Research, KAB-II, New Delhi 110 012

In rainfed agriculture, there is a need for adoption of new and emerging as well as established technologies for sustainable production and processing of food, fodder and other agriculture and allied commodities. Establishing robust value chains and better market access are few critical steps for enhancing income of smallholder farmers. Agro-processing centres form a very short value chain. By facilitating employment and promoting rural entrepreneurship, agro-processing centres also contribute to rural development. There is an urgent need to implement several strategies to build robust value chains of rainfed agriculture produce. Small farm appropriate mechanization of pre-harvest agricultural activities and automated post-harvest management as well as value-addition activities must be adopted. Infrastructure development, capacity building, policy support besides private sector engagement and adoption of sustainable practices are crucial in developing value chains in rainfed production systems.

Keywords: Agro-procoessing, Rainfed Agriculture, Value chains

IN terms of area covered, rainfed agriculture accounts for major share both in Indian and global agriculture. Globally, its share is 70-80% and in India, it is about 52% of total cultivated land. The rainfed agriculture is very complex due to diversity and is prone to high risk caused by vagaries of climate. The spectrum of crops grown in rainfed production systems is very wide. It includes cereals, legumes, oilseeds, fruits, vegetables, fibres, and medicinal plants. The major factors governing crop selection are availability of water and economic importance of the crop.

Rainfed agriculture encompass a wide variety of crops, each with its unique characteristics, economic importance, and adaptability to water-limited environments. Cereals, legumes, oilseeds, fruits, vegetables, fibres, and medicinal plants form the backbone of rainfed agriculture, supporting livelihoods, enhancing food security, and promoting rural development. These crops not only address caloric needs but also provide essential nutrients, oils, fibres, and medicinal compounds, contributing to both nutritional security and economic resilience.

Sustainable production and processing of food, fodder and other agriculture and allied commodities under rainfed agriculture systems needs adoption of new and emerging as well as established technologies. It also needs different approaches to tackle the challenges of small and fragmented land holdings and associated resource constraints. Climate-resilient practices to optimize productivity, establishing robust value chains and better market access are few critical steps for

enhancing income of smallholder farmers. Specific ways and means of achieving these objectives are elaborated.

Agro-processing centres

Agro-processing centres form a very short value chain. Value-addition at these centres, such as processing millets into flour or pulses into dal, significantly enhances the economic value of agricultural produce, allowing farmers to capture higher profits. By facilitating employment and promoting rural entrepreneurship, agro-processing centres also contribute to rural development. These centres create jobs in sorting, grading, milling, packaging, and transportation, fostering inclusive growth and empowering women and youth. Additionally, by acting as aggregation points for smallholder farmers, agro-processing centres enhance market access by linking farmers directly to wholesale buyers, export markets, and e-commerce platforms. This reduces farmers' dependence on intermediaries and improves their bargaining power. Furthermore, these centres promote decentralized processing, ensuring that value addition happens near the production sites, reducing transportation costs and preserving product freshness.

Agro-processing centres are essential for transforming agricultural products into value-added goods, particularly in rainfed systems. These models address specific processing needs based on regional crop patterns, such as cereals, pulses, fruits, and vegetables. By providing decentralized processing infrastructure, these centres reduce post-harvest losses,

Table 1. APC models relevant to rainfed area

Model	Focus	Major machinery	Estimated cost
APC-I	Primary processing of grains, pulses, oilseeds, and spices	Pre-cleaners, grinders, atta chakkies, dal mill, oil expeller	INR 25–30 lakh + INR 6–8 lakh for shed
APC-II	Rice milling and extruded products	Mini rice mill, extruder, pre cleaners	INR 30 lakh
APC-V	Minimal processing, drying, and powdering	Peeler, dryer, pulverizer, cold storage, packaging machine	INR 15 lakh

(Source: Nachiket *et al.* 2023)

improve income for smallholders, and promote local entrepreneurship. The modular design of these APC models allows for scalability, ensuring that both small and large farming communities can benefit from them. With the right policy support and financial incentives, these agro-processing centres will play a key role in building sustainable value chains and boosting rural economies.

Decentralized storage

Support for decentralized storage of grains, fruits and vegetables with public and private partnership at block level near to the agro-processing centres instead of centralized storage may be useful. Recent announcement of Government for building warehouses at local level under 'World's Largest Cooperative Food Grain Storage Scheme' will help a lot in this endeavour. The plan entails creation of various agri infrastructure facilities at PACS (Primary Agricultural Credit Society) level including decentralized godowns, custom hiring centres, processing units. Farming communities of rainfed areas need to be encouraged to come together and form the societies to tap funds from this umbrella scheme.

For smooth implementation of the proposal for

Agro processing centres types based on processing capacity

Basic Model Agro-Processing Centre (APC): This model is ideal for small-scale or community-based operations. It focuses on primary processing such as cleaning, grading, and simple milling.

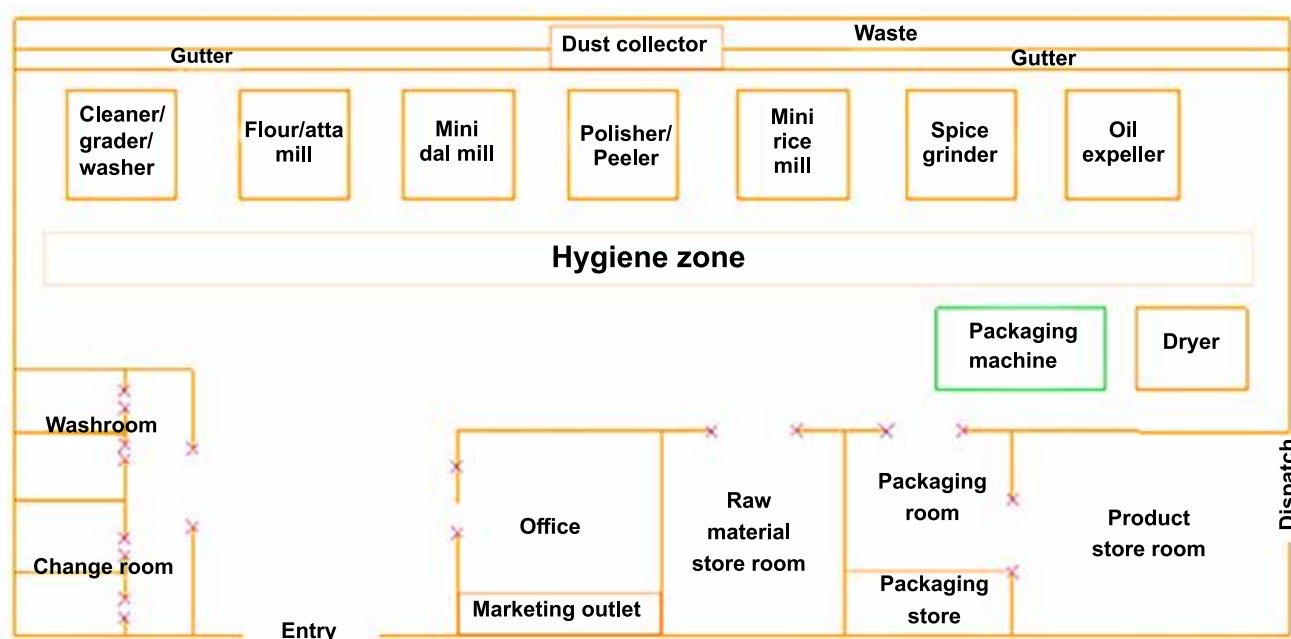
Intermediate Model APC (Cluster-Based Approach): This model supports farmer-producer organizations (FPOs) and cooperatives to scale up operations.

Advanced Model Agro-Processing Centre (Commercial Scale): This model is designed for large-scale processing and marketing of agricultural produce, suitable for regional processing hubs.

creation, modernization and upgradation of godowns and other infrastructure by Primary Agricultural Credit Societies (PACS), technical expertise of Agricultural Engineering (with specialization of processing of agricultural commodities and storage) is needed to get correct technical inputs at various levels of committees for implementing the scheme. Agricultural engineering inputs are vital for transforming the agricultural and rural landscape of Indian economy. The technical expertise will also come in handy for establishment and operation of cold chain infrastructure, custom hiring centers of processing equipment/facilities and farm machinery to be run by PACS as envisaged in the scheme.

Engineering integrated digital solutions

Information, computing and connectivity can be engineered to develop cutting edge digital technologies. Some of the examples are sensor-based network with block chain technology to enhance traceability and reduce inefficiencies in supply chain of agri-commodities, Internet of things, digital twinning of storage and transport processes, and cyber agrophysical systems for real time assessment. Although these technologies appear to be too expensive, public



A typical layout of APC (Source: Nachiket *et al.* 2023)

funding for establishment of enabling infrastructure and systems can help in their penetration. These disruptive technologies will aid digital transformation of the post-harvest activities. The integration of these digital technologies is expected to contribute to sustainable and efficient handling of produce from rainfed agriculture systems, address challenges such as resource optimization, climate change, and the need for increased food production. As technology continues to advance, the rainfed agriculture is likely to witness further innovations and improvements in commodity supply chains and usher in engineering integrated digital technologies with appliances, machinery and tools. These technologies are crucial in rainfed agriculture to ensure that the produce retains its nutritional value, flavour, texture, and overall market appeal.

Potential rainfed agriculture value chains

Before embarking on possibilities of potential rainfed agriculture systems, ways and means to realize them, it is prudent and prerequisite to study a successful model. Everlasting success story of framers' co-operative based supply chains, is of Gujarat Cooperative Milk Marketing Federation Ltd. (GCMMF). It is first successful FPO of independent India. It brought cheers into the lives of many poor farmers, who are owners of the Amul brand. By analysing the factors responsible for success of this case, key takeaways can be delineated to adopt/adapt them in rainfed agriculture systems. cursory search, of generalized literature on Amul success story, explains the overall factors responsible as innovation, efficient supply chain involving three tier cooperative system to augment capacities, strengthening of Amul brand and connecting to entire nation through witty and clever Ads of Amul girl, diversified product portfolio and backward as well as forward integration of entire supply chains. However, deeper analysis of situation at the start, i.e. 1970s, throws light on the role of engineering acumen of father of White Revolution Dr. Verghese Kurien. The foundation for this success was laid by the concept of converting surplus milk, collected in seasons when abundant milk is produced, into skim milk powder and reformulating the skim milk powder into milk for supply in lean season. This helped to even out the fresh milk supply fluctuations and led to strengthening of Amul brand. The invisible factor, often forgotten/not recognised, is the role of engineering interventions. GCMMF had the subsidiary Indian Dairy Machinery Company Ltd. (IDMC) to address the concern of affordable dairy machinery and equipment. It supplied all the machinery as well as installation, testing and commissioning of dairy plants to different dairy cooperatives in India and helped in scaling up dairy operations across the country.

As the time is ripe for establishing rainfed agriculture systems, the lessons from White Revolution can be well adapted suiting to present and future trends with main focus to usher in enabling environment with adequate supply of machinery equipment and process suiting the requirements. Following are two example cases

discussed and there could be many more and each case needs to be assessed specifically.

Millets: Millets are climate-resilient and nutritious grains. Synchronizing efforts to increase the productivity of millets with development of processing and value-addition processes and technologies can create huge market opportunities. This will provide enhanced farm income and create off-farm employment especially in the semi-arid tropical millet growing regions in India. Although the popularization efforts in International Year of Millets (2023) raised the awareness of millet benefits, it led to paradox of higher prices paid by consumer and low price realization for farmer. Though the reasons for this may be many, some can be addressed through engineering interventions to maintain consistent quality of supplied grain, suitable processing machines and enhancing shelf-life of millet flours.

Groundnut: Groundnut is a major oilseed crop of India and is pivotal for its oilseed economy. Groundnut has multiple uses. Major one is edible oil extraction. Groundnut oil is a preferred cooking oil of many regions of India. Deoiled cake is either used as feed or can be converted into foods. The sale of nuts in roasted form is low end application followed by packed and branded raw and roasted, conversion to confectionary items. High end products could be peanut butter, peanut paneer etc. However, there are many intermediaries in its supply chain and farmers usually do not get premium returns. This is ideally suited for value chain model with farmer producing organization making value-added products and building brand to reap higher profits.

SUMMARY

There is urgent need to implement several strategies to build robust value chains of rainfed agriculture produce. Small farm appropriate mechanization of pre-harvest agricultural activities and automated post-harvest management besides value-addition activities must be adopted. Infrastructure development is crucial, with a focus on establishing decentralized agro-processing units and cold storage facilities near production sites to reduce post-harvest losses and improve market access. Capacity building initiatives should train farmers in value-addition techniques and quality standards, empowering them to enhance the marketability of their produce. Policy support is essential, promoting crop insurance schemes, weather-based risk management tools, and access to institutional credit to mitigate risks associated with climate variability. Additionally, private sector engagement through public-private partnerships can attract investments in agro-processing, further strengthening value chains. Finally, adopting sustainable practices such as organic farming and integrated farming systems will improve ecological resilience, ensuring long-term productivity and environmental sustainability in rainfed agriculture. The concerted efforts in above manner will make rainfed agriculture more efficient, sustainable, and competitive.

*Corresponding author email: knarsan@gmail.com