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CHAPTER TWO

Short food supply chains to resolve food scarcity during COVID-19 pandemic—An Indian model

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1. Introduction

Indian economy was severely affected due to outbreak of COVID-19 like other economies and this in turn affected health of human and economic growth. Due to the sudden outbreak of COVID-19 virus, a complete lockdown was imposed across the country which affected farmers and agri producers in bringing their products to market because of shortage of man power. The Food and Agriculture Organization (USA, 2020) indicates that supply and demand for agricultural products and food are the two major aspects of the impact of COVID-19 on agriculture. Non availability of food and agricultural products has a direct implication on nation’s food security and combating poverty and hunger.

Also, in the recent years we can observe a critical disruption in the food supply chain, this is mainly due to the manpower shortage, difficulties faced during the transportation of agricultural products, state wise lockdown leading to the closure and shutting down of food processing units (Thulasiraman et al., 2021). Such a disruption in food chain have led to the need for a more self-reliable and sustainable alternative, which lead to the reconsideration of “local food supply chains” (Rizou et al., 2020). Government of India’s latest initiatives such as “One District One Product,” “Agri Infrastructure Fund” and “Formalization of MSME’s” calls for a balance between traditional food supply chains and integrated food processing plants (GOI, 2019a).

This paper starts with discussion about India’s green revolution and its role in fighting poverty and abolishing hunger post-independence. Green revolution as well as reformation in agricultural sector resulted in introduction of modern agro machineries, integrated food processing plants which led to the rapid industrialization of agricultural sector. Some consequences of this industrialization are increase in energy consumption, greenhouse emissions and loss of employment for marginal agri labourers. The paper then elaborates few resilient food supply chains in India such as Indian Dairy Cooperative Societies, Uzhavar Santhai (Farmer’s Market) and
Public Distribution system and its vital role during COVID-19 lockdown and concludes with the necessity for alternative policy for food processing sector which is more integrated and inclusive.

2. Green revolution and their role in food security

Green revolution, which is introduced in late 1960s is the process of research technology transfer initiatives for increasing production of crops and agricultural production globally. Green revolution resulted in bulk production of agro products by the usage of factory made fertilizers, agro chemicals and modern machineries (Phillips, 2014). When India is concerned, green revolution was unavoidable due to its largely growing population and to propel its economic progress (Hardin, 2008). Green revolution encouraged using advanced machineries, fertilizers, pesticides/fungicides, high-yielding varieties (HYV), various agricultural reformations resulted in surplus production of wheat and rice which can cater to India’s large population (Scroll and For, 2012).

However, Green revolution has its own disadvantages. Loss of employment of marginal farmers, growing dependence on fertilizers and pesticides, reduction in cultivation of indigenous crops, increased energy consumption and unavailability of plant seeds are some issues related to green revolution (Bowonder, 1979). Prior to green revolution, 80% of the total employment in India was agriculture based and agricultural sector contributed to half of the total GDP (Gross Domestic Product). Unfortunately, at present, employment rate in agricultural sector reduced to half in India. Approximately half of the total India’s cultivable lands are with small-scale and marginal farmers who owned less than 2 acres of farm land. There was a steep increase in the India’s food grain production between 1950 and 1968 with the usage of High Yield Variety Technology (HYVT). The food grain production increased from 50MT/year in 1950 to 95MT/year in 1968 despite a decrease in population associated with agricultural activities (Dhanagare, 1988). This excess production of agricultural products with minimal manpower requirement and technological interventions resulted in a prompt change from production in agricultural sector to business in agricultural sector in India. NITI Aayog (a public policy think tank) reported post-harvest losses of Rs. 90,000 crore (1 crore = 10 Million) in India in the year 2018 and to minimize this monetary loss, integrated food processing units and interventions in post-harvest technologies are indispensable (NITI Aayog, 2018). Based on the recommendations from NITI Aayog, several
Mega food parks are established and a many are under implementation in India (Table 1). The main aim of such food parks is to provide a mechanism to link agricultural production to the market by bringing farmers, processors and retailers all together to ensure maximum value addition, minimize food wastage, increase farmers income and also provide employment opportunities to the rural sector. Mega Food Park consist of supply chain infrastructure such as collection centers, primary processing centers, central processing centers, cold chain and about 25–30 fully developed plots for entrepreneurs for establishing food processing units. Theses food parks are established for processing fruits, vegetables, cereals, marine foods, etc.

Table 1 Various Food Processing Industries in India.

| S. No. | Name of the Food Park                          | Location                | Operationalization          |
|-------|-----------------------------------------------|-------------------------|-----------------------------|
| 1.    | M/s Srin Food Park Pvt. Ltd.                  | Andhra Pradesh          | Operational                 |
| 2.    | M/s Patanjali Food & Herbal Park Pvt. Ltd.    | Uttarakhand             | Operational                 |
| 3.    | M/s North East Mega Food Park Ltd.            | Assam                   | Operational                 |
| 4.    | M/s Integrated Food Park Pvt. Ltd.            | Karnataka               | Operational                 |
| 5.    | M/s International Mega Food Park Ltd.         | Punjab                   | Operational                 |
| 6.    | M/s Indus Mega Food Park Pvt. Ltd.            | Madhya Pradesh          | Operational                 |
| 7.    | M/s Jharkhand Mega Food Park Pvt. Ltd.        | Jharkhand               | Operational                 |
| 8.    | M/s Jangipur Bengal Mega Food Park Pvt. Ltd.  | West Bengal             | Operational                 |
| 9.    | M/s Paithan Mega Food Park Ltd.               | Maharashtra             | Implementation is in progress |
| 10.   | M/s Godavari Mega Aqua Food Park Pvt. Ltd.    | Andhra Pradesh          | Implementation is in progress |
| 11.   | M/s Pristine Mega Food Park Pvt. Ltd.         | Bihar                   | Implementation is in progress |
| 12.   | M/s Gujarat Agro Infrastructure Mega Food Park Pvt. Ltd. | Gujarat | Implementation is in progress |
| S. No. | Name of the Food Park                              | Location          | Operationalization          |
|--------|---------------------------------------------------|-------------------|-----------------------------|
| 13.    | M/s Cremic Food Park Pvt. Ltd.                    | Himachal Pradesh  | Implementation is in progress |
| 14.    | M/s Satara Mega Food Park Pvt. Ltd.               | Maharashtra       | Implementation is in progress |
| 15.    | M/s Himalayan Food Park Pvt. Ltd.                 | Uttarakhand       | Implementation is in progress |
| 16.    | M/s Zoram Mega Food Park Pvt. Ltd.                | Mizoram           | Implementation is in progress |
| 17.    | Mums Mega Food Park Private Limited               | Bihar             | Implementation is in progress |
| 18.    | Avantee Mega Food Park Pvt. Ltd.                  | Madhya Pradesh    | Implementation is in progress |
| 19.    | Kerala State Industrial Development Corporation Limited (KSIDC) | Kerala         | Implementation is in progress |
| 20.    | Kerala Industrial Infrastructure Development Corporation (KINFRA) | Kerala         | Implementation is in progress |
| 21.    | Andhra Pradesh Industrial Infrastructure Corporation Ltd. (APIIC) | Andhra Pradesh    | Implementation is in progress |
| 22.    | Haryana State Industrial and Infrastructure Development Corporation Limited (HSIIDC) | Haryana         | Implementation is in progress |
| 23.    | M/s Odisha Industrial Infrastructure Development Corporation (IDCO) | Odisha           | Implementation is in progress |
| 24.    | M/s Punjab Agro Industries Corporation Ltd. (PAIC) | Punjab            | Implementation is in progress |
| 25.    | M/s Raaga Mayuri Agro Vet Pvt. Ltd., Itikiyal,    | Telangana         | Implementation is in progress |
| 26.    | M/s Sukhjit Mega Food Park & Infra Ltd.,          | Punjab            | Implementation is in progress |
| 27.    | M/s Telangana State Industrial Infrastructure Corporation Ltd. | Telangana     | Implementation is in progress |
| 28.    | M/s Wardha Megha Food Park Pvt. Ltd                | Maharashtra       | Implementation is in progress |

*Continued*
India is now showing more interest towards processed food products and foods which are Ready to Eat and Ready to Serve. Studies revealed that consumption of dairy products, vegetables and fruits which are processed in a per capita scale is steadily increasing in India and on the other hand per capita consumption of wheat and rice remained constant (Alae-Carew et al., 2019). Data shows that during 2007, the agricultural sector contribute to about 18% of total Green-House Gas (GHG) emissions. Based on this data, studies predict that (GHG) in 2030 will reach about 25% (Nicot and Duncan, 2012). The major reason for this rise is because of extensive use of fertilizers and using electricity for food processing sector and agricultural activities (Garg et al., 2001).

Apart from greenhouse gas (GHG) emissions from agricultural sector, another factor that is of concern is the increased popularity for processed foods among public in India. The consumption of processed foods, sugar, oil is on rapid increase among India’s urban population (Meenakshi, 2016) because processed foods can be cooked in a very short time easily

| S. No. | Name of the Food Park                          | Location       | Operationalization     |
|--------|-----------------------------------------------|----------------|------------------------|
| 29.    | M/s Indus Best Mega Food Park Pvt. Ltd.       | Chhattisgarh   | Implementation is in progress |
| 30.    | M/s Sikaria Mega Food Park Pvt. Ltd.          | Tirupura       | Implementation is in progress |
| 31.    | M/s Greentech Mega Food Park Pvt. Ltd.        | Rajasthan      | Implementation is in progress |
| 32.    | M/s Smart Agro Food Park Pvt. Ltd.            | Telangana      | Implementation is in progress |
| 33.    | M/s JVL Agro Food Park Pvt. Ltd.              | Bihar          | Implementation is in progress |
| 34.    | M/s MITS Mega Food Park Pvt. Ltd.             | Odisha         | Implementation is in progress |
| 35.    | M/s RF Greens Meg Food Park Pvt. Ltd.         | Jammu and Kashmir | Implementation is in progress |
and it is becoming popular among working and urban citizens. These processed foods have high amount of sugar and preservatives like sodium benzoate, potassium metabisulfite. Thus the consumption of processed foods have disadvantages like increase in consumption of sugars, salts and fats (Thow et al., 2016).

Production of processed foods require few primary facilities such as proper units for cleaning process (Faille et al., 2018), units for separation and sorting (Compton et al., 2018), equipment for size reduction (Manlu Yu et al., 2013). Moreover there is a need for proper preservation units such as ozonation (Pandiselvam et al., 2017), UV radiation (Kuan et al., 2013), Plasma techniques (Thirumdas et al., 2018) etc. In addition to all these, a proper unit for packaging (Rodrı´guez-Rojas et al., 2019), processing lines and drying (Sagar, 2010), etc. is also required. Thus for setting up a state of art food processing unit, a good industrial facility with uninterrupted electricity and water source, skilled man power and a resilient food supply chain is required.

4. Energy requirement in food industries

From the energy consumption data available, it is observed that dairy sectors, crisps and fries manufacturing units, bread manufacturing units and instant coffee powder manufacturers consume more energy. Moreover, thermal processing methods such as blanching, pasteurization, ultra-pasteurization also consume more amount of energy. The supply chain of integrated large scale food processing units involve transportation of finished products from the point of production to various distribution points across the country and transportation of food products increased in recent days with the establishment of many such industries (Ladha-Sabur et al., 2019).

Thus for establishing a large scale food processing plants poses many disadvantages like increase in energy consumption, excess usage of plastics like polyethylene, polypropylene, etc. in food packaging and also transportation cost (Coley et al., 2009). Fig. 1 shows various large scale food processing industries and their respective energy and fuel requirements.

From Fig. 1 its evident that the energy consumption for producing 1 kg of milk products, sugar and cereals are high, because of their high energy consumption during drying (thermal process) and milling (size reduction). Recently, there is a vast interest been shown in exploring renewable energy source like solar energy as an effective alternative for the drying process (Eswara and Ramakrishnarao, 2013). However, using such alternative
renewable energy sources such as solar energy for the processing of other food is still under research and it is more challenging and thus energy consumption in food processing sector is still high.

5. COVID-19 and their impact on food security

COVID-19 is a deadly viral disease caused by a newly discovered coronavirus. This novel coronavirus was termed Coronavirus Disease 2019 by WHO in February 2020 and it was declared as a pandemic.
Because of this, a complete lock-down was implemented in India and state, districts borders were sealed to stop the movement of public. During this lockdown, shortage of man power, raw material and dispatch of products made the operations of food processing plants difficult and it affected the availability of processed foods to the people. People can only rely upon shortly distributed food supply chains during such crisis. In addition, SFSC creates micro-economy, employment opportunities for rural population and prevents rapid urbanization and helps to reduce hunger and poverty among rural.

For those countries that are highly industrialized, such integrated food processing plants are very suitable because only very few populations engage in agricultural activities. For example, in a country like USA only 1% of the total population engaged in agricultural activities in the year 2017 as per the Census of Agriculture which is approximately 34 lakh people (1 lakh = 0.1 Million). Thus, for these countries, integrated food processing plants are very suitable. However, even developed countries like United Kingdom, United States of America, Italy, France and Spain have large integrated food processing sectors got severely affected and there was an interruption in their food supply chain during COVID-19 (Cappelli and Cini, 2020).

While, in an agrarian country like India, the major workforce depends on agriculture and their associated jobs hence the major job creation depends on the local food supply chain, local food processing and production (GOI, 2019b). European Commission in the year 1996 stated that in times of emergency, availability of local food supply chains minimize the transportation cost and time duration for delivery of processed foods (Clark, 2018). In addition, 68% of total population in India lives in rural areas and this population rely on agricultural activities directly or indirectly. We can also find that the distribution of villages in India is uniform and every state in India constitute more than 50% of rural population (GOI, 2019b). One upsetting information is that there is a gradual decline in rural population from 89% in 1901 to 68% in the year 2011 as per 2011 Census report, which indicates that there is a continual migration of people from rural areas to nearby cities looking for employment opportunities and this resulted in decrease in agricultural activities (Census, 2011). During COVID-19 lockdown, state borders were sealed and movement of people was restricted and during such time of unusual crisis, local food processing and local food supply chains which are completely different from sophisticated large-scale processing units is capable of playing a pivotal role in guaranteeing food security of a nation. Thus by reviving local and traditional food processing sectors, migration
of people from rural to urban area can be minimized. Urbanization provides access to good medical facilities, uninterrupted electricity and hygienic living to common people and government must develop such facilities in rural areas to stop gradual decline in people engaging in agricultural and allied activities because of migration to urban areas.

6. Case study 1: Dairy processing industries vs. local milk supply chain

In milk industry, instead of using conventional evaporators, spray drying is used which consumes more than about 10–20 times more energy (Ramírez et al., 2006). In addition to that, to make the milk perishable for further, to increase the shelf life of the milk to about 60–120 days ultra-high sterilization (Chavan et al., 2011) is required which again consumes more energy. Almost all the dairy plants need energy source like electricity, steam for pumping, refrigeration, pasteurization and UHT processes (Xu and Flapper, 2011).

To function a large-scale dairy plant fully needs skillful man power, packaging materials, constant supply of raw material, continuous dispatch of finished products and continuous electricity and non-availability of any one of the above will cause disruption in the functioning of dairy industries. During COVID 19 pandemic in India, large scale dairy plants faced difficulty in delivery of milk products across states and this resulted in reduction in dairy production. This scenario was seen across nation due to difficulties in transportation of raw materials and products during lock-down period.

In contrast, in SFSC there will be direct interaction between the producers who are the farmers and the consumers. Hence, issues associated with transportation of good, high energy usage can be highly reduced. Official reported data show that about 48% of milk is consumed unprocessed, and remaining 52% is utilized in dairy processing plants (Ministry of Fisheries, 2020). Till today, milk requirement in India is predominantly taken care by the local milk supply chain and dairy cooperative societies.

India contributes to about 19% of the dairy production in the world. Unlike other agriculture and associated sectors, dairy business in India is mostly controlled by marginal and small-scale farmers associated with local milk supply chain. Establishment of large scale dairy processing plant in India is debatable because it will impact rural employment opportunities, and micro-economics (Kumar et al., 2019). Therefore, it is very much important
to make sure industrialization of such nature does spoil the village and district level local milk supply chain which is capable of providing uninterrupted milk supply during crisis like COVID-19 pandemic.

The development of dairy sector in India is mainly executed by the establishment of cooperative societies of the country. Prior to independence of India, the dairy producers in India were influenced by the philosophies of Mahatma Gandhi and other freedom fighters and this resulted in the establishment of dairy cooperative societies. A best example of this is Amul which is the establishment of Kaira District Co-operative Milk Producers’ Union Limited of Anand, Gujarat. The main reason for the establishment of this cooperative society was because the milk Producers had no option but to sell their milk to the Polson Dairy in Anand and they had to travel long distance for the same. After the independence of India, it was Jawaharlal Nehru, the first Prime minister of India who under his leadership encouraged the establishment of dairy cooperative societies across India.

In the year 1973, Gujarat Cooperative Milk Marketing Federation (GCMMF) was established by Kaira District Co-operative Milk Producers’ Union. The brand name AMUL which was established by Kaira District Co-operative Milk Producers’ Union in the year 1955 was handed over to GCMMF. GCMMF consists of three tier structure one at village level which is the base level and next one is at district level and the top one being at state level. The main function of Gujarat Cooperative Milk Marketing Federation (GCMMF) is to buy milk from milk producers, process the milk and market milk and milk products. This above structure was first incorporated in GCMMF and it got replicated all over India under the Operation Flood Programme.

Three tier structures of Dairy Cooperative Societies are listed in Table 2:

This model became very successful and this resulted in the formation of co-operative movement in milk production and marketing of milk products in India. The three-tier ‘Amul Model’ by Dr. Verghese Kurien or ‘Anand Model’ by Tribhuvandas Patel became the fundamental for bringing the White Revolution in India. The greatest strength of GCMMF was their robust distribution network. Government of India established the National Diary development board in the year 1965 based on this model. Various other states in India established their own dairy cooperative society and diary brand.

As per 2019–2020 annual operational report of National Dairy Development board it was reported that dairy cooperative societies in India covered 1,94,000 villages covering the length and breadth of the
country with a cumulative total membership of about 17.22 million milk producers. It was reported that 48,040 Tons per day of milk was procured in the financial year 2019–2020. The sales of consumable milk were 37.08 Million liter per day. Apart from marketing of raw milk, these dairy co-operative societies also produce and sell various milk related products such as ghee, curd, butter milk, yoghurt, cheese, milk powder, skimmed milk, vitamin A and D fortified milk, etc.

6.1 Role of dairy cooperative societies during COVID-19 lockdown

In India, milk cooperatives like Aavin, Amul, Nandini, Parag and several state milk cooperatives modified their supply chain to ensure an uninterrupted supply of milk to its consumers. These cooperatives also procured milk from other milk producers who were initially selling their milk to private as well as unorganized players as they either refused or reduced the procurement of milk from these milk producers (Table 3).
These milk cooperatives procured surplus milk from farmers and they utilized the excess milk to produce skimmed milk powder. Co-operative milk unions continued procuring milk from the milk producers despite a dip in the sale of milk products. These dairy cooperative societies utilized the excess milk for skimmed milk powder production. The production of skimmed milk powder was 70,000 metric tonne on March 15, 2020 (NDDB) and this doubled to almost 1.34 lakh metric tonne by April 30, 2020 (NDDB) and it got further increased to 1.54 lakh metric tonne by May 15, 2020 (NDDB). It was also reported that all the milk powder plants were running between 92 and 100% capacity during COVID 19 lockdown. It was estimated that there was only a 3.5% reduction in the procurement of milk from milk producers during the period March 15, 2020 to April 30, 2020 whereas the sale of milk products got reduced by 13.70% during the same period. Brands like Amul also provided incentives to dairy plant casual workers, truck drivers, distributors, retailers and sales executives for working even during pandemic lockdown.

A nation-wide lockdown was announced and government of India initiated and implemented the lockdown starting 25 March, 2020 initially for a period of 21 days then extended for another 19 days until 3 May, 2020 and further extended for 14 more days until 17 May, 2020 and again till 31 May, 2020 with few relaxations to slow down the spread of COVID-19. Lockdown means no work for the small and marginal farmers,

| Period                     | Milk procurement (Million liter per day) | Milk Sales (Million liter per day) | Sale as percentage of procurement |
|----------------------------|-----------------------------------------|-----------------------------------|-----------------------------------|
| February 2020              | 52.91                                   | 38.44                             | 72.6                              |
| March 1 to March 15, 2020  | 53.42                                   | 38.69                             | 72.4                              |
| March 16 to March 31, 2020 | 50.96                                   | 32.02                             | 62.8                              |
| April 1 to April 7, 2020   | 50.83                                   | 32.41                             | 63.8                              |
| April 8 to April 14, 2020  | 51.42                                   | 32.72                             | 63.6                              |
| May 1 to May 15, 2020      | 51.0                                    | 33.98                             | 66.6                              |
daily labourers and other economically poor people in the villages. A sudden nation wise lockdown has created an initial hitch in the supply chain of the Indian dairy sector. But the robust marketing network of cooperative milk societies helped for a quick rebound. For example, Gujarat Cooperative Milk Marketing Federation (GCMMF) which signed a 10 year contract with IBM in the year 2009 built a single enterprise platform to bring all the members and milk federations together to provide an end to end visibility of the milk supply chain. This helped them to track all the milk tankers 24h a day by remote technology at their command centres to ensure that the operations are being carried out constantly. IBM also provided a disaster recovery solution since the product which they are handling is perishable in nature. GCMMF also incorporated high end IT solutions in milk testing, warehouse management and milk procurement. This technology adoption also provided a tenfold growth to the brand AMUL. Thus the milk cooperative societies ensured uninterrupted supply of milk to consumers and utilized the excess milk in producing value added products which prevented the milk producers from dumping the excess milk. COVID 19 pandemic proved the inherent abilities of the dairy cooperative societies and the resilient distribution network built by brands such as Aavin, Nandhini, and Amul (beginning 1970s). With lessons learnt from COVID 19 pandemic, brands like AMUL are showing interest in introducing Artificial Intelligence and Machine Learning techniques in their supply chain for both cost savings and building an interruption free distribution network.

7. Case study 2: Uzhavar Santhai (Farmer’s Market)—Supply chain for fruits and vegetables

The concept of bringing the producers and consumers in direct face to face contact and thereby excluding traders and middlemen in Tamil Nadu called as Uzhavar Santhai ( Farmers Markets), started in 1999. It is popularly known as Farmers Market. Many farmers in India sell their agricultural products through local village markets, Mandies, Co-operative Societies etc. In this food supply chain, the middlemen/owners of Mandies exploit both the farmers and consumers. In order remove the middlemen from the supply chain between farmers and consumers, the state government of Tamil Nadu under the leadership of M. Karunanidhi established “UZHAVAR SANTHAI” in 1999. Uzhavar Santhai was established based on the “Apna Mandi” model of Punjab and Haryana. It was M.S. Gill, the former
agriculture secretary of India, in his visit to the former Soviet Union visited ‘Kal Ghoj’, a farmers’ market where farmers were selling green vegetables at a high price directly to the consumers on a collective basis. Impressed by this concept, he mooted the establishment of Apna Mandi which was proved to be a phenomenal success (Saji and Jeffy, 2020).

Usually, the owners of Mandies and wholesale vegetable sellers buy the vegetables and fruits from the producers at a cheaper price. They in turn sell them to retail shop owners at higher price and they eventually sell those agricultural products to the consumers at higher price. In this type of conventional supply chain, the farmers are paid less for the products produced by them while the consumers pay higher price for the same which helped the middlemen earn more income (Mitra et al., 2018). In order to eradicate this, Tamil Nadu state government proposed this new supply chain concept which is known as “UZHAVAR SANTHAI” in order to provide maximum benefits to the producers and consumers.

The location of the “Uzhavar Santhai” is of prime importance. Uzhavar Santhais or Farmers Market are normally located in main consumer area to ensure that it is easy for the maximum consumers to reach on daily basis. On 14 November, 1999, M. Karunanidhi, former Chief Minister of Tamil Nadu inaugurated the first Uzhavar Santhai in Madurai. At present approximately 102 Uzhavar Santhais are functioning in the state of Tamil Nadu with full vigor. Agricultural Marketing Department maintains all the Uzhavar Santhais. Phase by phase, some Uzhavar Santhais were decentralized and it were brought under the local municipal bodies. The District-wise number of Uzhavar Santhais in 2003 is provided in the Table 4 below.

Salient features of this scheme:

- It provides a one-to-one contact between the producers and the consumers.
- It eliminates the interference of middlemen.
- It helps to minimize wastage of agricultural products
- It ensures the availability of fresh fruits and vegetables on daily basis.
- It aims to offer higher price to the farmers for their vegetables and fruits.
- It enables availability of agricultural produce at the lesser price than that of retail price to consumers.
- Electronic weighing machines are available to the farmers on free of cost.
- Supervision by the authorities for the prevention of malpractices.
- Price list of the produce are provided in black boards in front of every shop.
Table 4 “A study on Working of Uzhavar Santhai in Erode District” by R. Sivakumar 2003.

| S. No. | Name of the district | No of Uzhavar Santhai |
|--------|----------------------|-----------------------|
| 1.     | Madurai              | 06                    |
| 2.     | Tiruvannamalai       | 04                    |
| 3.     | Thanjavur            | 03                    |
| 4.     | Tiruchirapalli       | 04                    |
| 5.     | Salem                | 06                    |
| 6.     | Dindugul             | 03                    |
| 7.     | Theni                | 04                    |
| 8.     | Tirunelveli          | 04                    |
| 9.     | Villupuram           | 03                    |
| 10.    | Dharmapuri           | 03                    |
| 11.    | Namakkal             | 04                    |
| 12.    | Vellore              | 07                    |
| 13.    | Sivagangai           | 03                    |
| 14.    | Ramanathapuram       | 02                    |
| 15.    | Virudhunagar         | 06                    |
| 16.    | Coimbatore           | 08                    |
| 17.    | Thoothukudi          | 02                    |
| 18.    | Pudukkottai         | 02                    |
| 19.    | Karur               | 03                    |
| 20.    | Cuddalore           | 04                    |
| 21.    | Tiruvallur          | 03                    |
| 22.    | Kanyakumari         | 02                    |
| 23.    | Nagappatinam        | 02                    |
| 24.    | Perambalur         | 02                    |
| 25.    | Nilgiris            | 02                    |
| 26.    | Erode            | 04                    |
| 27.    | Tiruvarur          | 03                    |
| 28.    | Kancheepuram       | 03                    |
| 29.    | Total            | 102                   |
Daily price for agricultural products are fixed by the team of officials including Agricultural officers and representatives from farmers group.

Farmers get ready cash in this type of supply chain unlike the wholesale market where the farmers are paid money only after 2 weeks.

There is no restriction on the quantities which enables even small farmers to sell their agricultural products.

7.1 Facilities for consumers and farmers available in Uzhavar Santhai (Farmer’s Market)

7.1.1 Identity Card
All eligible farmers are entitled to get ID card. ID card contains various details like name of the farmer, photo of the farmer, name of the village to which he/she belong, survey number of the land they own and details of the vegetables they grow. It is the responsibility of the farmer to renew the ID card issued by Uzhavar Santhai office once in every 6 months. Updation or correction of existing details in the ID card is done once in every 6 months.

7.1.2 Availability of shops
Stalls/shops are allotted to the farmers who are willing to sell their products mostly on first come first basis. State government don’t charge fees for the stalls occupied by the farmers and it is allotted free of cost.

7.1.3 Prices Fixation by market committee
The market committee publishes the moderate wholesale prices of vegetables every morning through fax communication. After this a meeting between farmers committee and market committee takes place and the prices are determined which may be +25%. The price of each and every fruit and vegetable is displayed in notice boards available in the market.

7.1.4 Weighing machine availability
As soon as the farmers reach Farmers Market, a register book is available for them to enroll their name, their village name, name of the vegetables and its quantity. Based on the registration a token is issued for each farmer. Weighing machines are provided to them on token basis and they return the weighing machines to the office before leaving the market premises. No fees is collected from the farmers for using the weighing machine.
7.2 Role of Uzhavar Santhai (Farmer’s Market) in Tamil Nadu during COVID-19 lockdown

Within a less span of time, the state Government of Tamil Nadu shifted the Farmers market to large premises to ensure the smooth functioning of Farmers market by following the social distancing norms. During the Covid-19 lockdown period, Uzhavar Santhai which is basically a district-centric market model ensured the availability of essential fruit and vegetables to the consumers within each district. It helped to minimize the wastage of fruit and vegetables during COVID-19 even though it could not eliminate the wastage of fruits and vegetables in several parts of Tamil Nadu. Digitalization of Farmer’s Market in the future can help to remove the bottlenecks in the supply chain. Various other state governments must come forward to adopt models like Uzhavar Santhai (Farmer’s Market) for building a robust supply chain to boost the economy of the small and marginal farmers who comprise the 90% of India’s agricultural sector. These farmers are very vulnerable to economic shocks including COVID-19 lockdowns as these marginal farmers are a crucial part of the food value chain in India.

8. Case study 3: Public distribution system—Supply chain for pulses and cereals

The public distribution system in India, which is one of the biggest food supply chains in the world ensures the distribution of food grains at an affordable price to the people of India. It has become the integral part of government’s policy to ensure food security. In Public Distribution system (PDS) both the state and the central government works hand in hand. The Food Corporation of India under the central government performs the process of procurement, storage, transportation of food grains. It also plays the major role of the allocation of bulk the of food grains to the state government. The state government performs the function of identification of eligible families, distribution of Ration cards, maintenance and operation of Fair price shops. Food grains like rice, wheat and sugar are available for distribution to the families under PDS. Apart from food grains, spices, cereals, edible oils like palm oil, iodized salt are also distributed under PDS for the benefits of the poor.

The concept of Public Distribution system was introduced in India prior to its independence. The then British government introduced this model in the year 1939 in Bombay, which is now called Mumbai and it got expanded
to other cities and towns. It was the first structured public distribution of food grains through rationing system in India. In the year 1942, Department of Food was established. By 1943, 13 cities were covered and by 1946, 771 cities/towns were covered under this system. Post-independence, India continued with this public distribution of food grains to embark on its path of economic development and poverty elimination. Thus in the first 5 year plan, this model was extended to rural areas which suffered from severe food shortage.

In the year 1992, Revamped Public Distribution system (RPDS) was introduced with the aim of strengthening and streamlining the existing PDS to ensure that all the poor families living in remote, hilly and far-flung area were covered. Thus in RPDS, ration cards were provided to left out families, new Fair Price shops were built and also storage capacities were augmented. In addition, new commodities like tea leaves, pulses and salt were also distributed through Fair Price shops. In RPDS, food grains were allotted to state governments at a price 50 paise lesser than the central issue price (CIP). Each ration card holder were entailed to get 20 kg of food grains per month in RPDS.

Later in the year 1997, government of India implemented Targeted Public Distribution system (TPDS) with a main emphasis on poor. This scheme was mainly entitled for about 6 crore poor families and approximately 72 lakh metric tonnes of food grain was earmarked for them. In order to help these Below Poverty Line (BPL) families, 10–20 kg of food grains per month was allotted to each family at 50% of the economic cost and all the families above BPL were to pay 100% of the economic cost in TPDS. In TPDS, the state government and Union territories fixed the final retail price of food grains after taking into consideration of transportation charges, local taxes, etc.

In order to make TPDS more focused toward the poorest segments among the Below Poverty Line population, a scheme called “Antyodaya Anna Yojana” (AAY) was started in December 2000 for almost 1 crore poor families. This scheme was launched after a National Sample Survey Exercise indicated that nearly 5% of the Indian population sleeps without even two square meals a day. Thus under the AAY scheme of TPDS, these families are provided food grains at a highly subsidized rate of Rs. 3 per kg for rice, Rs. 2 per kg for wheat and Rs. 1 per kg for Coarse-grains (Nutria-cereals) by the central government. Initially 25 kg per family per month was distributed to these families and this was increased to 35 kg per family per month. The state government and Union Territories should bear the distribution cost,
transportation cost and margin to dealers as well as retailers. Thus under AAY the entire food subsidy passed on to the consumers. AAY expanded phase wise and currently 2.5 crore poorest of the poor families are getting benefited under this scheme. Now 75% of the rural population and 50% of the urban population is covered under AAY.

State wise number of Fair price shops under TPDS as on 01.05.2021 is provided in the Table 5 below.

In the past 5 years, various reforms happened in TPDS through implementation of IT driven systems. The end-to-end computerization of TPDS has transformed the world’s largest food supply chain network from a manually operated system to a completely automated system which is now more

| S. No | Name of the State and Union Territory                          | No of Districts | Total No of Fair Price shops |
|-------|----------------------------------------------------------------|----------------|------------------------------|
| 1.    | Andaman and Nicobar Islands                                   | 3              | 450                          |
| 2.    | Andhra Pradesh                                               | 13             | 37,713                       |
| 3.    | Arunachal Pradesh                                             | 23             | 1968                         |
| 4.    | Assam                                                        | 27             | 37,402                       |
| 5.    | Bihar                                                        | 38             | 46,594                       |
| 6.    | Chhattisgarh                                                 | 28             | 12,843                       |
| 7.    | Dadra and Nagar Haveli and Daman and Diu                      | 4              | 115                          |
| 8.    | Delhi                                                        | 9              | 2013                         |
| 9.    | Goa                                                          | 2              | 481                          |
| 10.   | Gujarat                                                      | 34             | 15,276                       |
| 11.   | Haryana                                                      | 22             | 10,311                       |
| 12.   | Himachal Pradesh                                             | 12             | 5028                         |
| 13.   | Jammu and Kashmir including Ladakh                          | 22             | 6748                         |
| 14.   | Jharkhand                                                    | 24             | 24,321                       |
| 15.   | Karnataka                                                    | 34             | 20,017                       |
| 16.   | Kerala                                                       | 14             | 14,182                       |
consumer friendly with more transparency. Most of the States and Union Territories automated their supply chain operation. Stock management in go downs and movement of food grains into and out of the warehouses and go downs are automated. Also SMS is provided to the beneficiaries regarding the time of arrival of food grains in Fair price shops and after procurement of food grains, a SMS is delivered regarding the quantity purchased by the consumer to avoid any malpractice. Nearly 90% of ration cards are now AADHAAR (AADHAAR is a 12-digit individual identification number issued by the Unique Identification Authority of India on

Table 5 National Food Security Food, Department of Food and Public Distribution under Government of India.—cont’d

| S. No | Name of the State and Union Territory | No of Districts | Total No of Fair Price shops |
|-------|--------------------------------------|----------------|-------------------------------|
| 17.   | Lakshadweep                          | 1              | 38                            |
| 18.   | Madhya Pradesh                       | 51             | 24,713                        |
| 19.   | Maharashtra                          | 36             | 53,351                        |
| 20.   | Manipur                              | 9              | 3914                          |
| 21.   | Meghalaya                            | 11             | 4741                          |
| 22.   | Mizoram                              | 8              | 1245                          |
| 23.   | Nagaland                             | 11             | 1631                          |
| 24.   | Odisha                               | 30             | 12,240                        |
| 25.   | Puducherry                           | 4              | 515                           |
| 26.   | Punjab                               | 22             | 17,684                        |
| 27.   | Rajasthan                            | 33             | 26,867                        |
| 28.   | Sikkim                               | 4              | 1303                          |
| 29.   | Tamil Nadu                           | 37             | 34,773                        |
| 30.   | Telangana                            | 33             | 16,999                        |
| 31.   | Tripura                              | 8              | 1828                          |
| 32.   | Uttar Pradesh                        | 75             | 79,663                        |
| 33.   | Uttarakhand                          | 13             | 9189                          |
| 34.   | West Bengal                          | 23             | 20,530                        |
| 35.   | Total                                | 714            | 546,171                       |

Short food supply chains to resolve food scarcity
behalf of the Government of India to the residents of India) linked. 4.39 Crore ineligible/duplicate ration cards were weeded out from the TPDS since 2013 through digitalization. “One Nation One Ration Card (ONORC) plan” was implemented by the Department of Food & Public Distribution, Government of India to provide an option to all eligible ration card holders/beneficiaries covered under NFSA (National Food Security Act) to buy food grains from any FPS (Fair Price Shops also called as Public Distribution Shops) in any nook-and-corner of the country. This is possible by installation of ePoS devices at FPSs and linking the Aadhaar number of beneficiaries with their ration cards. This in turn makes the biometrically authenticated ePoS transactions easier in the State/UTs.

8.1 How Public Distribution System works in India?

- It is the responsibility of both the state and the central government to supply food grains to the beneficiaries who are identified across the country.
- The procurement of food grains from farmers is done by the central government at a minimum support price (MSP) and it sells the food grains to the state government at central issue price (CIP). The transportation of food grains to the godowns in various states is under central government responsibility.
- The state government then transfer the food grains available in godowns to Fair price shops.
- The food grains are then sold to the beneficiaries at a price lower than the central issue price as many state governments provide subsidies for food grains.

8.2 Significance of Public Distribution system

- It is one of the robust food supply chains ensuring the availability of food grains even during natural calamities, wars and COVID 19 pandemic lockdown.
- It ensures the distribution of food grains from surplus region to deficit region within the country.
- It ensures the food security and the nutritional security of the nation.
- It plays a major role in poverty reduction.
- It helps to stabilize the price of food grains and ensures its availability the poor families.
During the period of low agricultural production or natural calamities like cyclones, heavy rainfall and drought the buffer stock of food grains maintained in the warehouses and go downs keeps the food supply chain active.

Through PDS, the central government is ensuring minimum support price and procurement to the farmers which resulted in significant increase in the production of food grains in India over the years.

8.3 Role of Public Distribution System in India during COVID-19 lockdown

A disaster like COVID-19 is a low-probability event with high impact and the only way to cope with such disaster is to have a robust institutional structure. During the COVID-19 lockdown, computerized Public Distribution System helped in distributing the food grains almost twice that of normal quantity during the period April 2020 to November 2020. Nearly 680 lakh Metric tonne of food grains were allocated to the beneficiaries during this period when most of the retail shops and wholesale markets were closed to avoid the spread of COVID 19. Out of 680 lakh Metric tonne of food grains, 321 lakh Metric tonne of food grains were allotted under Pradhan Mantri Garib Kalyan Anna Yojana.

Under Pradhan Mantri Garib Kalyan Anna Yojana which was announced and implemented starting March 2020, each member of the ration card holder are entitled to get 5 kg of food grains free of cost. Also to ensure adequate availability of protein to the people, each ration card family were provided 1 kg of pulses free of cost. This benefitted nearly 80 crore people of India during COVID-19 lockdown. Thus free food grains were distributed to almost 80 crore people for almost 8 months free of cost and this also helped to keep the open market prices under control. The cost incurred for the same was paid by the Government of India. Apart from the state and central governments, Indian farmers played a pivotal role in handling an unprecedented amount of food grains during lockdown which helped to avoid disruptions in the food supply chain. Food Corporation of India (FCI) lifted on an average of 1.7 lakh Metric Tonnes per day of food grains from go downs and it is more than double its normal average movement of 0.8 lakh Metric Tonnes per day (Press Bureau, Government of India April 2020). FCI has ensured continuous supply of food grains across the country during these tough time with the full support of Indian Railways, Central Warehousing Corporation (CWC) and State Warehousing Corporations (SWC). Despite few system inefficiencies, PDS is proving its worth at a time of economic and health crisis.
9. Reviving traditional food processing sectors—Study on Gud (jaggery) production

India is listed as the world’s second largest producer of sugar next to Brazil. India contributes to nearly 15–25% of global sugar production. During COVID-19 lock-down, operation of sugar industries was affected due to difficulties in the shipment of sugar-cane to the sugar mills and there was shortage of chemicals. As a result, there was a reduction in sugar production because of unavailability of sulfur, phosphoric acid, lime, packing bags, etc. Reports show that about 70% of the sugar mills in Maharashtra was shut down due to the lockdown imposed as a result of COVID-19 pandemic situation (Solomon et al., 2020).

Gud commonly called as jaggery, is traditionally used in Indian villages as an alternative to sugar, which is produced by the direct evaporation of sugar cane juices followed by drying. India manufacturer about 70% of Gud in the world (Kumar and Kumar, 2018). Production of Gud involves juice extraction, clarification, heating and concentration, cooling, molding and packaging. One interesting fact is that the nutritional values of Gud is much higher than refined sugar (Abhai Kumar, 2020).

Gud production does not require specialized equipment, skilled manpower and electricity. Also packaging and transportation issues are very minimal as against sugar production. In terms of energy requirement, energy consumption for producing Gud is 16 MJ/kg (Pattnayak and Misra, 2004) whereas energy for sugar production is 25 MJ/kg.

Ministry of Micro, Small and Mini Enterprises of India states that Indian states of Uttar Pradesh, Maharashtra, Tamil Nadu and Madhya Pradesh alone contribute to 1,00,000 Gud production units (MSME, 2018). With rapid industrialization and globalization, production and consumption of Gud is declining since 1960s and the production dropped from 60 MT/year in 1950–30 MT/year 2010, with declining rate of production of 1.3% per year, while there is an increase in the production of sugar at the rate of 3.7% per year (Nath et al., 2015; World Association of beet and Cane growers, 2013). Despite having high nutritional values when compared to sugar, production and consumption of Gud is decreasing because of presence of impurities in finished product, unhygienic processing conditions, etc. (Sardeshpande et al., 2010). Also non availability of sugar cane for Gud production is also a matter of concern because many farmers prefer selling sugarcane at higher prices to sugar mills because Gud producers purchase sugar cane at lower
price. Support from government in terms of loan, subsidies, allocation of funds for research can help to revive traditional food processing like Jaggery production. Thus, government’s support to localized food processing and local food supply chain can ensure food security during crisis like COVID-19 pandemic.

10. Need for an inclusive approach in food production

The policy framework and regulations in agricultural sector and food supply should match with India’s agrarian culture and economy. Food and Agriculture Organization under United Nations (FAO) highlighted the significance of local food processing and micro economy for real poverty elimination. Sustainable development Goals (SDGs) of FAO recommends that elimination of poverty across all countries can be possible by family farming, local cultivation and local supply chains (McKenzie and Williams, 2015).

In India, food distribution systems like Public Distribution Systems (PDS) has been functioning well before its Independence and it is one of the best integrative supply chain bulk distribution of agricultural crops by the Government of India (Qureshi et al., 2015). Also, usage of renewable energy sources like solar energy for water pumping, drying of food crops and utilization of bio–gas will result in sustainable development and inclusive growth (Grote, 2014). In addition, production of healthy snacks and ready to eat food items by self-help groups, street side shops in a distributive manner is recognized as one of the successful model for ensuring food security and creating rural and urban job opportunities (Patel et al., 2014). Various technological innovations in the agricultural sector resulted in development of less costly agro equipment like hand operated or pedal operated de-husking and de-milling equipment for crop processing, deseeding equipment, etc. (Miller-Tait et al., 2019).

For ensuring food security in an agrarian country like India, the following sectors can be improved.

(i). Public Distribution System.
(ii). Short food supply chains like Farmer’s market.
(iii). Cooperative societies mainly operated by marginal and small scale farmers.

Also, latest technologies and machineries can be utilized for reducing post–harvest losses which in turn reduces monetary loss. Post industrialization of agricultural sector, there was a free movement of goods and agro
produces across borders and nations, which led to export of agricultural products across the nations. This, in turn eventually led to increase in export potential of Western Europe and American countries, thereby leading to intensification of imbalances due to agricultural trade liberalization (Anderson, 2010; Wu et al., 2014). Establishment of large scale industrial sectors in India will highly impact the marginalized farmers, especially rural population. Such large scale food processing sectors cannot guarantee food security for a country like India during crisis like COVID-19 pandemic. However, for eliminating hunger and poverty such modernization and industrialization of food sector is needed. Hence a balance is needed between traditional food processing with local food supply chains and integrated food processing sectors for an agrarian economy like India.

11. Conclusion

With rapid economic growth, there is an increasing demand for processed foods because it is easier to cook and time saving but India’s food security can be ensured by traditional processing and local food supply chain. This is relevant for almost all developing countries where agriculture is still predominant. Government of India has undertaken various steps in bringing improvement in food manufacturing sectors via Foreign Direct Investments, establishing mega scale processing units, modern agro machineries, etc. On the other hand, government should also take various steps for promoting SFSC, reviving and developing traditional food sectors. Informal food sectors like dairy supply chain, Gud production, etc. offer excellent job opportunities to rural population and ensure food security of a nation. Thus, there should be a balance between integrated food processing industry and SFSC in the future.

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