National Innovation Council

INNOVATION CLUSTER IN THE FOOD PROCESSING INDUSTRY AT KRISHNAGIRI, TAMIL NADU

A Case Study

Based on the Innovation Cluster Initiative of the National Innovation Council

by

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Nita Sachan, Venkat Munagala, Saswati Chakravarty and Niti Sharma wrote this case solely to provide a description of work carried out under the National Innovation Council's Innovation Cluster Initiative. The authors do not intend to illustrate either effective or ineffective handling of a managerial situation. The authors may have disguised certain names and other identifying information to protect confidentiality.

EXECUTIVE SUMMARY

India is world's second largest producer of fruits and vegetables. In 2011, a total of 74.878 million tonnes of fruits and 146.554 million tonnes of vegetables were produced[1]. The value of exports of fresh fruits and vegetables from India has nearly doubled from Rs 2,411.66 crores in 2006-07 to Rs 4801.29 crores in 2011-12[2][3]. Mango accounts for 40% of the national annual fruit production. It occupies 42% of the country's 24.87 million hectares land under fruit cultivation. A large part of the annual output is processed into pulp, juices and other derivatives. However, production and process inefficiencies and lack of quality assurance in the food processing industry has resulted in limited growth opportunities.

There are 80 processing units and 25,000 farmers in the Krishnagiri cluster and its surrounding districts of which about 3,000 farmers cultivate mangoes. A total of 3,00,000 tonnes of fresh mango is processed every year to generate 1,50,000 tonnes of pulp. The remaining crop is sold both in the domestic and international markets[4]. However, it is estimated that 30-35% of the produce perishes before it reaches the end customer due to operational inefficiencies in harvest, storage, grading, transportation, packaging and distribution[5].

The National Innovation Council (NInC) has facilitated pilot innovation interventions at the Krishnagiri cluster which are expected to impact the business economics of the cluster. NInC has focussed on facilitating the creation of an innovation ecosystem and a Cluster Innovation Centre (CIC) that is expected to address the long term challenges the cluster faces. The following study captures the challenges, evaluates the interventions and innovation ecosystem map for the Krishnagiri food processing cluster.

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[1] http://www.apeda.gov.in/apedawebsite/six_head_product/FFV.htm

[2] http://www.apeda.gov.in/apedawebsite/six_head_product/FFV.htm

[3] http://business.gov.in/agriculture/current_scenario_horticulture.php

[4] *NInC sources, 2012*

[5] http://www.dsir.gov.in/reports/ittp_tedo/agro/AF_Farm_Fruits_Vegetables_Intro.pdf

BACKGROUND OF THE CLUSTER

In Tamil Nadu, mango is cultivated in approximately 1,25,000 hectares of land generating about 5,40,000 tonnes of the fruit[6]. The major mango growing districts are Dharmapuri, Krishnagiri, Vellore, Dindigul, Thiruvallur and Theni. The Krishnagiri region has a semi-arid climate and the farmers primarily grow totapuri mango which is ideal for making pulp. The district cultivates mango in approximately 40,100 hectares of land with a total output of 3,40,000 tonnes of mango[7].

In October 2011, with the assistance if NInC, the Krishmaa Cluster Development Society (KCDS) was formed to engage with stakeholders of the industry, both within and outside the Krishnagiri region. A total of 22 processing units and 140 large scale farmers are members of the KCDS. National Innovation Council (NInC) identified the cluster based on factors such as market potential, workability and sustainability, easy availability of workforce and livelihood improvement. The cluster includes crucial partners such as the farmers, suppliers, buyers or exporters, government institutions, business associations, providers of business services etc.

Mr. Tilak Ram, the treasurer of Krishmaa Cluster Development Society (KCDS) highlights:

> *"All the processing units are located within a range of 40 km. Even with this distance 30-40% fresh fruit spoilage occurs. Our cluster has not done any export of fruits till now."*

KCDS faced challenges and foresaw opportunities in product diversification, operational improvement in production, technology, marketing and vocational training. KCDS has been instrumental in working with NInC and participating in the Cluster Innovation initiative.

KEY CHALLENGES

The cluster identified farming practices, fruit handling, waste management, processing and product marketing as candidate areas which would have maximum impact and provide significant benefits to the cluster. Of these innovations, pilots have been carried out for (a) solid and liquid waste management (b) product diversification and (c) farming, storage and handling protocols in collaboration with technology partners and the support of NInC. This study summarizes the results so far and the best practices followed for other clusters to replicate.

(a) Solid and liquid waste management

Solid and liquid waste management has been a major area of concern for the processing units. During the mango season approximately 3,00,000 tonnes of mangoes are processed which produce close to 1,05,000 tonnes of solid waste (kernel, skin, fibre) and 1,50,000 cubic meter of liquid waste (mixed with fibre and skin)[8]. The mango season lasts for a short span of 8-10 weeks. Disposal of this waste, coupled with environmental concerns associated with dumping, has been a major challenge for the processing units of the cluster. The wet waste decomposes quickly, which in tropical climates creates breeding ground for flies, rats and other disease causing pests. It also pollutes air and ground water. Waste management is thus essential for effective utilization of resources and alternate waste usage.

(b) Product diversification

The cluster produces an average of 1,50,000 tonnes of processed pulp annually, which is the major form of processed food product. The units do not have access to technological expertise for producing diversified mango products on a commercial scale. The Mysore-based CFTRI (Central Food and

[6] *Diagnostic study report on Krishmaa Mango cluster, prepared by IL&FS for NInC, March 2012*
[7] *Diagnostic study report on Krishmaa Mango cluster, prepared by IL&FS for NInC, March 2012*
[8] *KCDS and NInC sources*

Technology Research Institute) offered help to the processing plants to diversify into processed foods suiting wider market tastes.

(c) Farming, storage and handling protocols

Mangoes are prone to various fungal diseases (such as anthracnose or black spots on the skin) resulting in increased spoilage and reduced flavour. Additionally, the typical shelf life of the fruit is 5-7 days, making it difficult to store the excess produce for off-season consumption. Indian mangoes are largely exported to West Asia, UK, USA, Singapore and other countries, but the market potential remains unexploited due to the short shelf life of the fruit and lack of knowledge of best practices in handling mangoes. Exporting mango involves air lifting to foreign destinations to offset its short life span and adequate packaging, which is usually expensive.

According to Mr Selvam, a mango producer from the region:

> "*There is an urgent need for farmers to improve pre and post harvest techniques for better cultivation and quality. Due to poor infrastructure and harvesting techniques, almost 30-40% of the produce gets wasted every year. Only the cluster or the society can induce proper knowledge in this aspect. Export of mangoes from the Krishnagiri cluster is minimal due to lack of proper storage and packaging facilities.*"

The cluster members highlighted the above issues not only as the most challenging areas but also as having the maximum potential to benefit both the mango producers and processing units. These were chosen over other interventions which could provide equal or more value as these could also provide immediate benefit to the cluster. The following table summarizes the projected benefit to various stakeholders in the cluster.

Activity	Benefit to Mango producer / Farmer	Benefit to Processing Unit	Benefit to Cluster in general
Solid and liquid waste management	-	Yes	Yes
Product diversification	Yes	Yes	Yes
Farming, storage and handling protocols	Yes	-	Yes

CLUSTER ECOSYSTEM

The Krishnagiri cluster consists of 3,000 independent mango farmers and 80 processing units. In the past decade or so, all attempts to form co-operatives of mango producers and processing units turned out to be a futile exercise. Recently, with NInC’s support, members of the cluster decided to try out a new course of action.

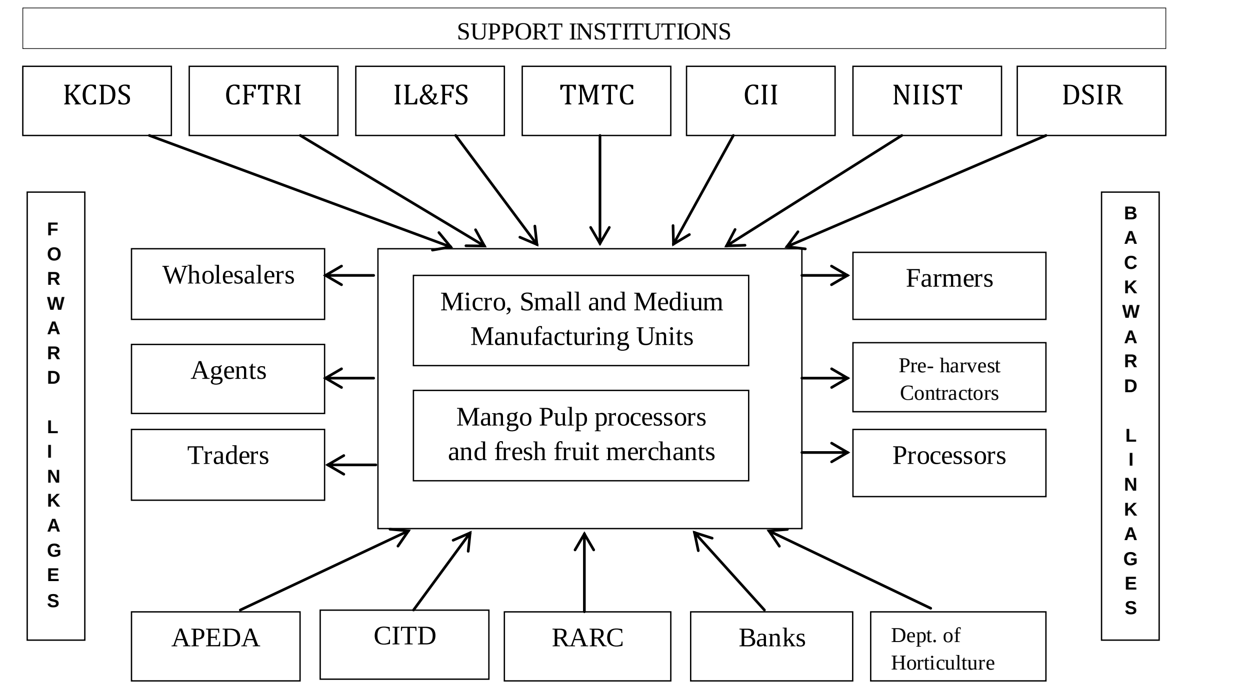
Since most of the cluster members were small and medium scale operations, they lacked access to information on latest farming practices and processing techniques and often depended upon informal sources of knowledge. A cluster level innovation ecosystem was mapped out by NInC to identify existing and new networks to address the challenges. These included public and private institutions which would work with the various cluster members on specific issues.

NInC facilitated KCDS to partner with Central Food Technology Research Institute (CFTRI), National Institute of Interdisciplinary Science and Technology (NIIST), Department of Scientific and Industrial Research (DSIR), Tamil Nadu Agricultural University (TNAU), Agricultural Products Export Development Authority (APEDA) for access to technologies and knowledge networks. With technology transfer and knowledge sharing activities tied into the respective institution mandates, the organisations were willing to support pilots to demonstrate benefits from such collaborations. These partners also provided access to technological know-how.

With minimal seed support from NInC, KCDS created a Cluster Innovation Centre (CIC), which ensured that the various stakeholders were engaged in collaborative activities and enabled execution of pilot innovation projects in Krishnagiri. Most of the stakeholders were self-motivated and highly committed towards the growth and development of the cluster. NInC helped bring a fresh approach to streamlining activities and achieving results faster. It provided a common platform for everyone to get their ideas together and bring in innovation according to the cluster's needs.

NInC has facilitated CIC to forge new partnerships and strengthen existing ties with various associations. NInC also helped identify various challenges and used best practices for capacity building and processes to tackle the challenges. These included implementing faster and innovative interventions with the help of multiple stakeholders. NInC was able to expedite the process by not only bringing on board the right partners with the knowhow but at minimal cost to the stakeholders.

Figure 1: Present Cluster Ecosystem of Krishnagiri Cluster



[9]*Abbreviations*

PILOT INNOVATION INITIATIVES UNDERTAKEN

(a) <u>Solid waste management</u>

The CIC provided support for setting up a pilot plant for making fuel briquettes from pulverized solid waste generated from one of the processing units. It is estimated that these fuel briquettes would not only reduce usage of expensive firewood, which is used traditionally to fire the boilers, but also help

[9] *KCDS- Krishmaa Cluster Development Society, CFTRI- Central Food Technology Research Institute, IL&FS- Infrastructure Leasing and Financial Services Ltd, TMTC- Tata Management Training Center, CII- Confederation of Indian Industries, NIIST- National Institute of Interdisciplinary Science and Technology, DSIR- Department of Scientific and Industrial Research, APEDA- Agricultural and Processed Food Products Export Development Authority, RARC- Regional Agricultural Research Center*

reduce environmental pollution and improve efficiency. Usage of briquettes instead of firewood is expected to result in an estimated savings of Rs 44,000 per day and a total savings of Rs 30,08,000 during the entire season[10]. The briquettes are not only cheaper when compared to firewood but also more efficient because of higher calorific value and low moisture content. The briquettes can also be sold at Rs 4,000-5,000 per tonne, providing the unit with a new revenue stream. NInC has helped KCDS has partner with National Institute of Interdisciplinary Science and Technology (NIIST) to provide technical assistance to improve the process efficiency of the briquetting units.

(b) Liquid waste management

Liquid waste (water mixed with mango skin, pulp fibre and other elements) is an effluent from the processing units. This waste can be used to produce biogas, which can be used to generate power for the processing units. KCDS setup a pilot plant at one of the processing units for producing electricity from the liquid waste. Pilot unit trials were successful and the CIC plans to help the cluster replicate such units. Power from liquid waste is estimated to make the processing units less susceptible to power outages and is significantly cheaper than the grid power. With increased efficiency and proper management, the bio-fuel based power is estimated to completely substitute grid power. An estimated 800 cubic meters of biogas can be produced by an average processing plant which generates 1,00,000 litres per day of liquid waste. This is equivalent to nearly 100kw of power per day, enough to power a processing plant for 16 hrs.

Item	**Calorific Value**	**Cost per tonne**	**Consumption**	**Expenditure/day**	**Selling price per tonne**
Firewood	2,400 k cal	Rs 5,000	10 tonnes	Rs 50,000	-
Briquettes	3,800-4400 kcal	Rs 1,000*	6 tonnes	Rs 6,000	Rs 4,000-5,000
Savings		**Rs 4,000**		**Rs 44,000**	

*Manufacturing cost; Plant Capacity = 400 tonnes/day; Average mango season lasts for 70 days
**[11]

As explained by Mr Ravi, a waste management consultant to the processing units in the cluster:

"*Due to the high level of contamination in biogas, like the presence of carbon-di-oxide, the energy efficiency comes down to 60%. The units cannot function at full capacity. However, there is still a cost benefit that accrues since the biogas is produced in-house at a fraction of the cost of purchased power".*

Item	**Calorific Value**	**Consumption**	**Cost per unit**	**Efficiency**
Biogas	5,000 kcal	800 m3	Rs 7-8	60%
Diesel	10,300 kcal	100 kw	Rs 14	100%

Estimates for 16 hrs of work
**[12]

[10] *Based on a processing plant capacity of 400 tonnes/ day capacity and 8-10 week mango season; KCDS and NInC sources*
[11] *** KCDS and NInC sources*
[12] *** KCDS and NInC sources; average of 16 hours of workday*

(c) Diversified mango products

CFTRI was consulted to suggest new products which would cater to wider tastes of the market. A hygienic form of mango fruit bar was developed to extend the working season for processing mango pulp and find new uses and markets for it. Other products to be made in future include mango flavoured corn flakes, jam and jelly etc. Local small scale industries decided to add the new range of products to their existing portfolio. Additionally, local women's Self Help Groups (SHGs) who were already making papads were trained to make pickles from raw mangoes. Each SHG can potentially create livelihoods for 20 people.

(d) Farming and storage protocols

CFTRI scientists extensively experimented with various pre and post-harvest techniques which was designed to prevent infections and extend the shelf life of mangoes by delaying ripening. The scientists worked with the farmers to do a test pilot by exporting a shipment to UK.

Talking about the CFTRI protocol, Udai, another local mango farmer says:

> *"Earlier we sprayed only pesticides only 1-2 times to save costs. CFTRI scientists taught us to spray a combination of fungicide and pesticide 3 times during the season- once during flowering, then in fruit stage and finally 20 days before harvest. This was meant to increase the shelf-life of the mangoes due to reduced anthracnose infections."*

These interventions are expected to increase the commercial value, for the farmers especially from exporting the mangoes which mandates higher quality, extended shelf life and command higher prices. These innovation interventions are expected to increase the shelf life of mangoes from 5-7 days to 30-40 days. Specially designed boxes were utilized to minimize damages during transportation and adequate cold storage facilities have been identified by KCDS. A few farmers have also ventured into growing alphonso mango variety which fetches higher price in the export market.

IMPACT AND WAY FORWARD

The Krishnagiri mango cluster has been the most proactive in the cluster initiative due to multiple factors such as the members being self-motivated, having common goals and financial stability. It is too early to assess the impact of the ground-level innovations. It may take couple of years before any results are visible. Hence, it is important for the momentum to be maintained. Additional infrastructure support in the form of cold storage chains and promotion of exports will be conducive to improving the livelihood of the farmers.

The partners of the initiative, encouraged by the success of the pilots, have started taking steps for long-term collaborations. CSIR-CFTRI is considering setting up a Regional Extension Centre to work closely with the cluster. This moved has been welcomed by the farmers and processing units alike, who have recognised the importance of science and technology for their industry and livelihoods.

KRISHNAGIRI FOOD CLUSTER KEY INTERVENTIONS AND IMPACT

ACTIVITY	PRE-INTERVENTION	EXPECTED IMPACT	BENEFIT TO	WAY FORWARD
Formation of Cluster Innovation Centre/ KCDS Association	• No knowledge sharing practices • No identification of common issues	• New organisational mechanism to focus on common needs • Identification of common R&D needs • Scalability of innovative practices across all units • Democratisation of socio-economic benefits	Cluster	• Forge new partnerships • Encourage involvement ground-up • Showcase benefits of common resource base • Community participation and ownership
Solid waste management	• Dumping of untreated waste • Rs 52,00,000 spent per season on waste disposal	• Production of fuel briquettes and edible kernel butter from waste • New streams for income generation. • Cleaner environment • Cost of solid waste disposal saved	Cluster Processing units	• Popularise manufacturing and usage of fuel briquettes • Replace firewood to light boilers • Find channels to sell briquettes to generate income
Liquid Waste Management	• Breeding ground for flies, insects, pests • Air, ground water pollution • Costs incurred to dispose liquid waste in tankers	• Production of methane gas through biogas plants • Bio-fuel-based power to run processing units • Cleaner environment • Cheaper cost per unit of power	Cluster Processing units	• Need to scale up by setting up biogas plants at multiple units • Improve efficiency and management of such units to replace grid power
Increasing shelf life of mangoes	• Typical shelf life of 5-7 days for fresh mangoes • Prone to fungal diseases • Mango season lasts 70 days • High cost of exports due to air freight and expensive packaging	• Fruits expected to last for 30-40 days • Longer season for processors. • Specially designed boxes for transportation • Better selling price for farmers in export market	Farmer Cluster	• Adequate cold storage facilities needed • Usage of sea route for exports could cut transportation costs by 30% • Access to newer markets • Prevent distress sales by farmers
Product diversification	• Only two products - fresh mangos and pulp • Dependence on pulp market • 70 working days	• Three new products - mango bar , pickle, jams • Additional revenue possibilities for SHGs • Extended working days to 90- 240 days instead of 70 days	Cluster Processing units Farmers	• Further extension of product portfolio needed • Identification of new markets for the products