ADB

# Technical Assistance Consultant's Report

Project Number: 53145-001
November 2020

# INDIA: Strengthening Capacity to Design and Implement Water and Rural Infrastructure Facility

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Haryana, India



Asian Development Bank

# TA-9738 IND: Strengthening Capacity to Design and Implement Water and Rural Infrastructure Facility - Agri Value Chain Technology Specialist (National) for Maharashtra Agribusiness Network Project (53145-001)

Asian Development Bank (ADB)

November 28, 2020

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Gurugram, November 28, 2020

To,

Mr. Masahiro Nishimura
Senior Rural Development Specialist,
Environment, Natural Resources & Agriculture Division (SARD)
South Asia Department,
Asian Development Bank (ADB)

Subject: Submission of **Final Report** for 'TA-9738 IND: Strengthening Capacity to Design and Implement Water and Rural Infrastructure Facility - Agri Value Chain Technology Specialist (National) for Maharashtra Agribusiness Network Project (53145-001)'

Dear Sir,

In accordance with your instructions as confirmed in our service contract dated 27th February 2020, we are pleased to submit **Final Report** for 'TA-9738 IND: Strengthening Capacity to Design and Implement Water and Rural Infrastructure Facility - Agri Value Chain Technology Specialist (National) for Maharashtra Agribusiness Network Project (53145-001)' as a part of the deliverables for the abovementioned consultancy services.

We request you not to make copies of this report available to other persons except as described in the Letter of Engagement and Terms of Business. Where provision has been made copies are subject to the conditions described therein. We will not accept any duty of care (whether in contract, tort (including negligence) or otherwise) to any person other than you, except under the arrangements described in the Letter of Engagement and Terms of Business.

If you require any clarification or further information, please do not hesitate to contact **Nitin K. Gaikwad on +91-992276699** or email **nitin.k.gaikwad@pwc.com.**

For and on behalf of **PricewaterhouseCoopers Pvt. Ltd.**

We remain,

Yours Sincerely,


**Authorized Signature**

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**Name of Consultant:** PricewaterhouseCoopers Pvt. Ltd.
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# Contents

# 1. *Context & Background*

## *1.1. Horticulture in Maharashtra*

Maharashtra is one of the leading states in the country in Horticulture Production. The diverse agro-climatic conditions of the state are very congenial for cultivation of various horticultural crops. The area under fruit crops which was 2.42 Lakh Ha in 1990 has gone up to 69.87 Lakh Ha in 2019[1]. Similarly, the area under various vegetables, spice crops and floriculture has also increased substantially.

*Table 1: Area and Production of Horticulture Crops (2018-2019)*

| Category | Production ('000 MT) | Area ('000 Ha) |
|---|---|---|
| Fruits | 9992.467 | 698.734 |
| Vegetables | 11610.485 | 682.86 |
| Plantation | 342.493 | 220.948 |
| Aromatics and Medicinal | 0.217 | 0.41 |
| Flowers | 29.08 | 5.485 |
| Spices | 35.01 | 56.99 |
| Honey | 1.78 | 385.11 |

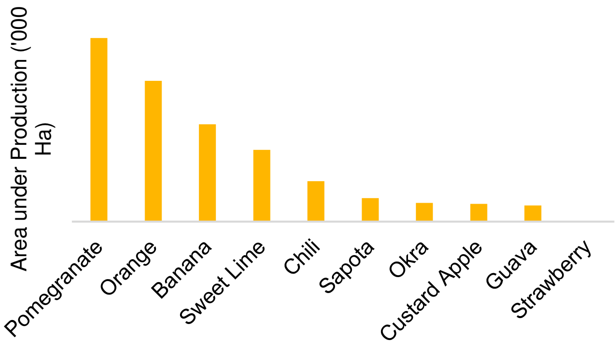
Based on the agro-climatic zones, there are four well-defined fruit zones in the state:

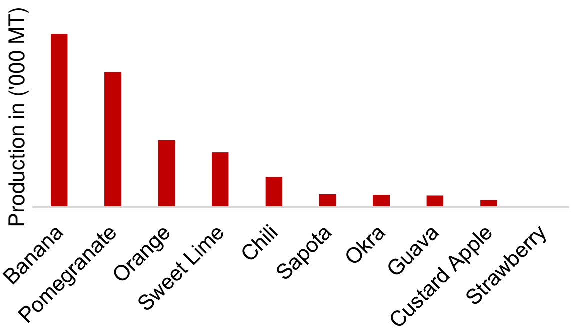
- Konkan (Ccoastal): Mangoes, Cashew nut, Coconut, Arecanut and Pineapples
- Jatgaon/Dhule: Bananas, Citrus and Lime
- Nagpur: Oranges
- Ahmednagar, Aurangabad, Pune, Satara, Sangli, Beed and Nasik: Grapes and Sweet Lime (Mosambies)

Different types of soil, diverse agroclimatic conditions, adequate technical manpower, well developed communication facilities, increasing trend in drip irrigation, green house, use of cool chain facilities and vibrant farmer Organisation offer wide opportunities to grow different horticultural crops in the State.

- The state is the home of the renowned Alphanso mango, ranks first in grape, orange, cashew nut and pomegranate production and has the highest productivity in banana in the country.
- State contributes towards 83% of the total production and market supply of strawberry in India. Mahabaleshwar strawberry also enjoys a geographical indicator status; thus giving it a unique brand recognition.
- The state also has four state agricultural universities, four colleges of horticulture and two colleges of forestry.
- It has three National Research Centers (Grapes, Citrus and Onions).
- Further, it also has infrastructure for floriculture industry in the form of greenhouses, pre-cooling units, cold storage units and reefer vans.
- The state also has crop-based farmer organizations such as Grape Growers' Associations which provides technical consultancy to farmers and Western India Floriculturist Association, which again provides service and support to farmers and promotes exports.
- The state has Pomegranate Growers' Association, Banana Growers' Association, Mango Growers' Association, Medicinal and Aromatic Plants Growers' Association and Association for Organic Spices Cultivation. All these associations promote cultivation and export of produce.
- There are also 1600 registered fruit nurseries in the state

[1] *Area and Production of Horticulture Crops, NHB (2018-2019)*




## 1.2. Issues faced by Horticulture Sector

The growth in horticulture sector has high potential driven by rising incomes, high-income elasticity and increasing demand from the current low values of per capita consumption but there are several emerging challenges that this sector face:

### 1.2.1. Marketing of the Produce

- As area under horticulture is showing an increasing trend over years, the production of fruits will naturally increase. Therefore, development of a well-coordinated market system, value addition and agro-processing will have to play a major role.
- In India however fruits are consumed mainly as table fruits and processed fruits and vegetables play only a marginal role. Moreover, only specific varieties of the fruits can be processed and hence farmers must be encouraged to grow these varieties

### 1.2.2. Very High Levels of Wastage and Value Loss

- The fruit and vegetable sector are marked by a very high degree of wastage and value loss. The storage and handling techniques at the farm are inadequate. By and large, all crops are harvested simultaneously, and the harvesting of the produce is done without considering the distance over which the produce has to be transported.
- As a result, the natural processes of ripening can greatly add to value loss during transportation, before the produce leaves the farm.
- While farmers in the more developed markets receive 40 per cent to 70 per cent of the final retail price, in India they receive as little as 25 per cent of the end consumer price.
- A further problem is that although the intermediaries are cumulatively high cost, they add little value to the produce, their primary role being to bring the buyer and seller together.

### 1.2.3. Water Constraints

- Although the area under horticultural crops has increased, the state of Maharashtra is regularly faced with severe drought conditions and untimely rains which lead to high mortality rates of plants.

### 1.2.4. Inadequate Infrastructure

- Horticultural crops have high export potential. However, several exporters face major constraints due to inadequate cold storage facilities.
- Horticultural produce is highly perishable and sensitive to temperatures and sudden exposure to high temperatures from refrigerated vans leads to deterioration in the quality of produce.

### 1.2.5. Quality Control to Meet Export Standards

- Exports are required to comply by the stringent export quality standards failing which would lead to barriers in trade.

- Although, the state has high export potential, farmers often lack awareness on export quality requirements and do not follow the recommended practices leading to low quality produce with high pesticide residue. This again leads to rejection of the produce.

## 1.3. Gaps and Issues in the Selected Value Chains

Information in this section has been abstracted from: **"Mapping Study on Agribusiness, Industry and Value Chain Players in the State of Maharashtra," Deloitte, 2018**. The Mapping Study was limited to: pomegranates, bananas, sweet limes, mandarins and custard apples.

The purpose of this section is to review major value chains and provide context for the next sections which will provide the basis for the consultants' work on analyzing the suitability, sustainability, innovativeness, cost-benefits of technology to improve the competitiveness of horticulture value chains in Maharashtra.

Additional summary information has been provided on other crops which were not included in the Mapping study. These crops Green and Red Chili, Guava, Sapota, Strawberry and Okra. Information on these crops has been summarized from government statistics and from preliminary discussions with government officials and the private sector. For easy understanding the gaps are bucketed into four major categories such as production, post-harvest management & processing, transportation and marketing.

### 1.3.1. Production

The selection of production technologies is focused on improving competitiveness through increasing yields, reducing costs while differentiating products through processing and quality. A comparison of yields between Maharashtra and other states for key products provides an indication of the effectiveness of production techniques, though variations in growing conditions will also be an important factor.

#### 1.3.1.1. Banana

**Yield:**

Banana yields for the State are approximately 60% of the lead state Madhya Pradesh and with an average of 41.14 MT / ha the province is ranked 5th on terms of yield.

**Production Cost:**

Establishment costs are estimated at Rs 88,920 of which irrigation set-up costs make up almost 70% with land preparation making up the remaining 30%. Total annual costs are estimated to be Rs 189,179. Tissue cultured suckers are replaced every 18 months and can be considered an annual cost making up 21% of the total. Fertilizer makes up the largest part (44%) of the total costs. Plant protection including bunch covers and chemical sprays make up 15.5% of the costs. With weeding and harvesting making up the remaining costs with 6.5% and 13% respectively.

#### 1.3.1.2. Custard Apple

**Yield:**

Maharashtra is the 1st ranked state wise for production of custard apple in the country. But if we compare the productivity of Maharashtra (7.1 MT / ha) with the national average (7.84 MT / ha) and with other

states, it lags well behind Madhya Pradesh (12.22 MT / ha), Rajasthan (11.76 MT / ha) and Gujarat (10.32 MT / ha).

**Production Cost:**

Establishment costs for custard apples are estimated at Rs 129,750 of which land preparation makes up 43% with irrigation making up 48% and planting material 8.6% of the set-up costs. Annual costs are estimated at Rs 207,500 of which fertilizer makes up 51%, harvesting 19%, pruning 16% with plant protection and weeding making up 7.6% and 6% of the costs respectively.

#### 1.3.1.3. Guava

**Production Cost:**

The planting material in case of Guava is comparatively costly.

#### 1.3.1.4. Orange

**Yield:**

Maharashtra is the 3rd. ranked state for mandarin in the country. The average productivity of Mandarin in Maharashtra (9.16 MT/Ha) is lower than the average productivity of India (11.1 MT/Ha) and less than half the productivity of Karnataka (23.18 MT/Ha).

**Production Cost:** At this stage it has not been possible to obtain a breakdown of production costs of mandarin.

#### 1.3.1.5. Pomegranate

**Cultivation Practices:**

- Mature fruits should be protected from direct exposure to sun rays – suggestion is covering the fruits and soil moisture conservation by mulching to minimize rate of evaporation
- Soil testing is essential to make soil specific amendments
- Water management is essential since under irrigation leads to moisture stress while over irrigation leads to leaching of nutrients from the root zone

**Yield:**

Maharashtra is the largest producer of pomegranates in India however the average productivity is about 11.5 MT/ha which is slightly lower than the national average of 12.1 MT / ha but significantly less Tamil Nadu where average yields of 27.43 MT / ha are achieved.

**Production Cost:**

Establishment costs are estimated at Rs 249,950 of which irrigation set-up costs make up almost 50%. Land preparation makes up 35% of establishment costs with the cost of seedlings making up the remaining costs. Annual costs are estimated to be Rs 314,925 of which fertiliser makes up the largest part (39%) of the total costs. A large proportion of this cost is farm-yard manure which has a relatively low nutrient status and needs to be applied at high rates with an intensive use of labour. Plant protection makes up 35% of annual costs with weeding, pruning and harvesting making up 9.4%, 6% and 3% respectively.

#### 1.3.1.6. Sweet Lime

**Yield:**

Although the area in Sweet Lime production accounts for 26% of the national total this translates into only 19% of the total production for the country due to lower productivity in the state (11.97 MT / ha) as compared to Madhya Pradesh (16.10 MT / ha), Karnataka (16.05 MT / ha) and Telangana (13.72 MT / ha).

**Production Cost:**

Sweet Limes are a relatively inexpensive crop to establish and maintain. Establishment costs are estimated at Rs 80,000 of which irrigation set-up costs make up almost 75% with seedlings making up the remaining 25%. Total annual costs are estimated to be Rs 69,360. Fertiliser makes up the largest part (58%) of the total costs. Weeding and harvesting contribute 18% and 14% respectively.

#### 1.3.1.7. Okra

**Cultivation Practices:**

Mulching is essential to prevent weed infestation.

### 1.3.2. Post-harvest Management and Processing

#### 1.3.2.1. Banana

**Primary Processing:**

Primary processing is carried out by traders and aggregators often at the farm gate rather than at specialized facilities such as the Banana Export Facility constructed by Maharashtra State Agricultural Marketing Board at Savda.13 It involves de-handing of the produce, washing, grading and packing the produce in cardboard boxes of either 14.5 kg or 16 kg. if they are consigned to markets 3 – 4 days travel away. For local markets the bananas may be packed into 20kg. plastic crates.

**Storage:**

Bananas have a shelf life of 8-10 days at ambient temperature, however this can go down to 5-6 days in the summer season, when the temperatures are high. it is important then that bananas are cooled as soon as possible to increase their shelf life. However, when the produce is to be marketed to distant markets involving a transit period of more than three days, then they are packed in corrugated cardboard boxes. The capacity of these boxes varies from 14.5 kg or 16 kg depending upon the requirement of the buyer in the distant markets. Some primary processors also have small cold store-cum-ripening chambers. These cool rooms may serve as pre-cooling rooms where the produce is cooled prior to long distance transport, or as holding rooms for produce to be sold on the local market. One Farmer Producer Organization (FPO) has constructed a pack house with a cold storage cum ripening chamber. The FPO uses this facility for its own purpose, and not as a common facility center, and the capacity is only 8 MT. IN general there is a shortage of cool storage capacity for bananas in the state that are accessible to FPOs.

**Secondary Processing:**

Secondary processors are the companies[2], which are involved in manufacture of processed products like banana chips, banana purees and concentrates, etc. Apart from the organized companies, there are a number of very small-scale road-side vendors who are involved in making banana chips. Apart from this, there are other products, which can be manufactured including banana powder as well as products made from the stem including plates, bags, coir etc.

#### *1.3.2.2. Custard Apple*

**Primary Processing:**

Primary processing of custard apples includes sorting, grading, & packaging. There are many private traders cum pack-houses operating in the state. They form the major procurement players to buy produce from the farmers and undergo value addition through sorting, grading, & packaging. Some of the farmers also perform sorting grading & packaging at their houses for their own produce. Custard apples are generally harvested in the morning and collected at the farm level in plastic crates. The fruit does not require any cleaning or waxing but needs to be handled with delicate care as its skin is easily damaged by rough handling. The farmer collects the produce in the crates and sells it to the trader. Only the produce is sold to the trader and the empty plastic crate is used again by the farmer thus reducing the recurring expenditure on farmers.

**Storage:**

Custard apples are harvested and fresh fruit is traded usually within the same day. The fruit has a very short shelf life and deteriorates if kept in cool storage for any period of time.

**Secondary Processing:**

There are around 40-45 small, medium & large processing/ pulping units in the state. These units procure custard apples directly from farmers. either at the mandi or through direct contact with the farmers. The pulping industry in the state is highly labour intensive as they follow the manual process of pulping.

The overall process of pulping involves manual sorting of fruit and separating the damaged, bug infected produce as it might affect the whole pulp. The fruit is then kept for around 2-3 days so that they reach the last stage of ripening before it starts decaying. The, pulp with seeds is removed manually using spoons and the seeds are separated out. The pulp is then frozen into packs for sale. Most of the large processors hold the pulp to sell it in off season as the prices offered during the off season are around 40-50% higher than the prices offered during the season. Around 5-10% of the produce is channelled through the processing sector from the state.

#### *1.3.2.3. Orange*

**Primary Processing:**

Primary processing includes sorting, grading, waxing & packaging. There are many private traders cum pack-houses operating in the state. They form the major procurement players to buy produce from the farmers and undergo value addition through sorting, grading, waxing & packaging. Some of the FPOs have also started building their pack-houses and waxing units for handling the produce. Mandarins are generally harvested in the morning and collected at the farm level. The majority of the produce is sold through pre-harvest contracts between

[2] Jain Irrigation and Systems Pvt Ltd., produces banana puree and concentrates; L. Venka Foods Pvt. Ltd., produces banana chips

traders & farmers. In cases where there is no cleaning & waxing performed on the fruit, then sorting & grading happens manually at the farm level itself. The fruits are then packed in wooden boxes or plastic crates depending on the requirement of the distant markets. Now-a-days most of the packaging happens in plastic crates due to ease of use and lower cost. A standard plastic would carry around 22-24 kg of fruit. A horizontal layer of fruit is placed in the plastic crate with covering of newspaper and cardboard over it. Then another layer of fruit is placed with same covering. Depending upon the size of the fruit, the number of layer can vary from 4-6. Old newspapers or cardboard sheets are placed between the two layers to protect the fruit from friction damage & reduce moisture loss. Waxing is usually carried out at packhouses where fruit maybe graded using a laser.

**Storage:**

Fresh mandarins are harvested early morning and is sorted, graded, waxed and packaged in plastic crates and loaded in trucks till late evening for dispatch. There appears to be no demand for cool storage for mandarins.

**Secondary Processing:**

There are around 80-85 small, medium & large processing units in the state for Mandarin. There are two major processing units located in Nagpur & Nanded district which are the major procurers of raw fruit from the farmers. They majorly procure directly from the FPOs / farmers and the produce is transported from the production clusters to the processing units through trucks. Around 5% of the produce is sold to the processing sector from the state.

### 1.3.2.4. Pomegranate

**Primary Processing:**

Sorting and grading operations, are carried out either by the farmers or by the post-harvest contractor (who buys the produce at the farm-gate). Once, the produce is harvested, it is temporarily stored at a suitable open area around the farm or at temporary collection sheds of the farmers. Traders report that produce packed in these conditions does not meet the required quality standards. Some of the farmer Producer Organizations (FPOs), who have opted to construct a pack-house, use the same as collection center for temporary storage of produce.

**Storage:**

Pomegranates have a shelf life of around 10-14 days when stored in shade at ambient temperature. Pomegranates, which are to be marketed for table consumption, are purchased by the post-harvest contractors at the farm-gate or by the commission agents / traders at the market yards and transported the same day to the distant markets. Therefore, there is no requirement of storage space felt by the traders / post-harvest contractors. Processors who produce value added products such as pomegranate arils, juice, anardana, etc. and the exporters have a requirement for cold storage space, so that the fresh produce can be stored / stocked for 1-2 months depending upon their requirements. At present cool storage for processing is limited to large companies such as Freshtrop and is generally not available to other pomegranate value chains.

**Processing:**

The major pomegranate-based products marketed are Frozen Pomegranate Arils and Pure Pomegranate Juice (without any additives). Besides fruit juice, there is significant potential for commercial production and up-scaling of various other value-added pomegranate products as pomegranate seed oil, powder of dried pomegranate peels, etc.

### 1.3.2.5. Sweet Lime

**Primary Processing:**

The majority of Sweet limes are sold at the farm gate without any sorting or grading and are loaded loose onto traders' trucks. The Pratisthan Agro Producer Company Ltd in Paithan, Aurangabad has constructed a packhouse, which also functions as a collection and sorting, grading center for multiple commodities. But the sorting and grading of the fruits is done manually by employing labor, there is no automated sorting grading line at the packhouse. Kalyani Farmer Producer Company Ltd., Jalna has commenced work on construction of a packhouse (2018).

**Storage:**

Sweet Lime has a shelf life of around 20 days when stored in shade at ambient temperature. The majority of the produce is purchased by contractors at the farm gate or by the commission agents / traders at the market yards and transported the same day to the distant markets. Therefore, there is no requirement or demand for storage

space. However there would be a demand for pre-cooling and cool store facilities for sweet lime that needed to be stored for longer periods of time to meet seasonal niches.

**Secondary Processing:**

There is only one major processing company in the state, Citrus Processing India Pvt. Ltd (Nanded). The company buys Grade C and Grade D fruit from market yards to produce concentrate to supply Coca Cola and Dabur who prepare ready to serve drinks.

## 1.3.3. Transportation

### 1.3.3.1. Banana

For transport within the state fruit is packed as bunches or packed loose in plastic crates. Up to 550 crates can be transported in a truck at a cost of around Rs 10,000-15000 depending upon the distance. For distant markets fruit is packed in corrugated boxes and then sent by trucks. An attempt by producers to utilize rail transport failed through lack of coordination which led to oversupply. A further difficulty with rail transport was the need to use road transport to and from rail heads which increased costs and losses through poor handling.

### 1.3.3.2. Custard Apple

Custard apples have a very short shelf life and for the fresh market are transported by air to other states at a cost of around Rs 33/kg (Delhi).

### 1.3.3.3. Orange

The majority of majority of mandarins are transported by truck with packhouses organizing the logistics however this is often slow and fruit that has not been pre-cooled has a limited shelf life in destination markets.

### 1.3.3.4. Pomegranate

Most orchards have poor internal roads and use tractors to get produce to the farm gate. Some farmers use mini-vans to transport to local markets. Very few farmers are involved in transporting their produce to the distant markets. This makes it difficult to locate packhouses and warehouse close to the farm gate. Packaging for transport is with plastic grates for local markets or corrugated boxes for more distant markets in Delhi, Kolkata and Bihar. Transportation costs are decided by local unions and range from Rs 40 – 50 (Delhi) to Rs 70 – 100 (Bihar).

### 1.3.3.5. Sweet Lime

As with pomegranates farmers who take their own produce to markets utilize mini-vans at a relatively low cost of Rs. 1.0-1.5 per kg depending on the distance of the farm from the market yard. For Delhi transport costs rise to Rs 4-5 / kg and up to Rs 6.5 for Kolkata.

## 1.3.4. Marketing

### 1.3.4.1. Banana

In most cases (90%) bananas are sold to traders at the farm gate and a price determined each day by the Raver Agricultural Produce Marketing Board (Raver Board) and farmers receive prices on their mobile farms. However anecdotal evidence suggests that traders often pay less than the set rate. Individual farmers find it difficult to trade in distant markets as they do not have bulk of supplies as demanded by the markets, lack awareness relating to grade specific pricing, lack of infrastructure for value addition, difficulty in arranging for labour & transportation for harvesting, loading & selling of produce. All these factors leads to the local trader taking advantage of the situation & offering lower prices to the farmers. With the growth of e-commerce platforms and organized retailers like Big-Basket, Grofers, Reliance Fresh etc., there is an increasing interest in demand for fresh bananas however these retailers avoid transactions with individual farmers and there are very few linkages with FPOs.

### 1.3.4.2. Custard Apple

The majority of the farmers sell their produce to the local traders either directly or through local mandi. Fresh fruit sold in local markets which are open to the elements and unhygienic, as a result, losses are high and farmers prefer to sell to traders at the farm gate. This practice leads to non-competitive prices being offered to farmers.

There is only one organized custard apple farmer groups (except one) in the state. This reduces the bargaining power of individual farmers when trading with the local traders or commission agents. Farmers generally have a fixed informal agreement with the local traders for the whole season. They tend to sell their produce to the same trader based on the local relation / trust gained over the years. This arrangement leads to lower profits to the farmers as they do not engage in obtaining current market pricing information before selling the produce as they go by the word of the trader. Thus, a support is required for training the farmers/ farmer groups to develop market linkages by assisting them in linking up with traders in the distant markets.

#### *1.3.4.3. Orange*

Major trading of the crop happens through traders by undergoing a pre-harvest contract with the farmers. Around 80-85% of the crop is traded through this channel. The current variety is small sized, has very short shelf life with a loose outer skin making it hard to sell in international markets.

The majority of farmers who market the produce themselves, have limited bargaining power due to lack of or unreliable market price information and little understanding of grading, packing and transport logistics. E-commerce in becoming increasingly popular with the major retailers mostly within the state and with some FPOs wanting to become more involved in direct marketing.

#### *1.3.4.4. Pomegranate*

About 50 – 60% of the fresh produce is traded through pre-harvest contracts between traders and farmers which are based on estimates by the traders. Nashik Fruit and Vegetable Market is the major market for fresh fruit within the state. Other APMC markets include, Satana, Pimpalgaon Baswant and Lasalgaon. In addition to this, there is a private market, Perfect Krishi, in Nashik city, which has also developed as a major market for trade of pomegranates.

In addition to local markets fresh produce is sent to distant markets like Delhi, Punjab, Chandigarh, Haryana, Lucknow, Kanpur, Kolkata, and Gorakhpur. Top quality fruit (Extra Class) are sold at the farm gate by private traders who supply exporters in Delhi and Mumbai. Class I and Class II fruit are sold in less discerning markets in Bihar and Uttar Pradesh. In general farmers are not well informed about market requirements and are not in a strong bargaining position.

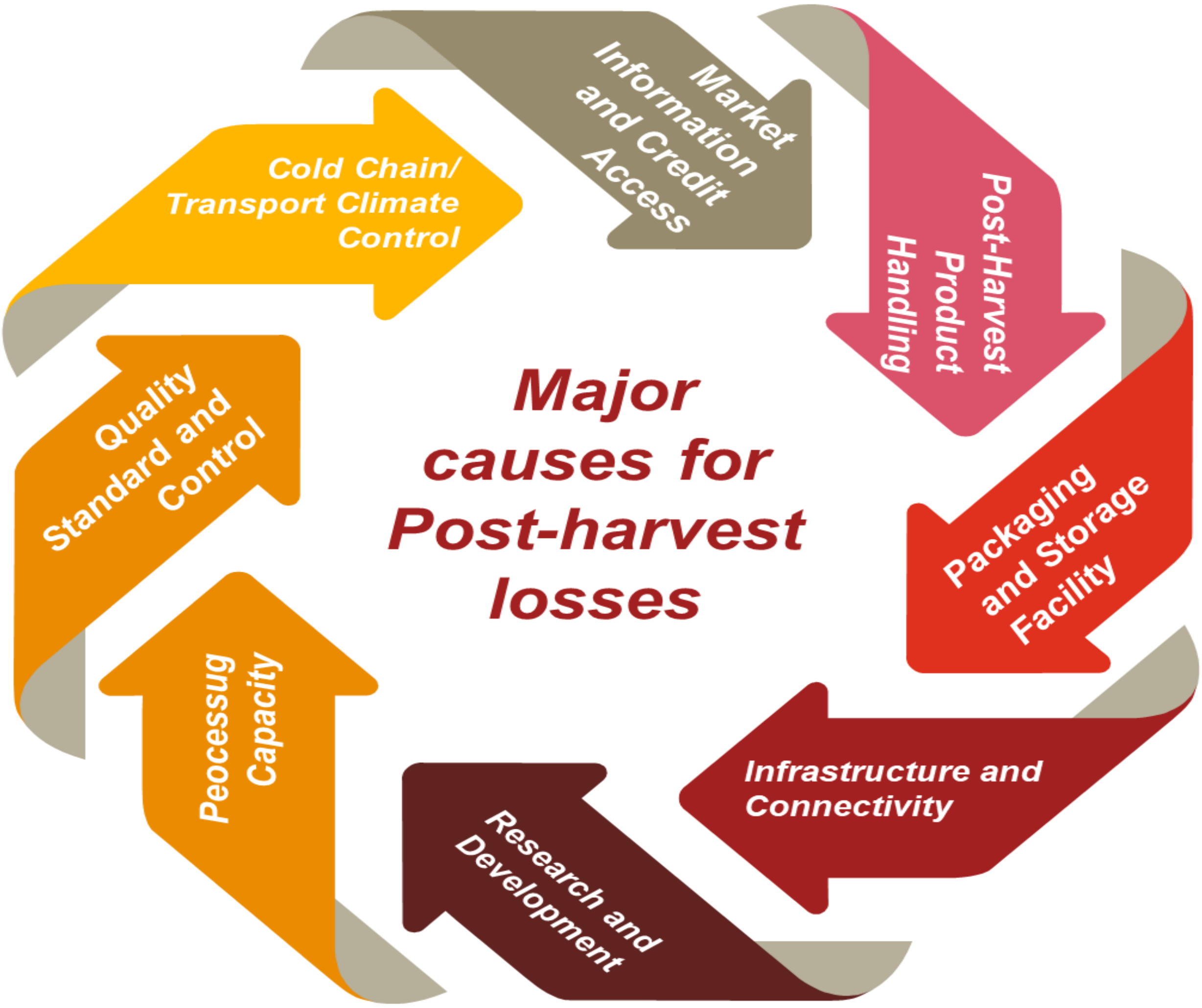
The produce is sorted as per size and appearance, packed in corrugated cardboard boxes, and transported through trucks. The produce is transported at ambient temperature conditions and reaches the destination markets in 2-5 days depending upon the distance. Commission Agents are liable and responsible for the payment to the farmers. The Commission Agents sell the produce to the Wholesalers; the Wholesaler pays commission to the Commission Agent.

#### *1.3.4.5. Sweet Lime*

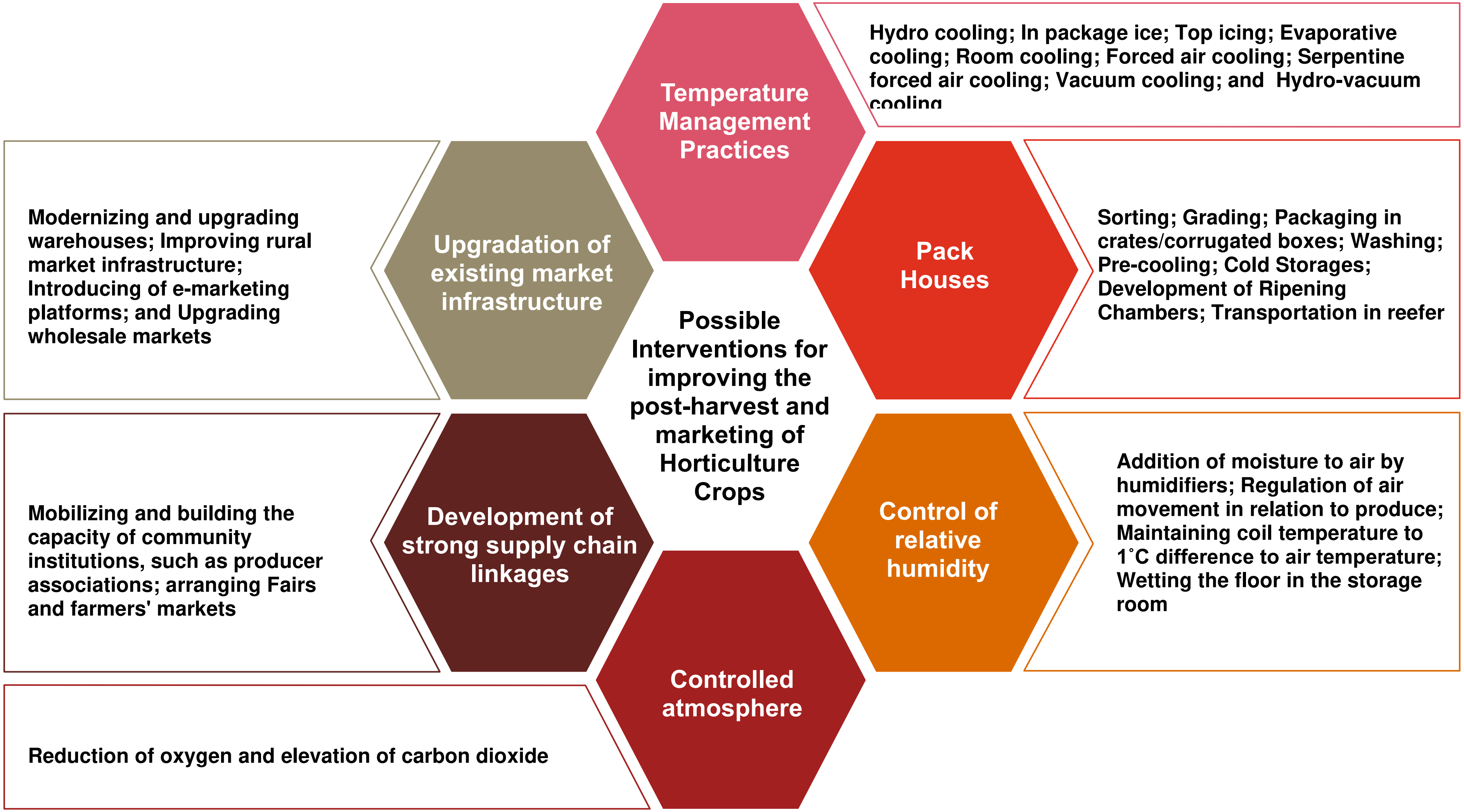
Sweet Limes are either sold at the farm gate or else sold via auctions at the Market yard. The majority of the Grade A fruit is sold to private traders at the farm gate who supply retailers such as Big Basket and Reliance Retail in Delhi and Bombay. Through mobile phone linkages farmers are quite well informed at local markets however they lack information about distant markets which can influence auction prices in local markets. In other words, lack of market intelligence of farmers about prices and demand leads to lower price realization.

Individual farmers find it difficult to trade in distant markets as they are unable to provide sufficient quantities. In addition, they lack infrastructure for value addition, harvesting and transportation. The position of farmers is further undermined by lack of transparency around market information.

## 1.4. Major cause for Post-harvest losses



## 1.5. Possible Interventions for improving the post-harvest and marketing of Horticulture Crops



# 2. Objectives and scope of the study

## 2.1. Need of the Assignment

Maharashtra with the varied Agro climatic regions has huge potential in the horticulture sector:

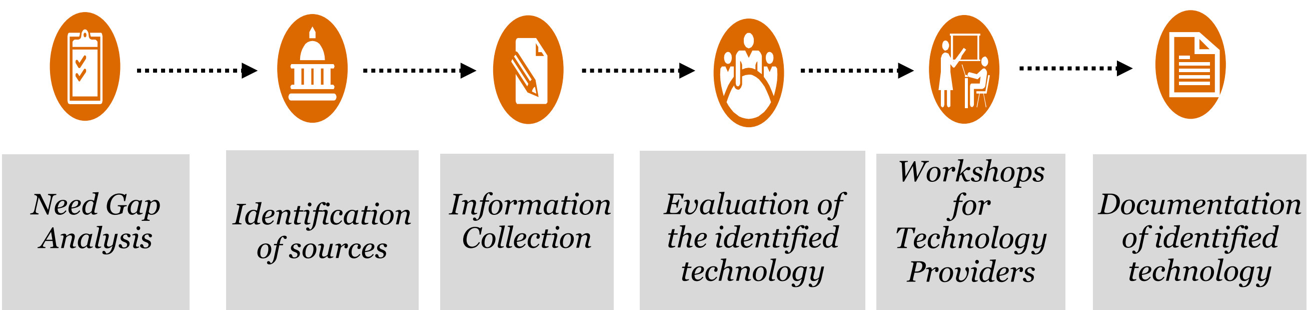
- The state is the home of the renowned Alphonso mango, ranks first in grape, orange, cashew nut and pomegranate production and has the highest productivity in banana in the country.
- State contributes towards 83% of the total production and market supply of strawberry in India. Mahabaleshwar strawberry also enjoys a geographical indicator status; thus giving it a unique brand recognition.
- The state also has four state agricultural universities, four colleges of horticulture and two colleges of forestry.
- It has three National Research Centers (grapes, citrus and onions).
- Further, it also has infrastructure for floriculture industry in the form of greenhouses, pre-cooling units, cold storage units and reefer vans.
- The state also has crop-based farmer organizations such as Grape Growers' Associations which provides technical consultancy to farmers and Western India Floriculturist Association, which again provides service and support to farmers and promotes exports.
- The state has Pomegranate Growers' Association, Banana Growers' Association, Mango Growers' Association, Medicinal and Aromatic Plants Growers' Association and Association for Organic Spices Cultivation. All these associations promote cultivation and export of produce.

In spite of being one of the leading producers of many horticulture crops, the fact remains that the levels of post-harvest losses are high and access to markets is low due to which the income realized by the farmers remain low. In addition, the processing infrastructure available in the state is inadequate resulting in significant wastage. This is hindering the state from realizing the economic potential that this sector offers. Keeping in view this scenario, ADB wants to identify applicable and innovative high-level technologies which can increase productivity and income by reducing post-harvest losses and thereby improving market access.

## 2.2. Objectives of the assignment

- **Identify problems/constraints at each step** of the value chain along with major causes/ practices for quality deterioration during material handling and identify scope for improvement.
- **Identify the technologies** suitable for the selected value chains which can help overcome the identified constraints
- **Identify the market potential and financial feasibility** of selected technology through a value chain and economic valuation study and providing the **enabling environment for a successful investment** opportunity in the sector
- **Prepare recommendations** for the selected technologies for ADB's High Level Technology Fund

## 2.3. Scope of the assignment



# 3. *Technology shortlisting*

## 3.1. Analysis of technical problems across value chains and need for technological solutions

By referring the "Mapping Study on Agribusiness, Industry and Value Chain Players in the State of Maharashtra," Deloitte, 2018, we tried to undertake preliminary analysis of value chains to understand the need for technological interventions required. The brief analysis is given below in the four major buckets such as production, post-harvest management & processing, transportation and marketing.

### 3.1.1. Production

The selection of production technologies is focused on improving competitiveness through increasing yields, reducing costs while differentiating products through processing and quality. A comparison of yields between Maharashtra and other states for key products provides an indication of the effectiveness of production techniques, though variations in growing conditions will also be an important factor.

Yields for all 5 selected commodities are all below the national average and vary from less than 42% (pomegranate) to 58% (custard apple) of the leading states. It is important then that a package that combines improved plant husbandry techniques including plant nutrition, pest and disease management. Associated with this is the need to reduce costs. The cost of establishing irrigation can be up to 70% (bananas), 50% (pomegranates) of the total establishment costs. Advances in irrigation technology tend to be focused on water saving rather than reducing the cost of the equipment. It is important then that a local solution is found. Land preparation is also a cost factor in establishment and consideration needs to be given to alternative methods such as no-tillage.

Plant nutrition is a significant annual cost ranging between 39% (pomegranates) to 58% for sweet limes. Reducing this cost and increasing yields will require attention to formulation, quantities used and placement. The use of slow release fertilizers increases nutrient efficiency by plants and reduces losses through leaching. However, given that a large proportion of the cost of plant nutrition is farm yard manure and its distribution then technology that aims increase nutrient content while reducing volume is important. Easy to use soil and leaf testing units would assist in optimizing fertilizer use and potentially increase yields particularly where crops are grown in marginal soil types.

Plant protection makes up 35% and 15.5% of annual production costs for pomegranates and bananas. The use of ultra-low volume sprayers and integrated pest management could significantly reduce annual costs and increase yields.

**Conclusion:**

There is no single and simple technology solution that will lower production costs and increase yields across a range of crops. The approach will instead involve the introduction of a range of innovations. Suggested innovations will target:

- Improving plant nutrition and reducing fertilizer costs through the use of soil analysis technology and amendments to farm-yard manure, which makes up a major part of the cost.
- Reducing the cost of irrigation establishment and water use. In the case of the latter this will involve use of mulches and water meters to soil moisture
- Reducing the cost of plant protection through the use of ultra-low volume sprays and protective costings for fruit.

### 3.1.2. Post-harvest management and processing

**Primary Processing:**

The majority of primary processing, i.e. cleaning, grading and packing is carried out at the farm gate by either the farmer of the trader. Invariably it is done in conditions that are unhygienic and exposed to the elements. Under these conditions it is difficult to provide technical solutions that would improve the quality of produce. An exception would be the use of simple devices to measure maturity for example Brix meters. The focus then should be on

FPOs that can act as collection / aggregation Centres. Economies of scale provide opportunities to use treated water for washing, grading machines that will accurately determine parameters such as size and color and uniform packing.

## Storage:

Interest in cool storage varies depending on the product. For bananas there are specialized pre-ripening rooms and cool storage. Cool stores are not used for custard apples as the fruit deteriorates at low temperatures. There are however other treatments involving waxing and chemical treatments to prevent microbial spoilage that will prologue shelf life up to 11 days. Traders do not feel there is a need for cool storage for sweet limes as they have a shelf life, of up to 20 days.

Similarly, there is no perceived need for cool storage of mandarins. It should be noted however that there is little or no information on quality of produce at market out turn. Traders do not feel the need to store pomegranates in cool stores as produce is often sold on the day of harvest. The overview would suggest that traders, wholesalers and retailers avoid cool storage on the basis that while there may be losses this is off-set by the cost of running and maintaining a cool store. Another factor influencing the lack of cool storage is that without economies of scale it is very difficult for individuals to recoup investments. In other countries it has been found that farmers tend to send 2nd grade produce to collection Centres in the belief that they can obtain higher prices through traders with the flow-on effect that centres struggle to be viable.

The use of solar powered evaporative coolers at the farm gate or collection centre level would provide a cost-effective technology to reduce field heat and would assist in prolonging post-harvest life. Coolbot technology utilising a standard AC unit and a foam insulated room would provide a very cost-effective method of cooling produce in a larger collection centre room.

## Secondary Processing:

While there is considerable scope to increase the volume of value-added products that would increase returns and reduce waste, a major constraint is the availability of technology suited to the conditions and scale of operations.

Traditional processing methods include: drying, concentrating, heating (cooking, baking, frying) cooling, use of additives – preservatives, acidification, fermentation. These methods while suited to very small-scale cottage industries are no longer competitive in rapidly evolving markets. Improved traditional methods of processing include: the application of increased temperatures (sterilization, pasteurization), the application of low temperature (cooling, freezing), aseptic packaging, controlled atmosphere, freeze-drying, microfiltration and membrane processes, modified atmosphere packaging.

New methods of processing are still in the trial stage and are likely to be restricted to large scale operations with large capital investment. They include: high voltage pulse techniques, photodynamic inactivation, microwave processing – heating, high-pressure treatment, ionizing radiation, heating of electrical resistance effect and induction. Intelligent packaging is also an option and involves the integration of a sensor/indicator into the food packaging system that has intelligent functions for monitoring of food quality and safety, e.g. freshness, leakage, carbon dioxide, oxygen, pH, time or temperature, and pathogens. The technology ensures real-time quality control and safety monitoring in terms of consumers, authorities, and food producers.

## Conclusions:

Losses occur along the value chain. Primary processing is generally inadequate and with grading and packaging not meeting high end market requirements. Lack of facilities to remove field heat and store products leads to high post-harvest losses in some cases may be up to 30% of the harvest volume. Value adding through secondary processing is either carried out using traditional methods which do not meet food safety standards or by large processors who do not pass increased returns down through the value chain. It is important to note that introducing cost-effective innovations depends on achieving economies of scale and that

this is likely to involve building the capacity of FPOs as collectors / business centres that provide a range of services. Innovations should aim to:

- Reduce field heat as soon as possible after harvest through the use of low cost solar or evaporative coolers that are individually of communally owned and operated.
- The use of optical sensors to improve grading i.e. colour and sizing

- Maintain optimum cool chain storage temperatures for both fresh and processed markets through the use cost effective innovations including: Hydro-cooling, Coolbot and Smart packaging that allows fruit to be stored in a modified atmosphere and reduces the risk of microbial decay.
- The use of solar powered processing equipment such as driers and slicers and where economies of scale make it viable freeze driers and aseptic packaging.

### 3.1.3. Transportation

Internal on-farm roads are rough and considerable damage often occurs before produce reaches the farm gate. Beyond the farm gate transport is largely organized by traders or large-scale processors. This makes improvements to transport logistics difficult unless it is done through collection centres of FPOs with linkages to markets. Experience in other countries indicates that farmers are reluctant to use collection centres even though they may be cooperatively owned unless the centre provides attractive incentives in the form or transport or links to markets.

**Conclusions:**

As the majority of produce is sold at the farm gate to small scale traders, transportation is uncoordinated making it difficult to identify technical innovations that will improve transport logistics. Where there are organized transport systems (i.e. through the FPOs) then innovations should focus on:

- Maintaining the cool chain through the use of passive refrigeration or the use of refrigerated containers.
- Ensuring that produce can be tracked through the transport system.

### 3.1.4. Marketing

Individual farmers selling at the farm gate have limited knowledge of how market prices are affected by supply and demand dynamics, quality and other factors that affect competitiveness such as presentation. Working in the other direction is the requirement by many markets that produce can be traced back through the value chain to the farm gate and would also include information on how produce has been produced.

**Conclusions:**

Providing real time information to farmers is problematic given the diversity of markets and geographic spread of farmers. IN general ICT for market information works well for closed supply chains i.e. where there are formal links and the chain performs as a business entity. There are also problems with traceability where produce from many producers is bulked up. Nevertheless the current situation needs to be improved on and it is recommended that communication platforms are trialed that will:

- Provide real time market information and allow direct trading between collection / aggregation Centres, processors and traders and large retailer markets
- Allow products to be traced from the farm gate to the point of sale and will provide a range of information on, where it was produced, the date of harvest and certification status.

## 3.2. Summary of common issues prevalent across F&V value chains

As discussed in detail in the previous section, we have identified the common issues at different stages across the value chains:

| Stage of Value Chain | Issues Identified |
|---|---|
| Input and Production | • High initial investment for orchards (especially for fruits)<br>• Lack of high quality inputs<br>• High input cost (e.g. rootstock, fertilizer, chemicals, irrigation etc.)<br>• Lack of labours<br>• Relatively susceptible to weather changes<br>• Low yields |
| Aggregation and Storage | • Information asymmetry across value chain<br>• Low level of market integration and lack of market intelligence<br>• Low shelf life (highly perishable)<br>• Lack of post-harvest facilities<br>• Lack of labours & manual processes |

| | |
|---|---|
| | • Higher cost of transportation/logistics and higher transit losses<br>• Lack of proper modes of transportation<br>• Poor connectivity |
| Processing and Market | • Lack of standard quality raw material<br>• Low value addition<br>• Information asymmetry across value chain<br>• Low level of market integration and lack of market intelligence<br>• Higher cost of transportation/logistics and higher transit losses<br>• Lack of traceability |

## 3.3. Summary of possible technological interventions needed to address issues prevalent across F&V value chains

The issues identified can be addressed by various interventions proposed under the MAgNet project, including:

| Stage of Value Chain | Interventions |
|---|---|
| Input and Production | • Higher level of agri mechanization or use of new production technologies<br>• Use of risk mitigation measures such as agri insurance<br>• Adoption of Good Agricultural Practices (GAP) |
| Aggregation and Storage | • Market intelligence using new technologies (e.g. AI, Blockchain etc.)<br>• Creation of post-harvest handling facilities (e.g. packhouses, cold storages etc.)<br>• Creation of enabling infrastructure (e.g. roads, rail etc.) |
| Processing and Market | • Focus on post-harvest research & development & processing capacity<br>• Improving quality standards & control<br>• Use of new technologies (e.g. AI, Blockchain) for market intelligence, market integration and traceability<br>• Use of multimodal transportation models |

## 3.4. About ADB's High Level Technology Fund (HLTF)

The High-Level Technology (HLT) Fund is a **multi-donor trust fund** (initial contribution USD 40 million from Govt. of Japan) established in **April 2017.** It provides grant financing to promote the integration of HLT and innovative solutions into ADB-financed and administered sovereign and non-sovereign projects throughout the project cycle—from identification to implementation and operation. The fund encourages more widespread adoption of HLT to address development challenges in developing member countries.

Grant Financing is provided for Technical assistance, Investment projects, Direct charges etc. covering sector and Thematic Groups, including:

- Energy
- Transport
- Urban,
- Water &
- Others (including agriculture)

### Characteristics of technologies to be considered under HLTF

- Technology has not been extensively supported by ADB
- The HLT and innovative solutions to be supported by the fund will have at least one of the following characteristics:
  - ✓ Improves efficiency, productivity, quality, functionality, and/or access to service delivery;
  - ✓ Addresses climate change mitigation, and adaptation, including resilience to disaster risks;
  - ✓ Introduces innovation in processes, methods, techniques, and the use of new improved equipment and materials in construction, operations, and maintenance;
  - ✓ Reduces environmental and social costs;

- ✓ Reduces life cycle cost, increases durability, and improves long-term performance;
- ✓ Enhances the scaling up of HLT and market opportunities for scale-up; and
- ✓ Promotes synergies and increases scale and impact through cross-sector collaboration.

- Risk should be manageable
- Technologies that are undergoing early stage research and development are not eligible.
- Focus technologies which are ready for deployment including support piloting and demonstration of new technologies
- Solutions that have sufficient after sales support, and prospect for scaling up are preferable

## 3.5. Methodology used for shortlisting/identification of suitable technologies

### 3.5.1. High Level Technology Fund (HLTF) – Technology Eligibility Criteria/Matrix

Based on the guidelines mentioned above, we understand that the proposed technology need to be eligible for further consideration. We have prepared following matrix to objectively assess the eligibility of the technology:

| | |
|---|---|
| 1. | Applicability in the most of value chains i.e.<br>a. Banana<br>b. Custard Apple<br>c. Guava<br>d. Orange<br>e. Pomegranate<br>f. Sapota<br>g. Strawberry<br>h. Sweet Lime<br>i. Green & Red Chili<br>j. Okra |
| 2. | Applicability at specific nodes of the value chains i.e. across various nodes such as<br>a. Production<br>b. Aggregation<br>c. Storage<br>d. Trade/Transportation<br>e. Processing<br>f. Marketing etc. |
| 3. | Is this technology already extensively supported by ADB? |
| 4. | Does this technology improve efficiency, productivity, quality, functionality, and/or access to service delivery? |
| 5. | Does this technology addresses climate change mitigation, and adaptation, including resilience to disaster risks? |
| 6. | Does this technology introduce innovation in processes, methods, techniques, and the use of new improved equipment and materials in construction, operations, and maintenance? |
| 7. | Does this technology reduce environmental and social costs? |
| 8. | Does this technology reduce life cycle cost, increases durability, and improves long-term performance? |
| 9. | Does this technology enhance the scaling up of HLT and market opportunities for scale-up? |

| | |
|---|---|
| 10. | Does this technology promote synergies and increases scale and impact through cross-sector collaboration? |
| 11. | Is the risk arising out of introduction of this technology manageable? |
| 12. | Does this technology ready for deployment including support piloting and demonstration of new technologies and not in the early stage research and development? |
| 13. | Does this technology have sufficient after sales support, and prospect for scaling up are preferable? |

### *3.5.2. High Level Technology Fund (HLTF) – Technology Selection Criteria/Matrix*

Based on previous eligibility criteria/matrix, once the technology is found to be eligible to be considered for evaluation under the HLTF, it will be subjected to objective selection criteria. The selection criteria/matrix will provide the basis for screening/shortlisting the technologies to be considered for feasibility assessment.

The technology should be such that it is usable across the range of selected horticultural produce and across various nodes of value chains. In order to screen such technologies, we propose to use the following selection criteria/matrix. This will ensure the selection of technologies which have applications across the value chains and will benefit most of the value chain actors.

| | |
|---|---|
| 1. | Applicability in the most of value chains i.e.<br>a. Banana<br>b. Custard Apple<br>c. Guava<br>d. Orange<br>e. Pomegranate<br>f. Sapota<br>g. Strawberry<br>h. Sweet Lime<br>i. Green & Red Chili<br>j. Okra |
| 2. | Applicability at specific nodes of the value chains i.e. across various nodes such as<br>a. Production<br>b. Aggregation<br>c. Storage<br>d. Trade/Transportation<br>e. Processing<br>f. Marketing etc. |
| 3. | Technology Innovativeness: Introduces innovation in processes, methods, techniques etc. |
| 4. | Technology Suitability:<br>a. Potential for improvement in Efficiency/Productivity of operations/services<br>b. Potential to facilitate the agricultural extension/capacity building of farmers/FPOs<br>c. Potential to address information asymmetry issues especially related to prices of commodities<br>d. Potential to increase/facilitate the process of access to credit for FPOs |
| 5. | Technology Sustainability:<br>a. Potential to address climate change mitigation and adaptation including resilience to disaster risks<br>b. Potential to reduce environmental and social costs<br>c. Potential for sufficient after sales support and opportunities for scaling up |

The selection matrix consists of scoring of technologies based on the above-mentioned objective criteria. The score will be estimated/calculated based on following proposed weightages:

| Sr. No. | Criteria | Sub-criteria | Scale | Allotted Weightage | Remark | Total Maximum Weightage |
|---|---|---|---|---|---|---|
| 1. | Applicability in the most of value chains | a) Banana | Yes | 0% | Each of the horticultural produce/commodity is allotted 1% weightage. The technology having applications for more than one horticultural produce/commodity will get more weightage and will have more chances of getting selected for feasibility assessment. | 10% |
| | | | No | 1% | | |
| | | b) Custard Apple | Yes | 0% | | |
| | | | No | 1% | | |
| | | c) Guava | Yes | 0% | | |
| | | | No | 1% | | |
| | | d) Orange | Yes | 0% | | |
| | | | No | 1% | | |
| | | e) Pomegranate | Yes | 0% | | |
| | | | No | 1% | | |
| | | f) Sapota | Yes | 0% | | |
| | | | No | 1% | | |
| | | g) Strawberry | Yes | 0% | | |
| | | | No | 1% | | |
| | | h) Sweet Lime | Yes | 0% | | |
| | | | No | 1% | | |
| | | i) Green & Red Chili | Yes | 0% | | |
| | | | No | 1% | | |
| | | j) Okra | Yes | 0% | | |
| | | | No | 1% | | |
| 2. | Applicability at specific nodes of the value chains | a) Production | Yes | 0% | --- | 10% |
| | | | No | 1% | | |
| | | b) Aggregation | Yes | 0% | | |
| | | | No | 1% | | |
| | | c) Storage | Yes | 0% | As most of the interventions are focused on post-harvest activities and focused on market linkages, more weightage is allotted to later part of the value chains | |
| | | | No | 2% | | |
| | | d) Trade/Transportation | Yes | 0% | | |
| | | | No | 2% | | |
| | | e) Processing | Yes | 0% | | |
| | | | No | 2% | | |
| | | f) Marketing | Yes | 0% | | |
| | | | No | 2% | | |
| 3. | | | No | 0% | In line with the HLTF desirable characteristics | 10% |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Technology Innovativeness | a) Introduces innovation in processes, methods, techniques etc. | Low | 3% | | |
| | | | Medium | 6% | | |
| | | | High | 10% | | |
| **4.** | Technology Suitability | a) Potential for improvement in Efficiency/Productivity of operations/services | No | 0% | | 10% |
| | | | Low | 3% | | |
| | | | Medium | 6% | | |
| | | | High | 10% | | |
| | | b) Potential to facilitate the agricultural extension/capacity building of farmers/FPOs | No | 0% | In line with the Output-1 of the propose project design | 10% |
| | | | Low | 3% | | |
| | | | Medium | 6% | | |
| | | | High | 10% | | |
| | | c) Potential to address information asymmetry issues especially related to prices of commodities | No | 0% | As project intends to focus on market linkages/marketing of the horticultural produce to increase realization where market prices play important role | 10% |
| | | | Low | 3% | | |
| | | | Medium | 6% | | |
| | | | High | 10% | | |
| | | d) Potential to increase/facilitate the process of access to credit for FPOs | No | 0% | In line with the Output-2 of the propose project design | 10% |
| | | | Low | 3% | | |
| | | | Medium | 6% | | |
| | | | High | 10% | | |
| **5.** | Technology Sustainability | a) Potential to address climate change mitigation and adaptation including resilience to disaster risks | No | 0% | In line with the HLTF desirable characteristics | 10% |
| | | | Low | 3% | | |
| | | | Medium | 6% | | |
| | | | High | 10% | | |
| | | b) Potential to reduce environmental and social costs | No | 0% | | 10% |
| | | | Low | 3% | | |
| | | | Medium | 6% | | |
| | | | High | 10% | | |
| | | c) Potential for sufficient after sales support and opportunities for scaling up | No | 0% | | 10% |
| | | | Low | 3% | | |
| | | | Medium | 6% | | |
| | | | High | 10% | | |
| | | | | | Total | **100%** |

## 3.6. List of shortlisted technologies

While undertaking the study, an unprecedented situation of Covid-19 affected the entire world. With the ongoing pandemic, priorities of all countries, their government and funding agencies have shifted. ADB has also decided to focus more on health related technologies to provide support to solutions needed immediately.

Keeping this in view, we decided to divide the study into parts, and have proposed technologies under two categories:

- Technology funded through the MAgNeT Project
- Technology funded through the HLT fund

### 3.6.1. Technologies proposed under project funding

As per our methodology used for shortlisting/identification of suitable technologies, we assessed over 130 technologies and shortlisted them based on factors, including:

- Cost effective and Commercially Available
- Addresses requirements of the stakeholders: improve efficiency, productivity, quality, functionality, and/or access to service delivery

The shortlisted technology under the category for different stages across the value chain are:

| Stage of Value Chain | Shortlisted Technology |
|---|---|
| Input and Production | • Soil Test and Fertilizer Recommendation Meter Kit<br>• Organic Slush Powder Gel/Super Absorbent Polymer (FasalAmrit)<br>• Solar Insect Trap<br>• Fruit Fly Trap (e.g. Barrix) |
| Aggregation, Storage & Transportation Stage | • Quick Quality Assessment (Intello Deep, Agrix, SpectraAnalyzer, Qualix AgNext etc.)<br>• Power/Manual Fruit & Vegetable Grader (spherical)<br>• Shelf Life Extension of F&V using Paper, Bag, Sachet, Capsules etc.<br>• Zero Energy Cool Chamber/Evaporative Cool Chamber |
| Processing, Logistics & Marketing Stage | • Solar Dryers and Smart Dryer (F&V Dryer)<br>• Pomegranate Aril Extractor<br>• Custard Apple Pulper |

### 3.6.2. Technologies proposed under HLTF

As per our methodology used for shortlisting/identification of suitable technologies, we assessed over 130 technologies and shortlisted them based on factors, including:

- High Level Technology/Sophisticated Technology
- Innovative and Commercially Available
- Addresses requirements of the stakeholders: improve efficiency, productivity, quality, functionality, and/or access to service delivery

The shortlisted technology under the category for different stages across the value chain are:

| Stage of Value Chain | Shortlisted Technology |
|---|---|
| Input and Production | • Precision Agriculture (Fasal etc.)<br>• ICT based Platform (e.g. DeHaat, BharatAgri etc.) for inputs, crop advisory & market info.<br>• Electrostatic Sprayers for greater chemical spray coverage<br>• Drone based Chemical sprays and image analysis (e.g. Agribot)<br>• Solar Water Pumps |
| Aggregation, Storage & | • Optical Camera based Fruit Grader (IntelloSort, Zentron etc.)<br>• Solar Powered Cold Storage (Ecozen) |

| | |
|---|---|
| Transportation Stage | • Ice-Battery (Passive Cooling) for transportation of perishables<br>• Walk in Cooler (CoolBot) |
| Processing, Logistics & Marketing Stage | • Digital Logistics & Supply Chain Solutions (Pando, Ksianrath, Crofarm)<br>• Online Platforms (e.g. e-NAM, etc.) |

# 4. *Details of proposed technologies*

## *4.1. Technologies proposed under project funding*

### *4.1.1. Soil Test and Fertilizer Recommendation Meter Kit (SFTR Meter Kit)*

**Description of Situation**

**Context:**

Indian soils suffer from widespread multi-nutrient deficiencies. The soil testing service is not adequate to cater the needs of large number of farm holdings. Farmers often apply fertilizers without any scientific recommendation. This increases the cost of production, lowers farm profits and leads to soil health deterioration. Soil Test and Fertilizer Recommendation (STFR) Meter has been developed for the areas where soil testing facility is not available and would serve as robust complement to the existing Soil Testing Labs network. It is a low cost, user friendly, digital embedded system and programmable instrument consisting of a meter, a mini shaker, a reagent-kit and other important accessories needed for soil testing.

**Where does it fit in along the value-chain?**

Technology will be used in the production node of the value chain.

**What problem(s) is the technology going to solve?**

Nutrient deficiency is the major problem in India and farmers often apply fertilizers without any scientific recommendation. This increases the cost of production, lowers farm profits and leads to soil health deterioration. The farmer can determine the available nutrients in the soil on the spot himself and unlike other soil test kits, the STFR Meter suggests the correct dosage of the fertilizer based on the crop, Sulphur and micronutrients recommendations based on critical value in soil using the in-built program.

**How has demand been assessed?**

Through multiple interactions with various farmers across Maharashtra along with desk research on available data for studying the soil health.

**Who is it aimed at and why are we targeting that sector of the value chain?**

- ✓ **Farmers:** There are many farmers in India who do not know which types of crops they should grow to get maximum yield. Basically, they do not know the quality and the type of their soil. They might know by experience what crops grow and what crops fail. But they do not know what they can do to improve the soil conditions. Through the STFR, farmers will get the report and this report will contain all details about the soil of their particular farm enabling them to make an educated choice about their farm and crops.
- ✓ **Youth willing to take up agripreneurship**: It is a low investment and easy to use technology. It is a cost-effective digital mobile quantitative soil test mini lab which provides soil Testing service at farmer's doorstep.

**Technology Design**

**How does it work?**

- ✓ It analyzes as many as fourteen soil parameters i.e., soil reaction (pH), lime requirement for acid soil, gypsum requirement for alkali soil, salt content, Organic carbon, available nitrogen, phosphorus and available potassium, available Sulphur, available boron, available zinc, copper, iron and manganese.
- ✓ It is a programmable colorimeter and analyses soil parameters quantitatively, thus its accuracy is better than other soil test kits which analyses qualitatively based on visual comparison of colors.
- ✓ Additionally it gives crop-specific fertilizer recommendation for about 100 crops including field crops, horticultural crops and spices.

### What stage of development is it at? (eg. still in R & D phase, pilot / demonstration, commercialisation?)

The STFR Meter has been licensed to 14 firms for commercial production. Several firms have already started its commercial production. This farmer friendly kit is now available in the market.

### What is the innovation? (ie how does it improve over existing situation – is it a significant improvement/)

- ✓ The STFR Meter is Unique as the farmer can determine the available nutrients in the soil on the spot himself and doesn't have to depend on external specialists before every sowing season.
- ✓ Unlike other soil test kits, the STFR Meter suggests the correct dosage of the fertilizer based on the crop, Sulphur and micronutrients recommendations based on critical value in soil using the in-built program.
- ✓ Easy to operate and use, it can be used by village panchayat, agri –input dealers and several self help groups working in village for soil testing purpose. It is portable and can be operated both by battery and as well as by electricity. It can be connected to PC through computer-interface and results can be communicated to the farmers through instant SMS on a pre-registered cell phone.

### How and where is it made?

The PUSA-STFR Meter technology has been brought out by the scientists of Soil Science and Agricultural Chemistry (SS & AC) Division of IARI.

Read more on: https://www.pusastfrmeter.com/

### Does it require specialist training?

Yes, it requires 2-3 days of trainings before using for soil testing by the farmers themselves

### Is after sales service provided?

Yes

## Cost / Benefit Analysis

### Costs

The cost of the unit is IRS 89,600. In addition, there would be the cost of consumables (testing reagents), IRS 17,000 for 100 tests. Assuming an FPO of 100 user farmers, tested on an annual basis.

### Benefits

- Direct Benefits:
  - an increase in yield (average of 1%)
  - A reduction in the cost of fertilizer & its application by 5% each
- Indirect Benefits: A reduction in the use of fertilizers will mitigate the impact of farming on the environment caused by run-off of nutrients into streams and rivers. Reducing chemical NPK fertilizers will also improve soil health through increasing the microbial population.

### Assumptions

The testing kit has an operational life of 5 years and is operated by an FPO of 500 farming members who are tested on an annual basis ie 500 tests / year on a cost only basis. The profit margin would be determined by the FPO. The capital cost of the testing kit is amortized over 10 years.

| Particulars | | Units & Assumptions | Pomegranate | Banana | Sweet Lime | Orange/ Mandarin | Custard Apple | Guava | Sapota | Strawberry | Okra | Chilli | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Operational Life** | **Maximum Operational Life of Technology** | Years | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** |
| **Costs** | Total Capital Cost (INR/Unit) | Per Kit | 89600 | 89600 | 89600 | 89600 | 89600 | 89600 | 89600 | 89600 | 89600 | 89600 | 89600 |
| | Total Operational Cost (INR/Unit) | For 100 tests | 17000 | 17000 | 17000 | 17000 | 17000 | 17000 | 17000 | 17000 | 17000 | 17000 | 17000 |
| | Capital Cost (INR/Acre/Season/Farmer) | Per FPO with 100 Farmers | 179 | 179 | 179 | 179 | 179 | 179 | 179 | 179 | 179 | 179 | 179 |
| | Operational Cost (INR/Acre/Season/Farmer) | Per FPO with 100 Farmers | 170 | 170 | 170 | 170 | 170 | 170 | 170 | 170 | 170 | 170 | 170 |
| | **Total Cost** | **INR/Acre/Season/Farmer** | **349** | **349** | **349** | **349** | **349** | **349** | **349** | **349** | **349** | **349** | **349** |
| **Benefit Streams** | Reduction in Fertilizer Consumption | 5% | 780 | 1041 | 367 | 367 | 500 | 548 | 616 | 816 | 225 | 375 | 564 |
| | Reduction in Fertilizer Application Cost | 5% | 200 | 400 | 125 | 125 | 150 | 200 | 150 | 306 | 31 | 51 | 174 |
| | Increased yield due to balanced use of Fertilizers | 1% | 2009 | 1755 | 884 | 690 | 1665 | 1855 | 1196 | 6035 | 1107 | 1096 | 1829 |
| | **Total Benefit** | **INR/Acre/Season/Farmer** | **2989** | **3196** | **1376** | **1182** | **2315** | **2603** | **1962** | **7157** | **1363** | **1522** | **2567** |
| **Net Incremental Benefit** | | **INR/Acre/Season/Farmer** | **2640** | **2847** | **1027** | **833** | **1966** | **2253** | **1612** | **6808** | **1014** | **1173** | **2217** |
| **Benefit Cost Analysis** | | **B/C Ratio** | **8.56** | **9.15** | **3.94** | **3.39** | **6.63** | **7.45** | **5.62** | **20.50** | **3.90** | **4.36** | **7.35** |

## Safeguards

| Environment | Yes | No | N/A | Comments |
|---|---|---|---|---|
| Will the **technology**:<br>- increase GHGs?<br>- decrease GHGs? | --<br>Yes | No<br>-- | | To some extent owing to optimized use of fertilizers |
| Will the technology:<br>- increase demand for energy?<br>- decrease the demand for energy | | | NA | |
| Will the technology improve the sustainability of the production system? | Yes | | | |
| Will the technology:<br>- Increase the demand for water?<br>- decrease the demand for water? | | | NA | |
| Will the technology increase noise pollution? | | No | | |
| Will the technology increase the generation of solid or hazardous waste? | | No | | |
| Will the technology have a negative impact on water quality? | | No | | |
| Will the technology have a negative impact on biodiversity? | | No | | May help to reduce the effect of excess fertilizers on soil |
| | | | | |
| **Social** | | | | |
| Will the technology negatively impact on poor people? (e.g. loss of income) | | No | | |
| Will the technology be accessible to the poor? | Yes | | | Through FPOs |
| Will the technology increase incomes along the value chain? | Yes | | | |
| Will women have access (or be able to use) the technology? | Yes | | | Through FPOs |
| Will the technology improve the access of women to the value chain? | | | NA | |
| Will the technology:<br>- increase women's labour?<br>- decrease women's labour | | | NA | |

### *4.1.2. Organic Slush Powder Gel/Super Absorbent Polymer (FasalAmrit)*

**Description of Situation**

**Describe the context:**

Maharashtra has been facing water emergency of unprecedented proportions and farmers grapple with water scarcity all his life. The crisis have escalated to such an extent that there was a decline in crop production, which increased the need to ensure crops receive a regular supply of water. FasalAmrit is an Eco-Friendly Water Retention Polymer made from natural bio-waste extracts that have water-absorption properties, making it ideal for use in water-scarce areas. The super absorbent polymer designed to absorb water in the soil, retain it for a long time, and supply it to the crops as required. The product is natural, and is made to out of bio-wastes that do not only prevent soil and water pollution, but also give high nutrition to the plants after slowly disintegrating in the soil

**Where does it fit in along the value-chain?**

Technology will be used in the production node of the value chain.

**What problem(s) is the technology going to solve?**

The three most common soil conditions that hinder plant growth and crop yield are **low water retention capability,** high evapo-transpiration rate and soil moisture leaching. Apart from these, factors like unforeseen drought conditions, degradation and salination, overuse of synthetic fertilizers and pesticides and improper irrigation practices severely affect soil and plants, often rendering permanent damage to soil biota as well.

Maharashtra's agriculture scenario is primarily rain fed (only 18 per cent of Gross Cropped Area is irrigated) and rainfall across regions is scattered with one-third area receiving scanty rainfall. State has 24 per cent of drought-prone area of the country the technology being an eco-Friendly Water Retention Polymer brings value to the table ideal for use by helping many farmers mitigate their water scarcity woes.

**How has demand been assessed?**

Through multiple interactions with various farmers across Maharashtra along with desk research on available data for studying the problems of water scarcity.

**Who is it aimed at and why are we targeting that sector of the value chain?**

The technology is being aimed at Farmers, who are unable to access more expensive irrigation technologies and suffer from water scarcity issues causing crop damage and income losses.

**Technology Design**

**How does it work?**

Super Absorbent Polymers act as micro water reservoirs at plant roots. They absorb natural and supplied water 400-500 times their own weight and release it slowly on account of root capillary suction mechanism thus preventing water loss in soil by leaching and evaporation. They influence soil permeability, density, structure, texture, evaporation and infiltration rates of water through soils. The product enhances soil health by providing micronutrients and maintaining moisture content along with helping the growth of microbe which is almost at zero level due to high usage of chemical fertilizer.

**What stage of development is it at? (eg. still in R & D phase, pilot / demonstration, commercialisation?)**

Organic Slush Powder Gel/Super Absorbent Polymer has been commercialized by EF Polymers since 2018.

**What is the innovation? (ie how does it improve over existing situation – is it a significant improvement/)**

- ✓ It is completely natural polymer, harmless to crop, soil, animals, and farmers and also improves the soil strength.
- ✓ It is 100% pollution free, being completely biodegradable, it degrades in soil and works as natural fertilizers, reducing the need for fertilizers in crops
- ✓ More economical as compared to other synthetic SAPs present in the market

**How and where is it made?**

Fasal Amrit is developed by EF Polymer Private Limited.

Read more on: http://efpolymer.com

**Does it require specialist training?**

No

**Is after sales service provided?**

Yes

## Cost / Benefit Analysis

**Costs**

The polymer is applied at a rate of 4.5 kg/acre @ cost INR 300 / kg.

**Benefits**

- Direct Benefits:
  - Reduction in Irrigation Cost
  - Increased yield due to uniform soil moisture
- Indirect Benefits:
  - The polymer is organic and as it breaks down it encourages the growth of soil micro-flora adding to the organic content of the soil. Over a period of time soil structure is improved.

**Assumptions**

The quantity of polymer required will vary from site to site and the impact of potential production cost savings will also vary. The savings for each benefit therefore have been reduced from the manufacturers claims to reflect more modest gains: yield increase 1%; water savings 10%.

| Particulars | | Units & Assumptions | Pomegranate | Banana | Sweet Lime | Orange/ Mandarin | Custard Apple | Guava | Sapota | Strawberry | Okra | Chilli | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Operational Life** | **Maximum Operational Life of Technology** | Years | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** |
| **Costs** | Total Capital Cost | Per Acre 4.5Kg @INR 300/Kg (INR/Unit) | 1350 | 1350 | 1350 | 1350 | 1350 | 1350 | 1350 | 1350 | 1350 | 1350 | 1350 |
| | Total Operational Cost | 2 Mandays per acre for application | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 |
| | Capital Cost | INR/Acre/Season/Farmer | 1350 | 1350 | 1350 | 1350 | 1350 | 1350 | 1350 | 1350 | 1350 | 1350 | 1350 |
| | Operational Cost | INR/Acre/Season/Farmer | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 |
| | **Total Cost** | **INR/Acre/Season/Farmer** | **2150** | **2150** | **2150** | **2150** | **2150** | **2150** | **2150** | **2150** | **2150** | **2150** | **2150** |
| **Benefit Streams** | Reduction in Irrigation Cost | 10% | 1000 | 1000 | 1000 | 1000 | 700 | 700 | 700 | 1633 | 122 | 122 | 798 |
| | Increased yield due to uniform soil moisture | 1% | 2009 | 1755 | 884 | 690 | 1665 | 1855 | 1196 | 6035 | 1107 | 1096 | 1829 |
| | **Total Benefit** | **INR/Acre/Season/Farmer** | **3009** | **2755** | **1884** | **1690** | **2365** | **2555** | **1896** | **7668** | **1230** | **1219** | **2627** |
| **Net Incremental Benefit** | | **INR/Acre/Season/Farmer** | **859** | **605** | **-266** | **-460** | **215** | **405** | **-254** | **5518** | **-920** | **-931** | **1520** |
| **Benefit Cost Analysis** | | **B/C Ratio** | **1.40** | **1.28** | **0.88** | **0.79** | **1.10** | **1.19** | **0.88** | **3.57** | **0.57** | **0.57** | **1.22** |

## Safeguards

| Environment | Yes | No | N/A | Comments |
|---|---|---|---|---|
| Will the **technology**:<br>- increase GHGs?<br>- decrease GHGs? | | | NA | |
| Will the technology:<br>- increase demand for energy?<br>- decrease the demand for energy | ---<br>Yes | No<br>--- | NA | To some extent owing to reduced irrigation requirement |
| Will the technology improve the sustainability of the production system? | Yes | | | |
| Will the technology:<br>- Increase the demand for water?<br>- decrease the demand for water? | --<br>Yes | No<br>-- | | |
| Will the technology increase noise pollution? | | No | | |
| Will the technology increase the generation of solid or hazardous waste? | | No | | Biodegradable |
| Will the technology have a negative impact on water quality? | | No | | |
| Will the technology have a negative impact on biodiversity? | | No | | |
| | | | | |
| **Social** | | | | |
| Will the technology negatively impact on poor people? (e.g. loss of income) | | No | | |
| Will the technology be accessible to the poor? | Yes | | | |
| Will the technology increase incomes along the value chain? | Yes | | | Owing to reduction in irrigation cost |
| Will women have access (or be able to use) the technology? | Yes | | | |
| Will the technology improve the access of women to the value chain? | | | NA | |
| Will the technology:<br>- increase women's labour?<br>- decrease women's labour | | | NA | |

### 4.1.3. Solar Insect Trap

## Description of Situation

**Describe the context:**

Farmers encounter the problems of various types of insect pests that harm crops and result in loss of productivity each year. Therefore, it is necessary for farmers to use pesticides to prevent crop damage. However, when pesticides are used in large quantity, they cause adverse impacts on people, animals and the environment.

This proposed Solar Energy-Based Insect Pests Trap has an automatic control system to lure insect pests when there is no sunlight and the system will stop when the sun shines. This is used to lure several types of insects near the device, they will be trapped in the trap under the bulb, which ensures prevention from crop damage.

**Where does it fit in along the value-chain?**

Technology will be used in the production node of the value chain.

**What problem(s) is the technology going to solve?**

Maharashtra faces the problem of crop damage due to insect attack, this leads to income losses and heavy distress amongst farmers, in order to avoid the damage farmers usually turn to insecticides and pesticides, which if used in excess leads to deterioration of the quality of soil and ultimately low yield in produce. The solar insect trap provides an easy and safe solution to avoid the problem of pests and insects, reducing crop damage and subsequently the income. It also identifies the Pest and Insects pattern to develop Pest Management and control plan.

**How has demand been assessed?**

Through multiple interactions with various farmers across Maharashtra along with desk research on available data for studying the problems of insect and pest infestation in their fields, and comparing them with the current available solutions.

**Who is it aimed at and why are we targeting that sector of the value chain?**

The technology is being aimed at Farmers, who are looking for an easy, safe and economical for distinguishing and controlling pest and insects damaging the crop and enabling pollination to improve the productivity.

## Technology Design

**How does it work?**

- ✓ It captures insect pests towards very special spectrum of light wavelength, based on electronically programmable controller to segregate beneficial and non-beneficial Insects sociological behavior. It only captures maximum of economically impacting non beneficial insect pests.

**What stage of development is it at? (e.g. still in R & D phase, pilot / demonstration, commercialisation?)**

It is widely commercialized and readily available.

**What is the innovation? (ie how does it improve over existing situation – is it a significant improvement/)**

- ✓ Produced output has less chemical impact which makes people healthy and protects eco system.
- ✓ Portable across the crop area without any changes and no major mounting or installation efforts required and easy to operate.
- ✓ Solar Chargeable and Automatic Timer Device
- ✓ No Electricity and Manpower required to operate the device
- ✓ Economical and helps reduction of chemical pest management cost.

### How and where is it made?

Manufactured by various players in the Agri inputs sector, including Hectare, Barrix, C2K, Shakti amongst other.

Read more on: https://hectare.in/products/solar-light-trap/

### Does it require specialist training?

No

### Is after sales service provided?

Yes

## Cost / Benefit Analysis

### Costs

One trap / acre @ cost INR 4.000. The traps have an operating life of approximately 5 years.

### Benefits

- Direct Benefits:
    - up to 5% saving in the cost of chemicals
    - up to 5% in the cost of applying chemicals
    - an increase of 1% in yield.
- Indirect Benefits:
    - Reduced chemical residues in produce and in the environment.

### Assumptions

The traps will are effective against a range of nocturnal flying insects and should be regarded as part of an Integrated Pest Management system. The effectiveness will vary depending on other measures used to control insect pests such as Integrated Pest Management and will also vary for each crop. The projections made for cost savings are an average across all crops and have been reduced from the manufacturers claims to reflect more modest gains.

| Particulars | | Units & Assumptions | Pomegranate | Banana | Sweet Lime | Orange/ Mandarin | Custard Apple | Guava | Sapota | Strawberry | Okra | Chilli | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Operational Life** | **Maximum Operational Life of Technology** | Years | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** |
| **Costs** | Total Capital Cost (INR/Unit) | Per Trap | 4000 | 4000 | 4000 | 4000 | 4000 | 4000 | 4000 | 4000 | 4000 | 4000 | 4000 |
| | Total Operational Cost (INR/Unit) | --- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Capital Cost | INR/Acre/Season/Farmer | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 |
| | Operational Cost | INR/Acre/Season/Farmer | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | **Total Cost** | **INR/Acre/Season/Farmer** | **800** | **800** | **800** | **800** | **800** | **800** | **800** | **800** | **800** | **800** | **800** |
| **Benefit Streams** | Reduction in Chemicals Usage | 5% | 750 | 405 | 200 | 200 | 200 | 200 | 200 | 612 | 122 | 122 | 301 |
| | Reduction in Chemicals Application Cost | 5% | 200 | 75 | 50 | 50 | 50 | 100 | 50 | 204 | 31 | 61 | 87 |
| | Increased yield due to reduction in pests | 1% | 2009 | 1755 | 884 | 690 | 1665 | 1855 | 1196 | 6035 | 1107 | 1096 | 1829 |
| | **Total Benefit** | **INR/Acre/Season/Farmer** | **2959** | **2235** | **1134** | **940** | **1915** | **2155** | **1446** | **6851** | **1261** | **1280** | **2218** |
| **Net Incremental Benefit** | | **INR/Acre/Season/Farmer** | **2159** | **1435** | **334** | **140** | **1115** | **1355** | **646** | **6051** | **461** | **480** | **1418** |
| **Benefit Cost Analysis** | | **B/C Ratio** | **3.70** | **2.79** | **1.42** | **1.18** | **2.39** | **2.69** | **1.81** | **8.56** | **1.58** | **1.60** | **2.77** |

## Safeguards

| Environment | Yes | No | N/A | Comments |
|---|---|---|---|---|
| Will the **technology**:<br>- increase GHGs?<br>- decrease GHGs? | | | NA | |
| Will the technology:<br>- increase demand for energy?<br>- decrease the demand for energy | | | NA | |
| Will the technology improve the sustainability of the production system? | Yes | | | Owing to reduced use of chemicals and Runs on renewable energy source |
| Will the technology:<br>- Increase the demand for water?<br>- decrease the demand for water? | | | NA | |
| Will the technology increase noise pollution? | | No | | |
| Will the technology increase the generation of solid or hazardous waste? | | No | | |
| Will the technology have a negative impact on water quality? | | No | | |
| Will the technology have a negative impact on biodiversity? | | No | | |
| | | | | |
| **Social** | | | | |
| Will the technology negatively impact on poor people? (eg. loss of income) | | No | | |
| Will the technology be accessible to the poor? | Yes | | | |
| Will the technology increase incomes along the value chain? | Yes | | | Owing to increased yield by protecting crop from insects |
| Will women have access (or be able to use) the technology? | Yes | | | |
| Will the technology improve the access of women to the value chain? | | | NA | |
| Will the technology:<br>- increase women's labour?<br>- decrease women's labour | | | NA | |

## 4.1.4. Fruit Fly Trap


### Description of Situation

**Describe the context:**

There are over 1000 species of insect found damaging fruit trees all over the world, of these as many as 800 have been reported from India. In Maharashtra, fruits such as mango, Guava, banana and many other fleshy fruits are cultivated on large scale. Out of various factors responsible for low yields, the major cause appears to be the damage caused by the fruit fly. For increasing the yield of fruit crops, it is necessary to accelerate the level of adoption of plant protection measures. Fruit fly trap is one of the innovative, ecofriendly method to manage fruit fly infestation.

**Where does it fit in along the value-chain?**

Technology will be used in the production node of the value chain.

**What problem(s) is the technology going to solve?**

Maharashtra faces the problem of crop damage due to insect attack, this leads to income losses and heavy distress amongst farmers, in order to avoid the damage farmers usually turn to insecticides and pesticides, but the family of Bactrocera dorsalis, commonly known as fruit fly, cannot be controlled by any pesticide, as no pesticide has been developed which leads to elimination of them. They continue to be a major pest of high risk and cause damages upto 100% pre-harvest damage. In order to control the damage, fruit fly trap can be used to attract and trap pests of the Bactrocera dorsalis with 83 sub species.

**How has demand been assessed?**

Through multiple interactions with various farmers across Maharashtra along with desk research on available data for studying the problems of insect and pest infestation in their fields and comparing them with the current available solutions.

**Who is it aimed at and why are we targeting that sector of the value chain?**

The technology is being aimed at Farmers, who are looking for an easy, safe and economical for controlling damage to the crop from fruit flies.

### Technology Design

**How does it work?**

- ✓ Pathway Block Technology: The direction of the fly entry is designed in such a way that the fruit flies can enter easily in to the trap.
  There are three equvi positioned openings for easy entry and exit of air and flies located at 120 degree angle. The free pathway is blocked by the specially positioned lure (at the top of the container and centre of the cap). The pathway block technology provides the following benefits for better performance:
  - ❑ The air entering into the container will hit the lure and is highly concentrated with the pheromone all the time so that the trapped fly will never try to go out of the trap.
  - ❑ The air enters, hits the lure and exits the trap with the pheromone.
  - ❑ The flies enter the trap, hit the lure block and fall down inside the trap.

As the fruit flies have very high attraction towards the pheromone, the flies will never leave the trap, due to suffocation and heavy licking of the lure the flies dies inside the container of trap.

- ✓ Color Alluring Technology: Specific yellow color is used for cap; this yellow shade in particular is visually alluring and optimized for better pest attraction.
- ✓ UV Technology: UV Proofing of each and every trap component provides stability against the adverse effects of oxygen and light, making them heat and extraction resistant.
- ✓ Rain Protection Technology: The trap container is designed in an Umbrella shape to avoid the entry of rain water into the trap even when tilted at 45 degree angle.

### What stage of development is it at?

It is widely commercialized and readily available.

### What is the innovation? (ie how does it improve over existing situation – is it a significant improvement/)

- ✓ As there are no pesticides available to control the infestation of fruit flies, this trap has been scientifically designed depending upon the Fruit fly flying pattern and colour attraction, reduces the changes of crop damage significantly.

### How and where is it made?

Manufactured by Barrix Agro Sciences Pvt. Ltd.

Read more on: http://www.barrix.in/BarrixCatchFruitFlyTrap

### Does it require specialist training?

No

### Is after sales service provided?

Yes

## Cost / Benefit Analysis

### Costs

Application requires 1 trap / acre @ cost INR 600. Around 2 traps are required for one acre.

### Benefits

- Direct Benefits:
  - saving in the cost of chemicals
  - saving in the cost of applying chemicals
  - an increase in the volume of marketable fruit
- Indirect Benefits:
  - Reduced chemical residues in produce and in the environment

### Assumptions

The traps are effective against a range of fruit fly and should be regarded as part of an Integrated Pest Management system. The economic impact varies depending on the crop. The manufacturers claim that losses due to fruit fly may be reduced by: guava 40%; mandarin 60%; lemon 70%; sapota 30%. It should be notes that these are optimum control percentages and that under field conditions the level of control is likely to be less than this. For the purpose of calculating the financial benefits an average figure of 1% increase in marketable fruit has been assumed. The cost of spray chemicals and application has been reduced by 5% respectively since fruit fly control makes up only part of the total cost of chemicals.

| Particulars | | Units & Assumptions | Pomegranate | Banana | Sweet Lime | Orange/ Mandarin | Custard Apple | Guava | Sapota | Strawberry | Okra | Chilli | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Operational Life** | **Maximum Operational Life of Technology** | Years | **0.5** | **0.5** | **0.5** | **0.5** | **0.5** | **0.5** | **0.5** | **0.5** | **0.5** | **0.5** | **0.5** |
| **Costs** | Total Capital Cost (INR/Unit) | 1 trap per acre | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| | Total Operational Cost (INR/Unit) | --- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Capital Cost | INR/Acre/Season/Farmer | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 |
| | Operational Cost | INR/Acre/Season/Farmer | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | **Total Cost** | **INR/Acre/Season/Farmer** | **1200** | **1200** | **1200** | **1200** | **1200** | **1200** | **1200** | **1200** | **1200** | **1200** | **1200** |
| **Benefit Streams** | Reduction in Chemicals Usage | 5% | 750 | 405 | 200 | 200 | 200 | 200 | 200 | 612 | 122 | 122 | 301 |
| | Reduction in Chemicals Application Cost | 5% | 200 | 75 | 50 | 50 | 50 | 100 | 50 | 204 | 31 | 61 | 87 |
| | Increased yield due to reduction in pests | 1% | 2009 | 1755 | 884 | 690 | 1665 | 1855 | 1196 | 6035 | 1107 | 1096 | 1829 |
| | **Total Benefit** | **INR/Acre/Season/Farmer** | **2959** | **2235** | **1134** | **940** | **1915** | **2155** | **1446** | **6851** | **1261** | **1280** | **2218** |
| **Net Incremental Benefit** | | **INR/Acre/Season/Farmer** | **1759** | **1035** | **-66** | **-260** | **715** | **955** | **246** | **5651** | **61** | **80** | **1313** |
| **Benefit Cost Analysis** | | **B/C Ratio** | **2.47** | **1.86** | **0.94** | **0.78** | **1.60** | **1.80** | **1.20** | **5.71** | **1.05** | **1.07** | **1.85** |

## Safeguards

| Environment | Yes | No | N/A | Comments |
|---|---|---|---|---|
| Will the **technology**:<br>- increase GHGs?<br>- decrease GHGs? | | | NA | |
| Will the technology:<br>- increase demand for energy?<br>- decrease the demand for energy | | | NA | |
| Will the technology improve the sustainability of the production system? | Yes | | | Owing to reduced use of chemicals |
| Will the technology:<br>- Increase the demand for water?<br>- decrease the demand for water? | | | NA | |
| Will the technology increase noise pollution? | | No | | |
| Will the technology increase the generation of solid or hazardous waste? | | No | | |
| Will the technology have a negative impact on water quality? | | No | | |
| Will the technology have a negative impact on biodiversity? | | No | | |
| | | | | |
| **Social** | | | | |
| Will the technology negatively impact on poor people? (eg. loss of income) | | No | | |
| Will the technology be accessible to the poor? | Yes | | | |
| Will the technology increase incomes along the value chain? | Yes | | | Owing to increased yield by protecting crop from insects |
| Will women have access (or be able to use) the technology? | Yes | | | |
| Will the technology improve the access of women to the value chain? | | | NA | |
| Will the technology:<br>- increase women's labour?<br>- decrease women's labour | | | NA | |

### 4.1.5. Power/Manual Fruit & Vegetable Grader (spherical)

**Description of Situation**

**Describe the context:**

Grading and sorting of fruits and vegetables is a traditional practice which is prevalent for many years now. But the manual grading, sorting is labour intensive, takes a lot of time and is inconsistent. Often skilled laborer are required for doing manual grading and it becomes a subjective exercise as a different person will have different perception about the size and quality of produce. With the rapid increase in production of fruits and vegetables, mechanical grading sorting i.e. using machines to sort and grade produce are becoming popular. Today, with a growing road network and increased trade with neighboring countries, exports from India to the neighboring countries are increasing. The well-sorted, graded fruits and vegetables have the potential to be exported to other countries and earn a premium price.

**Where does it fit in along the value-chain?**

Technology will be used in the processing node of the value chain.

**What problem(s) is the technology going to solve?**

- ✓ **Time saving:** The main advantages of this technology is that it is less labour intensive, fast and helps to standardize the process.
- ✓ **Increased price realization for produce**: While setting the price of an entire lot of produce, often the lowest quality of produce is used as a reference to set the price of the whole lot. This leads to financial loss to orchardist/ farmers. With the grading, farmers can demand higher prices for higher quality produce. Another incentive to accept and follow the established grading and packing practices is widening of the market and making e-trading possible. It reduces the cost of marketing by minimizing the expenses on the physical inspection of the produce, minimizing storage losses and eliminating the cost of handling and weighing etc. at every stage. This cost reduction will reflect positively in the form of higher profits for the farmers.

**How has demand been assessed?**

Out of all the value chains being considered under the project, the technology can be used for more than 60% of value chains. All the selected crops are highly important in the production cluster in Maharashtra. Thus demand for this machine would also be extensive.

**Who is it aimed at and why are we targeting that sector of the value chain?**

- ✓ **Farmers:** They can set up the machinery for standardizing different grades of produce, resulting in higher returns to farmer
- ✓ **Agripreneurs:** They can set up their own units for cleaning, grading and packing the produce provided by nearby farmers and charge service fee. The benefit of the service-based model is that it helps in reducing the inventory cost i.e. working capital

**Technology Design**

**How does it work?**

Unloading the fresh produce, precooling and initial sorting to remove physical impurities followed by sorting and grading by the machine and differently graded produce as per size and color are collected in separate crates. Each grade is packaged separately in the corrugated cardboard boxes by the workers manually. The packed boxes are then transported to their desired destination.

**What stage of development is it at?**

It has been developed by College of Agricultural Engineering and Technology, Bhopal and is commercially available.

**What is the innovation? (ie how does it improve over existing situation – is it a significant improvement/)**

✓ It helps in grading the produce as per size/color/etc, which increases the changes of better price realization in the market.

**How and where is it made?**

It has been developed by College of Agricultural Engineering and Technology, Bhopal

Read more on: https://icar.org.in/content/icar-ciae-bhopal%E2%80%99s-fruit-cum-vegetable-grader-paves-way-doubling-farmers%E2%80%99-income-0; http://ciae.nic.in/WriteReadData/News/201804050856413207888Recent-Technology-2018.pdf

**Does it require specialist training?**

Yes, training of 1-2 days for understanding how to operate the machine is required.

**Is after sales service provided?**

Yes

## Cost / Benefit Analysis

**Costs**

The cost of the unit is INR 70,000 with an operational life of 10 years.

**Benefits**

- Direct Benefits:
  - Reduction in labour cost and reduction in time
  - Increased price realization due to uniform grade
- Indirect Benefits:
  - Reduced management overheads from supervision of grading

**Assumptions**

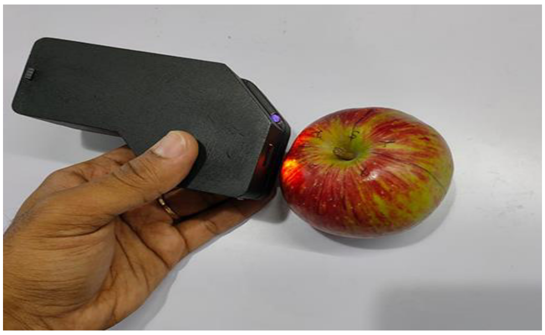
The machine works effectively with spherical shaped firm skinned produce such as oranges, limes, custard apple, sapota, pomegranate and guava. It is generally not suited to pomegranate, bananas, custard apple, strawberries, okra and chilli. Economic benefits are based on the cost of labour for grading versus the cost of operating the machine for grading. The machine has a throughput of 2 tons / hour and an operational cost of INR 300 / ton. For some products improvement to grading can result in a 50% increase in price in markets that are responsive to quality, however this varies according to supply and demand. An assumed increase in value of 10% has been taken as an average for all crops. The capital cost of the machine has been amortized over 10 years. Annual repairs and maintenance have been estimated at 10% of the capital cost / yr.

| Particulars | | Units & Assumptions | Pomegranate | Banana | Sweet Lime | Orange/ Mandarin | Custard Apple | Guava | Sapota | Strawberry | Okra | Chilli | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Operational Life** | **Maximum Operational Life of Technology** | Years | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **10** |
| **Costs** | Total Capital Cost (INR/Unit) | Per Unit | 0 | 0 | 70000 | 70000 | 0 | 70000 | 70000 | 0 | 0 | 0 | 70000 |
| | Total Operational Cost (INR/Unit) | 10% Maintenance per year & INR 300/ton @2TPH at 70% utilization in 1 shift for an year | 0 | 0 | 894040 | 894040 | 0 | 894040 | 894040 | 0 | 0 | 0 | 894040 |
| | Capital Cost (INR/Acre/Season/Farmer) | Per FPO with 200 Farmers | 0 | 0 | 35 | 35 | 0 | 35 | 35 | 0 | 0 | 0 | 35 |
| | Operational Cost (INR/Acre/Season/Farmer) | Per FPO with 200 Farmers | 0 | 0 | 4470 | 4470 | 0 | 4470 | 4470 | 0 | 0 | 0 | 4470 |
| | **Total Cost** | **INR/Acre/Season/Farmer** | **0** | **0** | **4505** | **4505** | **0** | **4505** | **4505** | **0** | **0** | **0** | **4505** |
| **Benefit Streams** | Reduction in labour cost and reduction in time | 50.0% | 0 | 0 | 707 | 552 | 0 | 1484 | 957 | 0 | 0 | 0 | 925 |
| | Increased price realization due to uniform grade | 10% | 0 | 0 | 8838 | 6900 | 0 | 18545 | 11956 | 0 | 0 | 0 | 11560 |
| | **Total Benefit** | **INR/Acre/Season/Farmer** | **0** | **0** | **9545** | **7452** | **0** | **20029** | **12913** | **0** | **0** | **0** | **12485** |
| **Net Incremental Benefit** | | **INR/Acre/Season/Farmer** | **0** | **0** | **5040** | **2947** | **0** | **15523** | **8408** | **0** | **0** | **0** | **7980** |
| **Benefit Cost Analysis** | | **B/C Ratio** | **---** | **---** | **2.12** | **1.65** | **---** | **4.45** | **2.87** | **---** | **---** | **---** | **2.77** |

## Safeguards

| Environment | Yes | No | N/A | Comments |
|---|---|---|---|---|
| Will the **technology**:<br>- increase GHGs?<br>- decrease GHGs? | | | NA | |
| Will the technology:<br>- increase demand for energy?<br>- decrease the demand for energy | | | NA | |
| Will the technology improve the sustainability of the production system? | Yes | | | Owing to reduced process time and Reduction in expenses |
| Will the technology:<br>- Increase the demand for water?<br>- decrease the demand for water? | | | NA | |
| Will the technology increase noise pollution? | | No | | |
| Will the technology increase the generation of solid or hazardous waste? | | No | | |
| Will the technology have a negative impact on water quality? | | No | | |
| Will the technology have a negative impact on biodiversity? | | No | | |
| | | | | |
| **Social** | | | | |
| Will the technology negatively impact on poor people? (e.g. loss of income) | | No | | |
| Will the technology be accessible to the poor? | Yes | | | |
| Will the technology increase incomes along the value chain? | Yes | | | Owing to reduced process time and Reduction in expenses |
| Will women have access (or be able to use) the technology? | Yes | | | |
| Will the technology improve the access of women to the value chain? | | | NA | |
| Will the technology:<br>- increase women's labour?<br>- decrease women's labour | | | NA | |

### *4.1.6. Quick Quality Assessment*



**Description of Situation**

**Describe the context:**

Demands for increased agricultural production and sustainable farming methods are always growing. Consumers demand high-quality, convenience, and diversity of selection. Quality of food products is dependent on internal and external factors that are potentially quantifiable and can be objective, which leads the world's researchers to seek novel ways to apply data to agricultural production.

**Where does it fit in along the value-chain?**

Technology will be used in the production node of the value chain.

**What problem(s) is the technology going to solve?**

- ✓ It will help study the quality of crops and gain more security about them by detecting various quality parameters, including Brix , pH , TSS, dry matter, moisture, pesticide residue and providing insights on same. With this knowledge, stakeholders can decide the use for the particular product as it delivers rapid, accurate, cost-effective results in the field with little or no sample prep, and multiple parameters can measure with the same scan. They can receive on-field support with information and answers to safeguard and increase their yields, mitigate risk, maintain high quality and optimize their farm's profitability.
- ✓ By scanning crops, farmers can best determine different parameters about the analyzed sample; e.g. protein, oil, sugar, starch and moisture which will help them to decide directly what their crops need and the best time for harvest based on individual customer requirements.

**How has demand been assessed?**

Out of all the value chains being considered under the project, the technology can be used for more than 60% of value chains. All the selected crops are highly important in the production cluster in Maharashtra. Thus demand for this machine would also be extensive.

**Who is it aimed at and why are we targeting that sector of the value chain?**

- ✓ **Farmers:** They can use the device for gaining control over the quality of their produce
- ✓ **Food Service Retailers and Processors:** While receiving products from farmers end, they can test the quality of produce and check if it matches with the raw material requirement.

**Technology Design**

**How does it work?**

Users will collect material samples and Measure samples using the scanner, Data analysis to correlate spectra data to reference measurements.

**What stage of development is it at? (eg. still in R & D phase, pilot / demonstration, commercialisation?)**

It has been developed by various manufacturers and is commercially available.

**What is the innovation? (ie how does it improve over existing situation – is it a significant improvement/)**

- ✓ It reduces the time required for studying various quality parameters of crops grown
- ✓ Give insights like can best taste or nutrition be guaranteed for premium customers? Is this orchard worth purchasing?

### How and where is it made?

It has been developed by Intello Deep

Read more on: https://www.intellolabs.com/

### Does it require specialist training?

Yes, training of 1-2 days for understanding how to operate the machine is required.

### Is after sales service provided?

Yes

## Cost / Benefit Analysis

### Costs

The cost of the device depends on the specific parameters to be measured.

### Benefits

- Direct Benefits:
    - Reduction in post-harvest losses due to quick assaying and reduction in time
    - Increased price realization due to uniform quality
    - reduction in time needed to get uniform grading
- Indirect Benefits:
    - Enhanced competitiveness of value chain products in the market place.

### Assumptions

The device offers potential to increase returns at each transactional step along the value-chain but this will vary according to product and other price setting parameters such as supply and demand. The average cost for quick quality assessment instrument varies, however, for calculation purpose it is assumed to be around INR 15000 with operational cost of around INR 5000. It is assumed that such device will be purchased/provided at FPO level and the user farmers can use them as per need. For easy estimation, conservatively, it is assoumed that around 25 farmers will use the devide.

Though benefits for transactions beyond the farm gate are difficult to calculate without more knowledge of the costs incurred, it is assumed that the average increase in price at the farm gate will be 1%; the decrease in p/h losses will be 0.5%.

| Particulars | | Units & Assumptions | Pomegranate | Banana | Sweet Lime | Orange/ Mandarin | Custard Apple | Guava | Sapota | Strawberry | Okra | Chilli | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Operational Life** | **Maximum Operational Life of Technology** | Years | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** |
| **Costs** | Total Capital Cost (INR/Unit) | Per Unit | 15000 | 15000 | 15000 | 15000 | 15000 | 15000 | 15000 | 15000 | 15000 | 15000 | 15000 |
| | Total Operational Cost (INR/Unit) | --- | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 |
| | Capital Cost (INR/Acre/Season/Farmer) | Per FPO with 25 Farmers | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| | Operational Cost (INR/Acre/Season/Farmer) | Per FPO with 25 Farmers | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 |
| | **Total Cost** | **INR/Acre/Season/Farmer** | **320** | **320** | **320** | **320** | **320** | **320** | **320** | **320** | **320** | **320** | **320** |
| **Benefit Streams** | Reduction in post-harvest losses due to quick assaying and reduction in time | 0.5% | 1005 | 878 | 442 | 345 | 833 | 927 | 598 | 3017 | 554 | 548 | 915 |
| | Increased price realization due to uniform quality | 1% | 1005 | 878 | 442 | 345 | 833 | 927 | 598 | 3017 | 554 | 548 | 915 |
| | **Total Benefit** | **INR/Acre/Season/Farmer** | **2009** | **1755** | **884** | **690** | **1665** | **1855** | **1196** | **6035** | **1107** | **1096** | **1829** |
| **Net Incremental Benefit** | | **INR/Acre/Season/Farmer** | **1689** | **1435** | **564** | **370** | **1345** | **1535** | **876** | **5715** | **787** | **776** | **1509** |
| **Benefit Cost Analysis** | | **B/C Ratio** | **6.28** | **5.49** | **2.76** | **2.16** | **5.20** | **5.80** | **3.74** | **18.86** | **3.46** | **3.43** | **5.72** |

## Safeguards

| Environment | Yes | No | N/A | Comments |
|---|---|---|---|---|
| Will the **technology**:<br>- increase GHGs?<br>- decrease GHGs? | | | NA | |
| Will the technology:<br>- increase demand for energy?<br>- decrease the demand for energy | | | NA | |
| Will the technology improve the sustainability of the production system? | Yes | | | Owing to reduced process time and Reduction in quality testing expenses |
| Will the technology:<br>- Increase the demand for water?<br>- decrease the demand for water? | | | NA | |
| Will the technology increase noise pollution? | | No | | |
| Will the technology increase the generation of solid or hazardous waste? | | No | | |
| Will the technology have a negative impact on water quality? | | No | | |
| Will the technology have a negative impact on biodiversity? | | No | | |
| | | | | |
| **Social** | | | | |
| Will the technology negatively impact on poor people? (eg. loss of income) | | No | | |
| Will the technology be accessible to the poor? | Yes | | | |
| Will the technology increase incomes along the value chain? | Yes | | | Owing to reduced process time and Reduction in assaying expenses |
| Will women have access (or be able to use) the technology? | Yes | | | |
| Will the technology improve the access of women to the value chain? | | | NA | |
| Will the technology:<br>- increase women's labour?<br>- decrease women's labour | | | NA | |

## *4.1.7. Shelf Life Extension of F&V using Paper, Bag, Sachet, Capsules etc.*


### Description of Situation

**Describe the context:**

Fresh Vegetables and Fruits start to ripen after harvesting and during the ripening process, the fruits and vegetables release ethylene gas. This ethylene gas when in the package increases the ripening rate of the fresh produce hence aggravating the ripening process resulting into faster rotting of the fresh produce. This leads to wastage of produce, financial losses and distress. The perishability of fruits and vegetables, as of now, is a factor that cannot be altered with, it is thus imperative to use technology/products which can help slow down the process of ripening.

**Where does it fit in along the value-chain?**

Technology will be used in the Aggregation, Storage and Trade/Transportation node of the value chain.

**What problem(s) is the technology going to solve?**

After harvest and during the ripening process fresh fruit and vegetables release ethylene gas. If produce is packed into conventional plastic bags or carton cartons that are not well ventilated then the ethylene gas builds up and accelerates the ripening process and the produce becomes more susceptible to microbial spoilage. Removing the ethylene gas and increasing the concentration of carbon dioxide slows the ripening process and increases the shelf life of the produce. This can be achieved in controlled atmosphere storage rooms and where storage times can be extended by several days and in some cases weeks. However these facilities are expensive to construct and maintain. An alternative and more affordable option is to use a storage bag that uses a compound to remove the ethylene.

**How has demand been assessed?**

Out of all the value chains being considered under the project, the technology can be used for all the crops. All the selected crops are highly important in the production cluster in Maharashtra and have a low shelf life. Thus demand for this product would also be extensive.

**Who is it aimed at and why are we targeting that sector of the value chain?**

- ✓ **Farmers:** They can use the products while packaging their produce, to increase the shelf life of the product helping them increase the realized price.
- ✓ **Aggregators:** They can use the products to store the products for a longer time, and sell when the price is desirable and profitable, instead of selling the produce right away.

### Technology Design

**How does it work?**

The Shelf life extension solutions is based on innovative technology that absorb the harmful ethylene gas, unrequired moisture and causing volatile bacterial inhibition (VBI) hence slowing the ripening and rotting process and increasing the shelf life of the packed and stored produce.

- ✓ **Papers:** Forms a breathable membrane the moment it comes in contact with fresh fruits and vegetables. These can be easily placed with the fresh produce and absorb the ethylene gas which gets entrapped within

these papers. The absorption of the gas reduces the ripening speed and *hence* increasing the shelf life of fresh produce.

- ✓ **Bags:** Pack the produce in the right sized bag in conventional way. KIF modified atmosphere packaging create a balance atmosphere inside bag and extends the shelf life of packed fresh fruit and vegetables. This would depend upon the kind of fresh produce and the quantity of ethylene produced.
- ✓ **Sachets:** Place the recommended number of sachets in the fruit and vegetable conventional corrugated boxes or export packing. The sachet/pouch absorbs ethylene gas from the pack and create a bacteria free environment to extend the shelf life of packed fresh fruit and vegetables. Doses would depend upon the kind of fresh produce and the quantity of ethylene produced.

### What stage of development is it at? (eg. still in R & D phase, pilot / demonstration, commercialisation?)

It has been developed by innovative technology provider company, Keep-it-Fresh and is commercially available.

### What is the innovation? (ie how does it improve over existing situation – is it a significant improvement/)

The use of ethylene "scrubber" technology is well established but outside of commercial controlled atmosphere cool-rooms it has not been widely used as a means of maintaining the quality of fresh produce. Tests performed on a range of fresh fruits and vegetables shows that the produce kept in open started to rot in 3-5 days where as the ones in the storage bags were still in marketable condition after 10 – 15 days. The improvement in storage time varies depending on the product and the degree of ripeness when it is placed in the bag. For example the storage time of tomatoes is extended by 3 times and up to 5 times for bananas. For example good even on the 10th day compared to the ones in generic plastic bag. Bags could be used by farmers however their effectiveness would be limited if the produce has not been prepared for sale i.e washed and graded. The bags would be more effectively used by packhouses.

### How and where is it made?

It has been developed by innovative technology provider company, Keep-it-Fresh

Read more on: https://keep-it-fresh.com/

### Does it require specialist training?

No

### Is after sales service provided?

Yes

## Cost / Benefit Analysis

### Costs

The cost of the bags is dependent on the size of the order, size of bags and additional options such as absorbent sachets.

### Benefits

- Direct Benefits:
  - Reduction in post-harvest losses
  - Increased price realization due to increased shelf life
- Indirect Benefits:
  - improved presentation at point of sale.

### Assumptions

The bags will reduce post-harvest losses by at least 1% at each transactional step along the value-chain but this will vary according to product and other price setting parameters such as supply and demand. Though

benefits for transactions beyond the farm gate are difficult to calculate without more knowledge of the costs incurred, the resultant increase in keeping quality or shelf life is assumed to increase the realization by 3%.

| Particulars | | Units & Assumptions | Pomegranate | Banana | Sweet Lime | Orange/ Mandarin | Custard Apple | Guava | Sapota | Strawberry | Okra | Chilli | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Operational Life** | **Maximum Operational Life of Technology** | Season | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** |
| **Costs** | Total Capital Cost (INR/Unit) | Per Unit | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 0 | 0 | 5000 |
| | Total Operational Cost (INR/Unit) | 2 Mandays per acre | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 0 | 0 | 800 |
| | Capital Cost | INR/Acre/Season/Farmer | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 0 | 0 | 5000 |
| | Operational Cost | INR/Acre/Season/Farmer | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 0 | 0 | 800 |
| | **Total Cost** | **INR/Acre/Season/Farmer** | **5800** | **5800** | **5800** | **5800** | **5800** | **5800** | **5800** | **5800** | **0** | **0** | **5800** |
| **Benefit Streams** | Reduction in post-harvest losses | 1.0% | 2009 | 1755 | 884 | 690 | 1665 | 1855 | 1196 | 6035 | 0 | 0 | 2011 |
| | Increased price realization due to increased shelf life | 3.0% | 6027 | 5266 | 2652 | 2070 | 4996 | 5564 | 3587 | 18105 | 0 | 0 | 6033 |
| | **Total Benefit** | **INR/Acre/Season/Farmer** | **8037** | **7021** | **3535** | **2760** | **6661** | **7418** | **4783** | **24140** | **0** | **0** | **8044** |
| **Net Incremental Benefit** | | **INR/Acre/Season/Farmer** | **2237** | **1221** | **-2265** | **-3040** | **861** | **1618** | **-1017** | **18340** | **0** | **0** | **4855** |
| **Benefit Cost Analysis** | | **B/C Ratio** | **1.39** | **1.21** | **0.61** | **0.48** | **1.15** | **1.28** | **0.82** | **4.16** | **---** | **---** | **1.39** |

## Safeguards

| Environment | Yes | No | N/A | Comments |
|---|---|---|---|---|
| Will the **technology**:<br>- increase GHGs?<br>- decrease GHGs? | | | NA | |
| Will the technology:<br>- increase demand for energy?<br>- decrease the demand for energy | | | NA | |
| Will the technology improve the sustainability of the production system? | Yes | | | Owing to increased shelf life of produce |
| Will the technology:<br>- Increase the demand for water?<br>- decrease the demand for water? | | | NA | |
| Will the technology increase noise pollution? | | No | | |
| Will the technology increase the generation of solid or hazardous waste? | | No | | |
| Will the technology have a negative impact on water quality? | | No | | |
| Will the technology have a negative impact on biodiversity? | | No | | |
| | | | | |
| **Social** | | | | |
| Will the technology negatively impact on poor people? (eg. loss of income) | | No | | |
| Will the technology be accessible to the poor? | Yes | | | |
| Will the technology increase incomes along the value chain? | Yes | | | Owing to increased shelf life of produce |
| Will women have access (or be able to use) the technology? | Yes | | | |
| Will the technology improve the access of women to the value chain? | | | NA | |
| Will the technology:<br>- increase women's labour?<br>- decrease women's labour? | | | NA | |

### 4.1.8. Zero Energy Cool Chamber/Evaporative Cool Chamber

Permanent Evaporative Cooler

Portable Evaporative Cooler

**Description of Situation**

**Describe the context:**

Much of the post-harvest loss of fruits and vegetables in developing countries is due to the lack of proper storage facilities. While refrigerated cool stores are the best method of preserving fruits and vegetables, they are expensive to buy and run. Consequently, in developing countries there is an interest in simple low-cost alternatives, many of which depend on evaporative cooling which is simple and does not require any external power supply. The basic principle relies on cooling by evaporation. When water evaporates it draws energy from its surroundings which produces a considerable cooling effect. Evaporative cooling occurs when air, that is not too humid, passes over a wet surface; the faster the rate of evaporation the greater the cooling. The efficiency of an evaporative cooler depends on the humidity of the surrounding air. Very dry air can absorb a lot of moisture so greater cooling occurs. In the extreme case of air that is totally saturated with water, no evaporation can take place and no cooling occurs. Generally, an evaporative cooler is made of a porous material that is fed with water. Hot dry air is drawn over the material. The water evaporates into the air raising its humidity and at the same time reducing the temperature of the air. There are many different styles of evaporative coolers. The design will depend on the materials available and the users requirements.

**Where does it fit in along the value-chain?**

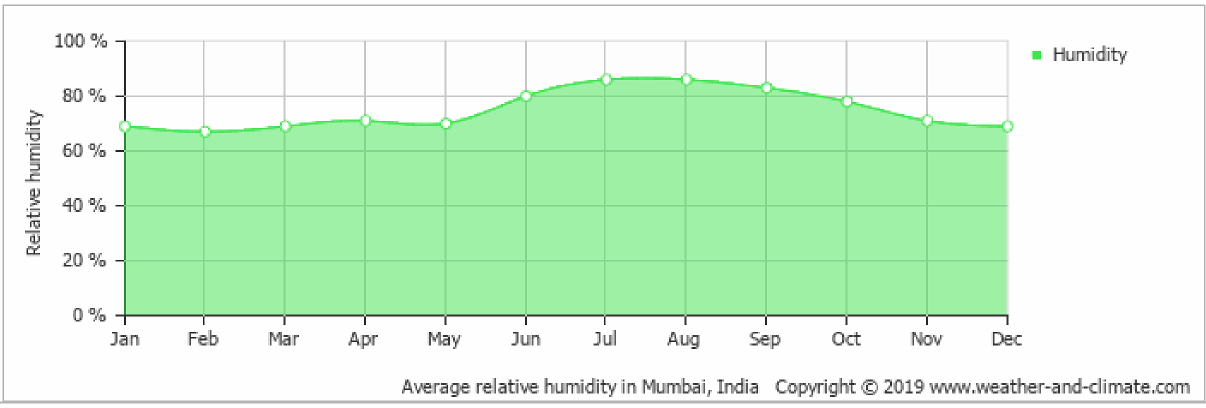
Technology will be used in the Aggregation and Storage node of the value chain.

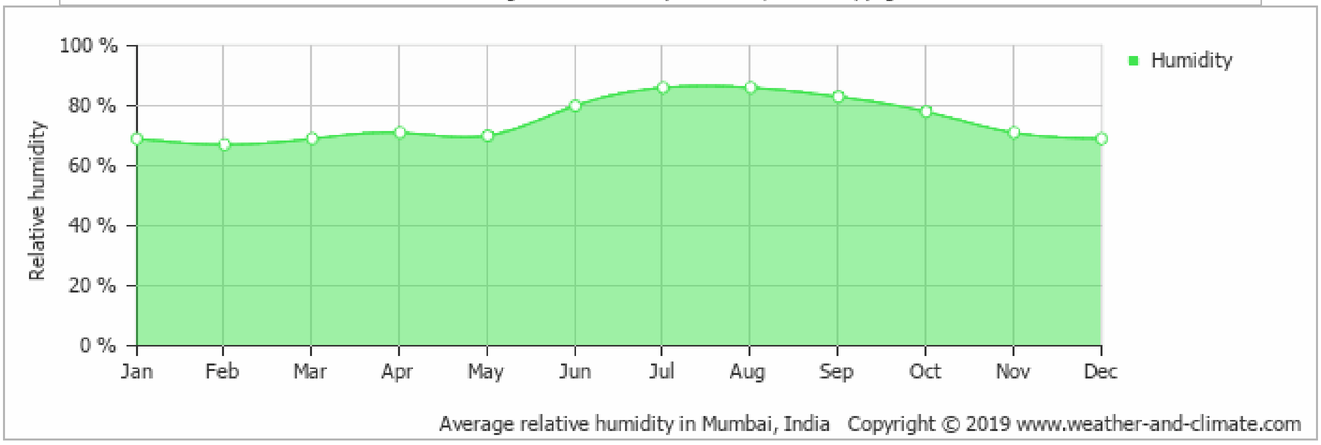
**What problem(s) is the technology going to solve?**

Conventional electric cool rooms are effective in circulating cold air and in maintaining the relative humidity to avoid water loss which can affect appearance, weight and quality. Conventional cool rooms also require a continuous power supply and regular maintenance. For most small farmers this is an additional cost that they are unlikely to recover. A passive-direct evaporative cooling system makes use of natural air flow, has no moving parts, is low cost and requires very little maintenance. The system comprises (i) cabinets where the produce is stored (ii) an absorbent material used to expose the water to the moving air (iii) an overhead tank. The absorbent material covering the cabinet absorbs water that drips from the holding tank. As air moves over the absorbent material water evaporates and cools the cabinet. As long as evaporation takes place, the cabinet will cool the contents to a temperature lower than the environment. The rate of cooling will depend on air flow, relative humidity and ambient temperature but it is possible for cabinet temperatures to be reduced from 5oC to 10oC. Performance can be enhanced by using sponge fibre pad sandwiched between plastic nets for support that allows it to be transported to different sites. The permanent evaporative cooler has a capacity of 2 – 7 tonnes and cooling temperatures of 150C may be obtained provided the chamber is watered twice a day.

Currently farmers harvest produce and store it under the shade of a tree or under a temporary shade house. While this practice is effective in lowering the temperature by 100C – 150C further gains of another 100C can be obtained using an evaporative cooler under optimum conditions. To be effective the relative humidity must be less than 70% although cooling will still take place at higher a higher relative humidity. Long range weather data for Maharashtra (figure 3) indicates that mean monthly relative humidity is approximately 70% for the period November to May and approximately 83% for the period June – October (figure 3). Evaporation not only lowers the air temperature surrounding the produce, it also increases the moisture content of the air. This helps to prevent the drying out of the produce, and therefore extends its shelf life.

**Figure 3:** The mean monthly relative humidity over the year in Pune (Maharashtra), India.




* Data from nearest weather station to Pune, Mumbai (Maharashtra), India (124 KM).

Correlating humidity data with harvest times and optimum storage temperatures Table 1) provides a means of assessing how effective evaporative cooling is likely to be.

**Table 1** Storage Temperature and Main Harvest Times

| Crop | Optimum Storage Temp. (0C) | Main Harvest Months |
|---|---|---|
| **Strawberries** | 0 - 2 | Oct – Nov : April May |
| **Sapota** | 6 - 10 | Jan – Feb: May - June |
| **Custard Apple** | 15 - 20 | August - November |
| **Mandarins** | 4 - 8 | Feb. - March |
| **Okra** | 15 - 20 | Sept. - April |
| **Green Chilli** | 7 - 10 | Year Round |
| **Sweet Orange** | 4 - 7 | Sept. – Dec. |
| **Pomegranates** | 5 - 7 | July - April |
| **Guava** | 6 - 8 | July - August |
| **Bananas** | 13 - 15 | March - August |

The optimum storage temperature for bananas is about 130C – 150C which is within the range of an evaporative cooler at the low humidity that exists from March – May and also during the period of high humidity from mid-June to August. At the other end of the spectrum the optimum storage temperature of strawberries is 00C – 20C and the harvest seasons are October – November and April – May. Evaporative coolers cannot reach these temperatures but putting strawberries in the chamber for a few hours will assist in removing a significant amount of the field heat and will contribute to reducing post-harvest losses. Typical improvements in storage life for some fruit and vegetables is show in Table 2.

**Table 2** Shelf life of produce in evaporative coolers.

| Produce | Shelf life without pre-cooling (days) | Shelf life with evaporative cooling (days) |
|---|---|---|
| **Tomatoes** | 2 | 20 |
| **Guava** | 2 | 20 |
| **Okra** | 4 | 17 |
| **Mandarins** | 20 | 42 |

### How has demand been assessed?

Out of all the value chains being considered under the project, the technology can be used for all the crops. All the selected crops are highly important in the production cluster in Maharashtra and have a low shelf life. Thus demand for this product would also be extensive.

### Who is it aimed at and why are we targeting that sector of the value chain?

✓ **Farmers:** They can use the chamber to store the products for a longer time, as evaporation not only lowers the air temperature surrounding the produce, it also increases the moisture content of the air. This helps to prevent the drying out of the produce, and therefore extends its shelf life enabling farmers to sell when the price is desirable and profitable, instead of "rush selling"

## Technology Design

### How does it work?

Zero energy cool chambers stay 10- 15° C cooler than the outside temperature and maintain about 90 percent relative humidity. And they are easy to build out of locally available materials, such as brick, sand, bamboo, straw, and gunny bags.

### What stage of development is it at? (eg. still in R & D phase, pilot / demonstration, commercialisation?)

The technology has been proven and demonstrated at a number sites in India. Evaporative coolers are manufactured and supplied by IARI, New Delhi, CIPHET, Ludhiana.

### What is the innovation? (ie how does it improve over existing situation – is it a significant improvement/)

The technology for evaporative coolers is well established and the principle is the same across a range of designs. Improvements come from the use of insultation in the chamber walls and the arrangement of the cooling pads to optimize evaporation and remove heat from the storage chamber. Although the benefits have been well established the adoption of the technology by farmers is still relatively low. Demonstrations to farmer organizations and key value chain influencers are needed to improve uptake by farmers.

### How and where is it made?

Evaporative coolers are manufactured and supplied by IARI, New Delhi and CIPHET, Ludhiana.

Read more on: https://www.iari.res.in/download/pdf/story4_eng.pdf

### Does it require specialist training?

No.

### Is after sales service provided?

Yes

## Cost / Benefit Analysis

### Costs

The cost of constructing an evaporative cooler is INR 45,000. It has an effective operational life of 15 years. Repairs and maintenance costs are estimated at 5% / year.

### Benefits

- Direct Benefits:
  - Reduction in post-harvest losses
  - Increased price realization due to increased shelf life
- Indirect Benefits:
  - Enhanced quality along the value chain and increased competitiveness of value chain products in the market place.

### Assumptions

The efficiency of the evaporative cooler will vary depending on atmospheric conditions. Some products will benefit more from pre-cooling on the farm than others. For example, strawberries deteriorate very rapidly after harvest if field heat is not removed quickly, whereas okra and chillies comparatively do not deteriorate as quickly. The impact on reducing post-harvest losses will also depend on the length of storage time. It is assumed that average farm gate post-harvest losses will be reduced by 2% and removal of field heat will improve the quality to fetch 5% additional realization.

| Particulars | | Units & Assumptions | Pomegranate | Banana | Sweet Lime | Orange/ Mandarin | Custard Apple | Guava | Sapota | Strawberry | Okra | Chilli | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Operational Life** | **Maximum Operational Life of Technology** | Years | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **10** |
| **Costs** | Total Capital Cost (INR/Unit) | Per Unit | 45000 | 45000 | 45000 | 45000 | 45000 | 45000 | 45000 | 45000 | 45000 | 45000 | 45000 |
| | Total Operational Cost (INR/Unit) | Maintenance @5%/yr | 2250 | 2250 | 2250 | 2250 | 2250 | 2250 | 2250 | 2250 | 2250 | 2250 | 2250 |
| | Capital Cost | INR/Acre/Season/Farmer | 4500 | 4500 | 4500 | 4500 | 4500 | 4500 | 4500 | 4500 | 4500 | 4500 | 4500 |
| | Operational Cost | INR/Acre/Season/Farmer | 2250 | 2250 | 2250 | 2250 | 2250 | 2250 | 2250 | 2250 | 2250 | 2250 | 2250 |
| | **Total Cost** | **INR/Acre/Season/Farmer** | **6750** | **6750** | **6750** | **6750** | **6750** | **6750** | **6750** | **6750** | **6750** | **6750** | **6750** |
| **Benefit Streams** | Reduction in post-harvest losses | 2.0% | 4018 | 3511 | 1768 | 1380 | 3331 | 3709 | 2391 | 12070 | 2215 | 2193 | 3659 |
| | Increased price realization due to increased shelf life | 5.0% | 10046 | 8777 | 4419 | 3450 | 8327 | 9273 | 5978 | 30175 | 5537 | 5482 | 9146 |
| | **Total Benefit** | **INR/Acre/Season/Farmer** | **14064** | **12287** | **6187** | **4830** | **11657** | **12982** | **8369** | **42245** | **7752** | **7675** | **12805** |
| **Net Incremental Benefit** | | **INR/Acre/Season/Farmer** | **7314** | **5537** | **-563** | **-1920** | **4907** | **6232** | **1619** | **35495** | **1002** | **925** | **7879** |
| **Benefit Cost Analysis** | | **B/C Ratio** | **2.08** | **1.82** | **0.92** | **0.72** | **1.73** | **1.92** | **1.24** | **6.26** | **1.15** | **1.14** | **1.90** |

## Safeguards

| Environment | Yes | No | N/A | Comments |
|---|---|---|---|---|
| Will the **technology**:<br>- increase GHGs?<br>- decrease GHGs? | | | NA | |
| Will the technology:<br>- increase demand for energy?<br>- decrease the demand for energy? | --<br>Yes | No<br>-- | | No requirement of energy |
| Will the technology improve the sustainability of the production system? | Yes | | | Owing to efficient low cost pre-cooling & increased shelf life of produce |
| Will the technology:<br>- Increase the demand for water?<br>- decrease the demand for water? | | | NA | |
| Will the technology increase noise pollution? | | No | | |
| Will the technology increase the generation of solid or hazardous waste? | | No | | |
| Will the technology have a negative impact on water quality? | | No | | |
| Will the technology have a negative impact on biodiversity? | | No | | |
| | | | | |
| **Social** | | | | |
| Will the technology negatively impact on poor people? (eg. loss of income) | | No | | |
| Will the technology be accessible to the poor? | Yes | | | |
| Will the technology increase incomes along the value chain? | Yes | | | Owing to efficient low cost pre-cooling & increased shelf life of produce (reduced losses) |
| Will women have access (or be able to use) the technology? | Yes | | | |
| Will the technology improve the access of women to the value chain? | | | NA | |
| Will the technology:<br>- increase women's labour?<br>- decrease women's labour | | | NA | |

### *4.1.9. Solar Dryers and Smart Dryer (F&V Dryer)*

**Description of Situation**

**Describe the context:**

Due to exponential rise in the price of fuel and depletion of fossil fuel, there is a need to look for other alternatives like nonconventional energy resources viz. solar energy. Solar energy is inexhaustible, ample and free of cost available all over the world. Due to this the attention has been gradually diverting to utilize the renewable energy for a number of applications. Open sun drying was followed in rural areas to dry agricultural products. In recent days solar dryers are used which protect farming produce from insect, dust and rain.

**Where does it fit in along the value-chain?**

Technology will be used in the Aggregation and Storage node of the value chain.

**What problem(s) is the technology going to solve?**

High moisture content is one of the reasons for its spoilage during the course of storage at time of harvesting. High moisture crops and other products are prone to fungus infection, attack by insects and the increased respiration of agricultural products. There is spoilage of food products can be prevented using dehydration techniques. Food drying is one of the oldest methods of preserving food products but sun drying is highly time consuming and dependent on climatic conditions, like rain, win, humidity etc. The solar dryer has considerable advantages over the traditional sun drying method in terms of less risk of spoilage because of the speed of drying. Drying is faster because inside the dryer it is warmer than outside. So the quality of the products dried inside the dryer is better in terms of nutrients, hygiene and color.

**How has demand been assessed?**

Fruits and vegetables are highly perishable, and a major percentage of the produce goes waste. The technology can be used to dry foods, increasing their shelf life, and hence market reach.

**Who is it aimed at and why are we targeting that sector of the value chain?**

- ✓ **Farmers:** They can use the product at farm level to preserve the produce, increasing its shelf life, allowing them to sell the

**Technology Design**

**How does it work?**

Solar dryers help provide more heat than the atmospheric temperature. In a solar dryer, air enters the drying chamber through the process of natural convection or through an external source like fan, pump, suction device, etc. Air gets heated as it passes through the chamber and then partially cools as it absorbs moisture from the food product placed in the chamber. Then, the humid air is removed by an exhaust fan or chimney.

**What stage of development is it at? (eg. still in R & D phase, pilot / demonstration, commercialisation?)**

The technology has been proven and demonstrated at a number sites in India. Evaporative coolers are manufactured and supplied by S4S Technologies, Aadhi Solar, ATR Solar Vishivkarma Solar Energy Corporation IARI, New Delhi, CIPHET, Ludhiana.

### What is the innovation? (ie how does it improve over existing situation – is it a significant improvement/)

- ✓ A dryer can be constructed from locally available materials at a relatively low cost, with no requirement of electricity.
- ✓ Solar dryers last longer. A typical dryer can last 15-20 years and will need minimum maintenance.
- ✓ Dehydrator that uses conduction – convection – radiation – all modes of heat transfer to deliver the world's highest drying efficiency.

### How and where is it made?

Evaporative coolers are manufactured and supplied by various manufacturers in the food preservation sector including S4S Technologies, Aadhi Solar, ATR Solar Vishivkarma Solar Energy Corporation

Read more on: https://s4stechnologies.com/, http://www.aadhisolar.in/; http://atrsolarindia.com/

### Does it require specialist training?

No.

### Is after sales service provided?

Yes

## Cost / Benefit Analysis

### Costs

The cost of the solar dryer ranges from INR 35,000 to INR 300,000 with throughput ranging from 10 kg. / day to 300 kg/day. For the calculation purpose the capital cost is considered as INR 170,000 with capacity of around 180Kg/day. Operational life is up to 10 years with low annual R & M of 10% of capital costs.

### Benefits

- Direct Benefits:
    - Reduction in post-harvest losses
    - Increased value addition for about 5% of per acre produce, at 90% operational efficiency, 10% conversion (dry product from fresh fruit) and 12 times increased value per Kg
- Indirect Benefits:
    - It provides an opportunity for alternative income streams when prices for fresh product fall.

### Assumptions

The volume of low-grade fruit will vary depending on the parameters that effect quality including: growing conditions, crop management, variety and market requirements. It is assumed that 5% of the total harvest will not be suitable for sale, however if B grade fruit are considered then the volume is likely to be 10% - 20% of the total harvest. Given that the market for dried products would be new for most farmers and FPOs the value of 5% will be used. The analysis is based on FPOs buying the dryer and using it for 10 user farmers to ensure there a critical mass for both drying and selling.

| Particulars | | Units & Assumptions | Pomegranate | Banana | Sweet Lime | Orange/ Mandarin | Custard Apple | Guava | Sapota | Strawberry | Okra | Chilli | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Operational Life** | **Maximum Operational Life of Technology** | Years | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **10** |
| **Costs** | Total Capital Cost (INR/Unit) | Per Unit | 0 | 170000 | 0 | 0 | 0 | 170000 | 170000 | 0 | 170000 | 170000 | 170000 |
| | Total Operational Cost (INR/Unit) | Operation & Maintenance @10%/yr, Processing capacity of 180Kg/day, Processing cost of INR 1/Kg | 0 | 59768 | 0 | 0 | 0 | 59768 | 59768 | 0 | 59768 | 59768 | 59768 |
| | No. of Farmer Users | 10 | 0 | 10 | 0 | 0 | 0 | 10 | 10 | 0 | 10 | 10 | |
| | Capital Cost | Per FPO with 10 users per year | 0 | 1700 | 0 | 0 | 0 | 1700 | 1700 | 0 | 1700 | 1700 | 1700 |
| | Operational Cost | Per FPO with 10 users per year | 0 | 5977 | 0 | 0 | 0 | 5977 | 5977 | 0 | 5977 | 5977 | 5977 |
| | **Total Cost** | **INR/Acre/Season/Farmer** | **0** | **7677** | **0** | **0** | **0** | **7677** | **7677** | **0** | **7677** | **7677** | **7677** |
| **Benefit Streams** | Reduction in post-harvest losses | 2.0% | 0 | 3511 | 0 | 0 | 0 | 3709 | 2391 | 0 | 2215 | 2193 | 2804 |
| | Increased value addition for about 5% of per acre produce, at 90% operational efficiency, 10% conversion (dry product from fresh fruit) and 12 times increased value per Kg | 1200.0% | 0 | 9479 | 0 | 0 | 0 | 10014 | 6456 | 0 | 5980 | 5921 | 7570 |
| | **Total Benefit** | **INR/Acre/Season/Farmer** | **0** | **12989** | **0** | **0** | **0** | **13723** | **8848** | **0** | **8195** | **8114** | **10374** |
| **Net Incremental Benefit** | | **INR/Acre/Season/Farmer** | **0** | **5312** | **0** | **0** | **0** | **6047** | **1171** | **0** | **518** | **437** | **2697** |
| **Benefit Cost Analysis** | | **B/C Ratio** | **---** | **1.69** | **---** | **---** | **---** | **1.79** | **1.15** | **---** | **1.07** | **1.06** | **1.35** |

## Safeguards

| Environment | Yes | No | N/A | Comments |
|---|---|---|---|---|
| Will the **technology**:<br>- increase GHGs?<br>- decrease GHGs? | | | NA | |
| Will the technology:<br>- increase demand for energy?<br>- decrease the demand for energy | --<br>Yes | No<br>-- | | Runs on renewable source of energy |
| Will the technology improve the sustainability of the production system? | Yes | | | Owing to reduction in energy consumption |
| Will the technology:<br>- Increase the demand for water?<br>- decrease the demand for water? | | | NA | |
| Will the technology increase noise pollution? | | No | | |
| Will the technology increase the generation of solid or hazardous waste? | | No | | |
| Will the technology have a negative impact on water quality? | | No | | |
| Will the technology have a negative impact on biodiversity? | | No | | |
| | | | | |
| **Social** | | | | |
| Will the technology negatively impact on poor people? (eg. loss of income) | | No | | |
| Will the technology be accessible to the poor? | Yes | | | |
| Will the technology increase incomes along the value chain? | Yes | | | Owing to reduction in energy consumption |
| Will women have access (or be able to use) the technology? | Yes | | | |
| Will the technology improve the access of women to the value chain? | | | NA | |
| Will the technology:<br>- increase women's labour?<br>- decrease women's labour | | | NA | |

## *4.1.10. Pomegranate Aril Extractor*


**Description of Situation**

**Describe the context:**

Pomegranate is one of the most important commercial fruit grown in Maharashtra. The area under this fruit is expanding day by day and its cultivation is now gaining high importance. The pomegranate has been regarded as medicinal fruit of great importance. But as the hard peel of Pomegranate fruits makes it difficult to release the arils, the consumption gets limited to fresh fruit. The field of invention was needed to develop a mechanical and continuous system for safe separation of arils from the Pomegranate fruit for its industrial processing point of view.

**Where does it fit in along the value-chain?**

Technology will be used in the Processing node of the value chain.

**What problem(s) is the technology going to solve?**

The developed machine is highly promising for increasing the industrial processing of Pomegranate as many processed food products such as juice, cold drinks, carbonated drinks, anardana (dried arils/seeds), wine, syrup etc are prepared from Pomegranate fruits. However, the hard peel of Pomegranate fruits makes it difficult to release the arils, thus limiting its consumption as fresh fruit. Since a Pomegranate contains several hundreds of arils completely held within the fruit, manual processing of pomegranates consisting of cutting the fruit by knife into pieces and then separation of arils tends to be very inefficient and highly labour intensive, time consuming and irritating. Arils are so firmly attached to each other and; with rind and peel that it makes difficult to separate manually for industrial processing in large quantity. The machine will help in a mechanical and continuous system for safe separation of arils from the Pomegranate fruit for its industrial processing point of view.

**How has demand been assessed?**

Pomegranate is an important fruit crop of Maharashtra. It produces about 85% of the total Indian production, thereby leading in Pomegranate production in the country. With increasing demand of processed items, the technology will be readily used and accepted in the market.

**Who is it aimed at and why are we targeting that sector of the value chain?**

✓ **Food Processing Units:** This provides an income source for young agripreneurs to set up their own fruit processing plant.

**Technology Design**

**How does it work?**

It is a mechanical system operated by electric motor and is capable to separate or extract arils (juice enclosed seeds) from the whole Pomegranate fruit. Pomegranate fruits of any size/shape/variety are fed into the receiving hopper of the machine and the separated arils are collected at the other end. The peels and other extraneous matters are collected at another end.

**What stage of development is it at? (eg. still in R & D phase, pilot / demonstration, commercialisation?)**

The technology has been proven and demonstrated at a number sites in India and now is ready for commercialization.

### What is the innovation? (ie how does it improve over existing situation – is it a significant improvement/)

The principle used to break the Pomegranate fruit inside cone frustums is unique and novel. The operation of the machine is continuous; it is capable to break any size of any variety of the Pomegranate fruit and safely separate or extract the arils. The percentage mechanical damage of arils is observed in the range of 1 to 2 % on the basis of separated arils.

### How and where is it made?

The machine is manufactured and supplied by ICAR-CIPHET Ludhiana

Read more on: https://mofpi.nic.in/sites/default/files/technologies_devoloped_by_icar_institutes.pdf

### Does it require specialist training?

It requires very little training to learn how to operate.

### Is after sales service provided?

Yes

## Cost / Benefit Analysis

### Costs

The cost of the Aril Extractor is INR 600,000. The machine has an operational life of 15 years with an annual R & M of 5% of capital costs.

### Benefits

- Direct Benefits:
  - Reduction in post-harvest losses
  - Increased value addition for about 5% of per acre produce, at 90% operational efficiency, 60% conversion (aril from fruit) and 3 times increased value per Kg
- Indirect Benefits:
  - It provides an opportunity for alternative income streams when prices for fresh product fall

### Assumptions

Potentially it would be possible to process all the fruit into arils, however a more risk averse strategy would be to process part of the crop including fruit that would not otherwise be of market quality and sell the remainder as fresh produce. The percentage of low-grade fruit will vary depending on the parameters that effect quality including: growing conditions, crop management, variety and market requirements. It is assumed that 5% of the total harvest will not be suitable for sale in the fresh market and will be processed. Calculations are based on a conversion of 1 kg. of fresh pomegranates yielding 0.6 kgs of arils. It is assumed the value addition will result into 3 times increase in the selling price of arils compared to unprocessed fruit. The machine has a capacity of 500kg/ hr. The analysis is based on FPOs buying the machine and using it for 25 farmers to ensure there is a critical mass to optimize use of the extractor.

| Particulars | | Units & Assumptions | Pomegranate | Banana | Sweet Lime | Orange/ Mandarin | Custard Apple | Guava | Sapota | Strawberry | Okra | Chilli | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Operational Life** | **Maximum Operational Life of Technology** | Years | **15** | **15** | **15** | **15** | **15** | **15** | **15** | **15** | **15** | **15** | **15** |
| **Costs** | Total Capital Cost (INR/Unit) | Per Unit | 600000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 600000 |
| | Total Operational Cost (INR/Unit) | 5% Maintenance per year & INR 300/ton @0.5TPH at 90% utilization in 1 shift | 251760 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 251760 |
| | No. of Farmer Users | 25 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | Capital Cost | Per FPO with 50 users per year | 1600 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1600 |
| | Operational Cost | Per FPO with 50 users per year | 10070 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10070 |
| | **Total Cost** | **INR/Acre/Season/Farmer** | **11670** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **11670** |
| **Benefit Streams** | Reduction in post-harvest losses | 2.0% | 4018 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4018 |
| | Increased value addition for about 5% of per acre produce, at 90% operational efficiency, 60% conversion (aril from fruit) and 3 times increased value per Kg | 300.0% | 16274 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16274 |
| | **Total Benefit** | **INR/Acre/Season/Farmer** | **20292** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **20292** |
| **Net Incremental Benefit** | | **INR/Acre/Season/Farmer** | **8622** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **8622** |
| **Benefit Cost Analysis** | | **B/C Ratio** | **1.74** | **---** | **---** | **---** | **---** | **---** | **---** | **---** | **---** | **---** | **1.74** |

## Safeguards

| Environment | Yes | No | N/A | Comments |
|---|---|---|---|---|
| Will the **technology**:<br>- increase GHGs?<br>- decrease GHGs? | | | NA | |
| Will the technology:<br>- increase demand for energy?<br>- decrease the demand for energy | | | NA | |
| Will the technology improve the sustainability of the production system? | Yes | | | Owing to increased value addition and reduced PH losses |
| Will the technology:<br>- Increase the demand for water?<br>- decrease the demand for water? | | | NA | |
| Will the technology increase noise pollution? | | No | | |
| Will the technology increase the generation of solid or hazardous waste? | | No | | |
| Will the technology have a negative impact on water quality? | | No | | |
| Will the technology have a negative impact on biodiversity? | | No | | |
| | | | | |
| **Social** | | | | |
| Will the technology negatively impact on poor people? (eg. loss of income) | | No | | |
| Will the technology be accessible to the poor? | Yes | | | |
| Will the technology increase incomes along the value chain? | Yes | | | Owing to increased value addition and reduced PH losses |
| Will women have access (or be able to use) the technology? | Yes | | | |
| Will the technology improve the access of women to the value chain? | | | NA | |
| Will the technology:<br>- increase women's labour?<br>- decrease women's labour | | | NA | |

### 4.1.11. Custard Apple Pulper

**Description of Situation**

**Describe the context:**

Custard Apple is widely grown fruit crop in Maharashtra and has good potential for value addition for socio-economic upliftment of farmers. Mostly custard apple fruit cultivation is in the form of unorganized farming. Due to unavailability of handling and processing machineries related with this fruit, it is being underutilized. Extraction of pulp is a major constraint in processing of custard apple fruits. The field of invention was needed to develop a machinery to be used in order to increase the processing of fruit.

**Where does it fit in along the value-chain?**

Technology will be used in the Processing node of the value chain.

**What problem(s) is the technology going to solve?**

This invention brings higher value for the fruits thus leads to get good income for the farmers as it helps in Quality enhancement (Hygiene, shelf life, consistency, texture and structure), Catering to market needs of bulk requirement (Manual process is slow and tedious), Reduction in post harvest losses, Management of market glut ensuring year round availability and Reduction in wastage.

**How has demand been assessed?**

Custard Apple is an important fruit crop of Maharashtra. With increasing demand of Custard apple based products, including ice-creams the technology will be readily used and accepted in the market.

**Who is it aimed at and why are we targeting that sector of the value chain?**

- ✓ **Food Processing Units:** This provides an income source for young agripreneurs to set up their own plants in Ice-cream Industry, Dairy and Food processing Industry, Bakery and Confectionary Industry etc

**Technology Design**

**How does it work?**

The custard apple pulper contains three mechanism viz. fruit cutting mechanism, fruit scooping mechanism and pulping mechanism. The machine is fully automatic with pneumatic actuators and electronic controls. Fruit is held without any damage and guided while cutting. It contains a special sieve and pulping shaft with beaters. The sieve is made with special design to maintain the shape of the pulp which is present with the seed.

**What stage of development is it at? (eg. still in R & D phase, pilot / demonstration, commercialisation?)**

The technology has been proven and demonstrated at a number sites in India by CIPHET Ludhiana and now is ready for commercialization.

**What is the innovation? (ie how does it improve over existing situation – is it a significant improvement/)**

- ✓ The machine increases the usage of fruit, for eg: Custard Apple based Ice-cream business portfolio of ice cream companies was at a very small scale before the advent of this innovation because pulp extraction was done manually which is tedious, cumbersome and inefficient giving a very low output. The machine is new

and innovative and has mechanized the extraction of Custard Apple pulp with higher yield, recovery, quality, and consistency.

- ✓ Reduction of wastage as the entire fruit can now be used: seeds available in bulk to needy users, Shell is used as manures, kernel is used as pesticides after extracting the active ingredient.

### How and where is it made?

CIPHET Ludhiana

Read more on: https://mofpi.nic.in/sites/default/files/technologies_devoloped_by_icar_institutes.pdf

### Does it require specialist training?

It requires very little training to learn how to operate.

### Is after sales service provided?

Yes

## Cost / Benefit Analysis

### Costs

The cost of the Custard Apple Pulper is INR 300,000. The machine has an operational life of 15 years with an annual R & M of 5% of capital costs.

### Benefits

- Direct Benefits:
  - Reduction in post-harvest losses
  - Increased value addition for about 5% of per acre produce, at 90% operational efficiency, 35% conversion (pulp from fruit) and 4 times increased value per Kg
- Indirect Benefits:
  - It provides an opportunity for alternative income streams when prices for fresh product fall

### Assumptions

Potentially it would be possible to process all the fruit into pulp, however a more risk averse strategy would be to process part of the crop and sell the remainder as fresh produce. Given that custard apple has a very short shelf life the higher the percentage of fruit processed the greater the financial returns.

Conservatively, it is assumed that up to 5% of the fruit will be processed per farmer per acre basis. Calculations are based on a 35% recovery of pulp and a throughput of 50 kg/hr.

It is assumed that the machine will be used by the members of the FPOs and conservatively considered very few members, say 10, may use it for the processing purpose.

**NB.** Consideration has not been given to the financial returns from the cost of selling the seeds or to the cost of freezing the pulp prior to shipment.

| Particulars | | Units & Assumptions | Pomegranate | Banana | Sweet Lime | Orange/ Mandarin | Custard Apple | Guava | Sapota | Strawberry | Okra | Chilli | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Operational Life** | **Maximum Operational Life of Technology** | Years | **15** | **15** | **15** | **15** | **15** | **15** | **15** | **15** | **15** | **15** | **15** |
| **Costs** | Total Capital Cost (INR/Unit) | Per Unit | 0 | 0 | 0 | 0 | 300000 | 0 | 0 | 0 | 0 | 0 | 300000 |
| | Total Operational Cost (INR/Unit) | 5% Maintenance per year & INR 1000/ton @0.05TPH at 90% utilization in 1 shift | 0 | 0 | 0 | 0 | 88920 | 0 | 0 | 0 | 0 | 0 | 88920 |
| | No. of Farmer Users | 10 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 10 |
| | Capital Cost | Per FPO with 10 users per year | 0 | 0 | 0 | 0 | 2000 | 0 | 0 | 0 | 0 | 0 | 2000 |
| | Operational Cost | Per FPO with 10 users per year | 0 | 0 | 0 | 0 | 8892 | 0 | 0 | 0 | 0 | 0 | 8892 |
| | **Total Cost** | **INR/Acre/Season/Farmer** | **0** | **0** | **0** | **0** | **10892** | **0** | **0** | **0** | **0** | **0** | **10892** |
| **Benefit Streams** | Reduction in post-harvest losses | 2.0% | 0 | 0 | 0 | 0 | 3331 | 0 | 0 | 0 | 0 | 0 | 3331 |
| | Increased value addition for about 5% of per acre produce, at 90% operational efficiency, 35% conversion (pulp from fruit) and 4 times increased value per Kg | 400.0% | 0 | 0 | 0 | 0 | 10491 | 0 | 0 | 0 | 0 | 0 | 10491 |
| | **Total Benefit** | **INR/Acre/Season/Farmer** | **0** | **0** | **0** | **0** | **13822** | **0** | **0** | **0** | **0** | **0** | **13822** |
| **Net Incremental Benefit** | | **INR/Acre/Season/Farmer** | **0** | **0** | **0** | **0** | **2930** | **0** | **0** | **0** | **0** | **0** | **2930** |
| **Benefit Cost Analysis** | | **B/C Ratio** | **---** | **---** | **---** | **---** | **1.27** | **---** | **---** | **---** | **---** | **---** | **1.27** |

## Safeguards

| Environment | Yes | No | N/A | Comments |
|---|---|---|---|---|
| Will the **technology**:<br>- increase GHGs?<br>- decrease GHGs? | | | NA | |
| Will the technology:<br>- increase demand for energy?<br>- decrease the demand for energy | | | NA | |
| Will the technology improve the sustainability of the production system? | Yes | | | Owing to increased value addition |
| Will the technology:<br>- Increase the demand for water?<br>- decrease the demand for water? | | | NA | |
| Will the technology increase noise pollution? | | No | | |
| Will the technology increase the generation of solid or hazardous waste? | | No | | |
| Will the technology have a negative impact on water quality? | | No | | |
| Will the technology have a negative impact on biodiversity? | | No | | |
| | | | | |
| **Social** | | | | |
| Will the technology negatively impact on poor people? (eg. loss of income) | | No | | |
| Will the technology be accessible to the poor? | Yes | | | |
| Will the technology increase incomes along the value chain? | Yes | | | Owing to increased value addition |
| Will women have access (or be able to use) the technology? | Yes | | | |
| Will the technology improve the access of women to the value chain? | | | NA | |
| Will the technology:<br>- increase women's labour?<br>- decrease women's labour | | | NA | |

## 4.2. Technologies proposed under HLTF

### 4.2.1. Precision Agriculture – Fasal/AgNext/Agsmartic/IBM

**Description of Situation**

#### Describe the context:

The agriculture sector is under increasing pressure to produce more food for an ever-growing global population. Meanwhile profit margins are feeling the pinch, weather volatility is impacting production, and farming practices are under increased scrutiny to align with sustainable use of resources, both on-farm and in the running of a business. It is thus important to gather inputs with respect to soil, weather and crop need in order to improve productivity, quality, and profitability in agriculture. This is where Precision Agriculture comes into picture. It is a modern agriculture practice involving the use of technology in agriculture like remote sensing, GPS and Geographical Information System (GIS) for improving productivity and profitability. Hence precision agriculture is about doing the right thing, in the right place, in the right way, at the right time.

#### Where does it fit in along the value-chain?

Technology will be used in the Production node of the value chain.

#### What problem(s) is the technology going to solve?

Precision farming focuses on reducing the production cost and wastage, as tailored needs of each plot is catered to. It enables farmers to use crop inputs more efficiently including pesticides, fertilizers, tillage and irrigation water. More effective utilization of inputs will bring in better land utilization, more crop yield, efficient farming practices and higher quality without polluting the environment and will result in sustainable agriculture and sustainable development. Use of the technology is helping in turning farming into a real business, whether it is the mobile app to calculate crop residue, amount of fertilizer required, type of nutrition, irrigation and, use of drones, more. This saves time, money and brings more precise and accurate results.

#### How has demand been assessed?

Use of Technology has been increasing in agriculture. Many innovative farmers, input companies and other stakeholders are taking up modern practices for agriculture. Governments are also promoting sustainable measures, which presents with a huge potential for the technology.

#### Who is it aimed at and why are we targeting that sector of the value chain?

- ✓ Innovative farmers/Large holding farmers who are eager to adopt technology to improve the productivity, crop yield, etc. in a sustainable manner.

**Technology Design**

#### How does it work?

Precision agriculture seeks to use new technologies to increase crop yields and profitability while lowering the levels of traditional inputs needed to grow crops (land, water, fertilizer, herbicides and insecticides). In other words, farmers utilizing precision agriculture are using less to grow more. GPS devices on tractors, for instance, allow farmers to plant crops in more efficient patterns and proceed from point A to point B with more precision,

saving time and fuel. Fields can be leveled by lasers, which means water can be applied more efficiently and with less farm effluent running off into local streams and rivers. The result can be a boon for farmers and holds great potential for making agriculture more sustainable and increasing food availability.

**What stage of development is it at? (eg. still in R & D phase, pilot / demonstration, commercialisation?)**

The technology has been commercialized and adopted as well in many states by innovative farmers.

**What is the innovation? (ie how does it improve over existing situation – is it a significant improvement/)**

- ✓ It has the ability to revolutionize modern farm management in India through improvement in profitability, productivity, sustainability, crop quality, environmental protection, on-farm quality of life, food safety and rural economic development.
- ✓ Farmers can use forecast and mitigate problems like water stress, nutrient deficiency, and pests/diseases.

**How and where is it made?**

Various Agri Tech companies are working on revolutionizing agriculture, including Fasal, AgNext, Agsmartic.

Read more on: https://fasal.co/; https://agnext.com/

**Does it require specialist training?**

Yes.

**Is after sales service provided?**

Yes

## Cost / Benefit Analysis

### Costs

The cost of the technology varies depending on the location and the parameters to be improved.

### Benefits

- Direct Benefits:
  - an increase in revenue from increased yields
  - reduced costs of inputs including fertilizer and chemicals.
- Indirect Benefits:
  - Increased prices from improved quality of produce
  - more sustainable farming practices
  - reduced negative impact of farming practices on the environment.

### Assumptions

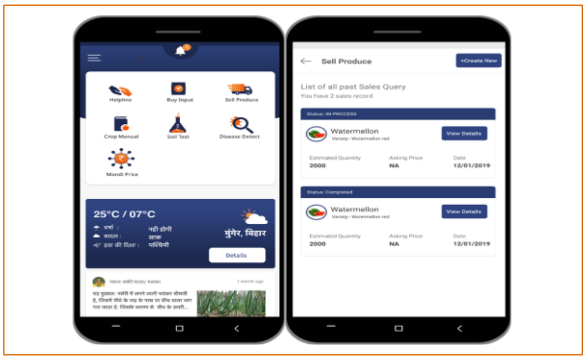
The impact of the technology on farming practices that will increase yield and reduce the cost of inputs will vary depending on the location and current farming practices and on the crop. Relatively modest predictions for gains have been made and it is likely that these can be improved on. It is assumed that inputs (fertilizers, chemicals and water) usage will be optimized, yield will be increased and the farmer will realize price for the produce. Since all the crops are perennial except for Okra and Chilli the cost is considered on per year basis. In case of Okra and Chilli the cost is considered for half yearly basis assuming the remaining half will be spread over other seasonal crop.

| Particulars | | Units & Assumptions | Pomegranate | Banana | Sweet Lime | Orange/ Mandarin | Custard Apple | Guava | Sapota | Strawberry | Okra | Chilli | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Operational Life** | **Maximum Operational Life of Technology** | Years | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** |
| **Costs** | Total Capital Cost (INR/acre) | Per Acre | 20408 | 20408 | 20408 | 20408 | 20408 | 20408 | 20408 | 20408 | 20408 | 20408 | 20408 |
| | Total Operational Cost (INR/Acre) | INR 800 per month charges, 5% Maintenance per year | 4335 | 4335 | 4335 | 4335 | 4335 | 4335 | 4335 | 4335 | 4335 | 4335 | 4335 |
| | No. of Farmer Users | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| | Capital Cost | INR/Acre/Season/Farmer | 4082 | 4082 | 4082 | 4082 | 4082 | 4082 | 4082 | 4082 | 2041 | 2041 | 3673 |
| | Operational Cost | INR/Acre/Season/Farmer | 4335 | 4335 | 4335 | 4335 | 4335 | 4335 | 4335 | 4335 | 2167 | 2167 | 3901 |
| | **Total Cost** | **INR/Acre/Season/Farmer** | **8416** | **8416** | **8416** | **8416** | **8416** | **8416** | **8416** | **8416** | **4208** | **4208** | **7575** |
| **Benefit Streams** | Optimum fertilizer usage (reduction in quantity used & saving in application thereof) | 20.0% | 3920 | 5763 | 1969 | 1969 | 2600 | 2992 | 3064 | 4490 | 1022 | 1704 | 2949 |
| | Optimum chemical usage (reduction in diseases, reduction in quantity used & saving in application thereof) | 10.0% | 1900 | 960 | 500 | 500 | 500 | 600 | 500 | 1633 | 306 | 367 | 777 |
| | Optimum water usage (reduction in water usage & saving in electricity thereof) | 40.0% | 8000 | 8000 | 4939 | 4939 | 3400 | 3400 | 3400 | 11429 | 735 | 735 | 4898 |
| | Reduction in plant maintenance operations | 10.0% | 3500 | 800 | 490 | 490 | 1200 | 1500 | 1200 | 4163 | 184 | 450 | 1398 |
| | Increased yield (due to optimum use of inputs, timely application) | 10.0% | 20091 | 17553 | 8838 | 6900 | 16653 | 18545 | 11956 | 60350 | 11074 | 10964 | 18293 |
| | Increased price realization (due to quality improvement) | 5.0% | 11050 | 9654 | 4861 | 3795 | 9159 | 10200 | 6576 | 33192 | 6091 | 6030 | 10061 |
| | **Total Benefit** | **INR/Acre/Season/Farmer** | **48462** | **42731** | **21597** | **18593** | **33512** | **37237** | **26696** | **115257** | **19412** | **20251** | **38375** |
| **Net Incremental Benefit** | | **INR/Acre/Season/Farmer** | **40045** | **34314** | **13181** | **10176** | **25096** | **28820** | **18280** | **106840** | **15204** | **16043** | **30800** |
| **Benefit Cost Analysis** | | **B/C Ratio** | **5.76** | **5.08** | **2.57** | **2.21** | **3.98** | **4.42** | **3.17** | **13.69** | **4.61** | **4.81** | **5.03** |

## Safeguards

| Environment | Yes | No | N/A | Comments |
|---|---|---|---|---|
| Will the **technology**:<br>- increase GHGs?<br>- decrease GHGs? | --<br>Yes | No<br>-- | | Owing to reduced/precise use of resources |
| Will the technology:<br>- increase demand for energy?<br>- decrease the demand for energy | --<br>Yes | No<br>-- | | Owing to reduced/precise use of resources |
| Will the technology improve the sustainability of the production system? | Yes | | | Owing to reduced/precise use of resources |
| Will the technology:<br>- Increase the demand for water?<br>- decrease the demand for water? | --<br>Yes | No<br>-- | | Owing to reduced/precise use of resources |
| Will the technology increase noise pollution? | | No | | |
| Will the technology increase the generation of solid or hazardous waste? | | No | | |
| Will the technology have a negative impact on water quality? | | No | | |
| Will the technology have a negative impact on biodiversity? | | No | | |
| | | | | |
| **Social** | | | | |
| Will the technology negatively impact on poor people? (e.g. loss of income) | | No | | |
| Will the technology be accessible to the poor? | Yes | | | Through FPOs |
| Will the technology increase incomes along the value chain? | Yes | | | Owing to reduced/precise use of resources |
| Will women have access (or be able to use) the technology? | | | NA | |
| Will the technology improve the access of women to the value chain? | | | NA | |
| Will the technology:<br>- increase women's labour?<br>- decrease women's labour? | ---<br>Yes | No<br>--- | | Owing to reduction in some of the cultivation practices |

### 4.2.2. ICT Platform for Farm & Supply Chain Management



## Description of Situation

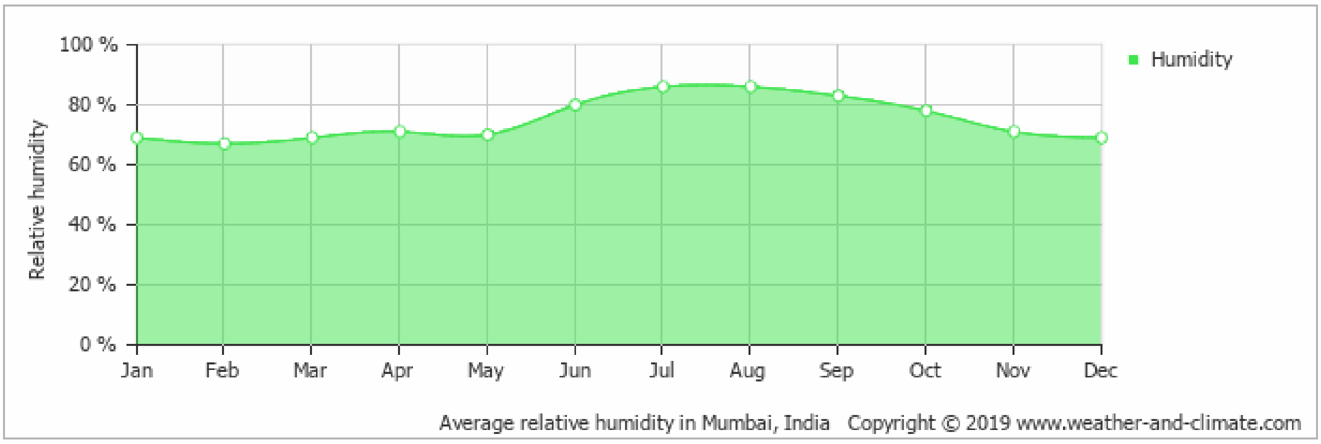
**Describe the context:**

The agriculture supply chain is complicated by fragmented inbound and outbound networks. The typical agriculture supply chain involves three steps: from farmers to intermediate storage/warehouses, from storage to aggregators/processing plants/mandis, and from plants/mandis to clients. Each step requires multiple decisions, with high uncertainty of each outcome. This uncertainty arises from two main sources: operational factors, such as unpredictable yields in each field, and external factors, such as weather, inputs, farmer capabilities, etc. Advances in digital and analytics technologies offer a way to optimize the agriculture supply chain.

**Where does it fit in along the value-chain?**

Technology is beneficial through the entire value chain of all selected crops.

**What problem(s) is the technology going to solve?**




Technology will help **strengthen the entire value chain** and enable all the players in the chain by using digitally connected tools to integrate the systems and make informed decisions.

**How has demand been assessed?**

Use of Technology has been increasing in agriculture. Many innovative farmers, input companies and other stakeholders are taking up modern practices for agriculture. Governments are also promoting sustainable measures, which presents with a huge potential for the technology.

**Who is it aimed at and why are we targeting that sector of the value chain?**

✓ It is a service providing technology, which can be utilized by farmers/ micro entrepreneurs/ all players in the value chain to provide assistance in all nodes of value chain, like offer crop advisory and market linkages.

## Technology Design

**How does it work?**

Technology provides an online platform that connects stakeholders in the value chain and assist in activities like Input Purchase, Demand aggregation, Traceability, Financial Management, Agri Advisory, Forecasting & Dissemination of Information/Extension, Assessment of Credit Worthiness/Linking with FIs, Crop Insurance, Dissemination of Government Advisories/Regulations/Policy Changes.

### What stage of development is it at? (e.g. still in R & D phase, pilot / demonstration, commercialisation?)

Technology is developed and supplied by many Agri Tech companies including Dehaat, CropIN, BharatAgri

### What is the innovation? (ie how does it improve over existing situation – is it a significant improvement/)

It helps in **optimized functioning of the entire value chain by improving the decision making**, and helps in following activities at each stage:

- ✓ Planning: Help farmers plan what, when to plant, Tighten relationship with buyers, processors, Adapt to climate change, Provide data for farmers to make business decisions on cash flow and maximizing profit
- ✓ Inputs: Reduce counterfeits, Reduce costs and risks for buyers, Increase access to quality inputs, Enable sellers to know demand in advance, Provide convenient and secure ways for farmers to purchase, save, and receive credit inputs.
- ✓ On Farm Production: Help extension services reach more farmers, Provide timely reminders/alerts, Use behavior change media to promote best practices among farmers, Increase precision and/or adaptability of farming interventions and crop choices through applied data
- ✓ Storage: Improve links between farmers, processors, Reduce post-harvest loss with digitally-enabled harvest loans and digitally warehouse receipts, Inform harvest practices to reduce post-harvest losses., Monitor storage conditions
- ✓ Post-Harvest Processing: Increase farmer negotiating power by providing market prices, Track provenance for supply chain optimization and grading
- ✓ Transport: Reduce costs of transport, Increase choice of different types of transport for farmers, Increase access to timely information so that farmers know if and when transport is arriving
- ✓ Access to Markets: Increase ability of smallholder farmers to sell to larger markets by allowing buyers to track crops to source (certification and provenance), Increase market information available to farmers so that they have more choices

### How and where is it made?

Technology is provided by various Agri Tech companies including Dehaat, CropIN, BharatAgri

Read more: https://community.nasscom.in/communities/digital-transformation/agritech/agritech-case-study-series-dehaat.html)

### Does it require specialist training?

Yes

### Is after sales service provided?

Yes

## Cost / Benefit Analysis

### Costs

The cost of the technology varies depending on the location and the parameters to be improved.

### Benefits

- Direct Benefits:
  - Reduction in fertilizer cost (due to comparatively resonable prices, reduction in transportation cost & use of genuine products and soil testing)
  - Reduction in chemical cost (due to comparatively resonable prices, reduction in transportation cost & use of genuine products)
  - Optimum water usage (reduction in water usage & saving in electricity thereof due to weather advisory)

  - Increased yield (due to optimum use of inputs, timely application)
  - Decreased marketing cost (due to online transactions & market linkages)
  - Increased price realization (due to institutional buyers, traceability & market linkages)

- Indirect Benefits:
  - improved quality of inputs
  - reduced risks to buyers
  - real time market pricing and market feedback
  - increased competitiveness in the market.

## Assumptions

The impact of the technology on the value chain is difficult to quantify unless it is piloted. The technology would improve financial returns at a number of stages along the value chain and will vary depending in the operation e.g. production, storage, transport etc.

As an approximate assumption the benefit has been calculated on savings that could be made from one acre of production along the value chain and based on the following assumptions:

- 5% reduction in fertilizer cost due to comparatively reasonable prices, reduction in transportation cost & use of genuine products and soil testing
- 5% reduction in chemical cost due to comparatively reasonable prices, reduction in transportation cost & use of genuine products
- 3% optimum water usage reduction in water usage & saving in electricity thereof due to weather advisory
- 1% increased yield due to optimum use of inputs, timely application
- 0.5% decreased marketing cost due to online transactions & market linkages
- 2% increased price realization due to institutional buyers, traceability & market linkages

Though most of these ICT platform service providers do not charge any fees to farmers, it is assumed that farmer will incur subscription based cost of around INR 250 per month. Since all the crops are perennial except for Okra and Chilli the cost is considered on per year basis. In case of Okra and Chilli the cost is considered for half yearly basis assuming the remaining half will be spread over other seasonal crop.

| Particulars | | Units & Assumptions | Pomegranate | Banana | Sweet Lime | Orange/ Mandarin | Custard Apple | Guava | Sapota | Strawberry | Okra | Chilli | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Operational Life** | **Maximum Operational Life of Technology** | Years | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** |
| **Costs** | Total Capital Cost (INR/acre) | Per Acre | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total Operational Cost (INR/Acre) | assuming INR 250 per month charges | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 |
| | No. of Farmer Users | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| | Capital Cost | INR/Acre/Season/Farmer | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Operational Cost | INR/Acre/Season/Farmer | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 1500 | 1500 | 2700 |
| | **Total Cost** | **INR/Acre/Season/Farmer** | **3000** | **3000** | **3000** | **3000** | **3000** | **3000** | **3000** | **3000** | **1500** | **1500** | **2700** |
| **Benefit Streams** | Reduction in fertilizer cost (due to comparatively reasonable prices, reduction in transportation cost & use of genuine products and soil testing) | 5.0% | 780 | 1041 | 367 | 367 | 500 | 548 | 616 | 816 | 225 | 375 | 564 |
| | Reduction in chemical cost (due to comparatively reasonable prices, reduction in transportation cost & use of genuine products) | 5.0% | 750 | 405 | 200 | 200 | 200 | 200 | 200 | 612 | 122 | 122 | 301 |
| | Optimum water usage (reduction in water usage & saving in electricity thereof due to weather advisory) | 3.0% | 600 | 600 | 370 | 370 | 255 | 255 | 255 | 857 | 55 | 55 | 367 |
| | Increased yield (due to optimum use of inputs, timely application) | 1.0% | 2009 | 1755 | 884 | 690 | 1665 | 1855 | 1196 | 6035 | 1107 | 1096 | 1829 |
| | Decreased marketing cost (due to online transactions & market linkages) | 0.5% | 1005 | 878 | 442 | 345 | 833 | 927 | 598 | 3017 | 554 | 548 | 915 |

| Particulars | | Units & Assumptions | Pomegranate | Banana | Sweet Lime | Orange/ Mandarin | Custard Apple | Guava | Sapota | Strawberry | Okra | Chilli | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Increased price realization (due to institutional buyers, traceability & market linkages) | 2.0% | 4018 | 3511 | 1768 | 1380 | 3331 | 3709 | 2391 | 12070 | 2215 | 2193 | 3659 |
| | **Total Benefit** | **INR/Acre/Season/Farmer** | **9162** | **8189** | **4031** | **3353** | **6784** | **7494** | **5256** | **23408** | **4279** | **4390** | **7634** |
| **Net Incremental Benefit** | | **INR/Acre/Season/Farmer** | **6162** | **5189** | **1031** | **353** | **3784** | **4494** | **2256** | **20408** | **2779** | **2890** | **4934** |
| **Benefit Cost Analysis** | | **B/C Ratio** | **3.05** | **2.73** | **1.34** | **1.12** | **2.26** | **2.50** | **1.75** | **7.80** | **2.85** | **2.93** | **2.83** |

## Safeguards

| Environment | Yes | No | N/A | Comments |
|---|---|---|---|---|
| Will the **technology**:<br>- increase GHGs?<br>- decrease GHGs? | | | NA | |
| Will the technology:<br>- increase demand for energy?<br>- decrease the demand for energy | | | NA | |
| Will the technology improve the sustainability of the production system? | Yes | | | Reduced process time and expenses |
| Will the technology:<br>- Increase the demand for water?<br>- decrease the demand for water? | --<br>Yes | No<br>-- | | To some extent based on advisory, automated processes |
| Will the technology increase noise pollution? | | No | | |
| Will the technology increase the generation of solid or hazardous waste? | | No | | |
| Will the technology have a negative impact on water quality? | | No | | |
| Will the technology have a negative impact on biodiversity? | | No | | |
| | | | | |
| **Social** | | | | |
| Will the technology negatively impact on poor people? (eg. loss of income) | | No | | |
| Will the technology be accessible to the poor? | Yes | | | Through FPOs |
| Will the technology increase incomes along the value chain? | Yes | | | Owing to reduced process time and expenses |
| Will women have access (or be able to use) the technology? | Yes | | | |
| Will the technology improve the access of women to the value chain? | | | NA | |
| Will the technology:<br>- increase women’s labour?<br>- decrease women’s labour | | | NA | |

### 4.2.3. Drone based Chemical Spray & Image Analysis

**Description of Situation**

**Describe the context:**

Farmers encounter the problems of various types of insect pests that harm crops and result in loss of productivity each year. Therefore, it is necessary for farmers to use pesticides to prevent crop damage. However, Manually spraying the pesticides, and fertilizers affects humans leading to cancer, hypersensitivity, asthma, and other disorders. Hence, automatic control of fertilizer spraying, and crop monitoring should be adopted.

**Where does it fit in along the value-chain?**

Technology will be used in the production node of the value chain.

**What problem(s) is the technology going to solve?**

Maharashtra faces the problem of crop damage due to insect attack which leads to income losses and heavy distress amongst farmers, they usually turn to labor intensive task of spraying the fertilizers, which is not only time consuming, it also poses a risk to human health. The drone technology reduces the quantity of pesticide used, but also save farmers from pesticide exposure. Drones have cameras, which also helps to monitor the health of the crops. The technology will help to increase protective and productivity of crop and improve the crop's growth towards fertilizer and pesticides spraying based on the crops damage

**How has demand been assessed?**

Use of Technology has been increasing in agriculture. Many innovative farmers, input companies and other stakeholders are taking up modern practices for agriculture. Governments are also promoting sustainable measures, which presents with a huge potential for the technology.

**Who is it aimed at and why are we targeting that sector of the value chain?**

- ✓ Innovative farmers/Large holding farmers who are eager to adopt technology to improve the productivity, crop yield, etc. in a sustainable manner.

**Technology Design**

**How does it work?**

The drones are controlled by the Transmitter Channel. Crops are to be monitored row wise studying crop health by identifying various diseases and damages in the crop through the camera mounted on the drone. After monitoring the crops, it is let to spray the fertilizer and pesticides based on the crop damages.

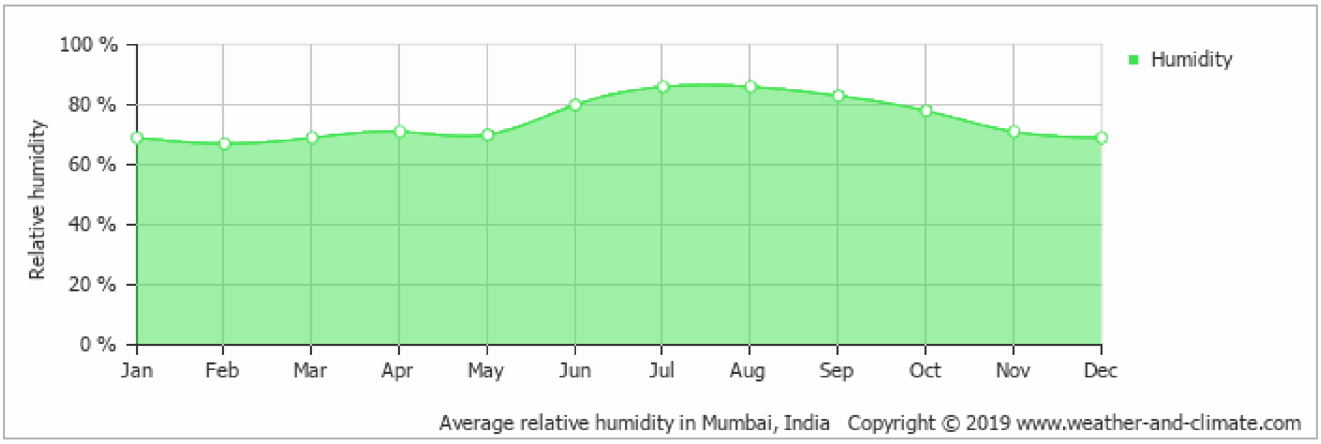
**What stage of development is it at? (eg. still in R & D phase, pilot / demonstration, commercialisation?)**

The technology has been commercialized by various agritech manufacturers, including Trithi (3thi), IoTech World, EI World, Ag-Copter and is available in 5L, 10 L, 15L and 20L capacity.

**What is the innovation? (ie how does it improve over existing situation – is it a significant improvement/)**

- ✓ Technology helps in improving the efficiency of spraying chemicals, by studying the health of the crops through image analysis and making an informed and educated decision.

- ✓ The technology can replace labour-intensive and potentially harmful use of backpack sprayers and similar equipment, in situations where terrain and/or ground conditions rule out the use of conventional or even specialist vehicles.




## How and where is it made?

Drones are manufactured and supplied by Trithi (3thi), IoTech World, EI World, Ag-Copter

Read more: https://croplife.org/wp-content/uploads/2020/03/Drones_Manual.pdf; http://www.3thi.com/;

## Does it require specialist training?

Yes.

## Is after sales service provided?

Yes

# Cost / Benefit Analysis

## Costs

The units cost between INR 300,000 and INR 15,000,000. The largest units are suitable for up to 125 acres. Smaller mid-range units that would service a cluster of farmers with an area of approximately 50 acres cost approximately INR 2,000,000. The drones would have an operational life of 10 years.

## Benefits

- Direct Benefits:
  - Optimum chemical usage (due to increased spraying efficiency, reduction in quantity used & saving in application thereof)
  - Reduction chemical application/labour cost (due to time saving, increased efficiency)
  - Reduction in plant maintenance operations (especially related to weeding)
- Indirect Benefits:
  - Reduced exposure to chemicals by operators
  - Reduced spray drift and impact on the environment

## Assumptions

Drones are practical on small areas of less than 50 acres for a medium range vehicle.3 In addition to the application of plant protection chemicals drones could also be used to apply foliar fertilizers which would further

[3] Guidance for use of Unmanned Aerial Vehicles for the application of plant protection products, CropLife International

enhance the yield. It is assumed that drones would be owned and operated by FPOs to service member as well as non-member farmers. The capital cost is amortized over 10 years and spread across 500 member farmers and 500 non-member farmers with an average farm size of 1 acre each. It is assumed that there would be 20% reduction in chemical cost, 20% reduction in application cost/labour saving and 10% reduction in interculture operation especially for weeding.

| | Particulars | Units & Assumptions | Pomegranate | Banana | Sweet Lime | Orange/ Mandarin | Custard Apple | Guava | Sapota | Strawberry | Okra | Chilli | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Proposed Usage Model** | **FPO to act as Service Provider & Farmers as Users** | | | | | | | | | | | | |
| **Operational Life** | **Maximum Operational Life of Technology** | Years | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **10** |
| **At FPO/Service Provider Level** | | | | | | | | | | | | | |
| **Costs** | **Total Capital Cost (INR/Unit)** | **Per Unit** | **1200000** | **1200000** | **1200000** | **1200000** | **1200000** | **1200000** | **1200000** | **1200000** | **1200000** | **1200000** | **1200000** |
| | Max. Total Acerage that can be sprayed annually (Acres/yr) | Assuming speed of @3 acres/hour (in Acres/yr) | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 |
| | Actual Acerage to be sprayed annually (Acres/yr) | for avg. of 500 user member farmers and 500 non member farmers | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 |
| | **Total Operational Cost (INR/Unit/Year)** | assuming operating expenses @INR 100/spray | **500000** | **500000** | **500000** | **500000** | **500000** | **500000** | **500000** | **500000** | **500000** | **500000** | **500000** |
| **Benefit Streams** | No. of User Farmers (minimum) | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |
| | Service Charge (INR/spray) | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| | Average Acerage to be sprayed per User Farmer (Acre/Farmer/Season) | assuming minimum 5 sprays per year | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| | **Total Benefit in terms of Service Charge** | **INR/Season** | **750000** | **750000** | **750000** | **750000** | **750000** | **750000** | **750000** | **750000** | **750000** | **750000** | **750000** |
| **Net Incremental Benefit** | | **INR/Season** | **250000** | **250000** | **250000** | **250000** | **250000** | **250000** | **250000** | **250000** | **250000** | **250000** | **250000** |
| **NPV of Net Incremental Benefit (@5% Discount Rate)** | | in INR with min. of 500 user member farmers and 500 non member farmers | **1930434** | **1930434** | **1930434** | **1930434** | **1930434** | **1930434** | **1930434** | **1930434** | **1930434** | **1930434** | **1930434** |

| Particulars | | Units & Assumptions | Pomegranate | Banana | Sweet Lime | Orange/ Mandarin | Custard Apple | Guava | Sapota | Strawberry | Okra | Chilli | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Payback Period (Years) - For FPO/Service Provider** | | in Years (assuming min. of 500 user member farmers and 500 non member farmers | 6.22 | 6.22 | 6.22 | 6.22 | 6.22 | 6.22 | 6.22 | 6.22 | 6.22 | 6.22 | 6.22 |
| **Benefit Cost Analysis - For FPO/Service Provider** | | **B/C Ratio** | **1.61** | **1.61** | **1.61** | **1.61** | **1.61** | **1.61** | **1.61** | **1.61** | **1.61** | **1.61** | **1.61** |
| **At Farmer Level** | | | | | | | | | | | | | |
| **Costs** | **Total Operational Cost** | **INR/Acre/Season/Farmer** | **750** | **750** | **750** | **750** | **750** | **750** | **750** | **750** | **750** | **750** | **750** |
| **Benefit Streams** | Optimum chemical usage (due to increased spraying efficiency, reduction in quantity used & saving in application thereof) | 20.0% | 3000 | 1619 | 800 | 800 | 800 | 800 | 800 | 2449 | 490 | 490 | 1205 |
| | Reduction chemical application/labour cost (due to time saving, increased efficiency) | 20.0% | 800 | 300 | 200 | 200 | 200 | 400 | 200 | 816 | 122 | 245 | 348 |
| | Reduction in plant maintenance operations (especially related to weeding) | 10.0% | 3500 | 800 | 490 | 490 | 1200 | 1500 | 1200 | 4163 | 184 | 450 | 1398 |
| | **Total Benefit** | **INR/Acre/Season/Farmer** | **7300** | **2720** | **1490** | **1490** | **2200** | **2700** | **2200** | **7429** | **796** | **1185** | **2951** |
| **Net Incremental Benefit** | | **INR/Acre/Season/Farmer** | **6550** | **1970** | **740** | **740** | **1450** | **1950** | **1450** | **6679** | **46** | **435** | **2201** |
| **Benefit Cost Analysis - For Farmer** | | **B/C Ratio** | **9.73** | **3.63** | **1.99** | **1.99** | **2.93** | **3.60** | **2.93** | **9.90** | **1.06** | **1.58** | **3.93** |

## Safeguards

| Environment | Yes | No | N/A | Comments |
|---|---|---|---|---|
| Will the **technology**:<br>- increase GHGs?<br>- decrease GHGs? | --<br>Yes | No<br>-- | | Owing to optimal use of chemicals due to efficient spraying operation |
| Will the technology:<br>- increase demand for energy?<br>- decrease the demand for energy | --<br>Yes | No<br>-- | | Owing to optimal use of chemicals due to efficient spraying operation |
| Will the technology improve the sustainability of the production system? | Yes | | | Owing to optimal use of chemicals due to efficient spraying operation |
| Will the technology:<br>- Increase the demand for water?<br>- decrease the demand for water? | --<br>Yes | No<br>-- | | To some extent |
| Will the technology increase noise pollution? | | No | | |
| Will the technology increase the generation of solid or hazardous waste? | | No | | |
| Will the technology have a negative impact on water quality? | | No | | |
| Will the technology have a negative impact on biodiversity? | | No | | |
| | | | | |
| **Social** | | | | |
| Will the technology negatively impact on poor people? (e.g. loss of income) | | No | | |
| Will the technology be accessible to the poor? | Yes | | | Through FPOs |
| Will the technology increase incomes along the value chain? | Yes | | | Owing to optimal use of chemicals due to efficient spraying operation |
| Will women have access (or be able to use) the technology? | Yes | | | |
| Will the technology improve the access of women to the value chain? | | | NA | |
| Will the technology:<br>- increase women's labour?<br>- decrease women's labour | | | NA | |

### *4.2.4. Electrostatic Sprayers*

**Description of Situation**

**Describe the context:**

Farmers encounter the problems of various types of insect pests that harm crops and result in loss of productivity each year. Therefore, it is necessary for farmers to use pesticides to prevent crop damage. However, Manually spraying the pesticides, and fertilizers affects humans leading to cancer, hypersensitivity, asthma, and other disorders. Other than that, coverage is not uniform leading to spoilage even after spraying pesticides, it is thus imperative to adopt technology which is easier to use and leads to Increase in deposition efficiency and Uniform canopy coverage.

**Where does it fit in along the value-chain?**

Technology will be used in the production node of the value chain.

**What problem(s) is the technology going to solve?**

Electrostatic spraying is one of the most appropriate methods of incapacitating the difficulties that arise due to non-uniform spray of pesticides. Electrostatic force field has been exploited in the design and development of an air-assisted electrostatic nozzle for agricultural applications to increase the mass transfer efficiency & pesticides bio-efficacy. It provides an uniform deposition onto the directly exposed as well as obscured surface of the crops and reaches to the hidden areas of target canopy. It reduces the drift of active ingredients of pesticides from the target microorganisms. It provides a means for efficient use of agricultural chemicals and natural resources.

**How has demand been assessed?**

Use of Technology has been increasing in agriculture. Many innovative farmers, input companies and other stakeholders are taking up modern practices for agriculture. Governments are also promoting sustainable measures, which presents with a huge potential for the technology.

**Who is it aimed at and why are we targeting that sector of the value chain?**

- ✓ Innovative farmers/Large holding farmers who are eager to adopt technology to improve the productivity, crop yield, etc. in a sustainable manner.

**Technology Design**

**How does it work?**

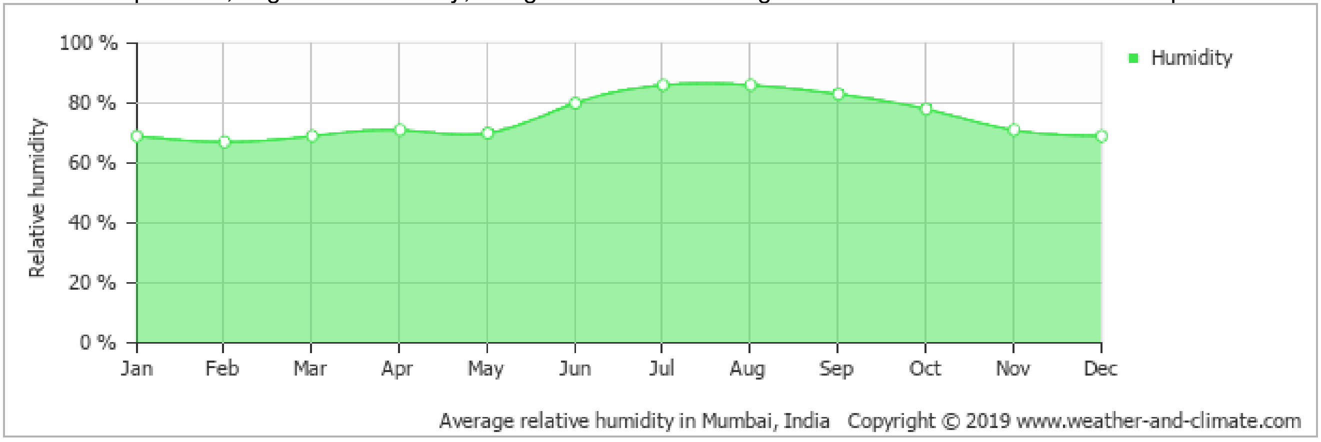
Electrostatic sprayers produce droplets 900 times smaller than those produced by conventional or hydraulic sprayers. After tiny droplets are atomized, they are then given an electrical charge they are carried deep into the plant canopy in a turbulent air-stream. The result provides more than twice the deposition efficiency of traditional hydraulic sprayers and foggers. The electrostatic charge pulls the spray towards the plant is up to 75 times greater than the force of gravity. Droplets change direction and move upwards against gravity to coat all of the plant surfaces. The “wrap around” effect also causes the spray to cling to the surface rather than being blown past the target, drifting away or falling to the ground.

**What stage of development is it at? (eg. still in R & D phase, pilot / demonstration, commercialisation?)**

The technology has been commercialized by various agritech manufacturers, including AgNext, MITRA, Eco Agro Services/Maxcharge, Gursukh Agro Works, Padgilwar Corporation, Fortune Agro Impex

### What is the innovation? (ie how does it improve over existing situation – is it a significant improvement/)

✓ Technology helps in improving the efficiency of spraying chemicals through reduction of pesticide use, Uniform deposition, Higher bio-efficacy, Longer distance coverage and reduction of environmental pollution




### How and where is it made?

They are manufactured and supplied by AgNext, MITRA, Eco Agro Services/Maxcharge, Gursukh Agro Works, Padgilwar Corporation, Fortune Agro Impex

Read more: https://sprayers101.com/electrostatic/; https://mitraweb.in/; https://agnext.com/

### Does it require specialist training?

Yes.

### Is after sales service provided?

Yes

## Cost / Benefit Analysis

### Costs

The units cost is considered as varies between INR 600,000. The units have an operational life of up to 10 years with an R & M cost of 10% per year of the capital outlay.

### Benefits

- Direct Benefits:
  - Optimum checmical usage (due to increased spraying efficiency, reduction in quantity used & saving in application thereof)
  - Reduction chemical application/labour cost (due to time saving, increased efficiency, reduction in sprays)
  - Reduction in post-harvest losses (due to increased keeping quality, protective coating against microbial attack etc.)
- Indirect Benefits:
  - Reduced exposure to chemicals by operators
  - Reduced spray drift and impact on the environment.

### Assumptions

Small units are available in the form of backpacks that operate off lithium batteries and are suitable for spraying areas up to 1 acre and would provide farmers with the versatility of spraying on an as needed basis. The tractor drawn units would be suitable for large farms or could be owned and operated by an FPO who would provide a contract spraying service to farmers. For the calculation purpose large unit is considered with cost of INR 6,00,000 per unit.

It is assumed that the saving in chemical costs is 35% and the saving in application costs is 50%. It is assumed that there will be reduction of 0.5% of post harvest losses owing to protective coating against microbial attack and increased keeping quality. The capital cost is amortized over 10 years.

| Particulars | | Units & Assumptions | Pomegranate | Banana | Sweet Lime | Orange/ Mandarin | Custard Apple | Guava | Sapota | Strawberry | Okra | Chilli | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Proposed Usage Model** | **FPO to act as Service Provider & Farmers as Users** | | | | | | | | | | | | |
| **Operational Life** | **Maximum Operational Life of Technology** | Years | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **10** |
| **At FPO/Service Provider Level** | | | | | | | | | | | | | |
| **Costs** | **Total Capital Cost (INR/Unit)** | **Per Unit** | **600000** | **600000** | **600000** | **600000** | **600000** | **600000** | **600000** | **600000** | **600000** | **600000** | **600000** |
| | Max. Total Acerage that can be sprayed annually (Acres/yr) | Assuming speed of @1 acres/hour (in Acres/yr) | 2400 | 2400 | 2400 | 2400 | 2400 | 2400 | 2400 | 2400 | 2400 | 2400 | 2400 |
| | Actual Acerage to be sprayed annually (Acres/yr) | for avg. of 250 user member farmers and 250 non member farmers | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 |
| | **Total Operational Cost (INR/Unit/Year)** | assuming operating expenses @INR 300/spray | **450000** | **450000** | **450000** | **450000** | **450000** | **450000** | **450000** | **450000** | **450000** | **450000** | **450000** |
| **Benefit Streams** | No. of User Farmers (minimum) | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 |
| | Service Charge (INR/spray) | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 |
| | Average Acerage to be sprayed per User Farmer (Acre/Farmer/Season) | assuming minimum 5 sprays per year | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| | **Total Benefit in terms of Service Charge** | **INR/Season** | **750000** | **750000** | **750000** | **750000** | **750000** | **750000** | **750000** | **750000** | **750000** | **750000** | **750000** |
| **Net Incremental Benefit** | | **INR/Season** | **300000** | **300000** | **300000** | **300000** | **300000** | **300000** | **300000** | **300000** | **300000** | **300000** | **300000** |
| **NPV of Net Incremental Benefit (@5% Discount Rate)** | | in INR with min. of 250 user member farmers and 250 non member farmers | **2316520** | **2316520** | **2316520** | **2316520** | **2316520** | **2316520** | **2316520** | **2316520** | **2316520** | **2316520** | **2316520** |

| Particulars | | Units & Assumptions | Pomegranate | Banana | Sweet Lime | Orange/ Mandarin | Custard Apple | Guava | Sapota | Strawberry | Okra | Chilli | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Payback Period (Years) - For FPO/Service Provider** | | in Years (assuming min. of 250 user member farmers and 250 non member farmers | **2.59** | **2.59** | **2.59** | **2.59** | **2.59** | **2.59** | **2.59** | **2.59** | **2.59** | **2.59** | **2.59** |
| **Benefit Cost Analysis - For FPO/Service Provider** | | **B/C Ratio** | **3.86** | **3.86** | **3.86** | **3.86** | **3.86** | **3.86** | **3.86** | **3.86** | **3.86** | **3.86** | **3.86** |
| **At Farmer Level** | | | | | | | | | | | | | |
| **Costs** | **Total Operational Cost** | **INR/Acre/Season/Farmer** | **1500** | **1500** | **1500** | **1500** | **1500** | **1500** | **1500** | **1500** | **1500** | **1500** | **1500** |
| **Benefit Streams** | Optimum checmical usage (due to increased spraying efficiency, reduction in quantity used & saving in application thereof) | 35.0% | 5250 | 2834 | 1400 | 1400 | 1400 | 1400 | 1400 | 4286 | 857 | 857 | 2108 |
| | Reduction chemical application/labour cost (due to time saving, increased efficiency, reduction in sprays) | 50.0% | 2000 | 750 | 500 | 500 | 500 | 1000 | 500 | 2041 | 306 | 612 | 871 |
| | Reduction in post-harvest losses (due to increased keeping quality, protective coating against microbial attack etc.) | 0.5% | 1005 | 878 | 442 | 345 | 833 | 927 | 598 | 3017 | 554 | 548 | 915 |
| | **Total Benefit** | **INR/Acre/Season/Farmer** | **8255** | **4462** | **2342** | **2245** | **2733** | **3327** | **2498** | **9344** | **1717** | **2018** | **3894** |
| **Net Incremental Benefit** | | **INR/Acre/Season/Farmer** | **6755** | **2962** | **842** | **745** | **1233** | **1827** | **998** | **7844** | **217** | **518** | **2394** |
| **Benefit Cost Analysis - For Farmer** | | **B/C Ratio** | **5.50** | **2.97** | **1.56** | **1.50** | **1.82** | **2.22** | **1.67** | **6.23** | **1.14** | **1.35** | **2.60** |

## Safeguards

| Environment | Yes | No | N/A | Comments |
|---|---|---|---|---|
| Will the **technology**:<br>- increase GHGs?<br>- decrease GHGs? | --<br>Yes | No<br>-- | | Owing to optimal use of chemicals due to efficient spraying operation |
| Will the technology:<br>- increase demand for energy?<br>- decrease the demand for energy | | | NA | |
| Will the technology improve the sustainability of the production system? | Yes | | | Owing to optimal use of chemicals due to efficient spraying operation |
| Will the technology:<br>- Increase the demand for water?<br>- decrease the demand for water? | --<br>Yes | No<br>-- | | To some extent |
| Will the technology increase noise pollution? | | No | | |
| Will the technology increase the generation of solid or hazardous waste? | | No | | |
| Will the technology have a negative impact on water quality? | | No | | |
| Will the technology have a negative impact on biodiversity? | | No | | |
| | | | | |
| **Social** | | | | |
| Will the technology negatively impact on poor people? (eg. loss of income) | | No | | |
| Will the technology be accessible to the poor? | Yes | | | |
| Will the technology increase incomes along the value chain? | Yes | | | Owing to optimal use of chemicals due to efficient spraying operation |
| Will women have access (or be able to use) the technology? | Yes | | | |
| Will the technology improve the access of women to the value chain? | | | NA | |
| Will the technology:<br>- increase women's labour?<br>- decrease women's labour | | | NA | |

### *4.2.5. Solar Water Pumps*

**Description of Situation**

**Describe the context:**

Out of 17 Sustainable Development Goals( SDG) framed by the UN, the SDG- 6 deals with Water and Sanitation. Especially Target of SDG 6.4 is to substantially increase water use efficiency by 2030 and ensure sustainable withdrawals and supply of fresh water to address water scarcity and sustainability and SDG 6.5 is on Implementation of Integrated Water Resource Management (IWRM ). Both these goals are achievable with an Improved Resource Management.

**Where does it fit in along the value-chain?**

Technology will be used in the Production node of the value chain.

**What problem(s) is the technology going to solve?**

Solar water pumps can supply water to locations which are beyond the reach of power lines. Commonly, such places rely on human or animal power or on diesel engines for their water supply. Solar water pumps can replace the current pump systems and result in both socio-economic benefits as well as climate related benefits. The water supplied by the solar water pump can be used to irrigate crops, water livestock or provide potable drinking water

**How has demand been assessed?**

Government has been actively working towards increasing the area under irrigation, which provides a huge demand of these solar water pumps in the sector.

**Who is it aimed at and why are we targeting that sector of the value chain?**

- ✓ Farmers who live in water scarce locations and do not have access to expensive irrigation technologies.

**Technology Design**

**How does it work?**

A solar photovoltaic array directly generates electricity from the sun's light with no moving or wearing parts. Here solar radiations are converted in to direct current (DC electricity) and this generated electricity is used to pump water through groundwater source. The size of the pump is designed based on the total requirement of water for irrigation of crop and total head. The size of the solar array is designed considering availability of yearly solar radiations on location, and power required to operate water pump.

**What stage of development is it at? (eg. still in R & D phase, pilot / demonstration, commercialisation?)**

The technology has been proven and installed at a number sites in India. Solar Water Pumps are manufactured and supplied by Tata Power Solar, Saj Solar, Kenbrook, Oswal Pumps, Urja Pumps, Shakti Pumps, Photon Solar, Kavita Solar.

**What is the innovation? (ie how does it improve over existing situation – is it a significant improvement/)**

- ✓ Solar water pumps do not require any fuel or electricity to operate. Once installed, solar water pumps do not incur the recurring costs of electricity or fuel.
- ✓ Does not get affected by power cuts, low voltage, single phase problems or the motor burning and can be installed in remote areas where electricity is unavailable or diesel is difficult to procure.
- ✓ Incurs low maintenance costs as solar water pumps have fewer moving parts as compared to a diesel-powered pump and thus, fewer chances of wear and tear.
- ✓ No lubricants are required for operation and hence no chances of water/soil contamination due to the lubricants.

### How and where is it made?

Solar water pumps are manufactured and supplied by Tata Power Solar, Saj Solar, Kenbrook, Oswal Pumps, Urja Pumps, Shakti Pumps, Photon Solar, Kavita Solar

Read more: https://www.tatapower.com/products-and-services/solar-pumps.aspx;

- ### Does it require specialist training?

Solar water pumps have no moving parts and require very little training to operate.

- ### Is after sales service provided?

Yes

## Cost / Benefit Analysis

### Costs

The units cost between INR 100,000 and INR 300,000. The units have an operational life of up to 25. There are no maintenance costs.

### Benefits

- Direct Benefits:
  - Reduction in electricity cost of irrigation
  - Increased yield due to timely irrigation even during daylight & compensates power outages

- Indirect Benefits:
  - reduced impact on the environment

### Assumptions

Calculating the financial benefits is dependent on an understanding of a number of parameters including: the area to irrigated; the pipe length; the delivery system (e.g. drip, micro-jets); the pumping head; the crop needs. For the purpose of this calculation an initial capital cost of INR 200,000 for 3HP pump has been used. It is assumed such pump will cater to around 5 acres of land and will have a life of around 15 years. The capital cost and operational cost is amortized over 15 years.

Since all the crops are perennial except for Okra and Chilli the cost is considered on per year basis. In case of Okra and Chilli the cost is considered for half yearly basis assuming the remaining half will be spread over other seasonal crop.

| Particulars | | Units & Assumptions | Pomegranate | Banana | Sweet Lime | Orange/ Mandarin | Custard Apple | Guava | Sapota | Strawberry | Okra | Chilli | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Operational Life** | **Maximum Operational Life of Technology** | Years | **15** | **15** | **15** | **15** | **15** | **15** | **15** | **15** | **15** | **15** | **15** |
| **Costs** | Total Capital Cost (INR/Unit) (assuming for 3HP pump) | Per Unit | 200000 | 200000 | 200000 | 200000 | 200000 | 200000 | 200000 | 200000 | 200000 | 200000 | 200000 |
| | Total Operational Cost (INR/Acre) | 1% Operation & Maintenance Cost per year | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 |
| | No. of Farmer Users | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| | Capital Cost (assuming 3HP pump catering to 5 acres) | INR/Acre/Season/Farmer | 2667 | 2667 | 2667 | 2667 | 2667 | 2667 | 2667 | 2667 | 1333 | 1333 | 2400 |
| | Operational Cost (assuming 3HP pump catering to 5 acres) | INR/Acre/Season/Farmer | 400 | 400 | 400 | 400 | 400 | 400 | 400 | 400 | 200 | 200 | 360 |
| | **Total Cost** | **INR/Acre/Season/Farmer** | **3067** | **3067** | **3067** | **3067** | **3067** | **3067** | **3067** | **3067** | **1533** | **1533** | **2760** |
| **Benefit Streams** | Reduction in electricity cost of irrigation | 100.0% | 5000 | 5000 | 5000 | 5000 | 3500 | 3500 | 3500 | 8163 | 612 | 612 | 3989 |
| | Increased yield due to timely irrigation even during daylight & compensates power outages | 0.5% | 1005 | 878 | 442 | 345 | 833 | 927 | 598 | 3017 | 554 | 548 | 915 |
| | **Total Benefit** | **INR/Acre/Season/Farmer** | **6005** | **5878** | **5442** | **5345** | **4333** | **4427** | **4098** | **11181** | **1166** | **1160** | **4903** |
| **Net Incremental Benefit** | | **INR/Acre/Season/Farmer** | **2938** | **2811** | **2375** | **2278** | **1266** | **1361** | **1031** | **8114** | **-367** | **-373** | **2772** |
| **Benefit Cost Analysis** | | **B/C Ratio** | **1.96** | **1.92** | **1.77** | **1.74** | **1.41** | **1.44** | **1.34** | **3.65** | **0.76** | **0.76** | **1.67** |

## Safeguards

| Environment | Yes | No | N/A | Comments |
|---|---|---|---|---|
| Will the **technology**:<br>- increase GHGs?<br>- decrease GHGs? | | | NA | |
| Will the technology:<br>- increase demand for energy?<br>- decrease the demand for energy | --<br>Yes | No<br>-- | | Runs on renewable source of energy |
| Will the technology improve the sustainability of the production system? | Yes | | | Runs on renewable source of energy and consistent irrigation schedule |
| Will the technology:<br>- Increase the demand for water?<br>- decrease the demand for water? | Yes<br>--- | ---<br>No | | To some extent |
| Will the technology increase noise pollution? | | No | | |
| Will the technology increase the generation of solid or hazardous waste? | | No | | |
| Will the technology have a negative impact on water quality? | | No | | |
| Will the technology have a negative impact on biodiversity? | | No | | |
| | | | | |
| **Social** | | | | |
| Will the technology negatively impact on poor people? (eg. loss of income) | | No | | |
| Will the technology be accessible to the poor? | Yes | | | |
| Will the technology increase incomes along the value chain? | Yes | | | Reduction in energy consumption and increased yield due to consistent irrigation schedule |
| Will women have access (or be able to use) the technology? | Yes | | | |
| Will the technology improve the access of women to the value chain? | | | NA | |
| Will the technology:<br>- increase women's labour?<br>- decrease women's labour | | | NA | |

### 4.2.6. Optical Camera based Fruit Grader

**Description of Situation**

**Describe the context:**

Grading and sorting of fruits and vegetables is a traditional practice which is prevalent for many years now. But the manual grading, sorting is labour intensive, takes a lot of time and is inconsistent. Often skilled laborer are required for doing manual grading and it becomes a subjective exercise as a different person will have different perception about the size and quality of produce. With the rapid increase in production of fruits and vegetables, mechanical grading sorting i.e. using machines to sort and grade produce are becoming popular. Today, with a growing road network and increased trade with neighboring countries, exports from India to the neighboring countries are increasing. The well-sorted, graded fruits and vegetables have the potential to be exported to other countries and earn a premium price.

**Where does it fit in along the value-chain?**

Technology will be used in the processing node of the value chain.

**What problem(s) is the technology going to solve?**

- ✓ **Time saving:** The main advantages of this technology is that it is less labour intensive, fast and helps to standardize the process.
- ✓ **Increased price realization for produce**: While setting the price of an entire lot of produce, often the lowest quality of produce is used as a reference to set the price of the whole lot. This leads to financial loss to orchardist/ farmers. With the grading, farmers can demand higher prices for higher quality produce. Another incentive to accept and follow the established grading and packing practices is widening of the market and making e-trading possible. It reduces the cost of marketing by minimizing the expenses on the physical inspection of the produce, minimizing storage losses and eliminating the cost of handling and weighing etc. at every stage. This cost reduction will reflect positively in the form of higher profits for the farmers.

**How has demand been assessed?**

Out of all the value chains being considered under the project, the technology can be used for more than 60% of value chains. All the selected crops are highly important in the production cluster in Maharashtra. Thus demand for this machine would also be extensive.

**Who is it aimed at and why are we targeting that sector of the value chain?**

- ✓ **Food Processing Units:** They can use the technology for inspecting quality of the fruits before exiting the inspection line

**Technology Design**

**How does it work?**

Depending on the types of sensors used and the software-driven intelligence of the image processing system, optical sorters recognizes objects' color, size, shape, structural properties and chemical composition. The sorter compares objects to user-defined accept/reject criteria to identify and remove defective products and foreign material (FM) from the production line, or to separate product of different grades or types of materials.

**What stage of development is it at? (eg. still in R & D phase, pilot / demonstration, commercialisation?)**

It has been commercialized by various manufactures, including Intello Labs (Intello Sort), Zentron Labs, SNG technologies, GP Grader, Elisam, Ellips

**What is the innovation? (i.e. how does it improve over existing situation – is it a significant improvement/)**

- ✓ Efficient and uniform sorting based on image processing algorithms.
- ✓ Grading based on multiple attributes such as color, size, weight & defects.
- ✓ Capable of grading many different fruits with the capacity 10 fruits/second

**How and where is it made?**

It is manufactured by Intello Labs (Intello Sort), Zentron Labs, SNG technologies, GP Grader, Elisam, Ellips

Read more: https://agfundernews.com/food-quality-startup-intello-labs-closes-5-9m-series-a-round-from-agfunders-grow-others.html; https://www.intellolabs.com/

**Does it require specialist training?**

Yes, training of 1-2 days for understanding how to operate the machine is required.

**Is after sales service provided?**

Yes

## Cost / Benefit Analysis

**Costs**

The cost of the unit is INR 25,00,000 with an operational life of 15 years.

**Benefits**

- Direct Benefits:
  - Reduction in labour cost for grading/sorting/waxing etc. and reduction in time
  - Increased price realization due to uniform grade
- Indirect Benefits:
  - reduced management overheads from supervision of grading
  - more consistently graded products are more competitive in the market-place

**Assumptions**

The machine works effectively with spherical shaped firm skinned produce such as oranges, limes, custard apple, sapota and guava. It is generally not suited to pomegranate, bananas, strawberries, okra and chilli. Economic benefits are based on the cost of labour for grading versus the cost of operating the machine for grading. It is assumed that a single lane machine would be owned and operated by a FPO or MSAMB or any other Service Provider that caters to farmers.

A single lane machine (Zentron Labs) has a throughput of 5 tons/hour with an operational cost of INR 600/ton. Reduced labour costs are based on an 8 hour day. For some products improvement to grading can result in an average of 10% increase in price in markets that are responsive to quality, however this varies according to supply and demand. An assumed increase in value of 10% has been taken as an average for all products. The capital cost of the machine has been amortized over 15 years and spread over 800 user farmers (out of which 400 are assumed member farmers of FPO and others as non-member farmers). Annual repairs and maintenance have been assumed in the operational cost.

| Particulars | | Units & Assumptions | Pomegranate | Banana | Sweet Lime | Orange/ Mandarin | Custard Apple | Guava | Sapota | Strawberry | Okra | Chilli | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Proposed Usage Model** | **FPO/MSAMB to act as Service Provider & Farmers as Users** | | | | | | | | | | | | |
| **Operational Life** | **Maximum Operational Life of Technology** | Years | **15** | **15** | **15** | **15** | **15** | **15** | **15** | **15** | **15** | **15** | **15** |
| **At FPO/MSAMB/Service Provider Level** | | | | | | | | | | | | | |
| **Costs** | Total Capital Cost (INR/Unit) | Per Unit | 0 | 0 | 2500000 | 2500000 | 0 | 2500000 | 2500000 | 0 | 0 | 0 | 2500000 |
| | Max. Total Quantity that can be processed annually (MT) | @5TPH at 90% operational efficiency with 1 shift per day (in MT/yr) | 0 | 0 | 10800 | 10800 | 0 | 10800 | 10800 | 0 | 0 | 0 | 10800 |
| | Actual Quantity to be processed annually | for avg. of 400 user member farmers and 400 non member farmers | 0 | 0 | 3928 | 2400 | 0 | 3904 | 2899 | 0 | 0 | 0 | 3283 |
| | **Total Operational Cost (INR/Unit/Year)** | assuming expenses @INR 600/MT | **0** | **0** | **2356898** | **1440000** | **0** | **2342531** | **1739102** | **0** | **0** | **0** | **1969633** |
| **Benefit Streams** | No. of User Farmers (minimum) | 800 | 0 | 0 | 800 | 800 | 0 | 800 | 800 | 0 | 0 | 0 | 800 |
| | Service Charge (INR/MT) | 1,000 | 0 | 0 | 1000 | 1000 | 0 | 1000 | 1000 | 0 | 0 | 0 | 1000 |
| | Average Quantity for Processing per User Farmer | MT/Farmer/Season | 0 | 0 | 5 | 3 | 0 | 5 | 4 | 0 | 0 | 0 | 4 |
| | **Total Benefit in terms of Service Charge** | **INR/Season** | **0** | **0** | **3928163** | **2400000** | **0** | **3904218** | **2898503** | **0** | **0** | **0** | **3282721** |
| **Net Incremental Benefit** | | **INR/Season** | **0** | **0** | **1571265** | **960000** | **0** | **1561687** | **1159401** | **0** | **0** | **0** | **1313088** |

| Particulars | | Units & Assumptions | Pomegranate | Banana | Sweet Lime | Orange/ Mandarin | Custard Apple | Guava | Sapota | Strawberry | Okra | Chilli | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **NPV of Net Incremental Benefit (@5% Discount Rate)** | | in INR with min. of 400 user member farmers and 400 non member farmers | **0** | **0** | **16309197** | **9964472** | **0** | **16209778** | **12034190** | **0** | **0** | **0** | **13629409** |
| **Payback Period (Years) - For FPO/Service Provider** | | in Years (assuming min. of 400 user member farmers and 400 non member farmers | **---** | **---** | **2.30** | **3.76** | **---** | **2.31** | **3.12** | **---** | **---** | **---** | **2.87** |
| **Benefit Cost Analysis - For FPO/Service Provider** | | **B/C Ratio** | **---** | **---** | **6.52** | **3.99** | **---** | **6.48** | **4.81** | **---** | **---** | **---** | **5.45** |
| **At Farmer Level** | | | | | | | | | | | | | |
| **Costs** | **Total Operational Cost** | **INR/Acre/Season/Farmer** | **0** | **0** | **4910** | **3000** | **0** | **4880** | **3623** | **0** | **0** | **0** | **4103** |
| **Benefit Streams** | Reduction in labour cost for grading/sorting/waxing etc. and reduction in time | 50.0% | 0 | 0 | 707 | 552 | 0 | 1484 | 957 | 0 | 0 | 0 | 925 |
| | Increased price realization due to uniform grade | 10.0% | 0 | 0 | 8838 | 6900 | 0 | 18545 | 11956 | 0 | 0 | 0 | 11560 |
| | **Total Benefit** | **INR/Acre/Season/Farmer** | **0** | **0** | **9545** | **7452** | **0** | **20029** | **12913** | **0** | **0** | **0** | **12485** |
| **Net Incremental Benefit** | | **INR/Acre/Season/Farmer** | **0** | **0** | **4635** | **4452** | **0** | **15148** | **9290** | **0** | **0** | **0** | **8381** |
| **Benefit Cost Analysis - For Farmer** | | **B/C Ratio** | **---** | **---** | **1.94** | **2.48** | **---** | **4.10** | **3.56** | **---** | **---** | **---** | **3.02** |

## Safeguards

| Environment | Yes | No | N/A | Comments |
|---|---|---|---|---|
| Will the **technology**:<br>- increase GHGs?<br>- decrease GHGs? | --<br>Yes | No<br>-- | | |
| Will the technology:<br>- increase demand for energy?<br>- decrease the demand for energy | Yes<br>--- | ---<br>No | | To some extent |
| Will the technology improve the sustainability of the production system? | Yes | | | Reduced process time, reduced expenses and higher throughput |
| Will the technology:<br>- Increase the demand for water?<br>- decrease the demand for water? | | | NA | |
| Will the technology increase noise pollution? | | No | | |
| Will the technology increase the generation of solid or hazardous waste? | | No | | |
| Will the technology have a negative impact on water quality? | | No | | |
| Will the technology have a negative impact on biodiversity? | | No | | |
| | | | | |
| **Social** | | | | |
| Will the technology negatively impact on poor people? (e.g. loss of income) | | No | | |
| Will the technology be accessible to the poor? | Yes | | | Through common infrastructure at MSAMB facilities |
| Will the technology increase incomes along the value chain? | Yes | | | Reduced process time, reduced expenses and higher throughput |
| Will women have access (or be able to use) the technology? | Yes | | | |
| Will the technology improve the access of women to the value chain? | | | NA | |
| Will the technology:<br>- increase women's labour?<br>- decrease women's labour | | | NA | |

### 4.2.7. Solar Powered Cold Storage

**Description of Situation**

**Describe the context:**

Much of the post-harvest loss of fruits and vegetables in developing countries is due to the lack of proper storage facilities. Cold storage is an important infrastructure for farmers and suppliers who face risk of crop losses due to perishable nature of the produce. Lack of power supply in remote rural areas as well its erratic supply make cold storage solutions even more critical. Use of diesel for power supply is neither sustainable nor cost effective. Installation of solar panels on roofs of storage units/warehouses where grid lines are practically absent can prove to be an important solution.

**Where does it fit in along the value-chain?**

Technology will be used in the Aggregation and Storage node of the value chain.

**What problem(s) is the technology going to solve?**

According to the Central Electricity Authority of India 98 percent of the villages are connected to the main grid. However, the reality is that this figure does not translate into uninterrupted power supplies that would make it possible to run conventional cool-stores 24/7. Installation of solar panels on roofs of storage units/warehouses where grid lines are practically absent can prove to be an important solution. Central Institute for Agricultural Engineering (CIAE)[67] , Bhopal, developed a 5x4.4x3 m and 20kwp plant with power storage at a cost of Rs, 20,00,000 with a 15 year life time. Solar powered cool rooms operate in the same was as conventional cool rooms. The solar cells generate a direct current which is converted into alternating current by and invertor and is then used to power a compressor that pressurizes the refrigerant gas and forces it through an expansion value that creates the cooling effect.

**How has demand been assessed?**

Out of all the value chains being considered under the project, the technology can be used for all the crops. All the selected crops are highly important in the production cluster in Maharashtra and have a low shelf life. Thus demand for this product would also be extensive.

**Who is it aimed at and why are we targeting that sector of the value chain?**

- ✓ **Farmers:** They can use the products while packaging their produce, to increase the shelf life of the product helping them increase the realized price.
- ✓ **Aggregators:** They can use the products to store the products for a longer time, and sell when the price is desirable and profitable, instead of selling the produce right away.

**Technology Design**

**How does it work?**

It is used for pre-cooling and storing the perishable item like flowers, fruit, beverages, vegetable etc. It uses solar energy to operate the system. It maintains controlled interior temperature of 4 – 10°C to save the produce from rotting, sprouting, damage from insects and other forms of degradation

### What stage of development is it at? (eg. still in R & D phase, pilot / demonstration, commercialisation?)

The technology has been commercialized in India. Solar Cold Storage are manufactured and supplied by Tessol, Ecozen, CIAE Bhopal (Govt.).

### What is the innovation? (ie how does it improve over existing situation – is it a significant improvement/)

Portable solar powered cold store is an innovative new solution we aptly named ″Solar Freeze″, which enables smallholder farmers to store temperature sensitive fresh agricultural produce. This solution helps smallholder farmers avoid huge investments in creation of storage space, enabling them to focus in producing high value horticulture and dairy produce. These off grid portable solar cold stores are designed and built with the user reliability, performance and running costs in focus.

### How and where is it made?

Solar Powered Cold Storages are manufactured and supplied by Tessol, Ecozen, CIAE Bhopal (Govt.).

Read more: www.ecozensolutions.com

### Does it require specialist training?

Cold Storages have no moving parts and require very little training to operate.

### Is after sales service provided?

Yes

## Cost / Benefit Analysis

### Costs

A unit with a 12 ton working capacity costs INR 600,000. The solar panel has an operational life of approximately 15 years. There would be some minor repairs and maintenance on the cool room structure, mainly to the doors and seals. This is estimated at 1% of the capital cost / year.

### Benefits

- Direct Benefits:
    - a reduction in storage costs that would contribute to lower post-harvest losses for medium sized farmers, aggregation centres and traders
    - improved product quality along the value chain result in an increase in retail prices
- Indirect Benefits:
    - Increase in market demand

### Assumptions

Calculations are based on a comparison of a solar unit powered unit with a conventional electricity powered unit and with a diesel engine genset unit. The following assumptions are made: (a) the dimensions of the unit have been based on a 26 $m^3$ capacity, approximately the size of a high-cube refrigerated container. This would provide storage for approximately 12 tons (mixed) of fresh produce (b) the storage temperature is between $4^0$C and $12^0$C (c) for a cost comparison it is assumed that the units would be operated for approximately 3,000 hrs / year and that the diesel unit would use an average of 2.6 litres / hour (this is an average figure based on a higher usage during pulldown and a lower usage during maintenance) at a current price of INR 77 / litre (d) the electric unit is assumed to operate at an average of 2.9 kwh for 3000 hours / year at an average cost of INR 20 / unit (e) it is assumed that the price of a standard 20' reefer is INR 500,000; the price of a diesel genset (7.5 kva) is INR 200,000 and the price of the solar powered cool room (Ecozen) is 600,000.

| Particulars | Diesel | Electric | Solar |
|---|---|---|---|
| Capital cost[1,2] | 45,000 | 30,000 | 40,000 |
| Operating Hours | 3000 | 3000 | 3000 |
| Consumption per hour (Litre or KWh) | 2.6 | 2.9 | 2.9 |
| Total Consumption (Fuel or Electricity) (Litre or KWh) | 7800 | 8700 | 1450* |
| Fuel price (INR/litre or INR/unit) | 77 | 20 | 20 |
| Annual operating cost (INR)[3] | 600,600 | 174,000 | 29,000 |
| Repair & Maintenance Rate (%) | 5.00% | 2.50% | 1.00% |
| Total Repair & Maintenance [4] | 35,000 | 12,500 | 6,000 |
| **Total Yearly Costs (INR)** | **682,267** | **219,833** | **75,000** |

1. Capital cost amortised over 15 years
2. Includes cost of a diesel genset
3. Based on 3,000 operating hours / year with 70% of hours operating at maintenance and 30% at pulldown i.e. higher fuel / energy consumption
4. Based on a percentage of capital costs 5% / year for diesel; 2.5% year for electric; 1% / year for solar

* On charge of 6 hrs Solar Cold Storage provides back up of 30 hrs (used factor of 1/6 for total electricity consumption)

## Safeguards

| Environment | Yes | No | N/A | Comments |
|---|---|---|---|---|
| Will the **technology**:<br>- increase GHGs?<br>- decrease GHGs? | --<br>Yes | No<br>-- | | Owing to reduced energy consumption, reduced PH loss |
| Will the technology:<br>- increase demand for energy?<br>- decrease the demand for energy | --<br>Yes | No<br>-- | | Owing to reduced energy consumption |
| Will the technology improve the sustainability of the production system? | Yes | | | Owing to reduced energy consumption, reduced PH loss, increased shelf life |
| Will the technology:<br>- Increase the demand for water?<br>- decrease the demand for water? | | | NA | |
| Will the technology increase noise pollution? | | No | | |
| Will the technology increase the generation of solid or hazardous waste? | | No | | |
| Will the technology have a negative impact on water quality? | | No | | |
| Will the technology have a negative impact on biodiversity? | | No | | |
| | | | | |
| **Social** | | | | |
| Will the technology negatively impact on poor people? (e.g. loss of income) | | No | | |
| Will the technology be accessible to the poor? | Yes | | | |
| Will the technology increase incomes along the value chain? | Yes | | | Owing to reduced energy expenses, |

| Environment | Yes | No | N/A | Comments |
|---|---|---|---|---|
| | | | | reduced PH loss, increased shelf life |
| Will women have access (or be able to use) the technology? | Yes | | | |
| Will the technology improve the access of women to the value chain? | | | NA | |
| Will the technology:<br>- increase women's labour?<br>- decrease women's labour? | | | NA | |

### 4.2.8. Ice-Battery (Passive Cooling) for transportation of perishables


## Description of Situation

**Describe the context:**

Maharashtra is one of top fruits/vegetables/dairy product producer in the market ,however more than 30% of these produce could not reach to the market in healthy condition thus could not be used due to lack of competitive cold chain logistics, cold storage in rural area. Reefer vans are an expensive mode of transportation and increase the price of the produce by manifolds making It difficult to market. It is important to develop sustainable cold chain technology solutions that deliver significant cost savings within the supply chain.

**Where does it fit in along the value-chain?**

Technology will be used in the Aggregation, Storage and Transportation node of the value chain.

**What problem(s) is the technology going to solve?**

Refrigerated containers (reefers) are an integral part of maintaining the cool chain in developed countries, however they are designed for maintaining the temperature of frozen and even if the electricity supply is interrupted there is sufficient ice to ensure that temperatures remain low enough to maintain sub-zero temperatures. For fresh produce however cool rooms typically operate at temperatures between $4^0$C and $8^0$C and if the electricity supply is interrupted the temperature can rise very quickly as the produce respiration increases. Ice batteries work like conventional batteries by storing energy in the form of ice. Ice can be formed at night when temperatures are cooler and the cost of electricity to produce the ice is less expensive. Insulated shipping containers and insulated cool boxes that are mounted on trucks.

**How has demand been assessed?**

Out of all the value chains being considered under the project, the technology can be used for all the crops. All the selected crops are highly important in the production cluster in Maharashtra and can be transported to different parts of the country, increasing the income generated by farmers.

**Who is it aimed at and why are we targeting that sector of the value chain?**

✓ Logistics/Transport Providers for transporting the perishable produce for medium and long distances without incurring cost of buying reefer vans.

## Technology Design

**How does it work?**

The IceBattery™ technology product line perfectly matches with existing story of saving this 30 % produce to contribute in food security, less imports and growth of Indian GDP. IceBattery™ does not require or use diesel/ petrol run vehicles to maintain temperature and humidity thus most environment-friendly, ITE's solutions are borderless, portable and designed to make the solutions easily adaptable for Train, land-, air-, or sea- based storage and transportation. By converting active cooling to passive cooling, IceBattery™ provides uninterrupted, temperature-controlled storage and distribution solutions. ITE's cold chain technology helps preserve and extend the shelf life of countless perishable products from Agriculture to Dairy to Pharma.

### What stage of development is it at? (eg. still in R & D phase, pilot / demonstration, commercialisation?)

Turn-key ice battery technology has been developed by Container Corporation of India Limited (CONCOR), who have partnered with Japan-based "Innovation Thru Energy™ " (ITE), to develop and commercialise an ice battery specifically for the Indian market. IceBattery™ is based around 20 foot Hybrid Containers that are fitted with ice batteries that when charged maintain the temperature inside the container for up to for next 72 hours with no active refrigeration.

### What is the innovation?

A major contributing factor to post harvest losses is that 85% of the cool chain are permanent cool stores. Even if produce is pre-cooled it is then transferred to container trucks that do not have cooling capacity and temperatures quickly rise. Ice batteries then can be used to cost effectively provide the missing link by converting conventional truck containers into cool stores.

### How and where is it made?

Turn-key ice battery technology has been developed by Container Corporation of India Limited (CONCOR), who have partnered with Japan-based "Innovation Thru Energy™ " (ITE), to develop and commercialise an ice battery specifically for the Indian market.

Read more:
https://valuepress.jp/pressrelease/484#:~:text=CONCOR%20has%20developed%20multimodal%20logistics,and%20Domestic%20containerization%20and%20trade.&text=million%20square%20feet%20to%2050,ice%2Dbattery%20technology%20to%20India.

### Does it require specialist training?

No.

### Is after sales service provided?

Yes

## Cost / Benefit Analysis

### Costs

The cost of the unit varies according to the scale. The approximate cost of a 20' hybrid (Ice/electricity) is approximately INR 600,000. The life time of the unit is 15 years and the annual R & M is 2% of the capital cost.

### Benefits

- Direct Benefits:
  - a reduction in p/h losses through the maintenance of a continuous cool chain
- Indirect Benefits:
  - Increase in market demand though improved quality at the point of sale.

### Assumptions

Calculations of financial benefits are based on reduced post-harvest losses through the maintenance of a continual cool chain. Post-harvest losses may occur at any point along the value chain and are not all due to lack of temperature control. A conservative estimate would be that 2.5% percent of post-harvest losses (with the average total being 35%) are due to extended storage times at temperatures above the optimum needed to maintain quality. The cost-benefit (pay-back) calculation would depend on a number of variables including: (a) the length of time in transit (b) cost of unit (c) size of unit (d) back loading revenue.

The comparative cost-benefit analysis is based on transportation of 20 feet container from Mumbai to Delhi in Ice Battery container vis a vis conventional refrigerated container powered by diesel.

| | |
|---|---|
| Distance - Mumbai to Delhi (Approx. in Kms) | 1500 |
| Time required for transportation (Hrs) | 48 |
| **Number of trips per month** | **10** |
| Number of hrs in a month | 480 |

| | |
|---|---|
| **Operating Cost - Diesel Container** | |
| Fuel consumption per hour (Litres) | 4 |
| Cost of Diesel (INR/Litre) | 75 |
| **Total Operating Cost (INR/trip)** | **14,400** |
| **Total Operating Cost for Diesel Compressor (INR/Month)** | **1,44,000** |

| | |
|---|---|
| **Operating Cost - Ice Battery Container** | |
| Electricity consumption per charge of Ice Battery for 12 hrs (in KWh) | 71 |
| Cost of electricity per unit (KWh) | 20 |
| Total Cost for charging Ice batteries (INR/trip) | 1,420 |
| Total Cost for charging Ice batteries for 10 trips (INR) | 14,200 |
| Monthly Rental of each container consist of 300 IB plates | 45,000 |
| **Total Operating Cost for IceBattery (INR/Month)** | **59,200** |

| | |
|---|---|
| **Net Saving in Monthly Operating Cost (INR)** | **84,800** |

## Safeguards

| Environment | Yes | No | N/A | Comments |
|---|---|---|---|---|
| Will the **technology**:<br>- increase GHGs?<br>- decrease GHGs? | --<br>Yes | No<br>-- | | Owing to reduced energy consumption, reduced PH loss |
| Will the technology:<br>- increase demand for energy?<br>- decrease the demand for energy | --<br>Yes | No<br>-- | | Owing to reduced energy consumption |
| Will the technology improve the sustainability of the production system? | Yes | | | Owing to reduced energy consumption, reduced PH loss, increased shelf life |
| Will the technology:<br>- Increase the demand for water?<br>- decrease the demand for water? | | | NA | |
| Will the technology increase noise pollution? | | No | | |
| Will the technology increase the generation of solid or hazardous waste? | | No | | |
| Will the technology have a negative impact on water quality? | | No | | |
| Will the technology have a negative impact on biodiversity? | | No | | |
| | | | | |
| **Social** | | | | |
| Will the technology negatively impact on poor people? (e.g. loss of income) | | No | | |
| Will the technology be accessible to the poor? | Yes | | | |

| Environment | Yes | No | N/A | Comments |
|---|---|---|---|---|
| Will the technology increase incomes along the value chain? | Yes | | | Owing to reduced refrigeration expenses, reduced PH loss due to passive cooling (compared to equipment breakdown / loss of power or electricity connection in active cooling) |
| Will women have access (or be able to use) the technology? | Yes | | | |
| Will the technology improve the access of women to the value chain? | | | NA | |
| Will the technology:<br>- increase women's labour?<br>- decrease women's labour? | | | NA | |

### *4.2.9. Walk in Cooler (CoolBot)*

**Description of Situation**


**Describe the context:**

Temperature management is the key tool for reducing postharvest losses in the developing world. Very few smallholder farmers have access to cooling or cool storage facilities, and refrigerated transportation is a rarity. The unreliability of local electricity supplies, the expense of conventional coolers, and the lack of technical expertise for the installation and maintenance all have led to the search for alternative solutions.

**Where does it fit in along the value-chain?**

Technology will be used in the Aggregation and Storage node of the value chain.

**What problem(s) is the technology going to solve?**

Traditional cool room systems use a “brute-force” approach to cooling. This involves using a lot of coolant, large cooling fans and large compressors. The CoolBot transforms any well-insulated room into a walk-in cooler by harnessing the cooling power of a standard air conditioner. Traditional walk-in cooler refrigeration systems can cost several thousand INR with installation and electrical setup. An alternative is to use air conditioning units however they are manufactured to electronically limited to lower the temperature to 160C. In an unmodified air conditioner the cooling efficiency drops dramatically as the temperature approaches 160C. This is because air conditioners do not have large enough fans or evaporative plates to dissipate the cold without freezing the coils.

**How has demand been assessed?**

Out of all the value chains being considered under the project, the technology can be used for all the crops. All the selected crops are highly important in the production cluster in Maharashtra and have a low shelf life. Thus demand for this product would also be extensive.

**Who is it aimed at and why are we targeting that sector of the value chain?**

- ✓ **Farmers:** They can use the products while packaging their produce, to increase the shelf life of the product helping them increase the realized price.
- ✓ **Aggregators:** They can use the products to store the products for a longer time, and sell when the price is desirable and profitable, instead of selling the produce right away.

**Technology Design**

**How does it work?**

It uses an intelligent thermostat system to control a standard room air conditioner to create a small-scale cooler out of a well-insulated room. The CoolBot uses multiple sensors, a heating element and a programmed micro-controller to direct the air conditioner to operate so that the temperature can be lowered to 20C without icing on the coils.

**What stage of development is it at? (eg. still in R & D phase, pilot / demonstration, commercialisation?)**

CoolBot is manufactured under license by Store It Cold. The price of the controller is approximately INR 70,000. This does not include the cost of the air conditioner and an insulated cool room.

### What is the innovation? (ie how does it improve over existing situation – is it a significant improvement/)

The CoolBot uses multiple sensors, a heating element and a programmed micro-controller to direct the air conditioner to operate so that the temperature can be lowered to 20C without icing on the coils. The CoolBot controller can be installed within 5 minutes without any prior training. Most importantly, when the air conditioner is close to freezing or when the cool room has reached the desired set temperature, the CoolBot is programmed to shut off the compressor on your A/C unit thereby reducing electricity costs. The traditional cool room unit uses about 4 kw/hour whereas the CoolBot modified air conditioning units uses about 1 kw/hour.

### How and where is it made?

CoolBot is manufactured under license by Store It Cold.

Read more: https://storeitcold.com/; https://horticulture.ucdavis.edu/project/demonstrating-low-cost-cooling-technology-uganda-honduras-and-india

### Does it require specialist training?

No

### Is after sales service provided?

Yes

## Cost / Benefit Analysis

### Costs

The cost of the CoolBot controller is INR 29,500. The cost of a standard 1.5 hp AC unit is INR 55,700 with an operating life of 10 years. Annual R & M costs are based on 5% of the capital costs

### Benefits

- Direct Benefits:
  - Saving in capital and running costs

- Indirect Benefits:
  - Reduction in GHG emissions

### Assumptions

Calculations of financial benefits are based on gains from the use of a standard AC system installed in a 21 cubic meter cool room against the capital and running costs of a conventional refrigeration plant.

| **Particulars** | **CoolBot Technology** | **Conventional Refrigeration Technology** |
| --- | --- | --- |
| CoolBot controller | 29,500 | --- |
| Standard AC unit | 55,700 | --- |
| Standard Cool Room Refrigeration Unit | --- | 174,700 |
| Installation | --- | 41,400 |
| **Total Setup Costs** | **85,200** | **216,100** |
| **R & M (/year)** | 4,260 | 10,805 |
| **Running costs (/ day)** | 9.6 | 13.6 |

## Safeguards

| Environment | Yes | No | N/A | Comments |
|---|---|---|---|---|
| Will the **technology**:<br>- increase GHGs?<br>- decrease GHGs? | --<br>Yes | No<br>-- | | To some extent compared to full fledge refrigeration units |
| Will the technology:<br>- increase demand for energy?<br>- decrease the demand for energy? | --<br>Yes | No<br>-- | | Runs on normal Air Conditioning unit |
| Will the technology improve the sustainability of the production system? | Yes | | | Reduced energy consumption, low cost alternative |
| Will the technology:<br>- Increase the demand for water?<br>- decrease the demand for water? | | | NA | |
| Will the technology increase noise pollution? | | No | | |
| Will the technology increase the generation of solid or hazardous waste? | | No | | |
| Will the technology have a negative impact on water quality? | | No | | |
| Will the technology have a negative impact on biodiversity? | | No | | |
| | | | | |
| **Social** | | | | |
| Will the technology negatively impact on poor people? (e.g. loss of income) | | No | | |
| Will the technology be accessible to the poor? | Yes | | | |
| Will the technology increase incomes along the value chain? | Yes | | | |
| Will women have access (or be able to use) the technology? | Yes | | | Reduced energy expenses, reduced PH losses |
| Will the technology improve the access of women to the value chain? | | | NA | |
| Will the technology:<br>- increase women's labour?<br>- decrease women's labour | | | NA | |

# 5. *Implementation plan*

## *5.1. Procurement*

The technologies identified ad proposed in the previous section, can be promoted either through project funding or through ADB's High Level Technology Fund (HLTF). The estimated costs and the suppliers thereof are given in the below tables:

### *5.1.1. Service Providers Identified for Technologies proposed under project funding*

| Stage in the Value Chain | Technology | Major Manufacturers/Suppliers | Approximate Price (INR) |
|---|---|---|---|
| **Inputs & Production Stage** | Soil Test and Fertilizer Recommendation Meter Kit (SFTR Meter Kit) | • W S Telematics Pvt. Ltd.<br>• Plasti Surge Industries | • 89,600/Set |
| | Organic Slush Powder Gel/Super Absorbent Polymer (FasalAmrit) | • Ef Polymer | • 300/Kg |
| | Solar Insect Trap | • Hectare<br>• Barrix<br>• C2K<br>• Shakti | • 2,500-4,000/Piece |
| | Fruit Fly Trap | • Barrix | • 500-600/Unit |
| **Aggregation, Storage & Transportation Stage** | Power/Manual Fruit & Vegetable Grader (spherical) | • CIAE Bhopal | • 70,000/Unit |
| | Quick Quality Assessment | • Intello Labs<br>• Agrix<br>• SpectraAnalyzer<br>• AgNext | • Depends on the technology |
| | Shelf Life Extension of F&V using Paper, Bag, Sachet, Capsules etc. | • Keep-it-fresh | • As Per Requirements |
| | Zero Energy Cool Chamber/Evaporative Cool Chamber | • IARI New Delhi<br>• CIPHET Ludhiana | • 35,000 To 45,000/Unit |
| **Processing, Logistics & Marketing Stage** | Solar Dryers and Smart Dryer (F&V Dryer) | • S4S Technologies<br>• Aadhi Solar<br>• ATR Solar<br>• Vishivkarma Solar<br>• Energy Corporation | • 35,000 To 3,00,000/Unit (10-100 Kg) |
| | Pomegranate Aril Extractor | • CIPHET Ludhiana | • 600,000/Unit |
| | Custard Apple Pulper | • Nexgen | • 3,00,000/Unit |

### 5.1.2. Service Providers Identified Technologies proposed under HLTF

| Stage in the Value Chain | Technology | Major Manufacturers/Suppliers | Approximate Price (INR) |
|---|---|---|---|
| **Inputs & Production Stage** | Precision Agriculture | • Fasal<br>• AgNext<br>• Agsmartic<br>• IBM | • Depends on the services availed, types of sensors used, farm size, number of users etc. |
| | ICT Platform for Farm & Supply Chain Management | • DeHaat<br>• BharatAgri<br>• CropIn | • Depends on the services availed, types of sensors used, farm size, number of users etc. |
| | Drone based Chemical Spray & Image Analysis | • Trithi (3thi)<br>• IoTech World<br>• EI World<br>• Ag-Copter | • 3,00,000 To 15,00,000/Unit |
| | Electrostatic Sprayers | • AgNext<br>• MITRA<br>• Eco Agro Services/Maxcharge<br>• Gursukh Agro Works<br>• Padgilwar Corporation<br>• Fortune Agro Impex | • 25,000 To 6,00,000/Unit |
| | Solar Water Pumps | • Tata Power Solar<br>• Saj Solar<br>• Kenbrook<br>• Oswal Pumps<br>• Urja Pumps<br>• Shakti Pumps<br>• Photon Solar<br>• Kavita Solar | • 1,00,000 To 3,00,000/Unit |
| **Aggregation, Storage & Transportation Stage** | Optical Camera based Fruit Grader | • Intello Labs (Intello Sort)<br>• Zentron Labs<br>• SNG technologies<br>• GP Grader<br>• Elisam<br>• Ellips | • 25,00,000/Unit |
| | Solar Powered Cold Storage | • Tessol<br>• Ecozen<br>• CIAE Bhopal (Govt.) | • 6,00,000 onwards |
| | Ice-Battery (Passive Cooling) for transportation of perishables | • Innovation Thru Energy (ITE) | • Based on scale and produce |
| | Walk in Cooler (CoolBot) | • Store It Cold LLC | • 70,000/Device |
| **Processing, Logistics & Marketing Stage** | Digital Logistics & Supply Chain Solutions | • Pando<br>• Kisanrath<br>• Crofarm | • Depends on the services availed, Number of entities involved |

## 5.2. Financial / institutional arrangements

The identified and proposed technologies need to be promoted through various project components or project outputs. These technologies are mapped against the project components/outputs based on following parameters:

- applicability of the technology at particular node/stage of the value chain
- applicability of the technology across targeted horticultural crop/value chain
- compatibility between the output objectives & envisaged benefits of technologies and
- type of targeted beneficiaries

### 5.2.1. Proposed institutional/implementation arrangement for promotion of identified technologies under project funding

| Stage in the Value Chain | Proposed Technology | Approximate Price (INR) | Source of Funds | Targeted Beneficiaries | Proposed Implementation Arrangement | Mapping with Project Output |
|---|---|---|---|---|---|---|
| **Inputs & Production Stage** | Soil Test and Fertilizer Recommendation Meter Kit (SFTR Meter Kit) | 896,000/Set | Project Funding | • Farmers/FPOs | • Project to promote the technology through capacity building and pilot testing on fields at FPO level | • Output-1 (Capacity Building) |
| | Organic Slush Powder Gel/Super Absorbent Polymer (FasalAmrit) | 300/Kg | Project Funding | • Farmers/FPOs | • Project to promote the technology through capacity building and pilot testing on fields at FPO level | • Output-1 (Capacity Building) |
| | Solar Insect Trap | 2,500-4,000/Piece | Project Funding | • Farmers/FPOs | • Project to promote the technology through capacity building and pilot testing on fields at FPO level | • Output-1 (Capacity Building) |
| | Fruit Fly Trap | 500-600/Unit | Project Funding | • Farmers/FPOs | • Project to promote the technology through capacity building and pilot testing on fields at FPO level | • Output-1 (Capacity Building) |
| **Aggregation, Storage & Transportation Stage** | Power/Manual Fruit & Vegetable Grader (spherical) | 70,000/Unit | Project Funding | • Farmers/FPOs<br>• Other value chain actors | • Project to promote the technology through capacity building and pilot testing on fields at FPO level | • Output-1 (Capacity Building)<br>• Output-2 (Financial support through FIL) |

| Stage in the Value Chain | Proposed Technology | Approximate Price (INR) | Source of Funds | Targeted Beneficiaries | Proposed Implementation Arrangement | Mapping with Project Output |
|---|---|---|---|---|---|---|
| | | | | | • Also, by including it into the business plans of FPOs/other value chain actors | • Output-3 (Agri value chain enhancement) |
| | Quick Quality Assessment | Depends on the technology | Project Funding | • Farmers/FPOs<br>• Other value chain actors | • Project to promote the technology through capacity building and pilot testing on fields at FPO level<br>• Also, by including it into the business plans of FPOs/other value chain actors | • Output-1 (Capacity Building)<br>• Output-2 (Financial support through FIL)<br>• Output-3 (Agri value chain enhancement) |
| | Shelf Life Extension of F&V using Paper, Bag, Sachet, Capsules etc. | As Per Requirements | Project Funding | • Farmers/FPOs | • Project to promote the technology through capacity building and pilot testing on fields at FPO level | • Output-1 (Capacity Building) |
| | Zero Energy Cool Chamber/Evaporative Cool Chamber | 35,000 To 45,000/Unit | Project Funding | • Farmers/FPOs<br>• Other value chain actors | • Project to promote the technology through capacity building and pilot testing on fields at FPO level<br>• Also, by including it into the business plans of FPOs/other value chain actors | • Output-1 (Capacity Building)<br>• Output-2 (Financial support through FIL)<br>• Output-3 (Agri value chain enhancement) |
| **Processing, Logistics & Marketing Stage** | Solar Dryers and Smart Dryer (F&V Dryer) | 35,000 To 3,00,000/Unit (10-100 Kg) | Project Funding | • Farmers/FPOs<br>• Other value chain actors | • Project to promote the technology through capacity building and pilot testing on fields at FPO level<br>• Also, by including it into the business plans of FPOs/other value chain actors | • Output-1 (Capacity Building)<br>• Output-2 (Financial support through FIL)<br>• Output-3 (Agri value chain enhancement) |
| | Pomegranate Aril Extractor | 600,000/Unit | Project Funding | • Farmers/FPOs<br>• Other value chain actors | • Project to promote the technology through capacity building and pilot testing on fields at FPO level<br>• Also, by including it into the business plans of FPOs/other value chain actors | • Output-1 (Capacity Building)<br>• Output-2 (Financial support through FIL)<br>• Output-3 (Agri value chain enhancement) |

| Stage in the Value Chain | Proposed Technology | Approximate Price (INR) | Source of Funds | Targeted Beneficiaries | Proposed Implementation Arrangement | Mapping with Project Output |
|---|---|---|---|---|---|---|
| | Custard Apple Pulper | 3,00,000/Unit | Project Funding | • Farmers/FPOs<br>• Other value chain actors | • Project to promote the technology through capacity building and pilot testing on fields at FPO level<br>• Also, by including it into the business plans of FPOs/other value chain actors | • Output-1 (Capacity Building)<br>• Output-2 (Financial support through FIL)<br>• Output-3 (Agri value chain enhancement) |

### 5.2.2. Proposed institutional/implementation arrangement for promotion of identified technologies under HLTF funding

| Stage in the Value Chain | Technology | Approximate Price (INR) | Source of Funds | Targeted Beneficiaries | Proposed Implementation Arrangement | Mapping with Project Output |
|---|---|---|---|---|---|---|
| **Inputs & Production Stage** | Precision Agriculture | • Depends on the services availed, types of sensors used, farm size, number of users etc. | HLTF | • Farmers/FPOs<br>• Other value chain actors | • Project to promote the technology through capacity building and pilot testing/ demonstrations on fields at FPO level<br>• Also, by including it into the business plans of few FPOs based on the willingness of FPO (to create few model/ anchor FPOs) | • Output-1 (Capacity Building)<br>• Output-2 (Financial support through FIL)<br>• Output-3 (Agri value chain enhancement) |
| | ICT Platform for Farm & Supply Chain Management | • Depends on the services availed, types of sensors used, farm size, number of users etc. | HLTF | • Farmers/FPOs | • Project to promote the technology through capacity building and pilot testing/ demonstrations on fields at FPO level<br>• Also, by including it into the business plans of few FPOs | • Output-1 (Capacity Building)<br>• Output-2 (Financial support through FIL)<br>• Output-3 (Agri value chain enhancement) |

| Stage in the Value Chain | Technology | Approximate Price (INR) | Source of Funds | Targeted Beneficiaries | Proposed Implementation Arrangement | Mapping with Project Output |
|---|---|---|---|---|---|---|
| | | | | | based on the willingness of FPO (to create few model/ anchor FPOs) | |
| | Drone based Chemical Spray & Image Analysis | • 3,00,000 To 15,00,000/Unit | HLTF | • Farmers/FPOs | • Project to promote the technology through capacity building and pilot testing/ demonstrations on fields at FPO level<br>• Also, by including it into the business plans of few FPOs based on the willingness of FPO (to create few model/ anchor FPOs) | • Output-1 (Capacity Building)<br>• Output-2 (Financial support through FIL)<br>• Output-3 (Agri value chain enhancement) |
| | Electrostatic Sprayers | • 25,000 To 6,00,000/Unit | HLTF | • Farmers/FPOs | • Project to promote the technology through capacity building and pilot testing/ demonstrations on fields at FPO level<br>• Also, by including it into the business plans of few FPOs based on the willingness of FPO (to create few model/ anchor FPOs) | • Output-1 (Capacity Building)<br>• Output-2 (Financial support through FIL)<br>• Output-3 (Agri value chain enhancement) |
| | Solar Water Pumps | • 1,00,000 To 3,00,000/Unit | HLTF | • Farmers/FPOs | • Project to promote the technology through capacity building and pilot testing/ demonstrations on fields at FPO level<br>• Also, by including it into the business plans of few FPOs based on the willingness of FPO (to create few model/ anchor FPOs) | • Output-1 (Capacity Building)<br>• Output-2 (Financial support through FIL)<br>• Output-3 (Agri value chain enhancement) |

| Stage in the Value Chain | Technology | Approximate Price (INR) | Source of Funds | Targeted Beneficiaries | Proposed Implementation Arrangement | Mapping with Project Output |
|---|---|---|---|---|---|---|
| **Aggregation, Storage & Transportation Stage** | Optical Camera based Fruit Grader | • 25,00,000/Unit | HLTF | • Farmers/FPOs<br>• Other value chain actors | • Project to promote the technology through MSAMB facilities to make this technology accessible to FPOs/other value chain actors | • Output-3 (Agri value chain enhancement) |
| | Solar Powered Cold Storage | • 6,00,000 onwards | HLTF | • Farmers/FPOs<br>• Other value chain actors | • Project to promote the technology through capacity building and pilot testing/ demonstrations on fields at FPO level<br>• Also, by including it into the business plans of few FPOs based on the willingness of FPO (to create few model/ anchor FPOs) | • Output-1 (Capacity Building)<br>• Output-2 (Financial support through FIL)<br>• Output-3 (Agri value chain enhancement) |
| | Ice-Battery (Passive Cooling) for transportation of perishables | • Based on scale and produce | HLTF | • Farmers/FPOs<br>• Other value chain actors | • Project to promote the technology through capacity building and pilot testing/ demonstrations on fields at FPO level<br>• Also, by including it into the business plans of few FPOs based on the willingness of FPO (to create few model/ anchor FPOs) | • Output-1 (Capacity Building)<br>• Output-2 (Financial support through FIL)<br>• Output-3 (Agri value chain enhancement) |
| | Walk in Cooler (CoolBot) | • 70,000/Device | HLTF | • Farmers/FPOs<br>• Other value chain actors | • Project to promote the technology through capacity building and pilot testing/ demonstrations on fields at FPO level<br>• Also, by including it into the business plans of few FPOs based on the willingness of FPO (to create few model/ anchor FPOs) | • Output-1 (Capacity Building)<br>• Output-2 (Financial support through FIL)<br>• Output-3 (Agri value chain enhancement) |

| Stage in the Value Chain | Technology | Approximate Price (INR) | Source of Funds | Targeted Beneficiaries | Proposed Implementation Arrangement | Mapping with Project Output |
|---|---|---|---|---|---|---|
| **Processing, Logistics & Marketing Stage** | Digital Logistics & Supply Chain Solutions | • Depends on the services availed, Number of entities involved | HLTF | • Farmers/FPOs<br>• Other value chain actors | • Project to promote the technology through capacity building and pilot testing/ demonstrations on fields at FPO level<br>• Also, by including it into the business plans of few FPOs based on the willingness of FPO (to create few model/ anchor FPOs) | • Output-1 (Capacity Building)<br>• Output-2 (Financial support through FIL)<br>• Output-3 (Agri value chain enhancement) |

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