Post-Harvest Analysis

PHASE - III REPORT

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Organization of the report

The third phase report of Post-harvest component present DPRs for onion storage structure and value addition propositions of agri-commodities in PoCRA region. These DPRs are templates that can be customized for the FPCs based on their business plans.

The third phase report on Post-harvest component is divided in two parts. The first part covers 'Onion Storage structure' and the second part covers 'Value addition component'.

'CA Onion storage structure' part involves the details project report for establishment of 300 MT CA onion storage structure with FPCs in the PoCRA region. Report contains need assessment, project proposal, socio-economic analysis, scenario analysis, financial analysis and road map for implementation of the project. It further discusses the impact of intervention on the baseline situation (from environmental and economic lens) and expected outcomes from the project.

Second part of the report deals with 'Value addition' of agri-commodities. During inception phase, strategy for selecting FPCs for visits and interviews was proposed. In second phase, description and feasibility of four value added products namely poultry feed, soy milk/Tofu, turmeric powder and curcumin was mentioned along with their process flow diagrams and financial analysis. In current phase of the work, a DPR is prepared for all the four proposed products. The DPR covers details of techno-economic analysis, risk analysis, potential buyers of the value-added products, backward and forward linkages, SWOT analysis and food safety standards and social, environmental and operational checklist for the processing of proposed products.

SECTION-1 A:

DPR

on

300 MT Climate Agnostic

Onion Storage Structure

1 Introduction

Climate change and its links with the vulnerability of food value chain and agriculture are now well established. This Detailed Project Report (DPR) presents details of Climate Agnostic Smart Integrated Onion curing and storage structure for the PoCRA region. DPR is a part of collaboration between Nanaji Deshmukh Krishi Sanjeevani Project (PoCRA), Govt of Maharashtra and Indian Institute of Technology Bombay.

2 Background

To get an idea and vision of the project, it is important to have glimpse at the background of the work that has been done till now, based on which the current project is proposed.

2.1 Overview of Onion Value chain

Nearly three quarters of Indian families live in rural India and their economy is connected with the rural income. Post industrialization of last few decades, share of agriculture in economy has declined sharply below 15%. Along with economic policies, changing climatic conditions, increased fluctuations in market of agriculture produces, increasing production costs and decreasing profits have made farming in India vulnerable. (World Bank, 2012). India is prominent producer of vegetable and fruits in the world. Production of onion in India is second highest in the world with the production of 24.4 million MT onion in 2019. India generates huge revenue by exporting onion. Despite of the importance of this agricultural commodity, there is ignorance to the losses occurring in onion supply chain and subsequent infrastructure building. (NABARD, 2017). Storage structure can play a pivotal role in changing the scenario of this gap and ensuring profits to the onion growing farmers.

2.2 CA Storage structure at CTARA, IIT Bombay

CTARA, IIT Bombay has developed Climate Agnostic (CA) storage structure to curb losses of onion during storage. In 2018, working prototype of CA storage structure was developed for performance evaluation and installed at DOGR, Pune. MOU with DOGR was signed for continuing research in the field of onion and garlic. 100 MT CA Storage structure will be constructed at VNMKV, Parbhani by August 2022.

3 Analysis of the Onion Storage structures in PoCRA region

As a part of MoU between PMU-PoCRA and IIT Bombay, field visits in the PoCRA regions (Jalna and Aurangabad districts) were organised and extensive survey of FPO directors, farmers and private players engaged in the onion storage infrastructure was carried out. Following major issues were found which contribute to storage losses of onion (qualitative and quantitative).

1. Poor quality onion seed
2. Mixing of varieties of onion
3. Heavy and uncertain rain and exposure to direct sunlight
4. Lack of appropriate ventilation (forced)
5. Spread of rotting due to heavy stacking
6. Accumulation of dew on surface of ceiling
7. Expensive loading/unloading and sorting operation
8. Defective onion bulbs due to improper curing
9. Uncontrolled use of powder to control to prevent sprouting

Specific details of the survey are available in the report submitted to PMU-PoCRA.

3.1 Major problems faced by farmers with traditional onion storage structures

During the visit to various locations of large onion warehousing systems (500 MT and above) in Jalna district, it was found that the owner of the system has employed his own understanding along with the traditional design. It involved alterations in dimensions, materials and methods. Though it came from their own understanding of the system, little came from the advice of the experts.

Figure 3.1 Locations of visits to Onion storage facilities in PoCRA regions

Extreme rotting and sprouting of the onion: Due to unscientific design, the onion was exposed to the extreme and uncertain rain that caused direct immediate damage and later resulted in extreme rotting and sprouting of the onion. The important thing observed was that there is no designated agency to check and approve the designs for such warehouses (though some government departments like NABARD use designs suggested by ICAR-DoGR).

3.2 Important observations from visits and surveys

It was observed during the discussion that farmers were more focused on saving on initial costs of the structure than understanding the effect of design parameters on storage efficiency as well as operational costs of the storage structure. Budget constraints of FPCs, limited subsidies on storage structure, focus on more storage capacity with less investment at the cost of quality were some of the reasons for poor functioning of onion storage structures.

3.3 Comment on current government interventions for Onion storage structures

Most of the MahaOnion supported storages are running on the 'NAFED model' where risks of onion spoilage and subsequent financial loss to owner are highly reduced. Owner has to make sure that 75% of the onion stored at the start of rabi onion harvesting period (or period designated by NAFED) will be available for dispatch during the period of approximately 6 months (with intervals and quantum of each dispatch being decided by NAFED). Owner of the storage is paid a rent amount of 1.25 Rs per KG for the entire period of the storage. In case onion quantity goes below 75% (65% good quality onion and 10% average quality onion), the owner is accounted for replenishment of the onion beyond the above limit.

Though this model works well for farmers, the focus is not on reducing losses and thus 25% losses are assumed at the start. In such cases, the owner has more focus on enhancing storage capacities in order to earn more rent (profits) and the novel objective of reducing storage losses is ignored.

Major objective of NAFED behind this initiative is not to reduce losses but to stabilize prices in the market through high stocking of the onion.

3.4 Concluding remarks from the feasibility study (from phase II)

As a part of collaborative work with PoCRA, comparative feasibility study was carried out to see the efficacy of different storage solutions available in the market. Techno-economic feasibility analysis (Separately attached with the DPR) evidently speaks about the efficacy of going for controlled environment storages. Three potential storage options available in the market were compared on every technical and financial front to arrive at conclusion that choosing the CA storage structure for onions with specified capacities would help in reduction of losses during storage as well as improve the profitability of the business for FPOs working with smallholder onion grower farmers.

Considering the minimum capacities of storage structures from the profitability indicators and budgetary constraints of the project, onion storage structure of 300 MT capacity and beyond is advisable to be constructed. For detailed Techno-economic feasibility analysis, please refer to chapter *‘Comparative Techno-economic feasibility analysis’*.

3.5 Scope of the project

Project is part of the MoU between IIT Bombay and PoCRA (Govt. of Maharashtra). It is limited for the FPCs operating in the PoCRA districts. There are guidelines for selection of the eligible FPCs for the project intervention. FPCs fulfilling these criteria will be chosen for the storage structure establishment.

Also, the total cost of the project is advised to limit within INR 1 Crore as subsidy of 60% does not apply for an extra cost beyond INR 1 Crore.

Project involves establishment of the Climate Agnostic Onion storage structure with the technological support and hand holding from IIT Bombay Post Harvest team and administrative and financial support from the PoCRA team.

4 Project details

4.1 Project objective

Objective of the project is to install the 300 MT climate agnostic onion storage structure developed by CTARA, IIT Bombay in order to enhance shelf life of stored onions and get better market prices during better market conditions.

4.2 Project description

Project proposes to establish an innovative climate agnostic onion storage structure in order to facilitate farmers to store their onion for extended duration (over 6 months) without undergoing significant losses. Project activities involve planning, designing and construction of the 300 MT climate agnostic storage structure and handling it over to the selected eligible farmer producer company in the PoCRA region.

There are three major strategic partners in implementation of the project. IIT Bombay team has developed the technology for climate agnostic storage structure. IIT Bombay team through MoU with PoCRA Project Management Unit has collaborated for dissemination of the technology to the farmers. PoCRA Project Management Unit extend all the financial and ground support for the implementation of the project. Farmer Producer Company is the formal legal entity which will take up this project for the execution.

4.3 Business plan

Following Business Model Canvas shows different activities associated with the proposed business and is helpful tool visualise the overall structure of the proposed business activities.

<table>
<tr>
<td rowspan="2">Problem
• Huge losses in Onion Storage
• Less prices to farmers in peak harvesting time
• High onion prices to customers in high demand season</td>
<td>Solution
• Controlled conditioned Storage to reduce Losses
• Advanced Technologies to track and reduce losses in value chain</td>
<td rowspan="2">Unique Value Proposition
• Climate Agnostic Storage system
• Integrated Curing facility along with storage
• Well Ventilated stacking system</td>
<td>Unfair Advantage
• Medium scale and Indirect Network effect</td>
<td rowspan="2">Customer Segments
Producer's end:
Small and medium landholder farmers (Individual)
Onion processing FPCs
Government Departments (NABARD, PoCRA etc.)

Consumer's end :
Institutional Buyers
Retailers (Vegetable shops)</td>
</tr>
<tr>
<td>Key Metrics
• No. of buyers connected
• No of member farmers Connected
• Losses prevented during storage</td>
<td>Channels
• APMC direct selling
• Year round contracts with Institutional buyers</td>
</tr>
<tr>
<td colspan="2">Cost Structure
Major Costs: Product Manufacturing and Developing, Setting up distribution Channels</td>
<td colspan="3">Revenue Streams
• Direct Selling
• Ownership
• Partnership (Year round Contracts)</td>
</tr>
</table>

Figure 4.1 Business model canvas for Climate mate agnostic Onion storage structure

5 300 MT Climate Agnostic Onion Storage Structure

300 MT capacity onion storage structure is the storage facility developed by CTARA, IIT Bombay. This storage structure involves air tight enclosure, internal stacking system for onion and air handling system for precise control of the internal atmosphere.

5.1 Features

Following are the salient features of the climate agnostic onion storage structure developed by CTARA, IIT Bombay

5.1.1 Curing and storage at specified atmospheric conditions

CA storage structure integrates curing as well as storage of onions. Curing is performed on freshly harvested onion to make them ready for storage. Curing process involves uniform and steady heating of onion to maintain the curing temperatures. Here, air with uniform temperature, relative humidity and air flow rate is allowed to interact with onion bulbs in a controlled fashion. Artificial curing duration differs from 48 hours to 96 hours depending on the variety of onion and their initial conditions.

Figure 5.1 Photograph depicting the 3D visualization of the 300 MT CA storage structure

5.1.2 Scientific design of stacking system

Stacking system is backbone of the storage ecosystem as it defines the flow of material and associated costs and manpower. CA storage consist of stacking system with optimum strength and also worker friendly. The cost-effective design facilitates air to flow in streamlined manner throughout the storage structure and allow workers to interact with the system in safe and secure manner.

5.1.3 Semi-Automated loading and unloading operation

Storage structure has internal stacking system which has specially designed bin arrangement with the consideration of ventilation needs and integration of stacking system with conveying system. Motorised conveyor system allows fast and precise loading of onion into the bins and unloading of onion out of bins. Complementary equipment like sorting and grading machine can be attached to this conveyor system for further efficient sorting and grading of the onion.

5.2 Plant Layout

Following given plant layout depicts the land area needed to construct and run the storage facility smoothly. Main storage facility requires 342 Sqm floor area where overall land area required is 1082 sqm. All the necessary considerations and assumptions are already explained in the assumption section. The storage facility includes main storage area, staging area, store room, office and control room, space for weighing bridge (load cells), loading/unloading vehicles and buffer area for safety and security reasons.

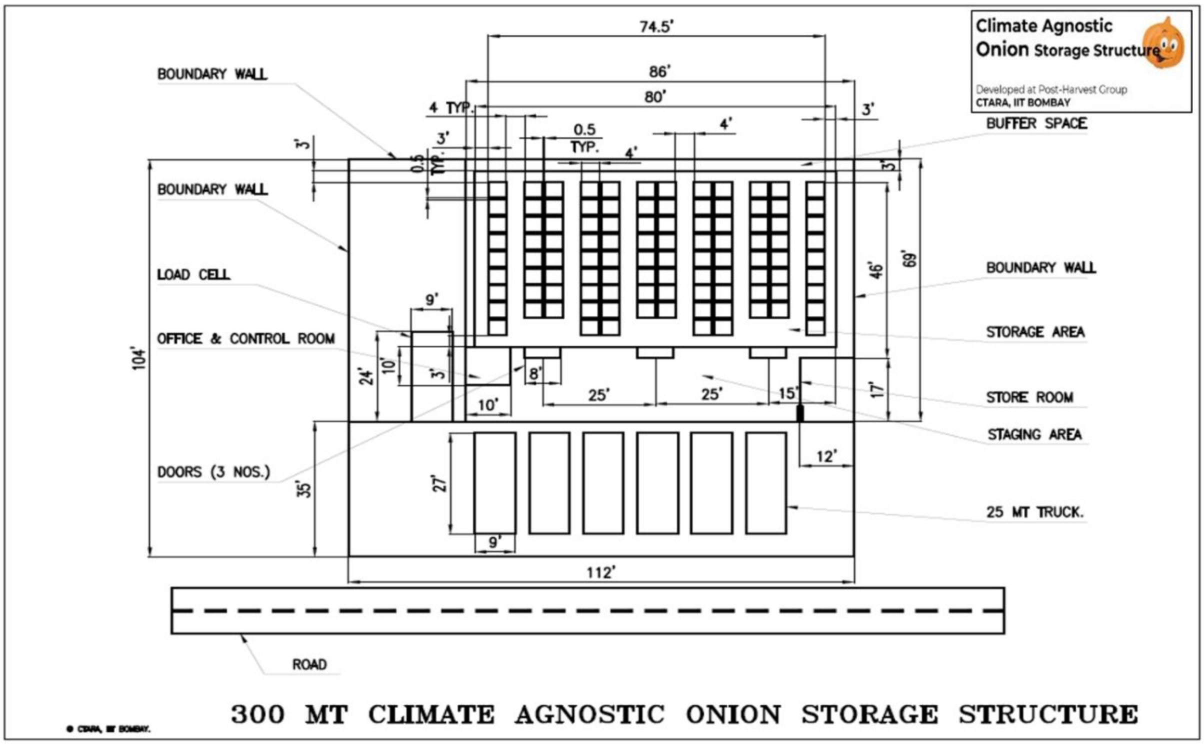


Figure 5.2 3D visualization of 300 MT Climate Agnostic onion Storage structure

5.2.1 Specifications and other details of the project

Following are given the space requirement for the project. It consists of three main areas, Main storage space, foundation flooring space which includes staging area and buffer space and finally the overall are involving loading spaces, weigh bridge, office space etc.

Particulars	Specifications (ft)	Area (Sq ft)	Area (Sqm)
Main Storage	80' X 46' X 17'	3,680	342
Foundation flooring	86' X 69' X 2'	5,934	551
Surrounding Area (Overall)	**112' X 104'**	**11,648**	**1,082**

Following general assumptions are considered while developing the project,

1. Land ownership- FPC owns the land and no separate money needs to be paid for the land acquired for the construction of the climate agnostic storage structure.
2. Connectivity to the main road- lands is not too far from the main road or no separate costs incurred for developing the basic infrastructure (road and electricity supply)
3. There is continuous supply of 3 phase electricity to operate the storage structure equipment and necessary documentation and permissions (formal commercial/industrial electricity connection to the storage site) will be completed by the FPC.
4. At least 80% of the members of the FPC are involved in the cultivation of onion and procurement of onion is done from these members.

5.3 Capital Investments

Following are the details of costs incurred as a capital investment. It includes taxes and contingencies involved in the setting up of CA onion storage though it does not consider supervision costs.

Table 5-1 Capital costs (INR) associated with construction of CA storage structure*

Capacity (MT)	**300**
Specifications	**80'*46'*17'**
Enclosure (A)	**22,46,480**
Panel	10,74,091
Ceiling	9,92,575
Door	1,79,814
Air handling System (B)	**11,75,000**
Evaporator and condenser	7,00,000
Heating	1,00,000
Damper and Exhaust fan	1,75,000
Installation	2,00,000
Civil construction works (C)	**6,50,000**
Stacking fabrication and Installation (D)	**17,01,000**
Conveyer + Weighbridge (E)	**11,50,000**
Total 1 (A+B+C+D+E)	**68,72,480**
Total with 18% GST (F)	81,09,526
Contingency @10% (G)	6,87,248
Total 2 = Total 1 + F + G	**87,96,774**
First season Operational cost (H)#	5,35,000
Total 3 = Total 2 + H	**93,81,774**
Final Total rounds up to	**94,00,000**

*Cost figures subject to change depending upon market fluctuations

Working capital 60% of the working costs of one season

5.3.1 Onion as a raw material

Commodity to store in the storage structure is onion. Though, we have considered rabi onion as the only commodity to be stored in the storage facility for the comparative analysis, kharif onion as well as other perishable agricultural commodities (fulfilling the storage structure's criteria) can be stored to utilize the full potential of the storage facility. Onion varieties that are grown in the PoCRA region and are the focus of the project for rabi season are Bhima shakti, Bhima Kiran and Bhima Super. In most cases, other varieties are also used. It is assumed and advisable to use uniform onion seed by the member farmers which would add to effectiveness of storability of onion. Details of the costs associated with the onion and price fluctuation analysis is discussed in subsequent sections and annexure.

5.4 Operational expenses

Climate agnostic smart onion storage structure focuses on effective utilization of labour to reduce the drudgery involved in the process. Loading, unloading and sorting equipment provided will help reduce the operational costs associated with the manual labour and also reduce the time required for the loading/unloading operation. Following are the details of the operational costs and man power involved in the day to day operations.

5.4.1 Operating costs and respective manpower required

Major role of air handling equipment is to keep the quality of atmosphere inside the storage structure within the acceptable range. Analysis of daily usage of system throughout the duration of storage is given below. For the purpose of simplicity of calculations, numbers are round off to nearest integers.

Table 5-2 : Daily usage of system

Month	**No of hours**
May	6
June	8
July	10
August	10
September	8
October	6
Average	8

Table 5-3 shows the specifications of the conveyor system being used for loading/unloading process. It also denotes the usage and specific costs associated with it.

Table 5-3: Specifications of the conveyor system

Conveyor capacity	**Amount**	**MT/day**
Rating	5	HP
Efficiency	80	%
Power consumed	4.6	Kw
Daily usage	12	Hrs
units utilised	56	Units/day
Electricity charges	10	Rs/unit
Amount	480	Rs/day
Frequency of usage	40	Days/season

Table 5-4 summarises the details of man power required for the smooth operation of the storage facility.

Table 5-4 Details of the operational costs associated with CA storage structure

	Particulars	**Amount**	**Unit**
1	**Electricity**		
	Storage Capacity	Up to 325	MT
1.1	Power rating of the equipment	23	KW
1.2	Units consumed per season	35,460	Units/season
	Electricity cost per season	3,54,000	Rs
2	**Human Resource (for 1 season)**		
2.1	Security person	1,00,000	Rs
2.2	Facility operations head	1,72,000	Rs
2.3	Conveyor system expenses	57,000	Rs
2.4	Labours	42,000	Rs
2.5	System maintenance	30,000	Rs
	HR Sub Total	4,21,000	Rs
3	**Other (Office expenses)**	1,40,000	Rs
	Total	**8,95,000**	Rs

6 Financial analysis of the 300 MT CA Onion storage structure

Considering the scale at which CA storage structure gives considerably good returns and budgetary constraints of FPCs and subsidy available, 300 MT storage structure will be a suitable capacity for the project.

6.1 Assumptions

Following assumptions are made based on the data from the field and the literature available.

a. *Worst case scenario:* Losses in the IITB storage structure have been observed to be in the range of 10-12% during field experiments. For the purpose of analysis, the losses are considered to be 20% which then accounts the ground level uncertainties (various causes of poor storability those we discussed in the first chapter). On the other hand, losses for other traditional storage facilities have been reported to be in the range of 35% to over 60%. These values have come out from the field surveys, interviews and literature. Minimum losses at 35% happen only when all the critical factors (Appropriate and timely rain, supporting weather conditions, resilient seed variety and appropriate harvesting practices) are under acceptable limit. So, the losses value of 35% and 30% has been considered for the 'MahaOnion' and 'TaTa Steel storage structure.'
b. *Procurement and Selling prices:* Though, rigorous analysis of APMC data has been carried out to find the modal prices and its variance, there is significant gap in the data on available from the web portal (agmarket.gov.in) and the data collected directly from the field. Using the understanding of the both sources, values of selling price and procurement price is set to be 20Rs/Kg and 8 Rs/Kg.
c. *Capital and operational costs for different capacities of storages*

   Three potential storage structures have been shortlisted for the analysis. Specific capacities (100MT, 300MT, 500MT and 1000MT) have been considered for the analysis. In reality, all the three storage structures are not available in all the capacities. To calculate their respective capital costs and operational costs, base of 1000MT storage structure is used and other values are calculated via extrapolation. Care has been taken to consider the costs associated with the standard parts as well as shared costs (economy of scale).

6.2 Scenario A: Without Subsidy

Two cases are presented, one without any government subsidy and other with the subsidy. This is purposely done to see the dynamics of the business associated with the CA storage structure facility. Sensitivity analysis and scenario analysis is also carried out to see the important factors affecting the profitability of the CA storage structure.

6.2.1 Parameters for the financial analysis

Table 6-1 Assumption for financial analysis of 300 MT CA Storage structure

Particulars	**Amount**	**Unit**
Procurement Cost	8	Rs/Kg
Selling price	20	Rs/Kg
Discount Rate	10	%
Inflation rate	4	%
%Loan	75	%
Loan interest rate	10	%
Subsidy	0	Rs

6.2.2 Bifurcation of Costs

Table 6-2 Bifurcation of costs for 300 MT CA storage structure without subsidy scenario

Particulars	**Amount (in Rs)**	**%**
Capital Investment	94,00,000	100
Subsidy	0	0
Loan	70,50,000	75
Self-investment	23,50,000	25

6.2.3 Outcomes of case without Subsidy

Table 6-3 Outcomes of financial analysis for 300 MT CA storage without subsidy scenario

Net Present Value (INR)	55,02,160
Internal Rate of Return	18%
Discounted Pay Back Period	11
Benefit Cost Factor	0.59

From the results of the analysis, it can be observed that project intervention is profitable at the scale of 300 MT. But, payback period (discounted) is very high for the intervention. From the sensitivity analysis shown in graph given below given, it is clear that BCR and hence profitability is highly dependent upon the selling price, capital investment and storage losses. Though selling price is the external factor and depends on the market situation, capital investment is the area where support can be provided to improve the profitability of intervention and to make it sustainable.

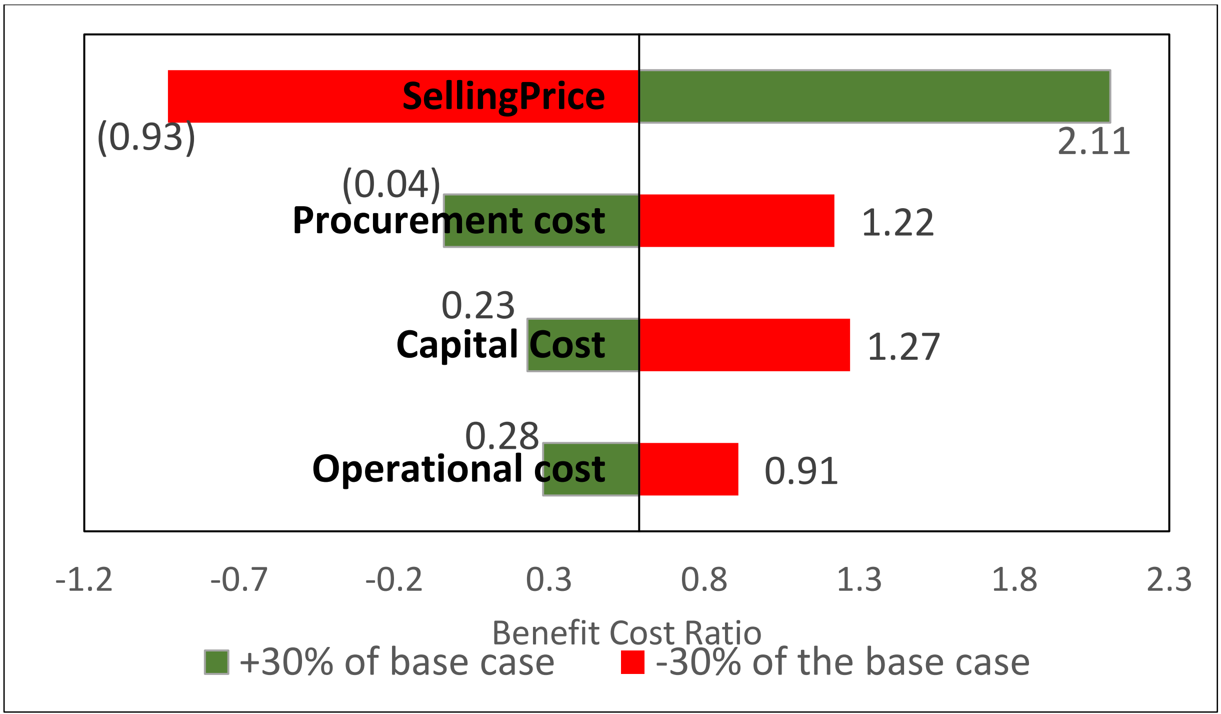


Figure 6.1Sensitivity analysis for 300 MT CA storage structure for BCR

Sensitivity analysis of the 300 MT storage structure (without subsidy) is carried out in order to study the effect and its weightage of each parameter in the benefit Cost Ratio. These four parameters are selling price, Procurement cost, Capital cost and the operational cost.

Most sensitive parameter comes out to be the selling price which is also the most vulnerable one as per the previously done price analysis. Selling price depends primarily on the keeping quality of onion. Precise control of storage conditions would result in better quality of the onion and will help achieve the highest range of selling prices.

6.3 Scenario B: With Subsidy

6.3.1 Parameters for the financial analysis

Table 6-4 Assumptions for 300 MT CA storage structure for with subsidy scenario

Particulars	Amount	Unit
Procurement Cost	8	Rs/Kg
Selling price	20	Rs/Kg
Discount Rate	10	%
Inflation rate	4	%
%Loan	75	%
Loan interest rate	10	%
Subsidy	60	%

6.3.2 Bifurcation of Costs

Table 6-5Bifurcation of costs for 300 MT CA storage structure for with subsidy scenario

Particulars	Amount (in Rs)	%
Capital Investment	94,00,000	100
Subsidy	56,02,225	60
Loan	28,51,112	30
Self-investment	9,33,704	10

6.3.3 Outcomes of case without Subsidy

Table 6-6 Outcomes of financial analysis for 300 MT CA storage for with subsidy scenario

Net Present Value (INR)	1,11,04,385
Internal Rate of Return	46%
Discounted Pay Back Period (years)	4.7
Benefit Cost Factor	2.97

Here, it is now clearly evident that CA storage structure is profitable even at very conservative parameters, so it will definitely be going to give better results in the real-life scenario. Further, providing subsidy support will further enhance the financial gains to the FPC.

6.4 Summary of Scenario analysis

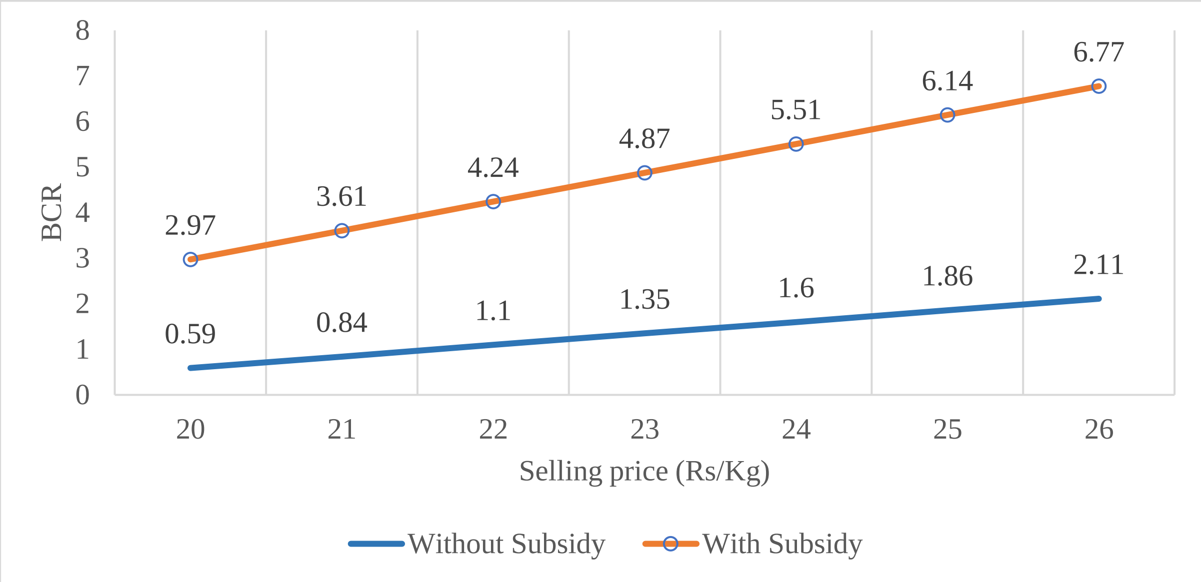


Figure 6.2Comparison of BCR for 'with' and 'without' subsidy scenario at various selling prices

Above shown graph shows the comparison of Benefit Cost Ratio for both the cases. As selling price of onion increases, BCR for storage structure begins to improve. Minimum BCR of 1 is always advisable for business to be viable. Subsidy plays an important role to achieve BCR more than 1 even in most conservative cases.

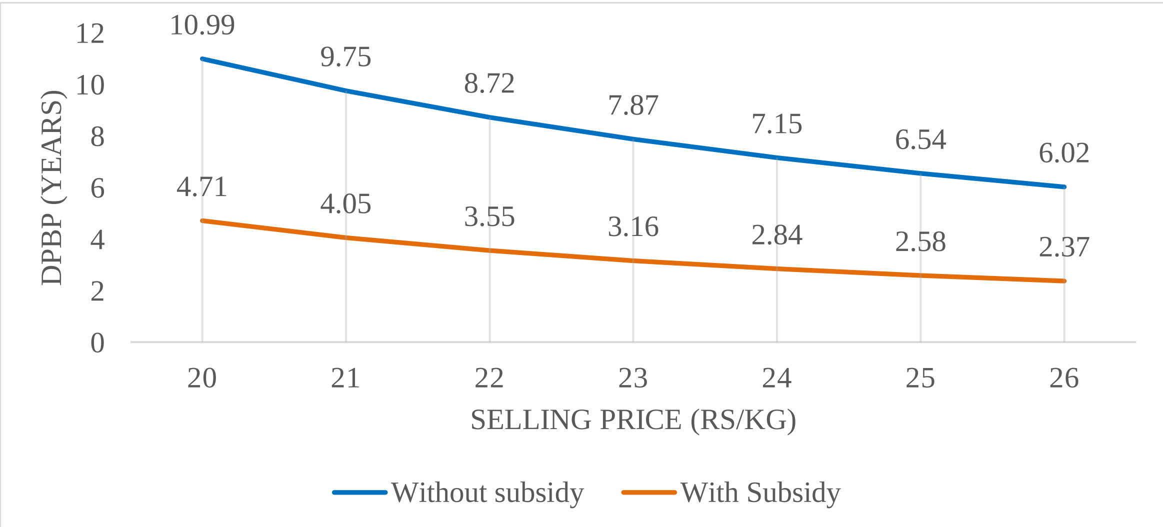


Figure 6.3Comparison of DPBP for 'with' and 'without' subsidy scenario at various selling prices

One of the major parameters to be taken into consideration is payback period. Above graph compares both the cases for discounted payback period. Subsidy helps to bring down the payback period and even at the most conservative selling price ranges.

6.5 Project viability

The first thing to keep in mind while understanding the results of the financial analysis is that the values of selling prices used while doing it are very conservative and hence it depicts the *worst-case scenario* implications in the result. As we have seen in the price analysis, selling prices of onion goes up to Rs.35/Kg (where we have considered it to be Rs. 20/kg). Also, Procurement cost goes down to Rs. 6/Kg (where we have considered it to be Rs 8/Kg). The Internal Rate of Return (IRR) of the project is 48.6% which are significantly higher than the average rate of returns by bank which is about 10%. Analysis of BCR ratio under various conditions revealed that project is viable even for the 180 days of operation. Storage structure can be used for storage of kharif onion as well as other suitable agricultural commodities which would give bonus returns to the farmers.

Hence, the project is financially viable. The NPV of the project is positive at a discount factor of 10% during the period of operation considered. This implies that the project generates sufficient funds to cover all its cost, including loan repayments and self-investments and interest payments during the period.

Subsidy entitlement

Since total capital investment requirement is about 94 lakh rupees, eligible FPCs can apply under PoCRA program for maximum a subsidy of 60 lakhs or 60% (depending on the proposal) for the project.

6.6 Project implementation

The key factors that would facilitate successful and timely project implementation are:

- Selection of capable and eligible Farmer Producing Company
- Selection of contractors for civil construction and erection of CA storage structure.
- Training and skill building of FPCs and employees to operate the storage system.
- Establishment of an efficient system for project planning & monitoring including reporting procedures for progress review & co-ordination.

6.7 Implementation Schedule

After acceptance of DPR (principally), procedure for selection of FPC and location can be done. After initial approval for starting, the construction of the Storage structure, actual work will start within two months (based on payment procedures and documentation involved). Final quality check and handing over the storage structure to FPC will take another one month.

6.8 Forward & Backward linkage

6.8.1 Backward linkages

Farmer Producer Company with majority of onion growing farmers as its members will be given a priority. Here, owner of the storage structure will themselves be the major suppliers of the onion.

Onion farmers will be acting as a client of the FPC as well as its shareholders. So, FPC can procure onion from member farmer via three major modes

a. Direct purchase of onion through prior contracts (Least risk to farmer members)
   Through this model, onion will be procured right from farm gate of the farmer and farmer will be paid fixed pre decided price. Freshly harvested onion will then be a responsibility of the FPC. Price slabs for the procurement and guidelines to be followed can be made in consultation with the board of directors and facilitating agency.

b. Rental scheme for onion growers (Least risk to FPC)
   In rental scheme, farmers will keep their freshly harvested onion for curing and storage and then will pay weekly or monthly rent for the duration of the storage. Final selling decision will then be taken by farmer members (owner of produce) in consultation with the CEO and BODs. All the guidelines for rental model will be finalised after consultation with facilitating agency, FPO and funding agency.

6.8.2 Forward linkagesMajor objective of the project is to enhance the shelf life of onion and to provide benefit to member farmers and to help stabilise the market fluctuation of onion in the retail market. Having said this, forward linkages and respective marketing channels can be designed in several ways.

Few of the potential options for the forward linkages are

a. Direct selling in the APMC

   This is traditional way of doing business. After storage duration gets complete and market rates starts reaching peak rates in the season, FPC can directly sell the onion to traders through APMC. Also, direct contracts with the traders from the non-onion producing regions can be developed to sell the onion at competitive rates with decent profit margins.

b. Institutional contracts (B2B)

   Though 300 MT seem to be very large quantum, if we check the quantum of daily consumption of onion in any urban institution, it won't be difficult to establish institutional linkages through year-round contracts. These institutions can be the big educational institutions with residential facilities, restaurants, and canteens of the companies.

   These institutions also face the uncertainties of onion prices. Also, they lack the proper storage facility for such big quantum of the onion. Considering this problem as an opportunity to establish contracts with the institutional buyers is a win-win deal. A fixed rate for purchase can be set (with proper profitability analysis with help of facilitating agency). Such contracts will help FPC to reduce uncertainties involved in the businesses and help develop good networks.

6.9 Government Policy related to onion storage structures

There are various state and central government schemes for setting up the traditional onion storage structures. Nanda Kasabe of Financial Express has put a light in some of the major schemes of government in regard to onion storages. Following are given few excerpts from her analysis.

The government has allocated a grant of 60 crore to farmers for developing onion chawls (warehouses) for storage of the commodity under the Rashtriya Krishi Vikas Yojana (RKVY)

2019-20. The central government's scheme is aimed at enhancing the storage facilities in the state so that farmers are not forced to sell their produce in distress and retain the commodity until the market conditions improve. Around 6,500 farmers from 28 districts in Maharashtra, who have developed onion chawls or open onion storage structures will be eligible for the grant given by the government.

According to the experts in the industry, the scheme which falls under the National Horticulture Mission (NHM) gives a grant of 50% on the construction of a 25 MT chawl, which have to be properly ventilated structures with proper storage. Normally, a 25 MT storage capacity chawl requires an investment of 1.75 lakh, of which a 50% subsidy is offered to onion farmers for setting up such structures.

The 27th State Level Project Approval Committee had given the green signal for setting up onion storage structures across Maharashtra in the wake of the price volatility and to prevent farmer from distress sale. Around INR 150 crores will be spent on the project and accordingly, the government has approved INR 60 crores within a year. The scheme envisages 50% of the funds to be invested by the farmer and the remaining 50% would come from the government in the form of a grant.

Meanwhile, MahaFPC-the apex body of farmer producer companies in Maharashtra, has signed tripartite agreements with 16 farmer producer companies in the state and NAFED to develop a value chain for onion procurement, storage and disposal**.** This is a joint project proposed by NAFED and MahaFPC with contribution of 25 FPCs in the state to execute a Public Private Partnership (PPP) Integrated Agriculture Development (PPP-IAD) project under the Rashtriya Krishi Vikas Yojana (RKVY-RAFTAAR) for building storage capacities for onion and setting up marketing infrastructure. This 25-crore project will see the government investing 50% while the rest will be raised by NAFED and FPCs.

The project will enable FPCs to remove monopoly of traders in onion markets. The project envisages building storage infrastructure for 25,000 MT of onion in the state wherein each FPC will establish a cluster on a 1-1.5-acre land parcel for 1,000 tonne each. Each cluster will be set up for 1 crore where 20% of the investment will come from the FPC (from around 100 farmers in each FPC), 25% from NAFED, 5% from MahaFPC and the remaining funds from the state government under the RKVY scheme.

6.10 Market potential & marketing strategy

Following bar graph shows the production of onions since 2007-08. Being a cash crop, onion has been attracting farmers who invest their money and land in hope of good prices. Production in last few years has tremendously increased and now has passed the domestic requirement which has worsened the condition.

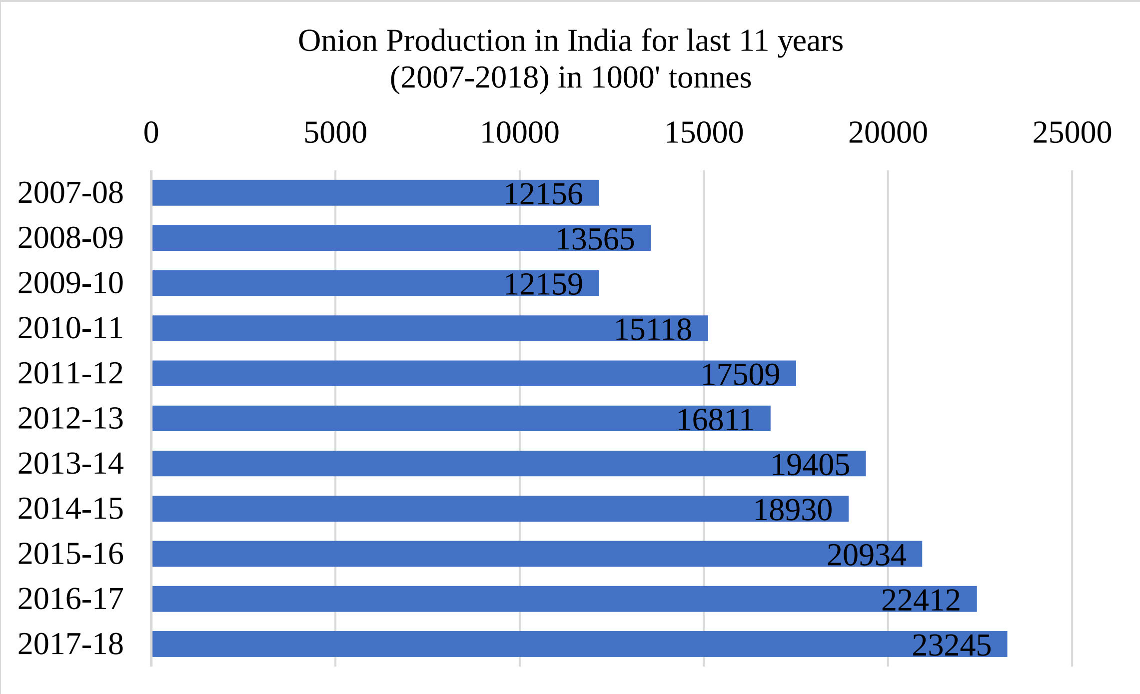


Figure 6.4Onion production for last 11 years

Year 2019 witnessed huge fluctuation in prices of onion all over the country. Heavy and uncertain rain causes arrivals of onion in market to decline and then prices of onion shoot up dramatically. Researchers and scientists have written much on this issue but due to the complexity of the problem, the issue has remained unsolved. According to FAO, India produces 230 lakh MT of onion, out of that 200 lakh MT gets consumed domestically (and some part goes into export). Government subsidised storage system only provides 4.3 lakh MT capacity (NABARD, 2017). Due to lack of infrastructure, this additional onion cannot be stored and comes into market which bring down prices in wholesale and retail markets.

Agricultural Development and Rural Transformation Centre- Institute for Social and Economic Change published a report on onion and its price variations. Analysis in the report showed that poor and marginal farmers are bearing loss in cultivation of onion every year due to increase in per hectare cultivation prices and uncertain fall in market prices. In the survey of farmers, along with the issue of good quality of seeds, farmers chose poor refrigeration facility and infrastructure for onion which is also the major concern.

6.11 Costs associated with the onion (Analysis of literature and field data)

Several studies have been done which proposes different cultivation or production costs for the onion. (BARAKADE A.J.1, 2011) in his paper says that cultivation prices for onion are more in rabi than in kharif season. Onion production cost contains land preparation cost, nursery cost, manure cost, pesticide, irrigation, harvesting, curing, and loading and transportation costs. In the study, it was found that onion production costs for onion growing farmers in Maharashtra is Rs. 3.97 per Kg. Though this study was conducted and published in 2011 and production has increased tremendously in last 10 years. Study conducted by ADRTC-ISEC came out with the onion production prices ranging between Rs. 6.5 per kg to Rs.15.5 per Kg for farmers having different land holdings. It is evident from the above two studies that onion production prices vary according to region, variety and type of onion grower and their economic conditions.

6.12 Trends in onion wholesale prices

Following table summarises the wholesale prices of onion at Pune APMC for the last 10 years. For our analysis of financial viability, we have considered procurement cost at Rs 8/kg and Selling price at Rs 20/kg. This is the real situation if see at procurement cost of Rs 8.3/Kg in April 2021 and selling price of Rs 20.1/Kg in October 2021 (highlighted cells with yellow colour)

Table 6-1 Average modal prices for onion at Pune APMC

	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Mar	4.9	3.7	7.9	6.7	9.9	7.0	5.5	6.4	4.3	13.9	12.7
Apr	4.8	4.1	7.2	7.7	9.2	7.3	5.4	5.5	5.9	14.1	8.3
May	5.0	4.3	8.2	8.8	12.0	7.7	4.5	5.3	7.7	9.5	10.1
Jun	7.0	5.4	12.4	15.1	16.4	9.5	6.3	8.6	11.7	6.8	13.7
Jul	8.3	6.1	17.4	17.3	24.0	9.5	7.3	10.1	12.5	6.7	13.3
Aug	9.7	6.6	35.4	15.3	44.5	7.9	19.0	9.7	17.8	9.1	12.5
Sep	9.9	6.3	37.8	14.5	47.0	6.7	14.2	7.5	25.6	19.4	12.5
Oct	8.6	7.8	34.5	13.7	38.1	6.5	22.0	10.7	18.4	26.8	20.1
Nov	8.5	10.6	30.5	14.0	33.9	9.7	29.8	10.4	28.6	29.8	17.5
Dec	6.6	12.5	12.9	14.2	16.5	9.1	20.9	7.5	50.2	20.1	18.7
Jan	4.2	11.4	8.1	11.8	15.0	6.5	17.7	5.7	27.8	21.1	17.9
Feb	3.5	11.0	5.2	11.8	9.0	6.0	12.0	3.7	17.3	26.8	16.9

Table 6-2Average maximum prices for onion at Pune APMC

	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Mar	6	5	11	9	14	9	6	13	6	19	18
Apr	6	5	10	10	13	9	6	8	9	17	12
May	6	6	11	12	17	13	6	8	11	12	15
Jun	9	7	18	21	22	11	9	11	14	9	20
Jul	10	8	23	25	25	11	9	14	14	9	20
Aug	12	8	41	22	48	9	23	12	20	13	18
Sep	13	8	43	21	50	8	18	11	32	29	18
Oct	11	10	40	20	40	8	27	15	34	44	32
Nov	12	15	34	20	38	12	38	14	64	49	28
Dec	9	18	16	21	20	11	37	10	95	29	32
Jan	6	17	11	17	17	8	29	8	40	30	30
Feb	5	15	7	17	11	7	17	6	21	38	28

Source: Agmarket.gov.in

Now to get idea of how conservative and realistic our analysis is, let have look at market data shown in the table. If we see at the modal prices of onion for months April and May, we can see that for almost all years (except 2015 and 2020), prices were below Rs 8/Kg. On the other hand, if we see the modal prices in the month of September and October, we could see that these values (with some years as exception due to market dynamics) are well above Rs20/Kg and reach up to Rs 34/kg in some cases.

Similarly, if we see average of maximum prices, we get better understanding. Of course, after precise storage of onion for 4 to 6 months, FPC get better chances to tap the top 10% price slab for selling their stored produce and can easily do business in safe zone.

6.13 Social and environmental risks and impacts

As the storage structure does not consist of any synthetic chemicals in its operational, it does not cause any health hazards. Also, it only stores onion and does not do any primary or secondary processing, it does not involve any alteration to its composition.

6.14 Contribution to the Sustainable Development Goals

The project is intended to reduce huge losses that occur during the storage of onion through an appropriate technological intervention. It helps to reduce food wastage at the pain points in the value chain. Also, through participatory approach, it ensures the profitability as well as sustainability of the onion cultivation practice.

SDG 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture

SDG 12 talked about reducing food wastage and make it accessible to masses at affordable prices. Project intervention aligns itself with the SDG2 to make Onion value chain resilient.

SDG 13: Take urgent action to combat climate change and its impacts

Target 13.1 exclusively states to “Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries”.

Onion has been vulnerable to climate change and its ill effect on the environment. Making Storages agnostic to such hazards will save farmers from the financial blows and subsequent effects on their overall development.

6.15 Expected results and impact

After completion of the project, major expected outcomes of the project are,

a. Reduction in the wastage of onion by a significant amount compared to the solutions available in the market and enhance the quality and shelf life of onion.
b. Contribution towards ‘Doubling farmers’ income’ initiative by the government
c. Resilient supply chain through the strong backward and forward market linkages
d. Contribution to national targets of Sustainable Development goals related to climate, food and Technology nexus
e. Empowered co-operative institutions and boosting rural entrepreneurship with appropriate technology dissemination

6.16 Conclusion

The Detailed Project Report (DPR) document covers all the necessary details pertaining to the project including background of the problem, insights from baseline survey, comparative feasibility analysis of the solutions available in the market and finally the financial and viability analysis of the project.

Setting up the 300 MT capacity climate agnostic onion storage structure would be the appropriate intervention considering the financial and operating capabilities of FPCs and subsidies available for such interventions.

Climate agnostic storage structure has capacity to provide assurance of justifiable return to the small holder onion grower farmers and also contribute to government’s policies to reduce losses in the value chain.

SECTION-1 B:

Comparative Techno-economic feasibility analysis of Onion storage structures

in PoCRA region

7 Comparative Techno-economic feasibility analysis

Feasibility study has been done by the IIT Bombay post-harvest team to check the competitiveness of the climate agnostic onion storage structure developed by the team with other similar solutions available in the market. Detailed feasibility report is submitted to PoCRA PMU and can be accessed by FPCs interested.

7.1 Technologies employed in three potential storage structures

Following is given the working principles of the potential storage structures available in the Maharashtra state. As some of the interventions are part of ongoing research, details related to exact specification are restricted from being published.

7.1.1 MahaOnion Storage structure

MahaOnion storage structure uses semi enclosure to prevent the stored onions from getting exposed to the direct sunlight as well as rain and wind. Bins made out of metal beams and wire mesh are used to store the onion in bulk. Heavy stacking (Each storage bin containing more than 10 MT onion) is used with the manual material handling (loading/sorting/grading etc). It results in the drudgery of labours, mechanical injury to the onion due to high compression. It also slows down the loading & sorting time. There are no special arrangements available for the forced ventilation, temperature, RH and CO_2 monitoring. As it is semi-enclosed system, it is impossible to prevent the onion from high humid and high temperature conditions. Though the stacking system can be dissembled after the storage period, due to frequent usage and resulting wear and tear, it results in lower service life.

7.1.2 Tata Steel Onion storage structure

Apart from having similar internal stacking system, Tata Steel storage structure operates on the evaporative cooling principle and therefore, it is a closed system. Temperature and RH sensors are deployed inside the storage structure. Control system with feedback loop tries to maintain the temperature within limit by operating blower fans, but it is near to impossible to operate it in the rainy season when the Relative humidity is very high (>90% RH). Manual material handling (like in MahaOnion) system increases the labour related costs. Due to heavy stacking resulting in tightly packed onions in it (Where each bin carries more than 10 MT of onion), onion bins get lesser ventilation, mechanical injuries and higher chances of spoilage propagation within the system.

7.1.3 IITB storage system

It has custom designed internal stacking system that ensures enough ventilation to avoid easy spread of spoilage and provides lighter staking system that carries onions in smaller bins (bins with ~1MT onion), stacked over one another in order to avoid mechanical injury to the onion. Both curing (preheating at specified uniform temperature, RH and air flow rate conditions) and storage operations are carried out to improve the storability. Enclosed storage prevents the unwanted loss or gain of heat and moisture from the storage. Controlled air flow rates are incorporated to avoid the unnecessary physiological weight loss (PWL) and enables precise recirculation of the fresh and conditioned air. Control system uses enough energy (electricity) to maintain the favourable conditions and optimises the performance by circulating maximum possible fresh air at the suitable outside conditions. It complements the manual sorting, grading, loading and unloading operations by semi-automated conveyor-based system to reduced labour drudgery and improve the accuracy and speed of operations.

7.2 Parameters for comparative feasibility analysis

Following parameters are considering for performing Techno economic analysis of the Onion storage structure

Table 7-1Parameters for TEA

Variable	**IITB CA Storage**	**MahaOnion Storage**	**TATA Steel NestIn**	**Unit**
Onion Procurement cost	**8**	**8**	**8**	Rs/kg
Onion Selling price	**20**	**20**	**20**	Rs/kg
Storage structure Life	15	15	15	Years
Storage duration	6	6	6	Month
Losses during duration of storage	20	35	30	%
Discount Rate	10	10	10	%
Salvage Value of Storage Structure	15	15	15	% of initial Cost
Difference in Prices	12	12	12	Rs/Kg
Inflation rate	4	4	4	%

Loan Interest rate (Annual)	10	10	10	%
% Loan of capital investment	75	75	75	%

7.2.1 Initial Unit Price

This is wholesale price of onion per Kg at which procurement of onion in bulk is being done. From the analysis of data from APMCs and published researches, these prices are considered. Initial unit price is market gate price which is to be paid to the farmers. This is reoccurring cost and hence associated with the operating costs in the analysis.

7.2.2 Final Unit Price

This is wholesale price of onion per Kg at which selling of onion in bulk is being done. These prices are taken into account from the analysis of data from APMCs and published researches. Final unit price is warehouse/storage gate price which is paid to storage structure owner and goes directly into revenue.

7.2.3 Storage structure life

Storage structure life depends mainly on quality of its material and the atmospheric conditions it is expected to face. Considering standard warehousing & storage norms and data from on field survey, storage life of 15 years is considered for all the three types of storage structures.

7.2.4 Storage duration

It has been calculated from the agronomic data of rabi onion which are primarily being stored in the storage structures. Market price fluctuations are also considered for the right time of the sale of the onion and possibilities of sustained shelf life. Storage of onion starts from the month of May and storage structure gets unloaded by the month of November. So, the period of 6 months is considered for the TEA.

7.2.5 Loss after given storage duration

This is one of the major deciding factors for calculating efficacy of the storage structure. Through experimental results from IITB CA Storage structure, it was seen that losses in the storage can be prevented well below 10% with precise control of inside atmosphere. Considering the scale of the storage and uncertainties involved, safety factor of 2 is considered (with worst case scenario in mind) and hence losses are considered as 20% for the analysis.

Based on field level observation and literature, for MahaOnion storage structure (and similar open ventilated storage structures), losses vary between the range of 30% to 70% (huge uncertainty!). Again, the best-case scenario is considered for open ventilated MahaOnion storage structure and losses are considered to be 35%. This will help us understand the performance of IIT Bombay CA storage structure in worst possible cases.

In similar way, Tata Steel onion storage structure uses evaporative cooling method and blowers to bring down the temperature in summer but used the same internal stacking as that of MahaOnion storage structure. It is on field experience and data that this storage structure doesn't perform under high humidity conditions during rainy season which is major reason for sprouting and rotting. Inappropriate usage of technology does not significantly reduce the losses. Losses up to the degree of 40-45% are observed in the Tata Steel storage structure (field level observations) but loss value of 30% is considered for the analysis.

7.2.6 Discount Rate

It is the opportunity cost rate which can be seen as the gains we would have received of we had invested in any traditionally safe option. Here Discount rate of 10% per annum is considered for the analysis.

7.2.7 Salvage Value of Storage Structure

It is depreciation cost after the standard life of storage structure gets over. 15% salvage value is considered as standard in storage and warehousing industry.

7.2.8 Price inflation rate

All the future Net revenue values are inflated with the inflation rate of 4%.

7.2.9 Loan Interest rate

Loan interest rate of 10% is considered in case, part of capital costs is to be covered with the Loan. As the amounts are huge, FPOs has to opt for loan or subsidies from the governments to set up the storage facilities.

7.2.10 % Subsidy

It is the subsidy given for setting up the storage structure. For the preliminary analysis, no subsidy is considered as it would not have reflected the real business dynamics. Detailed analysis with and without subsidy will be conducted for 300 MT capacity.

7.3 Costs

7.3.1 Capital costs (Capital Investments)

Capital costs for setting up the storage facilities for the different storage structures are listed in the table. These costs are inclusive of installation and taxes. This is the final amount FPCs need to pay to buy (build in case of this project) the storage facilities. MahaOnion builds only 1000 MT of storages (modern ones) and hence values for other capacities are extrapolated. Tata steel Nest has recently produced storage facility for 500 MT and same market price is considered for the analysis.

Three potential storage structures have been shortlisted for the analysis. Specific capacities (100MT, 300MT, 500MT and 1000MT) have been considered for the analysis. In reality, all the three storage structures are not available in all the capacities. To calculate their respective capital costs and operational costs, base of 1000MT storage structure is used and other values are calculated via extrapolation. Care has been taken to consider the costs associated with the standard parts as well as shared costs (economy of scale).

The costs of IIT Bombay CA storage structure are calculated after detailed design and inviting quotations from material providers, equipment providers and fabricators to custom build the storage structure.

Table 7-2Capital costs of Storage structures

Capacity (MT)	IITB Storage	TATA Steel	MahaOnion
100	38	31	24
300	94	78	61
500	126	107	86
1000	225	192	150

*Values are in Lakh Rs

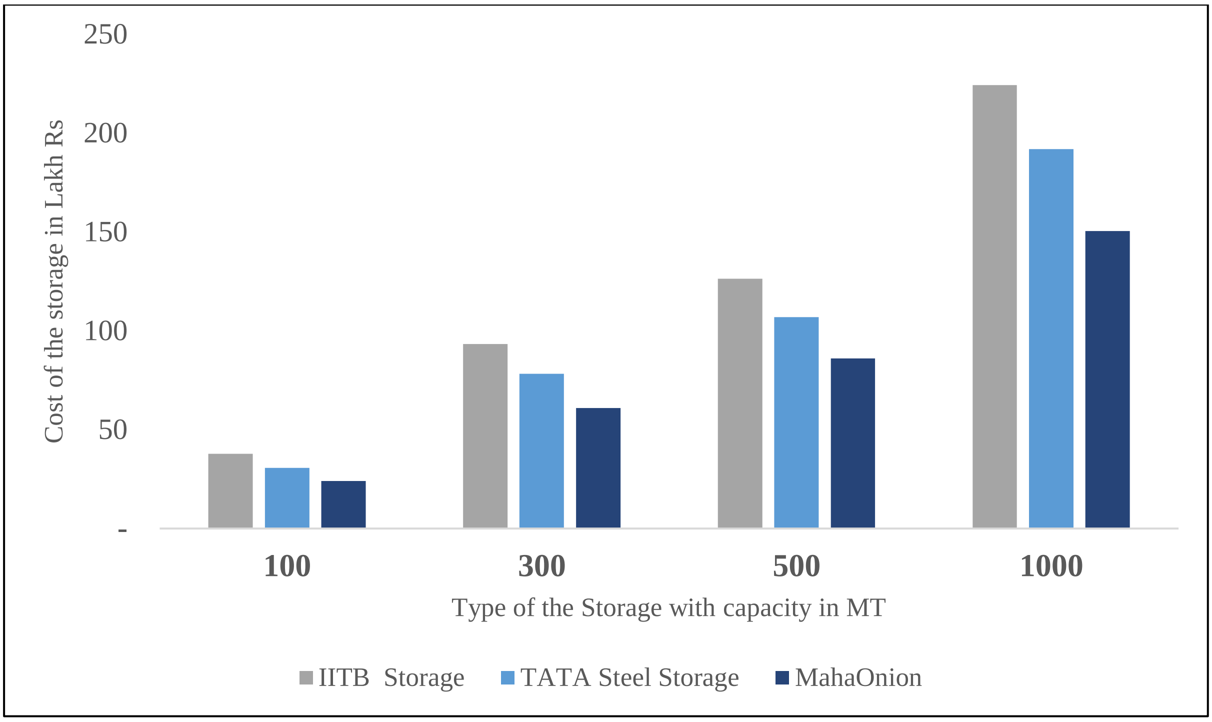


Figure 7.1Graphical representation of capital costs for Storage structure

7.3.2 Operational Costs

Operational costs are deciding factor in the feasibility analysis of the Onion storage structures. Following table depicts the annual operational costs for all three storage structures. Details of the operational costs can be found in Annexure.

Table 7-3Operational costs (in Lakh Rs)

Capacity in MT	IITB Storage	TATA Steel Storage	MahaOnion
100	4.64	3.16	2.69
300	8.95	7.32	5.85
500	10.65	11.56	10.14
1000	15.48	19.73	17.37

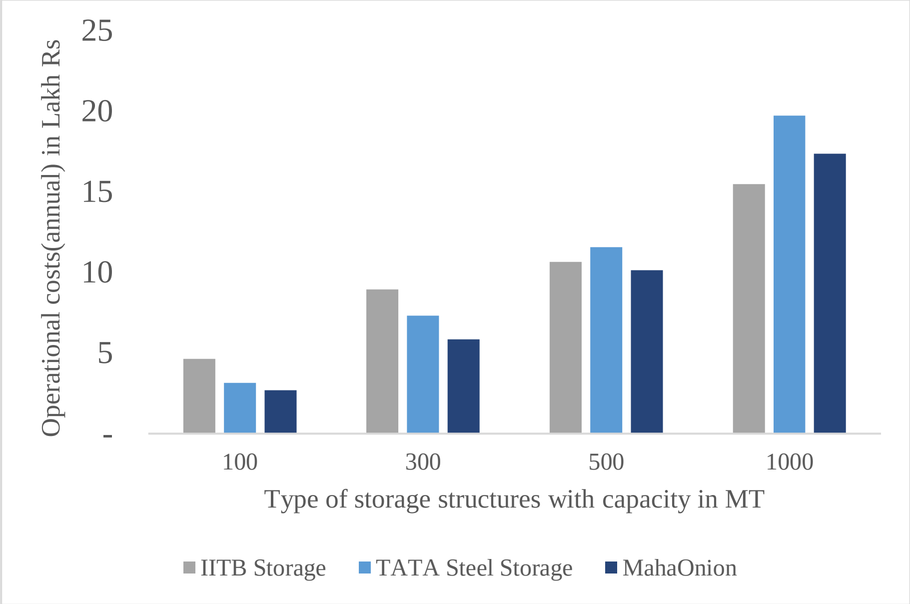


Figure 7.2 Operational costs for various types of storage

7.4 Analysis

7.4.1 Labor costs as a fraction of total operational costs

It is evident from the data presented above that labor and related costs are major concern for the operational costs. Due to use of automatic loading, unloading and sorting operations, time and efforts (and drudgery too) involved in the operations significantly reduces.

Table 7-4Percentage of Operational costs constituting labour costs

Capacity in MT	**IITB CA Storage**	**TATA Steel Storage**	**MahaOnion**
100	3%	38%	45%
300	5%	50%	59%
500	7%	52%	59%
1000	9%	61%	69%

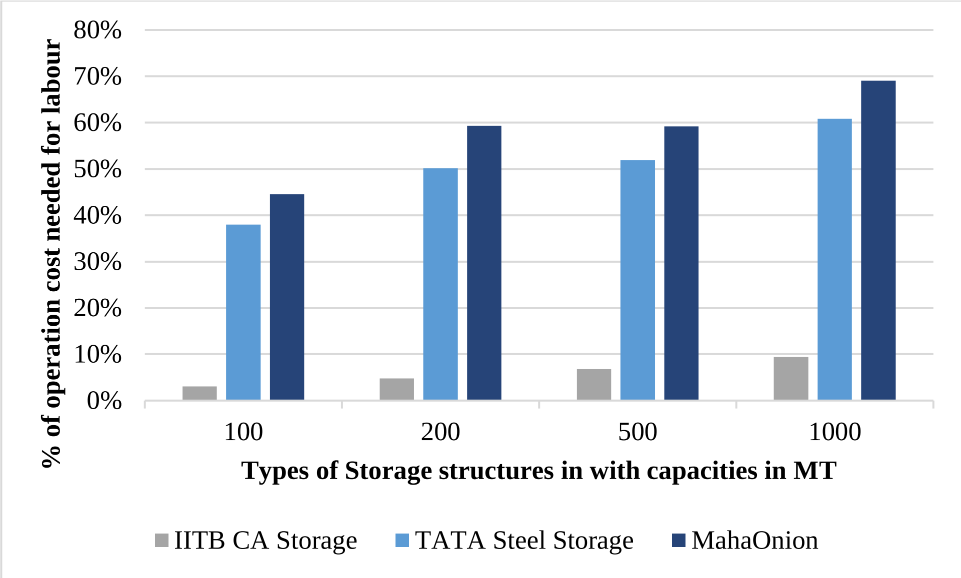


Figure 7.3: Share of labour cost in operational costs

For IITB CA Storage structure, fraction of costs is below 10% for operational costs. As we can see, this fraction goes on increasing for higher capacities due difference in increment of static and dynamic operational costs.

7.4.2 Net Present Value

Net Present Value is valuable indicator to decide the profitability of the intervention or business. It shows the money that can be produced over the period of business activity (in terms of its present value).

Net present value is calculated based on the discount rate, inflated values of net profits for each year and the self-investment of the farmer. Here, we have considered that 75% of the amount will be loan which will be paid in EMIs with annual Interest rate of 10%. Loan period is taken as 15 years. Based on all the above factors.

Structure for calculations of the Economic parameters (In MS Excel 2020) is explained in the appendix.

Table 7-5Net Present Value for three storage structures (in Lakh Rs)

Capacity in MT	IITB CA Storage	TATA Steel Storage	MahaOnion
100	-4.6	-2.7	-1.3

300	55	27.1	29.3
500	163	74.9	60.5
1000	412	205.2	171.3

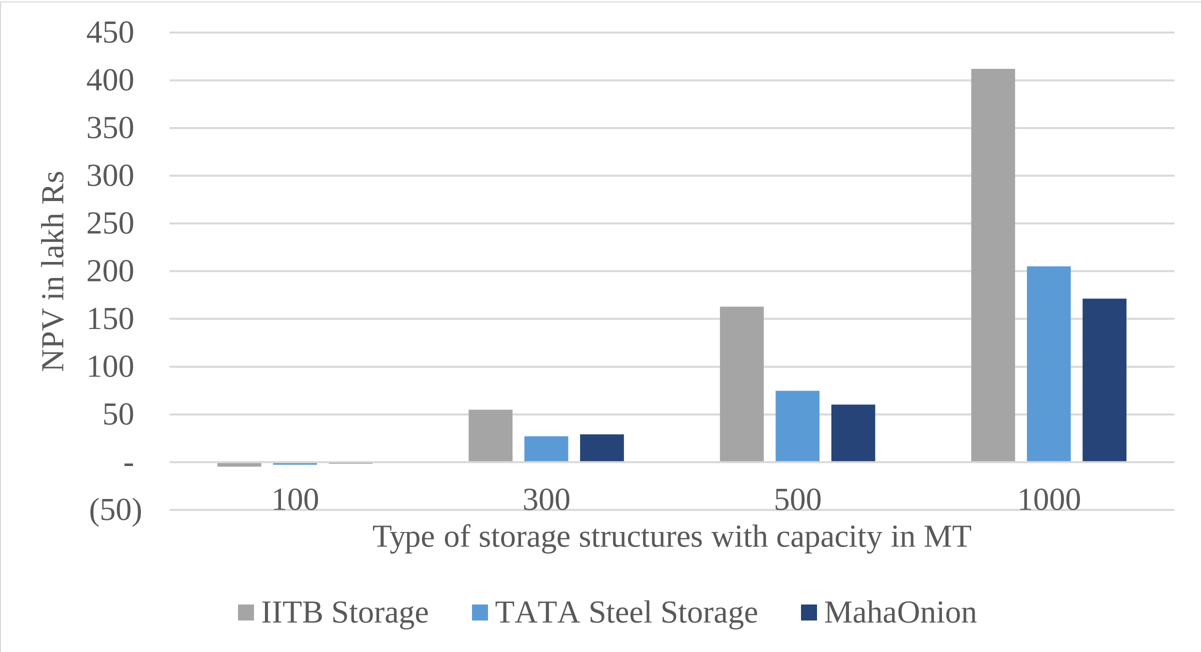


Figure 7.3Comparison of storage structures based on NPV (in Lakh Rs)

If we observe the above shown graph, we could understand that NPV for Tata Steel storage structure is negative and negligible at lower capacities. Though positive and better in comparison to the Tata Steel Nest in Storage structure, MahaOnion storage structure generates lesser NPVs for the given investments. As these are absolute values and doesn't necessarily give comparative picture, other comparative indicator such as Benefit Cost Ratio or Benefit Cost Factor (BCR) is studied.

7.4.3 Benefit Cost Ratio (BCR)

Benefit Cost Ratio below 1 is indicator of loss in the business. It gives us the picture of profit earned in terms of present value (Considering Discount rate as well as inflation rate) against every rupee invested in the business.

Table 7-6 BCR for all three-storage structure

Capacity in MT	IITB CA Storage	TATA Steel Storage	MahaOnion
100	-0.12	-0.09	-0.05
300	0.59	0.35	0.48
500	1.29	0.70	0.70
1000	1.84	1.07	1.14

Values in the above table are visualized through graphical representation in Figure 14.5. It is evident from the analysis that BCRs are comparatively much higher for IITB CA storage structure compared to other two storage structure. But here, we have restrictions over capacities. We have to build storage facility of capacity 500 MT or higher if want to realize higher BCRs.

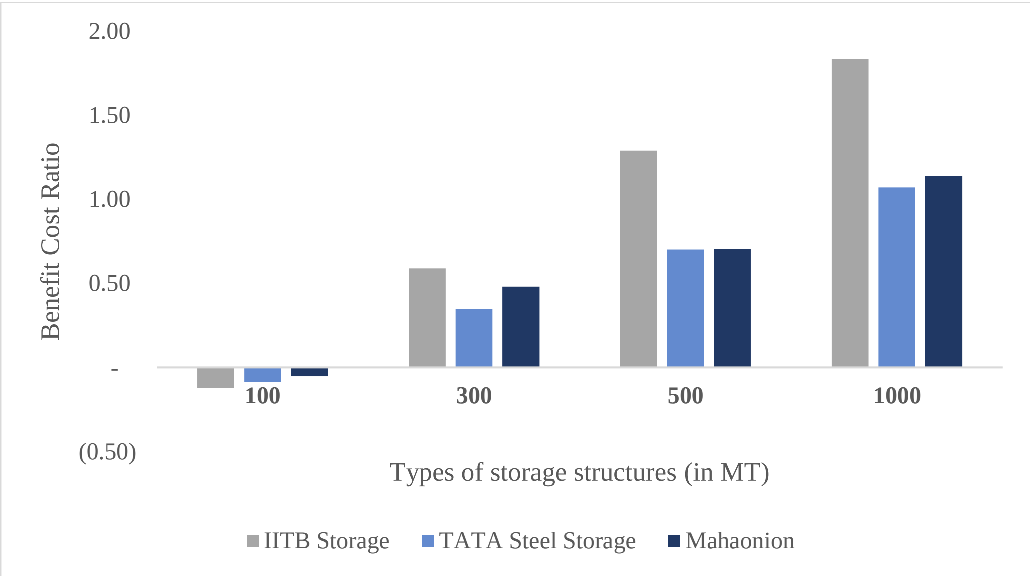


Figure 7.4Comparison of BCR for all three storage structure

7.4.4 Risks associated with price fluctuations

Fluctuation in procurement and selling price significantly affects the profit margins and hence Benefit Cost Ratio. Following scenario analysis gives a glimpse of what happens when prices vary on both sides. Both procurement and selling prices are mentioned in terms of Rs/kg.

a. *Effect of Selling price of onion on BCR of the Storage structure chosen for the intervention*

   When we fix the procurement cost at Rs 8 /Kg and start to increase the selling price from Rs 20 /Kg to Rs 26 /Kg, value of BCR starts to change. Cells marked with green in the following table shows the value of BCR more than 1 (i.e. the value above which business is considered to be profitable). In the case of IITB Storage structure, storages with the capacity 300 MT and more are profitable even for the least values of selling prices. Whereas for other two storage structures of same capacity, we have to get better selling prices to get the same profit. Even within the green cells, values of BCR for IITB onion structures are more than that of other two storage structures.

Table 7:7 Variation of BCR for varying selling prices for a fixed procurement cost

IITB Storage structure

Selling price (Rs/kg) / BCR	100	300	500	1000
20	-0.12	0.59	1.29	1.84
21	0.09	0.84	1.60	2.19
22	0.29	1.10	1.91	2.54
23	0.50	1.35	2.23	2.89
24	0.71	1.60	2.54	3.24
25	0.92	1.86	2.85	3.59
26	1.13	2.11	3.16	3.95

MahaOnion storage structure

Selling price (Rs/kg) / BCR	100	300	500	1000
20	-0.05	0.48	0.70	1.14
21	0.21	0.80	1.07	1.56
22	0.48	1.11	1.45	1.99
23	0.75	1.43	1.82	2.42
24	1.01	1.74	2.19	2.84
25	1.28	2.06	2.56	3.27
26	1.55	2.37	2.94	3.70

TATA Steel storage structure

Selling price (Rs/kg) / BCR	100	300	500	1000
20	-0.09	0.35	0.70	1.07
21	0.14	0.61	1.02	1.43
22	0.36	0.88	1.35	1.79
23	0.59	1.14	1.67	2.15
24	0.81	1.41	1.99	2.51
25	1.04	1.67	2.31	2.87
26	1.26	1.94	2.64	3.23

b. *Effect of Selling price of onion on DPBP (Discounted Payback Period) of the Storage structure chosen for the intervention*

When we fix the procurement cost at Rs 8 /Kg and start to increase the selling price from Rs 20 /Kg to Rs 26 /Kg, value of DPBP starts to change. Cells marked with green in the following table shows the value of DPBP less than 4 years (i.e., the value below which business is considered to be profitable).

Table 7:8 Variation of DPBP for varying selling prices for a fixed procurement cost

IITB Storage structure

Selling price in Rs/k / DPBP	100	300	500	1000
20	>15	10.99	8.06	6.59
21	13.57	9.75	7.15	5.87
22	11.88	8.72	6.42	5.29
23	10.73	7.87	5.81	4.81
24	9.69	7.15	5.30	4.41
25	8.72	6.54	4.86	4.06
26	7.81	6.02	4.50	3.77

MahaOnion storage structure

Selling price in Rs/k / DPBP	100	300	500	1000
20	>15	11.60	10.41	8.57
21	13.34	9.96	8.80	7.25
22	11.60	8.67	7.58	6.26
23	10.19	7.63	6.63	5.49
24	9.03	6.80	5.87	4.87
25	8.08	6.12	5.26	4.38
26	7.30	5.55	4.76	3.97

TATA Steel storage structure

Selling price in Rs/k / DPBP	100	300	500	1000
20	>15	12.43	10.42	8.82
21	13.90	10.87	9.00	7.63
22	12.33	9.60	7.88	6.69
23	11.00	8.56	6.98	5.94
24	9.89	7.70	6.25	5.34
25	8.95	6.98	5.65	4.84
26	8.15	6.37	5.15	4.42

In the case of IITB Storage structure, storages with the capacity 500 MT and more are shows DPBP less than 5 years for wide range of selling prices (more than Rs 25 /Kg). Whereas, for other two storages, even the selling price of Rs 26 /Kg do not provide DPBP below 5 years. Even within the green cells, values of DPBP for IITB storage structures are less than that of other two storage structures.

c. *Effect of varying selling price of onion on IRR of the Storage structure chosen for the intervention*

Table 7:9 Variation of IRR for varying selling prices for a fixed procurement cost

	IRR	100	300	500	1000
Selling price in Rs/kg	20	8%	18%	27%	33%
	21	11%	22%	31%	37%
	22	14%	25%	34%	41%
	23	17%	28%	38%	45%
	24	20%	31%	41%	49%
	25	23%	33%	44%	52%
	26	25%	36%	48%	56%

IITB Storage structure

	IRR	100	300	500	1000
Selling price in Rs/kg	20	9%	17%	20%	25%
	21	13%	21%	24%	30%
	22	17%	25%	29%	35%
	23	20%	29%	33%	40%
	24	24%	32%	37%	44%
	25	27%	36%	41%	49%
	26	30%	39%	45%	53%

MahaOnion storage structure

	IRR	100	300	500	1000
Selling price in Rs/kg	20	9%	15%	20%	24%
	21	12%	19%	24%	29%
	22	15%	22%	28%	33%
	23	18%	25%	31%	37%
	24	21%	28%	35%	41%
	25	24%	31%	38%	45%
	26	27%	34%	42%	48%

TATA Steel storage structure

When we fix the procurement cost at Rs 8 /Kg and start to increase the selling price from Rs 20 /Kg to Rs 26 /Kg, value of IRR starts to change. Cells marked with green in the following table shows the value of IRR more than 10% (i.e. the value above which business is considered to be profitable).

Though, in all the cases, IRR is well above 10% (except few cases), in the case of IITB Storage structure, its value is better compared with the other two structures. With few differences, selling price restriction is quite tight in case of MahaOnion and TATA Steel storage structure. Finally, when we count the number of green (Positive BCR) cells for all the three tables, IITB CA Storage counts for maximum. It denotes the ranges of lower selling prices it can withstand without going into loss.

IITB storage structure performs better with the higher capacities and moderate selling price range. Objective of the intervention is to reduce the onion losses and efficiency of natural resource use and to remain profitable on economic grounds at the same time. IITB storage structure serves this purpose with its significant results.

7.5 Consolidated results (**N:** Normal scenario, **S:** Subsidy from Govt.)

IIT Bombay CA Storage									
		100 MT		300 MT		500 MT		1000 MT	
	Unit	**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**
Cap_Inv	Lakh Rs	**38**	**15**	**94**	**38**	**127**	**67**	**225**	**165**
Cap_Inv	Rs/Kg	38.00	15.00	31.33	12.67	25.40	13.40	22.50	16.50
Op_Cost	Lakh Rs/Season	4.64	4.64	8.95	8.95	10.65	10.65	15.48	15.48
Op_Cost	Rs/Kg/Season	4.64	4.64	2.98	2.98	2.13	2.13	1.55	1.55
Subsidy	Lakh Rs	**0**	**23**	**0**	**56**	**0**	**60**	**0**	**60**
NPV	Lakh Rs	-4.63	18.04	55.02	111.04	163.00	223.00	411.88	471.88
IRR	%	0.08	0.26	0.18	0.46	0.27	0.50	0.33	0.45
DPBP	Years	>15	7.71	10.99	4.71	8.06	4.29	6.59	4.84
BCR		-0.12	1.19	0.59	2.97	1.29	3.36	1.84	2.87

MahaOnion Storage									
		100 MT		300 MT		500 MT		1000 MT	
		N	**S**	**N**	**S**	**N**	**S**	**N**	**S**
Cap_Inv	Lakh Rs	**24**	**10**	**61**	**24**	**86**	**34**	**150**	**90**
Cap_Inv	Rs/Kg	24.00	10.00	20.33	8.00	17.20	6.80	15.00	9.00
Op_Cost	Lakh Rs/Season	2.69	2.69	5.85	5.85	10.14	10.14	17.37	17.37
Op_Cost	Rs/Kg/Season	2.69	2.69	1.95	1.95	2.03	2.03	1.74	1.74
Subsidy	Lakh Rs	**0**	**14**	**0**	**37**	**0**	**52**	**0**	**60**
NPV	Lakh Rs	-1.28	13.13	29.28	65.83	60.45	112.10	171.28	231.28
IRR	%	0.09	0.28	0.17	0.43	0.20	0.49	0.25	0.41
DPBP	Years	>15	7.82	11.60	5.06	10.41	4.40	8.57	5.27
BCR		-0.05	1.37	0.48	2.70	0.70	3.26	1.14	2.56

TATA Steel storage									
		100		300		500		1000	
		N	**S**	**N**	**S**	**N**	**S**	**N**	**S**
Cap_Inv	Lakh Rs	**31**	**13**	**78**	**31**	**107**	**47**	**192**	**132**
Cap_Inv	Rs/Kg	31.00	13.00	26.00	10.33	21.40	9.40	19.20	13.20
Op_Cost	Lakh Rs/Season	3.16	3.16	7.32	7.32	11.56	11.56	19.73	19.73
Op_Cost	Rs/Kg/Season	3.16	3.16	2.44	2.44	2.31	2.31	1.97	1.97
Subsidy	Lakh Rs	**0**	**18**	**0**	**47**	**0**	**60**	**0**	**60**
NPV	Lakh Rs	-2.69	15.73	27.11	74.03	74.88	134.88	205.22	265.22
IRR	%	0.09	0.27	0.15	0.39	0.20	0.45	0.24	0.35
DPBP	Years	>15	8.08	12.43	5.57	10.42	4.83	8.82	6.21
BCR		-0.09	1.28	0.35	2.37	0.70	2.87	1.07	2.01

As a part of collaborative work with PoCRA, comparative feasibility study was carried out to see the efficacy of different storage solutions available in the market. Techno-economic feasibility analysis evidently speaks about the efficacy of going for controlled environment storages. Three potential storage options available in the market were compared on every technical and financial front and came to conclusion that choosing the CA storage structure for onions with specified capacities would help in reduction of losses during storage as well as improve the profitability of the business for FPOs working with smallholder onion grower farmers.

Considering the minimum capacities of storage structures from the profitability indicators and budgetary constraints of the project, onion storage structure of 300 MT capacity and beyond is advisable to be constructed.

7.6 Economy of the Scale for IITB Storage structures

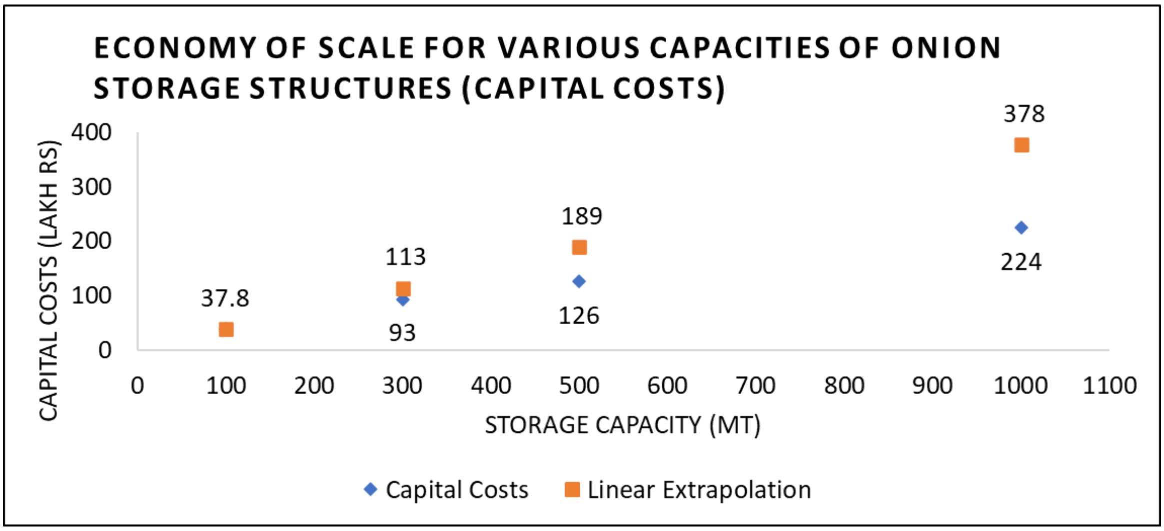
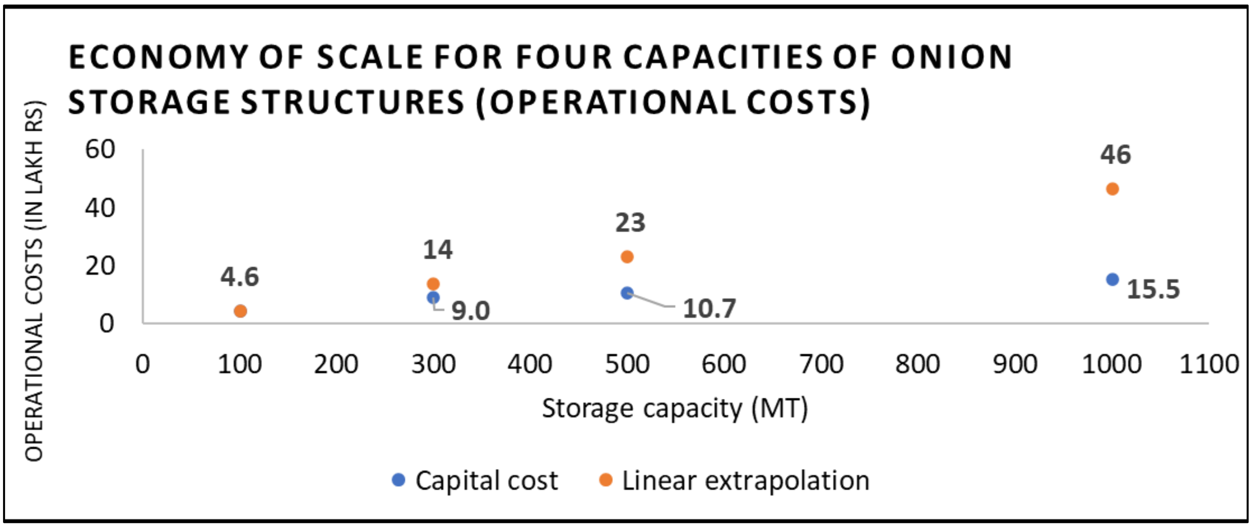


Figure 7.5Economy of Scale for Capital costs for IITHB Storage structure



Above two graphs show that with larger capacities of the storage structure, costs associated with them are reduced. Linear interpolation points in the graphs shows as if there is linear scale for the increasing capacities of the storage structure, but in reality, as we go with larger capacities, benefits of standard equipment (enclosure, Conveyor system, Air handling system), space and other finite resources can be utilised across the capacities to their best possible potential and hence it reduce downs the costs

SECTION-2:
VALUE ADDITION

8 Background

In line with the vision of promoting value addition opportunities for FPCs, the current component aims at exploring and assessing feasible value addition routes around commodities. As a deliverable, a DPR is developed for potential products which would enable the FPC to take informed decision to enter new ventures of value addition.

In the previous report (phase-II), a preliminary feasibility of four products namely protein rich poultry feed, soy milk/tofu, turmeric powder and curcumin were explored with a techno-economic analysis. The current report presents the DPR including the plant layout, techno-economic analysis, risk analysis, potential buyers of the value added products, backward and forward linkages, SWOT analysis and food safety standards for all the proposed products.

9 Methodology

Figure 9.1 presents a general methodology used to develop DPR. The methodology include steps for screening FPCs for field work, primary data collection, preliminary feasibility/techno-economic feasibility study and DPR preparation.

Figure 9.1Flow chart showing general methodology used to develop DPR

10 Screening of FPC for field work

The purpose of screening was to select certain FPCs with whom field surveys and interactions could be initiated. A list of 1451 FPCs which belonged to various districts in the PoCRA region was received from the PMU. Top three districts with highest production in each Soybean, Maize and Turmeric were identified and FPCs from these districts were screened.

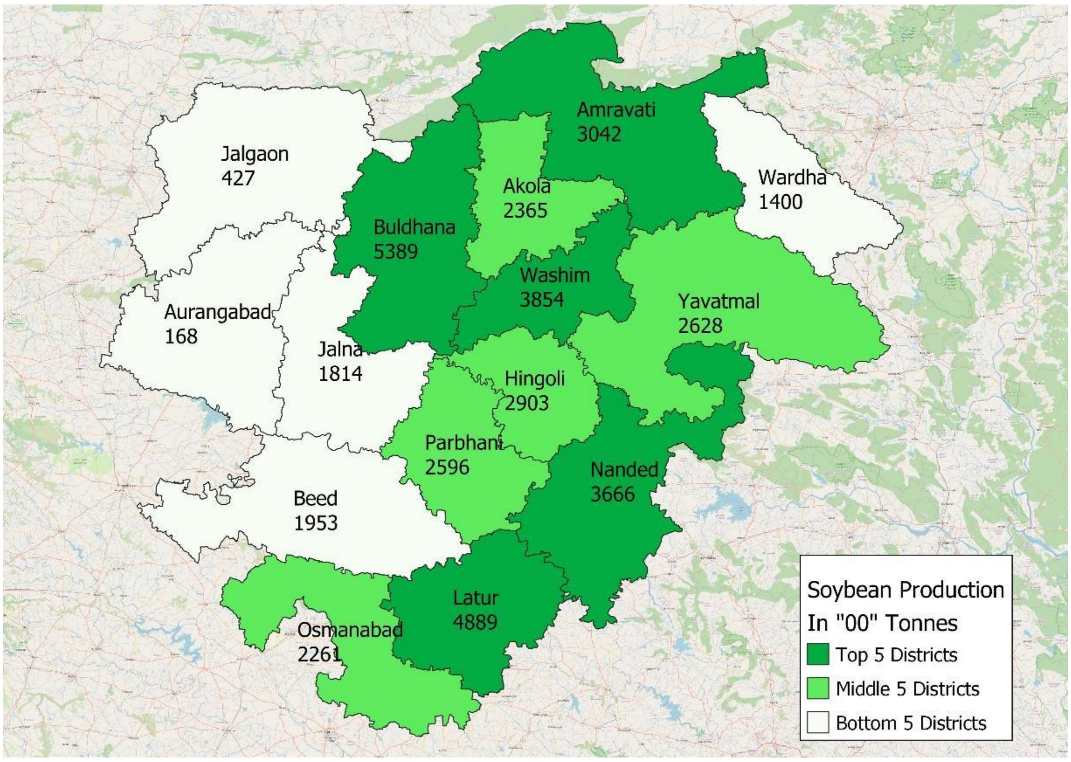


Figure 10.1 Distribution of soybean production in PoCRA districts

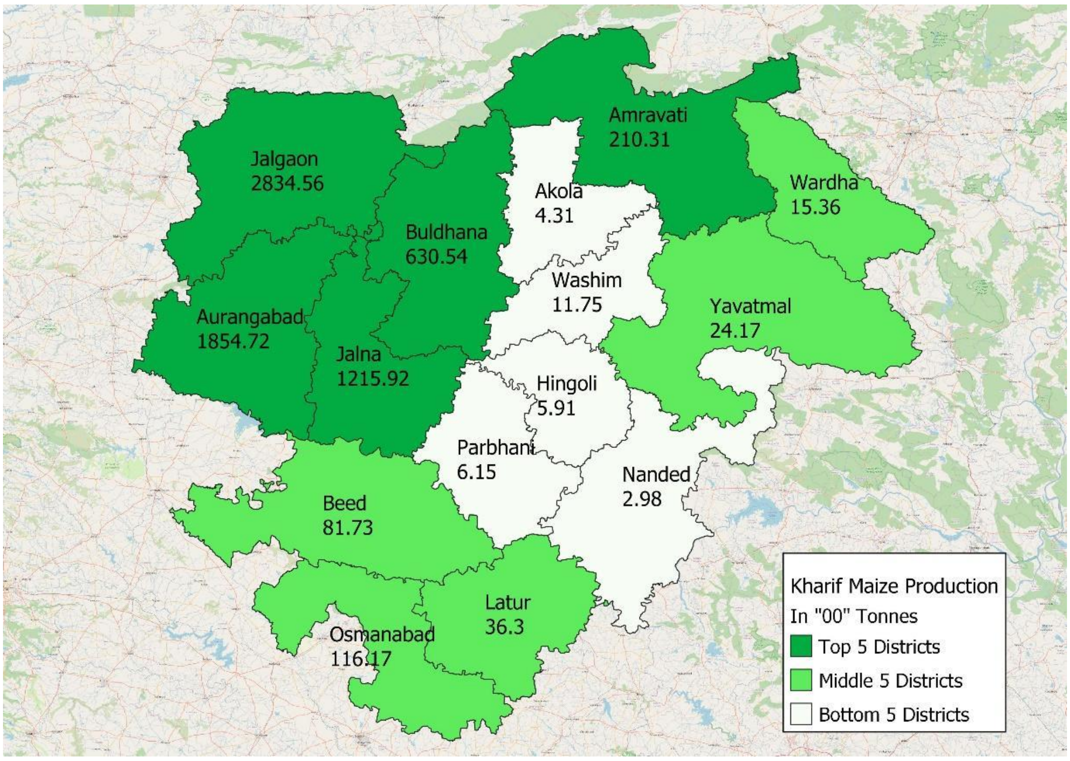


Figure 10.2 Distribution of maize production in PoCRA districts

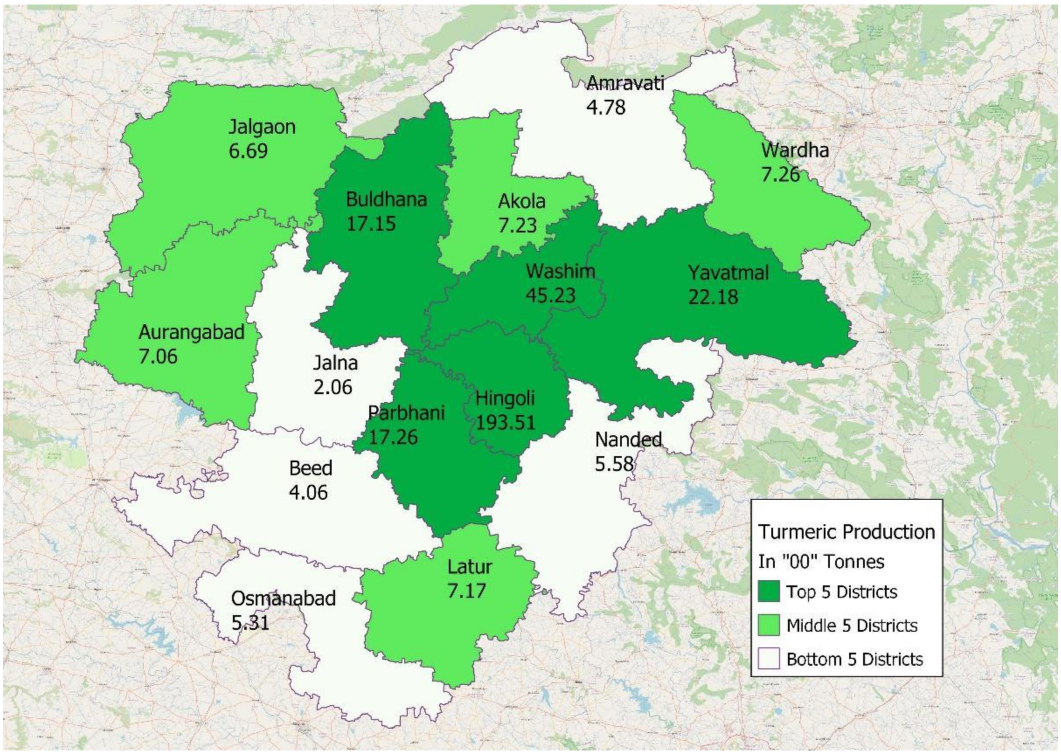


Figure 10.3 Distribution of turmeric production in PoCRA district

Figure 10.1, Figure 10.2, Figure 10.3 represent the distribution of production among districts in Soybean, Maize and Turmeric respectively. It could be observed in Figure 10.1 that Latur, Buldana and Washim are the top three producing districts for Soybean. Similarly, Figure 10.2

clearly depicts that Jalgaon, Aurangabad and Jalna are the top three districts for Maize while Hingoli, Washim and Yavatmal were top three producing districts in Turmeric as depicted in Figure 10.3. The FPCs in selected districts were screened using certain criteria that were derived using data received from PMU. The criteria were as follows:

- Age of FPC -
  - FPCs operating for more than one years from the date of registration were considered
- Principal crops-
  - FPCs solely dealing with commodities that were out of scope of this project such as cotton, milk, poultry, etc. were screened out
- Number of stakeholders-
  - FPCs having several stakeholders below 10 were screened out
- Rating:-
  - Assessment of FPCs was done by PMU based on several criteria such as organizational, administrative, financial, infrastructural, and managerial performances. After putting the above criteria
  - The rating data was sorted in descending order and top score FPCs were selected

The FPCs screened using the above criteria are presented in Table 10-1. The field visit comprised of interviews with the FPCs director mainly using a semi-structured survey form which included questions related to principal commodities, quantum of commodities, current activities, infrastructure related to current activities and willingness for value addition interventions. Figure 10.4 shows the location of screened FPCs. The quantum summary of FPCs visited in the select 8 districts along with the FPC's preliminary feasibility for potential value added products is given in Appendix A

Table 10-1 FPCs selected in top three districts for soybean, maize and turmeric

Soybean			*Maize*			*Turmeric*		
Latur	**Buldana**	**Washim**	**Jalgaon**	**Aurangabad**	**Jalna**	**Hingoli**	**Washim**	**Yavatmal**
Bhogeshwar Agro Producer Company Ltd	Sonpaul Farmers Producer Company Ltd	Nardas Farmer Producer Company	Padmalaya Farmer Producer Co Ltd	Akash Farmers Producer Company Ltd, Silod	Krushiputra Farmer Producer Company Limited	Shishiwar Shetakari producer Company. Ltd	Nardas Farmer Producer Company	Jiavanonnati Mahila Fpc Ltd
Shivhar Agro Producer Company Limited	Ruj Farmers Producer Company Ltd	Hari Om Agro Producer Company	Chinawal Farmers Producer Co Ltd	Krushi Kranti Hitech Agro Producer Company Ltd	Aamhibaliraja Producer Company Limited	Mishrilal Food Producer Company Ltd	Hari Om Agro Producer Company	Indujaa Mahila Milk Producer Co.Ltd.
Tivatghal Agriculture Producer Company	Rajashree Farmers Producer Company Ltd.	Shendurjana Farmer Producers company	Kashtkari Farmers Producer Co Ltd	Ghrushneshwar Shetkari Utpadak Company Ltd.	Dyanjyoti Mahila Farmers Producer Company Limited	Shrisant Namdev Maharaj Farmer Producer Company Ltd.	Shendurjana Farmer Producers company	Rivagro Fpc.Ltd.
Jangave Agro Producer Company Limited	Laxminarayan Farmers Producer Company Ltd.	Ayush Farmer Producer Company	Reva Valley Agro Producer Co Ltd	Pinakeshwar Shetkari Producer Company Limited	Tukoba Agro Producer Company Limited	Appaswami Shetakari Utpadak Company Ltd	Ayush Farmer Producer Company	Ghatanji Mahila Producer Company Ltd

Ltr agro foods producer company limited	Sant Gajanan Agri Development Farmers Producer Company Ltd.	Krushisamrajya Farmer Producer Company	Development agro vision farmers producer company limited	Karmad Farmer Producer Company Limited	Purna Kelna Producer Company Ltd	Anukaran Farmer Producer Company Ltd	Krushisamrajya Farmer Producer Company	Vadal Fpc Ltd
Satyaai agro producer company ltd.	Shemba Kranti Shetkari Utpadak Company Ltd.	Krushi Mauli Shetkari Utpadak Company Ltd.	Anjani khore farmer producer com ltd.	Jai Siddheshwar Krishi Producer Company Limited	Jadaimata Producer Company Ltd	Surya Farmers Producer Company Ltd	Krushi Mauli Shetkari Utpadak Company Ltd.	Yavatmalkrushi samurdhi trading and prosessing producer company limited
Katpur agro producer company ltd katpur tq.latur	Kulbhushan Shetkari Utpadak Company Ltd.	Sant Dnyaneshwar Shetkari Utpadak Company Ltd.	Tapi farmers producer company limited	Mandana producer company limited	Walsavangi Agro Producer Company Ltd	Shree Faleshwar Maharaj Farmer Producer Company Ltd	Sant Dnyaneshwar Shetkari Utpadak Company Ltd.	painganga agro producer co.ltd.
Lokmauli agro producer company ltd.	Jay Sardar krushi vikas Shetkari Utpadak Company Ltd.	Parivartan Organic Shetkari Utpadak Company Ltd.	Sant Changdev Tapi Purna Farmer Producer Cimpany ltd		Mhasrul Farmers Producer company Ltd	Pradnyashil Taruna Farmers Producer Company Ltd	Parivartan Organic Shetkari Utpadak Company Ltd.	sweekar agro produser company limited
Panagro services producer company ltd	Kelvad Shetkari Utpadak Company Ltd.	Krushideep Agriculture Producers company.	Aadishakti muktai krushi vikas farmers producer company limited		Bhudan Agro Producer Company Ltd	Godavary Valley Farmers Producer Company ltd	Krushideep Agriculture Producers company.	Vasant-sudha Farmers Producer Company Limited

Shivneri agro prod.company lmt.shivani	Vidarbha Samruddhi Shetkari Utpadak Company Ltd.	Greenza Producers company ltd.	Dhayanai punyai agro farmer producer company			Kisan Disha Farmers Producers Company ltd.	Greenza Producers company ltd.	bumitra self reliyant farmers producer farmers producer company
Agrotech agro producer company ltd								

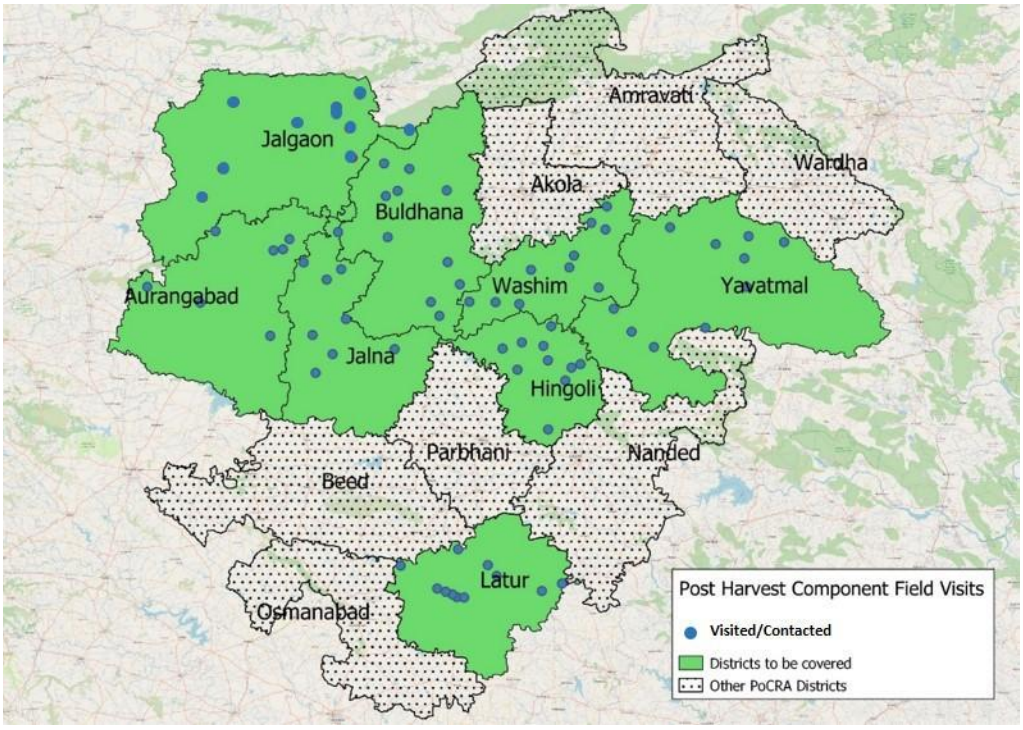
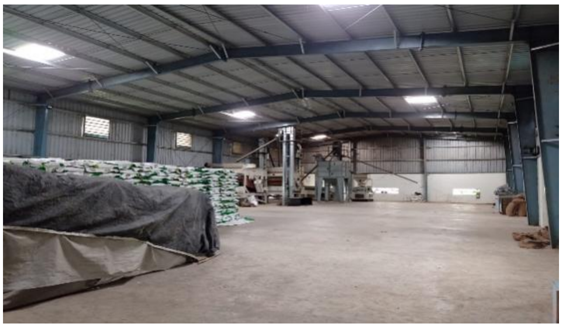


Figure 10.4 Location of selected FPCs in the PoCRA region

(a)

(b)

(c)



(d)

Figure 10.5 Field visit photos

(a)- Steam distillation unit at Nardus FPC, Washim
(b)- Grading machine at Krushi Mauli FPC, Washim
(c)- Cleaning grading sorting unit at Jai Siddheshwar FPC, Aurangabad
(d) Seed processing and Warehouse at Sonpaul, Buldana

Challenges during field visits

- Data was received based on discussion with either FPC directors or senior members, however the accuracy of data was solely dependent on the respondent's heuristics and could not be validated using any other media. In fact, there were some dissimilarities in the data received from PMU and field visit data.
- FPCs assumed that we were representatives of PoCRA and had expectations that the team would provide them with immediate solutions or grant approvals for certain projects. When the respondent realised that the purpose of current field visits was data collection for study and research, the attitude of respondent changed.
- For Washim district, the contact details of FPCs were inaccurate. The actual details were acquired from district coordinators and local sources.

11 Potential value-added products for PoCRA region

Considering that the PoCRA districts have large quantum of soybean, maize and turmeric production, their lies a potential for value addition intervention in these three commodities. Currently the FPCs in PoCRA are mainly into trading and generate low profit margins, therefore a profitable and sustainable business venture pertaining to processing of agri-commodities will be well accepted by the FPCs.

A list of potential value-added products pertaining to soybean, maize and turmeric are mentioned in Appendix B. The profitability of any food processing intervention depends on the economics of scale wherein raw material availability play a key role. Out of the potential products, the following value-added products of soybean, maize and turmeric are proposed:

1. Poultry feed
2. Soy Milk and Tofu
3. Turmeric power
4. Curcumin

These products are chosen based on the observations (from field visits) of raw material availability in the PoCRA region. Moreover, the proposed products have a well-established market, therefore forward linkages/marketing of the products would be convenient. The profitability of the processing would depend on the economics of scale therefore a feasibility study is necessary to determine the optimal plant capacity considering all practical variables. The following sections presents the DPR of each product.

12 DPR for Poultry Feed manufacturing Unit

12.1 Introduction

Across the world poultry market, India ranks sixth (using FAOSTAT rankings). The domestic poultry industry is the fastest growing segment with a compound growth rate of 18%. As per Agricultural and Processed Food Products Export Development Authority (APEDA) India has become the world's fifth largest egg producer. Egg production has increased quadrupled in two decades in our country (30 billion in 2000 to 114 billion in 2020). Similarly, poultry meat production growth, is also very significant, crossing 4.3 MMT in 2020 (www.indiastat.com). It is projected that egg production may reach 136 billion eggs by 2023, with poultry meat production to total 6.2 MMT.

Andhra Pradesh is the country's largest egg producing state. Besides Andhra Pradesh, Tamil Nadu, Telangana, West Bengal, Karnataka, Harayana, Maharashtra, Punjab, Uttar Pradesh and Bihar are major egg producers. In case of poultry meat, Haryana tops the list followed by the West Bengal and Uttar Pradesh. The government of India fixed targets for annual production of poultry with a view to ensure availability of eggs and broilers both to meet domestic consumption as well as export. With this projected development of the poultry industry, the demand for production of balanced poultry feed has become imperative.

Poultry sector in India is largely an organized commercial sector with about 80% of the total market share. The unorganized sector (largely backyard poultry that supplements income generation and family nutrition) has about 20% of the total market share.

In 2020, India's consumption of poultry meat was over 3.9 million metric tons, still quite limited relative to the overall population size. Demand for protein rich food, combined with improved consumer purchasing power is spurring increased poultry meat consumption.

Egg offers as a low cost, highly nutrient dense food which includes a wide variety of essential micronutrients. Eggs can supplement household plant-based diets. In the last two decades, per capita availability of eggs has more than doubled in the country (Figure 12.2). Of course, this may not be proportional to the population of the states.

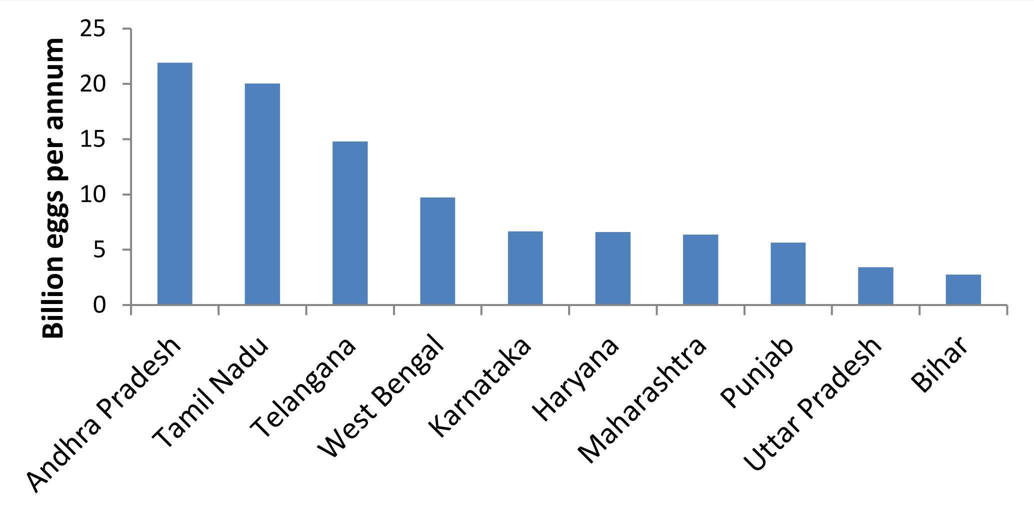


Figure 12.1 Top 10 states in egg production in India (FY 2019-20).

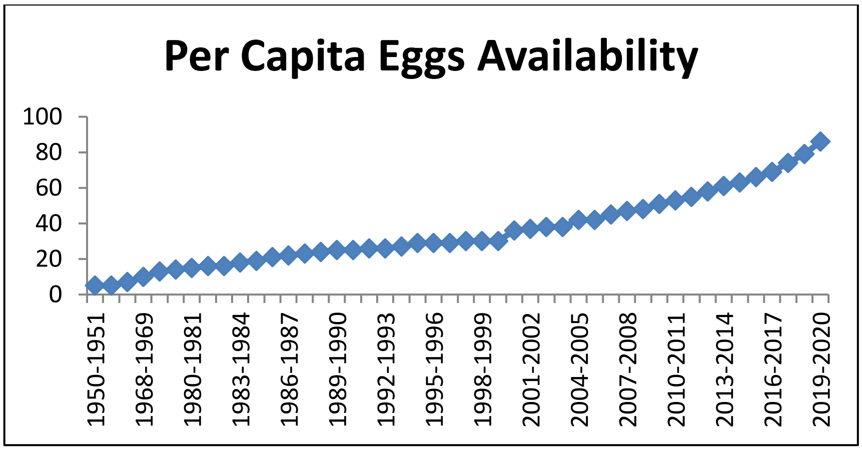


Figure 12.2 Per capita eggs availability per annum in India

There is no uniformity in terms of size and housing environment of poultry farms. It may vary from 200 birds to more than 50,000 birds. Typically, small poultry are open sheds while only a few large poultry integrators have controlled-environment housing with automatic feeding and drinking systems. For small farmers, poultry business poses various challenges due to high capital cost requirement which restrict them to adopt sophisticated housing system for better performance of poultry and high price of feed which accounts for more than 80 percent of the total production cost.

12.2 Poultry feed status in India

The current demand for poultry feed in India is ~25 million tons. Poultry segment dominates the market due to the growing meat consumption leading to the higher demand for poultry feed.

Increasing per capita income, and rising awareness of healthy products among consumers quality poultry products have significantly contributed to the rising demand for poultry feed in India. According to the 19th Livestock Census by Department of Animal Husbandry, growing demand for poultry products will further increase to drive growth in India poultry feed market in the coming years.

The predominant feed grain used in poultry feeds worldwide is maize. The plant protein source traditionally used for feed manufacture is soybean meal, which is the preferred source for poultry feed. Feed supplements like probiotics, vitamins, minerals, amino acids, mold inhibitors, enzymes, preservatives, coccidiostats, antioxidants etc. are mostly imported. Feed represents the major cost of poultry production, constituting about 80 percent of the total cost and about 65-75% of total cost is shared by maize and soymeal.

12.2.1 Maharashtra Scenario

On the geographical front, South India represents the leading market for animal feed, accounting for the largest market share. In recent years, the market has witnessed growth in Andhra Pradesh, Karnataka and Tamil Nadu, owing to the rise in the manufacturing of poultry products. While poultry integrators are much stronger in regional pockets of Andhra Pradesh, Karnataka and Tamil Nadu, the much larger landscape for the poultry industry and its expansion beyond these belts provide ample opportunity for standalone feed players. The demand is expected to grow by 7-8 percent in near term.

The demand of maize depends largely on demand as feed for poultry and livestock, and partially on its direct demand for human food and industrial uses. Maize is the preferred energy cereal used in poultry feed formulations because of its high energy, low fibre and the presence of pigments and essential fatty acids. Consequently, because it is a primary source of energy, due to its higher level of inclusion in poultry diets (60-70%), it contributes approximately 30% of the protein requirement of poultry. However, maize, like other cereals, is deficient in certain essential amino acids, such as lysine and tryptophan. Soymeal, a byproduct of soybean oil industry is a common plant protein source, which contain about 44- 45% crude protein. The protein in soybean provides the building blocks for muscles, organs, feathers, and eggs. Maize and soymeal have been considered as the primary feed ingredients in the poultry diets.

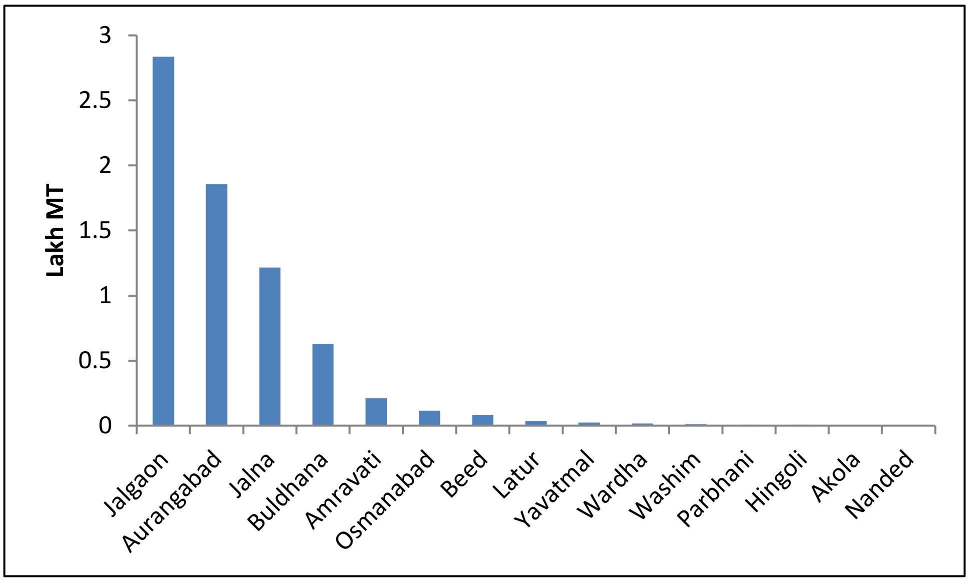
Maharashtra holds a great potential to become a hub for poultry feed production as it has significant production of soybean and maize. Maharashtra is second largest producer of soybean in India after Madhya Pradesh. As shown in the maps below, PoCRA districts in Maharashtra contribute significantly to the production of soybean and maize. It should be noted that with the announcement of new biofuels policy in 2018, cropping pattern under maize will increase significantly in these districts in the next few years. It has been estimated that maize productivity will also increase significanty, thus improving the chances of farmers to diversify their market portfolio. Bihar, a major producer of corn in India, accounting for 8 per cent of the national production of corn in 2019-20, has come up with a state-level policy on ethanol production (Government of Bihar, 2021). This could be seen as an opportunity for states like Maharashtra to emerge as alternative markets in poultry feed industry.

The layer industry alone creates the feed demand of about 12 million tonnes with 5-6 percent CAGR. In the near term, significant opportunities exist in layer industry for compound feed demand. With farms consolidating and growing in size in long term, layer farmers will be integrated backwards into feed milling.

Total maize production in Maharashtra is about 2.3 million tonnes (FY 2020). The cumulative production of maize in the 15 districts of POCRA region is about 7 lakh tonnes of which Jalgaon, Aurangabad, Jalna, Buldhana and Amravati contributes to 95% of total production.

Similarly, soybean production in POCRA districts is also quite significant. Cumulative production of thse districts FY 2020 was 39 Lakh tonnes. The production distribution of soybean and maize in PoCRA district and non-PoCRA district is presented in Figure 12.5.

(a)



(b)

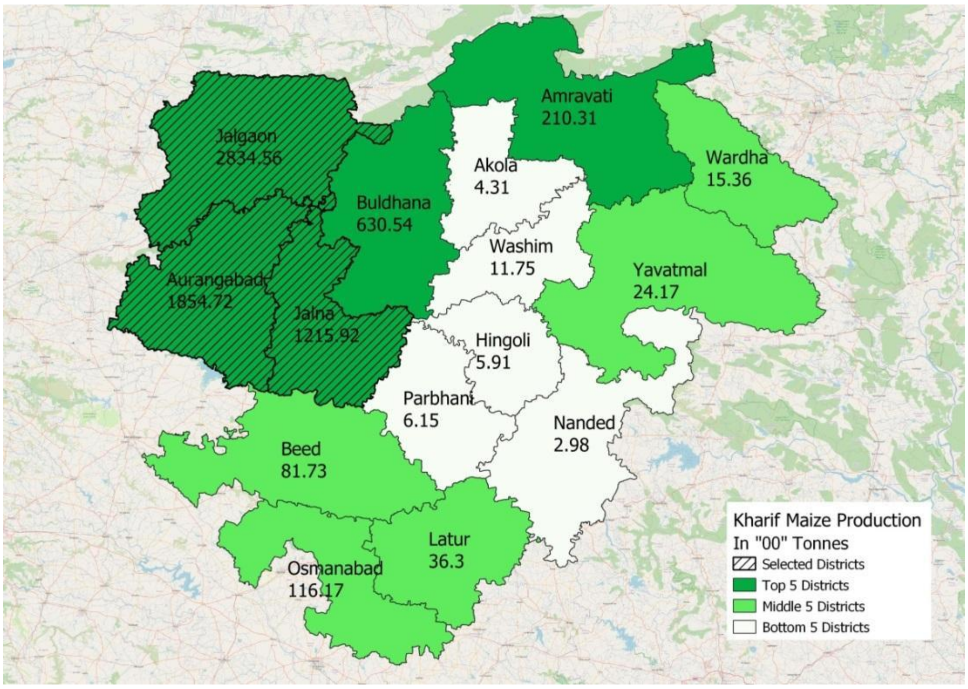
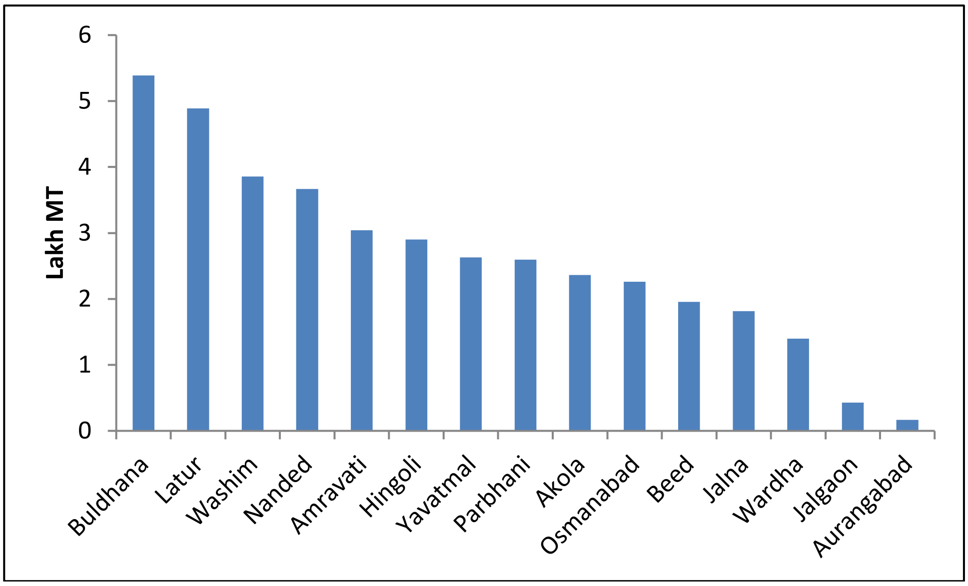


Figure 12.3 Maize production in PoCRA districts of Maharashtra

(a)



(b)

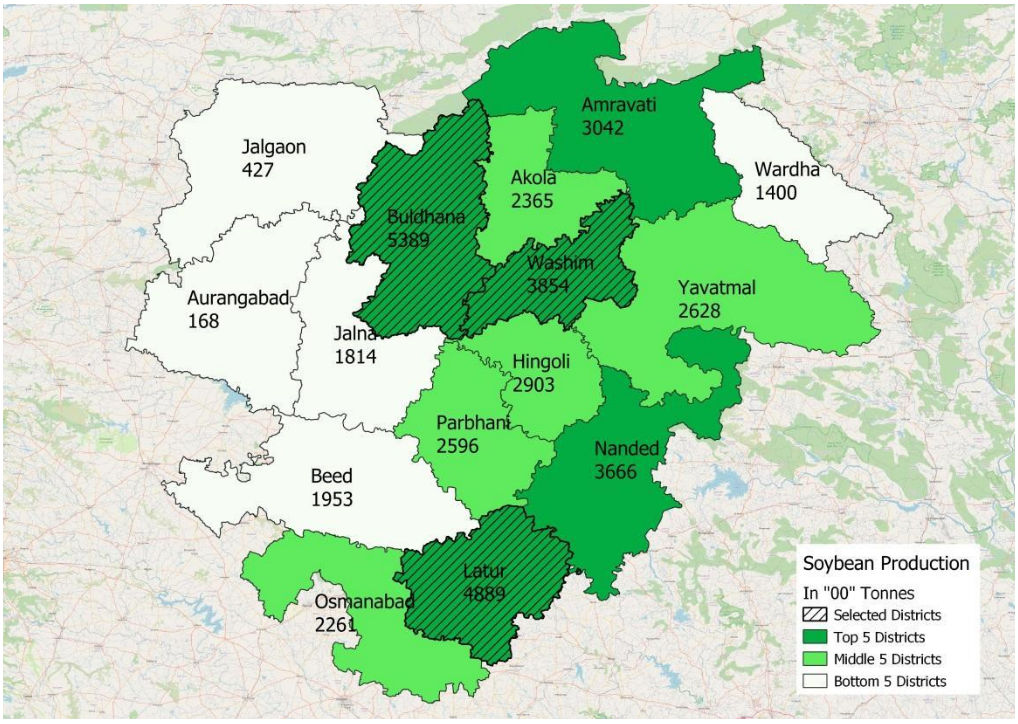
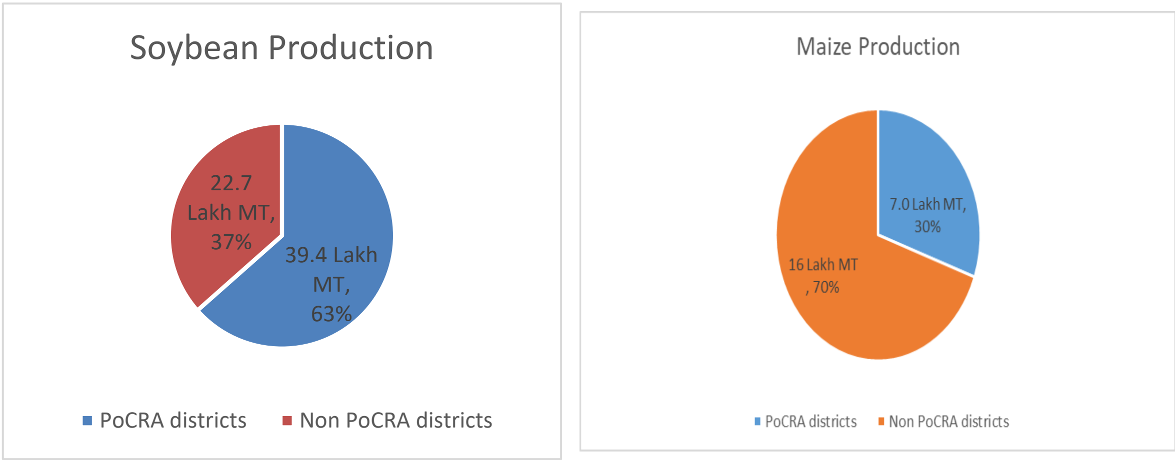


Figure 12.4 Soybean production in POCRA districts of Maharashtra

In this context, feasibility analysis of a poultry feed manufacturing business has been done for POCRA districts that carry a great potential for supplying significant quantum of feed to the state and neighbouring states.



(a) (b)

Figure 12.5 Production of soybean (a) and maize (b) in Maharashtra with respect of PoCRA and Non-PoCRA districts

12.3 Project description (TEA)

Considering the quantum of raw material availability in the region, this project has been proposed for establishment of poultry feed unit of 1 ton per hour. The proposed project will offer flexibility to produce –

- Prestarter feed
- Crumbs (started feed)
- Pellet Feed (Finisher feed)

Since Pellet feed manufacturing is most exhaustive process which subsumes above two processes, all calculations presented in the feasibility analysis are for pellet feed.

12.3.1 Poultry Feed production process

1.1.1.1 **Raw material procurement**

For commercial poultry farming, feed serves as the largest cost of the operation. Therefore, sourcing high quality raw material is of utmost importance for the success of the business. This mixture of various concentrate feed ingredients in suitable proportion is known as compound feed.

Considering that Farmer producer companies in the region are going to be the direct stakeholder of the project, procurement of maize and soymeal (largest cost contributor) can be managed well within 100 kilometers radius of the project site. Even though procurement of raw material can happen from multiple suppliers, consistency of feedstock can be ensured by utilizing selected varieties to minimize variations in proximate composition. The low variability in the unit value realization in case of poultry feed demands greater incentives for the processing sector.

1.1.1.2 **Weighing and quality check:**

Raw materials stored in storage area are sent for weighing. High degree of accuracy and precision is required for weighing. After that ingredients are sent to laboratory for analysis. After acceptance from feed laboratory, these ingredients are sent for grinding with the help of equipment's like conveyor and elevators.

1.1.1.3 **Grinding:**

Size reduction is an important unit operation of feed manufacturing process. The grinding improves feed digestibility, acceptability, mixing properties, palatability, and increases the bulk density of some ingredients. In a commercial poultry feed mill, hammer mills are the most popular.

The raw materials are grinded in grinding machine to obtain appropriate size of grains. The end product is in form of pellet or mesh. So grinding is done accordingly. Grinded materials are further separated by means of a sieve, and then stored in the assorting tanks according to the kind of raw materials.

1.1.1.4 **Mixing:**

The raw materials are mixed by means of a feed mixer. In this process, fatty ingredients are added to the materials in order to raise the nutritional value of the feed. The feed obtained from the mixer is blended with molasses. Proper mixing is crucial for uniformity of composition of product. Double ribbon blender is used to mix all ingredients after grinding.

1.1.1.5 **Conditioning:**

Direct and indirect injection of steam in feed mix for 10-50 seconds is done. Conditioner should have provision for varying conditioning time as per formulation requirement. It adds moisture content of feed to 17-18%.

1.1.1.6 **Pelletization:**

In this process, blend of raw material put into a Pelleting machine.

Pellets are made using extrusion principle with the use of temperature, moisture and high pressure. The heat generated in conditioning and pelleting makes the feedstuffs more digestible by breaking down the starches. Pelleting minimizes waste during the eating process. Pellet size may vary from 1.8 mm to 10 mm diameter as per the need. The positive effects of pelleting are higher feed density, no feed ingredient separation, better bacteriological quality, easier ingestion, improved growth and feed conversion ratio. Pelleting of meal leads to hardness and increased durability of the feed meal.

1.1.1.7 **Cooling:**

From the pellet machine chamber, the pellets normally flow by gravity into a device for cooling and drying of the pellets. Pellets will leave the pellet mill at temperatures as high as 90°C and moisture contents are high as 20%. For proper storage and handling of the pellets, their moisture content must be reduced to less than 10%. This is to be accomplished by passing a stream of air through a bed of pellets. This evaporates the excess moisture, causing cooling both by the evaporation of water and by contact with the air. The counter flow pellet cooler has automatic control for optimum cooling. Its air flow opposite to movement of hot pellets results in fast cooling and removal of moisture.

1.1.1.8 **Product Quality Inspection:**

Proximate composition of pellet feed is done in the lab. In general practice, protein content 22% minimum, fibre maximum 10%, fat 5% minimum, maximum 2% ash and moisture content should be maximum 10% in the pellet.

1.1.1.9 **Weighing and Packing:**

Poultry feed is weighed with the help of electronic balance and packed suitably in a poly bag.

1.1.1.10 **Storage**

Packed poultry feed stored in cool and dry place and deliver as per demand.

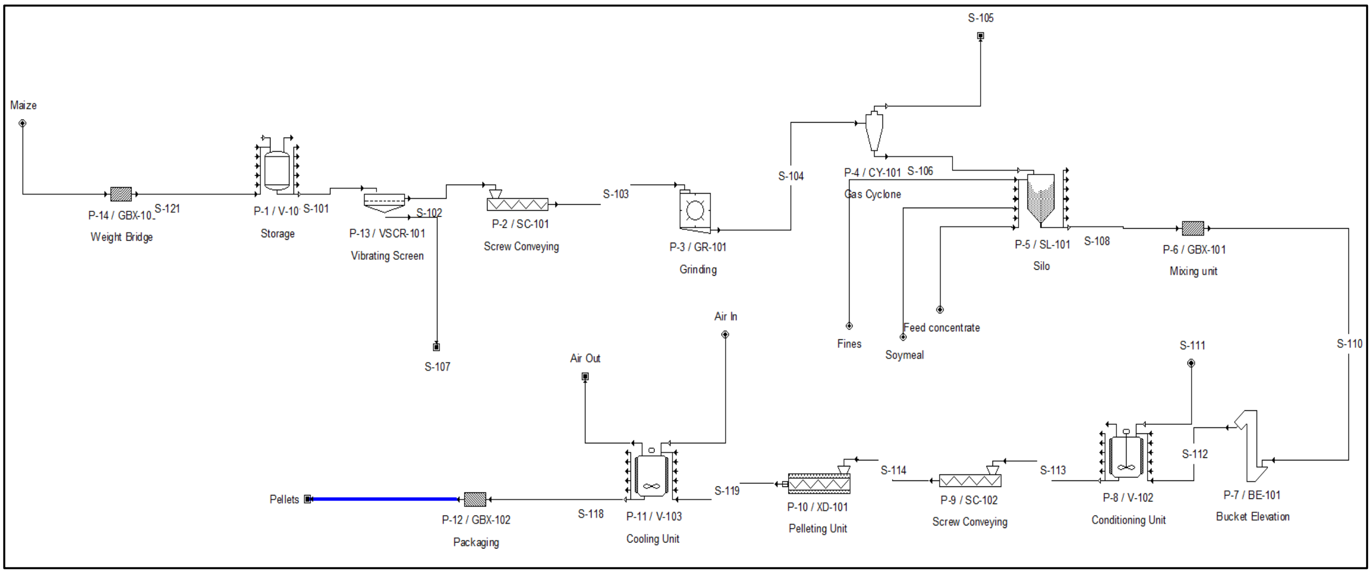
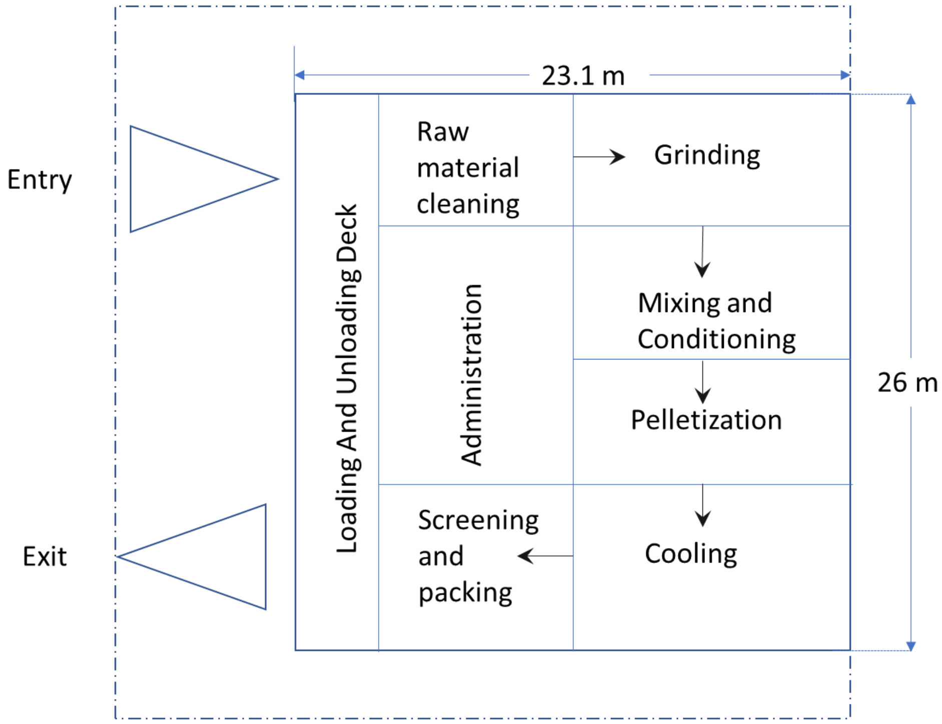


Figure 12.6 Process flow diagram of poultry feed pellet production

12.3.2 Plant Layout



Total Area = 1000 sq. m
Built up Area = 600 sq. m

Figure 12.7 Plant layout of poultry feed unit

12.3.3 Feed Composition

The feed consists of three macronutrients: Carbohydrates, proteins and lipid, together with molasses, and micronutrients (minerals and vitamins). Major raw materials required for the manufacture of poultry feed are maize, soymeal, molasses, salt, limestone (ground), other grains (optional), meat bone meal, vitamins, amino acids and minerals. A ration of corn and soybean meal is recognized as technically superior for raising broilers, but other ingredients are sometimes substituted based on availability and price. Animal feed for modern high-performance breed is blend of grains, protein meals, vitamins, minerals and a number of feed additives pelleted and crumbled to suit ingestion by different age of birds. The feed composition may vary depending upon the age of the bird and end use. Largely, the change is observed in the protein content of feed composition. In the analysis, two different compositions based on protein content were evaluated as follows –

Table 12-1 Feed compositions for 1 TPH feed model

S.No.	Ingredients	Composition 1 (%)	Composition 2 (%)
1	Maize	65	55
2	Soya meal	23	33
3	Dicalcium phophate	1	1
4	Meat bone meal	2	2
5	Mustard DOC	2.35	2.35
6	Soybean Oil	1	1
7	Mineral and Vit. mixture	0.2	0.2
8	Methionin + Tryptophane	0.3	0.3
9	Lysine	0.15	0.15
10	Rice bran deoiled	3	3
11	Molasses	1	1
12	limestone	1	1

Composition 2 has 10% more soymeal which may be needed as a special dietary requirement for poultry birds. In that case, poultry feed price would also vary depending upon the protein content of the feed. For example, broiler birds have higher protein requirement as compared to layer birds. Within broiler birds, protein requirement may vary from 19 to 22% depending upon the age of the bird. Likewise, 14-17% protein is considered good for layer birds.

In our analysis, we have assumed two compositions with 17 and 21% proteins, respectively by the changing the ratios of maize and soybean meal.

Wholesale market price for layer feed and broiler feed has seen an unprecedented change all across the globe. In India, layer and broiler feed price has shot up by more than 70% in the last

5 years. In 2021, there was a sharp spike in the feed prices due to soybean meal becoming expensive which is one of the most critical sources of protein in poultry feed. As per Soybean Processors Association of India, soybean price has increased by 156% in one year. Likewise, maize price has also increased significantly. This has led to increase poultry layer feed price from INR 32/kg (in Jan 2020) to INR 43/kg (in April 2022). Similarly, for broiler birds feed, price has changed from INR 35/kg to INR 50/kg (in April 2022).

Our techno-economic analysis showed that breakeven point (NPV =0) for both compositions are INR 31/kg and INR 33.5/ kg feed. However, to be able to make a good business case, we have taken as assumption of selling price of INR 35/kg of feed (irrespective of composition type). This price is the outcome of the average wholesale market price average of last 3 years. This conservative approach still shows good commercial potential of both feed types as discussed in the economics section.

Moving average of poultry feed for last three years (INR of 38.3/kg) shows very promising picture of the commercial viability of the process considering moving average procurement prices.

12.3.4 Economic analysis

1.1.1.11 **Capital Investment Cost**

In this study, an economic analysis was conducted to estimate the NPV, IRR, and PBP, respectively which is based on the capital investment, and on operating costs of the refinery. Model for integrated biorefinery was constructed in Superpro designer software. Capital investment costs are estimated based on the purchased costs of each piece of operating equipment (Table 19-1). The purchased costs for the major equipment items were based on budgetary quotations from equipment suppliers. In those instances where the capacities of the equipment in the model vary from the equipment, costs are adjusted for capacity using standard engineering scaling factors. The mass and energy balance outputs from the processing model were used to evaluate the capital and operating costs. Equipment cost information was derived from literature, equipment suppliers.

Direct Fixed Capital Cost (DFC) is a sum of Direct Cost (DC), Indirect Cost (IC), and contingency. The DC estimated is based on total equipment purchase cost (EPC). The plant considered here is assumed to be financed with 75% loan and 25% equity. The plant has a 15-year lifetime with 5 % salvage value at the end.

Table 12-2 shows economic evaluation parameters considered for the base case i.e. 1 ton per hour (TPH). The annual depreciation cost is calculated via the straight-line method.

Table 12-2 Economic evaluation parameters for 1 TPH Poultry feed model

Time parameters	**Value**	**Financing parameters**	**Value**
Analysis year	2022	Equity and loan	25% and 75%
Project life	15	Depreciation method	Straight line
Construction period (months)	12	Depreciation period	10 years
Start up period (Months)	1	Income tax	35%
Inflation rate (%)	6	Discount rate (%)	10
Operating parameters		**Construction plan**	**Value**
Annual operating time (days)	300	1st year (% DFC)	75
Start up cost (% DFC)	5	2nd year (% DFC)	25
Salvage Value (%DFC)	5		

Table 12-3 Summary of equipment list for 1 TPH feed model

Description	**Unit Cost (INR)**	**Cost (INR)**
Receiver Tank	200,000	200,000
Vessel Volume = 481.97 L		
Screw Conveyor	74,000	74,000
Pipe Length = 15.00 m		

Grinder	200,000	200,000
Rated Throughput = 433.50 kg/h		
Cyclone	74,000	74,000
Rated Throughput = 433.78 L/h		
Silo/Bin	100,000	100,000
Vessel Volume = 873.26 L		
Generic Box	400,000	400,000
Rated Throughput = 668.04 kg/h		
Bucket Elevator	50,000	50,000
Elevator Length = 10.00 m		
Blending Tank	200,000	200,000
Vessel Volume = 818.45 L		
Screw Conveyor	143,000	143,000
Pipe Length = 15.00 m		
Extruder	500,000	500,000
Screw Diameter = 9.56 cm		
Blending Tank	100,000	100,000
Vessel Volume = 831.85 L		
Generic Box	400,000	400,000
Rated Throughput = 679.23 kg/h		
Generic Box	800,000	800,000
Rated Throughput = 433.50 kg/h		
Unlisted Equipment		360,000
	TOTAL	**3,601,000**

Table 12-4 Fixed capital estimate summary

4A. Total Plant Direct Cost (TPDC) (physical cost)	
1. Equipment Purchase Cost	3,601,000
2. Installation	907,000
3. Process Piping	0
4. Instrumentation	720,000
5. Insulation	0
6. Electrical	1,440,000
7. Buildings	1,080,000
8. Yard Improvement	360,000
9. Auxiliary Facilities	720,000
TPDC	8,829,000
4B. Total Plant Indirect Cost (TPIC)	
10. Engineering	883,000
11. Construction	2,649,000
TPIC	3,531,000
4C. Total Plant Cost (TPC = TPDC+TPIC)	
TPC	12,360,000
4D. Contractor's Fee & Contingency (CFC)	
12. Contractor's Fee	0
13. Contingency	1,236,000
CFC = 12+13	1,236,000

4E. Direct Fixed Capital Cost (DFC = TPC+CFC)

DFC	13,596,000

Table 12-5 Summary of raw material cost (Composition 1)

Bulk Material	**Unit Cost (INR)**	**Annual Amount**	**Unit**	**Annual Cost (INR)**	**%**
Fines	18.00	74,412	kg	1,339,416	1.01
Maize	18.00	2,715,444	kg	48,877,992	36.99
mixture	50.00	576,000	kg	28,800,000	21.79
soy meal	50.00	1,060,301	kg	53,015,040	40.12
Water	120.00	995	MT	119,367	0.09
TOTAL				**132,151,815**	**100.00**

Table 12-6 Summary of raw material cost (Composition 2)

Bulk Material	Unit Cost (INR)	Annual amount	Unit	Cost (INR)	**%**
Fines	18	69,602	kg	1,252,843	1.01
Maize	18	2,297,009	kg	41,346,158	36.99
mixture	50	576,000	kg	28,800,000	21.79
soy meal	50	1,520,640	kg	76,032,000	40.12
Water	120	956	MT	114,743	0.09
TOTAL				147,545,744	100

Table 12-7 Summary of utilities cost for 1 TPH poultry feed model

Utility	Unit Cost (INR)	Annual Amount	Ref. Units	Annual Cost (INR)	%
Std Power	10.00	409,181	kW-h	4,091,813	86.73
Steam	888.00	596	MT	528,958	11.21
Chilled Water	5.00	19,397	MT	96,985	2.06
TOTAL				4,717,756	100.00

Table 12-8 Annual operating costs for (A) Composition 1 and (B) Composition 2

Item	Composition 1		Composition 2	
	Cost (INR)	Contribution (%)	Cost (INR)	Contribution (%)
Raw Materials	132,152,000	91.07	147,546,000	91.93
Labor	2,680,000	1.85	2,680,000	1.67
Facility Dependent	2,707,000	1.87	2,707,000	1.69
Laboratory/QC/QA	402,000	0.28	402,000	0.25
Utilities	4,718,000	3.25	4,718,000	2.94
Advertising/Selling	2,445,000	1.68	2,445,000	1.52
Total	145,104,000	100	160,498,000	100

Manpower (Labor) requirement

The manpower cost has been assessed based on an organization structure and requirement to run 2 shifts of operation per day. It is estimated that total manpower cost would be approximately Rs. 26.80 Lacs per annum.

Table 12-9 Manpower (Labor) requirement

	Number	Unit cost (in Lakhs)	Total (in Lakh rupees)
Manager	1	6	6
Maintenance Engineer	1	5	5
Accountant	1	2.4	2.4
Technical operator	2	2.2	4.4
Labors	6	1.2	7.2
Guard	1	1.8	1.8

Table 12-10Summary of project economics for feed compositions

	Composition 1	Composition 2
Total Capital Investment (INR)	28,911,000	30,388,000
Annual operating cost (INR)	145,104,000	160,491,000
Net Unit Production cost (INR/kg)	29.67	32.66
Product Selling price		
Pellets (INR/kg)	35	35
Net Profit		
Pellets (INR/year)	16,940,000	7,460,000
IRR % (after taxes)	27.1	51.9
Payback period (years)	1.7	4.1

1.1.1.12 **Sensitivity analysis**

It is evident through analysis that raw material is the predominant contributor in deciding the fate of the project. Likewise, the market price of feed product would also strongly affect the economic viability of the process. Likewise, plant capacity, days of plant operation etc. will have bearing on the economic viability of the plant. The sensitivity bounds are chosen based on what is expected due to market fluctuations. This was accomplished by evaluating NPV after changing one parameter keeping other parameters constant. To test the sensitivity of results, tornado charts were constructed for baseline scenario and associated variables sensitivities.

1.1.1.13 **Raw material price**

Base case Scenario: Maize- Rs. 18/kg, Soymeal - Rs. 50/kg and Feed mixture - Rs.50/kg

Low price: Maize- Rs. 15/kg, Soymeal - Rs. 40/kg and Feed mixture - Rs.40/kg

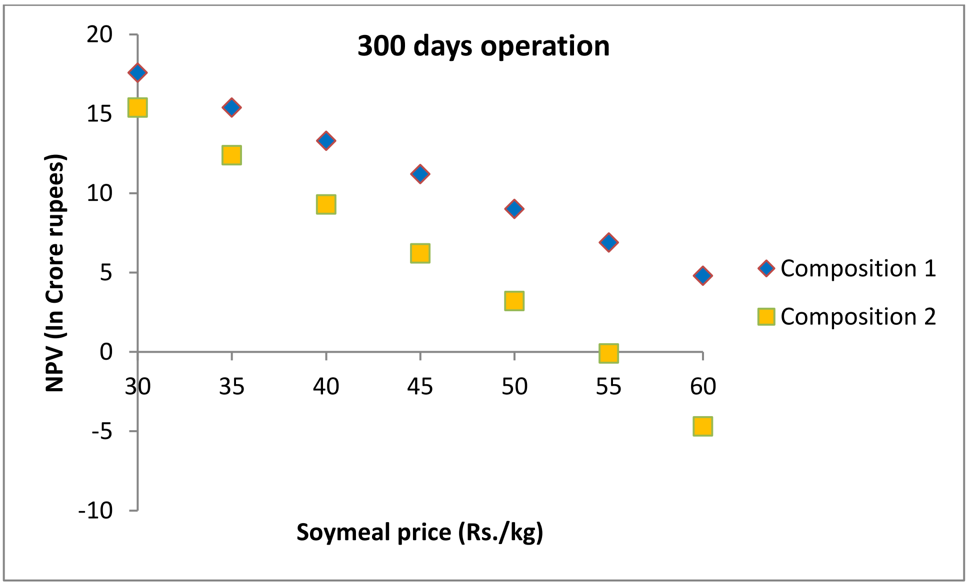
High price: Maize- Rs. 21/kg, Soymeal - Rs. 60/kg and Feed mixture - Rs.60/kg

1.1.1.14 **Effect of soymeal price on NPV**

Historical data shows that soymeal price was considered quite stable and it would hover between 20 to 30 rupees per kg. Last year, unprecedented increase in Soybean price had rattled the animal feed sector. Since soybean meal is a major constituent of poultry feed, volatility in soymeal would directly affect poultry feed cost of production.

As mentioned above, for base case scenario, soymeal price is considered INR 50 /kg. If price moves towards right by 10%, NPV for composition 2 becomes Zero, which implies that project is not viable. However, if proportion of soymeal is kept below 25% in the final feed composition for the same price hike, project may turn out to be profitable (Figure 19.8) for 180 days and 300 days of operation.

(a)



(b)

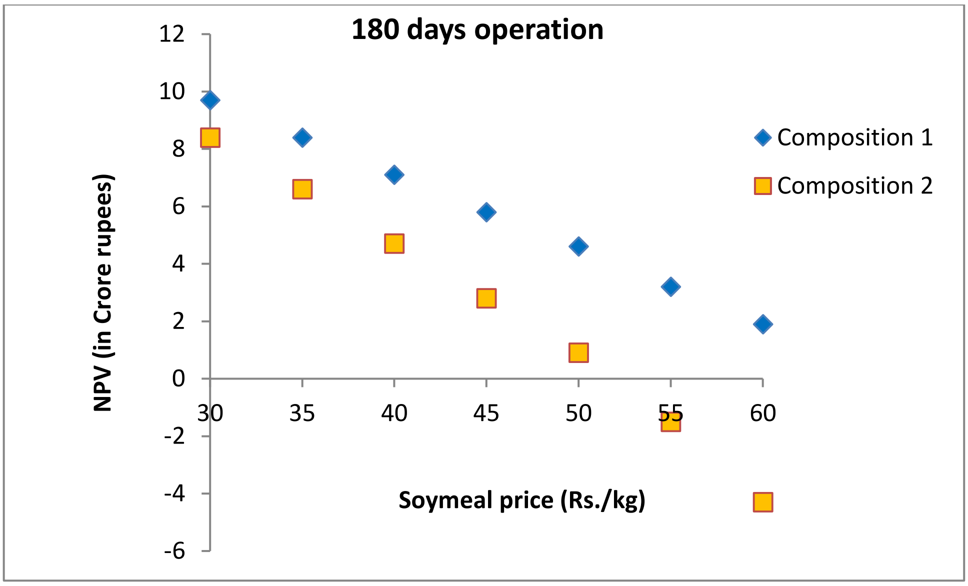


Figure 12.8 Effect of operating days on NPV for both feed compositions

1.1.1.15 **Effect of plant capacity on NPV**

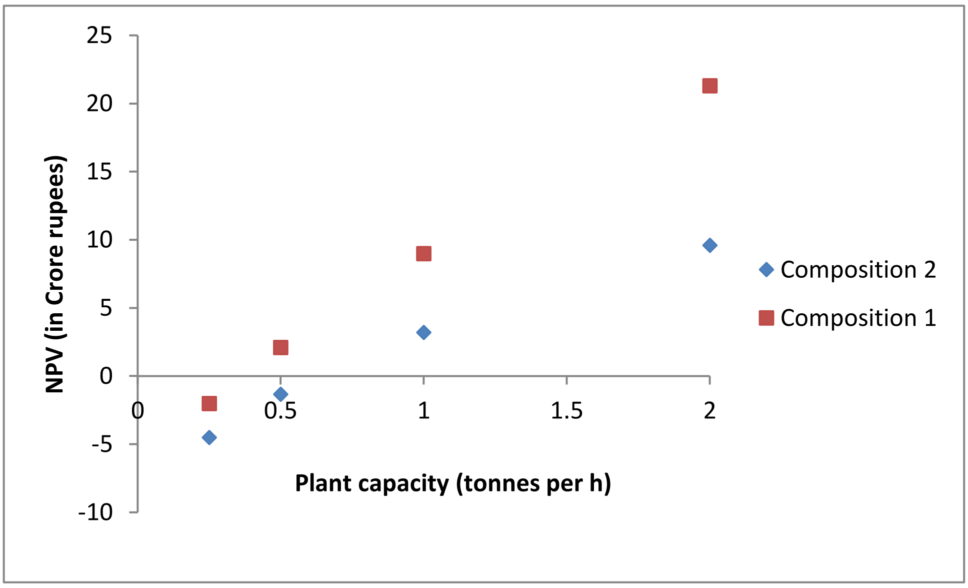


Figure 12.9 Effect of plant capacity on NPV for both feed compositions

1.1.1.16 **Conjoint analysis**

(i) Effect of raw material price and no. of days of operation on NPV

It is evident from the Figure 12.10 that raw material price inflation would directly affect project economics. Project viability comes out to be negative for 180 days of operation.

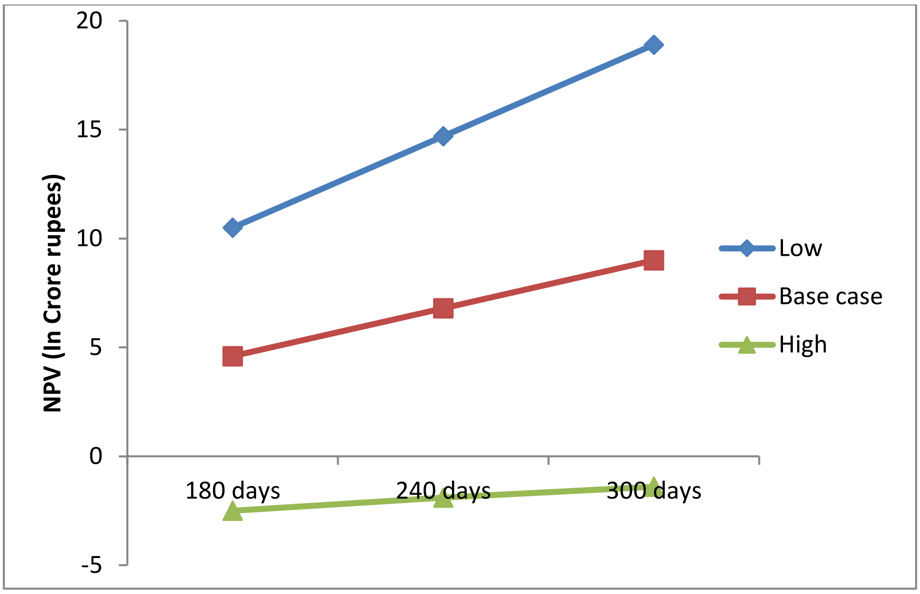


Figure 12.10 Effect of raw material price and operating days on NPV

1.1.1.17 **Effect of raw material price and pellet selling price on NPV**

The most important factors affecting the project economics is variability on raw material and selling price of pellets.

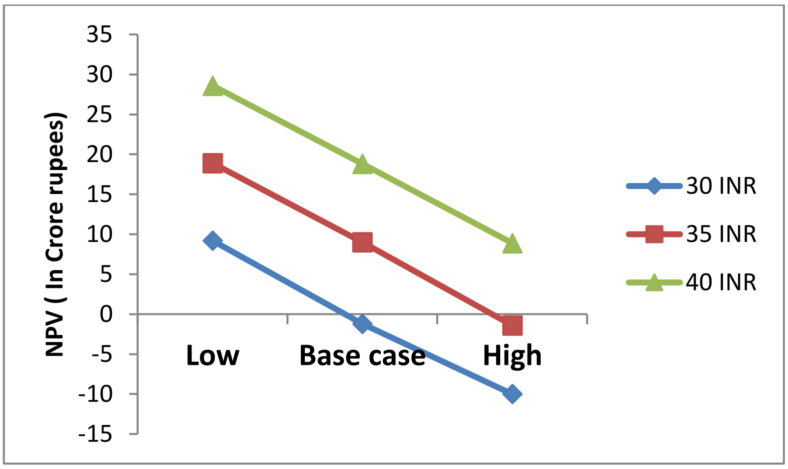


Figure 12.11 NPV w.r.t Pellet price

Benefit Cost Ratio (BCR):

(i) Effect of plant capacity and feed compositions on BCR

	0.25 TPH	0.5 TPH	1 TPH
Composition 1	-1.14	**1.01**	**3.14**
Composition 2	-2.33	-0.59	**1.05**

It is apparent from the above Table that project economics is viable at 1 TPH capacity for both feed compositions. Scaling down the plant capacity to 0.5 TPH is still a profitable venture for 1st feed composition whereas project economics for 2nd feed composition doesn't seem viable.

(ii) **Effect of operating days and feed compositions on BCR (for 1 TPH model)**

BC ratio	**180 days**	**240 days**	**300 days**
Composition 1	**1.6**	**2.4**	**3.14**
Composition 2	0.3	0.7	**1.06**

For feed composition 1, all operating days (180 days through 300 days) present a great potential for the business viability as BCR is more than 1.0 in all three cases. However, for feed composition 2, reducing no. of days of operation from 300 days to 240 days or lower adversely affects the project economics. It is therefore suggested to run the plant for 300 days if all other parameters are constant.

(iii) Effect of pellet selling price and feed composition on BCR (for 1 TPH and 300 days model)

BC ratio	**INR 30**	**INR 35**	**INR 40**
Composition 1	-0.3	**3.1**	**4.3**
Composition 2	-3	**1.06**	**3.33**

Current market price of poultry pellet is varying between 40 and 45 rupees per kg. It is apparent from the above table that project economics is favourable wen pellet selling price is ≥ 35 rupees.

12.3.5 Breakeven points

The project is viable for all prices of soymeal for composition 1 both for 180 and 300 days of operation. In case of composition 2, the project is viable if the cost of soymeal is below ₹55 when operated for 300 days and below ₹50 if operated for 180 days.

The plant must operate at least at1 tonne per hour for both the composition. In case of composition 1, the plant can operate at least at 0.5 tonne per hour. The price of pellets should be at least ₹35 for the project to be viable the low case, base case and high case scenario mentioned above.

12.3.6 Monte Carlo Simulation

Sensitivity analyses (one factor at a time) poses a limitation of not strictly representing real-life scenarios when more than one orthogonal parameters could vary simultaneously, making the analysis complicated. As discussed before, processes under evaluation are strongly affected by uncertainties that are associated with the process design and model development, or can be associated with raw material variability, volatile prices of products, investment cost etc. In order to establish the confidence in the new project, possible uncertainties and the risks should be carefully analysed. In this context, Monte Carlo simulation method was used as an intriguing method for solving stochastic system problems. This method provides approximate solutions to a variety of mathematical problems by performing statistical sampling experiments on a computer. To achieve this, a probabilistic model based on Monte-Carlo method was developed with varying process parameters and various economic parameters. The model consists of equations that separately estimated the total revenue, and operational costs associated with the process in order to calculate NPVs and BCRs.

Parameters that may vary simultaneously are as follows –

	Min	Max	Mode	Average
Input				
Maize price	18	22	18	20
Soymeal price	40	60	50	50
Mixture price	45	55	45	50
Fines	18	21	18	19.5
Output				0
Pellet price	30	40	40	35

Simulation results:

The following graphs show the probability of success of venture for (1) Composition 1 Feed and (2) Composition 2 Feed.

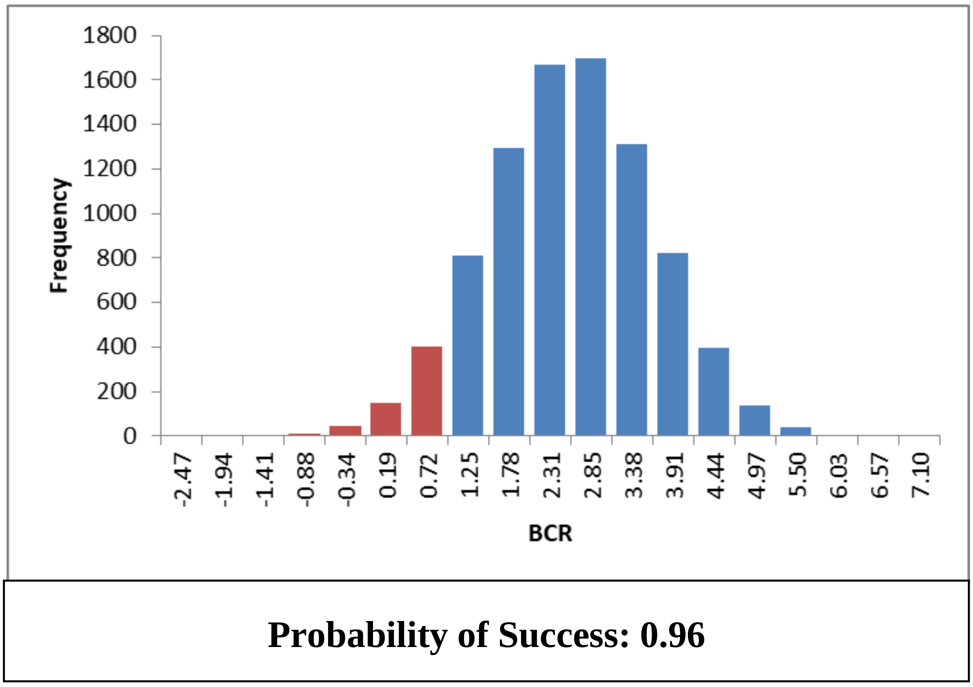


Figure 12.12 Profitability probability of composition 1 feed using Monte Carlo simulation
Blue bars denote probability of BCR > 1 and red bars indicate BCR < 1.

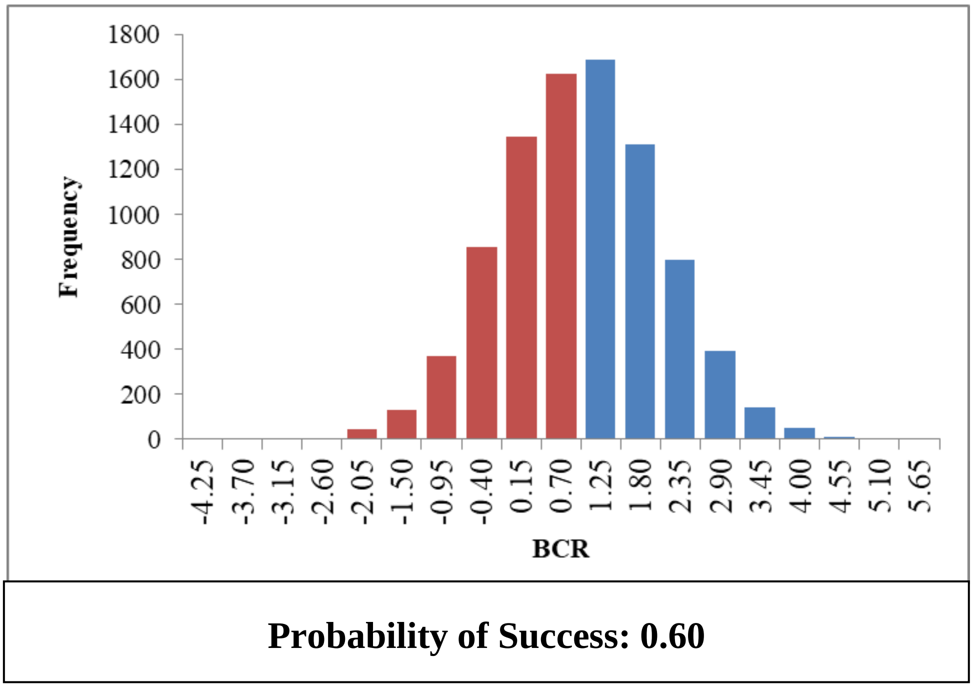


Figure 12.13Profitability probability of composition 2 feed using Monte Carlo simulation

Blue bars denote probability of BCR > 1 and red bars indicate BCR < 1.

12.3.7 Project viability

The Internal Rate of Return (IRR) of the project is 140% and 41%, for two compositions, which are significantly higher than the bank return rate of 10%. Analysis of BCR ratio under various conditions revealed that project is viable for feed composition 1, even under less operating days and reduced plant capacity. For feed composition 2, project is viable when plant capacity is kept at 1 TPH or higher. In addition, plant has to operate for 300 days.

Hence, the project is financially viable. The NPV of the project is positive at a discount factor of 10% during the period of operation considered. This implies that the project generates sufficient funds to cover all its cost, including loan repayments and interest payments during the period.

The situation may change further depending upon the selling price of the pellet. In this project, pellet selling price of 35 rupees per kg is a very conservative figure. As stated above, current wholesale market price is hovering between 40 and 45 rupees. This may change the overall scenario for the feed composition 2. A detailed uncertainty analysis using Monte Carlo method clearly shows that probability of success of the venture is very high (~96%) when soymeal contribution as a protein source is limited within 25% (Figure 12.12 and Figure 12.13). On the other hand, dependency on soymeal as a protein source esp. for high protein diets when selling price of pellets is floats between 30 and 40 rupees per kg, makes it a risky proposition (Probability of success is 60%). However, same venture could be considered profitable when pellet selling price varies between 35 and 45 rupees per kg (which is quite realistic as change in price of the product proportional to the change in the process of raw material). Considering the current wholesale market price regime (INR 43/kg) and current raw material price, probability of success turned out to be more than 95% in composition 2. Considering shift in selling price from INR 35/kg to INR 38/kg for composition 2, payback period would drop from 4.1 to 1.8 years. Similarly, IRR improvement would quite significant (from 41% to 133%).

12.3.8 Subsidy entitlement

Since total capital investment requirement is about 1.32 crore rupees, eligible FPCs can apply under POCRA program for maximum a subsidy of 60 lakhs for the project.

12.3.9 Project implementation and schedule

The key factors that would facilitate successful and timely project implementation are:

- Selection of proper technology and plant machinery vendors.
- Adequate diligence in formulating the technical concept and system design.
- Selection of contractors for civil construction and erection of equipment.
- Formulation of an effective project team led by an experienced Project Manager.
- Establishment of an efficient system for project planning & monitoring including reporting procedures for progress review & co-ordination.

12.3.10Implementation Schedule

It is proposed in the analysis that the project implementation will take 12 months before plant operation begins. First six months will be allotted for pre project activities and the rest should be done within the next six months from the date the project is approved by the Ministry of Economic Affairs.

12.3.11 Occupational Health and Safety

All workers in the plant will be provided with and shall be mandated to use protective gear and equipment to ensure their personal safety.

Mandatory safety trainings will be conducted on a regular basis from time to time in order to ensure that safety procedures are followed at all times. A safety inspector shall be appointed (plant manager) to monitor and ensure compliance to safety norms and procedures.

12.4 Backward and Forward Linkages

12.4.1 Raw material supply

For raw material supplies, maize, limestone and soy meal can be procured locally. Rice bran and molasses could be procured from rice mills and sugar mills. There are many suppliers who can be contacted for raw material procurement. A list of some vendors has been given below –

Oil Cake

(i) Shree Ganpati Enterprises

No. 2647, 1st Floor Street

Raghunandan, Naya Bazar

New Delhi-110006, India

Contact Number: +91-9811077100, 011-43536445

(ii) Marudhar Foods Private Limited

B-108, Asthivinayak Complex

2nd Floor, Outside Dariiyapur Darwaja

Ahmedabad-380004

Gujarat, India

Contact Number: +91 7965437111

Bone Meal

(i) Global Enterprise

No. 10, Green Park Society, Opposite M.S. Public School, Near Pirkamal Masjid, Danilimada

Ahmedabad: 380028, Gujarat

India

(ii) Sri Sai Sagar Traders

No. 206, Ellora, Sant Muktabai Marg, Vile Parle East

Mumbai: 400057, Maharashtra

India

Contact Number: 08045136604

(iii) Giriraj Chemicals

No. 201-A, IInd Floor, Sumedha Market Complex, RDC Raj Nagar

Ghaziabad: 201002, Uttar Pradesh

India

Contact Number: 09643203160

Molasses

(i) Canny Overseas Private Limited

B-170, Priyadarshini Vihar

New Delhi - 110092

Delhi, India

Contact Number: 08045359140

(ii) Atlas

No.55, K.J.Building

34/A Khadak Street, Near Snow White Hotel

Masjid Bunder (W)

Mumbai: 400009

Maharastra, India

Contact Number: 08046035474

a) Plant machinery

(i) Metal Tech Engineers

V.P.O. - Chari, Tehsil. - Khamano, Distt .

Fatehgarh Sahib, (Punjab) -141 801

(ii) Pratap Enterprises

Opp. U.K Palace,

G.T Road Khanna, (Punjab) -141401

(iii) Priti International

Bhowanipore, Kolkata West Bengal

(iv) Feed Milling Tech

Por, Vadodra, Gujarat

12.4.2 Forward Linkage, Marketing potential and marketing strategy

The demand for animal feed is mainly influenced by the awareness of farmers on the importance of the compound feeds, size of population, and development of modern poultry farms and availability of the product at right price. A wide network of dealers shall be created by the sales and marketing team of the FPC. The FPC would sell its products in B2B mode and in retail under its own brand name. Expenses incurred in creating marketing channels and network has already been added in the project cost. Based on our research, the following channels **(**Figure 12.14**)** for marketing of feed could be utilized. The trading of poultry feed is a profitable venture to the dealers and sub-dealers as it gives a good margin to them.

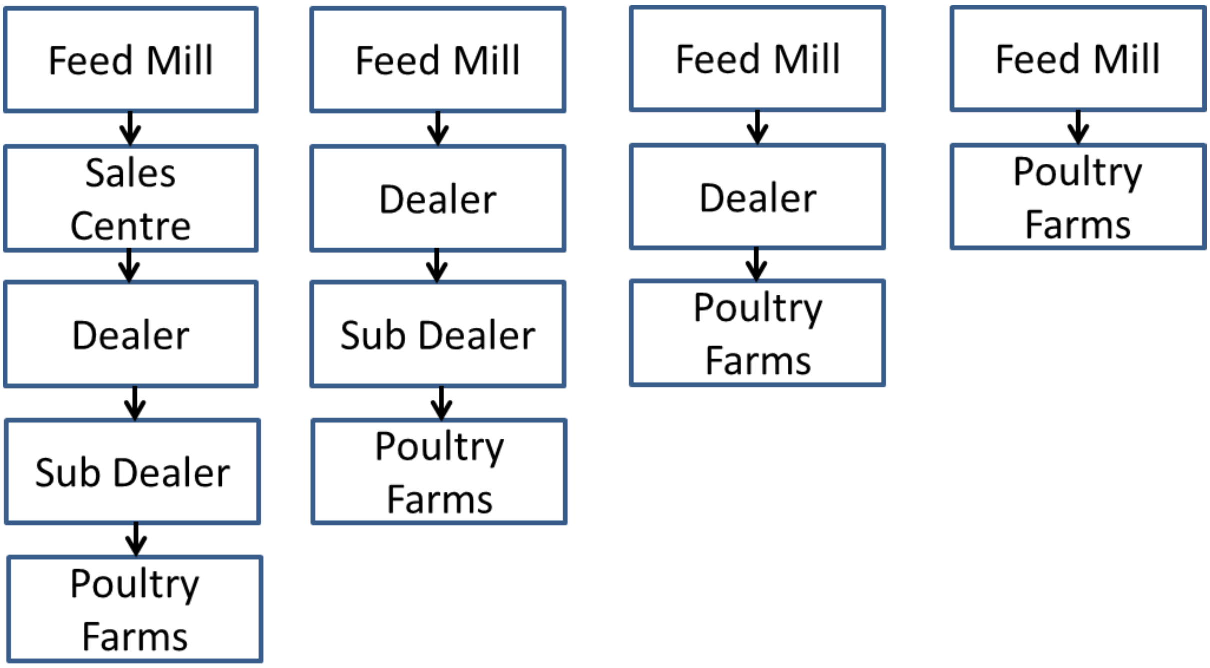


Figure 12.14 Distribution channels for poultry feed

12.5 SWOT analysis

A SWOT analysis of the Poultry Feed units has been carried out keeping in mind the technology, marketing, product quality, skills, inputs, innovation, business environment and sustainability

Strength 1. Inputs: Availability of raw materials from local dealers. 2. Business environment: (a) Exponential growth in domestic demand. (b) High production potential of the plant. (c) Not highly crowded business in the region. Hence, competition is not severe. 3. Environment sustainability: No such unit operation in the process which harms the environment. 4. Skill/Manpower: (a) Automated plant would not require many labours. (b) Presence of ICAR research institutes for training. 5. Technology sophistication: Practical know how available to run the plant with minimal obstructions. To create poultry feed testing facility for whole region.	**Weakness** 1. Input: (a) Volatile price of soymeal may affect the profitability of the plant. (b) Sourcing of high quality raw materials can be a challenge. 2. Business environment: Lack of knowledge of regulatory frameworks and government schemes. 3. Skill/Manpower: Lack of interaction between enterprises and technical institutes for providing technical training. 4. Innovation: Potential to represent the state in the poultry feed sector has not been leveraged.
Opportunity Potential to represent the state in the poultry feed sector. Engage technical and industry Like Cargill and Godrej for skill development programs.	**Threat** Input: Increase in rate of raw material. Business environment: Competition from vendors manufacturing products at lower costs. Change in policies and regulatory environment might affect business.

Expansion of feed portfolio to a wide range of feed in the region.	Skill/Manpower: Presence of large private player in the region in future may attract manpower to shift.

12.6 BIS standards for poultry feed

In India, BIS standards are followed for poultry feed. Table 12-11 shows the BIS standards.

Table 12-11 BIS standards for poultry feed

Characteristics	**Broiler starter feed**	**Broiler finisher feed**	**Chick feed**	**Grower feed**	**Layer feed**	**Breeder feed**
Moisture max %	11	11	11	11	11	11
Crude protein min %	23	20	20	16	18	18
Crude fibre max %	6	6	7	8	8	8
Acid insoluble ash max %	3	3	4	4	4	4
Salt (as (NaCl) Max %	0.6	0.6	0.6	0.6	0.6	0.6
Calcium min %	1.2	1.2	1.0	1.0	3.0	3.0
Available phosphorus min %	0.5	0.5	0.5	0.5	0.5	0.5
Lysine min %	1.2	1.0	0.9	0.6	0.65	0.65
Methionine min %	0.5	0.35	0.3	0.25	0.3	0.3
Metabolizable energy (ME) Kcal/ kg	2800	2900	2600	2500	2600	2600
Manganese, mg/kg	90	90	90	90	90	90
Vitamin A, IU/kg	6000	6000	6000	6000	6000	6000
Vitamin D3, IU/kg	600	600	600	600	1200	1200
Vitamin E, mg/kg	15	15	15	10	10	10
Vitamin K, mg/kg	1	1	1	1	1	1
Riboflavin, mg/kg	6	6	6	3	3	3
Biotin, mg/kg	0.2	0.2	0.2	0.15	0.15	0.15
Choline	1400	1600	1300	900	800	800
Pyridoxine, mg/kg	5	5	5	5	5	8
Aflatoxin, max, P.P.b.	50	50	50	50	50	50

13 DPR of Soy milk and tofu processing unit

13.1 Soybean as a commodity

Glycine max (L.) Merrill is a self-pollinated diploid annual legume. It is thought to have been domesticated for food around three thousand years ago in eastern China from its viny wild relative, Glycine soja. Most soybean seeds, unlike Glycine soja, do not have a dormancy phase following harvest, and hence rely on human agriculture. The soybean is a tall, branching plant that can grow to be more than 2 metres (6.5 feet) tall. Soybeans may be grown in a variety of soil types, but they thrive in sandy loam that is warm, productive, and well-drained. Soybean flowers are white or purple, and seeds can be yellow, green, brown, black, or bicolored, however most commercial cultivars have brown or tan seeds. Each pod contains one to four seeds.

Because of its high productivity, profitability, and critical contribution to soil fertility, soybean occupies a significant position in the world's oilseed farming situation. The crop is also the world's most important seed legume, contributing 25% of worldwide vegetable oil production, nearly two-thirds of the world's protein concentrate for cattle feeding, and is a valuable element in formulated poultry and fish diets.

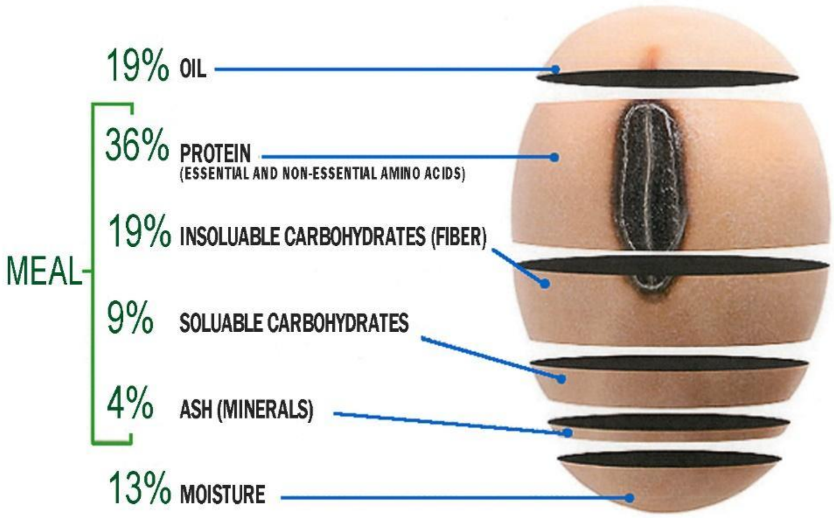


Figure 13.1 Composition of Soybean grain

(Source-https://www.nopa.org)

13.1.1 Composition of Soybean

Soybeans are abundant in protein and have a high nutritional value. It contains around 19% oil and 36% high-quality protein (as against 7.0 per cent in rice, 12 percent in wheat, 10 per cent in maize and 20 to 25 per cent in other pulses). Soybean protein is high in the essential amino acid lycine (5%), which is lacking in most cereals. It also has a lot of minerals, salts, and vitamins (thiamine and riboflavin), and its sprouting grains have a lot of Vitamin C. Vitamin A is present in the form of precursor carotene, which is transformed into vitamin A in the intestine.

13.1.2 Production of soybean in PoCRA district

Production of Soybean in India has increased at a CAGR of 9.60 per cent while a convincing growth of 43% in the annual production is observed in Maharashtra in the previous decade (43.16 lakh tonnes in 2010-11 to 62.01 lakh tonnes in 2020-21). Over the decade, an average annual production of soybean in Maharashtra has been 62.01 lakh tonnes wherein a major contribution has been from the PoCRA district (39.3 lakh tonnes). That means, around 63% of the state's soybean production has come from the PoCRA district. Figure 13.2 shows the distribution of Soybean production in the PoCRA district. The three major producing districts are Buldana, Latur and Washim.

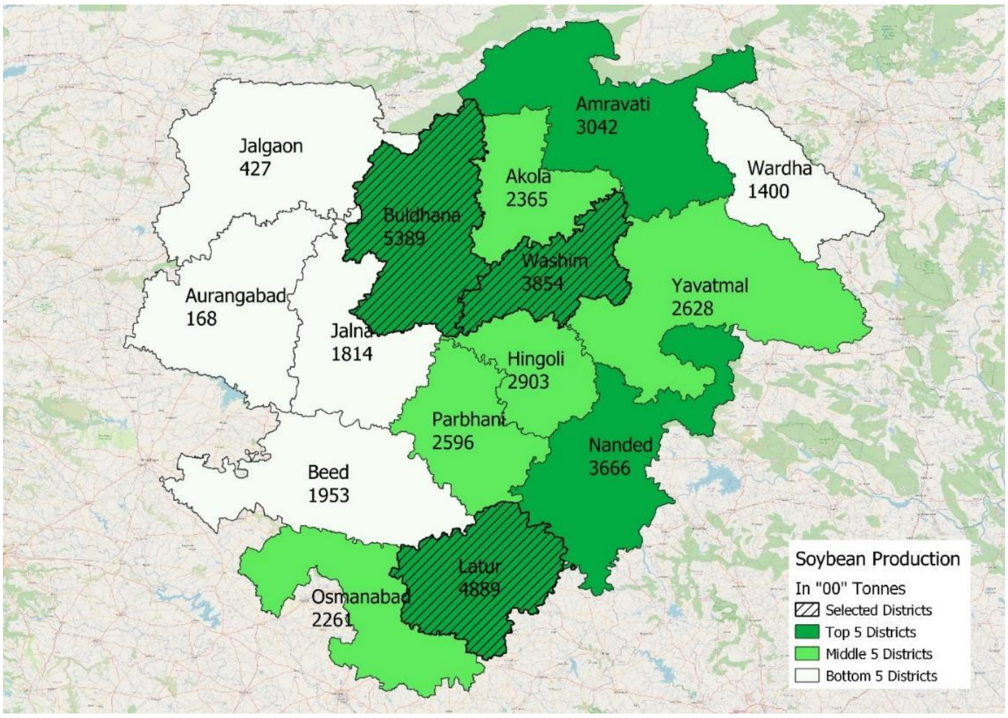


Figure 13.2 Production of Soybean in PoCRA districts

13.1.3 Quantum of Soybean in visited FPCs

The field work suggested that the quantum of soybean in FPCs was variable and a summary of the observed quantum is presented in Table 13-1. Four categories of quantum being <10MT/annum, 10-100MT/annum, 100-500MT/annum and >500MT/annum was made. Most of the visited FPCs dealt in >100MT/annum. The purpose of field visit as stated was to understand ground realities and current practices of FPCs. Moreover, the field work was a sample survey comprising of a small sample size, therefore generalization of quantum based on geography, capacity of FPCs etc. would be inappropriate. (Turmeric row in the below table could go in the turmeric part)

Table 13-1 Quantum of Soybean in visited FPCs

	<10 MT/annum	**10 to 100 MT/annum**	**100 to 500 MT/annum**	**> 500 MT/annum**
Soybean	7 (B-2,J-3, L-1, Y-1)	6 (B-1, H-3, J-1, Y-1)	10 (B-1, H-1, J-1, L-4, W-2, Y-1)	8 (B-1, H-2, L-3, W-2)

A- Aurangabad, B- Buldana, H- Hingoli, J- Jalna, L- Latur, Y- Yavatmal , W- Washim

The current soybean related activities in most of the FPCs comprised on cleaning, grading, packaging and trading. Based on discussions with the FPC directors, it was calculated that the soybean grain trading provided them a profit of around 2%. Certain FPCs were involved in soybean seed processing which generated an average profit of 15%. However rejection rate in seed processing was high and the rejected soybean would be sold as grain in market. Pertaining to soybean, no other processing activities were observed during field visits.

13.2 Proposed value added product

Given the numerous benefits of soybean consumption, it is past time to promote soybean consumption as a food component. When processed into edible forms, soybean can replace traditional diets due to its high nutritional value. In daily dietary systems, it can be used in the form of soymilk and milk products such as tofu / soy paneer.

13.2.1 What is Soymilk?

Soymilk is prepared by soaking and crushing soybeans in water to produce a creamy, milk-like beverage. In mainland China, soymilk has been consumed for centuries. Soymilk is an economical, lactose-free, highly digestible, and nutritious alternative to a dairy and meat-based diet, in addition to being high in protein, vitamins, and minerals. It can perform nearly all of the functions of bovine milk. It is a cholesterol-free product with a low fat content and a high concentration of polyunsaturated phospholipid fatty acids, particularly lecithin and linolenic acid. Soymilk typically has a total solids content of 7-8 percent. When 3-4 percent sugar and around 0.05 percent salt are added, it reaches a sugar, salt, and total solids level that is similar to toned (2 percent fat) cow's milk, i.e. about 12-13 percent total solids. This can be consumed as such or after sweetening and diluting, alternatively, it can be made into yogurt (curd) or tofu (paneer).

1.1.1.18 **Health benefits and comparison to dairy milk**

Table 13-2 illustrates that soymilk has a nutritional content that is nearly equal to or better than human and cow milk. Lactose intolerance affects around half of India's adult population. They get sick, bloated, have abdominal pain, and have gas after drinking milk. Lactose intolerance occurs in humans when the capacity to digest lactose, the carbohydrate component of cow/buffalo milk, is lost. The majority of people who have this problem are unable to notice signs when they consume dairy products. They simply refuse to consume milk. For children and adults who are lactose intolerant or allergic to bovine milk, soymilk is the effective alternative.

Table 13-2 Composition of Soy milk as compared to other milks

	Human	Cow	Buffalo	Soybean
Moisture	87.43	87.20	82.76	93.00
Fat	3.75	3.70	7.38	2.00
Protein	1.63	3.50	5.48	3.00
Lactose	6.98	4.90	5.48	0.00
Ash	0.21	0.70	0.78	0.20
Other carbohydrates	0.00	0.00	0.00	0.00

13.2.2 Market demand and Potential in PoCRA region

Currently Soy beverages have a niche market but with the increasing health consciousness among the general people, the use of Soybean is getting acceptance in the form of Soya milk, Tofu and Soya curd etc. Globally, the consumption of soy milk has increased at a rate of 20.8% from being 13.48 billion litres in 2015 to 16.29 billion litres in 2018. The global Leaders in soy milk production are as follows:

USA: DuPont, Kraft, SunOpta, Twin Oaks, Vermont Soy, White Wave, Biodyn

Europe: Unilever, TofuTown, Kalma, Assoy

Canada: Earth's Own, Yeliv

Israel: Tnuva

India: Hershey, Life Health Foods

Iran: Soya Sun

South Korea: Namyang

Latin America: Compania de Alimentos, Café Soluble, Toni S.A.

Africa: Health Life, Relish

In India, the soya milk sector is valued at Rs 50 crore. International brands like Silk and Soyfresh, as well as domestic names like Sofit (Hershey Foods) and Staeta Soy Milk, currently dominate the soy milk market (ProSoya Foods). In 2011, even Hindustan Unilever made a stir in the sector with Kissan Soya Milk. Ruchi Soya Industries, an FMCG company, also intends to re-enter the soya milk market with a changed offering and maybe a new brand. In 2008, the creator of the Nutrela brand of soya nuggets and edible oil entered the soya milk industry under the N'rich brand, but later exited. Since India is mainly a country of vegetarians, India has high potential for Soya products. Soy products are already penetrating in the Indian markets and the soy milk and soy drinks category is forecasted to grow at a CAGR of 10.6 % between 2018 to 2023 (Fnbnews, 2019). The characteristics of soy milk being lactose free makes it a superior alternative for lactose tolerant population. Soymilk and soy products has the potential to be competitive in the functional food market which is constant growing due to the health awareness and rising incomes of the Indian populations.

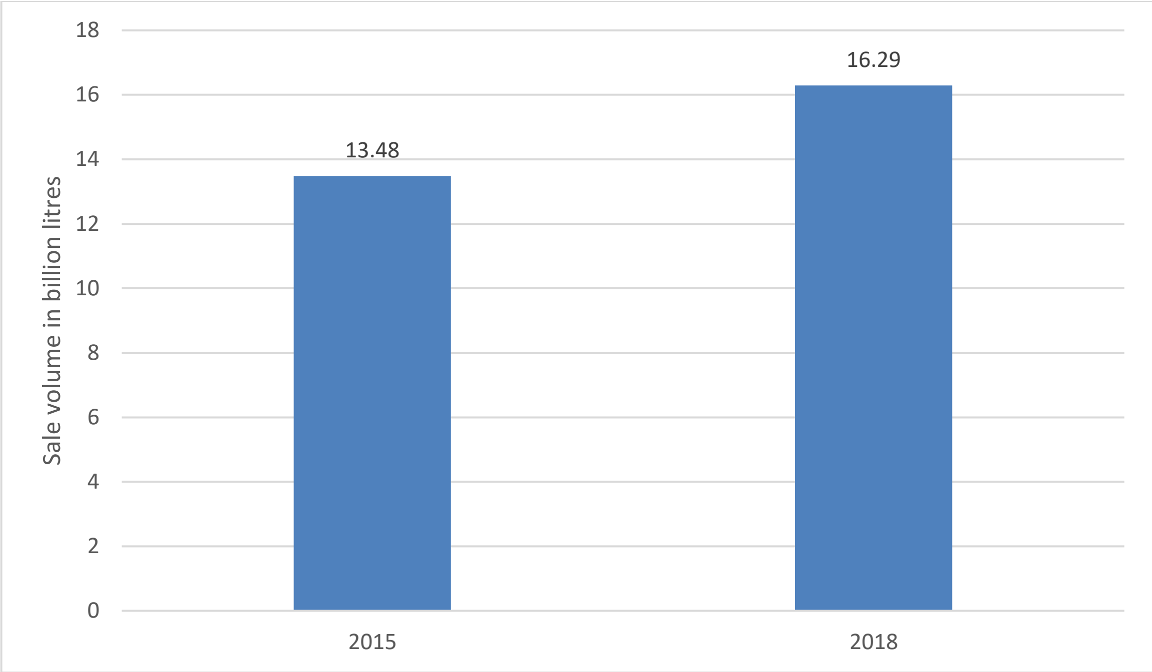


Figure 13.3Global sale of soy milk in year 2015 and 2018

Since PoCRA region has large soybean production, the availability of soybean as raw material should be convenient. Currently, the market of soy beverage is already well established in Tier-1 cities and due to the growing trend of health consciousness in Tier-2 and Tier-3 cities, the demand of soy milk and tofu is expected to rise in PoCRA region as well. The soy milk intervention could be setup even at small scale. The processing technology is simple and ready available in the Indian markets. Details of soy milk processing and economics of manufacturing is discussed in following section.

13.3 Techno-economic analysis

The following section describes the process and financial analysis of soy milk and tofu manufacturing plant.

13.3.1 Process flow diagram

The soymilk is produced in the processor by cold grinding of properly soaked soybeans in water without air, pressure cooking the resulting slurry with culinary steam and separating the soymilk from the undissolved solids (okara) in a filter press (Figure 13.4). The basic soymilk thus obtained is absolutely free from any chemical impurity and can be easily formulated into tasty cold or hot drinks, or further processed to produce tofu, yogurt, frozen desserts and a variety of other products. The list of equipment required are Grinder, Cooker; Steam generator (Boiler); and Tofu press. The production of tofu consists of two main steps: 1.The preparation of soy milk. 2. The coagulation of this soymilk to form curds which are then pressed to form tofu cakes. In general, 1 kg of soybean produced around 7.5 litre of soy milk while 1 litre of soy milk produced around 0.2 kg of Tofu after processing soy milk with coagulant.

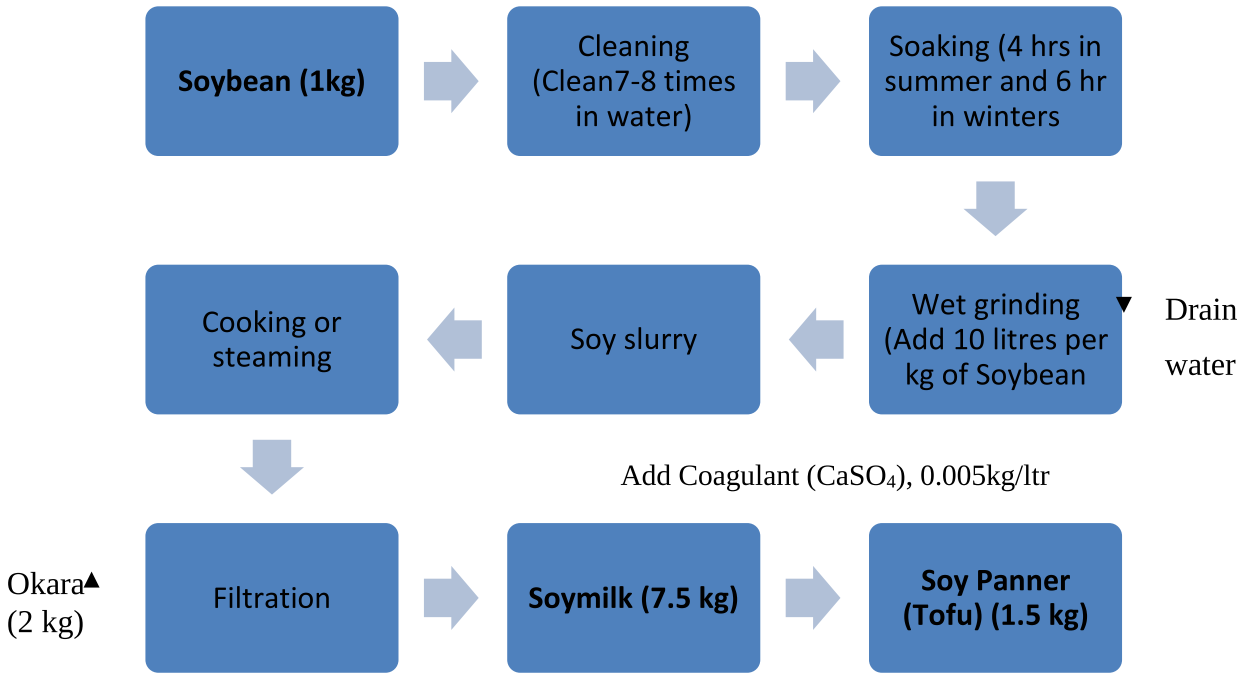


Figure 13.4 Process flow diagram of Soy milk and Tofu processing

13.3.2 Plant layout

The plant layout for soy milk and tofu processing plant is presented in Figure 20.5.

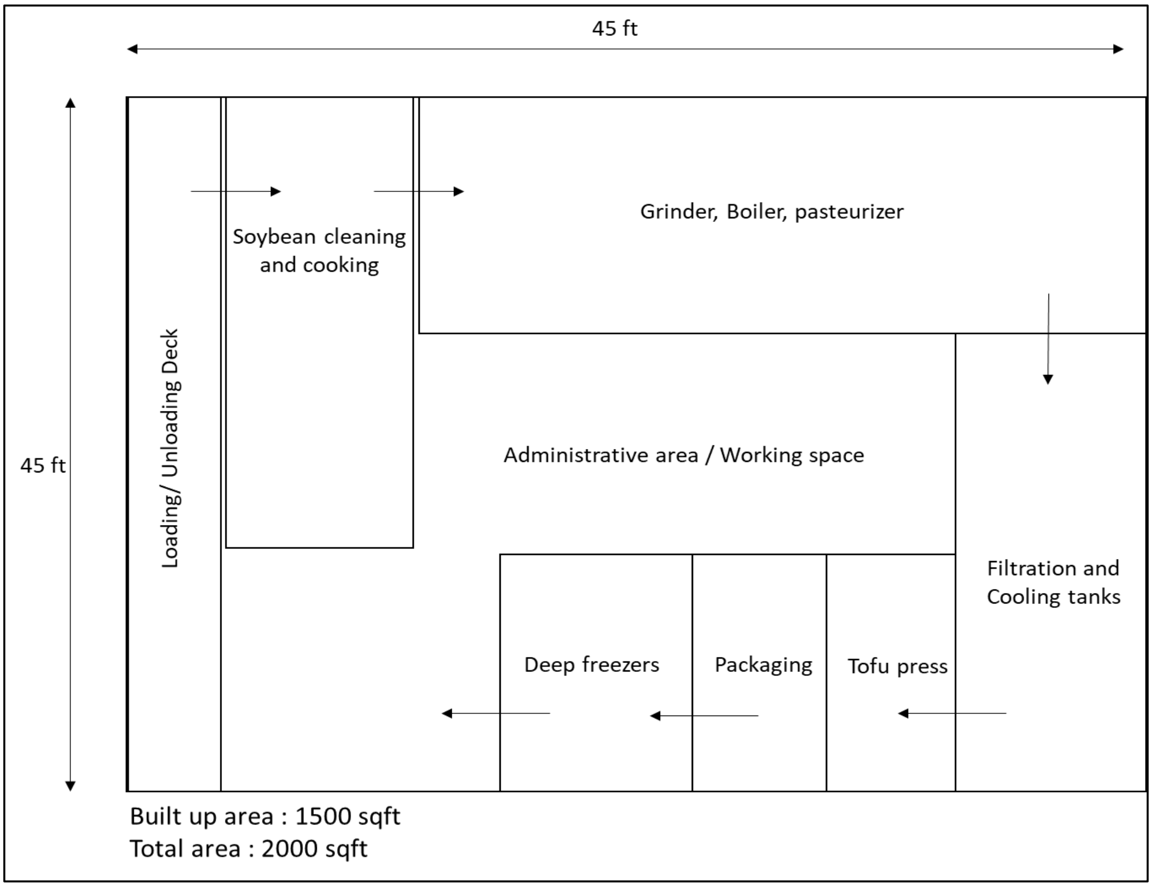


Figure 13.5 Plant layout for Soy milk and tofu processing plant

13.3.3 Financial analysis

Table 13-3 presents the financial analysis for a soy milk and tofu processing unit of 350 ltr/hr capacity. The assumptions and costs are considered after through study of literature and contact with manufacturers/vendors. The analysis has been done considering the 200 days of operations. A work shift of 8 hours is used for the analysis and based of these considerations, the annual raw material requirement (raw soybean) is estimated to be around 75 tonnes. The fixed cost (capital investment) include the cost of machinery, land, civil construction, taxes and pre-operative expenses. The operating or variable cost include the salaries of staff, cost of raw material, power/electricity, fuel, maintenance and contingency. The costs of individual items is mentioned in Table 13-3.

It is considered that of the total production, soy milk is 60% while Tofu is 40%. That means, that the 40% milk is converted into tofu. As mentioned in the process flow diagram (Figure 20.4), 1 litre of milk produces 0.2 kg of tofu. Therefore the annual production of the plant at full capacity and 60-40% distribution of milk and tofu is 336000 litres and 44800 kg respectively. Assuming a wholesale selling price of soy milk and tofu as Rs. 30 litre and Rs.

120/kg, the annual income of the plant is estimated as Rs. 1,54,56,000. Considering the life of plant as 10 years, the Net Present Value (NPV) is calculated to be Rs 1,25,26,666 at a discount rate of 10%. The calculation indicate an internal rate of return (IRR), benefit to cost ratio (BCR) and discounted payback period (DPBP) as 36%, 1.67 and 3.13 years respectively. Since, the value of IRR is in the acceptable range while BCR is more than one, it could be inferred that the soy milk and tofu processing unit of the proposed capacity is convincingly profitable.

Table 13-3Financial summary of Soy milk and Tofu processing unit

Value addition intervention – Soy milk/Tofu processing unit		**Remarks/Details**	**Values**
A.	**Machine Capacity**	In litre/hour	350
A.1	*Number of operating days*		200
A.2	*Raw material requirement per annum (at full capacity)*	In kg	74667
B.	**Capital Investment**		
B. 1	*Cost of Machine excluding taxes & duties (Grinder, Cooker, Manual Boiler, Tofu box, Tofu Press)*		385467
B.2	*Accessories*		
B.2.1	Containers and Utensils		100000
B.2.2	Vacuum packing machine	70000/unit x 2	140000
B.2.3	Pouch sealing machine	12000/unit x 2	24000

	B.2.4	Tofu slice/cutting machine (Cap-100 kg/hr)	15000/unit x 2	30000
	B.2.5	Deep freezer cost (500kg/hr)	Seven days storage post Tofu production	169641
B.3	*Land (plant area)*		In sqft (square feet)	2000
	B.3.1	Land cost (ownership/leased)	1500/- sqft including taxes	3000000
	B.3.2	Civil Work including water tank and electrical work	Construction cost 1200/sqft + utility cost 300/sqft (Electrical)	3000000
B.4	*Pre-Operational Expenses*			
	B.4.1	GST on machines	18%	152839
	B.4.2	Licencing and registration fees		300000
	B.4.3	Training, Installation and delivery charges	10% of equipment cost	70911
	B.4.4	Office Furniture & Equipment		50000
	B.4.5	Miscellaneous		50000
B.5	*Total Capital Investment (B.1+B.2+B.3+B.4)*			7472858
C. Annual Expenses				
C.1	*Interest on Loan@ 10%pa*		Considering 40% of capital cost is loaned by FPC	298914

C.2	*Manpower Cost 3 Workers @ 10000/- per month*			400000/- marketing expenditure per annum	760000
C.3	C.3.1	Raw soybean		60 Rs/kg	4480000
	C.3.2	Coagulant ($CaSo_4$)		25 Rs/kg	70000
	C.3.3	Packaging material			
		C.3.3.1	Milk packing material	Tetra pack (200 ml) - 5 Rs/unit	1678320
		C.3.3.2	Tofu packing material	250 gram pieces - 2.5 Rs/unit	111888
C.4	*Power Consumption*				
	C.4.1	Unit consumed per annum			107461
	C.4.2	Cost of Electricity @ Rs. 10/kWh		Industrial power supply- 10Rs/kWhr	1074610
C.5	*Cost of Water*			RO water - 0.4 /litre	2240000
C.6	*Maintenance*				20000
C.7	*Fuel-LPG*			900 Rs/cylinder	44053
C.8	*Contingency*			5% of total fixed cost	373643
C.9	*Depreciation*				
	C.9.1	Depreciation on Furniture		at 10%	5000
	C.9.2	Depreciation on Machines		at 10%	74911

	C.9.3	Depreciation on Civil work	at 10%	300000
C.10	Total Annual Expenses (C1:C9)			11531340
D.	**Total production per annum**		**Distribution of production**	
D.1	*Soy milk (Plain)*		60% of total production	336000
D.2	*Soy Tofu*		40% of total production	44800
E.	**Cost of production**			
E.1	*Soy milk (Plain)*			20.59
E.2	*Soy Tofu*			102.96
F.	**Annual Income (Full capacity)**			
F.1	*Soy Milk (Plain)*		Soy milk selling price -30 Rs/ltr	10080000
F.2	*Soy Tofu*		Soy Tofu selling price -120 Rs/ltr	5376000
F.3	*Total income*			15456000
G.	**Economic Indices**		Plant life: 10 years. Capacity Utilization : Year 1- 50% , Year 2 – 65%, Year 3 – 80%, Year 4 onwards 100%	
G.1	*Net present value (NPV)*		In Rs.	12,52,6666
G.2	*Internal rate of return (IRR)*		%	35.98
G.3	*Benefit to cost ratio (BCR)*			1.676
G.4	*Discounted payback period*		In years	3.136

13.3.4 Sensitivity analysis

To understand the impact of fluctuation of variables on the returns, a sensitivity analysis is done. Those variables are chosen which might vary in real time situations. These variables are cost of raw soybean, cost of water, cost of packaging material, soy milk selling price, soy tofu selling price, capital investment, operating days, production distribution and plant capacity. A variation of ± 30% in the variables is considered for this analysis while its impact on the BCR is studied. The plant capacity is varied at 200 lph, 350 lph (base case) and 500 lph while scenarios for production distribution are 80-20, 60-40 and 40-60 (Soy milk- Tofu). The analysis is done by changing one variable at a time while keeping others constant.

Figure 13.6 shows the results of the sensitivity analysis. The base case-350lph is taken as benchmark to understand the variation due to each variable. As seen in Figure 13.6, soy milk selling price is the most sensitive variable as it causes the highest variation. Similarly, in the order of sensitivity, operating days, tofu selling price and cost of raw soybean are the next three sensitive variables. Production distribution turns out to be the least sensitive, meaning that by changing the production distribution pattern from 60-40 to 80-20 doesn't affect the BCR significantly as compared to other variables. It could also be observed in Figure 13.6 that the BCR in certain scenarios is less than 1, suggesting that those scenarios should be avoided to prevent losses.

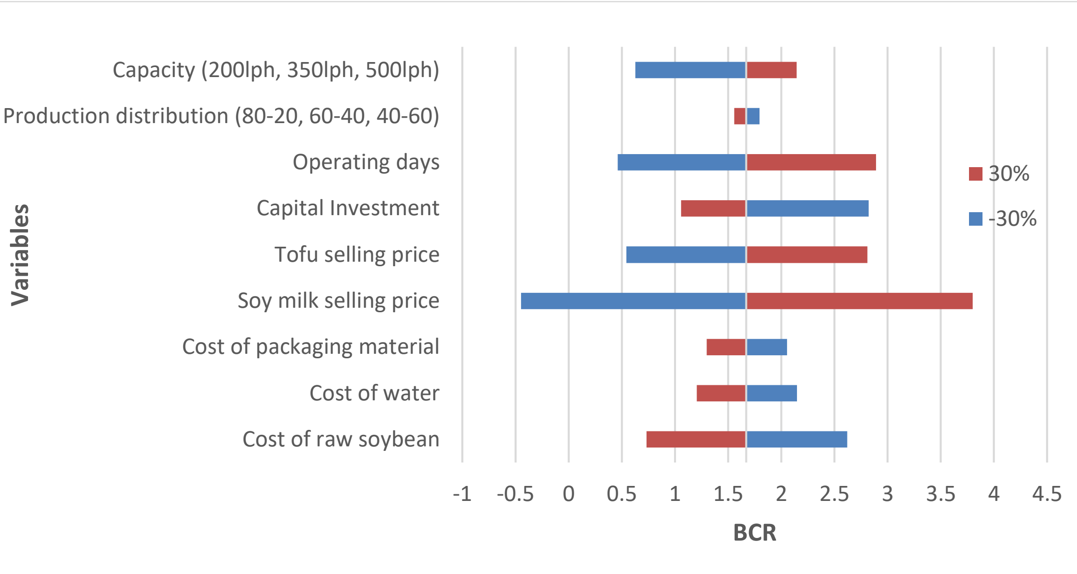


Figure 13.6 Sensitivity analysis of Soy milk and Tofu processing

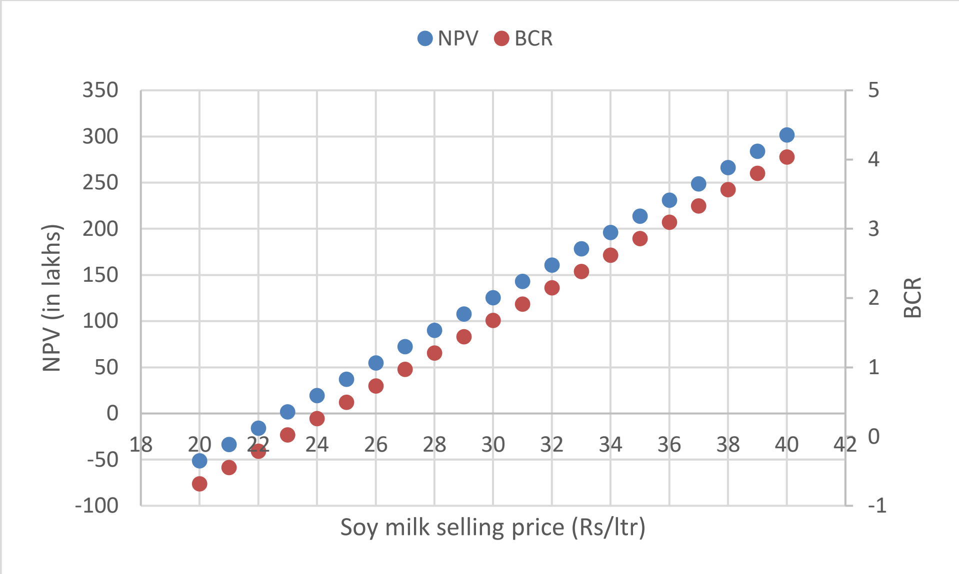


Figure 13.7 NPV and BCR vs Soy milk selling price

Since soy milk selling price is observed to be the most sensitive parameter, another study is performed to understand the variation of soy milk selling price with NPV and BCR. The purpose of this study is to identify threshold values of soy milk selling price, below which the soy milk should not be sold to avoid losses. The cost of production of soy milk is estimated as Rs. 20.59/ltr which means selling soy milk higher than Rs. 20.59/ltr would be profitable. However, as suggested in Figure 13.7, for positive NPV, the milk selling price should be above Rs. 23. Also, considering a BCR more than 1, the minimum value for selling milk should be more than Rs. 27.15. For better scenarios such as a selling price of Rs. 40, the BCR could be as high as 4.03. It could be inferred that an appropriate price for selling the soy milk should be above Rs. 27.15/kg while to achieve a BCR of 2 and 3, the prices should be Rs. 31.4/kg and Rs. 35.6/kg.

13.3.5 Conjoint analysis

Three cases of raw material prices (raw soybean) are developed for conjoint analysis.

Low – Rs. 48/kg

Baseline – Rs. 60/kg

High - Rs. 72/kg

The effect on NPV of variation in raw material price and milk selling price is shown in Figure 13.8. Similarly, the effect of variation in raw material price and operating days in shown in

Figure 13.9. The project viability is negative (NPV<0) in high case with low milk selling price and less operating days. Therefore these scenarios should be avoided for profit viability.

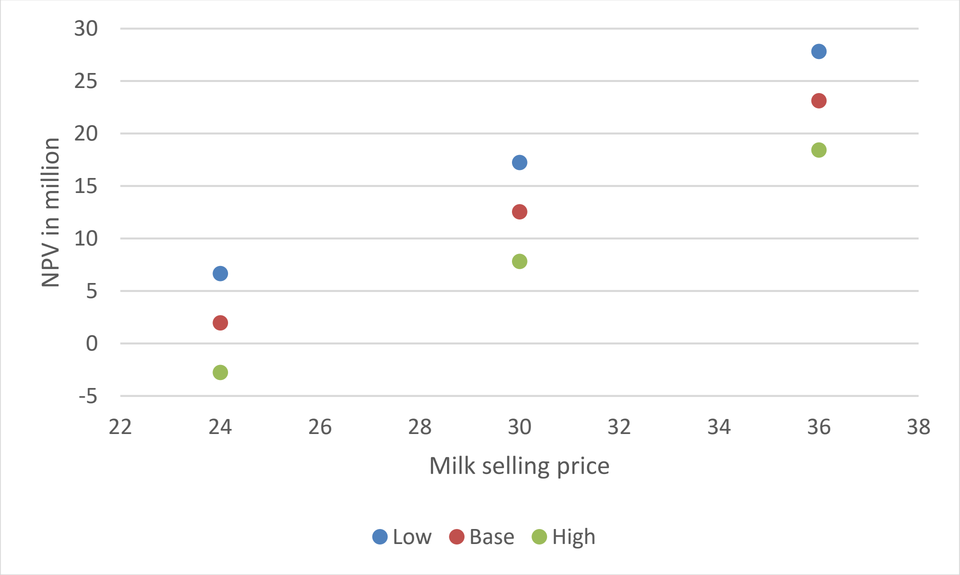


Figure 13.8 Effect of soy milk selling price and raw material price on NPV

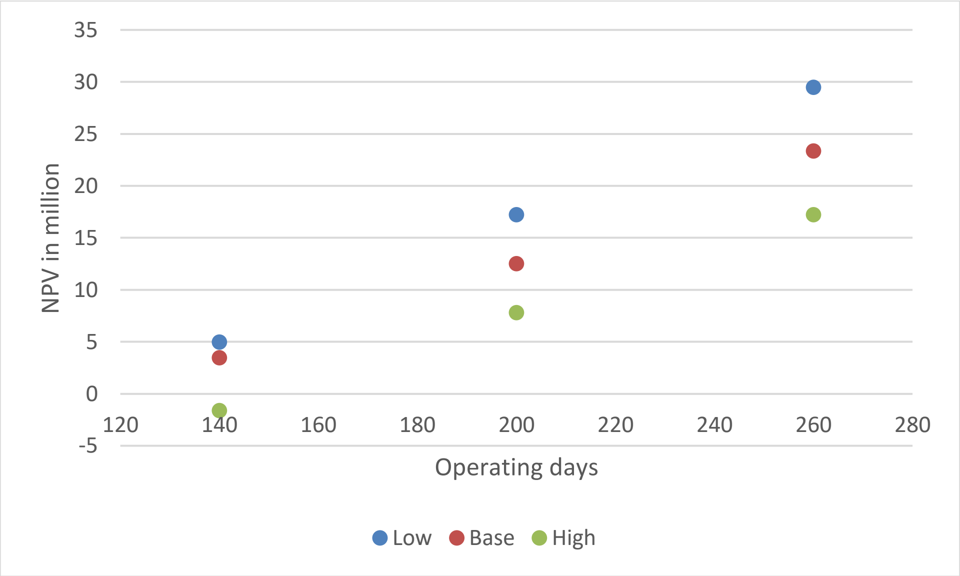


Figure 13.9 Effect of operating days and raw material price on NPV in soymilk processing

13.3.6 Breakeven points

The project is profitable only when the selling price of soy milk is above ₹ 27.15/lit. The project is profitable when operated at least for 140 days in case of low case and base case scenario as mentioned above and in case of high case scenario it is profitable when operated at least for 160 days.

13.3.7 Monte-Carlo simulations (Uncertainty analysis)

As discussed in section 13.3.5, a monte-carlo simulation has advantages over sensitivity analysis to estimate the uncertainty in a project. The parameters that may vary in soymilk processing plant simultaneously are as mentioned in Table 13-4.

Table 13-4 Range of uncertain parameters considered for monte-carlo simulation of soy milk/tofu processing unit

Parameter	Min	Max
Soybean cost (Raw material)	50	70
Soymilk selling price	25	35
Soy tofu selling price	100	140

The simulation results in terms of NPV and BCR are shown in Figure 13.10 and Figure 13.11 respectively. Ten thousand scenarios are generated using the range of uncertain parameter to capture every possible real life scenario. The blue bars indicate a favourable scenario while a red bar is an unfavourable scenario. A probability that among all the scenarios, the plant would have a positive NPV is 99.7% while that the plant will have a BCR greater than one is 78.8%.

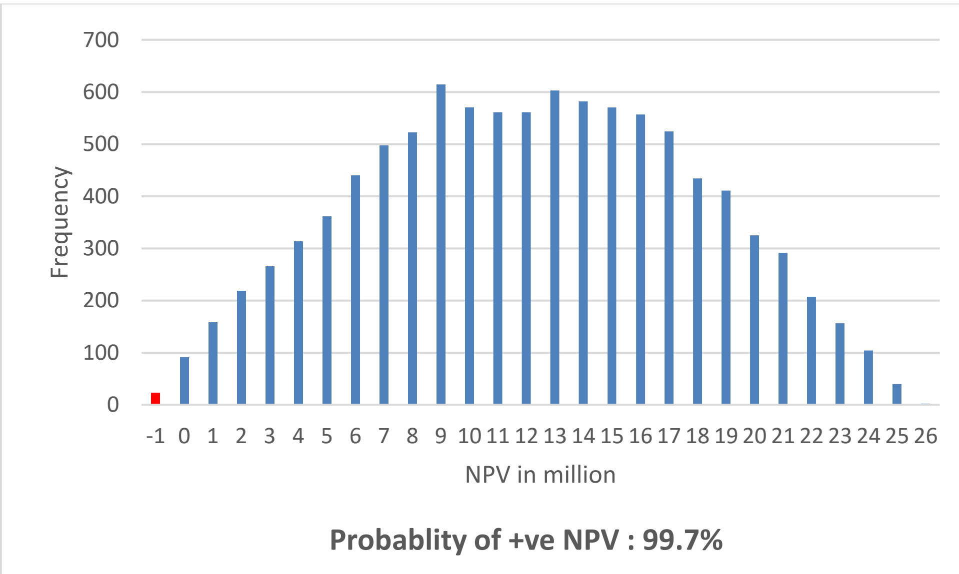


Figure 13.10 Histogram showing Monte Carlo simulation w.r.t to NPV for soymilk plant

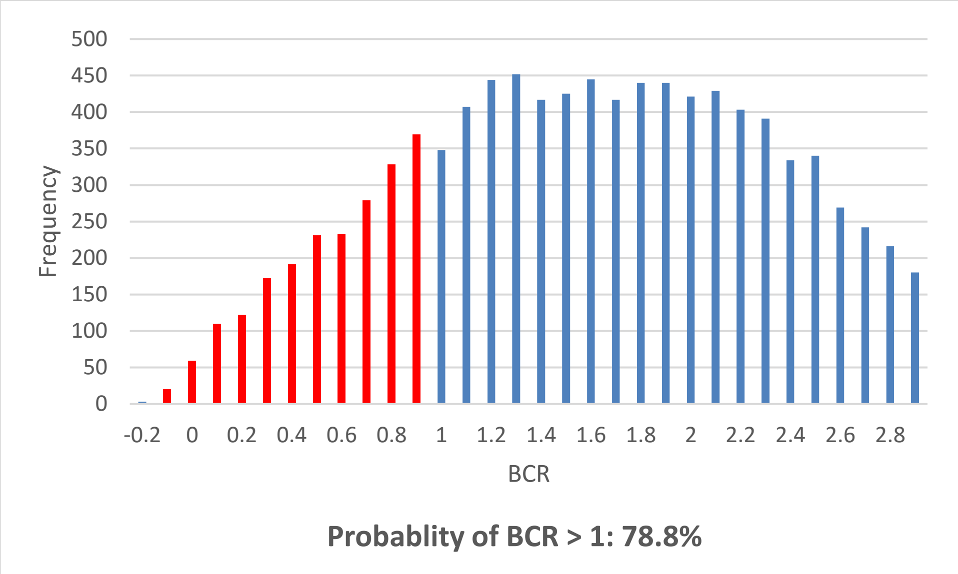


Figure 13.11Histogram showing Monte Carlo simulation w.r.t to BCR for soymilk plant

13.4 SWOT analysis

Strength	Weakness
• Soy milk captures the nutritional qualities of soybean and is an impressive alternative to dairy milk. • Soymilk base lends itself to making several value added products like tofu, yogurt, soy-cream, soy ice-cream and soymilk base chocolates, energy bars and sweets. • Efficient and cost-effective technologies are now available for soymilk processing.	• Lack of awareness among the general public belonging to all classes, ages and groups about the value and role of soybean and its products as indispensable part of daily diet, in providing vitamins, minerals and proteins, is a major challenge. • Advertising and promotional measures to increase the sales are also a weak point of the industry. • Lack of awareness regarding the latest innovations in the soymilk production process is another reason for low rate of adoption among entrepreneurs.
Opportunities	**Threats**
• Large scope of tapping the "Protein rich- lactose free-healthy" products market.	• The taste of soymilk is different than dairy milk therefore competition with dairy milk is difficult

● Scope for technology upgradation. ● FPOs can also tap opportunity of soymilk for malnourished children programs or distribution in school programs.	● Branded products have high visibility and acceptance due to their constant high cost marketing efforts. Even on shelf, consumers often chose these brands due to familiarity with these brands. ● Perishability of soy milk and allied products

13.5 Forward and Backward linkages

Following is the list of Soymilk Wholesaler:

- **Yash Enterprises**, B u bhandari industrial estate B/38 GAT No.15, taluka shirur, Sanaswadi, Pune-412208, Maharashtra, India, +91-8048250466
- **Heet Enterprise**, Mahadev nagar 136 nr. nivrutinath mandir bhatar, althan, Surat-395017, Gujarat, India +91-8048371514
- **Supreme Enterprises**, A-3, Brindavan Housing Society, Near B.A.R.C. Hospital,Lala Jamnads Marg, Deonar, Mumbai-400088, Maharashtra, India, +91-8046073527
- **Nisha Agencies**, 1st Floor 57/54 Kutti Thambiran Street, Muthu Hospital, Pulianthope, Chennai-600012, Tamil Nadu, India, +91-8046075599
- **Laksh Agro,** Kamlabai chawl halavpool masrani lane near gauri, Near gauri shankar mandir, Kurla, Mumbai-400070, Maharashtra, India, +91-8048781453
- **Amara Services,** C3/13, Nilgiri CHSL, Deonar Baug, Deonar, Mumbai-400088, Maharashtra, India, +91-8048372664

The entrepreneur must provide tentative supplier list and quotations with respect to his project. However, there are many machinery suppliers available within India for soymilk machineries and equipment. Following is the list of machine suppliers:

- **Pushpanjali** Agro Tech, Gaurav park 29 jagadhri road ambala cantt, Tangri Bridge, Mahesh Nagar, Ambala-133001, Haryana, India, +91-8048372771
- **KSP Equipment**, MCF 24, Gali No. 2, Bhikam Colony, Dominos Pizza, Ballabhgarh, Faridabad-121004, Haryana, India, +91-8048738957

- **Bhavya Unity India Services**, Mahadev nagar kerakatpur, Shiv Mandir, Bhitari Road, Varanasi-221107, Uttar Pradesh, India, +91-8048570683

13.6 Food safety standards for soy milk/tofu processing unit

Food processing industry in India require certain licences to produce and market their consumable products. FSSAI (Food Safety and Standard Association India) lays the science based standards for food articles that regulates manufacturing, storage, distribution, sale and import of food. FSSAI is mandatory before starting any food business and is issued with a validity of one to five years. It is a 14 digit registration or licence number which is printed on food package.

The Codex Alimentarius Commission (CAC) was created in 1961/62 by Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO), to develop food standards, guidelines and related texts such as codes of practice under the Joint FAO/WHO Food Standards Programme. The FSSAI, (Ministry of Health and Family Welfare) has been designated as the nodal point for liaison with the Codex Alimentarius Commission. Codex standards are preferred for import and export of food articles.

13.6.1 FSSAI specification for raw material

Soybean shall be obtained from the plants of Glycine max (L.) Merr, which shall be mature, clean and dried seeds free from moulds and musty odour and shall also be free from non-edible and toxic seeds. Table 13-5 mentions the parameters and respective limits for FSSAI specification for soybean.

Table 13-5FSSAI specification for raw material (Soybean)

Parameter	**Limit**
Moisture (%), Maximum	12
Extraneous matter	< 1 % by weight of which not more than 0.25 % by weight shall be mineral matter and < 0.1 % by weight shall be impurities of animal origin
Organic (%), Maximum	
Inorganic (%), Maximum	
Immature, Shrivelled and green seeds (per cent. by mass), Maximum	6

Weevilled Seeds by count (no. of grains/100g) (%), Maximum	2
Damaged or split or cracked seed (% by mass), Maximum	4
Oil content (% on dry basis), (%), Minimum	13
Acid Value of extracted oil (Maximum)	2.5
Uric acid (mg per kg), Maximum	100

13.6.2 FSSAI specifications for soybean based beverages

Table 13-6 presents the FSSAI specifications for Soybean based beverages.

Table 13-6 FSSAI specification for soybean based beverages

Food Category system	**Food Category**	**Food Additive**	**INS No.**	**Recommended maximum level**
6.8.1	Soybean based beverages	Caramel III - ammonia caramel	150 c	1500 mg/ kg
		Phospahates		1300 mg/ kg
		Riboflavins		50 mg/kg
		Steviol glycosides	960	200 mg/kg
		Sucralose (Trichlorogalactosucrose)	955	400 mg/kg

13.6.3 Codex standards for soy milk

The term ‘soybean milk’ is also inconsistent with the use of terminology in the Codex General Standard for Food Additives, CODEX STAN 192, (GSFA), section 06.8.1 which uses the term ‘Soybean-based beverages’ and does not use the term ‘Soybean milk’. Furthermore, the GSFA 06.8.1 acknowledges that in a number of countries the category ‘Soybean-based beverage’ includes products referred to as ‘soybean milk’ but does not use this terminology in the Codex standard. This approach is consistent with the spirit of the GSUDT (General Standards for the Use of Dairy Term) and is prudent.

13.7 Conclusion

In this section, soy milk and tofu processing unit is introduced and its market potential is discussed. Based on the techno-economic analysis, it is understood that the soy milk and tofu plant of the proposed capacity is profitable with a quantum requirement of around 75 MT/annum. Based on the field visit experience, majority of the FPCs have sufficient quantum to venture into the soy milk business. Additionally, it is observed in the analysis that as the capacity of the unit is increased, the profitability increases therefore FPCs with large quantum could plan higher capacity processing plants.

The plant economics is highly dependent on the selling price of the soy milk and tofu as observed in the sensitivity analysis. A detailed uncertainty analysis using Monte Carlo method clearly shows that probability of achieving positive NPV and BCR greater than one is high.

As compared to the current activities of FPCs, soy milk processing plant could provide a profit of around 135% while trading and seed processing could generate merely 2% and 15% respectively. Therefore soy milk and tofu processing unit could be seen as highly profitable value addition intervention for the PoCRA region.

14 Comparison of Poultry feed and Soy milk/tofu unit

Currently in India, soy milk and tofu have a growing yet market and the forward linkages primarily depend on the demand and marketing. Whereas, the demand for protein rich poultry feed in India is established and perpetual. With respect to the financial analysis done in this study, soy milk and tofu could be produced at the same scale as poultry feed which would further improve the economic indicators. However, due to conservative demand, the production quantum of soy milk/tofu is kept low in this study. The FPCs could start with small capacity plant and could upgrade the scale in 4-5 years after establishing markets for these products.

The main raw material for soy milk/tofu unit is raw soybean grain while in poultry feed unit, soybean in the form of soymeal is used along with maize as main raw materials. Soymeal is a by-product of soy oil extraction process therefore a poultry feed unit could to be aligned with soy oil unit to add value to soymeal which in else case is generally traded at a nominal rate of around Rs. 50/kg.

The perishability of final products in soy milk/tofu unit and poultry feed unit is distinct. The shelf life of pellets is high therefore its post-production handling and management is easy.

Whereas, soy milk and tofu are highly perishable and require a consistent cold chain to reach the consumers. Moreover, due to the high perishability & sensitivity of soy milk and tofu, the plant hygiene require immense care unlike poultry feed unit.

Table 14-1 presents certain economic parameters for the two propositions considering the base cases. A comparison of plant economics suggests that the soy milk/tofu venture could be started with less capital investment and operating cost than poultry feed. While, the economic indicators (NPV, BCR, IRR) suggest poultry feed unit as more profitable. There's a trade-off in terms of initial investment and returns. For both the unit, the raw material cost (soymeal and raw soybean) contribute to around 40% in the operational cost. A 10% increase in soymeal cost reduces the NPV of poultry feed unit by 23% while in case of soy milk/tofu unit, an increase of 10% in raw soybean cost reduces the NPV by around 19%. On the other hand, if the selling price of poultry pellet is increased by 16%, then the NPV increases by around 108%. In soy milk/tofu unit, an increase of 16% in selling price of soy milk increases the NPV by 70%. The poultry feed unit is slightly more sensitive to changing price of raw material and finished products. The monte-carlo simulation shows the riskiness of any business and this exercise in the current study suggest that the probability of success (BCR>1) in poultry feed unit (composition one) is 96% while that in soy milk/tofu business is 78.8%. It could be commented that the poultry feed business is safer as compared to soy milk/tofu considering the uncertain factors such as prices of inputs and outputs.

Table 14-1 Comparison of Poultry feed and Soymilk/tofu unit (Base cases)

Parameter for comparison	**Poultry feed unit**	**Soy milk and Tofu unit**
Plant Capacity	1 TPH	350 lit/hr
Direct capital investment (in Rs.)	13,596,000	7,472,858
Total Operational Cost (in Rs.)	145,104,000	11,531,340
Soybean associated raw material cost as the percent of total operating cost	40.12%	38.8%
NPV (in Rs.)	90,000,000	12,526,666
IRR	27.1	35.98
BCR	3.14	1.67
PBP	1.7	3.13
Probability of success (BCR>1)	96%	78.8%

15 DPR of Turmeric powder and Curcumin extraction

15.1 Turmeric as commodity

Curcuma Longa L. is the scientific name for turmeric. It is a member of the "Zingiberaceae" family. It's a South East Indian and Indonesian native. It's a common ingredient in foods, pharmaceuticals, and other products. It's also used in the textile business to make oils, ointments, and poultices, as well as in cosmetics to make natural and herbal creams, lotions, and hair dye. Turmeric, the principal spice powder in Indian cuisine, is often regarded as the world's most powerful herb for combating and possibly reversing disease. Turmeric is an annual crop, although it is produced as an erect perennial crop. It's widely utilized in the food, textile, pharmaceutical, and cosmetic sectors. Turmeric is grown in both tropical and subtropical climates.

15.1.1 Composition of turmeric

The detail chemical composition is mentioned in Table 15-1

Table 15-1 Composition & Nutritive Value of Turmeric (per 100 g of edible portion), fresh weight basis

Principle	**Nutrient Value**	**Percentage of RDA**
Energy	354 Kcal	17%
Carbohydrates	64.9 g	50%
Protein	7.83 g	14%
Total Fat	9.88 g	33%
Cholesterol	0 mg	0%
Dietary Fiber	21 g	52.5%
Vitamins		
Folates	39 µg	10%
Niacin	5.140 mg	32%
Pyridoxine	1.80 mg	138%

Riboflavin	0.233 mg	18%
Vitamin A	0 IU	0%
Vitamin C	25.9 mg	43%
Vitamin E	3.10 mg	21%
Vitamin K	13.4 µg	11%
Electrolytes		
Sodium	38 mg	2.5%
Potassium	2525 mg	54%
Minerals		
Calcium	183 mg	18%
Copper	603 µg	67%
Iron	41.42 mg	517%
Magnesium	193 mg	48%
Manganese	7.83 mg	340%
Phosphorus	268 mg	38%
Zinc	4.35 mg	39.5%

Source: USDA National Nutrient Database

15.1.2 Production of turmeric in PoCRA district

The production turmeric in PoCRA region has increased significantly in last 5 years from 1.23 lakh metric tons in 2016-17 to 2.71 lakh metric tons in 2020-21. The area under cultivation of turmeric in the region has increased from 7.12 thousand hectare to 52.16 thousand hectare in 2020-21. In last 5 years, the average annual production of turmeric in PoCRA region has been 3.52 lakhs tons. Table 15-2 shows major species grown the PoCRA region and their range of curcumin content. Figure 15.1 Table 15-1shows the production distribution of Turmeric in PoCRA and non-PoCRA districts

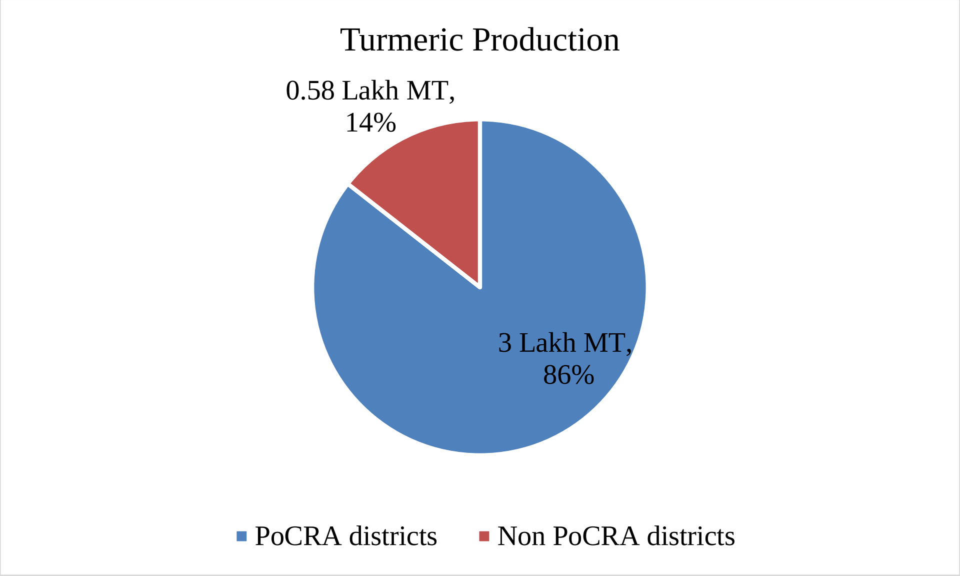


Figure 15.1 Production of Turmeric in Maharashtra with respect of PoCRA and Non-PoCRA districts

Table 15-2 Spices of turmeric in PoCRA region

Species of turmeric	**Approx curcumin content**
Pratibha	3.5-7.7 %
Selam	2.2-5.9 %
Rajapuri	2.8-4.4 %
Krishna	1.6-3.5 %

Figure 15.2 shows the distribution of turmeric in PoCRA region. The three major producing districts are Hingoli, Washim and Yavatmal. Since the quality of turmeric is dependent on its curcumin content, the species that are grown in the region need to be considered.

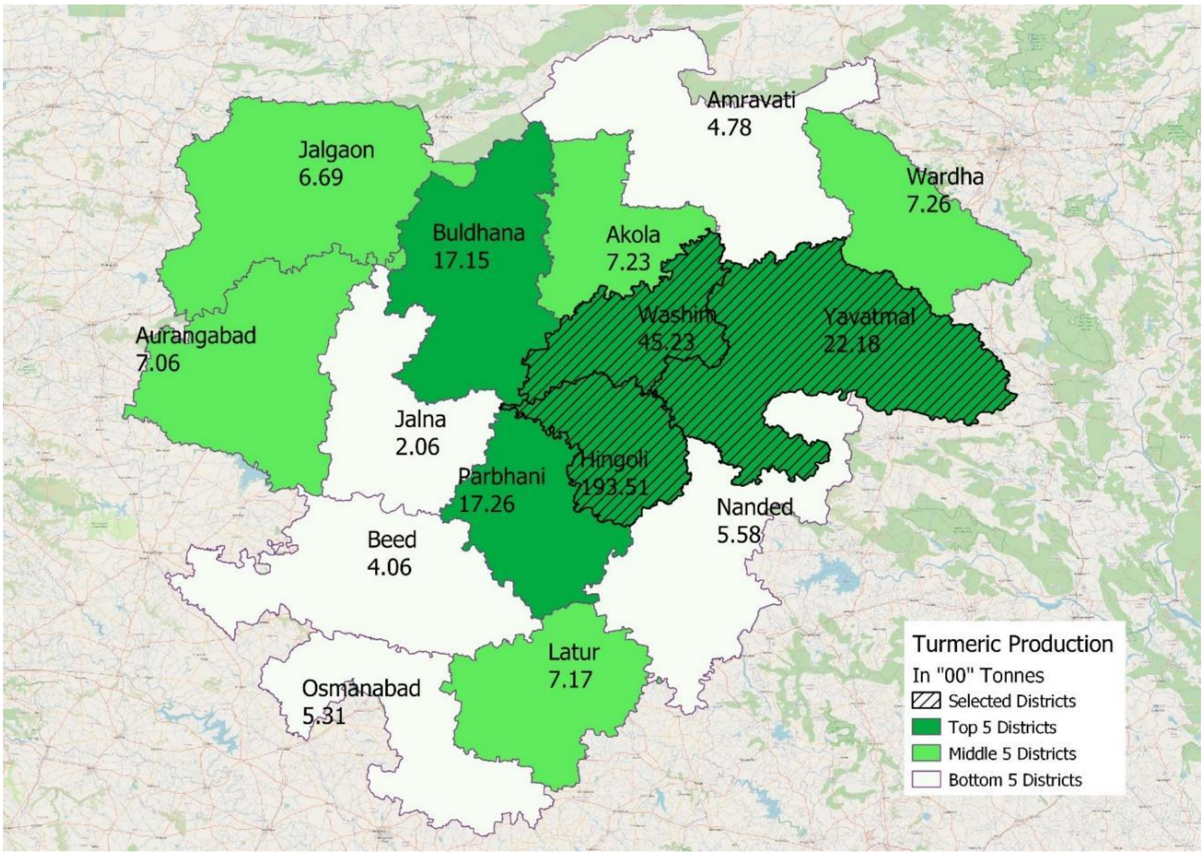


Figure 15.2Production of Turmeric in PoCRA districts

15.1.3 Quantum of turmeric in visited FPCs

The field work suggested that the quantum of soybean in FPCs was variable and a summary of the observed quantum is presented in Table 15-3. Four categories of quantum being <10MT/annum, 10-100MT/annum, 100-500MT/annum and >500MT/annum was made. Most of the visited FPCs dealt in >100MT/annum. The purpose of field visit as stated in section 16 was to understand ground realities and current practices of FPCs. Moreover, the field work was a sample survey comprising of a small sample size, therefore generalization of quantum based on geography, capacity of FPCs etc would be inappropriate.

Table 15-3 Quantum of Turmeric in visited FPCs

Quantum Commodity	**<10 MT/annum**	**10 to 100 MT/annum**	**100 to 500 MT/annum**	**> 500 MT/annum**
Turmeric	2 (H-2)	1 (H-1)	2 (A-1 , H-1, L-1, W-1)	1 (H-1)

A- Aurangabad, H- Hingoli, , L- Latur, W- Washim

The current soybean related activities in most of the FPCs comprised on trading. No other processing activities were observed during field visits.

15.2 Proposed value added product

Given the high medicinal value and multiple uses in various industries such as nutraceuticals, textile, food etc. turmeric and its value added products have the potential to seek high prices as well as have high demand in the market. Figure 15.3 shows the potential value added products of turmeric rhizomes. The most commonly used is turmeric powder. Other popular products are curcumin powder, oleoresin and volatile oil. The subsequent sections describe processing of turmeric powder and curcumin powder along with oleoresin from dried turmeric rhizomes.

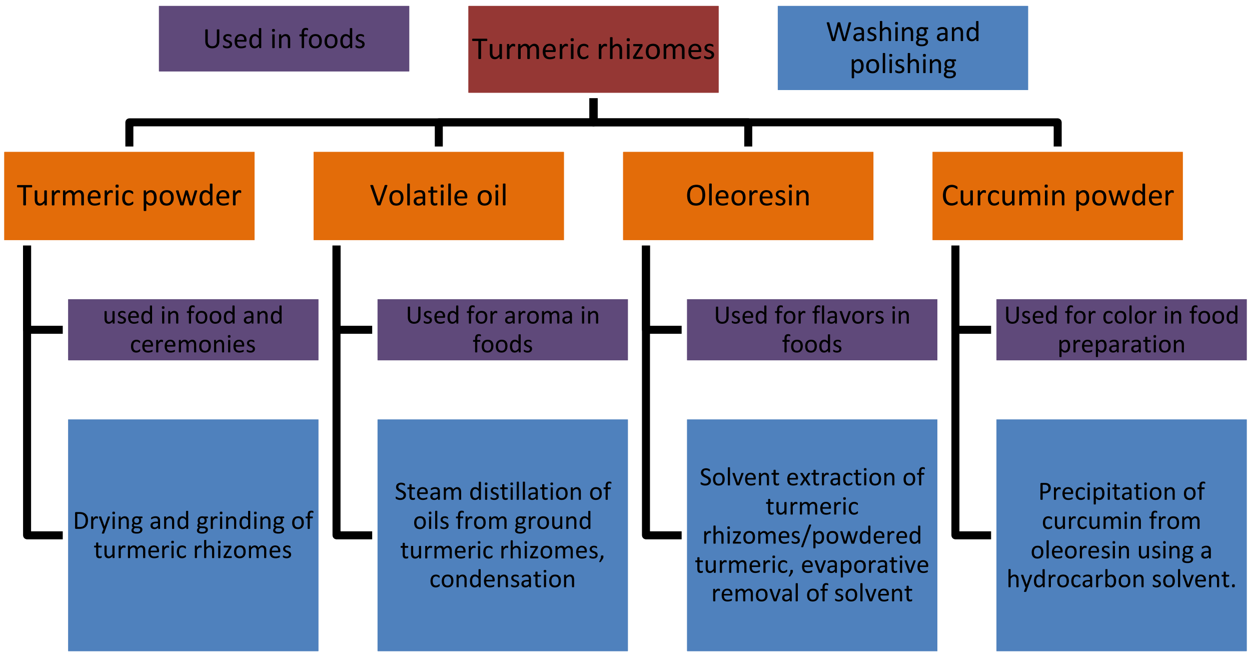


Figure 15.3Potential value added products of turmeric rhizome

The turmeric is most commonly consumed as its powder. The detail process of getting turmeric powder from the cultivated rhizomes along with the financial and sensitivity analysis is given in the following section.

15.2.1 Market demand and Potential of Turmeric powder and Curcumin

India is the world's leading producer, consumer, and exporter of turmeric. Turmeric was grown on 1.94 lakh hectares in India in 2016-17, with a production of 10.51 lakh tonnes. Turmeric production is estimated to be over 11 lakh tonnes per year worldwide. India leads the global production scenario with 78 percent, followed by China (8 percent), Myanmar (4 percent), and Nigeria and Bangladesh, which together account for 6% of global production. With a share of around 76 percent of total worldwide output and 90 percent of global trade, India is effectively a monopolistic provider to the world. Among Indian states, Maharashtra is second top producer and contributes around 18.57% in the total turmeric production.

The increasing urbanization offers huge market for readily available Turmeric powder packaged attractively and merchandised in organized urban platforms such as departmental stores, malls, super markets. Moreover, the increasing demand for natural products as food additives makes turmeric powder an ideal candidate as a food colorant, thus increasing demand for it

Curcumin has been shown to lower blood cholesterol in studies conducted over the previous five decades. The major yellow bioactive component of turmeric, curcumin (diferuloylmethane), has been proven to have a wide range of biological activities. Its anticancer activity is primarily mediated by apoptosis induction. Curcumin's potential as a therapy for Alzheimer's disease, viral infections, inflammation, malignancies, gastrointestinal disorders, and other conditions has prompted much research and development. It is certainly clear that the medicinal properties of curcumin generates its huge demand in the pharmaceutical industry. India is the world's largest producer of curcumin, accounting for more than 80% of global production. The worldwide curcumin showcase measure is anticipated to reach USD 99.3 million by 2024 and USD 151.9 million by 2027, growing at a CAGR of 12.7%. The pharmaceutical application segment led the market in 2020 with the highest revenue share of more than 51%. The segment is estimated to expand further at the fastest CAGR from 2020 to 2028. For many centuries, curcumin has been widely used in traditional Asian herbal medicines to treat infections and inflammation. The cosmetics application segment is estimated to have significant growth over the forecast period.

Sudden outbreak of the COVID-19 pandemic has led to the increasing utilization of curcumin in the healthcare sector based on its anti-inflammatory, anti-oxidative, anti-fungal, and anti-bacterial properties that help in treating the viral infection. Global market for curcumin was record at over USD 70 million in 2020 and will expand at more than 11% CAGR through 2027. In Europe, the application of curcumin in the pharmaceuticals sector accounted for a share of 57.2% in terms of revenue in 2019 owing to increasing focus on the marketing of capsules/tablets that offer aid to the immune system, joint, and digestive health.

Some of the major players in the global curcumin market include Arjuna Natural Pvt Ltd., Biomax Life Sciences Limited., Helmigs Prima Sehejtera, Herboveda India Pvt. Ltd., Hindustan Mint & Agro Products Pvt. Ltd., Konark Herbals & Healthcare, Rosun Natural Products Pvt. Ltd., Sabinsa Corporation, Star Hi Herbs Pvt. Ltd., SV Agrofood, Synthite Industries Ltd., and Wacker Chemie AG.

Since, PoCRA region, especially Hingoli has recently become the epicentre of turmeric trade in the state, availability of raw material for processing should be comfortable. Also, the established demand of turmeric powder and curcumin in regional, national and international markets make turmeric powder and curcumin proposition advantageous for the FPCs.

15.3 Techno-economic analysis of turmeric powder

The following section describes the process and financial analysis of turmeric powder manufacturing plant.

15.3.1 Process flow diagram

The process involved in manufacturing turmeric powder are as follows: boiling, drying, polishing, grinding, sieving and packaging. Figure 15.4 presents the process flow diagram.

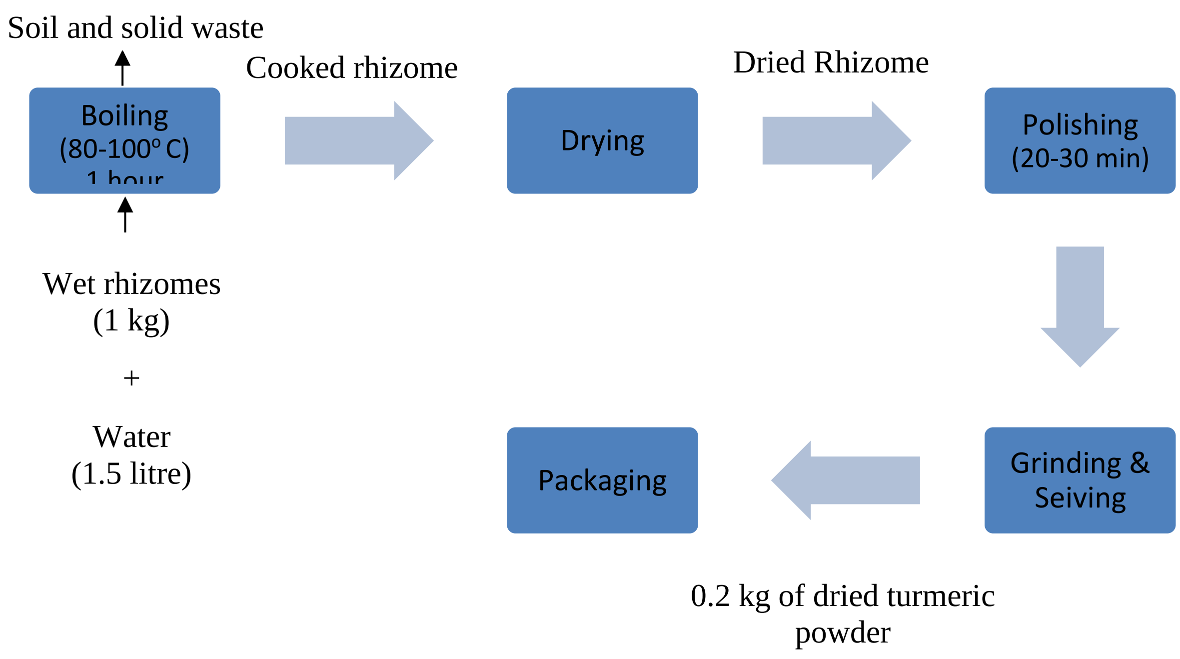


Figure 15.4 Process flow diagram of turmeric powder processing

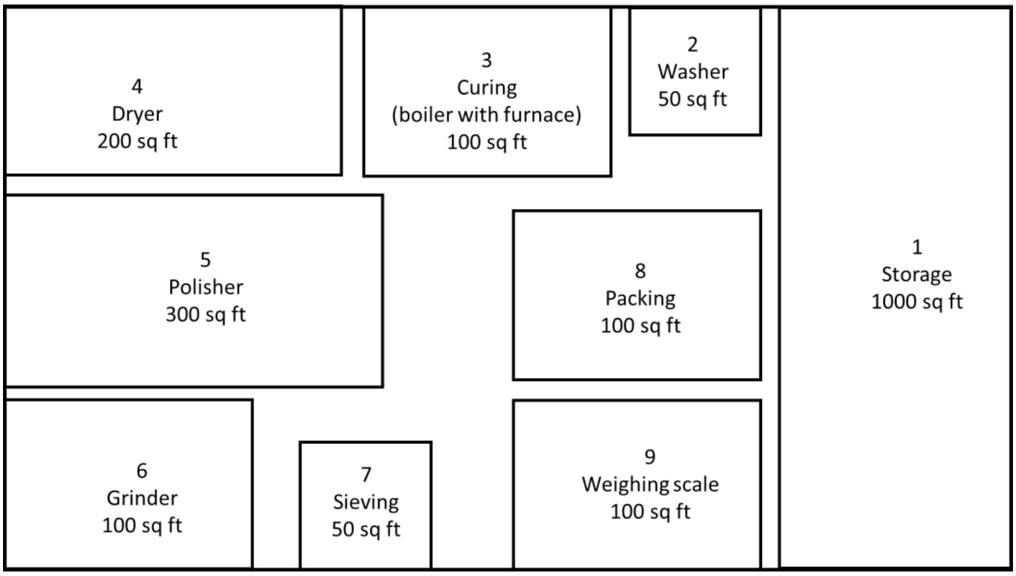
Boiling is the first post-harvest operation to be performed during turmeric powder processing which involves cooking of fresh/wet rhizomes in water until soft before drying. Boiling destroys the vitality of fresh rhizomes, avoids the raw odour, reduces the drying time and yields uniformly coloured product. An effective cooking time of 45 to 60 minutes for fingers and 90 minutes for mother rhizomes is considered essential at around 80-100o C. The next process is drying which involves removal of moisture from cooked rhizome. Different technologies for drying are available such as vacuum drying, microwave drying and solar drying. The choice of dryer depends on the economics of the plant. Usually, at farm level, the most common drying technique is sun drying however in a processing unit sophisticated drying such as vacuum and microwave is preferred. Dried turmeric has poor appearance and rough dull outer surface with scales and root bits.

The appearance is improved by smoothening and polishing the outer surface by manual or mechanical rubbing. Usually 5 to 8%of the weight of turmeric is the polishing wastage during full polishing and 2 to 3% during half polishing. The polished turmeric fingers are subjected to grinding. Grinding is one of the most common operations used to prepare turmeric powder for consumption and resale. The main aim of particular spice grinding is to obtain smaller particle sizes, with good product quality in terms of flavour and colour. There are different ambient grinding mills and methods available for this process; such as hammer mill, attrition mill and pin mill. Ground spices are size sorted through screens, and the larger particles can be further ground. The screens usually used are 60 - 80 mesh size.

The turmeric powder is packed in packaging materials that deal with the common deteriorating factors of turmeric powder such as hygroscopicity, loss of aroma/ flavour, discoloration, insect infestation and microbial contamination. The volatile oil present in the spice product has a tendency to react with the inner/ contact layer of the packaging material, at times leading to a greasy and messy package with smudging of the printed matter.

15.3.2 Plant Layout

Figure 15.5 presents the layout of turmeric processing unit.



Built up area: 2500 sq ft, Storage area: 1000 sq ft

Figure 15.5 Plant layout of turmeric processing unit

15.3.3 Financial analysis

Table 15-4 presents the financial analysis for a Turmeric powder processing unit of 200 kg/hr capacity. The assumptions and costs are considered after through study of literature and contact with manufacturers/vendors. Since, the availability of wet rhizome is limited to 3 to 4 months per year, therefore this analysis considers 120 days of plant operation per year. To effectively utilize the plant capacity (since it is operating for 120 days only), two work shift of 8 hours each is used for the analysis and based of these considerations, the annual raw material requirement (wet rhizomes) is estimated to be around 384 tonnes. The fixed cost (capital investment) include the cost of machinery, civil construction, taxes and pre-operative expenses. It is assumed that the land is already available with the FPC and only civil construction cost is applicable. The operating or variable cost include the salaries of staff, cost of raw material, power/electricity, maintenance and contingency. The costs of individual items is mentioned in Table 15-4.

As mentioned in the process flow diagram in Figure 15.4, 1 kg of wet rhizome produces 0.2 kg of turmeric powder. Therefore the annual production of the plant at full capacity is 76.8 tonnes. Assuming a wholesale selling price of turmeric powder as Rs. 160 /kg, the annual income of the plant is estimated as Rs. 1,22,88000. Considering the life of plant as 10 years, the Net Present Value (NPV) is calculated to be Rs ₹ 1,07,00,670 at a discount rate of 10%. The calculation indicate an internal rate of return (IRR), benefit to cost ratio (BCR) and discounted payback period (DPBP) as 33%, 1.49 and 3.37 years respectively. Since, the value of IRR is in the acceptable range while BCR is more than one, it could be inferred that the turmeric powder processing unit of the proposed capacity is convincingly profitable.

Table 15-4 Financial summary of turmeric powder processing unit (2q/hr)

Value addition intervention- Turmeric powder processing unit		Remarks/Details	Values
A.	**Plant capacity per annum (MT)**		384
A.1	*Plant capacity per hr (kg)*		200
A.2	*Number of operating days*		120
A.3	*Number of shifts per day*	8 hrs per shift	2
A.4	*Raw material input per annum*		384000
B.	**Capital Investment**		
B.1	*Cost of machine excluding taxes (Washer, curing boiler, dryer, polisher, grinder, siever)*		3626100
B.2	*Accessories*		
B.2.1	Packing machine		574350
B.2.2	Weighing scale		20000
B.2.3	Utensils		114900
B.3	*Land (plant area-sqft)*	Land already available with FPC-Assumed	2500
B.3.1	Civil Work including water tank and electrical work	Construction cost 200/sqft + utility cost 300/sqft (Electrical)	1250000
B.4	*Pre-Operational Expenses*		
B.4.1	GST	18%	5115670
B.4.2	Licencing, registration, documentation, accountant fees		300002
B.4.3	Training, Installation and delivery charges	10% of equipment cost	433531
B.4.4	iii. Office Furniture & Equipment		50000
B.4.5	iv. Miscellaneous		50000

B.5	*Total Capital Investment*		7199204
C. Annual Expenses			
D.1	*Interest on Loan@ 10%pa*	Considering x% of capital cost is loaned by FPC	287968
D.2	Salaries		247000
	D.2.1 Manpower cost	3 per shift-Rs.8000/month, 1 manager-Rs.15000/month	207000
	D.2.2 Marketing cost per annum	40000 per annum	40000
D.3	*Raw Material cost*		
	D.3.1 Raw Turmeric cost		5760000
	D.3.2 Packaging material	1/- per kg of produce	384000
D.4	*Power Consumption*		
	D.4.1 Unit consumed per annum		100363
	D.4.2 Cost of Electricity	Rs. 10/kWhr	1003635
D.5	*Cost of water*	1 kg rhizome = 1.5 litre water, Plain water at Rs. 0.12/litre	69120
D.6	*Maintenance*		30000
D.7	*Contingency*	5% of total fixed cost	359960
D.8	*Depreciation*		
	D.8.1 Depreciation on Furniture	at 10%	5000
	D.8.2 Depreciation on Machines	at 10%	422044
	D.8.3 Depreciation on Civil work	at 10%	125000
D.9	*Total Annual Expenses (D.1 : D.8)*		8693727
E. Total production per annum		20% recovery from wet rhizomes	76800
F. Cost of Production		Rs/kg	113.19
G. Annual Income (Full capacity)		Turmeric powder selling price - Rs. 160/kg	12288000
H. Economic Indicators		Plant life: 10 years. Capacity Utilization : Year 1-50% , Year 2 – 65%, Year 3 – 80%, Year 4 onwards 100%	
G.1	*Net present value (NPV)*	In Rs.	₹ 1,07,00,670
G.2	*Internal rate of return (IRR)*	%	33

G.3	*Benefit to cost ratio (BCR)*		1.49
G.4	*Discounted payback period*	In years	3.37

15.3.4 Sensitivity analysis

To understand the impact of fluctuation of variables on the returns, a sensitivity analysis is done. Those variables are chosen which might vary in real time situations. These variables are cost of wet rhhizome, cost of packaging material, turmeric powder selling price, capital investment, operating days and plant capacity. A variation of ± 30% in the variables is considered for this analysis while its impact on the BCR is studied. The plant capacity is varied at 100 kg/hr, 200 kg/hr (base case) and 300 kg/hr. The analysis is done by changing one variable at a time while keeping others constant.

Figure 15.6 shows the results of the sensitivity analysis. The base case-200 kg/hr is taken as benchmark to understand the variation due to each variable. As seen in Figure 15.6, turmeric powder selling price is the most sensitive variable as it causes the highest variation. Similarly, in the order of sensitivity, wet rhizome cost, operating days and plant capacity are the next three sensitive variables. Cost of packaging material turns out to be the least sensitive, meaning that by changes in cost of packaging material doesn't affect the BCR significantly as compared to other variables. It could also be observed in Figure 15.6 that the BCR in certain scenarios is less than 1, suggesting that those scenarios should be avoided to prevent losses.

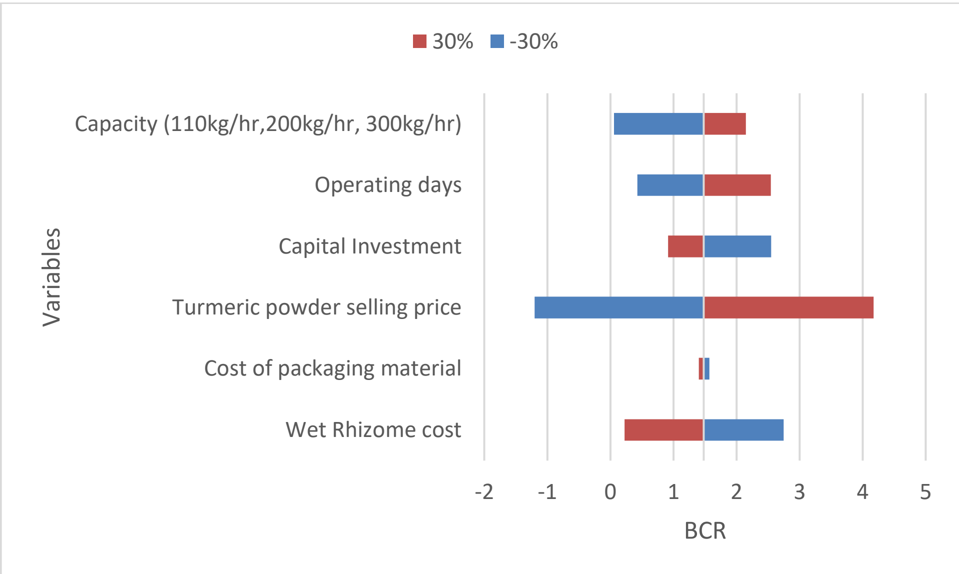


Figure 15.6 Sensitivity analysis of Turmeric powder processing unit

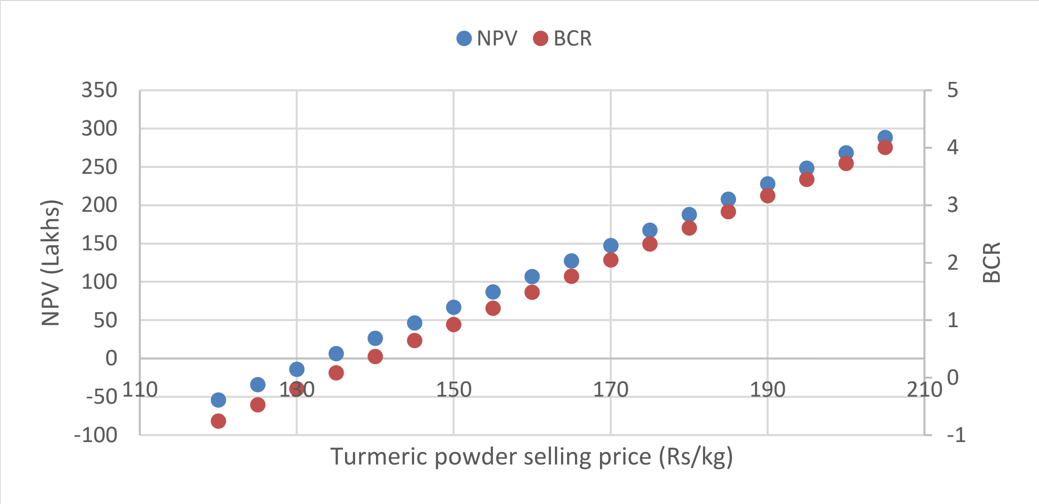


Figure 15.7 NPV and BCR vs Turmeric powder selling price

Since turmeric powder selling price is observed to be the most sensitive parameter, another study is performed to understand the variation of turmeric powder selling price with NPV and BCR. The purpose of this study is to identify threshold values of turmeric powder selling price, below which the turmeric powder should not be sold to avoid losses. The cost of production of turmeric powder is estimated as Rs. 113.19/kg which means selling turmeric powder higher than Rs. 113.19/kg would be profitable. However, as suggested in Figure 15.7, for positive NPV, the turmeric powder selling price should be above Rs. 133.47/kg. Also, considering a BCR more than 1, the minimum value for selling turmeric powder should be more than Rs. 151.3/kg. It could be inferred that an appropriate price for selling the turmeric powder should be above Rs. 151.3/kg while to achieve a BCR of 2, 3 and 4 the prices should be Rs. 169/kg, Rs. 187/kg and Rs. 205/kg respectively.

As mentioned above, turmeric is also processed to get curcumin powder and oleoresin which contribute as the mail component which give medicinal properties to the commodity. The following section explains detail techno-economic analysis of curcumin extraction plant along with financial analysis.

15.3.5 Conjoint analysis

Three cases of raw material prices (fresh rhizome) are developed for conjoint analysis.

Low – Rs. 12/kg

Baseline – Rs. 15/kg

High - Rs. 18/kg

The effect on NPV of variation in raw material price and turmeric powder selling price is shown in Figure 15.8. Similarly, the effect of variation in raw material price and operating days in shown in Figure 15.9. The project viability is negative (NPV<0) in high case with low milk selling price and less operating days. Therefore these scenarios should be avoided for profit viability.

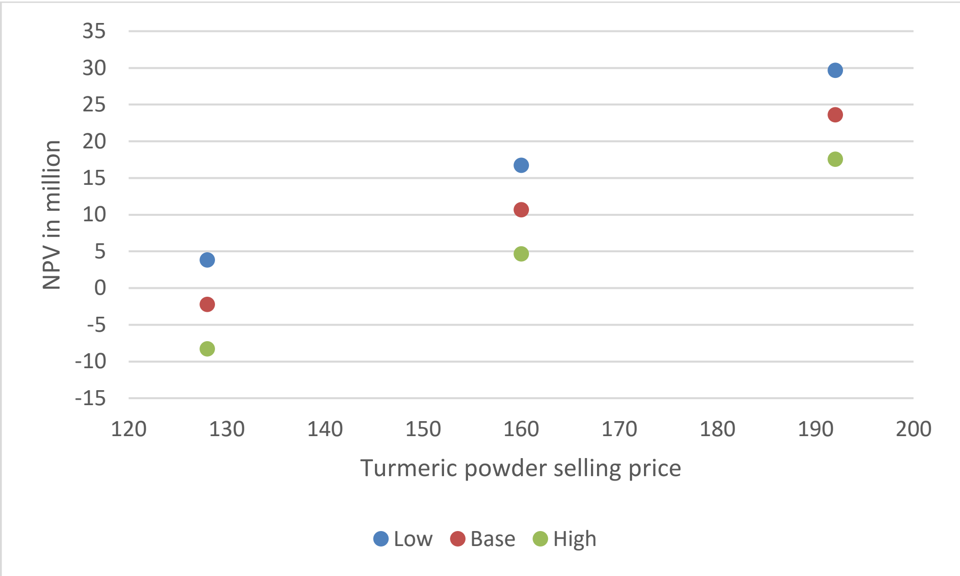


Figure 15.8 Effect of turmeric powder selling price and raw material price on NPV

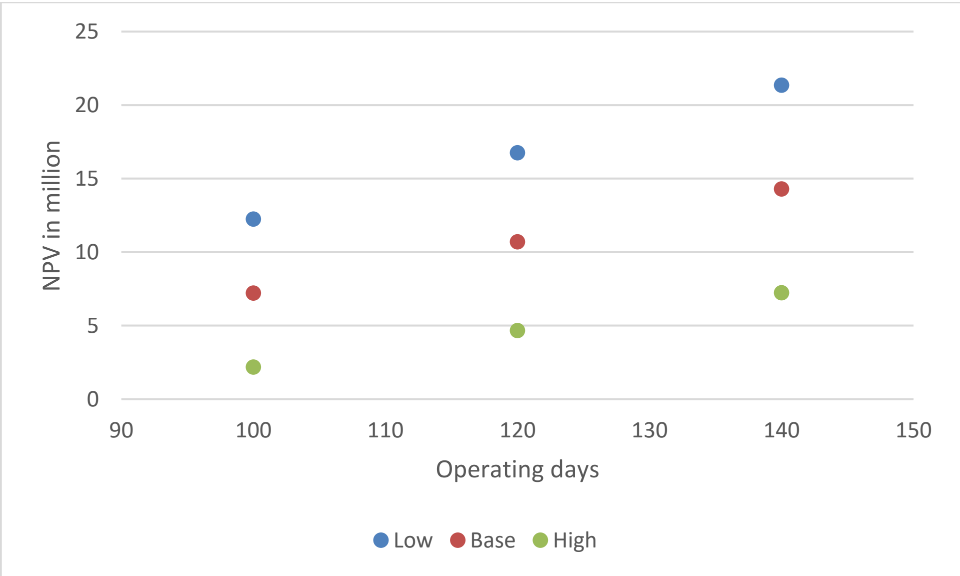


Figure 15.9Effect of operating days and raw material price on NPV in turmeric processing plant

15.3.6 Breakeven points

The project is profitable only when the selling price of turmeric powder is above ₹155/kg. The project is profitable when the selling price of turmeric powder is at least ₹130 in case of low case scenario, ₹ 140 in case of base case scenario and ₹ 150 in case of high case scenario.

15.3.7 Monte Carlo simulation (Uncertainty analysis)

A Monte Carlo simulation has advantages over sensitivity analysis to estimate the uncertainty in a project. The parameters that may vary in soymilk processing plant simultaneously are as mentioned in Table 15-5.

Table 15-5 Range of uncertain parameters considered for Monte Carlo simulation of turmeric powder processing unit

Parameter	**Min**	**Max**
Fresh Rhizome (Raw material)	12	18
Turmeric powder selling price	140	180

The simulation results in terms of NPV and BCR are shown in Figure 15.10 and Figure 15.11respectively. Ten thousand scenarios are generated using the range of uncertain parameter to capture every possible real life scenario. The blue bars indicate a favourable scenario while a red bar is an unfavourable scenario. A probability that among all the scenarios, the plant would have a positive NPV is 100% while that the plant will have a BCR greater than one is 69%.

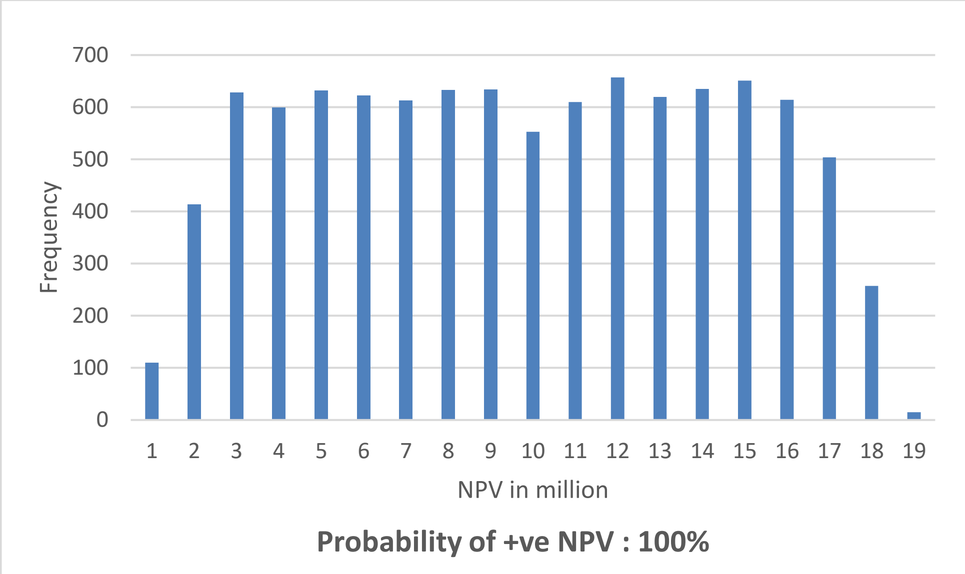


Figure 15.10 Histogram showing Monte Carlo simulation w.r.t to NPV for turmeric powder plant

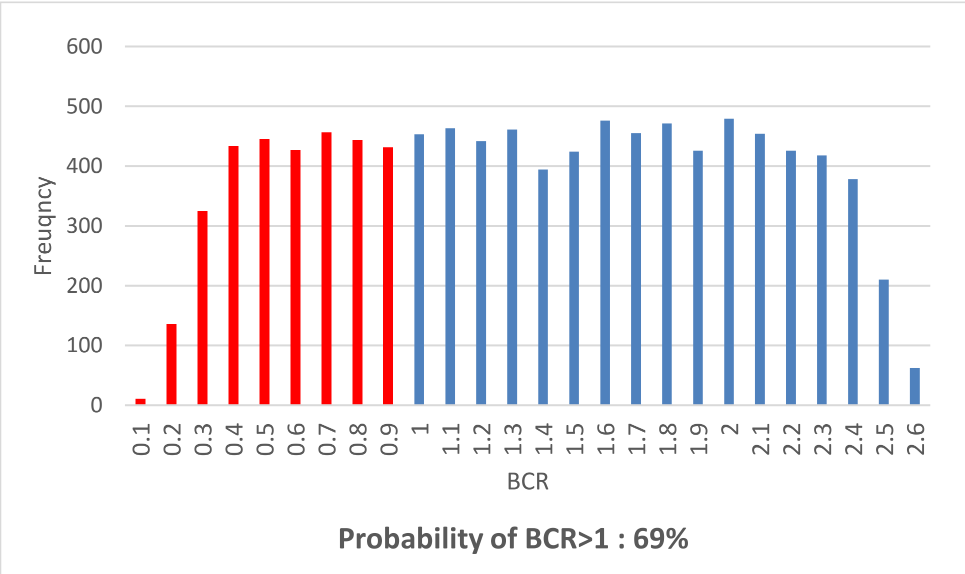


Figure 15.11Histogram showing Monte Carlo simulation w.r.t to BCR for turmeric powder

15.4 SWOT analysis

Strength	Weakness
• Processing is simple and equipment are easily available in local markets	• Fresh rhizome availability is limited to 90-120 days

• Shelf life of finished product (Turmeric powder) is high	• The curcumin content is highly dependent on turmeric variety
Opportunities	Threats
• Huge demand in regional, national and international markets • Advanced technologies are available to upgrade and improve the recovery rate	• Informal and non-standardized processing units sell turmeric powder at very cheap rates with adulteration. • Local nexus of traders could reduce the profit margin

15.5 Forward and Backward linkages

Following is the list of Turmeric powder wholesaler:

Sohan Enterprises, Post Jejuri, Palkhi Maidan, Taluka Purandar, Vetaleshor Nagar Near Palkhi Maidan, Pune - 412303, Maharashtra, India

Radha Kishan Gobind Ram Ltd, C 23, Lawrance Road Industrial Area Delhi - 110035, India

Gandhi Spices Private Limited, Para Bazar, Golpith Chowk, Satta Bazaar, Rajkot - 360001, Gujarat, India

The entrepreneur must provide tentative supplier list and quotations with respect to his project. However, there are many machinery suppliers available within India for Turmeric powder processing machineries and equipment. Following is the list of Turmeric powder processing equipment suppliers

Boilers

Microtech Boilers Private Limited Plot No. 105, Road No. 7, GIDC, Kathwada Ahmedabad - 382430, Gujarat, India

Ashoka Machine Tools Corporation, D- 62-67, Epip Site- V, Kasna G. Buddha University, Greater Noida - 201301, Uttar Pradesh, India

Brickvision Equipments Private Limited 201, 202 Mahakalika Complex, Katraj Bypass, Ambegaon Pune - 411046, Maharashtra, India

Dryers

Acufil Machines, S. F. No. 120/2, Kalapatty Post Office Coimbatore - 641 035

Tamil Nadu India Tel: +91 422 2666108/2669909

Bombay Engineering Works, 1 Navyug Industrial Estate 185 Tokersey Jivraj Road Opposite Swan Mill, Sewree (W) Mumbai 400015 India Tel: +91 22 24137094/24135959

Planters Energy network (PEN), No 5, Power House 3rd Street, N R T Nagar Theni 625531 Tamil Nadu India Tel: +91 4546 255272

Slicing machines

Central Institute of Agricultural Engineering, Nabi Bagh Berasia Road Bhopal 462 038 Madhya Pradesh India Tel: +91 755 2737191 Eastend Engineering Company 173/1 Gopal Lal Thakur Road
Calcutta 700 035 India Tel: +91 33 25536937

Gardners Corporation 158 Golf Links New Delhi 110003 India Tel: +91 11 3344287/3363640

Cleaning/abrasive machines

Central Institute of Agricultural Engineering India (see above)

Gardners Corporation India (see above)

Rajan Universal Exports Post Bag no 250 162 Linghi Chetty Street Chennai 600 001 India Tel: +91 44 25341711/25340731/25340751

Milling and grinding machines

Central Institute of Agricultural Engineering India (see above)

Gardners Corporation India (see above)

Premium Engineers PVT Ltd India (see above)

Rajan Universal Exports PVT Ltd India (see above)

Packaging and labelling machines

Acufil Machines India (See above)

Gardners Corporation India (see above)

Gurdeep Packaging Machines Harichand Mill compound LBS Marg, Vikhroli Mumbai 400 079 India Tel: +91 22 2578 3521/577 5846/579

15.6 Food safety standards for turmeric powder processing unit

FSSAI have certain regulations for turmeric rhizome and powder to ensure food safety. The rhizome be in natural state or machine polished. The product shall have characteristic odour and flavour and shall be free from mustiness or other foreign flavours. It shall be free from mould, living and dead insects, insect fragments, and rodent contamination. The product shall be free from Lead Chromate added starch and any other extraneous colouring matter. The Indian standards for turmeric follow the Agmark Specifications (Agricultural Directorate of Marketing) to ensure quality and purity of the products. As per Agmark standards, turmeric rhizome shall conform to the following standards:— (i) Extraneous matter Not more than 1.0 percent by weight (ii) Defective Rhizomes Not more than 5.0 percent by weight (iii) Moisture Not more than 12.0 percent by weight (iv) Insect damaged matter Not more than 1.0 percent by weight (v) Test for lead chromate Negative

The powder shall have characteristic odour and flavour and shall be free from mustiness or other foreign odour. It shall be free from mould, living and dead insects, insect fragments, and rodent contamination. The powder shall be free from any added colouring matter including Lead Chromate and morphologically extraneous matter including foreign starch. As per Agmark standards, turmeric powder shall conform to the following standards: — (i) Moisture Not more than 10.0 percent by weight (ii) Total ash on dry basis Not more than 9.0 percent by weight (iii) Ash insoluble in dil. HCl on dry basis Not more than 1.5 percent by weight (iv) Colouring power expressed as Not less than 2.0 percent by weight curcuminoid content on dry basis (v) Total Starch Not more than 60.0 percent by weight (vi) Test for lead chromate Negative.

15.7 Techno economic analysis of curcumin extraction plant

The following section describes the process and financial analysis of curcumin extraction plant.

15.7.1 What is curcumin?

Curcumin is an orange–yellow crystalline powder essentially insoluble in water. Curcumin is yellow in color shade and is most precious constituent of turmeric. Curcumin is one of the three curcuminoids that appear in turmeric, the other two being desmethoxycurcumin and bis-desmethoxycurcumin. These curcuminoids allow turmeric its yellow color and curcumin is utilized as a yellow food colorant and additive. Curcumin is extracted from the dried rhizome of the turmeric plant, which could be a lasting herb that is cultivated majorly in south and

Southeast Asia. The rhizome or the root is processed to create turmeric which contains 2% to 5% curcumin. Curcumin is the most naturally dynamic photochemical compound of Turmeric.

15.7.2 Process flow diagram

The curcumin extraction unit describes here is based on solvent extraction method. The raw materials required for the plant are dried turmeric rhizomes, solvent (ethanol) and isopropanol.

Industrial scale extraction of curcumin analyzed in this work can be represented in five steps:

1. Extraction of curcumin from turmeric using a solvent (ethanol).

2. Separation of curcumin-laden solvent from soaked rhizomes.

3. Recovery of solvent and concentration of extracted solution using evaporation.

4. Separation of curcumin from the oleoresin via crystallization.

5. Drying to obtain curcumin powder.

The primary step is to add cleaned turmeric rhizomes in a percolator tank. After the rhizomes are added, the solvent is added into the percolator chamber for almost 6 hours. This operation time of 6 hours is evaluated with regard to residence time of 4 hours. A fluid extract or curcumin loaded solvent is obtained. This liquid is then pumped and after that filtered to isolate the insoluble impurities such as skin, rootlets, rhizome particles etc. with the help of a centrifuge. This decontaminated fluid extract is at that point concentrated using an evaporator to a wanted concentration. The evaporator boils the ethanol solvent and water from the blend, taking off an oily residue with high curcumin concentration called oleoresin. The oleoresin contains fixed oil, curcuminoids (generally from 20-60%), together with some amounts of ethanol and water.

The oleoresin is cooled to room temperature using a heat exchanger. Within the base-case design, half of the oleoresin is collected as a product, and the curcumin from the remaining oleoresin is crystallized utilizing isopropanol as solvent at low temperatures for higher yields. Amid centrifugation, settled oils alongside isopropanol clears out as mother alcohol, and the precipitate is collected. At last, the solids from the centrifuge are dried in a vacuum tray dryer to get dried curcumin which can be powdered and packed. The process flow diagram in shown in Figure 15.12

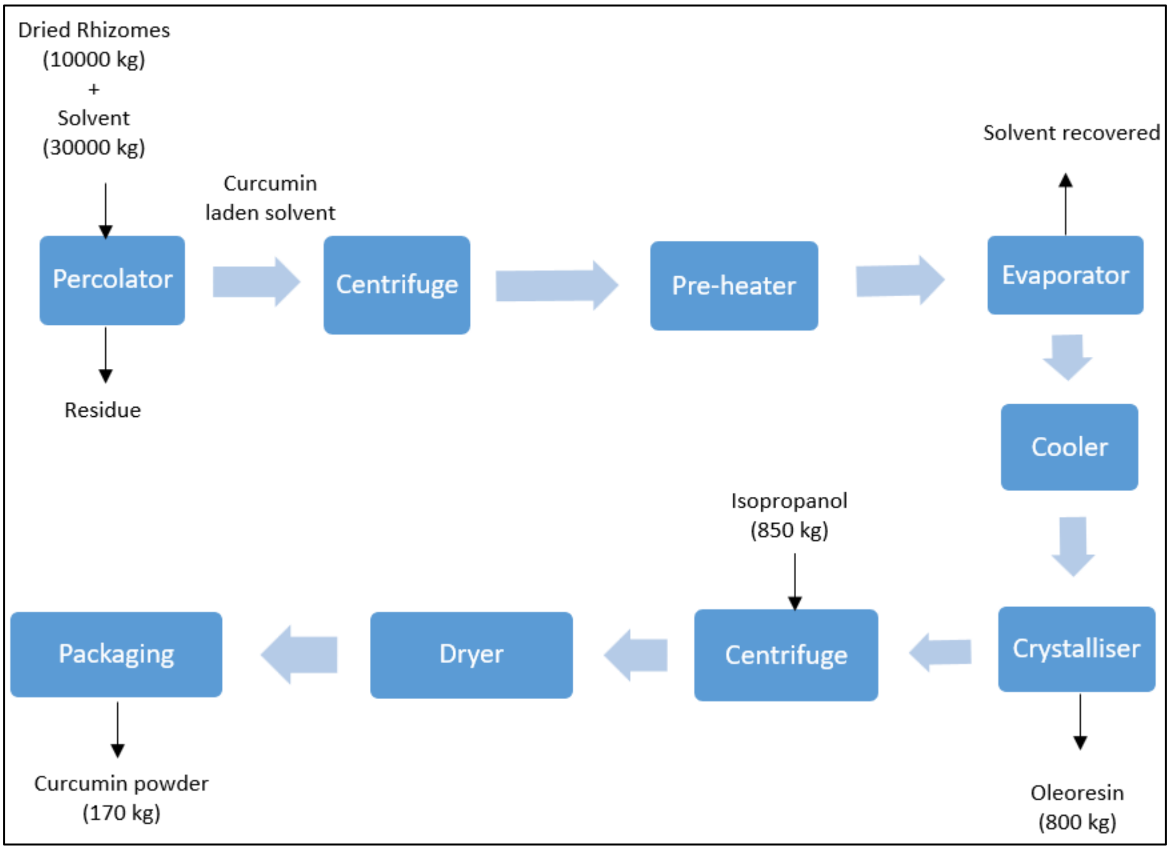


Figure 15.12 Process flow diagram of Curcumin

15.7.3 Plant layout

Figure 15.13presents the layout of curcumin extraction plant.

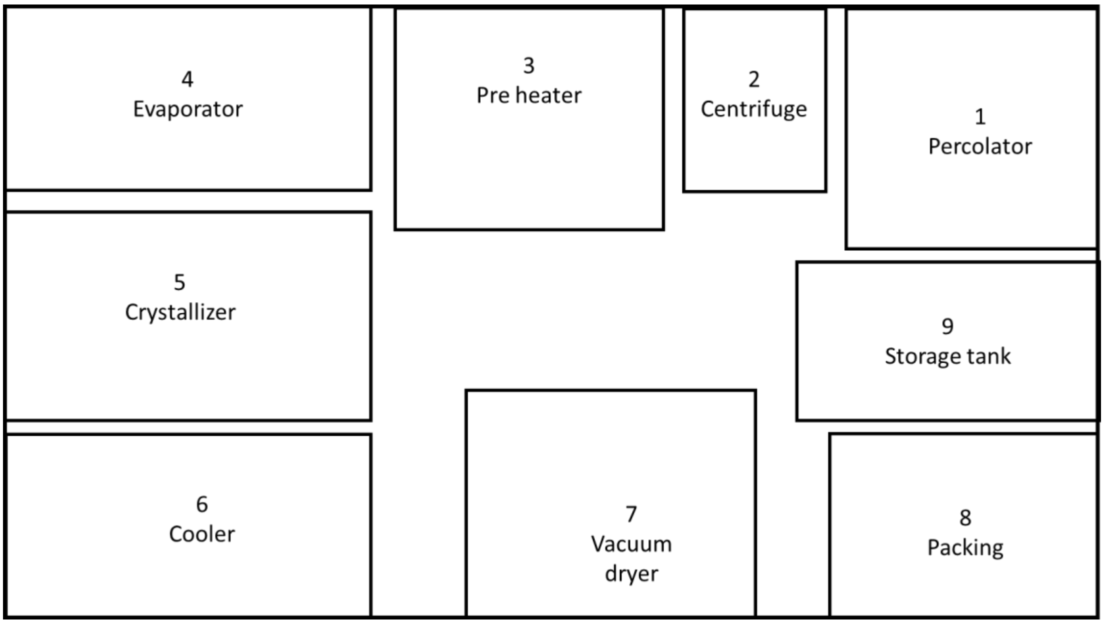


Figure 15.13Plant layout of Curcumin extraction plant

15.7.4 Financial analysis

Table 15-6 presents the financial analysis for a curcumin processing unit of 10 tonnes per day capacity. The assumptions and costs are considered after through study of literature and contact with manufacturers/vendors. The analysis has been done considering the 300 days of operations. Based on these considerations, the annual raw material requirement (dried rhizomes) is estimated to be around 3000 tonnes. The fixed cost (capital investment) include the cost of machinery, land, civil construction, taxes and pre-operative expenses. The operating or variable cost include the salaries of staff, cost of raw material, power/electricity, fuel, maintenance and contingency. The costs of individual items is mentioned in Table 15-6.

It is considered that of the total curcumin content present, 50 % is in curcumin powder and 50% is in oleoresin. As mentioned in the process flow diagram, 1 kg dried turmeric rhizomes will yield 85g oleoresin while 17.7 g curcumin powder. The annual production of the plant at full capacity is 34 tons curcumin powder and 160 tons oleoresin. Assuming the wholesale price of curcumin powder as Rs.5000/kg, that of oleoresin as Rs.200/kg, the annual income of the plant is estimated to be Rs. 30,30,00,000. Considering the life of plant as 10 years, the Net Present Value (NPV) is calculated to be Rs 6,55,92,949 at a discount rate of 10%.

The calculation indicate an internal rate of return (IRR), benefit to cost ratio (BCR) and discounted payback period (DPBP) as 48.77%, 2.72 and 2.58 years respectively. Since, the value of IRR is in the acceptable range while BCR is more than one, it could be inferred that the curcumin processing unit of the proposed capacity is convincingly profitable.

Table 15-6 Financial Summary of curcumin extraction unit (10 TPD)

Value addition intervention- Curcumin extraction unit			**Details**	**Values**
A.	**Plant capacity per day (MT)**			10
A.1	*Number of operating days*			300
A.2	*Raw material input per batch*			
	A.2.1	*Dried Turmeric rhizomes*	*in kg*	10,000
	A.2.2	*Solvent (Ethanol)*	*in kg*	1,00,000

	A.2.3	*Isopropanol*	*in kg*	6,000
B. Capital Investment				
B.1	*Cost of Machine excluding taxes & duties (Grinder, Percolator, Centrifuge, Pre-heater, Evaporator, Cooler, Crystallizer, Dryer)*			86,15,000
B.2	*Solvents*			
	B.2.1	*Solvent (Ethanol)*	*Rs. 60/kg*	60,00,000
	B.2.2	*Isopropanol*	*Rs. 130/kg*	7,80,000
B.3	*Land (plant area)*		*In sqft (square feet)*	2,000
	B.3.1	Land cost (ownership/leased)	*2000/- sqft including taxes*	30,00,000
	B.3.2	Civil Work including water tank and electrical work	*Construction cost 200/sqft + utility cost 300/sqft (Electrical)*	10,00,000
B.4	*Pre-Operational Expenses*			
	B.4.1	GST on machines	*18 %*	27,71,100
	B.4.2	Licencing, registration, documentation, accountant fees		3,00,000
	B.4.3	Training, Installation and delivery charges	*10% of equipment cost*	15,39,500
	B.4.4	iii. Office Furniture & Equipments		50,000
	B.4.5	iv. Miscellaneous		50,000

B.5	*Total Capital Investment (B.1+B.2+B.3+B.4)*			2,41,05,600
C. Annual Expenses				
C.1	*Interest on Loan@ 10%pa*		*Considering 40% of capital cost is loaned by FPC*	9,64,224
C.2	*Manpower Cost 3 Workers @ 10000/- per month and 1 supervisor @ 30000/- per month and*		200000/- marketing expenditure per annum	9,20,000
C.3	C.3.1	Raw Turmeric cost	*Rs. 75/kg*	22,50,00,000
	C.3.2	Solvent (Ethanol)	*2% losses per batch*	3,60,00,000
	C.3.3	Isopropanol	*2% losses per batch*	46,80,000
	C.3.4	Packaging material	*20/- per kg of produce*	58,20,000
C.4	*Power Consumption*			
	C.4.1	Unit consumed per annum		1000372
	C.4.2	Cost of Electricity @ Rs. 10/KW		1,00,03,729
C.5	*Cost of water*		*1 kg rhizome = 10 litre water*	12,00,000
C.6	*Maintenance*			20,000
C.7	*Contingency*		*5% of total fixed cost*	12,05,280
C.8	*Depreciation*			
	C.8.1	Depreciation on Furniture	*at 10%*	5,000
	C.8.2	Depreciation on Machines	*at 10%*	5,66,500
	C.8.3	Depreciation on Civil work	*at 10%*	1,00,000

C.9	*Total Expenses (C.3 + C.12)*		19,15,81,004
D. Total production per annum			
D.1	*Curcumin Powder*	*in kg*	51000
D.2	*Turmeric oleoresin*	*in kg*	240000
F. Annual Income (Full capacity)		*Selling price of curcumin : Rs. 5000/kg* *Selling price of oleoresin : Rs. 200/kg*	30,30,00,000
G. Economic Indices		Plant life: 10 years. Capacity Utilization : Year 1- 50% , Year 2 – 65%, Year 3 – 80%, Year 4 onwards 100%	
G.1	*Net present value (NPV)*	IN Rs.	6,55,92,949.78
G.2	*Internal rate of return (IRR)*	%	48.77%
G.3	*Benefit to cost ratio (BCR)*		2.72
G.4	*Discounted payback period*	In years	2.58

It was observed during the financial analysis that the minimum threshold capacity for viable curcumin extraction plant was 10MT/day. A plant below 10MT/day capacity produced negative NPV and therefore is not recommended based on the considerations in Table 15-6.

15.7.5 Sensitivity analysis

A sensitivity analysis is done by creating scenarios of the dried turmeric rhizome cost, curcumin powder selling price and oleoresin selling price. The sensitivity of NPV and BCR is studied under three different scenarios. Following are the three scenarios.

Base case Scenario: Dried turmeric rhizomes cost- Rs. 75/kg, Curcumin powder selling price- Rs. 5000/kg and Oleoresin selling price - Rs.200/kg

Low price: Dried turmeric rhizomes cost- Rs. 70/kg, Curcumin powder selling price- Rs. 4000/kg and Oleoresin selling price - Rs.150/kg

High price: Dried turmeric rhizomes cost- Rs. 80/kg, Curcumin powder selling price- Rs. 6000/kg and Oleoresin selling price - Rs.250/kg

It is clearly visit in Figure 15.14, that the scenarios drastically affect the overall economics of the curcumin extraction unit. A high raw material cost negatively affects the economics while in case of high price scenario, along with a high raw material cost, the selling price of curcumin powder and oleoresin as also kept high and it could be observed that the NPV is almost seven times higher than the case. The high volatility of curcumin plant for raw material cost and selling price is evident through this analysis.

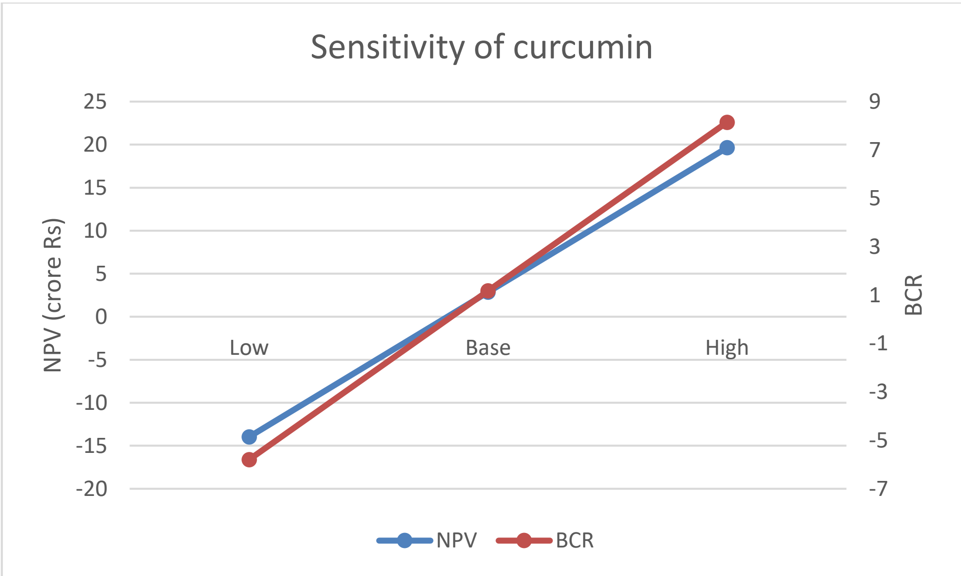


Figure 15.14 Sensitivity of NPV and BCR with different cases of raw material cost and selling prices

15.7.6 Conjoint analysis

Three cases of raw material prices (Dry rhizome, Ethanol, isopropanol) are developed for conjoint analysis.

Low – Dry rhizome: Rs. 67.5/kg, Ethanol: Rs. 54/kg, Isopropanol: Rs. 117/kg

Baseline – Dry rhizome: Rs. 75/kg, Ethanol: Rs. 60/kg, Isopropanol: Rs. 130/kg

High - Dry rhizome: Rs. 82.5/kg, Ethanol: Rs. 66/kg, Isopropanol: Rs. 143/kg

The effect on NPV of variation in raw material price and turmeric powder selling price is shown in Figure 15.15. Similarly, the effect of variation in raw material price and operating days in shown in Figure 15.16. The project viability is negative (NPV<0) in high case with low milk selling price and less operating days. Therefore these scenarios should be avoided for profit viability.

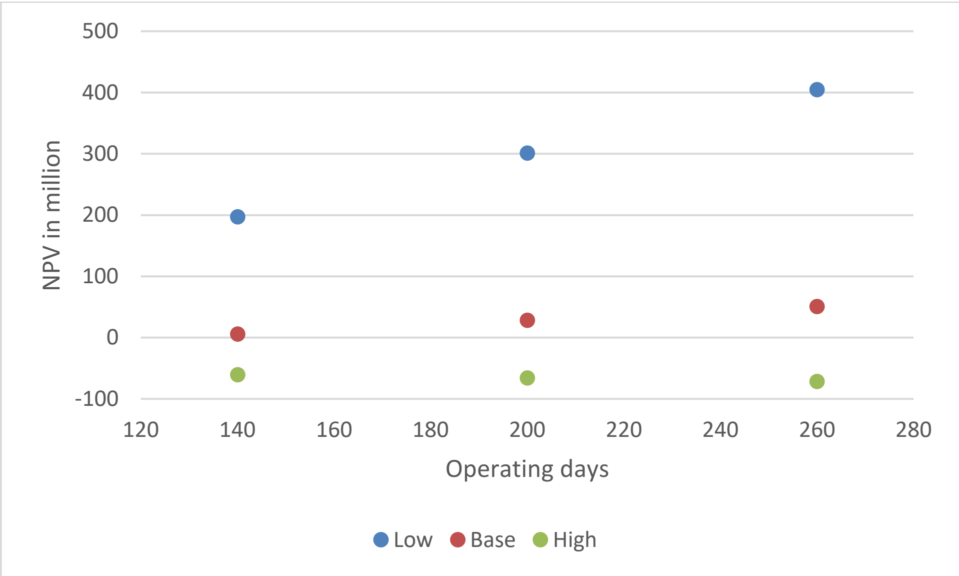


Figure 15.15 Effect of operating days and raw material price on NPV in Curcumin extraction plant

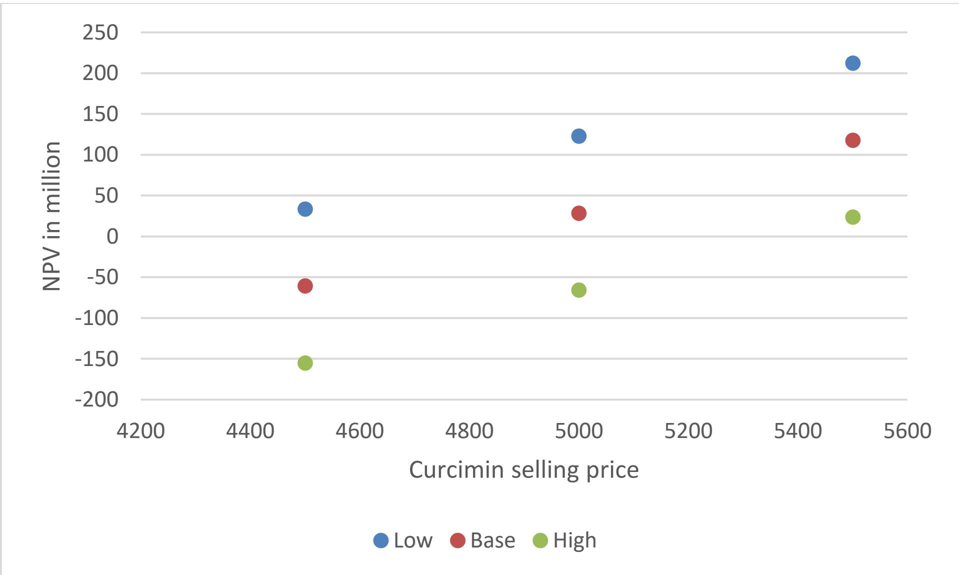


Figure 15.16 Effect of curcumin selling price and raw material price on NPV

15.7.7 Breakeven points

The project is viable when the cost of dried rhizomes is at least ₹ 75, selling price of curcumin is at least ₹5000/kg and selling price of oleoresin is at least ₹200/kg. The project is viable when the selling price is at least ₹4300/kg considering low case scenario, ₹4900 in case of base case scenario and ₹5400 in case of high case scenario as mentioned.

15.7.8 Monte carlo simulation (Uncertainty analysis)

A monte-carlo simulation has advantages over sensitivity analysis to estimate the uncertainty in a project. The parameters that may vary in soymilk processing plant simultaneously are as mentioned in Table 15-7.

Table 15-7 Range of uncertain parameters considered for Monte Carlo simulation of soy milk/tofu processing unit

Parameter	**Min**	**Max**
Turmeric rhizomes cost per kg	60	80
Curcumin powder selling price per kg	4000	6000
Turmeric oleoresin selling price	150	250

The simulation results in terms of NPV and BCR are shown in Figure 15.17and Figure 15.18 respectively. Ten thousand scenarios are generated using the range of uncertain parameter to capture every possible real life scenario. The blue bars indicate a favourable scenario while a red bar is an unfavourable scenario. A probability that among all the scenarios, the plant would have a positive NPV is 38.3% while that the plant will have a BCR greater than one is 31.2%.

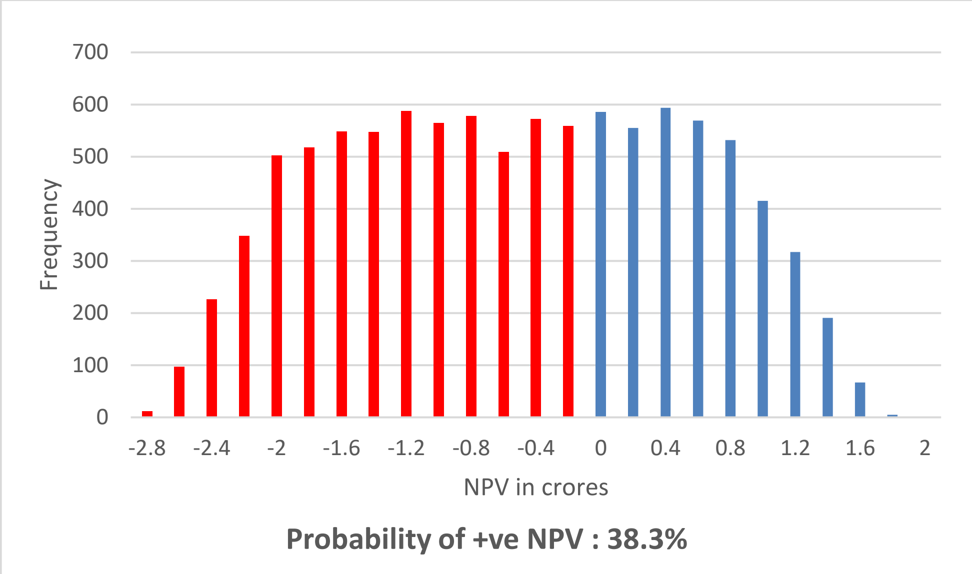


Figure 15.17 Histogram showing Monte Carlo simulation wrt to NPV for curcumin plant

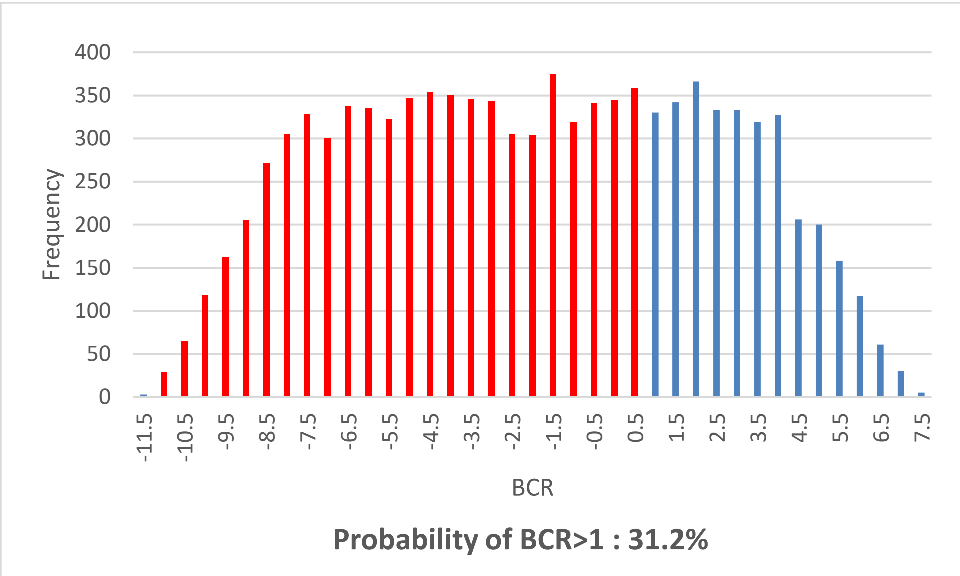


Figure 15.18 Histogram showing Monte Carlo simulation wrt to BCR for curcumin plant

15.8 SWOT analysis

Strengths	Opportunities
• High value of final product • With more research, rising demand for use in treatment of	• Rising awareness of Neutraceuticals pharmaceutical use of curcumin after covid outbreak

various diseases such as cancer, heart diseases etc	• Good market value for by-products such as oleoresin, volatile oil
Weakness	Threats
• Cost intensive extraction process • Have niche market • Percent extraction of main product is very low • Price volatility	• Extraction rate is dependent on variety of raw material • Extraction process involves handling of inflammable substances such as solvents

15.9 Forward and Backward linkages

The entrepreneur must provide tentative supplier list and quotations with respect to his project. However, there are many machinery suppliers available within India for curcumin processing machineries and equipment. Some of the suppliers are:

Machine suppliers

1. Dolphin Engineers, Uttam Patil, Plot No. 222, Sector No. 4, Sant Nagar, Moshi Pune - 412105, Maharashtra, India
2. Ved Engineering, Sagar Chadha, B-38, Sector 60, Noida - 201301, Gautam Budh Nagar, Uttar Pradesh, India
3. Excel Plants & Equipment Private Limited, Vishal Dange, Gat No. 611, Mouje Kuruli, M. I. D. C. Chakan, Pune - 410501, Maharashtra, India
4. Himanshu Shah No. 506, World Trade Center, Sayajigunj Vadodara - 390005, Gujarat, India
5. Swaraj Process And Systems Yogesh Patil, Gat No. 183, Ganesh Nagar, Talwade, Pune - 411062, Maharashtra, India
6. Avalon Separation Jitendra Patel, A-32 Akshardham Industrial Estate, Vatva GIDC Ahmedabad - 382445, Gujarat, India
7. Nikul Pharma Equipment, Mahendra Jadeja, Sr. No.257, Abdullah And Rasid Compound, Bhavkal, Virar East, Vasai Virar - 401202, Mumbai, Maharashtra, India
8. Omkar Industries, Mahadeo Patil, S. R. No. 52/3, Maruti Nagar, Wadgaon Sheri Vadgaon Sheri Pune - 411014, Maharashtra, India

15.10 Risk mitigation in curcumin extraction plant

Sources of Ignition

- Electrical installations shall conform to the requirements of NFPA 70, National Electrical Code®, as hereinafter specified.
- There shall be no smoking or other sources of ignition within the restricted and controlled areas.

Housekeeping

- Waste materials such as oily rags, other wastes, and absorbents used to wipe up solvent, paints, and oils, shall be deposited in approved waste cans and removed from the premises not less than once each day.
- The space within the restricted and controlled areas shall be kept free of dry grass, weeds, trash, and all combustible materials.
- Any spills of oil, solvent, or deposits of solvent bearing material shall be cleaned up immediately and removed to a safe place.

Emergency Procedures

- Personnel shall be thoroughly indoctrinated as to the location of exits.
- All personnel shall be thoroughly trained in the use and limitations of each type of fire-fighting equipment on the premises, including control valves for the water spray system.

Solvent Transfer Equipment

- Pumps shall be designed for the solvent, the working pressures, and the structural stresses to which they will be subjected.
- The use of air pressure as the solvent transferring medium shall be prohibited.

Piping, Valves, and Fittings

- Pipe systems shall be substantially supported and protected against physical damage caused by expansion, contraction, and vibration.
- Drain valves shall be provided with plugs to prevent leakage.

Exits

- A building shall be provided with at least two remotely located means of egress, one of which shall be enclosed or separated from the process by a wall that is blank except for doors.
- Self-closing, non-combustible doors, normally kept closed, shall be provided for access to the protected stairway.

Fire Protection

- An approved system of automatic sprinklers shall be provided in the preparation area.
- Fire alarm signals shall be relayed or sent to a constantly supervised point on or off the premises.
- An approved system of automatic sprinklers shall be provided in the preparation area.

Location

- Bulk solvent storage tanks shall be located outside of any building.
- The arrangement shall be such that all portions of solid floor areas will be subjected to continuous positive movement of air.

15.11 Conclusion

In this section, turmeric powder and curcumin extraction unit is introduced and its market potential is discussed. Based on the techno-economic analysis, it is understood that the turmeric powder and curcumin extraction plant of the proposed capacity is profitable with a quantum requirement of around 380 MT/annum and 3000 MT/annum respectively. Based on the field visit experience, majority of the FPCs have sufficient quantum to venture into both turmeric powder and curcumin business. The monte-carlo simulation suggest the volatility of the proposed interventions of turmeric. It is observed that turmeric powder unit has a higher probability of positive NPV and BCR <1 as compared curcumin plant. The monte carlo simulations also suggest that the curcumin extraction business is risky since, the probability of achieving a BCR>1 is mere 31% which is very less as compared to other products discussed in this report.

16 Social, Environmental and Operational checklist/recommendations

A general checklist/ recommendations for an ideal processing unit construction, operations and maintenance is given in Table 16-1.

Table 16-1 Checklist/Recommendations for construction, operations and maintenance of food processing unit

Sr. no	Details/Recommendations
A. Social	
A.1 Social Management Plan	
A.1.1	The project should involve/engage nearby FPCs for product aggregation and marketing in areas where no FPC is there and scale of production is having potential for remunerative market linkage
A.1.2	The project should strengthen FPCs in inaccessible / poorly accessible pockets and scheduled areas through training, hand holding and exposure
A.1.3	The project must not promote child labor or forced labor in any form during any activity
A.2 Tribal Peoples Planning Framework (TPPF)	
A.2.1	The project should ensure participation of tribal / tribal farmers in different activities implemented
A.2.2	The project should support infrastructure and services in less accessible scheduled areas / tribal dominated areas
A.2.3	The project should include tribes and their active involvement with better operational and management capabilities
A.2.4	The project should take exclusive measure to promote FPCs in inaccessible tribal areas
A.2.5	The project should ensure capacity building of tribal members on FPC management
A.3 Gender Action Plan (GAP)	
A.3.1	The project should have participation of women / women farmers in different activities implemented under the project
A.3.2	The project should support infrastructure and services that can be operated by women
A.3.3	The project should reduce gender biasness and positive discrimination to bring gender equity

A.3.4	The project should include women and ensure their active involvement with better operational and management capabilities
A.3.5	The project should ensure parity in wage (equal work equal pay) payouts and abide by the legal provisions
A.3.6	Required measures for ensuring involvement of women in aggregation center activities, based on work suitability should be ensured
A.3.7	The project should have exclusive inclusion criteria for ensuring women membership and participation
A.4 Land Availability for Infrastructure	
A.4.1	No activities under the project components will be taken-up if it involves physical displacement of local people, either from their residences and/or commercial places
A.4.2	No activities under the project components should have involuntary land acquisition or forceful eviction
A.4.3	The land must be free of squatters, encroachers, share cropping or other claims or encumbrances
A.4.4	The facilities requiring land should not be site specific (exploration of alternative)
A.4.5	The facilities requiring land should not result in any physical relocation
A.4.6	The facilities requiring land should not result in restrictions on accesses and transit
A.4.7	In case of voluntary donation of land, required legal process should be followed with verification by appropriate authority. Under no circumstances, the land user will be subjected to any pressure, directly or indirectly, to part with the land
A.4.8	It is to be ensured that there shall be no significant adverse impacts on the livelihood of the household donating / selling the land
A.4.9	Provision shall be made for redressal of grievances, if any
B. Environmental	
B.1 Site Selection	
B.1.1	Appropriate approvals should be taken from forest department if the project site is located in Forest / Wildlife Sanctuary / National Park / Wildlife conflict area/ steep slopes.
B.1.2	Appropriate approvals should be taken from Maharashtra Pollution Control Board (MPCB) if the project site is located in waste dump site.
B.1.3	Appropriate approvals should be taken from MPCB if the project site is located in polluted/contaminated land.

B.1.4	Appropriate approvals should be taken from local water resource dept. if the project site is located in natural drainage courses/riverside
B.1.5	Appropriate approvals should be taken from Archaeological Survey of India dept. if the project site is located in heritage sites/archaeological sites
B.1.6	The project site shouldn't be in an area prone to floods/ landslides/degraded lands in hills.
B.2 Construction	
B.2.1	Appropriate approvals should be taken from forest department if the construction required cutting of trees and practice appropriate compensations
B.2.2	Construction material and water should be taken from sustainable and reliable sources
B.2.3	Ensure labour safety and proper waste disposal (wet/dry/air) during construction
B.2.4	Stripping of topsoil should not be conducted earlier than required in order to prevent the erosion (wind and water) of soil.
B.2.5	Excess topsoil should be used for landscaping purpose. The disturbed areas and soil stockpiles should kept moist to avoid wind erosion.
B.2.6	All generator sets (diesel, petrol, kerosene, LPG, CNG) will meet the CPCB (Central Pollution Control Board) noise and emission control standards for Generator Sets
B.3 Operation	
B.3.1	All manufacturing processes should comply with the relevant MPCB standards for waste water effluents
B.3.2	All manufacturing equipment should comply with the relevant BIS standards
B.3.3	Vehicles should be Bharat Stage IV compliant
B.3.4	The organic waste and residue water should be segregated and disposed or reused as per MPCB norms
B.3.5	The plant machinery should be BEE star rated (5 or 4 star rated)
B.3.6	The plant could have solar based equipment for power saving and conservation
C. **Design and facilities**	
C.1	The design of processing unit should provide adequate working space; permit maintenance, cleaning and prevent entry of dirt, dust and pests
C.2	The internal structure & fittings should be made of non-toxic and impermeable material

C.3	Floors should be non-slippery and sloped appropriately
C.4	Equipment and containers be made of non-toxic, impervious, non-corrosive material which is easy to clean and disinfect
C.5	Premise should have sufficient lighting, ventilation, personal hygiene facilities
	D. **Control of operation**
D.1	Raw material be inspected at the time of receiving for food safety hazards
D.2	Incoming material and finished products be stored at recommended temperatures and humidity
D.3	Process conditions/requirements should be strictly adhered. For ex. In case of soy milk, the pasteurization temperature and holding time should be properly maintained
D.4	Food manufactured/processed be packed in a hygienic manner. Food handler should wear gloves, aprons, headcover, shoe cover.
D.5	Cleaning chemicals & other hazardous substance should be clearly identified &stored separately from food.
D.6	Transporting vehicle should be capable of meeting requisite temperature (where applicable).
	E. **Maintenance and Sanitation**
E.1	Cleaning of equipment, food premises be done as per cleaning schedule & cleaning programme.
E.2	Preventive maintenance of equipment and machinery should be carried out regularly as per the instructions of the manufacturer.
E.3	Measuring & monitoring devices be calibrated periodically
E.4	Drains should be designed to meet expected flow loads and equipped with traps to capture contaminants
E.5	Disposal of sewage and effluents be done in conformity with standards laid down under MPCB norms
	F. **Training and Complaint Handling**
F.1	Internal / External audit of the system be done periodically. Check for records.
F.2	Food business should have an effective consumer complaints redressal mechanism
F.3	Food handlers should have the necessary knowledge and skills & trained to handle food safely. Check for training records.
F.4	Appropriate documentation & records be available and retained for a period of one year or the shelf-life of the product, whichever is more.

17 List of Statutory Clearances Required

The following table mentions the list of statutory clearances required to set up the processing unit of the proposed value added products (Poultry feed, soy milk/tofu, turmeric powder/curcumin).

S.NO.	Approval and Clearances required	Departments/Offices to be consented
1	State Investment Promotion Board, Stage – I clearance	Department of Industries
2	Environmental clearance	Maharashtra State Pollution Control Board
3	GST registration	Commercial Taxes
4	Change in land use	Land revenue department
5	Sanction and supply of power	DISCOM
6	Sanction and supply of water	

18 Way forward

As a part of the future work, attempts will be made to quantify reduction in post-harvest losses due to specific interventions under POCRA since the program's inception. Reducing postharvest losses of grains, fruits and vegetables could lead to a virtual land gain and huge savings in input resources. This would require assessment of traditional and improved post-harvest systems (POCRA interventions) in terms of produce savings, cost of intervention and energy use. Post-harvest losses contribute significantly to the increase of Greenhouse Gas Emissions (GHGe). This information will subsequently be used for quantifying GHGe emissions under both scenarios which would help estimate net effects adequately. The climate change mitigation impact would help us decide the best strategy to optimize the systemic interventions. Given increasing demand for food products and increasing input price, this is a critical means of mitigating global emissions.

Indicators such as benefit-cost ratio, CO2e saved, net returns, net present value, internal rate of return, break-even point, avoided losses of produce, quantum of input resources saved would be considered for the study.

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19 Work Plan for the year 2021-2022

Tasks completed

Tasks ongoing

Tasks planned

Section 1: Technology Intervention to reduce post-harvest losses of onions

Tasks	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**
Preliminary Report (Overall: Field & Desk)												
1. Matrix Development												
1.1 Mapping of Onion FPC within PoCRA-												
1.2 Total Production/Productivity/Area Sowing & Harvesting Schedule, Variety of onion.												
1.3 Current Practices (Selling in Market/Processing), Mode of Selling, Any Current Value Addition & Storage, Seasonality												
1.4 FPC Portfolio (No of Farmers associates, variety of onion, Revenue, Profit												
1.4.1 Identifying potential buyers based on the current demand of products (Onion). Prepare a list of potential forward linkages.												

1.5 Identification turn- key providers for onion storage intervention (Pre fab structure, cooling system, sensors & controls)												
1.6 Screening of FPCs from PoCRA project list for Technological Intervention based 1.												
1.7 Detail Market Analysis of Onion/Onion based products resulting from technological intervention (seasonality-based Market Demand, Export, Price trends, Profit margins												
2. Match Making with FPCs with Technological Intervention												
3. Financial Viability Model												
4. Installation & Commissioning												
4.1 Selection of vendors from 1.5												
4.2 Installation and post Installation support (As per MoU)												
4.3 Final Impact report preparation												

Section 2: Technology Intervention for value addition of agriculture produce via processing

Tasks	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Preliminary Report (Overall: Field & Desk)							
1. Matrix Development							
1.1 Mapping of Crops FPC within PoCRA							
1.2 Total Production/Productivity/Area Sowing & Harvesting Schedule, Variety							
1.3 Current Practices (Selling in Market/Processing), Mode of Selling, Any Current Value Addition							
1.4 FPC Portfolio (No of Farmers associates, variety of crops, Revenue, Profit							
1.5 Screening of FPCs for Technological Intervention based 1.4							
1.6 Ranking/Screening of Crops based on (1.1-1.4) Economic Value, Market Integration/Demand							
1.6.1 Identification of a list of technological interventions which are feasible (based on Shelf life, scale & economics) eg: Soybean to protein, soya oil etc.: Turmeric to curcumin etc.							
1.6.2 Identifying potential buyers based on current demand of products. Prepare list of potential forward linkages.							

1.7 Identification turnkey providers for screened technological interventions							
1.8 Detail Market analysis of product resulting from technological intervention (Market Demand, Export, Domestic Demand, Price trends, Profit margins)							
1.9 Logistics of processed products (Storage + Transport)							
2. Match Making with FPCs with Technological Intervention							
3. Financial Viability Model							
4. Details food safety measures & regulatory aspects.							
5. Preparation DPR and necessary revisions							

Table A1: Cash Flows in 300MT onion storage structure (Case 1: Without Subsidy)

Capacity	300 MT	Loan Amount	70,02,781.05	Self-Investment	23,34,260.35	Subsidy	-

Year	Cap_Inv	OP_Cost	Revenue	Net	Net PV	Cum_PV	Balance_PV	Net Debt_PV
	93,37,041			-				
1		32,95,069	48,00,000	15,04,931.0	5,85,860.15	5,85,860	-17,48,400.2	-1,46,37,949.2
2		32,95,069	48,00,000	15,04,931.0	5,84,339.91	11,70,200	-11,64,060.3	-1,31,32,927.2
3		32,95,069	48,00,000	15,04,931.0	5,80,135.71	17,50,336	-5,83,924.6	-1,16,32,109.5
4		32,95,069	48,00,000	15,04,931.0	5,73,645.47	23,23,981	-10,279.1	-1,01,37,781.9
5		32,95,069	48,00,000	15,04,931.0	5,65,222.57	28,89,204	5,54,943.5	-86,51,877.3
6		32,95,069	48,00,000	15,04,931.0	5,55,180.29	34,44,384	11,10,123.8	-71,76,014.9
7		32,95,069	48,00,000	15,04,931.0	5,43,795.94	39,88,180	16,53,919.7	-57,11,536.9
8		32,95,069	48,00,000	15,04,931.0	5,31,314.55	45,19,495	21,85,234.2	-42,59,540.3
9		32,95,069	48,00,000	15,04,931.0	5,17,952.12	50,37,447	27,03,186.4	-28,20,906.1
10		32,95,069	48,00,000	15,04,931.0	5,03,898.69	55,41,345	32,07,085.1	-13,96,325.3
11		32,95,069	48,00,000	15,04,931.0	4,89,321.05	60,30,666	36,96,406.1	13,677.8
12		32,95,069	48,00,000	15,04,931.0	4,74,365.12	65,05,032	41,70,771.2	14,08,725.0
13		32,95,069	48,00,000	15,04,931.0	4,59,158.21	69,64,190	46,29,929.4	27,88,565.3
14		32,95,069	48,00,000	15,04,931.0	4,43,810.99	74,08,001	50,73,740.4	41,53,058.3
15		32,95,069	48,00,000	15,04,931.0	4,28,419.28	78,36,420	55,02,159.7	55,02,159.7

NPV	Rs. 55,02,159.69
IRR	18.4%
DPBP	10.99
BCR	0.59

*All the currency values are in Indian Rupees (INR)

Table A2: Cash Flows in 300MT onion storage structure (Case 2: With Subsidy)

Capacity	**300 MT**	**Loan Amount**	**28,01,112.42**	**Self-Investment**	**9,33,704.14**	**Subsidy**	**56,02,224.84**

Year	Cap_Inv	OP_Cost	Revenue	Net	Net PV	Cum_PV	Balance_PV	Net Debt_PV
	93,37,041			-				
1		32,95,069	48,00,000	15,04,931.0	10,88,050.37	10,88,050	1,54,346	-50,01,473
2		32,95,069	48,00,000	15,04,931.0	10,40,876.48	21,28,927	11,95,223	-35,92,324
3		32,95,069	48,00,000	15,04,931.0	9,95,168.95	31,24,096	21,90,392	-22,28,882
4		32,95,069	48,00,000	15,04,931.0	9,50,948.42	40,75,044	31,41,340	-9,09,661
5		32,95,069	48,00,000	15,04,931.0	9,08,225.25	49,83,269	40,49,565	3,66,837
6		32,95,069	48,00,000	15,04,931.0	8,67,000.90	58,50,270	49,16,566	16,02,111
7		32,95,069	48,00,000	15,04,931.0	8,27,269.23	66,77,540	57,43,835	27,97,653
8		32,95,069	48,00,000	15,04,931.0	7,89,017.54	74,66,557	65,32,853	39,54,943
9		32,95,069	48,00,000	15,04,931.0	7,52,227.56	82,18,785	72,85,081	50,75,444
10		32,95,069	48,00,000	15,04,931.0	7,16,876.37	89,35,661	80,01,957	61,60,593
11		32,95,069	48,00,000	15,04,931.0	6,82,937.12	96,18,598	86,84,894	72,11,803
12		32,95,069	48,00,000	15,04,931.0	6,50,379.73	1,02,68,978	93,35,274	82,30,455
13		32,95,069	48,00,000	15,04,931.0	6,19,171.49	1,08,88,149	99,54,445	92,17,900
14		32,95,069	48,00,000	15,04,931.0	5,89,277.61	1,14,77,427	1,05,43,723	1,01,75,450
15		32,95,069	48,00,000	15,04,931.0	5,60,661.66	1,20,38,089	1,11,04,385	1,11,04,385

NPV	**Rs. 1,11,04,384.53**
IRR	**45.6%**
DPBP	**4.71**
BCR	**2.97**

*All the currency values are in Indian Rupees (INR)

21 Appendix B

Table B1 mentions the potential commodities for value addition and their value added products. The information mentioned in Table B1 is based on preliminary knowledge and experience in food processing industry.

Table B1: Potential commodities for value addition and their value added products

Commodity	Potential value added products	Remarks
Soybean	Soy oil	Viability -Solvent extraction -150T/day and Mechanical Extraction > 20T/day
	Soybean protein	
	Protein isolate	
	Soybean atta	
	Soy milk	Highly perishable
	Soy tofu	Highly perishable
	Animal feed (Okara)	
	Fermented soy food (Soy sauce)	
	Soya snacks (namkeen, sticks, chunks)	
Maize	Corn flour	
	Corn flakes	Cereal and namkeen. General viability > 2T/day
	Corn starch	Residue could go as poultry feed
	Glucose	Economics of scale is critical

	Protein rich poultry feed	
	Pop corn	Based on variety
	corn snacks	Chips and extruded snacks markets are upcoming
	Silage	
Ginger	Dried ginger powder (Sunth)	
	Ginger oil	
	Pickle	Unsure of market
	Ginger extract	
Turmeric	Turmeric powder	Depends on the curcumin content
	Curcumin extraction	Residue is starch
	Essential oil extraction	
Gram	Dal mill	
	Dal mixture/snacks	
	Protein (Depending on quality)	
	Besan	
Tur	Dal mil	Better value for unpolished dal

Soybean is known for its high protein and no lactose content, therefore soybean milk and tofu becomes a prevalent alternative to dairy milk, hence suggesting its high demand in the market. However, due to the high perishability of soy milk and tofu, it requires appropriate cold chain technologies. The bi-product in soy milk processing is Okara which could be converted into animal feed. Soy oil is also a popular value added product and its processing generally requires a minimum quantum of 150T/day and 20T/day in case of solvent extraction and mechanical extraction respectively. The oil extraction efficiency in mechanical extraction is lower than solvent extraction however, recently, the demand for mechanically pressed oils has increased in the market due to its higher purity. Therefore mechanical pressed oils could be proposed for FPCs which have smaller quantum yet are interested in soy oil processing. The residue for soy oil extraction could be converted in soy protein/isolate which is again well accepted product in the fitness industry. Lately, the concept of multigrain flour for regular use is emerging and soy flour remains an important ingredient due to its protein and fibre content. Similarly, soy namkeen/snacks is a healthy alternative to refined flour snacks and products such as soy sticks have become popular in urban and semi-urban areas. The government nutrition programs such as mid-day meals could be benefitted by the use of soy products due to its rich nutritional profile. Moreover, inclusion of soy products in government programs would promote local soybean processing and revenue generation.

Products such as corn flour, corn flakes, popcorn etc. are popular value added products of Maize. Corn flour is an essential ingredient in many Indian recipes and therefore has high demand in local and national markets. Similarly, corn flakes are common in namkeen and breakfast cereals which is found in many urban and semi-urban households. A general corn flakes processing unit requires a minimum quantum of 2 T/day for its economic viability. Popcorn is a common snack and its production is highly dependent of the variety of maize. Another prevalent product of maize is the corn starch which has household as well as industrial application in food processing, paper making, adhesive, cosmetic industries etc. The residue of corn starch processing could be converted into poultry feed which is high in protein content. Glucose is another product from maize, however the facility of enzyme treatment is expensive therefore glucose extraction from maize is critical of economics of scale. Corn snacks in the form of chips (nachos) and extruded items are upcoming snacks in the national market as it is looked upon as a healthier option to potato chips.

Potential ginger products are dried ginger powder (Sunth), ginger oil, ginger extract and pickle. While all the ginger products go well in food, pharmaceutical and cosmetic industries, the market for ginger pickle is niche and need to be explored further. Turmeric on another essential spice widely used in the domestic and international market. Turmeric in the form of dried powder is regularly used by Indian household and is heavily in demand throughout the year. Curcumin content in the turmeric determine the quality of turmeric powder. Alternatively, curcumin could also be extracted from turmeric for wide scale application such as dietary supplement, flavouring and colouring agents and cosmetic industries. Turmeric essential oil is another value added product finding its application in pharmaceutical and cosmetic industries. Gram and tur have similar value added products which include milled dal. Other than dals, besan could be made from Gram which is in heavy demand in Indian market. Depending on the quality of gram, protein could be extracted using wet processes. Gram and tur dal could also be used in the package of mixed dal which is a popular Indian recipe.

Categorisation of value-added products for FPC based on quantum

The following section presents the potential value added products (Table B2) for FPCs visited in selected district. This preliminary analysis is based on their current quantum of dealing and a general knowledge of economics of scale. Table B2, Table B3 and Table B4, presents the potential products for FPCs dealing in soybean, maize and turmeric respectively.

Solvent extraction method for soybean oil extraction is an efficient process but requires huge quantum for economic feasibility and the visited FPCs did not deal in sufficient quantum of soybean for solvent extraction. Therefore, if the FPCs want to venture into soy oil extraction, mechanical soy oil extraction process is suggested if they are dealing in quantum more than 500MT considering they process 2T/day for around 250-300 days. Processing of soy atta, snacks, soy milk and allied products is feasible at smaller quantum (~50MT) while a combination of these products is suggested if the quantum exceeds above 150MT depending on the marketing ability of the FPCs.

In case of Maize processing, glucose extraction is expensive due to the enzyme facility, therefore only the FPCs dealing in large quantum such as 2000MT are recommended glucose processing as seen in Table B3. Another option for large quantum FPCs could be a combination of starch extraction, glucose, protein rich poultry feed/cattle feed, corn flakes and corn flour depending on the marketing channels and forward linkages. For FPCs with maize quantum around 1000MT, starch extraction and protein rich poultry feed/cattle feed would be more profitable than corn flakes and corn flour options (which are suggested for FPC with quantum in the range of 200MT).

Table B2 : FPCs dealing in Soybean, their quantum, current activities and potential value added product

Name of FPC	Location	Current Quantum (MT)	Current activities	Potential value added products
Rajshree FPC	Buldhana	10	Seed program and trading	Soybean atta
Sonpaul FPC	Buldhana	700	Seed program and trading	Soybean tofu, snacks, atta, oil (Mechanised), protein
Ruj FPC	Buldhana	51	Seed program and trading	Soybean atta and snacks
Jay Sardar FPC	Buldhana	10	Seed program and trading	Soybean atta
Kelvad FPC	Buldhana	150	Seed program and trading	Soybean tofu + snacks + atta (Together)
Krushi Mauli FPC	Washim	500	Seed program and trading	Soybean milk, tofu, snacks, atta, oil (Mechanised), protein
Parivartan FPC	Washim	600	Seed program and trading	Soybean milk, tofu, snacks, atta, oil (Mechanised), protein
Hari Om FPC	Washim	110	Seed program and trading	Soybean tofu + snacks + atta (Together)
Bhanudas FPC	Washim	250	Seed program and trading	Soybean tofu + snacks + atta (Together)
Bhanudas FPC	Latur	250	Cleaning, grading Storage, trading and Seed program	Soybean tofu + snacks + atta (Together)

Karpur FPC	Latur	700	Cleaning, grading Storage and trading	Soybean tofu, snacks, atta, oil (Mechanised), protein
Vikasratna FPC	Latur	20	Storage and trading	Soybean atta
Om sai FPC	Latur	410	Cleaning, grading Storage, trading and seed program	Soybean tofu + snacks + atta (Together)
Deoni FPC	Latur	700	Cleaning, grading Storage trading and seed program	Soybean tofu, snacks, atta, oil (Mechanised), protein
Rao saheb patil FPC	Latur	300	Cleaning, grading Storage and trading	Soybean tofu + snacks + atta (Together)
Agritech agroproducer FPC	Latur	1000	Cleaning, grading, Storage, trading and seed program	Soybean tofu, snacks, atta, oil (Mechanised), protein
Rasika FPC	Latur	500	Cleaning, grading Storage trading and seed program	Soybean tofu, snacks, atta, oil (Mechanised), protein
Siddhnath Nagnath FPC	Hingoli	100	Cleaning, grading grinding, Aata mill	Soybean tofu + snacks + atta (Together)
Icon FPC	Hingoli	170	Cleaning, grading, storage, trading and soya nuggets	Soybean tofu + snacks + atta (Together)
Pradnyashil Taruna FPC	Hingoli	50	Cleaning, grading, storage, Trading and Dal mill	Soybean atta and snacks

Godavari valley FPC	Hingoli	3000	Cleaning, grading, storage, Trading.	Soybean tofu, snacks, atta, oil (Mechanised), protein
Shri Faleshwar Maharaj FPC	Hingoli	700	Cleaning, grading, storage trading and Seed program	Soybean tofu, snacks, atta, oil (Mechanised), protein
Surya FPC	Hingoli	1760	Cleaning, grading, storage and trading.	Soybean tofu, snacks, atta, oil (Mechanised), protein
Jivannonanti FPC	Yavatmal	73	Procurement seiving and trading	Soybean atta and snacks
Bhumitra self-Reliant FPC	Yavatmal	100	Procurement, trading and Dal mill.	Soybean atta and snacks
Painganga FPC	Yavatmal	180	Cleaning, grading, storage, trading and Dal mill	Soybean atta and snacks
Agripath FPC	Yavatmal	12	Procurement, storage and trading	Soybean atta
Ideal FPC	Jalana	100	Cleaning, grading, storage trading, Atta mil and dal mill	Soybean atta and snacks
Purna kelana FPC	Jalana	65	Cleaning, grading, storage, trading, and Seed program	Soybean atta and snacks
Krushiputra FPC	Jalana	7	Procurement and Trading	Soybean atta

Table B3: FPCs dealing in Maize, their quantum, current activities and potential value added product

Name of FPC	Location	Quantum (MT)	Current activities	Potential value added products
Akash FPC	Aurangabad	300	Cleaning grading and trading	Corn flour, snacks
Godavari valley FPC (Karmad FPC)	Aurangabad	2000	Cleaning grading and trading	Starch, glucose, poultry feed, corn flakes, corn flour
Ghrushneshwar FPC	Aurangabad	750	Poultry and cattle feed, Cleaning grading and trading	Corn flour, snacks
Pinakeshwar FPC	Aurangabad	200	Cleaning grading and trading	Corn flour, snacks
Krushi Kranti FPC	Aurangabad	1000	Poultry and cattle feed, Cleaning grading and trading	Starch, protein rich poultry feed
Renukamata FPC	Aurangabad	1000	Cleaning grading and trading	Starch, protein rich poultry feed
Jay Sardar FPC	Buldhana	2000	Poultry and cattle feed, Cleaning grading and trading	Starch, glucose, poultry feed, corn flakes, corn flour
Purna kelana FPC	Jalna	20000	Procurement, Cleaning, grading, storage and trading	Starch, glucose, poultry feed, corn flakes, corn flour
Krushiputra FPC	Jalana	500	Procurement and trading	Corn flour, snacks

Khadeshwar FPC	Jalna	135	Procurement,cleaning, grading and trading	Corn flour, snacks
Gopdam FPC	Jalgaon	100	Procurement and trading	Corn flour, snacks
Adishakti muktai krishi vikas FPC	Jalgaon	100	Procurement trading and Dal mil	Corn flour, snacks

Table B4: FPCs dealing in Turmeric, their quantum, current activities and potential value added product

Name of FPC	Location	Quantum (MT)	Current activities	Potential value added products
Krushi Kranti FPC	Aurangabad	500	Drying of rhisome	Turmeric powder, essential oil
Nardus FPC	Washim	500	Trading of rhisome, Essential oil from leaves	Turmeric powder, essential oil
Anukaran FPC	Hingoli	50	Procurement, storage and grinding	
Appaswami FPC	Hingoli	10	Procurement and grinding	
Icon FPC	Hingoli	17	Procurement, storage, trading and grinding	
Pradnyashil Taruna FPC	Hingoli	3	Procurement,storage and grinding	
Godavari valley FPC	Hingoli	2000	Procurement, cleaning, grading and polishing	Turmeric powder, essential oil Curcumin powder
Surya FPC	Hingoli	760	Procurement, storage and Trading	Turmeric powder, essential oil
Rajodak FPC	Jalgaon	500 (Dried) 500(wet)	Procurement, storage trading and grinding	Turmeric powder, essential oil

22 Appendix C

Table C1: Cash flow for soy milk/tofu unit

Year	Cash outflow (INR)	Cash inflow (INR)	Net cash flow (INR)	Cumulative discounted flow value (INR)
0	7472858	0	-7472858	-7472858
1	6105082	7728000	1622918	-5849941
2	7732960	10046400	2313440	-3536501
3	9360837	12364800	3003963	-532537
4	11531340	15456000	3924660	3392123
5	11531340	15456000	3924660	7316783
6	11531340	15456000	3924660	11241443
7	11531340	15456000	3924660	15166103
8	11531340	15456000	3924660	19090763
9	11531340	15456000	3924660	23015424
10	11531340	15456000	3924660	26940084

Table C2: Cash flow for turmeric powder processing unit

Year	Cash outflow (INR)	Cash inflow (INR)	Net cash flow (INR)	Cumulative discounted flow value (INR)
0	7199204	0	-7199204	-7199204
1	5466370	7372800	1906430	-5292774
2	6780178	9584640	2804462	-2488312
3	8093985	11796480	3702495	1214183
4	9845728	14745600	4899872	6114055
5	9845728	14745600	4899872	11013927
6	9845728	14745600	4899872	15913799
7	9845728	14745600	4899872	20813671

8	9845728	14745600	4899872	25713543
9	9845728	14745600	4899872	30613415
10	9845728	14745600	4899872	35513287

Table C3: Cash flow for curcumin extraction plant

Year	Cash outflow (INR)	Cash inflow (INR)	Net cash flow (INR)	Cumulative discounted flow value (INR)
0	24105600	0	-24105600	-24105600
1	144018364	151500000	7481636	-16623964
2	186457156	196950000	10492844	-6131120
3	228895948	242400000	13504052	7372932
4	285481004	303000000	17518996	24891928
5	285481004	303000000	17518996	42410924
6	285481004	303000000	17518996	59929920
7	285481004	303000000	17518996	77448916
8	285481004	303000000	17518996	94967912
9	285481004	303000000	17518996	112486908
10	285481004	303000000	17518996	130005904