DETAILED FEASIBILITY REPORT

Fruit & Vegetable Cleaning, Grading and Packaging Unit

in conformity with

The Royal Government of Bhutan's Vision of Achieving Economic Self-Reliance

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Ministry of Economic Affairs

Royal Government of Bhutan

CONTENT

ABBREVIATIONS AND DEFINITIONS

ARI	Acute Respiratory Infection
BAFRA	Bhutan Agriculture and Food Regulating Authority
BEP	Break Even Point
BHU	Basic Health Units
BPC	Bhutan Power Corporation
BTL	Bhutan Telecom Limited
CAC	Codex Alimentarius Commission
CaOCl	Calcium Hypochlorite
CI	Chilling Injury
CAGR	Cumulative Average Growth Rate
CIPHET	Central Institute of Post Harvest Engineering and Technology
ClO_2	Chlorine Dioxide
CPC	Central Procurement Centre
CUSP	Caltech – USGS Seismic Processing
DSCR	Debt Service Coverage Ratio
EA	Environment Assessment
EI	Environmental Information
EMP	Environment Management Plan
EPI	Expanded Program on Immunization
ETP	Effluent Treatment Plan
FDA	Food and Drug Administration
GMP	Good Manufacturing Practice
GRAS	Generally Regarded as Safe
HACCP	Hazard Analysis and Critical Control Point
HOCl	Hypochlorous Acid
HSC	Hydropower Service Centre
IMNCI	Integrated Management of Neonatal and Childhood Illness
IPPC	International Plant Protection Convention
IRR	Internal Rate of Return

ISO	International Standards Organization
ISP	Internet Service Provider
MAP	Modified Atmosphere Packaging
MoAF	Ministry of Agriculture & Forests
MRP	Maximum Retail Price
MT	Metric Ton = 1000 Kilogram
MUM	Modularization, Unitization and Metrication
NACP	National HIV/AIDS & STIs Control Program
NAOCl	Sodium Hypochlorite
NEC	National Environment Commission
NHDCL	Narmada Hydroelectric Development Corporation Limited
NPHC	National Post Harvest Centre
NPPF	National Pension & Provident Fund
NTCP	National Tuberculosis Control Program
OHS	Occupational Health & Safety
ORC	Out Reach Clinics
RPM	Revolutions per Minute
RUB	Royal University of Bhutan
RWSS	Rural Water Supply & Sanitation Program
SPM	Suspended Particulate Matter
TICL	Tashi Info Comm Limited
TSPM	Total Suspended Particulate Matter
TSS	Total Suspended Solid
USDA	United States Department of Agriculture
USDA-APHIS	U.S. Department of Agriculture, Animal and Plant Health Inspection Service
VDCP	Vector Borne Disease Control Program
VHW	Village Health Workers Program
VTI	Vocational Training Institute
WFP	World Food Program

1.0 EXECUTIVE SUMMARY

This report is a detailed feasibility study on setting up a fruit and vegetable cleaning, grading and packaging unit in Bhutan which has been conducted by the Department of Industry, Ministry of Economic Affairs of the Royal Government of Bhutan.

The Royal Government of Bhutan, in the Investment Opportunity Study – 2006 identified a "fruits/ vegetables cleaning, grading and packaging unit" as a priority project that required further detailed studies. Bhutan imports huge amount of food from India each year. In 2010, 17% of the total imports from India were food imports, of which vegetable and fruit imports alone accounted for Nu. 676.5 million. Bhutan produces a large number of fruits and vegetables throughout the year. Unfortunately, a huge amount of fruits and vegetables go to waste due to lack of storing capacity or are not able to command a premium in the export market owing to poor packing house processing facilities. Significant amount of imports happen during the lean season.

It has been proposed that the unit will have a capacity of processing 50MT of fruits and vegetables in a day. It would also have a storing capacity of 100 MT. This will also be able to curb wastage, reduce the import of fruits and vegetables and give a fillip to exports.

The following chapters present detailed discussions on the justification of the project, market analysis, resources required, technology used in the plant, plant location, environmental aspects, implementation of the project, cost presentation and financial analysis.

(i) **Justification of the project:** This unit will help to reduce the loss incurred from the wastage of fruits and vegetables. It would also help in getting a better value for the fruits and vegetables particularly in the export market. It would also discourage to a limited extent, the import of fruits and vegetables in the lean season.

(ii) **Market Analysis:** There is a scope for exploiting both the domestic and the exports market

(iii) **Resources required:** Fruits and vegetables are available from the local farmers. Apart from this the unit requires manpower, electricity and a huge amount of water, which are available locally. But the consumables would have to be imported from India.

(iv) **Technology required:** A part of the operation is mechanized. So, some basic training program should be conducted to enable personnel to operate the machineries, recognize and report faults and do elementary trouble shooting

(v) **Plant Location:** The ideal location proposed for the plant is Jigmeling in Sarpang dzongkhag.

(vi) **Environmental Aspects:** This unit produces some wastes, which should be treated properly to prevent environment pollution.

(vii) **Implementation of the Project:** The implementation of the project will take 12 months including pre-project activities.

(viii) **Cost Presentation & Financial Analysis:**

Table 1: Cost Presentation and Financial Analysis

Plant Capacity:	**50 MT per day; 16000 MT per year**
No. of Shift:	One (8 hours per shift) per day
Working Days in Year:	320
D.S.C.R. :	2.31
B.E.P. :	16.88 %
IRR :	29.73%
NPV :	37.2

Summary of Cost Benefit Analysis:

The total cost of the project is Nu.56.76 million. The Internal Rate of Return of the project is 29.73%, which is much higher than the bank rate of 13%. The NPV over ten years is Nu. 37.2 million. Hence it can be concluded that the project is financially viable.

2.0 JUSTIFICATION OF THE PROJECT

2.1 The Need for the Project:

General Scenario: Bhutan has highly diverse agro-climatic conditions due to major differences in altitude and rainfall as well as in slope characteristics. In the absence of proper transport infrastructure, however, fruits were grown in the past only for domestic consumption. Today, with a growing road network and increased trade with neighbouring countries, surplus fruits can be sold in domestic markets or exported to countries that have a tropical climate but an insatiable market for temperate fruits. Table 2a and 2b present the production level of some fruits and vegetables grown in Bhutan as per figures released by the Ministry of Agriculture & Forests for 2011.

Table 2.a: Production of Fruits

Sl. No.	Fruits/vegetables	Production (MT)
1	Mandarin	60,993
2	Apple	20,752
3	Arecanut	9,781
4	Banana	2,439
5	Peach	1,649
6	Pear	1,354
7	Guava	950
8	Plum	565
9	Walnut	474
10	Jackfruit	245

Table 2.b: Production of Vegetables

Sl. No.	Fruits/vegetables	Production (MT)
1	Potatoes	52,116
2	Chilli	8,121
3	Turnip	7,823
4	Pumpkin	5,368
5	Radish	4,865
6	Ginger	4,533
7	Cucumber	2,796
8	Squash	2,766
9	Green Leaves	2,510
10	Mustard	2,344

Scope for reducing trade deficit: For some categories, there is a phenomenal possibility for import substitution. Bhutan imports huge amount of food from India. In 2010, 17% of the total imports from India were food imports, of which vegetable and fruit imports alone accounted for Nu. 676.5 million. As per figures released by the Department of Revenue and Customs for 2014, the import figures for fruits are given below in Table 3: As is evident, Bhutan imports a fair volume of apples. This is despite the country becoming a major producer (refer table 2.a) and a major exporter of apples (refer table 4). Owing to inadequate storage facilities, the post harvest period sees the excess apples being wasted through decomposition or being fed to animals. So in the lean season, the country is forced to import apples from places as distant as Australia. With superior storage this import can be eliminated altogether.

Table 3: Import Value of Fruits and Vegetables

Sl. No.	Fruits/vegetables	Import value in Nu.
1	Mango	22,898,477
2	Onions & shallots	65,450,150
3	Apple	6,204,875
4	Tomatoes	48,033,857
5	Pineapples	3,176,682
6	Mandarin/Oranges	2,037,631
7	Banana	1,925,925
8	Pear	1,327,295
9	Peas	3,157,043
10	Guava	281,951

Using data from the Bhutan Trade Statistics 2014, the import and export figures for selected fruits are presented below. If the industry can be supported by setting up suitable cleaning, grading and packaging units, the agro exports industry has the potential to command higher prices and reduce loss from spoiled produce.

Table 4: Export Value of Fruits and Vegetables

Sl. No.	Fruits/Vegetables	Export value in Nu.
1	Potatoes	686,297,083
2	Apple	79,974,646
3	Betel nuts	70,336,847
4	Lettuce	28,534,590
5	Carrots & turnips	13,665,520
6	Mandarin/Oranges	22,445,807
7	Lentils	7,593,691
8	Peas	41,69,480
9	Chillies	1,122,760
10	Cauliflowers and headed Broccoli	127,500

Minimizing loss: The extent of loss on account of wastage of fruit and vegetables owing to improper storing can be astounding. The results of a study conducted by FAO suggest that roughly one-third of food produced for human consumption is lost or wasted globally, which amounts to about 1.3 billion tons per year. As per the latest estimates, by Central Institute of Post Harvest Engineering and Technology (CIPHET), Ludhiana, in India, the wastage of fresh horticultural produce is up to 18 per cent due to poor postharvest management practices. The prevailing scenario in Bhutan cannot be very different.

Lack of storage infrastructures during peak production season acts as a major handicap for producers. During good harvest, respondents sell their products at throwaway prices. Even though there may be certain cold storage facilities available like the one at Sisina or at the NPHC Paro, marginal farmers are of the view that it would be difficult for them to store at the facilities, as they have to incur additional transportation costs unless it is collected at the farm gate by the management.

Value creation: Bhutanese fruits and vegetables find ready market in India and Bangladesh. However there is little premium attached as the products are unsorted and lack grading aspects. It is the middleman from the other side of the border who make large profits as they command a higher realized price brought about by sorting, grading and packaging. In case superior post harvest processing can ensure proper sorting, grading and packaging, substantially higher values can be realized from exports.

2.2 Competition Analysis:

The products coming out of the processing unit would have to compete with the imported products – mostly Indian products. This would be both in the domestic as well as the overseas market.

Besides there could be direct completion from similar units which are either in operation or coming up fast. There is a National Post Harvest Centre at Paro, which provides similar facilities. But its capacities are oversubscribed. As per available information, the Ministry of Agriculture and Forests (MoAF) has identified five places in the country to establish advanced cold storage facilities to store home grown vegetables, especially potatoes, to make them available for the Bhutanese consumers round the year and in the process curb vegetable import in the lean season. The estimate and plans for setting up the cold storage technology is complete and such cold storage facilities would be soon established in Gelephu, Samdrup Jongkhar, Nganglam under Pemagatshel and Gyelposhing under Mongar.

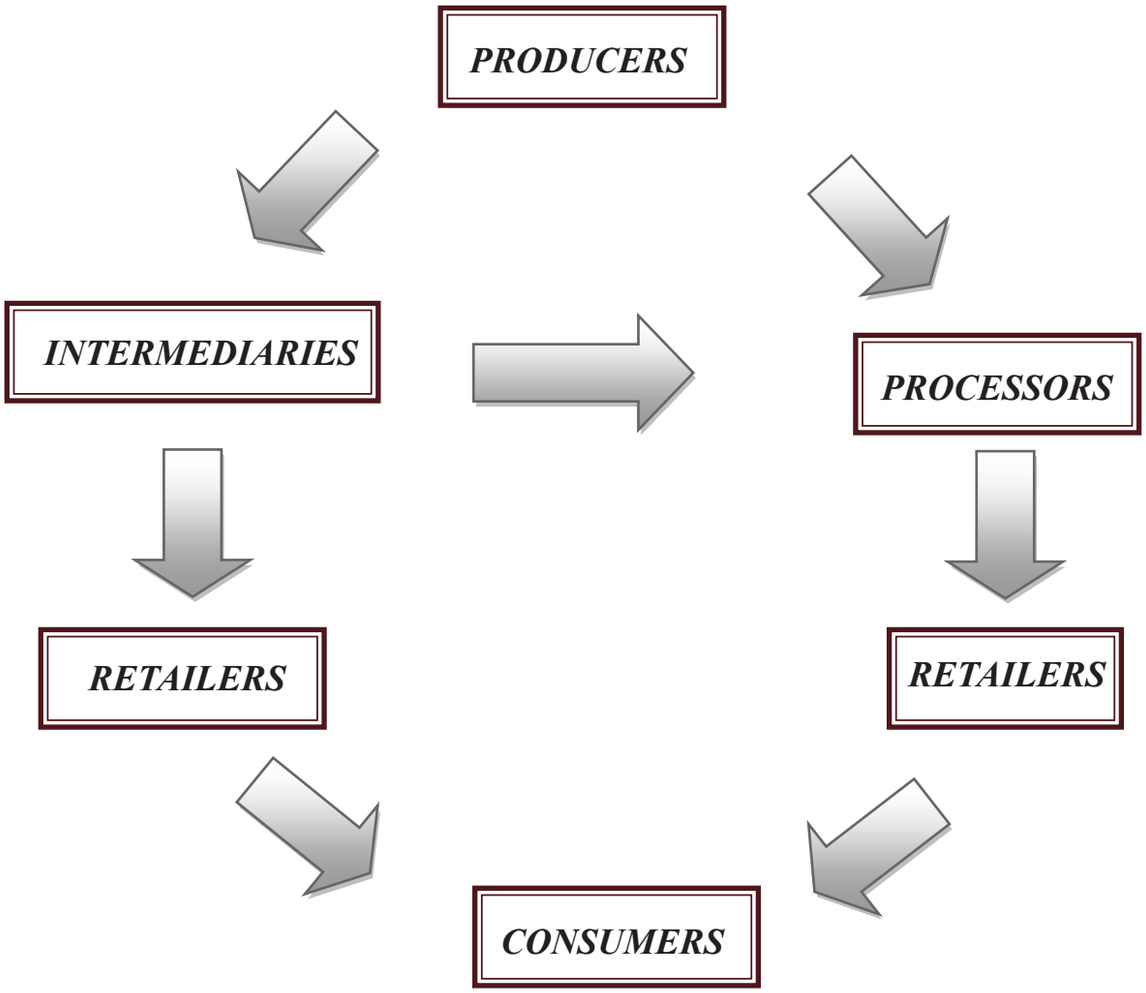
However, since the potential for business is enormous, it is estimated that NPHC unit at Paro and these MOAF units as and when they come up, would not cannibalize the units that are being proposed through this study.

3.0 MARKET ANALYSIS

3.1 Structure of the Industry:

The Key stakeholders: For Bhutan, the agricultural and food marketing systems can be said to comprise of the following stakeholders

Figure 1: The Key Stakeholders



The key stakeholders in the value chain as shown in Figure 1 are:

Producers: The farmers who actually grow the fruit or vegetables

Intermediaries: They buy the produce from the farmers, transport the same and sell them off in wholesale markets onto retailers.

Processors: They process the produce to make agro products. Many of them source from the farmers directly but when that is not possible they also depend on intermediaries.

Retailers: They buy from the intermediaries and sell to the consumers. A few may belong to the organized sector like a departmental store and sell branded products – both fresh as well as bottled products.

The Key Functions: The key functions that support the industry are as follows:

Pack house processing: After harvest, fruits and vegetables need to be prepared for sale. Regardless of the destination, preparation for the fresh market comprises four basic key operations:

1. Removal of unmarketable material
2. Sorting by maturity and/or size
3. Grading
4. Packaging

Storage: An inherent characteristic of horticulture production is that it is seasonal while demand is generally continuous throughout the year. Hence the need for storage arises to allow a smooth, and as far as possible, uninterrupted flow of product into the market.

In agriculture and horticulture, supply often exceeds demand in the immediate post-harvest period. The glut reduces producers' prices and wastage rates can be extremely high. For much of the lean period before the next harvest, the product can be in short supply, with traders and consumers having to pay premium prices to secure whatever scarce supplies are available. The storage function is one of balancing supply and demand.

Both growers and consumers gain from a marketing system that can make produce available when it is needed. A farmer, merchant, co-operative, marketing board or retailer who stores a product provides a service. That service costs money and there are risks in the form of wastage and slumps in market demand and price, so the provider of storage is entitled to a reward in the form of profit.

Transportation: The transport function is chiefly one of making the product available where it is needed, without adding unreasonably to the overall cost of the produce. Adequate performance of this function requires consideration of alternative routes and types of transportation, with a view to achieving timeliness, maintaining produce quality and minimizing transportation costs. Effective transport management is critical to efficient marketing. Whether operating a single vehicle or a fleet of vehicles, transportation has to be carefully managed, including cost monitoring.

There are two broad categories of transportation – outbound and inbound. **Outbound** comprises of moving products from the processing or storage centre onto customers. **Inbound** would be moving the products from the Nodal Collection Centres and from there onto the Central Processing cell. There is an implicit challenge which one must not lose sight of. The SNV study on the Citrus in Bhutan – A Value Chain Analysis. 2009 highlights this issue as revealed in a survey that was a part of this study. During the survey, 80% of respondents stated that they carry oranges to the depots on their own back or on a pack horse, whereas 11% make a deal with contractors who collect oranges from different farms and transport them to the export depot. The remaining 9% are flexible; depending upon the situation either they take their oranges to the depot or sell to contractors at their farm.

Processing: Most horticulture produce in Bhutan is not in a form suitable for direct delivery to the consumer when it is first harvested. Rather it needs to be changed in some way before it can be used. The processing function is sometimes not included in a list of marketing functions because it is essentially a form changing activity. However, it is for this very reason that processing ought to be included as a marketing function. The form changing activity is one that adds value to the product.

Standardization: Standardization is concerned with the establishment and maintenance of uniform measurements of produce quality and/or quantity. This function simplifies buying and selling as well as reducing marketing costs by enabling buyers to specify precisely what they want and suppliers to communicate what they are able and willing to supply with respect to both quantity and quality of product. The absence of such standards becomes a deterrent to trade.

Quality differences in horticulture products arise for several reasons. Quality differences may be due to production methods and/or because of improper plucking in the farm and collecting. Technological innovation can also give rise to quality differences. In addition, a buyer's assessment of a product's quality is often an expression of personal preference. Thus, for example, in some markets a small banana is judged to be in some sense 'better' than a large banana and white maize is 'easier to digest' than yellow maize.

Financing: In this production system there are inevitable lags between investing in the necessary raw materials system (e.g. machinery, cleaning and grading, packaging, flavouring, stocks etc.) and receiving the payment for the sale of produce. During these lag periods some individual or institution must finance the investment. The question of where the funding of the investment is to come from at all points between production and consumption is one that marketing must address.

How the new proposition affects the value chain in the horticulture industry: The new project advocates setting up an integrated horticultural cleaning, grading, packing and marketing unit in Bhutan. The objectives of the project would be to remove non-value adding intermediaries from the value chain leading to

- Better price realization for farmers
- Reduction in wastage for farmers particularly during harvest
- Reduction in import during lean seasons
- Better price realization for retailers
- Better value for the consumers
- Higher export realization

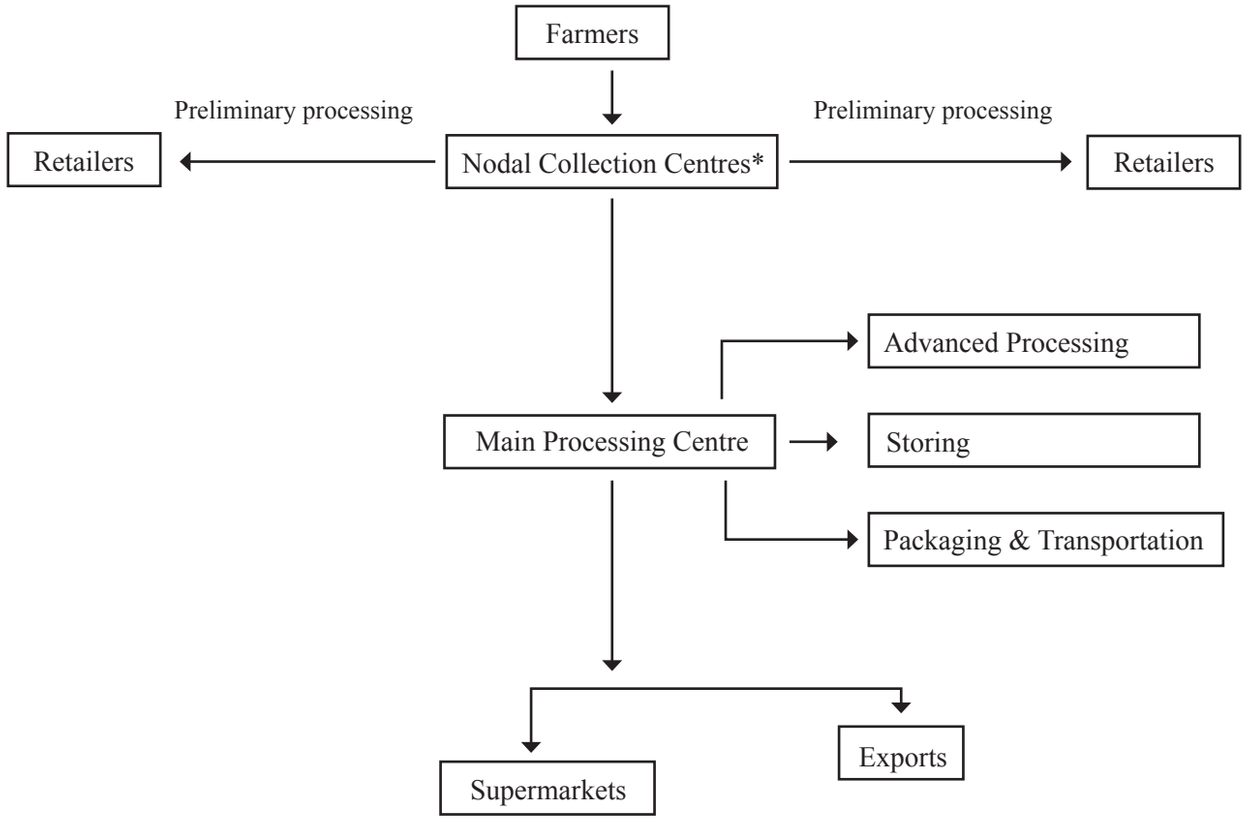


Figure 2: The Overview of the Project

* 5 Nodal Collection Centres in the adjoining dzongkhags

The overview of the project is shown in Figure 2. The project will follow an area wise collection route and set up procurement centers called Nodal Collection Centres (NCC). The NCCs would perform the preliminary processing consisting of sorting, hand cleaning and manually grading the products. Then, the low end products are supplied directly to the regular domestic market through retailers. The products which have a higher grade are sent to the Main Processing Center (MPC). In the MPC advanced processing is carried out, which involves washing, drying, degreening, controlled ripening, treatment for pest control , packaging, and cold storage if required before dispatch. These superior products are then labelled and attractively packaged. These products are destined for high end stores and the overseas market and can command a premium price.

3.2 Demand vs. Supply:

The huge gap between demand and supply for services like food processing and storage can possibly be understood from estimates of fruits and vegetables that get wasted every year in Bhutan in the absence of such services. A recent survey was conducted by SNV and the findings presented in January 2014. The survey gauged the total weekly imports and the wastage due to lack of cold storage and processing unit. It was found that 40 respondents who were all wholesalers would be foregoing products worth Nu. 1.820 million annually as waste. The average figure per wholesaler works to a staggering Nu 45,500/-.

3.3 Pricing & Marketing Strategies:

This marketing effort will call for a strategy based on segmenting, targeting & positioning.

Segmenting: The act of dividing the market into distinct groups of buyers who might require separate offerings in terms of product attributes, pricing, promotion and distribution. Broadly speaking there could be two sectors – export & domestic. The domestic market can again be segregated into

1. Super markets/ Departmental stores
2. Fruit processing units
3. General retailers

It is felt that the export market and the supermarkets/departmental stores would be willing to pay a premium for a high grade product. But the rest of the domestic market would be price sensitive.

Accordingly two types of products would be in the offering:

a. Fruits and vegetables after preliminary processing namely sorting, cleaning & grading

b. Products after advanced processing namely de greening, control ripening, pest and disease control and of course superior packaging using fibre board cartons and a brand name and a logo preferably printed on stickers

Targeting: This is the act of choosing some of the segments identified from considerations of commercial attractiveness. Products under category (a) would go to general retailers and fruit processing unit. They would be sold at a reduced price using conventional packaging using baskets and plastic crates. Products under category (b) would come to the Main Processing Centre for further value addition. Eventually they will go to super markets and the export market at a premium pricing. The volume split is expected to be 50:50.

Positioning: This is the act of providing a viable competitive positioning of the firm and its offer in each target market. It should ideally communicate uniqueness that adds value. Some viable positioning statements could be

- A Quality product – highlighting attributes like aesthetic appeal, freshness, taste, nutritional value & hygiene
- Readily available

The marketing mix should accordingly be defined encompassing aspects like the product attributes including quality and packaging, pricing strategy, promotion and distribution and logistics all carefully designed to ensure a high level of consumer satisfaction.

Product: By ensuring proper quality in sourcing, cleaning, grading, packaging the unit can ensure that the quality of their supplies is actually well ahead of the market. The unit can then even think

of branding their supplies with an appropriate logo printed on stickers.

Price: If the high quality is really established, the company can resort to a premium pricing strategy thereby strengthening its perceived superior quality through price – value perception.

Promotion: The study recommends two-pronged promotional strategy. The first strategy targets growers/producers through local government and agriculture extension channels through awareness and sensitization programs at the grassroots. The second strategy targets retailers/wholesalers and consumers on the benefits of organic/local and fresh products and its health benefits through proper media channels. In Table 5, the promotional activities have been listed down.

The targeted marketing mix would comprise of fruits and vegetables with export potential. These would be mandarin, banana, guava, pineapple, potato, chilly, ginger and raddish. The accompanied research work is presented under item no 6.1 of this report entitled 'Availability of Raw Materials'

Table 5: Promotional Activity

Serial Number	Promotional Activity
01	Grand opening/launch of the Nodal Collection Centres and Central Processing Cell. The event should be covered on the radio & TV.
02	Occasional TV and radio advertisements to make farmers aware about the activities of the organization
03	Distribution of leaflets, pamphlets, stickers; Wall paintings & hoardings wherever possible
04	Promotional visits to the processing unit and the storage facilities by the farmers and retailers
05	Promotional & discounted sales campaigns to departmental stores, institutional buyers, retailers and overseas buyers

Place: Superior Distribution & Logistics would be the key to success in a geographical area where rural roads as well as transportation facilities are in a state of evolution. Since majority of the producers face transportation constraints and easy access to market, the management will have to address these problems through pooled collection and transportation of products. Sales offices should be present in all major towns.

Figure3: Weekend Farmers' Market in Thimphu, Bhutan

3.4 Technological Changes that could Impact Costing:

One of the biggest technological changes that can impact the way the unit would conduct business in the future would be the progress of information technology in shaping ecommerce and its adaption in the Bhutanese economy.

In India it has been successfully adapted in contract agricultural farming by ITC using e choupals – electronic virtual market places that farmers can access from designated nodal centres in villages which would give them an idea about demand conditions and pricing trends so that they can take informed selling decisions ensuring a better return on their investments which in turn can motivate them to produce more.

Similarly on the customer side of the supply chain, it may be possible to generate and respond to enquiries on line and transact business on line at least with the organized sector, which would include departmental stores, institutional buyers and export customers.

The basic impact of all this would lead to the business cycle reducing, greater predictability and control which would help to reduce the cost and therefore the price of the offerings.

3.5 Competitiveness of the Project:

The project advocates setting up a packinghouse and storage operation.

This would compete against some of the intermediaries in the value chain who were primarily playing the role of middlemen and transporters without performing the desired value adding processes.

The unit aspires to deliver quality products to discerning clientele at prices comparable to prevailing market rates. The superior technology used for processing would ensure the availability of fresh, hygienic and aesthetically appealing product in the market. It is expected that there would be a demand pull at the customer end which can be further strengthened through innovative promotional strategies. This in turn would create a demand pull on the farmers through the Nodal Collection Centres. The demand pull is estimated to be significant ensuring lowering of costs through economies of scale. The unit can further cash in on their advantage as a 'big buyer' by facilitating collection at the nodal centres by extending some transportation and logistics support to farmers.

It is expected that some of the competing would eventually get eliminated.

3.6 Special Attributes Desired by Target Customers:

In general customers would prefer the following:

1. Fresh, aesthetically appealing, hygienic and graded properly
2. They would prefer an affordable price: some may prefer to have a credit period
3. Some would look forward to promotional offer

4. Timely delivery in good condition

However the customer needs and wants may vary from one customer segment onto the other. For example a consumer procuring vegetables from a small roadside retailer may not attach much significance to grading. But grading may be a primary requirement for a buyer like a departmental store.

Besides for exports there would be stringent regulatory requirements, which would have to be adhered to. There are usually two sets of requirements, which must be fulfilled – one is specific to Bhutan which is enforced by BAFRA (Bhutan Agriculture and Food Regulating Authority) and the other would be the standards followed by the importing country. Chapter 7 of BAFRA regulations lists the requirements for exports. (See Box A)

Box A: Export Inspection regulations of BAFRA

The Minister under the power conferred by section 6 (g) of the Plant Quarantine Act authorises BAFRA Inspectors duly appointed under the Act to inspect and examine and otherwise treat plant /plant products and goods offered for export.
After examination the inspector may issue a certificate (Phytosanitary Certificate) indicating that plants, plant products or goods are free from injurious pests according to the import regulations of the importing country.
The permit requirements shall be in general accordance with the International Plant Protection Convention (IPPC) of 1951.
Any agricultural products for export to India and other countries have to go through BAFRA.
A Phytosanitary Certificate will be issued to goods from a third country only after inspection and certification of the consignment.
Nu. 5/-(five) only will be collected as the Phytosanitary Certificate fee.

3.7 Terms &Conditions and Product Specifications Desired by Target Customers:

Fruits and vegetables are considered 'health food' as they are microbiologically safer than meat, poultry and other foods. However, soil selection and preparation, variety selection and other decisions influence the quality of the product. Quality is also affected by climatic conditions during the growing period, as well as irrigation, fertilizers, control of pests and diseases and other cultural practices.

Generally speaking, fruits like oranges, which are protected by peel, are relatively safe for consumption. They are not considered to be a cause of food-related illnesses. However in some cases, if fruits are ruptured and over-ripened, or treated with chemicals for ripening, then there is a possibility of contamination. It is difficult for consumers to detect whether fruits contain any dangerous substances originating from soil, water, chemical fertilizers or pesticides used on the plant and fruit. They generally assess the fruit's quality based on taste, freshness, ripeness, color and appearance.

Taste is usually expressed in terms of the combination of sweet and sour principles. The content of soluble solids is a good estimate of total sugar content, and mandarin should have at least 8% solids. Organic acids (citric, malic, oxalic and tartaric acid) are the other important components of taste, particularly in their relationship with soluble solids.

Freshness is the condition of being as close to harvest as possible, whereas ripeness refers to the point of maximum eatable quality. Appearance is the first impression that the consumer receives and the most important component of the decision to purchase the fruit.

In recent decades, food safety has become a significant issue. For example International quality standards for citrus fruits and products are normally set in Codex Alimentarius, a joint commission of WHO and FAO (See Box B). For quality testing, the fruit is squeezed from the sample fruit and the juice is tested for two main attributes, brix (total soluble solids) and acid. From these two attributes, the sugar/acid ratio, which gives the flavor of the juice, is determined.

Apart from internationally established standards or quality, buyers, supermarkets and retailers also demand quality products with third party certification. In Bhutan, BAFRA is the government authority that inspects the quality based on size (meel and keel), colour and general appearance and issues certificates for export. It has the right to reject any lots of fruits that do not meet the prescribed standards. There is strong regulation concerning the transportation of seedlings/saplings from one Dzongkhag to another. It is prohibited to introduce plants into new areas without permission from the concerned authority. As per regulations, fruits and vegetables can be sold only in designated market places and juice and value-added products need to be labeled and packaged according to prescribed standards.

Box B: Minimum Quality Requirements as provisioned by Codex Alimentarius

In all classes, subject to the special provisions for each class and the tolerances allowed, the oranges must be:
Whole;
Sound, produce affected by rotting or deterioration is excluded
Clean, practically free of any visible foreign matter;
Practically free of pests affecting the general appearance of the produce;
Practically free of damage caused by pests;
Free of abnormal external moisture
Free of any foreign smell and/or taste;
Free of damage caused by low and/or high temperatures;
Free of damage caused by frost;
Free of signs of internal shrivelling;
Practically free of bruising and/or extensive healed-over cuts.

3.8 Packaging & Transportation:

The main purpose of packaging is to ensure that the product is inside a container along with packing materials to prevent movement and to cushion the produce (plastic or moulded pulp trays, inserts, cushioning pads, etc.) and for protection (plastic films, waxed liners, etc.). It needs to satisfy three basic objectives. These are to:

1. Contain product and facilitate handling and marketing by standardizing the number of units or weight inside the package.

2. Protect product from injuries (impact, compression, abrasion and wounds) and adverse environmental conditions (temperature, relative humidity) during transport, storage and marketing.

3. Provide information to buyers, such as variety, weight, number of units, selection or quality grade, producer's name, country, area of origin, etc. Recipes are frequently included such as nutritional value, bar codes or any other relevant information on traceability.

A well-designed package needs to be adapted to the conditions or specific treatments required to be undertaken on the product. For example, if hydro cooling or ice-cooling need to be undertaken, it needs to be able to tolerate wetting without losing strength;

if product has a high respiratory rate, the packaging should have sufficiently large openings to allow good gas exchange; if produce dehydrates easily, the packaging should provide a good barrier against water loss, etc. Semi-permeable materials make it possible for special atmospheres inside packages to be generated. This assists in maintaining produce freshness.

Figure 4: Packaging of Fruits

There are three types of packaging:

1. Consumer units or prepackaging
2. Transport packaging
3. Unit load packaging or pallets

When weighed product reaches the consumer in the same type of container in which it is prepared - this is described as a consumer unit or prepackaging. Normally, this contains the quantity a family consumes during a certain period of time (300 g to 1.5 Kg, depending of product). Materials normally used include moulded pulp or expanded polystyrene trays wrapped in shrinkable plastic films, plastic or paper bags, clamshells, thermoformed PVC trays, etc. Onions, potatoes, sweet potatoes etc are marketed in mesh bags of 3-5 Kg. Colors, shapes and textures of packaging materials play a role in improving appearance and attractiveness.

Transport or packaging for marketing usually consists of fiberboard or wooden boxes weighing from 5 to 20 Kg or bags can be even heavier. They need to satisfy the following requirements: be easy to handle, stackable by one person; have the appropriate dimensions so that they fit into transport vehicles and materials should be constructed with biodegradable, non-contaminating and recyclable materials. Packaging intended for repeated use should be: easy to clean and dismantle so that it is possible to significantly reduce volume on the return trip; ability to withstand the weight and handling conditions they were designed for, and meet the weight specifications or count without overfilling.

In these types of packages it is common to use packaging materials, which serve as dividers and immobilize the fruit. For example, vertical inserts can be used. They also assist in reinforcing the strength of the container, particularly when large or heavy units such as melons or watermelons are packed. Trays also have the same objective but they separate produce in layers. They are common in apples, peaches, plums, nectarines, etc. Plastic foam nets are used for the individual protection of large fruits like watermelons, mango, papayas, etc. It is also possible to use paper or wood wool, papers or other loose-fill materials.

In many developing countries containers made of natural fiber are still used for the packaging of fruits and vegetables. Although cheap, they cannot be cleaned or disinfected. They therefore represent a source of contamination of microorganisms when reused. Moreover, there is a risk of bruising as a result of compression. This is because they were not designed for stacking. In addition to this, the significant variations in weight and/volume makes marketing a complex business.

Finally, pallets have become the main unit load of packaging at both domestic and international level. Their dimensions correspond to those of maritime containers, trucks, forklifts, storage facilities, etc. As unit loads they reduce handling in all the steps in the distribution chain. Different sizes exist. However, the most common size internationally is 120 x 100 cm. It is sometimes made of plastic materials. Depending on the packaging dimensions, a pallet may hold from 20 to 100 units. To ensure stability, pallet loads are secured with wide mesh plastic tension netting or a combination of corner post protectors and horizontal and vertical plastic strapping. In many cases individual packages are glued to each other with low tensile strength glue that allow separate units but prevent sliding. They are also stacked crosswise or interlocked to contribute to the load stability.

There is a trend towards standardization of sizes. This is because of the wide variety of shapes and sizes of packaging for fruits and vegetables. The main purpose of standardization is to maximize utilization of the pallet's surface based on the standard size 120 x 100 cm. The ISO (International Standards Organization) module (norm ISO 3394) sets 60 and 40 cm as basic horizontal dimensions divided in subunits of 40 x 30 cm and 30 x 20 cm. There are no regulations regarding the height of individual packages. However, the palletized load should not exceed 2.05 m to ensure safe handling. On the recommendation of USDA, the MUM system (Modularization, Unitization and Metrication) also has as its objective, container standardization on the basis of the 120 x 100 cm pallet.

The trend towards the use of non-returnable containers poses an environmental challenge. To reduce the impact, packages need to be designed to meet their functional objectives, with minimal wastage of materials and need to be recyclable, after their main functional use.

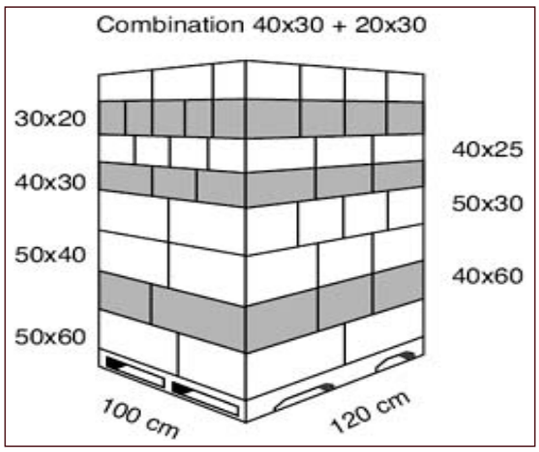


Figure 5: Different horizontal package dimensions to maximize utilization of a 100 x 120 cm pallet, according to MUM and ISO (shaded) systems.

3.9 Assessment of Comparative Advantage:

Three factors combine to provide a distinct Comparative Advantage for setting up Packing House cum Storage Operation in Bhutan

i) **Ready Availability of fruits & vegetables:** Agriculture is the main foundation of the Bhutanese economy. It provides the livelihood base for 69% of Bhutan's total population. Agricultural production accounts for 21.4% of the GDP of Bhutan, while horticulture accounts for approximately 13% of agriculture.

Bhutan is the source of 'winter vegetables in summer' for the neighboring Indian states. Bhutanese vegetables are being increasingly demanded because of the taste and freshness, and the conditions under which they are grown.

Mandarin and apples are the dominant fruits grown in Bhutan. In 2011, 20,752 MT of apples were produced. Mandarin production was recorded at 60,993 MT in 2011.

Vegetable production is more varied, with potatoes, legumes, chilies, radish, mustard greens, cabbage, tomatoes, and onions among the most important (Gurung, T., 2008). Potato is one of the major vegetables grown in the country with production of 52,116 MT in 2011. In fact as per export records released by Department of Revenues and Customs, Ministry of Finance, potatoes at Nu. 688,787,925 happens to be the seventh largest exported items.

(ii) Abundance of Hydroelectric Power:

Bhutan is an energy surplus state. 97% of its energy is obtained from hydro power. During the summer months Bhutan exports quite a bit of electricity to India. Total exports to India were Nu. 10,633.639million for 2013 – 14. The cost of electricity is lower than many power deficient

economies.

(iii) Availability of water

Bhutan is endowed with rich perennial water resources fed with permanent glaciers, glacier lakes and recurrent monsoons. The per capita mean flow availability is as high as 109,000 m^3. This compares very favourably with a developing economy like India which has per capita mean flow availability as low as 1,588 m^3.

3. 10 Potential for Marketing Collaboration:

There is a tremendous potential for marketing collaborations at the customer end of the supply chain. The unit can think of appointing independent sales agents or exclusive tie ups with certain stores or outlets. In our supply chain we have seen that there are intermediaries too who can purchase these cleaned, graded, frozen fruits and sell them off either to the local market or export those. These intermediaries may sell those fruits to the fruit processing units for making juice, jam, pickles etc. There are a number of fruit suppliers in Bhutan who supplies the products within and outside the country. They are listed below:

Table 6: Suppliers of Processed Fruits

S. No	Name of the Supplier	Items Sell / Export	Contact Details
1	KNT Industries	Packaged drinking water, apple juice, fruit jams, orange juice, pine apple juice, mango juice, straw-berry juice, Bhutan pickle, Bhutan sauce.	Contact Person: Mr. Wangay Contact No: +97517598800 Email id: wangay2@gmail.com wwangay@ymail.com
2	Bhutan Fruits Product Limited	Juice (apple), Squash (Orange, Lemon & Pineapple) and Sweet corn.	Contact Person: Mr. K Virmani Fax No: +9755365287 Post Box No 70 Samtse
3	Ugyen Export	Cordyceps, matsutake mushrooms, packaged drinking water, canned fruits, juices, canned asparagus, fruit jams	Contact Person: Mr Karma Dhendup Phone No: +9752346581

One of the major objectives of setting up marketing collaborations would be to export the products.

4.0 RESOURCES

4.1 Sources of Inputs Including Water

4.1.1 Sources of Power:

Electricity is required to run the production machinery and to provide lighting for the plant. The vast majority of Bhutan's energy is provided by hydroelectric power stations. So except for very remote areas availability of electricity is not a handicap.

4.1.2 Source of Water

There is a need of 10,000 liters of water per day. Bhutan is drained by many rivers flowing south between these ranges and for the most part ultimately emptying into the Brahmaputra River in India. The river basins are oriented north-south and are, from west to east, the Jaldhaka, Torsa, Raidak, Sankosh, Mao Khola/Aie, Manas and eastern river basins, this last basin being composed of the Bada and Dhansiri rivers. There is no wastewater treatment in Bhutan, but two wastewater collection and treatment projects are being implemented in the cities of Thimphu and Phuntsoling.

Sources and piping systems

For proper cleaning of a facility, sufficient hose stations positioned strategically around the structure should be installed. Hoses must be sufficiently long so as to ensure all locations can be reached without the need for draping or hanging the hose on to equipment. Ideally, each hose station should have its own hose and hose hanger. Cracked hoses should be immediately replaced.

The source of water should be identified and its microbial and chemical quality tested in order to ascertain its suitability for different packing-house operations. Water supplies should be adequate and of a quality appropriate for use in a fresh produce handling operations. The quality of water that comes in contact with fresh produce during preliminary dumping, washing, disinfecting, cooling (hydro cooling, icing), and other operations where water is used or added as in fungicide or wax application, is as a control point in a Hazard Analysis and Critical Control Point (HACCP) plan.

If water comes from wells, pump pressure should be adequate to carry water to all required locations in the packing-house. Back-flow devices can be installed to prevent contamination of clean water with potentially contaminated water (such as between potable water fill lines and dump tank drain lines). There should be separate lines, preferably using color-coded pipes, for water used for different purposes.

Non-potable water in the facility is used for fire control, steam production or for refrigeration. Non potable water should have its own separate distribution system that is easily identified (e.g color-coded). There should be no possibility of any backflow into the potable water system (CAC 1969).

4.2 Comparative Analysis of Critical Inputs

Electricity: It may be possible to set up one's own generator set and produce electricity. Theoretically it may also be possible to set up one's own solar panels and be self sufficient on electricity. But it would certainly be more cost effective to source power from the grid. Keeping a small generator as a part of redundancy may be considered to take care of the lighting load.

Water: The most cost effective manner of catering to the requirements of water would be to locate the plant near a river. This is because deep tube wells may not be feasible owing to the mountainous terrain and from the point of view of cost. It is recommended however a hard water treatment plant be set up as the water is likely to be hard and unsuitable for boiler operation.

4.3 Source of Raw Materials

The raw material required would be fruits, which are directly procured from the farmers. The main consumables for this unit are packaging material, ethylene gas and potassium permanganate, chlorine, hydrogen peroxide, pyroxyacetic acid and electrolyzed water. These chemicals have to be imported from other countries.

Suppliers' List

1. Potassium Permanganate:

Acuro Organics Ltd, New Delhi

No.27, Ashoka Chambers, 5-B, Rajendra Park,

New Delhi - 110060, Delhi

www.chemicals99.com

08373903549

2. Ethylene Gas

Aanshus Innovative Creations

203, Splendour County, Besides Five Garden Near Jagtap Diary, Rahatani,

Pune - 411017, Maharashtra

www.aanshusgases.com

08376808933

3. Hydrogen Peroxide

Akshar Exim Company Private Limited

131 B K Paul Avenue, Near Sovabazar Metro,

Kolkata - 700005, West Bengal

www.aksharexim.com

07838440729

4. Pyroxyacetic Acid

Chemtex Speciality Limited

111 Haute Street Bldg, 86A Topsia Road (S) E.M. Byepass,

Kolkata - 700046, West Bengal

www.chemtexlimited.com

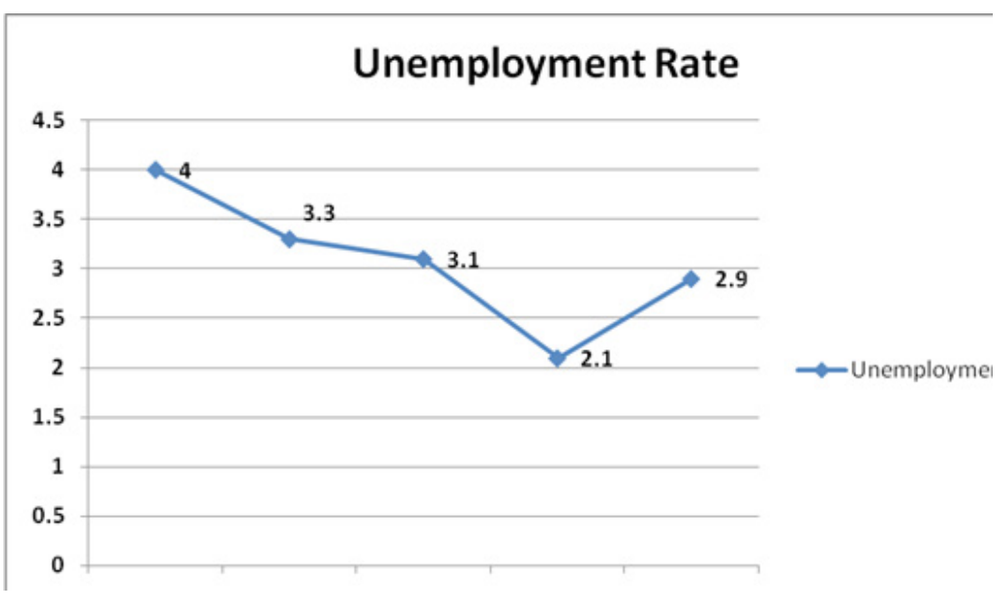
08447536393

4.4 Availability of Manpower and Skills

The Labour Force Survey Report 2013 finds that the agriculture sector employs over 55 percent of total employed persons, while 17 percent are employed in public administration & defense, education, electricity, gas & water supply sectors, and the remaining 28% in real estate, construction, hotels & restaurants, and mining & quarrying sectors.

The survey finds that a total of 335,870 individuals were employed and 9,916 were found to be unemployed out of a total projected population of 745,939 in 2013, making unemployment rate at the national level by 2.9%.

Chart 1: Unemployment Rate in Bhutan



(*Source:* Statistical Yearbook of Bhutan 2014)

The Labour Force Survey Report 2012 indicates that by 2020 there will be 267,000 students seeking jobs.

A variety of skills are available from the various training institutions to support any service enterprise. However, higher technical courses for engineering & technology, international law and finance are required to meet the requirements of the imminent future.

4.5 Need for Skill Development

As the workforce is not so much skilled there is a need to develop their skills according to the need of the industry. Workshops or on-site short term trainings may be organized by the suppliers of machineries on how to control the temperature, operate machineries etc. The training should be a combination of theory sessions, on the job coaching sessions and on the job supervision. For new joinees with no relevant experience training on their respective functional area would be mandatory. There should be a periodic skill assessment done by the management on the basis of observation of on the job performance. Based on the findings, a training calendar needs to be drawn up.

5.0 THE PLANT

5.1 Choice of Technology

The Process:

The manufacturing process include the following steps:

1. Sorting
2. Cleaning
3. Grading
4. Packaging
5. Refrigeration
6. Computer invoicing and dispatching to retail outlets and bulk order suppliers.

There will be a 100 ton cold storage facility to store the surplus assuming 50 tons per day output capacity for the cleaning and grading facility.

1. Sorting

At this stage, the material that will really be used in the process will be separated from material presenting some sort of defect, which will become second-choice and will be used for a different purpose, or will simply be eliminated.

Figure 6: Brushing and Hand Removal of Damaged Fruits

Such a process will entail the removal of all of the fruit and vegetables that do not have uniform characteristics compared to the rest of the lot, in terms of ripeness, color, shape and size, or which present mechanical or microbiological damage.

Field sorting can help to reduce the volume of produce to be handled at a packing facility. It also lessens the chances of introducing contaminants into the packing facility. Tents or mobile packing sheds can be used as working areas for preliminary sorting of freshly harvested produce. Sorting for mechanical damage, pest damage, presence of decay or misshapen produce can easily be done in the field. For large-scale facilities, sorting operations may be semi- or fully mechanized for rapid handling of large volumes of produce. These facilities usually cater to export markets, with excess volumes or second-class produce diverted to local markets or processing plants. Sorting and grading can be done manually using conveyors that move produce in front of trained personnel situated along the sides. For fully automated operations, machines equipped with machine-vision capability can sort and grade produce on the basis of colour and size. Machines equipped with near-infrared systems can sort produce according to sweetness and can detect physical injury.

2. Cleaning

A pathogen is any microorganism that causes illness. Food pathogens cause food-borne illnesses such as food poisoning or food intoxication. Sterilization destroys all pathogenic and spoilage micro-organisms in foods and inactivates enzymes by heating. All canned foods are sterilized in a retort (a large pressure cooker). The operation consists of eliminating the dirt sticking to the material before it enters the processing line, thus avoiding complications deriving from the possible contamination of the raw material. The washing must be performed using clean water, which should be as pure as possible, and if necessary should be made potable by adding sodium hypochlorite, 10 ml of 10%, solution for every 100 litres of water.

The different methods of cleaning include:

Washing – microbial contamination is usually found on the surfaces of fruits and vegetables, so washing is an important step in reducing the microbial load. The different methods of washing include:

Dump washing or immersion dipping – dump tanks are used for removing dirt, hence water should be frequently changed and antimicrobial agents should be added. The water temperature in the dump tank should be slightly warmer than that of the produce because cooler water temperatures in the dump tank may lead to water absorption by the produce. This can cause microorganisms associated with the produce or in the water to be internalized making subsequent washing and sanitizing treatments ineffective. In most instances, it is not practical to expose produce to warm water. GMPs such as the use of antimicrobials in the wash water spray washing and ensuring that both produce and water are clean, will reduce the number of microorganisms in the water and those that are associated with the produce. Recycled water can be used without additional treatment as long as its use does not compromise produce safety. For example, water recovered from the final rinsing stage of leafy vegetables can be used for washing freshly harvested produce (CAC 2003).

Spray Washing – this method makes use of a jet of fresh clean water. This method can also spread microorganisms by direct contact or when an aerosol is created, hence sanitizers must be added. When compared with immersion dipping, however, spray washing is less likely to spread microbial contamination.

Brush Spraying – the commodity is brushed using soft sponges or brushes as they are sprayed with water. Brushing is usually done if the commodity is encrusted with dirt or sooty mould. Brushes should be clean and sanitized. For some types of produce, a series of washes may be more effective than a single wash. Root and tuber crops for example may be washed initially to remove the bulk of field soil from the produce followed by second washing and/or sanitizing and a final rinse in fresh clean water.

3. Grading:

Grading is the process of classifying the fruits and vegetables into groups according to set criteria of quality and size recognized or accepted by governments and the industry. Each group bears an accepted name and size grouping, such as Extra Class, Class I or Class II in the case of the Codex Alimentarius Commission (CAC) standards for fresh produce. Although the criteria used in grading vary with the commodity, some common properties that are used include:

Appearance – the external condition of the product that includes uniformity of variety, cleanliness, wholeness (no missing parts), color and shape.

Stage of maturity and/or ripeness – stage of maturity can either refer to commercial maturity or physiological maturity in the case of fruits and vegetables. Commercial maturity or horticultural maturity is the stage of development when the plant part possesses the necessary characteristics preferred by consumers. Physiological maturity on the other hand, is the end of development of the crop when it has developed the ability to ripen normally after harvest. In some cases, stage of maturity and stage of ripeness are combined into color grades such as green mature, colored, semi-ripe or ripe.

Texture – a characteristic related to finger-feel and mouth-feel like firmness, smoothness, turgidity, crispness, solidity, juiciness and toughness.

Presence of damage or defect – refers to any imperfection, lack of completeness or other conditions that differ from what is described as acceptable. Defects could either be permanent quality defects or those that do not progress or change with time such as deformities, growth cracks in tomato and potato, wind scars in mango, avocado and citrus. The other type of defect is called condition defect, which is of a progressive nature such as disease, physiological disorders, sprouting and discoloration such as yellowing and browning.

Safety and wholesomeness – the condition of being clean and free from harmful contaminants such as heavy metals, pesticide residues, additives, food spoilage microorganisms and physical contaminants such as hairs, wood splinters and broken glass.

Some Special Operations

These operations are commodity specific. They are different from basic operations because they are carried out on every fruits and vegetables independent of size and sophistication of the packinghouse.

Color sorting

These are common in fruits and vegetables and can be undertaken electronically. Fruits are usually harvested within a range of maturity that needs to be uniform for sale. Harvesting within a narrow range of maturity reduces color sorting. However, this is only possible for low-volume operations.

Waxing

Some fruits such as apples, cucumbers, citrus, peaches, nectarines and others, are waxed for the following reasons: to reduce dehydration, improve their postharvest life by replacing the natural waxes removed by washing and to seal small wounds produced during handling. Waxes are also used as carriers of some fungicides or just to increase shine and improve appearance. Different types and formulae of waxes are available.

Figure 7: Waxing of Citrus by Spraying

These can be applied as sprays or foams, or by immersion and dripping or in other ways. Uniform distribution is important. Soft brushes, rollers or other methods are used to ensure that application on the surface of fruit is thorough and texture is even. Heavy application can block fruit gas exchange and produce tissue asphyxia. Internal darkening and development of off-flavors and off-odors are some of the characteristics. It is very important that waxes are approved for human consumption.

Degreening

The main causes of greening are climatic conditions before harvest. For example, citrus often reaches commercial maturity with traces of green color on the epidermis (flavedo). Although not different from fruits with color, consumers sense that they are not ripe enough and have not reached their full flavor. Degreening consists of chlorophyll degradation to allow the expression of natural pigments masked by the green color. In purpose built chambers, citrus fruits are exposed from 24 to 72 hours (depending on degree of greening) to an atmosphere containing ethylene (5-10 ppm) under controlled ventilation and high relative humidity (90-95%). Conditions for degreening are specific to the production area. Artés Calero (2000) recommends temperatures of 25-26 °C for oranges, 22-24 °C for grapefruit and lemon and 20-23 °C for mandarins.

Controlled ripening

Maturity at harvest is the key factor for quality and postharvest life. When shipped to distant markets, fruits need to be harvested slightly immature (particularly climacteric ones) to reduce bruising and losses during transport. Prior to distribution and retail sales, however, it is necessary to speed up and achieve uniform ripening. The main reason for this is so that product reaches consumers at the right stage of maturity. As with degreening, ethylene is used but at higher concentration. Banana provides a typical example of this type of operation. It can however, also be carried out on tomatoes, melons, avocados, mangoes and other fruits.

Controlled ripening is performed in purpose built rooms where temperature and relative humidity can be controlled and ethylene removed when the process has been completed. The process involves initial heating to reach the desired pulp temperature. This is followed by an injection of ethylene at the desired

concentration. Under these conditions, the product is maintained for a certain amount of time followed by ventilation in order to remove accumulated gases. On completion of the treatment, the temperature is reduced to the desired level for transportation and/or storage. Ethylene concentration and exposure time are a function of temperature, which accelerates the process.

Table 7: Conditions for controlled ripening of some fruits

	Ethylene concentration (ppm)	Ripening temperature °C	Exposure time to these conditions (hr.)
Avocado	10-100	15-18	12-48
Banana	100-150	15-18	24
Honeydew Melon	100-150	20-25	18-24
Kiwifruit	10-100	0-20	12-24
Mango	100-150	20-22	12-24
Stone fruits	10-100	13-25	12-72
Tomato	100-150	20-25	24-48

(*Source:* Thompson, 1998)

Pest and disease control

Different treatments are performed to prevent and control pests and diseases at postharvest level. Fungicides belonging to different chemical groups are widely used in citrus, apples, bananas, stone fruits and other fruits. Must have a fungi static activity. This means that they inhibit or reduce germination of spores without complete suppression of the disease. Chlorine and sulfur dioxide are amongst those most widely used.

Chlorine is probably the most widely used sanitizer. It is used in concentrations from 50 to 200 ppm in water to reduce the number of microorganisms present on the surface of the fruit. However, it does not stop the growth of a pathogen already established. Table grapes are usually fumigated with sulfur dioxide to control postharvest diseases at a concentration of 0.5% for 20 minutes followed by ventilation. During storage, periodic (every 7-10 days) fumigations are performed in concentrations of 0.25%. During transport, pads impregnated with sodium metabisulfite can be used inside packages. These slowly generate sulfur dioxide in contact with the humidity released by fruits.

Gas fumigation is the most important method for eliminating insects, adults, eggs, larvae or pupae. Methyl bromide was probably the most widely used fumigant for many years but it is banned in most countries. It has been replaced by temperature (high and low) treatments, controlled atmospheres, other fumigants or irradiation.

It is also possible to prevent some postharvest physiological disorders with chemical treatments. For example, calcium chloride (4-6%) dips or sprays for bitter pit in apples. Other methods include dipping or drenching fruits in chemical solutions to avoid storage scalds or other disorders. Similarly, the addition

of low concentrations of 2.4-D to waxes assists in keeping citrus peduncles green.

Temperature treatments

Heat treatment can be used in low temperature tolerant fruits (apples, pears, kiwifruit, table grapes, etc.) and other potential carriers of quarantine pests and/or their ovipositors. Exposure to any of the following combinations of temperatures and time is provided in the following recommendations.

Heat treatments like hot water dips or exposure to hot air or vapor have been known for many years for insect control (and for fungi, in some cases). When restrictions were extended to bromine based fumigants, however, heat treatments were reconsidered as quarantine treatments in fruits such as mango, papaya, citrus, bananas, carambola and vegetables like pepper, eggplant, tomato, cucumber and zucchinis. Temperature, exposure and application methods are commodity specific and must be carried out precisely in order to avoid heat injuries, particularly in highly perishable crops. On completion of treatment, it is important to reduce temperature to recommended levels for storage and/or transport.

Hot water immersion requires that fruit pulp temperature is between 43 and 46.7 °C for 35 to 90 minutes. This depends on commodity, insect to be controlled and its degree of development (U.S. E.P.A., 1996). Dipping in hot water also contributes to reduced microbial load in plums, peaches, papaya, cantaloupes, sweet potato and tomato (Kitinoja and Kader, 1996) but does not always guarantee good insect control (U.S. E.P.A., 1996). For the export of mangoes from Brazil, it is recommended that dipping is performed at 12 cm depth in water at 46.1 °C and for 70-90 minutes (Gorgatti Neto, et al., 1994).

Many tropical crops are exposed to hot and humid air (40-50 °C up to 8 hours) or water vapor to reach a pulp temperature which is lethal to insects. Hot air is well tolerated by mango, grapefruit, Navel oranges, carambola, persimmon and papaya. Similarly, vapor treatments have been approved by the USDA-APHIS (U.S. Department of Agriculture, Animal and Plant Health Inspection Service) for clementines, grapefruits, oranges, mango, pepper, eggplant, papaya, pineapple, tomatoes and zucchinis (U.S. E.P.A., 1996).

Sprout suppression

In potatoes, garlic, onion and other crops, sprouting and root formation accelerate deterioration. They also determine the marketability of these products. This is because consumers strongly reject sprouting or rooting products.

After development, bulbs, tubers and some root crops enter into a “rest” period. This is characterized by reduced physiological activity with non response to environmental conditions. In other words, they do not sprout even when they are placed under ideal conditions of temperature and humidity. Different studies show that during rest, endogenous sprout inhibitors like abscisic acid predominate over promoters like gibberellins, auxins and others. This balance changes with the length of storage to get into a “dormant” period. They will then sprout or form roots if placed under favorable environmental conditions. There are no clear-cut boundaries between these stages. Instead, there is a slow transition

from one to the other as the balance between promoters and inhibitors change. With longer storage times, promoters predominate and sprouting takes place.

Refrigeration and controlled atmospheres reduce sprouting and rooting rates but because of their costs, chemical inhibition is preferred. In onions and garlic Maleic Hydrazide is sprayed before harvest while in potatoes CIPC (3-chloroisopropyl-Nphenylcarbamate) is applied prior to storage as dust, immersion, vapor or other forms of application. As CIPC interferes with periderm formation, it must be applied after curing is completed.

Gas treatments before storage

Different studies have shown that exposure to carbon dioxide rich atmosphere (10-40% up to week) before storage, contributes towards maintaining quality in grapefruits, clementines, avocados, nectarines, peaches, broccoli and berries (Artes Calero, 2000). Control of insects is possible with higher concentrations (60-100%). The effect of this gas is not well understood. What is known is that it has an inhibitory effect on metabolism and ethylene action and the effect is persistent after treatment. Also, at higher concentrations (> 20%) there is difficulty in spore germination and growing of decay organisms.

Similarly, exposure to very low oxygen atmosphere (< 1%) also contributes towards preserving quality and controlling insects in oranges, nectarines, papaya, apples, sweet potatoes, cherries and peaches (Artés Calero, 2000). Lowering oxygen concentration reduces respiratory rate and the whole metabolism.

4. Packaging

Packaging materials can be classified into two main groups: (1) Bulk packaging materials used for transport, hauling and wholesale marketing, and (2) retail packaging. Regardless of their classification, packaging materials should be convenient to handle, provide protection from mechanical damage and allow air circulation. Retail packaging should in addition contain information about the contents (such as volume, source, and country of origin), be attractive and provide convenience to the consumer (for example resalable, convenient to carry). Some markets may also specify that packaging materials be recyclable, reusable or biodegradable. Bulk packaging materials include plastic or wooden crates and bins. Bins are usually larger than crates, facilitate the efficient handling of produce and require equipment such as forklifts or hoists for handling. The depth of these containers should not, however, induce compression damage. For manual handling, crates should not have a capacity exceeding 23 kilograms (50 pounds) (CAC 1995c). Overly large or overfilled crates are difficult to handle and can cause physical injury to workers, produce damage and the collapse of containers. On the other hand, under filled containers can result in vibration damage as produce is free to move around during transit, particularly at the top layers in a package. Cost is

Figure 8: Wooden Crates for Fruits

a prime consideration in selecting packaging for retail, but it should not be the sole criterion. Other considerations include availability, market requirements and ability to provide physical protection.

Baskets – dried leaves and bamboo strips are woven into baskets that are widely used for hauling and wholesale marketing.

These are readily available in many local markets, are light in weight and are inexpensive. They do not, however, offer physical protection against compression or impact and may damage the fruit through cuts and punctures due to sharp edges and points. It is a sensible practice to line the baskets with newspaper or polyethylene sheets in order to minimize physical damage. Wooden/plastic crates and bins offer greater protection against physical stress and can be stacked in several layers. Rough edges and splinters of wooden crates can, however, injure produce. Wooden crates and bins are also heavy and are difficult to clean and sanitize. Plastic crates approach the ideal for produce handling in that they are: lightweight, convenient to handle, easy to clean, reusable, stackable and nestable. When nested, the reduction in volume should be in the range of 2:1 or 3:1 to reduce the cost of returning empty crates. Disadvantages include theft, non-biodegradability and cost, the latter making them unsuitable for export. The cost of returnable plastic crates can be recovered after eight to ten uses. They can, however be reused up to 100 times. Users of plastic crates indicate that pilferage is approximately 5-25 percent if a security deposit is not required or if crates can be used for other purposes. A deposit should be at least as high as the cost of a new container to discourage theft and to replace lost containers (Fraser 1995).

Figure 9: Fiberboard Cartoons

Fiberboard cartons – these are preferred for export. They can be manufactured in various shapes and sizes, are lightweight, clean and are printable. The cost of the carton is a disadvantage, especially if the material must be imported.

Fiberboard cartons for produce that passes through hydro cooling, that is packed in a wet condition, or is packed with icemust be treated with wax or must have a water-resistant coating. Fiberboard material tends to absorb moisture, especially under high-humidity conditions, resulting in a loss of compression strength. At 90 percent RH, untreated fiberboard can lose 50 percent if its strength (CAC 1995c).

Plastic films and trays are also used for retail packaging. Modified atmosphere packaging (MAP) has long been used to extend the shelf-life of many fresh and fresh-cut commodities. Under MAP, O2 concentration is brought down to levels (typically 3-5 percent) that are sufficient to decelerate respiration. This extends the shelf-life, allowing produce to reach distant markets and increasing availability beyond the normal harvest season. A wide range of materials for MAP are available; the most commonly used are polyethylene and polypropylene films. Correct selection of film thickness and material is needed to avoid anaerobic conditions in MAP (O2) containers. When used for this purpose, they are designed as

single service containers. The size of the container may vary according to the degree of mechanization in the supply chain, produce characteristics and market preferences. The dimensions of the container must maximize the quantity of produce it can contain, without becoming too heavy or unwieldy. Containers that are manually handled should not be too heavy when filled, otherwise they can cause back injury to workers on lifting. For mechanized systems, larger containers can be used as long as this does not result in compression damage to the commodity. If containers are to be used as retail displays, they should be shallow enough to display produce in single layers only, because retailers and consumers dislike 'hidden' produce.

5. Refrigeration

The refrigeration system has two stages viz., Pre cooling and Cold storage.

Pre Cooling:

Cold storage facilities, refrigerated trailers and refrigerated trucks are often only designed with enough cooling capacity to maintain their loads at a set temperature. This means that the commodity must already be at the desired temperature when loaded into the storage room or cargo truck. If the commodity is still maintained at field temperature, the refrigeration unit will be overworked and may not succeed in reducing produce temperature to the desired level (also known as the set point temperature). In some cases, cooling may not occur if the commodity is respiring too rapidly and the volume is large enough to overwhelm the refrigeration system.

Produce must, therefore, be pre-cooled as soon as possible after harvest and prior to refrigerated transport or storage.

A 12-metre (40-foot) refrigerated trailer with a cooling capacity of 42,000 kJ/hour can contain about 11 250 kilograms of mangoes. The heat to be removed from a material (Q) can be estimated using Equation 2-1 where, m = weight of the material (kg), Cp = specific heat (kJ/kg/K), and ΔT = change in temperature.

$Q = mCp\Delta T$ (2-1)

For a fruit (specific heat of 3.56 kJ/kg/K) the fastest cooling time needed to bring fruit temperature from a field temperature of 30°C down to its optimum level of 13°C can be calculated as follows:

Q = (11 250 kg) (3.56 kJ/kg/K)(30-13)K = 680 850 kJ

The fastest cooling time that could be achieved would now be 680,850 kJ divided by 42,000 kJ/hour or approximately 16 hours. This cooling time is too long and could give the fruit sufficient time to ripen, thereby reducing its shelf-life. Furthermore, the actual cooling time would probably be significantly longer because this rough estimate does not take into consideration actual conditions during cooling (for example, air circulation patterns, or packaging materials also need to be cooled down).

If pre-cooling time is known, Equation 2-1 can also be used to determine the required cooling capacity. Using the previous example for a desired pre-cooling time of 5 hours:

Q = (11 250 kg) (3.56 kJ/kg/K (30-13) K/ (5 h) = 136 170 kJ/h = 3.78 kW

The value of 3.78 kW represents the cooling capacity needed to cool the fruit down from 30ºC to

13ºC. A factor of 25 percent is added to the calculated value for cooling capacity to take into account heat coming from produce respiration, packaging materials, workers and air leakage from doorways. Therefore, the total refrigeration capacity required is 47.2 kW (Picha 2004).

Methods of pre-cooling include room cooling, forced air cooling, hydro cooling, vacuum cooling and package icing. The method to be used will depend on the characteristics of the commodity and the resources of the operator.

Water and ice used in cooling operations should be considered as potential sources of microbial contamination. Reuse of water to cool continuous loads of produce increases the risk of cross-contamination. For example, contaminated produce from a single container going through a cooling process, as in batch hydro cooling, may result in the buildup of microorganisms over time in the cooling water supply. Good manufacturing practices during pre-cooling include the following:

i. Proper temperature management– the choice of pre-cooling method should consider that fruits and vegetables have varying temperature requirements for optimum quality. Many pathogenic and food spoilage organisms do not thrive at low temperature.

ii. Use clean and sanitary ice and water– water and ice used in cooling operations are potential sources of contamination, especially water reused during hydro cooling. Ice used for package icing or for direct application to food should be produced from potable water. Water used in ice-making should be periodically tested. Operators should contact ice suppliers for information about the source and quality of their ice. Water in hydro coolers should be changed as needed to maintain quality. Antimicrobials can be added in cooling water to reduce the potential for microbial contamination of produce.

Cold Storage

After pre-cooling, produce must be immediately loaded into refrigerated trucks for shipment to market. In situations when transport is delayed or sufficient volume needs to be accumulated before shipment, then produce must be kept in storage at low temperature to avoid rewarming and to minimize deterioration.

Given that production volumes may not be sufficient and that several types of commodities maybe handled by a packing facility, it is often not feasible to provide a dedicated storage room to each commodity. The solution is to sort commodities into groups that are compatible with each other with respect to temperature Secondary compatibility issues include RH, ethylene production and sensitivity and odor emission and absorption.

Cold rooms should be equipped with calibrated thermostats and calibrated thermometers to ensure proper temperature settings and to confirm that the actual temperature in the cold room is the same as the temperature setting. When possible, actual product temperatures should be monitored.

In situations where a packing facility requires several cold storage units, the cost of investment may be minimized by installing self-constructed insulated rooms. These rooms may be constructed using double-walled plywood panels with polystyrene sheets for insulation. In situations where commodities can be stored at temperatures above 10ºC, residential air-conditioners are less expensive options than are packaged systems (Thompson 1992). Plywood panels should be painted white with a smooth finish.

Factors to be considered during and after cold storage include:

- Chilling injury (CI) – low storage temperatures reduce respiration rates, ethylene production and moisture loss. However, holding produce below optimum storage temperatures for extended periods can result in CI. This is especially true for tropical produce that is sensitive to chilling conditions. CI is impacted by time and temperature and, therefore, the effect of temperature on CI is cumulative. Hence, holding produce at chilling temperatures for short periods of time may not induce CI. For example, Carabao mangoes can be held below 12ºC for two weeks or less without any adverse effects. However, extending the storage period will induce CI, with symptoms usually expressed when fruits are brought out of storage and allowed to ripen. Jicama yambeans stored at 0ºC and 5ºC showed less weight loss and similar quality to those held at 15ºC or 20ºC for the first five days of storage. After two weeks, Jicama yambeans stored at 0ºC or 5ºC were inedible, while those at 15ºC had fair to poor visual quality (Barile and Esguerra 1984).
- Symptoms of CI include pitting of the peel, failure to ripen, wilting, loss of aroma and flavor, increased susceptibility to disease and browning of the pulp or peel.
- These are manifestations of the physical and biochemical changes in the commodity that include permeability of cell membranes, respiration rate and ethylene production.
- Condensation of moisture– condensation occurs when warm air comes in contact with the cold surface of a commodity or container as it is brought out of storage. As the air cools, its capacity to hold moisture in vapor form decreases, causing moisture to form on the commodity in droplets. The temperature at which condensation occurs is referred to as the dew point. Condensation enhances sprouting of bulb and tuber crops and favors disease development when condensate allowed to remain on the commodity. To minimize the effects of condensation, the following measures can be adopted:
    - Provide blowers to hasten evaporation of condensed moisture; leaving gaps between containers and pallets for better air circulation. Warm dry air is best for removing condensation.

- Gradually bring the temperature of the commodity to ambient by setting the system at progressively higher temperatures. The temperature of the commodity must be higher than the dew point when it is removed from chilling conditions in order to prevent condensation.
- If practical, produce can be brought out at night or early in the morning to take advantage of lower dew point temperatures of the air.

The refrigeration equipment should conform to requirements laid down in national codes of practice, insurance companies, as well as international recommendations (ISO R1662) (BS4434 1989/). Heat leakage or transmission load can be calculated fairly using the known over-all heat transfer coefficient of various portions on the insulated enclosure, the area of each portion and the temperature difference between the cold room temperature and the highest average air temperature likely to be experienced over a few consecutive days.

Heat infiltration load varies greatly with the size of the room, number of door openings, protection of door openings, traffic through the doors, cold and warm air temperatures and humidity. The best basis for this calculation is experience. The type of store has a marked influence on the heat load, as has the average storage time. In comparing long-term storage, short-term storage and distribution operation it can be found that there is a 15 percent increase in refrigeration load for the short-term storage as compared to the long-term storage, whereas the refrigeration load in the distribution operations is in the order of 40 percent higher than for long-term storage, due mainly to additional air exchanges. Most large cold stores are equipped with 2-stage ammonia refrigeration installations. For smaller plants, usually less than 6,000 kcal/h refrigeration capacity, approved refrigerant will probably be used in single stage systems operating with thermostatic expansion valves. Such systems are thermodynamically less efficient, but in areas where only staff with relevant refrigerant experience is available the system may be preferred for service reasons.

The refrigeration system should be designed for high reliability, and easy and proper maintenance. Once a cold store plant has been pulled down in temperature, it is expected to maintain this temperature, literally, forever. Even maintenance jobs that need carrying out only every 5-10 years must be taken into consideration.

4. Computer invoicing and dispatching to retail outlets and bulk order supplier:

When businesses purchase goods from a company and the goods are shipped to them, the business receives them and that is receipt. Dispatch of goods is when that company ships out those goods purchased from them by the businesses. Dispatching is the part of production control that translates the paper work into actual production in accordance with the details worked out under routing and scheduling functions. Dispatching deals with setting the production activities in motion through the release of orders and instructions in accordance with previously planned timings as embodied in production schedules. An invoice or bill is a commercial document issued by a seller to the buyer,

indicating the products, quantities, and agreed prices for products or services the seller has provided the buyer. An invoice indicates the buyer must pay the seller, according to the payment terms. In the cold storage there should be a different unit with weighing machines for this purpose. The dispatch area should be clean and spacious to allow for the temporary storage of packed produce and for free movement of loading staff and vehicles.

5.2 Source

Source of Plant and Machinery

Selection of plant and machinery is the most important decision for setting up a food processing unit. All machinery and equipments used in the processing line should have proper efficiency. All the plant and machinery should be erected in such a way that the material flow is unidirectional to avoid cross contaminations. The machinery should not occupy more than 1/3rd of the total floor area for smooth operation of labor. Various plant and machinery proposed for this model are discussed in this section.

1. Chain Pulley Block

Capacity: 5 Ton

Supplier: Max Industries, India

Supplier Product Code: HH2050

Price: 17910INR

Power Source: Hand Pulled

2. Motorized Conveyor for Bulk Material Handling

Supplier: AMC System Technology (Suzhou) Co., Ltd

Model No. – AMCRL006

Dimension (L*W*H) – Customized

Voltage – 110V/220V/380V

Power – 1500 W or Customized

Capacity – 1500kg or customized

Price – US $500 – 2,000

3. Hydrolic Pallet Truck

Supplier: Baoding Dali Hoisting Machinery Co. Ltd

Model No. – PDL -3T hand Pallet

Price – US $137 – 149

4. **Battery Operated Fork lift 2 MT**

Supplier: Taizhou Ruyi Handling Machinary Factory

Model No. – CDD - S

Dimension (L*W) – 1150 * 180 mm

Capacity – 500 – 2000 kg

Price – US $2,000 – 8,000

5. **Box Strapping Machine**

Supplier: Henan Bedo Machinery Equipment Co. Ltd

Model No. – BD-001

Voltage – 220V

Power – 50 KW

Price – US $100 – 1000

6. **Gantry Crane**

Supplier: Henan Mine Crane Co. Ltd

Model No. – Gantry crane with hook

Voltage – 220V/380V

Price – US $1,000 – 50,000

7. **Electronic Weighing Machine**

Supplier: Yuvo

Model No. – 730

Voltage – 220V

Capacity – 1500kg

Price – US $80 – 130

8. **Shrink Wrapping Machine**

Supplier: Ruian Yongxin Machinery Factory

Model No. – BTH 450 + BM500L

Dimension (L*W*H) – 3850*1500*1300mm

Voltage – 220V/380V

Power – 50Hz

Price – US $1,000 – 27,000

9. Grading and Sorting Table

Supplier: Tianjin Sure International Trading Co. Ltd

Model No. – Sure -CBM

Dimension – 1000 - 10000mm

Voltage – Customized

Power – 0.18 – 2.5KW

Price – US $ 1,000 -50,000

10. Platform Type Scales

Supplier: Sanghai Uniweigh System (Tech)Co. Ltd

11. Tray Hand Wrapping Machine

Supplier: Shandong China Coal Group Ltd

Model No. – HW450

Dimension – 540*680*200mm

Voltage – 220V

Power – 270W

Price – US $50 -60

12. Dryer

Supplier: Henan Xingyang Mining Machinery Manufactory

Model No. – ZT

Dimension – Depends on the model

Voltage – 380V

Price – US $ 8,000 -100,000

13. Washing Machine

Supplier: Zhengzhou Azeous Machinery Co. Ltd

Model No. – AUSNW

Dimension (L*W*H) – 3800*760*1200mm

Voltage – 380v/50hz/3phase

Power – 3.5KW

Capacity – 500kg – 4000kg/hr

Price – US $500 -30,000

14. Ethylene Generator

Supplier: Taizhou Nimbus Machinery Co. Ltd

Price – US $100 -800

5.3 Rate of Consumption of Fuel, Utilities &Consumables

Power Consumption

For this project about 225 KVA (180 KW) connections will be required**.** Depending on the requirements of equipment to be installed in the facility, single-phase or three-phase service may need to be installed by the power company. A backup power supply should be available to ensure that operations can continue during a power interruption. Diesel generators are usually used for large applications; the unit to be purchased should be sufficient to operate the entire facility.

Water Consumption

The water requirement for cleaning and washing will be approximately 10,000 liters per day based on the processing capacity of 50 MT per day. Water is mostly required for washing and also in various unit operations during processing. Apart from it, water will also be required for domestic consumption purpose. The water should be clean and treated well for hardness before use. It is preferable to carry out water testing from a reputed testing laboratory before setting up a plant.

Since water is in direct contact with the commodity, it should be of the highest quality. Water that is recirculated should also be of high quality. Water from the final rinsing stage is, for example, filtered and directed back or used directly in the initial dump tank or flume system for washing.

Recycling improves water utilization but may introduce new microorganisms and cause the buildup of organic matter in the water, thus increasing cross-contamination. Water re-use should be in counter flow to the production line, i.e., water used in the final rinse must be of the highest quality while water used to remove field soil from the produce need not be of high quality. Washing water should be changed

as frequently as necessary to maintain sanitary conditions. Water contact surfaces such as dump tanks, wash tanks, sprays and brushes should be cleaned and sanitized to ensure the safety of fresh produce.

Consumables

Chlorine– this is a commonly used sanitizer in most packing-houses; it is added to water at 50-200 ppm total chlorine at pH 6.0-7.5 for a contact time of 1-2 minutes. Chlorine when dissolved in water generates hypochlorous acid (HOCl), the active compound that kills microorganisms.

Common sources of chlorine are sodium hypochlorite (NaOCl), calcium hypochlorite($Ca(OCl)_2$) and chlorine dioxide (ClO_2). NaOCl is also known as an ordinary bleaching agent or laundry bleach, while

$Ca(OCl)_2$ is referred to as pool chlorine. NaOCl is generally marketed as a solution at a concentration of 5.25 percent; $Ca(OCl)_2$ is available in powder form but is not readily soluble in water. Undissolved particles can injure produce. To avoid this problem, the powder can be dissolved in a small volume of warm water prior to diluting to the appropriate concentration. Water circulation should be adequate and continuous during the sanitizing process to ensure the uniform distribution of chlorine. Ritenour *et al.* (2002) recommended a constant free chlorine concentration of 100-150 ppm maintained at a pH range of 6.5-7.5 for sanitizing purposes. At a minimum, chlorine levels should be monitored on an hourly basis. Time constraints during packing-house operations can, however, result in inadequate testing of water quality.

Hydrogen peroxide– this is classified by the United States Food and Drug Administration(FDA) as a 'Generally Regarded as Safe' (GRAS) compound. The recommended level of usage is 0.27-0.54 percent (Biosafe Systems 2002). Hydrogen peroxide can be applied under ambient conditions or at high temperatures (40ºC) without loss of effectiveness. It can, however, cause browning or bleaching in some vegetables.

Peroxyacetic acid– this is a strong oxidant formed from hydrogen peroxide and acetic acid. It is highly soluble in water and leaves no known toxic breakdown residues or products. It is less affected by organic matter than chlorine and has broad-spectrum activity. Activity is greatly reduced at pH >7-8. *Ozone* – a water-soluble gas that is a very strong oxidizing agent and sanitizer and has the ability to diffuse through biological cell membranes. It is also a GRAS chemical and is currently legal for food contact applications. Concentrations of 0.5-2.0 ppm are effective against pathogens. Ozone readily decomposes in water with a half-life of 15-20 minutes (Sargent *et al.* 2000).

Electrolyzed (acidic or alkaline) water– this is generated by electrolysis of a dilute solution of sodium chloride. Acidic electrolyzed water has a pH of 2.6-2.8 and also includes hypochlorous acid as a constituent, thereby providing strong antibacterial effects (Kim *et al.* 2001).

5.4 Raw Materials Consumption

The raw material required would be fruits, which are directly procured from the farmers. The main consumables for this unit are packaging material, ethylene gas and potassium permanganate for which the value has been estimated as 1% of the raw material cost as reflected in the table Raw Materials Consumption.

As the fruits are highly perishable in nature, raw material stock only for 7 days is considered for assessment of working capital. Some antimicrobials are also used. Antimicrobials reduce the microbial population in water and on the surface of produce by 10- to a 100-fold. Commonly used antimicrobials are written above under the consumables.

5.5 Manpower Requirements and Organization Chart

A total no. of 109 employees will be needed to operate the plant. Out of which 58 employees will be engaged in administration and the rest will be looking after the production process. The breakdown of manpower and incidence of salaries & wages are shown in the table of Manpower Requirement.

5.6 Specification of the Product with the Byproduct if any

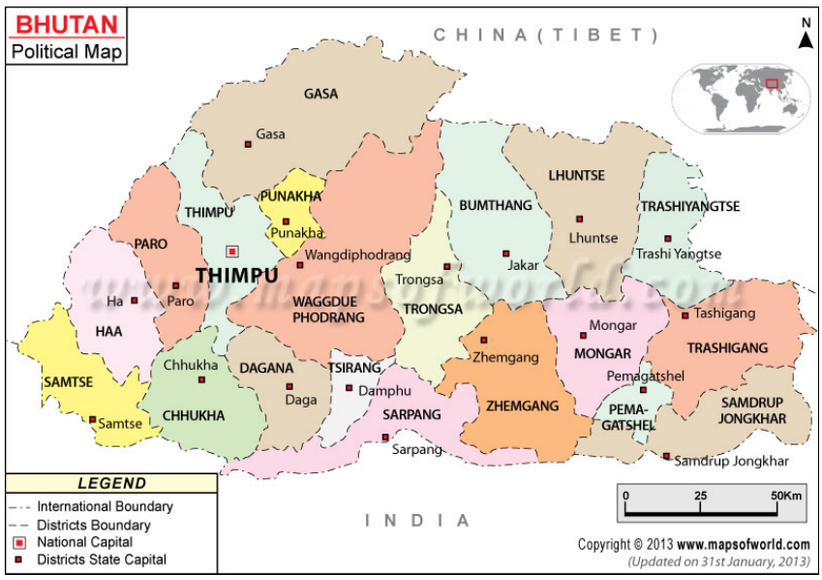
The final product for this unit will be fresh fruits that have been stored in the cold storage for a specific period. No new product will be produced, as the unit will be dealing with the cleaning, grading and storing. As a result there will be no by-product at all. The unsorted product has to be sorted out properly and then after making some treatments the final product would be stored in the cold storage.

5.7 Extent of technical assistance needed including training

Although food manufacturing production jobs don't typically require formal education, a certificate in food science introduces the fundamental concepts of food production and prepares for entry-level positions in the food manufacturing industry. These programs can be completed in a few weeks of study. The organization can sponsor these types of coursework for their employees to develop their skill.

6.0 PLANT LOCATION AND INFRASTRUCTURE

The ideal location for this plant will be Jigmeling in Sarpang dzongkhag as this dzongkhag produces the highest amount of fruits in Bhutan. Sarpang Dzongkhag is situated in the south-central part of the country and shares its 200 kilometers southern border with the Indian state of Assam.



The main processing unit would be located there with the nodal collection centres would be at Zhemgang, Trongsa, Tsirang, Dagana and Chukha.

The proposed industrial estate in Sarpang Dzongkhag is Jigmeling. The total area earmarked for Jigmeling industrial estate development is 733 acres. Jigmeling is located in 15 kilometers west of Gelephu. The area has already seen a vibrant urban growth as there are Police Training Centre, Vocational Training Institute (VTI), Hydropower Service Centre (HSC), Power sub-station, domestic airport and Central Bhutan Regional Referral Hospital, which are already being positioned in the area.

Since the Dzongkhag is close to the Indian markets, it has been the commercial hub for the central region of the country. The main economic activity of the dzongkhag is export of oranges to Bangladesh and ginger & areca nuts to India.

6.1 Availability of Raw Materials

Plant location largely depends upon the availability of raw material. For this unit the main raw materials will be the fruits. So, the plant should be set up in such a location where the production of fruit is maximum. Primarily five industrial estates have been selected for setting up industries. Production of fruits in these estates is given in the following table:

Table 8a: Production of Fruits

	Samdrup Jongkhar (MT)	Mongar (MT)	Samtse (MT)	Sarpang (MT)	Chhukha (MT)
Apple	1	24	0	0	414
Mandarin	2842	2723	2877	15389	2089
Areca nut	452	38	2954	3915	1104
Mango	37	110	20	70	20
Peach	330	131	69	44	68

Plum	45	96	9	21	14
Walnut	50	29	5	1	9
Banana	108	110	373	560	123
Guava	17	108	93	103	20
Pineapple	17	108	93	103	20
Total	3899	3477	6493	20206	3881

(*Source:* Agricultural Statistics 2011)

From the above table it can be said that the plant can be set up in Sarpang dzongkhag. The desired mix of fruits that could be considered for processing are mandarin, banana, guava and pineapple – approximately in the ratio of 4:2:1:1.

The vegetable production in Sarpang could also be an indicator of the types of vegetables to be processed.

Table 8: Production of Vegetables

Vegetable	Potato	Radish	Cabbage	Chilli	Ginger
Total(MT)	471.79	178.37	29.88	71.75	228.66

(*Source:* Dzongkhag wise Inventory of Resources, 2005 – Ministry of Agriculture)

The desired mix of vegetables that could be considered for processing are potato, radish, chilly and ginger – approximately in the ratio of 4:1:1:2.

6.2 Availability of Electricity

Jigmeling with the development of 10,000 MW will get continuous and non-stop power supply. The Bhutan Power Corporation (BPC) has already been allotted land within the estate to come up with a power station which will help serve the industrial estate.As of 2013, Bhutan has 5,021.27 km & 104.41 km of overhead and underground high-tension lines respectively. (Source: Statistical Yearbook of Bhutan, 2014)

6.3 Topography, Hydrology & Seismology Data Requirement

Topography, Hydrology & Seismology of the location must be checked before setting up the manufacturing plant.

Topography: Topography is a detailed map of the surface features of the land. It represents a particular area in detail, including everything natural and manmade- hills, valleys, roads or lakes.

An objective of topography is to determine the position of any feature or more generally any point in terms of both horizontal and vertical coordinate system such as latitude, longitude, and altitude. Identifying (naming) features and recognizing typical landform patterns are also part of the field. A topographic study may be made for detailed information about terrain (vertical & horizontal dimension

of land surface) and surface features is essential for the planning and construction of any major civil engineering, public works, or reclamation projects.

Hydrology: Hydrology is the scientific study of the movement, distribution and quality of water on Earth including the hydrologic science, water resources and environmental watershed sustainability. Hydrology is subdivided into surface water hydrology, groundwater hydrology (hydrogeology), and marine hydrology.

Application of Hydrology

- Determining the water balance of a region.
- Determining the agricultural water balance.
- Mitigating and predicting flood, landslide and drought risk.
- Real-time flood forecasting and flood warning.
- Assessing the impacts of natural and anthropogenic environmental change on water resources.
- Assessing contaminant transport risk and establishing environmental policy guidelines.

Seismology: Seismology is the scientific study of earthquakes and the propagation of elastic waves through the Earth or through other planet-like bodies. The field also includes studies of earthquake environmental effects, such as tsunamis as well as diverse seismic sources such as volcanic, tectonic,

oceanic, atmospheric, and artificial processes (such as explosions). Seismic waves are elastic waves that propagate in solid or fluid materials. They can be divided into body waves that travel through the interior of the materials; surface waves that travel along surfaces or interfaces between materials; and normal modes, a form of standing wave.

Seismological instruments can generate large amounts of data. Systems for processing such data include:

- CUSP (Caltech-USGS Seismic Processing)
- RadExPro seismic software
- SeisCom

6.4 Availability of Land

The area of the Dzongkhag stretches from Lhamoy Zingkha in the west to Manas National Park in the east. It encompasses a total geographical area of approximately 2,288 sq. km. Its topographic features have undulated terrain with an elevation ranging from 200 m to 3,600 m above mean sea level.

6.5 Availability of Transportation Facility

The Government, in order to promote and develop the surface transport, with emphasis on safety, formulated the Roads Safety and Transport Act, which became operational since October 1997. All Gewogs of the dzongkhag are connected by vehicle road except Nichula, Dovan, Deorali, and Lhamoyzingkha. Some communities in these Gewogs are located more than threeday's walk from the road head. Druk Air, the national airline was founded in April 1981 and was commercialized in February 1983. It is a Government owned airline run by the Druk Holding Investment. Bhutan established its first international air links with Kolkata, followed by six destinations in South Asia, including Bangkok. Druk Air Corporation Limited introduced domestic flights to Bumthang, Younphula(Trashigang) and to Gelephu (Sarpang) in 2011

6.6 Availability of Ancillary Units

Ancillary unit is an industrial unit which manufactures parts or intermediaries, or provides services. A large chunk of its production or services is used by another industrial taking. An ancillary unit is typically small - whose investment in fixed assets in plant and machinery, does not exceed Nu. 7.5 million. So, a farmer's cooperative growing apples or any other fruits, manufacturer of jam, jelly, pickle, juice could be the ancillary units for this unit.

6.7 Availability of Housing, Schooling and Hospital Facilities

Housing

The present location of the Sarpang town has been declared a disaster prone area after three severe floods hit the town in 1996, 2000 and 2007. An area about 2 km away at Rani Bagan has been earmarked by the government and the plan approved for reconstructing the town there. The plan has been approved by the government and the reconstruction workis expected to begin in 2015.

Figure 11: Housing Facility at Sarpang Dzongkhag

Schooling:

There are a total of 16 schools in the Sarpang dzongkhag. Some of the schools have the facility for boarding for students. The types of schools in the dzongkhag are given in the following table

Figure 12: Gelephu Higher Secondary School

Table 9: Number of Schools, Institutes & Centres, Bhutan, 2015

S. No.	Type of School	No.
1	Community School	4
2	Primary School	6
3	Junior High School	2
4	High School	4

(*Source:* Bhutan Majestic Travel, 2015)

Hospital Facilities:

Health Care is delivered in a totally integrated three-tiered system with National Referral Hospital at the apex, regional referral hospitals, district hospitals, and Basic Health Units (BHUs) at the Community Level. BHUs serve remote populace and are staffed by well-trained health personnel who are equipped to treat minor ailments and advice on preventive measures to avoid the spread of communicable diseases. Extended Health Centres such as Out Reach Clinics (ORCs) and Sub-posts support these BHUs. There are also numbers of special health programs in Bhutan administered by the Ministry of Health.

The types of facilities available in Sarpang dzongkhag is given below

Table 10: Health Facilities

S. No.	Facility Type	No.
1	Hospital	0
2	BHUs	3
3	Malaria centre	1

(*Source:* Bhutan Majestic Travel, 2015)

6.8 Communication Facilities

Sarpang is one of the oldest towns in the country with access to motorable roads as far as early 1950s**.** Bhutan Telecom Limited (BTL), Tashi Info Comm Limited (TICL), Samden Tech and Drukcom are the four Internet Service Providers (ISPs) in the country. Bhutan Telecom Limited is the sole provider of fixed-line telecommunication services while cellular mobile services are provided by B-Mobile (Bhutan Telecom Limited) and Tashi-Cell. With the exception of Bhutan Telecom, all other ISPs are private sector ventures. This Dzongkhag has excellent postal & telecommunication facilities. Postal service consists of 2 post offices and for telecommunication there are 2 telephone exchanges, 1,619 mobiles users and 1,939 households with telephone connection (Source: Dzongkhag wise distribution of Resources, 2006).

6.9 Presence of Approach Road

Presence of approach road from and to the plant must be taken into consider before setting up the plant.

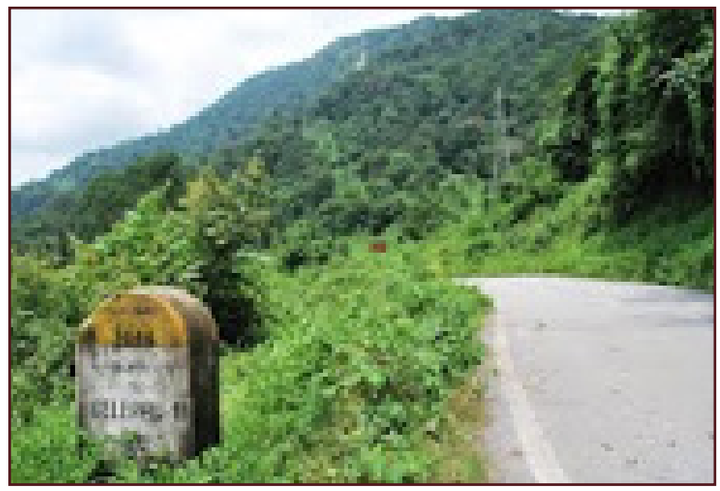
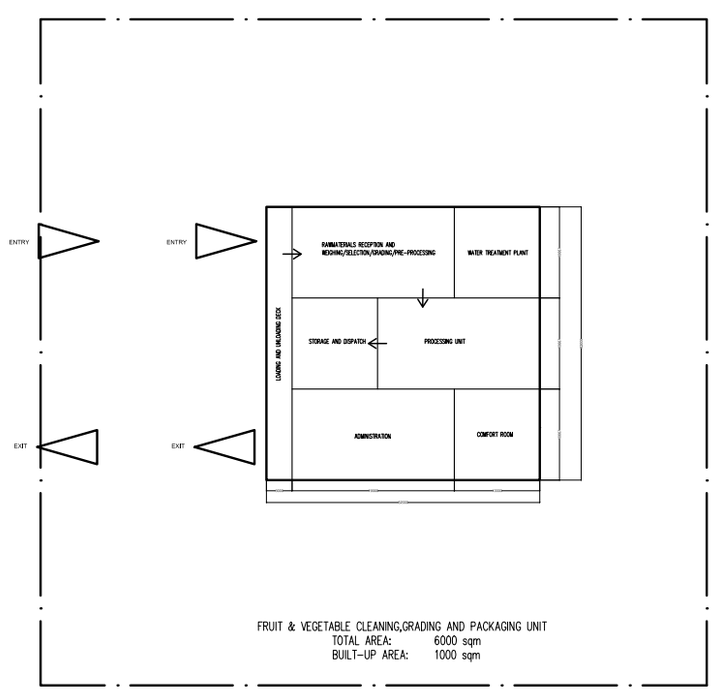


Figure 13: Road Connectivity

6.10 Factory layout plan



7.0 ENVIRONMENTAL ASPECTS

Environmental aspects are of high importance during setting up any plant. These aspects play a vital role in the ecological balance. Some methods are given below that will help to make the environment free from pollution.

1. Waste Management

Waste produced by the facility should not contaminate the environment or the finished product. A waste management program should identify the different forms of waste that are generated during operations, as well as activities of personnel. Following table provides some guidelines on the proper management of waste products.

Table 11 : General guidelines for managing waste of the packing facility

Item	Guidelines for Management
Waste receptacles	Item must be covered and located far from packing and storage areas; item must be easily accessible.
Wet waste (fruit and vegetable rejects, trimmings)	Dispose using metal or plastic receptacles with tight-fitting lids. Waste should be removed daily and measures taken to prevent decay.
Dry waste (paper, plastic, metal, glass)	Use metal or plastic receptacles with tight-fitting lids; multiple receptacles should be used to segregate waste and promote recycling
Floor waste	Must be removed immediately and segregated into wet or dry waste, the floor should be cleaned and sanitized regularly.
Containers/ packaging for raw materials	Must not be used for storing produce; empty containers and packaging should be segregated or disposed of immediately
Used containers for finished products	Must not be used for storing chemicals, fuel, oil, other non-food items.
Used chemical solu-tions	Only registered chemicals should be used; follow disposal instructions on the label. Do not pour directly into water bodies (lakes, rivers, canals).

(*Source:* FAO Report, 2012)

An alternative method also exists for disposing of waste fruits. This includes digging the ground, putting the fruits inside the deep hole under the ground and levelling the ground again by roller. This process helps to remove the bad smell off and decompose the rotten fruits.

2. Pest control

Pests commonly found in a packing facility can be classified into insects (flies, cockroaches),rodents (rats), reptiles (snakes, lizards), arachnids (spiders) and birds. Stray cats and dogs are also sources of contamination (faecal matter, animal hair and parasites such as lice and ticks).

Maintaining effective control of pests is necessary to prevent disease and contamination. If pesticides are used for controlling pests, the method of application should not contaminate raw materials, packaging

materials or finished product. Only experienced and licensed contractors should be employed for these pest controlling activities. Use of rodent bait within the packing facility should not be allowed. If unavoidable, all materials should be removed before application of the bait.

Pest control measures

1. Hygienic conditions should be maintained in the areas immediately surrounding the packing facility. They should be litter-free and garbage should be stored in closed receptacles. Grassy and weedy areas can serve as breeding grounds for pests and should be trimmed on a regular basis.

2. Unused bins, containers and equipment should not be allowed to accumulate inside the facility.

3. Scheduled inspections should be conducted of all areas in the packing facility for evidence of pest activity as well as for identifying potential nesting or hiding places.

Figure 14: Pest Control

4. Produce and equipment should be kept 50 centimetres away from walls to allow personnel to clean and inspect for infestation on all sides of the equipment.

5. Screened windows and vents should be installed and holes in walls, floors and doors must be blocked to prevent the entry of pests.

6. Traps or bait used for the eradication of pests must be placed in locations that will not contaminate produce or packaging materials. Traps should be inspected and cleaned on a regular basis. Trapped pests should be disposed of humanely.

3. Drainage System

Drains should be constructed in order to facilitate drainage, especially in areas where floors are subject to flood-type cleaning or where operations discharge water or liquid waste on the floor. Drains should flow from the end of the packing line to the receiving area of raw materials to avoid contamination.

Figure 15: Drainage and Cleaning of Industrial Wastes

This chapter covers the environment management aspects for the project. The degree of detail is based on the Reference Document, Environment Assessment Act, 2000 and the Regulation for the Environmental Clearance of Projects, 2002. Reference has also been made to the Procedures for Project Review in the

NEC guidelines and rules and regulations for establishment and operation of Industrial and commercial ventures in Bhutan, 1995. In accordance to these, for this project an Environment Assessment (EA) document including Environment Management Plan (EMP) and a monitoring plan shall be required. Since the impacts of the project are known, an Initial Environmental Evaluation is not required.

This report includes characterization of environmental consequences due to various project activities, both during the construction phase as well as the operational phase and measures to mitigate them. The elaboration of these features shall meet the requirements of EA document. The environmental elements considered for this purpose are shown in the following table

Table 12: Elements considered for environmental impacts

	Element		Element		Element
1	Land Use	2	Soil	3	Ecology
4	Subsidence and Landslide	5	Noise Quality and Ground Vibration	6	Vehicular Movement
7	Water Resources	8	Hydrology	9	Water Quality
10	Air Quality	11	Solid Waste	12	Human Settlement
13	Socio-economic Conditions	14	Aesthetics	15	Site of Cultural Heritage and Scenic Importance

Environmental Impacts

The environmental impacts that are likely to arise out of the proposed project, during their construction and operation phases, are summarized in the sub-sections that follow.

During Construction Phase

Table 13: Environmental impacts during construction phase

S. No.	Attributes	Problem Impacts Due to Plant
1	Land Use	Degradation in land values due to construction waste & construction silt runoff.
2	Soil	Loss of soil due to clearing, excavation, soil removal, road construction, etc.
3	Ecology	Encroachment in ecology; loss of flora and fauna.
4	Water Resources	Depletion of ground water resources, if used.
5	Water Quality	No effect of domestic waste, if a sewage treatment plant will be installed for the labour camp as well as the plant.
6	Air Quality	Fugitive emission and dust impair air quality.
7	Noise Quality	Increase in noise levels.
8	Vehicular Movement	Traffic congestion/accidents and adverse effects on air quality & noise levels
9	Solid waste	Increased excavated soil, debris, garbage, etc., at the construction site.

10	Aesthetics	Depreciation of environmental aesthetics by project structures.
11	Site of Cultural, Historical and Scenic Importance	Impact on the site of Cultural, Historical and Scenic Importance, if available

During Operation Phase

Table 14: Environmental impacts during operation phase

S. No.	Attributes	Due to Plant
1	Land Use	Area is industrial/agricultural land.
2	Soil	Positive impact due to horticulture and plantation.
3	Ecology	No major impact due to vegetation and plantation in the surrounding area.
4	Subsidence and Landslide Problems	No impact.
5	Water Resources	Depletion of water resources due to water withdrawal.
6	Water Quality	Discharge of sewage and storm water run-off may cause deterioration of water quality.
7	Air Quality	Increase in TSPM and RPM levels and impairment of ambient air quality.
8	Noise Quality	Increase in noise level in the surrounding area.
9	Vehicular Movement	Traffic congestion/accidents in conjunction with loss in air quality.
10	Solid Waste	Inappropriate disposal of garbage/ sewage could be hazardous.
11	Aesthetics	Loss in environ-aesthetics to some extent.
12	Site of Cultural, Historical and Scenic Importance	Impact on the site of Cultural, Historical and Scenic Importance, if available
13	Human Settlement	No impact as no relocation/resettlement required if industrial area.
14	Socio-Economic condition	Increased economic activities in the region resulting in additional jobs. Improvement in quality of life of people.

Environmental Management

The mitigation measures including prevention and control for each environmental component have been delineated in the sub-sections that follow.

During Construction Phase

Table 15: Mitigation measures during construction phase

S. No.	Attributes	Mitigation Measures Proposed at Plant
1	Land Use	Plantation and green belt development shall commence.
2	Ecology	Plantation and vegetation shall commence
3	Water Resources	Controlled use of water resources
4	Water Quality	Debris shall be isolated from waste water and disposed off separately. All waste shall be treated in septic tanks and ETP.
5	Air Quality	Regular water sprinkling at the construction site. Construction materials shall be totally covered during transportation.
6	Noise Quality	Use of silencers, noise isolators etc. in machines. Use of equipment, which keep noise levels within limits prescribed by regulatory agencies.
7	Solid Waste	Sewage treatment plant will be installed in the colony as well as at the plant.
8	Vehicular Movement	Proper metallic access road will be constructed upto the site.
9	Aesthetics	Construction activities commensurate with landscaping in the area.

During Operation Phase

Table 16: Mitigation Measures During Operation Phase

S. No.	Attributes	Mitigation Measures Proposed at Plant
1	Land Use	Development of green belt in and around the plant.
2	Soil	Tree plantation all around the plant.
3	Ecology	Development of green belt in and around the plant.
4	Water Resources	There shall be a perpetual demand on water resources. There will not be any substantial requirement of water at the plant other than for sanitation and general cleaning purposes. The water requirement in the plant will have no adverse effect on the water source and the water required at the plant can be adequately met from the current allocation to the plant from the community.
5	Hydrology	The plant shall take into consideration the local geological, geomorphological and hydro-geological settings.
6	Water Quality	There will be substantive generation of waste water at the plant premises besides the use at the staff quarters for sanitation purposes. This waste water will be collected in septic tanks.
7	Air Quality	Provision of suitable bag filters for dust control. Provision of leak proof and properly covered transport equipment to prevent dust from being airborne. Adequate dust suppression and extraction facilities at material handling and transfer points. Provision of green belt around the plant. Provision of a well-equipped workshop for regular maintenance of vehicles in order to control emissions.

8	Noise Quality and Ground Vibration	Noise abatement at source by choosing machinery and equipment suitably. Proper mounting of equipment and ventilation systems. Provision of noise insulating enclosures or padding, wherever possible. Provision of personal protective equipment for workers. Dense belt of trees to act as acoustic barriers.
9	Vehicular Movement	Provision of wide tar/concrete road. Provision of a well-equipped workshop for regular maintenance of vehicles in order to control emissions.
10	Solid Waste	No solid waste will be generated besides from the staff quarters. Proper disposal of the waste based on terrain, landscaping, drainage & aeration. Septic tanks will be constructed at the staff quarters.
11	Aesthetics	Landscaping and use of vegetation.
12	Human Settlement	Not applicable.
13	Socio-Economic Conditions	Maintaining good communication with local communities before, during and after construction. Training of local personnel for specific (skilled) positions. Welfare measures for local populace.

Solutions Adopted in the Technical Concept

The guidelines for various industrial units stipulate "limiting values" for water quality, air quality and noise quality.

For the project, adequate pollution control equipment has to be considered. The general requirement and measures to be considered for arresting the pollutants is tabulated in the following table:

Table 17: Estimated release of pollutants

Sl #	General Requirement		Measure Considered
1	Water Quality		
A	For plant		
	Treated Effluent discharges should have a pH in the range of 6-9.		Sewage treatment plant of adequate capacity to control the pH and TSS.
2	Air Quality		
A	For Plant		
	The air quality should conform to the limiting values of SPM, limiting values of SPM,		Bag Filters & modern burner with precise fuel dosing system should be considered for the air quality.
3	Noise Quality		
	For Plant		
	A maximum increase in background levels of 3 dB (A) or the following levels:		The plant should be designed not to generate more than 60 dB (A) maximum. All high noise emitting machinery such as the roller mills will be enclosed in a housing (lined with a 2 inch glass wool) so as to minimize sound emissions outside the plant. The walls of the structure housing the machinery will be made of mud bricks to absorb the sound
	Residential	55/45 dB (A)	
	Industrial	75/70 dB (A)	
	Commercial	65/55 dB (A)	

Occupation Health and Safety

All workers in the plant location will be provided with and shall be mandated to use protective gear and equipment to ensure their personal safety. Safety boots, gloves, eye goggles, helmets, nose masks (wherever necessary), ear plugs, reflective jackets and other protective equipment will be provided by the company. Trainings on safety for all new recruits as well as refresher courses on safety for the regular staff will be conducted regularly from time to time in order to ensure that safety procedures are followed at all times.

A safety inspector shall be appointed (plant manager) and an OHS committee comprising of employees shall be formed to monitor and ensure compliance to safety norms and procedures.

8.0 PROJECT IMPLEMENTATION SCHEDULE

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

- Proper choice of technology and machinery suppliers.
- Adequate diligence in formulating the technical concept and system design.
- Proper choice 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.

Implementation Strategy

Typically any project has four core dimensions which are as follows –

- Engineering: this directly impacts the smooth operations of the plant over its entire life.
- Procurement: is critical on account of the impact that it has on investment and performance benchmarks and also in ensuring the choice of appropriate technology.
- Construction: is critical in terms of its impact on completion quality and the duration of the project phase.
- Project Management: other than its obvious impact on project timeliness it also contributes to risk minimization for the promoter.

Implementation Schedule

It is suggested that the project implementation will not take more than 12 months out of which 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.

Pre-project Activities include:

1. Hydrological investigations for ensuring the availability of the requisite quantum of water.
2. Receipt of requisite clearances from competent authorities with respect to :
   - Environmental clearance
   - Sanction and supply of power
   - Sanction and supply of water
   - Tying up sources of funds for the project to achieve financial closure

- Procurement of land
- Topographic & Seismologic survey for plant area

Floating tender inquiries, evaluation of order for main machinery

3. Site Preparation and Levelling of land

The table given below shows the project schedule:

Table 18. A: Implementation Schedule

Sl.No.	Activity	Months											
		1	2	3	4	5	6	7	8	9	10	11	12
1	Site Preparation & Leveling of Land												
2	Construction of factory shed & Civil Infrastructure												
3	Hiring of People (Phase 1)												
4	Installation of Machineries												
5	Hiring of more people (Phase 2)												
6	Training & Commissioning of People												
7	Trial Production Runs												

Table 18. B: Legend

Color Coding	
	Site Preparation
	Construction & Civil Infrastructure
	Manpower Hiring
	Installation of Machineries
	Hiring of more manpower
	Training & Commissioning
	Trial Production Runs

9.0 COST PRESENTATION

Project cost/ Total Investment

Summary:

Table 19 : Project Summary

Plant Capacity:	50 MT per day; 16000 MT per year
No. of Shift:	One (8 hours per shift) per day
Working Days in Year:	320
D.S.C.R. :	2.31
B.E.P. :	16.88 %
IRR :	29.73%
NPV :	37.2

9.1 Capital Costs

Building and Civil Work

About 6,000 sq. meter of land will be required for this project and built up area required will be 1,013 sq. meter consisting of production hall, washing, packaging, storage etc. The cost of building and civil work would be Nu. 13 million at a rate of Nu. 13,000/square meter

Plant and Machinery

The cost of plant & machinery is estimated at Nu.15.15 millions including installation and commissioning. The installed production capacity is 50 MT per day. The cost estimates for plant & machinery have been worked out based on the cost figures available from budgetary offers and/or orders placed for similar items in the recent past, duly updated to cover the price escalation in the intervening period. The detailed itemized estimates are given in table Plant and Machinery

Freight and insurance have been considered on the assumption that all goods are transported by road.

Table 20: Plant and Machinery

S. No.	Particulars	Qty.	Rate (Nu. In Millions)	Value (Nu. In Millions)
1	Chain pulley Block 1 Ton	1	0.02	0.02
2	Motorized Conveyor for bulk Material handling	1	0.20	0.20
3	Hydraulic Pallet Truck 2.5 ton	2	0.02	0.04
4	Battery operated fork lift 2MT	2	0.10	0.20
5	Box Strapping Machine	2	0.02	0.04
6	Gantry Crane	1	0.20	0.20

7	Traveling Trolley	10	0.004	0.04
8	Electronic Weighing machines (150Kg.)	4	0.01	0.04
9	100 Ton Cold Storage Unit for Main Storage with Insulation and Air Curtain	1	4.80	4.80
10	Shrink Wrapping Machine	4	0.05	0.20
11	Grading & Sorting Table	50	0.01	0.50
12	Inspection Tables	5	0.005	0.025
13	Platform Type Scales (30kg)	4	0.008	0.032
14	Platform Type Scales with Printer (15 kg)	40	0.010	0.40
15	Platform type scales (120 kg)	1	0.015	0.015
16	UPS for above Machines	40	0.006	0.24
17	Tray Hand Wrapping Machine	1	0.03	0.03
18	Dryer – for Removing the Water Applied Externally	1	0.10	0.10
19	Waxing Unit	1	0.18	0.18
20	Washing Machine	1	0.20	0.20
21	Packaging machine, Pouch sealing machine	5	0.060	0.30
22	Pre Cooling unit of 50 MT capacity in a batch of 6 hours (one static chamber and two units in conveyors)	1	1.00	1.00
23	Automatic Fruit grading and Sorting Lines(One Ton per Hour)	1	1.50	1.50
24	Vegetable trimming and packaging with shrink wrapping unit	1	1.50	1.50
25	Ethylene Generator 3 nos. (Sure Ripe)	3	0.08	0.24
26	Ethy-gen II Concentrate (45 cases)	1	0.55	0.55
27	Gastech. Air Sampling Kit Unit 1 no.	1	0.05	0.05
28	Ethylene Monitoring Tube - 2 Box	1	0.04	0.04
29	Carbon di-oxide Monitoring Unit	1	0.04	0.04
30	Additional Dryers for Removing Moisture- 1MT Per Day	3	0.35	1.05
31	Installation, Erection and Commissioning @ 10% of Value of Machinery	1	1.38	1.38
			Total	**15.15**

Misc. Fixed Assets

Nu. 10.55 millions have been estimated under the heading of MFA. The details of electrical installations for power distribution have been considered commensurate with the power load and process control requirements. Other miscellaneous fixed assets including furniture, office machinery & equipment,

equipment for water supply, laboratory, workshop, firefighting equipment, etc have been provided on a lump sum basis as per information available with the consultants for similar assets. The details of miscellaneous fixed assets and their associated costs are been shown in table below:

Table 21: Misc. Fixed Assets

S. No.	Particulars	Qty. (No.s)	Rate(Nu. In Millions)	Amount (Nu. In Millions)
1	Office Equipment	1	0.30	0.30
2	Furniture and Fixture	-	-	0.75
3	Miscellaneous Accessories	1	0.50	0.50
4	Vegetable Display Crate	3,000	0.0003	0.90
5	Electronic Weigh Bridge	1	0.30	0.30
6	Display Board	20	0.001	0.02
7	Fire Fighting	15	0.005	0.08
8	Computer with Accessories	-	-	0.25
9	ERP System	1	1.00	1.00
10	Water Treatment Plant – 5000 litres per hour	1	0.25	0.25
11	Car	1	0.80	0.80
12	Loading Tempo	6	0.15	0.90
13	Pick up Van	3	0.55	1.65
14	Mini Truck	3	0.55	1.65
15	Electrical Installation	1	1.20	1.20
			Total	**10.55**

Preliminary Expenses

Table 22: Preliminary Expenses

S. No	Particulars	Estimation (Nu. In Millions)	Amount (Nu. In Millions)
1	Company Formation Expenses, Legal & Liaisoning	0.10	0.10
		Total	0.10

Pre-Operative Expenses

Expenses incurred prior to commencement of commercial production are covered under this head that total Nu. 7.21 million Pre-operative expenses include establishment cost, rent, taxes, traveling expenses, interest during construction insurance during construction and other miscellaneous expenses. Based on the financing pattern envisaged, interest during construction has been estimated considering the phasing of in the cash requirements and the norms prevalent for various sources of funds. It has been assumed

that the funds from various sources shall be available, as required.

Based on the project implementation schedule, the expected completion dates of various activities and the estimated phasing of cash requirements, interest during construction has been computed. Other expenses, under this head have been estimated on a block basis, based on information available for similar projects.

Table 23: Pre- Operative Expenses

S. No.	Particulars	Estimation	Amount (Nu. in Millions)
1	Interest up to Production @ 13% on term loan amount of Nu 24,053,000	For 1 year on Term Loan	4.43
2	Insurance during Construction Period	0.25% of factory assets	0.10
3	Electricity Charges during Construction Period		0.18
4	Marketing Launch Expenses		0.5
5	Technology Know-how and Consultancy Fees		1.00
6	Training Expenses		0.50
7	Travelling Expenses		0.50
		Total	**7.21**

Cost of Raw Material

Based on the processing capacity of 50 MT per day considering 320 days in a year the annual raw material consumption of the project will be 16,000 MT and the cost of the same will be Nu.365.6 millions based on the average arrival price of these produce in the selling yards as sourced from farm level average pricing as revealed by a sample of buyers at Paro and Thimpu..

Table 24: Cost of Raw Materials

S. No.	Particulars	Qty. (MT)	Rate Per Kg (Nu.) at the company gate	Amount (Nu. in Millions)
A	Vegetables			
1	Potato	4,000	11.00	44
2	Chilli Fresh	1,000	42.00	42
3	Ginger	2,000	82.00	164
4	Raddish	1,000	9.00	9
B	Fruits			

	Mandarin	4,000	32.00	128
	Banana	1,000	16.00	16
	Guava	2,000	21.00	42
	Pineapple	1,000	21.00	21
C	Consumables (approx 1%)			4.66
		16,000	Total	470.66

Land Lease Charge

Required land is 6,000 sq. meter (64,585 sq. ft.), which has been considered on lease @ Nu.4.00 per sq. ft. per annum for first three years and @ Nu. 6.00 per sq feet for the fourth year and subsequently @ 3% increase every year.

Table 25: Land Lease Charges

S. No.	Year	Lease Rate Per Sq. Ft Per Year (Nu.)	Lease Charges Per Annum (Nu. In Millions)
1	1st Year	4.00	0.26
2	2nd Year	4.00	0.26
3	3rd Year	4.00	0.26
4	4th Year	6.00	0.39
5	5th Year	6.20	0.40
6	6th Year	6.40	0.41
7	7th Year	6.60	0.43
8	8th Year	6.80	0.44
9	9th Year	7.00	0.45

Sales Realization

It is assumed that 60% capacity utilization will be achieved during first year of operation, 70% in the second year and 80% from the third year onwards. The selling price for the domestic is considered on the basis of the wholesale prices prevalent in Bhutan revealed through a deep stick survey involving convenience sampling of resellers at Thimpu. For exports, wholesale rates prevalent in India were considered through a convenience sampling of resellers in Kolkata, Guwahati and Siliguri.

Table 26.A: Sales Realization (Domestic- Category a products)

S. No.	Particulars	Production Per Annum (MT)	Rate Per Kg for domestic retailers at the NCC	Total Amount Per Annum (Nu. In Millions)
1	Potato	2,000	13	26
2	Chilli Fresh	500	64	32
3	Ginger	1,000	96	96
4	Raddish	5,00	13	6.5
5	Mandarin	2,000	38	76
6	Banana	500	24	12
7	Guava	1,000	33	33
8	Pineapple	500	33	16.5
			Total	**298**

Table 26.A: Sales Realization (Export Category a products)

S. No.	Particulars	Production Per Annum (MT)	Rate Per Kg for export(FOB Jigmeling)	Total Amount Per Annum (Nu. In Millions)
1	Potato	2,000	15	30
2	Chilli Fresh	500	72	36
3	Ginger	1,000	110	110
4	Raddish	5,00	14	7
5	Mandarin	2,000	42	84
6	Banana	500	26	13
7	Guava	1,000	36	36
8	Pineapple	500	36	18
			Total	**334.0**

Table 26.B. Sales Realization

Total sales realization at 100%(Addition of revenues from Domestic and Export category products)	632
First year 60%	379.2
Second Year 70 %	442.4
Third Year 80%	505.6

Salary and Wages

Salaries & wages (including benefits) for different categories of employees have been considered based on present day expenses being incurred by other industries in the vicinity. Adequate adjustments have been considered for expatriates. The breakdown of manpower and incidence of salaries & wages are

detailed in the table Salary & Wages.

Salary & wages are increased @ 5% every year.

Table 27: Salary and Wages

S. No.	Description	Require-ment	Salary Per Month (Nu.)	Salary Per Month (Nu. In Millions)	Salary Per Annum (Nu. in Millions)
A.	Administrative				
1	General manager	1	38,783	0.40	0.47
2	Manager (Pur & Mktg.)	1	21,718	0.02	0.26
3	Manager (MIS & Logistics)	1	21,718	0.02	0.26
4	Manager (Agricultur-al Extension)	1	21,718	0.02	0.260
5	Accountant	1	11,635	0.01	0.14
6	Purchase Executive	1	10,860	0.01	0.13
7	Sales & Export Exec-utive	5	10,860	0.01	0.66
8	Drivers	13	9.23	0.0092	1.44
9	Helper	6	5,431	0.005	0.36
10	Security Guards	2	5,431	0.005	0.12
11	Front Line Executives	24	7,757	0.008	2.30
				Sub Total	6.42
B.	Production				
S. No.	Description	Requirement	Salary Per Month (Nu.)	Salary Per Month (Nu. In Millions)	Salary Per Annum (Nu. in Millions)
1	Production Manager	1	15,514	0.016	0.19
2	Supervisor	5	11,635	0.01	0.72
3	Skilled Workers	15	9,308	0.009	1.62
4	Semi Skilled Worker	30	6,979	0.007	2.52
				Sub Total	5.05
				Grand Total	11.47

Electrical and Water Consumption Charges

Power & water charges are increased @ 5% every year. The unit cost of electricity has been considered @ Nu.1.81/ kwh assuming that the entire power requirement is met from the grid. A power supply of 225 KVA is deemed appropriate. The expense on water supply, treatment and distribution has been suitably

considered, based on the Thimpu City Corporation water tariff of Nu.3.49/ m³ with an additional 50% levy for sewerage. Water requirements are approximately 10,000 litres per day.

Table 28: Electrical & Water Consumption Charges

S. No.	Description	Amount Per Annum(Nu. In Millions)
1	Power Consumption	0.83
2	Water Consumption	0.02
	Total	**0.85**

9.2 Operating Costs

Term Loan Requirement from Financial Institutions

Table 29: Term Loan Requirement

S. No.	Particulars	Amount (Nu. in Millions)	Promoters Contribution (Nu. in Millions)	Bank Loan(Nu. in Millions)
1	Land 6000 sq. meters	0.00		
2	Building and Civil Construction	13.00		
3	Plant & Machinery	15.15		
4	Other Misc. and Fixed Assets	10.55		
5	Preliminary Expenses	0.10		
6	Pre-operative Expenses	7.21		
7	Margin Money for Working Capital	6.9		
8	Contingencies	3.87		
	Total	**56.78**	**22.71**	**34.07**

Working Capital Requirement

Working capital requirements have been worked out in the following table:

Table 30: Working Capital Requirement

S. No.	Particulars	Period	Margin	Amount (Nu. In Millions)	Promoters Contribution (Nu. In Millions)	Bank Loan (Nu. In Millions)
1	Raw Material	15 days	25%	11.77	2.94	8.82
2	Receivables	15 days	25%	15.80	3.95	11.85
Total				**27.61**	**6.9**	**20.71**

Means of Finance

Table 31: Means of Finance

S. No.	Particulars	Value (Nu. In Millions)
1	Promoters' Equity	22.71
2	Term loan from FIs	34.07
	Total	**56.78**

The term loan has been arrived based on the breakup of individual investment item and bank's financing pattern as given in table Requirement of Term Loan

Cost of Project:

The total cost of the project is estimated at Nu. 56.78 millions as per the particulars given in the following table

Table 32: Cost of Project

S. No.	Particulars	Value (Nu. In Millions)
1	Land 6,000 sq. meters (On lease)	
2	Building & Civil Construction	13.00
3	Plant and Machinery	15.15
4	Misc. Fixed Assets	10.55
5	Preliminary Expenses	0.10
6	Pre Operative Expenses	6.9
7	Margin Money for Working Capital	7.09
8	Contingencies 10% of Fixed Assets	3.87
Total		**56.78**

Estimated Cost of Production & Profitability

The profitability projections have been worked out for 10 years; at 60% capacity utilization during first year of operation, 70% in second year and 80% from third year onwards and following assumptions and basis as relevant and applicable to Bhutan have been considered while preparing the profitability.

- Repairs & maintenance have been taken as @4% p.a. on fixed assets.
- Bank interest rate has been calculated @13% p.a. on term loan & working capital loan.
- Insurance charges @0.25% on all assets in first year, then @5% decrease every year.
- Power & water charges are increased @5% every year.
- Administrative expenses have been increased @5% every year.
- Debt equity ratio has been taken to be 60:40 for term loan.
- Margin money on bank loan has been considered @ 25% on working capital
- Bank loan has been considered for repayment in 8 years with one year moratorium
- Preliminary exp. will be written off @10% every year in next 10 years.
- Pre operative exp. will be written off from II year @10% every year in next 10 years.
- Straight Line Depreciation has been charged taking useful life for buildings to be 30 years with a residual value of 10%; 7 years on other fixed assets and 6 years on machinery with no residual value.
- Insurance, lease rent & interest has been taken as fixed cost for calculating B.E.P.
- Income tax has been charged @30% every year as per Bhutan's tax rates.

10.0 FINANCIAL ANALYSIS

10.1 Profitability

Table 33: Estimated Cost of Production & Profitability

S. No.	Particulars	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7thYear	8th Year	9th Year	10th Year
1	Raw Material Consumed	282.40	329.46	376.53	376.53	376.53	376.53	376.53	376.53	376.53	376.53
2	Power and water	0.85	0.89	0.94	0.98	1.03	1.08	1.14	1.20	1.26	1.32
3	Salary and Wages	11.47	12.04	12.65	13.28	13.94	14.64	15.37	16.14	16.95	17.79
4	Fringe Benefits @15%	1.72	1.81	1.90	1.99	2.09	2.20	2.31	2.42	2.54	2.67
5	Insurance	0.10	0.09	0.09	0.08	0.08	0.07	0.07	0.07	0.06	0.06
6	Repair & Maintenance @ 4%	1.55	1.63	1.71	1.79	1.88	1.98	2.07	2.18	2.29	2.40
7	Land Lease Rate	0.26	0.26	0.26	0.39	0.40	0.41	0.43	0.44	0.45	0.47
8	Other Admn. Exp.	0.46	0.48	0.51	0.53	0.56	0.59	0.61	0.65	0.68	0.71
9	Production cost	298.80	346.66	394.57	395.58	396.51	397.50	398.53	399.61	400.75	401.95
10	Sales	379.20	442.40	505.60	505.60	505.60	505.60	505.60	505.60	505.60	505.60
11	S&D expenses	56.88	66.36	75.84	75.84	75.84	75.84	75.84	75.84	75.84	75.84
12	Cost of Sales	355.68	413.02	470.41	471.42	472.35	473.34	474.37	475.45	476.59	477.79
13	PBIDT.	23.52	29.38	35.19	34.18	33.25	32.26	31.23	30.15	29.01	27.81
14	Int. On term loan @13%	4.43	4.15	3.60	3.04	2.49	1.94	1.38	0.83	0.28	0
15	Working Capital @ 13%	2.69	2.69	2.69	2.69	2.69	2.69	2.69	2.69	2.69	2.69
16	Total Interest	7.11	6.84	6.28	5.73	5.18	4.62	4.07	3.52	2.96	2.69
17	Profit Before Dep.	16.41	22.54	28.91	28.45	28.07	27.64	27.16	26.63	26.04	25.12
18	Dep.	4.31	4.31	4.31	4.31	4.31	4.31	2.55	0.39	0.39	0.39
19	Profit After Dep.	12.09	18.23	24.60	24.14	23.76	23.33	24.60	26.24	25.65	24.73
20	Pre Operative Exp. Write Off	0	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
21	Preliminary Expenses Write Off	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
22	Profit Before Taxation	11.99	17.41	23.78	23.32	22.94	22.51	23.79	25.42	24.83	23.91
23	Taxation @30% of Net Profit	3.60	5.22	7.13	7.00	6.88	6.75	7.14	7.63	7.45	7.17
24	Profit After Taxation	8.39	12.18	16.64	16.32	16.06	15.75	16.65	17.79	17.38	16.74
25	Accumulated Profit	8.39	20.58	37.22	53.55	69.60	85.36	102.01	119.80	137.18	153.92

10.2 Calculation of Interest on Term Loan

Table 34: Interest on Term Loan

Year	Opening Balance (Nu. in Millions)	Repayment (Nu. in Millions)	Closing Balance (Nu. in Millions)	Interest (Nu. in Millions)
1	34.06	0.00	34.06	4.43
2	34.06	4.26	29.80	4.15
3	29.80	4.26	25.55	3.60
4	25.55	4.26	21.29	3.04
5	21.29	4.26	17.03	2.49
6	17.03	4.26	12.77	1.94
7	12.77	4.26	8.52	1.38
8	8.52	4.26	4.26	0.83
9	4.26	4.26	0.00	0.28

10.3 Calculation of DSCR

Computation of Net Operating Income

Table 35: Net Operating Income

	Year1	Year2	Year3	Year4	Year5	Year6	Year7	Year8	Year9	Year10
PAT	8.39	12.18	16.64	16.32	16.06	15.75	16.65	17.79	17.38	16.74
Dep.	4.31	4.31	4.31	4.31	4.31	4.31	2.55	0.39	0.39	0.39
Int	7.11	6.84	6.28	5.73	5.18	4.62	4.07	3.52	2.96	2.69
NOI	19.82	23.34	27.24	26.37	25.55	24.69	23.28	21.70	20.74	19.82

Computation of Debt Services

Table 36: Debt Services

	Year1	Year2	Year3	Year4	Year5	Year6	Year7	Year8	Year9	Year10
Repayment	0.00	4.24	4.24	4.24	4.24	4.24	4.24	4.24	4.24	
Lease	0.26	0.26	0.26	0.39	0.40	0.41	0.43	0.44	0.45	0.47
Int	7.11	6.84	6.28	5.73	5.18	4.62	4.07	3.52	2.96	2.69
DS	7.37	11.34	10.78	10.36	9.82	9.28	8.74	8.20	17.76	13.23

Computation of DSCR (Net Operating Income/Debt Services)

Table 37: Computation of DSCR

	Year1	Year2	Year3	Year4	Year5	Year6	Year7	Year8	Year9	Year10
DSCR	2.69	2.06	2.53	2.54	2.60	2.66	2.66	2.65	1.17	1.50

Average value over ten years is 6.04

10.4 Break Even Point

Table 38: Break Even Point

Calculation of B.E.P	1st Year	2nd Year	3rd Year
Sales	379.20	442.40	505.60
Variable Cost	355.32	412.67	470.06
Fixed Cost	7.47	7.19	6.63
Break Even Point (B.E.P)	18.78	16.93	14.93
Average B.E.P	16.88%		

Note on unit Costing & Pricing

Table 39: Unit Costing and Pricing

Heads	Average %
Raw Material Costs	74.47
Sales & Distribution Costs	15.00
Overheads	7.37
Margin	3.16
Total	100.00

10.5 NPR AND RI

Table 40: NPR and RI

Ratio	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year	8th Year	9th Year	10th Year
Net Profit Ratio	9.48	9.97	10.46	10.41	10.37	10.32	10.50	10.72	10.66	10.55
Return on Investment	23.81	31.08	37.27	37.08	36.94	36.78	37.41	38.21	37.98	37.59

10.6 Cash Flow Statement (Nu. In Millions)

Table 41: Net Cash Flow Statement

S. No.	Years	0	1	2	3	4	5	6	7	8	9	10
1	Inflows											
1.1	Net Profit After Tax	0.00	8.39	12.18	16.64	16.32	16.06	15.75	16.65	17.79	17.38	16.74
1.2	Depreciation	0	4.31	4.31	4.31	4.31	4.31	4.31	2.55	0.39	0.39	0.39
1.3	Preliminary Expenses Write Off	0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
1.4	Pre Operative Expenses Write off	0	0	2.06	2.06	2.06	2.06	2.06	2.06	2.06	2.06	2.06
1.5	Net Cash Inflows	0	12.81	18.66	23.11	22.79	22.53	22.23	21.36	20.34	19.93	19.29
2	OUTFLOWS											
2.1	Investment in Fixed Assets	38.70										
2.2	Investment Working Capital	2.61										
2.3	Interest		7.11	6.84	6.28	5.73	5.18	4.62	4.07	3.52	2.96	2.69
2.4	Total Outflows	- 41.31	7.11	6.84	6.28	5.73	5.18	4.62	4.07	3.52	2.96	2.69
3	Net Cash flow	-41.31	5.69	11.82	16.83	17.06	17.35	17.60	17.29	16.82	16.97	16.60

Internal Rate of Return (IRR) 29.73%

Net Present Value (NPV) at 13% Nu.37.2 Millions

Project Viability: - The Internal Rate of Return of the project is estimated at 29.73%, which is significantly higher than the bank return rate of 13%.Hence, the project is deemed financially viable. The NPV of the project is positive (Nu. 37.2Million) at a discount factor of 13% during the first 10 years 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. This also indicates that the project is financially viable over the long term.

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