Contract Number:	GBTI II Task Order No.EEM-4-07-07-00008-00
Contractor Name:	Chemonics International Inc
USAID Technical Office:	Office of Economic Opportunities, USAID Pakistan
Date of Report:	August 30, 2010
Document Title:	Dried Mango Production (FINAL)
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SOW Title and Work Plan Acton	USAID Pakistan FIRMS Project Dried Mango Production Private Sector Development Component Action ID No. 2116

Data Page

Name of Component: Private Sector Development

Author: Edward J. Valentine

Practice Area: Processing Industry

Keywords:

Dried Mango, Dryer, PCSIR, Nawazabad Farms, pretreatments, meta bisulfite, blanching, marketing strategy, GlobalGAP, market research, processing facility, packaging, exports, international trade potential, gender integration, feasibility study, drying technology, processing, standards,

ABSTRACT

The opportunity to utilize more mangoes and eliminate waste exists by developing an industry around the dried mango. Availability of mangoes for drying will not be a limitation. The opportunities for absorbing Pakistan dried mango production exist both domestically and internationally. There is currently no competition domestically as no one is producing a dried mango for the domestic market and virtually none are imported. Although the international market is dominated by the Philippine product, it is a growing market and there is room for another supplier of a quality mango. In Pakistan, the farms are large, several are GlobalGAP certified, and more are either applying for certification or are following the required procedures. This certification eliminates one of the main obstacles to export. As the processors for the dried will be starting from the ground up, food safety requirements will be built into the processing units at startup, eliminating another obstacle to export. Fresh mango exports from Pakistan are in their infancy and are an introductory ground breaking opportunity for the familiarization of foreign markets with other mango products from Pakistan including the dried mango. The US is the largest importer of dried mangoes and is a target market. That market can be accessed through well established retail chains and through promotional interchange at food shows and other venues. The same is true of the EU markets, Japan and the Middle East. In the already mature fresh mango market in Pakistan, the addition of a new product, the dried mango, will generate export earnings for Pakistan, additional revenue for processors of dried mangoes and create jobs, especially for women.

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Executive Summary

Mango production n Pakistan is about 1.8 million tons per year. Of that amount, somewhere between 20% and 40% is wasted, either due to poor handling and harvesting practices or to market gluts at certain periods during the mango season that result in spoilage. It is estimated that through improved handling and harvesting practices, about half of that wastage is salvageable or at least 180,000 tons per year. It is assumed that this is the maximum amount for processing as value added products, of which dried mangoes are only a small percentage. Availability of mangoes for drying is not an obstacle in the foreseeable future to meet sales both domestically and internationally.

A few numbers of farms are certified as GlobalGAP producers or are following the GlobalGAP regulations on traceability and harvesting practices. These farms form the core units for initial production and for emulation by others. The process flow is detailed and one of the critical elements, the pretreatment of the mango before drying to preserve color, was developed through testing various hypotheses. Finally, two methods proved to have market viability. These were the placing of the mango slices in a 1% sodium Meta bisulfite solution for five minutes and then placing on trays for drying. The second method was to blanch the whole mango before peeling in 60 degree hot water for three to five minutes. This method may not preserve color for long, but there is a market for dried mango without additives of any sort among the health conscious or those with an allergy to sulfur.

There are many preconceived ideas about drying technology that have no basis in fact. Choice of drier does impact quality, energy costs, drying time and manpower requirements. Among the dryer choices--solar, cabinet, tunnel dryers and continuous belt dryers--the cabinet dryer seems to be the most popular, but the least desirable. It does not dry the product uniformly. Any of the other types are a better choice, but the solar dryer is not suitable for Pakistan because the mango season overlaps with the rainy season. Although the sunshine is available during the rainy season, it is not there consistently enough and intermittent drying causes deterioration in quality and may result in some rotting of the fruit. Both the tunnel dryer and the continuous belt dryer meet the criteria of even drying with the least expenditure of energy and manpower. There are some cabinet dryers that give satisfactory results. These dryers are imports from the US and are manufactured by a company that has been in the dryer business for many years. Their capacity is high compared to the single stack trays that characterize most of the Pakistani made dryers, and rather than buy 20 or 30 of these small dryers, it is better to purchase a large cabinet dryer from an experienced manufacturer at roughly the same price as multiple small cabinet dryers of equivalent capacity.

For the processors that already have the washing, sorting and grading equipment in place for the fresh mango processing, it is recommended that they build their own tunnel dryer. Enough

information is contained in this report to successfully build one. The initial capacity is recommended at one ton per day of fresh mango with an expected output of 100 to 125 kg of dried product. Drying time for a one centimeter thick slice is about six hours, but may vary depending on air velocity, temperature and humidity of the air in the dryer. The Philippine mango is dried to 15 % moisture or less and 15 degrees Brix. The Pakistan mango will be dried to the same moisture content because that is a food safety issue. The Brix is higher for the Pakistani mango and, because it is natural, differentiates the mango from the Philippine product for many people it is a better tasting mango.

The cost study using Pakistan inputs shows considerable profitability in the dried mango business. Profit opportunity is the primary incentive to encourage entry into this industry. Profit is possible only if the product can be sold. A marketing strategy is outlined for both the domestic and international markets. It entails efforts both to obtain shelf space and to promote the product to potential consumers. Packaging and labeling are both integral to any marketing effort. Because of their importance, it is recommended that a market research firm be employed to assist with these critical parameters. Promotional activities such as taste panels, food shows, free samples and other established techniques should be used. To avoid wasting effort and to keep focused, it is recommended that a consultant with extensive marketing experience be hired to guide this process.

Although cultural barriers exist in some industries against hiring women, the mango preparation area should not be one of them. Essentially, the preparation of mangoes is seasonal and resembles ordinary kitchen activities. Because of its seasonal nature, it is an opportunity for the employer to retain an experienced work force from season to season by hiring the same women which would be primarily housewives that want to supplement family income, but are not mobile in searching for work. The same women could be used for drying other products when mangoes were not in season. That would give them a break between seasons.

The dried mango industry appears to be profitable enough to encourage participation by the mango growers and others who are interested in the processing industry. Drying the mangoes is the easy part. It will take much effort to develop a market to serve fully the industry potential.

Introduction

Pakistan produces between 1.7 and 1.8 million tons of mangoes per year for which estimates of wastage range from 20% to 40% with some as high as 60%. Much of this wastage is attributable to poor growing, harvesting and handling practices, but a narrow marketing base and lack of processing facilities is a contributing factor. This study addresses some of the obstacles encountered in marketing and processing and suggests that the addition of a new product, dried mangoes, may contribute to reducing wastage and increasing revenue for the mango grower. There currently exist a small number of plants that produce pulp, the basis for juice, nectar, jam and ingredients for confectionaries. These plants only make a small dent in the amount of recoverable wastage, i.e. wastage that occurs because of too small a market base to absorb the mango production and the spoilage that occurs because of the poor handling, harvesting and marketing practices. The capital investment required to establish a pulping plant is in excess of half a million Euros, depending on the capacity, seriously limiting the number of plants. In addition, pulp is an intermediate product and absorption of production depends on the establishment of juice, nectar, jam, confectionary and other users of the pulp. Dried mangoes, on the other hand, are an end product with shelf life of about one year, and the utilization of the final product depends on the marketability of a standalone product. The drying of mangoes is an opportunity to utilize some of the mango production profitably and reduce these losses.

Pickled mangoes are not a factor in evaluating the processed mango industry. Pickled mangoes are produced primarily from ground fruit resulting from wind and hail. These mangoes are not suitable for drying, fresh market or for processing into pulp.

There currently is only one known producer of dried mangoes and that person only has the capacity to produce about 3 to 5 kg per day of dried mangoes. In this study, the possibilities of establishing dried mango production facilities throughout the growing areas of Singh and Punjab will be addressed. Such facilities require minimal capital investment compared to other processing plants, and because of the nature of the work, peeling, pitting and slicing the mangoes, it will be a substantial employment opportunity for women.

The success of this endeavor depends on its economic feasibility. In discussions with growers, it became apparent that there is interest in developing an additional revenue stream for their mango production that is also profitable.

Marketing the final product is the primary obstacle to establishing an industry in Pakistan. The export market is well established with successful exporters from the Philippines, Mexico, Thailand and several other countries. This study will examine the volume, value and growth of these exports and target those importing countries that seem to present the best opportunities for market penetration.

There may be a domestic market for the dried product, but currently none exists. Without a base line for estimating the marketability of a new product, there is no way to measure success or failure. The Pakistani's love of mangoes suggests that there is a market during the off season for fresh mangoes, but this market may be limited. The dried mango is relatively expensive when compared to other dried fruit because of the high drying ratio of 12 to 01 or even 15 to 01. This study will estimate the domestic market price for the dried mango that is profitable for the processor and suggest steps that may be taken to develop a domestic market. The market research necessary for developing a realistic estimate of the size of the domestic market for dried mangoes is left for another project.

Objective

The purpose of this study is to determine the feasibility of establishing a profitable and flourishing dried mango industry in Pakistan in order to increase revenues for growers and to reduce losses through increased use of the fresh mango.

Mango Supply

If the development of the dried mango industry is to be successful, it is necessary to penetrate the markets of the importing countries of the US, EU, the Middle East and probably Japan.

For purposes of this study, the regulations established under Codex Alimentarius for dried fruit (Annex I) will be the standards that will apply. These standards apply to most of the EU countries and are similar to standards acceptable to the US and Japan.

There is a dried fruit industry in Pakistan, but no significant production of dried mangoes. One grower is processing enough mangoes to produce up to 3 to 5 kg of dried product per day. Some of the research institutes are developing capabilities to start testing for dried mangoes, but this research is in its infancy and is not likely to produce commercial applications for a few years. This study is intended to jump start the dried mango industry.

Mangoes from GlobalGAP certified farms and other farms that observe good harvesting and handling practices are eligible for this project. The GlobalGAP requirement is in compliance with the regulations of the EU countries and covers traceability and food safety. In the near future, it also appears that the US will tighten their requirement for traceability. Although the requirement for GlobalGAP certification limits the number of farms eligible to supply mangoes for the EU, there are other countries that insist on food safety and traceability, but not necessarily GlobalGAP certification. Certification is recommended and the number of farms seeking certification is increasing, but it is not mandatory. However, good harvesting and handling practices are mandatory.

For food safety and mango quality reasons, ground fruit is not acceptable. The mango is a very delicate fruit and dropping to the ground bruises the fruit even though the bruise is not immediately visible. With the introduction of GlobalGAP, the harvesting techniques will change. The cutting of the mango from the tree using scissors on a pole and catching the mango in a net is the only acceptable practice for the drying industry that is going to be built initially around exports. Also the packing of mangoes in wooden crates is a waste of time and money for the processor who wants the loose mangoes for grading, sorting and washing before beginning the process. In the future, growers who want to serve the drying industry must pack the mangoes in the field in plastic crates. Some growers who operate their own packing house already use these crates for delivery to the packing house.

These crates hold about 25 kg of mangoes and are stackable, washable and reusable. These crates allow free air flow throughout a full crate of fruit. The mangoes do not incur any significant damage transported in these crates compared to the wooden crates and the handling cost is reduced considerably as is the damage to the fruit from packing in the wooden crates.

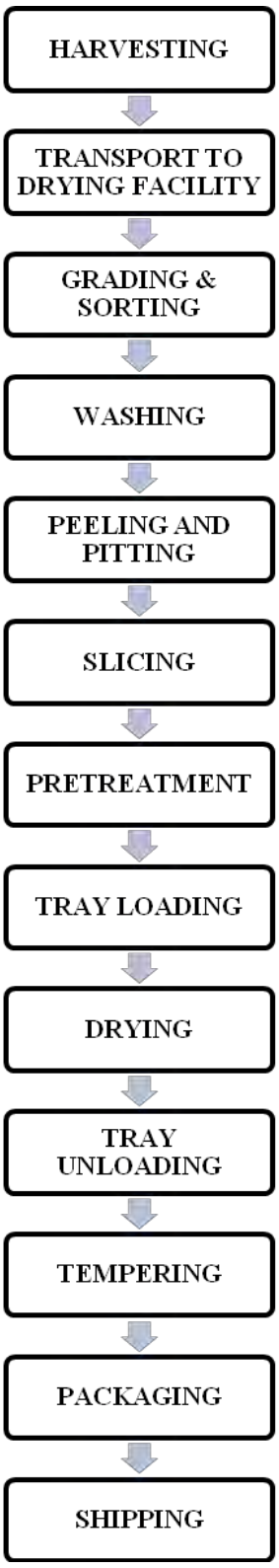
The net effect of these changes in the growing, harvesting and handling of the mangoes is a reduction in the number of growers supplying the processors, but less wastage. Growers who are already following these recommendations experience about 20% wastage because of oversize, undersize, and irregular shapes. There is also some wastage because of the short shelf life of the mango combined with oversupply in the market for fresh. Diseased, rotting or badly bruised fruit is not suitable for drying.

Supply of raw material is not considered an obstacle to growth. It is unlikely that the drying industry will cause any reduction in fresh market sales because the price of fruit for the fresh market is too expensive to justify using that fruit for drying. Any surplus from the fresh market would have to be dumped at an acceptable price for the value added industry to purchase. An acceptable price is the maximum established by the processor to meet profit targets. In the domestic market there is some flexibility in setting sales price as there is no outside competition. Some variations in raw material costs can be compensated by passing through the raw material costs, although with a price elastic product such as dried mangoes, this flexibility is limited. In the export markets, competition from foreign producers sets limits on the sell price that in turn limit the processors leeway in passing through increases in the cost of raw material. At the retail level, it is a classic case of supply and demand determining sell price on a product that is probably rather price elastic, especially since there are so many substitute dried fruit products on the same shelves as the dried mangoes. Sales are influenced by retail sale price, quality, and availability (shelf space). The processor as a price taker has almost no influence on retail price. Profitability is determined through good procurement practices and strict cost control at the processing level.

Drying Requirement

Initially, those growers who have or are in the process of establishing on farm processing facilities for fresh mangoes offer the most promise for becoming dryers of mangoes, but other food processors and entrepreneurs should also be encouraged to enter the mango drying business. In any case, mangoes for this business should be procured from those growers who are GlobalGAP certified or are in the process of obtaining certification. These are the growers that do their own harvesting and do not rely on third parties. This control enables them or those who purchase from them to meet the traceability and food safety requirements of the EU and other importing countries. Those growers, processors and entrepreneurs who have experience in export markets have knowledge of the distribution channels and marketing costs associated with export. Others may have strengths in the domestic market that can assist in introducing a new product. This study will demonstrate whether or not the revenue stream generated by drying mangoes justifies the investment required to enter the market.

Process Flow Diagram



Process Description

Harvesting:

Harvesting is accomplished on qualified farms using a scissors on a pole to cut the stem of the mango and a net to catch the mango so that it does not touch the ground. No ground fruit is to be included in the harvest for drying. The harvested fruit is collected in clean plastic containers that are well ventilated, stackable and reusable and hold about 25 kg of fruit.

Transport to drying facility:

The crates of mangoes are stacked onto a motorized conveyance for transport to the processing facility. Donkeys or other animals should not be used to haul the mangoes to the processing facility because they will deposit animal waste in the orchard and near the processing facility, contributing to unsanitary conditions. At the processing facility, the crates are off loaded and placed in the raw material receiving area.

Grading and Sorting:

From the washer, the fruit is dried and conveyed onto a stainless steel grading table or a roller conveyor and sorted into three categories--fresh market, drying and waste. The main criteria for dividing the mangoes into different categories are size, appearance and degree of ripeness. Marks on the peel are acceptable for drying since the mangoes will be peeled. The mangoes for drying can be of any size. Mangoes those are too small for drying as a slice may be dried as scraps for the cereal or confectionary industry. Mangoes not ripe enough for either the fresh market or for drying are sent to the ripening room until they are ready for processing. Mangoes that are fully mature are generally not suitable for drying because they are too slippery and hard to handle. The mangoes for drying must be firm to the touch and free of physical defects. Mangoes with insect damage or bruises are not acceptable for drying. After dumping the contents, crates must be thoroughly washed with a light detergent followed by a rinse with fresh water. A high pressure sprayer is recommended for this function.

Washing:

The crates are emptied into the washer. The washer is either a stainless steel or plastic tub equipped with drains and running water feeding directly into the tub. The water in the washing tub must be kept clean at all times. Keep the drain partially open for water to run out and let fresh water run into the tank during the washing procedure. The rate of water replacement should be about 10% per hour.

Peeling:

This operation may be automated, but at a cost of over $100,000, it is not considered practical and is not recommended. The mangoes graded out for drying are delivered to stainless steel tables approximately 1 m x 2m. Each table has six employees, preferably women, peeling mangoes at the rate of 35 pieces per hour per worker based on an average mango size of 300 grams. The peeled mangoes are placed in a clean plastic crate and delivered to another stainless steel table of the same size for slicing. The workers at this function wear latex gloves.

Pitting and Slicing:

It is estimated that four women wearing latex gloves can manually pit and slice the output of eight peelers. Each mango will produce 4 full slices of about 1 cm thickness plus two half slices of about 1 cm thickness. This production entails cutting 2 slices on each side of the mango parallel to the pit and 1 half slice on each narrow side of the pit. There will be considerable flesh left on the pit. This flesh may be recovered in a finisher as pulp. The estimated recovery is about 4% of the weight of the fresh mangoes before peeling[1]. The peel is suitable as cattle feed or for composting. The pit can be used for oil extraction if there is a facility nearby.

Pretreatment:

Several pretreatment methods were tested at PCSIR. The 2 methods which were acceptable, i.e. prevented excessive browning of the product when exposed to air over a one week period, were blanching and treatment with a solution of 1% sodium meta bisulfite. Both methods are applicable to the dried mango industry. Blanching is suitable for either an organic product or for a sulfur free product. The meta bisulfite solution is suitable for all other. The end product is different. The blanched and sulfured product retains its original sweetness. The recommendation from the test program is revised to blanching the whole unpeeled mango in 50 degree hot water for three to five minutes. After sample results, it is recommended that the temperature should be around 85 degrees for blanching.

[1] PCSIR report , phase I sample tests. Attached at Annex VI

Additional research is required on this procedure. In general, steam blanching is preferred, but the capital cost for a boiler is probably not justified for seasonal use at relatively low rates of production. The sulfured product is soaked in a 1% potassium meta bisulfite solution for five minutes. The original test also added ascorbic acid to the solution, but results from Nawazabad Farms suggest that the ascorbic acid may not be necessary. Again, additional testing is desirable.

Tray loading:

The ratio of one pitter to two peelers is excessive as the slicer and pitter will have some excess time on their hands. Therefore, any idle time for the slicing operation can be used to assist in peeling. Also, the women assigned to slicing the mangoes will have sufficient time to load the trays. All persons must wear latex gloves. Hair nets are advisable for women without scarf coverings for their hair. Trays should be placed at working height at the end of the stainless steel table used for the pitting/slicing operation. The women assigned to the task of placing the mangoes on trays will gather the slices and place them uniformly on the trays.

The mangoes slices should be touching one another on the trays. Space between them will occur soon after the drying begins. The trays must be food grade material. A food grade plastic such as teflon is the ideal. Stainless steel is also acceptable, but the drying must be watched more carefully as the stainless steel retains heat and can cause overheating. Trays should have perforations of about 1 cm spaced at about 2 cm to allow for hot air to circulate through the trays. To prevent sticking and to make tray cleanup easier, it is recommended the trays be covered with a teflon or nylon mesh cloth before loading the trays with sliced mangoes.

Drying:

Selecting the right dryer is critical. The dryer must have even air flow throughout to prevent uneven drying both of the different trays and on the same tray. Uneven drying will result in both excess labor in managing the dryer and in unnecessary energy consumption in separating the product that is dry and continuing to dry the product that is not yet dry. A technical discussion of dryer options is included later in this report.

Tray unloading:
The dried mangoes should be scraped from the trays and deposited in clean plastic crates lined with polyethylene or in polyethylene bags. To prevent sticking together of the dried mangoes it may be necessary to sprinkle them with powdered sugar. Trays must be cleaned immediately after use. A brush with water and detergent will remove any encrusted or sticky sugar residues. The high pressure sprayer used for cleaning the crates may also be used on the trays. The teflon mesh covers, if used, must be soaked in a detergent solution and then rinsed in fresh water.

Tempering:

Leave the dried mangoes in these plastic containers for three to five days to allow equalization of moisture through osmotic action. Cover the containers with plastic to limit the amount of exposure to air. Even though treated, the mango will oxidize over time. At this point the mangoes should have a moisture content of about 15%. 15% seems to be the food safety threshold for a safe water availability level. Through experience, the persons working with the dryer can determine moisture content within a percentage or two by feel. The dried mangoes should be pliable with a slight leathery feel when the moisture level is right. The mango slices should be tested in the lab for water availability to insure that it is low enough not to promote microbial growth. Note that water availability and moisture level are different measurements. Water availability is a technical term that describes the water vapor pressure of pure water at a given temperature divided by the water vapor pressure of the product at the same temperature. Engineering handbooks have tables listing the vapor pressure of pure water at various temperatures. Instrumentation is available for measuring water availability directly without drawn out lab procedures.

Shipping:

Product may either be packaged for retail or for bulk. Initially, it is expected that order volume will be small. For bulk packaging, the container size is usually 20 kg consisting of four 5 kg heat sealed polyethylene packages in a corrugated cardboard carton. This requirement will vary depending on the needs of the customer. The packaging should be done on stainless steel tables by ladies wearing latex gloves and using scales for the filling of each container. The number of ladies employed in this operation will vary with the order frequency and size. Retail packaging is done to order and the package size will vary. Most dried fruit is packaged in 250gm or 500gm packages. Again, packaging is manual using scales and table top heat sealing equipment. Initially, labeling can be done by pasting labels to the weighed and sealed packages. When the business develops to the extent that some automation is desirable, form, fill and seal machines with labels pre-printed on rolls of packaging material can be used. The retail packages are then placed in corrugated cardboard boxes of about 20 kg. For both retail and bulk packaging, the boxes are sealed and placed on pallets. The full pallets are then either strapped with steel bands or wrapped in polyethylene to prevent the boxes from spilling during shipment. All boxes and packages in

each box must be labeled in accordance with the importing countries legal requirements. Annex II contains an illustration of the labeling and packaging used for the Philippine mango that meets the labeling requirements in the US. The EU requirements are similar. The marketing portion of the label includes the logo. It is recommended that a graphic designer, possibly a grad student from one of the universities, be hired to submit label and logo designs for approval. This can be done by the advertising company as well. The graphic designer, working in conjunction with an advertising firm, could include some good buzz words about how great the Pakistan mango is.

Drying Technology

There are several different methods of drying. All of them are subject to the four principles of drying to varying degrees of control. These are time, temperature, humidity and air velocity. The basic designs of solar dryers, tunnel dryers, cabinet dryers and continuous belt dryers are briefly explained below. Sun drying requires no special equipment and time is the only controllable input. All else depends on the weather. Sun drying is not recommended in most cases because of the unsanitary conditions. The product is exposed to the elements throughout the drying process which is usually several days long.

For solar drying, there are two basic designs. In the first case, there is direct solar heating in which the product is on tables or conveyors under glass or solar panels. To control humidity, there is usually an air inlet at one end with a fan bringing fresh air from the outside and moving it across the product. An exhaust opening at the other end allows the humid air to escape. Some solar dryers are equipped with black coverings over part of the system to increase the heat buildup inside the dryer or to insulate the drier against heat loss after the sun goes down. The management control over humidity, temperature and air velocity is limited which also limits control over the residence time in the dryer, but the operating cost is minimal. The only energy cost is the small fan for controlling the humidity and air flow inside the drier.

Another version of the solar drier is to install a plenum with solar panels separate from the drying unit and connected only by an air inlet. From the plenum, the air is circulated over the product and out the exhaust at the other end of the drying unit. The initial cost of this type of unit is more than the other type of solar drier, but gives the operator better control over air flow which influences both humidity and temperature. This type of drier is seldom used because the advantages over the direct sunlight solar dryer do not justify the additional capital investment nor the larger footprint.

Neither type of solar dryer is recommended because the mango drying season runs partially concurrent with the rainy season. The intermittent availability of sunlight is not desirable for drying fruit because it prolongs the drying time and allows for significant periods of time when there is no drying. These breaks will cause some deterioration in product quality due to spoilage.

For small operations, there is a solar dryer which supplements the heat source with a small boiler on cloudy days. This dryer was developed by a Canadian NGO. There is no real life experience to evaluate the merits and demerits of this system. However the cost is minimal--about $5000. Capacity is unknown, but it is small.

There are three basic types of driers that use a man made heat source for the drying energy. These types are cabinet dryers, continuous belt dryers and tunnel dryers. Among these, the cabinet dryer design is least adaptable to efficient drying because of the difficulty in controlling air flow, temperature and humidity. To dry efficiently, the temperature and humidity at all points in the dryer must be nearly the same at all times. Very often the result from a cabinet dryer is uneven drying from the top tray to bottom and within each tray. This result is primarily a function of air flow. Uneven air flow results in uneven humidity and temperature. A competent manufacturer is aware of these pitfalls and through good design and placement of air inlets, outlets, fans and heat source, minimizes the deficiencies normally found in cabinet driers. It is a buyer beware situation. Purchases of this type of dryer are best limited to an experienced manufacturer of dryers who can furnish reliable references.

The continuous belt dryer allows for complete control of the four parameters of drying technology. As the name implies, this dryer is a wide stainless steel belt that runs continuously the length of the drier. The drying area is a totally enclosed cabinet. The width can vary from a little over a meter to several meters. The length is also variable. The variation of length and width of the belt are a function of capacity. There are multiple heat sources along the side of the dryer and each heat source is equipped with a fan that blows the heat across the width of the dryer. The temperature of each heat source is controllable. This type of dryer is the ultimate in control of the drying process, but it is a high capacity system and is expensive. Because of the initial capital expenditure, this type of dryer is seldom used for drying fruit. It is primarily used for drying product to the 5% moisture level, a level not easily achieved in other types of dryers.

The tunnel dryer is often used for the drying of fruit. This type of dryer consists of a plenum for heating the air. This plenum can either be above the drying tunnel or side by side. The two story system is probably less expensive than side by side units and is a smaller footprint. Natural gas is the usual energy source in this type of dryer because the heated air is exposed to the heat source and the heated air will not leave any harmful residues as it blows across the fruit. If residues are a concern, the heat source may be enclosed in a heating tube so that the air is heated indirectly. Some efficiency is lost in this modification of the system.

The heating system is at one end of the plenum. About one third or halfway along the plenum is a high velocity circulating fan capable of moving the air across the fruit a velocity of about 2 m per second. The volume of air between the fan and the heat source must be adequate to allow for heating of the air to the required temperature, usually about 70 degrees, but not so large as to

consume excess energy. The heat source should be thermostatically controlled to maintain a constant temperature of the air. At the far end of the plenum is an air inlet to the tunnel where the fruit is on trays on trolleys. It is at this air inlet that the temperature is measured and controlled.

Air enters the system just behind the heat source. The velocity of the air and the humidity is controlled by varying the opening for the fresh air entering the system or by a variable speed fan. Humidity is measured at the discharge end of the tunnel. Trolleys are placed in the tunnel at equal time intervals. They can either be placed at the hot end of the tunnel or the cool end. The cool end provides for counter-current flow, i.e. the trolleys move in the opposite direction of the air flow. This is the most common method of using the tunnel dryer. Although the drying time is longer, the quality of the end product is better. Concurrent flow results in shorter drying time, but more bleeding and possible caramelization or losses of flavor elements. A complete description of Tunnel dryer is in Annex III.

The choice of technology for mangoes depends on expected throughput. Annex IV contains descriptions of the several types of dryers that are suitable for different capacity operations. Initially, a small capacity dryer is best suited for a startup operation. As the mango season runs partially concurrent with the rainy season, solar drying alone is not a satisfactory choice. The tunnel dryers and continuous belt dryers are for large capacity operations that will meet the expectations of some of the growers. For a startup operation of a small grower with limited financial resources, a hybrid dryer combining a solar system with a heat source that allows drying to continue in spite of a lack of sunshine is a good choice. When the sun is out, this dryer has a solar panel that heats the air that is then distributed by a fan throughout a standard cabinet dryer containing fruit on trays. On cloudy or rainy days, the heat source is a small oil fired boiler. This system is low capacity and requires minimal energy costs and allows for continuous drying throughout the rainy season. Continuous drying is an important requirement for a drying operation. If there is intermittent drying because of a lack of sunshine, there is a possibility of the mango quality deteriorating because of spoilage.

For the medium size operation, a cabinet dryer may be the best choice, but only one that gives relatively even drying and has sufficient capacity to meet the needs of the processor. Buying multiple units of rather inefficient dryer is not a good choice. In the end, they will cost more than a good cabinet dryer. Keep in mind that costs are not only for the equipment, but the energy and manpower consumption as well. Cabinet dryers of the type described in the brochures in Annex IV give relatively even drying compared to other cabinet dryers and have a smaller footprint than multiple units of small cabinet dryers.

Standards

As there is no commercial dried mango industry in Pakistan, there are no standards for the dried product. The Philippines has published standards for the dried mango. Attached is Annex V, Draft of Philippine Standards for Dried Mangoes. These standards have served the Philippine dried mango industry well, allowing them to consolidate production with consistent quality standards from multiple sources and export it all over the world. It is recommended that Pakistan develop standards for the dried mango industry patterned after the Philippine example.

Comparative Characteristics with the Market Leader, Philippines*

Characteristics	Philippines	Pakistan Chaunsa
Moisture Content	20.34% (15 % Philippines mango standard requirement)	14.86%
Brix Level	70	70
Color	Yellow to Yellow Orange	Yellow to Yellow Orange
Sulfur Residue	6.4 ppm Less than 300 ppm - Philippines mango standard requirment	35.2 ppm
Texture	Firm and Gummy	Firm and Gummy

***** The comparison of dried mango characteristics reflects results derived from PCSIR Test reports. PCSIR reports are attached as Annexure VI.

Cost/ Revenue Study

This cost/revenue study is based on results of testing conducted at PCSIR for FIRMS and observations during a visit to Nawazabad farm.

Dried mango sample testing was conducted at PCSIR Lahore. The primary purpose of the testing was to compare various methods of pretreatment to preserve the color of the mango. Chaunsa was the only variety used for phase I test. Additionally, yields of peel, pit and slices were measured and recorded. The time for peeling and slicing was also recorded. This function was performed by relatively inexperienced personnel and the times may be excessive compared to Nawazabad Farms. To evaluate the quality of the final product, two thicknesses of mango were tested - one centimeter and two centimeter. The two centimeter slice is no longer under consideration because the final product is too thick and the slices do not dry evenly, probably because the fresh slices are not uniform. The same may be said of the one centimeter slices, but tempering for several days will compensate for the differences in moisture content among the slices. See Annex 7 for complete test procedures and results.

Nawazabad Farms is the only known farm in Pakistan that is drying mangoes somewhat commercially. All of their production is purchased by a German company that specifies the drying procedures for the Farm. The purpose of Nawazabad drying facility visit was to determine how the mango is pretreated to preserve color. It was noted that the color was good for all the varieties in stock. Another purpose was to observe and record the time involved for experienced personnel to peel and slice the mangoes. The farm only produced one centimeter fresh slices for drying. Although this thickness is not maintained through a cutter, and fresh slices do vary in thickness. A final purpose was to record the yields of fresh mango slices, peel and pits and to determine the loading of the trays and the final yield of dried mango.

The Farm processes several varieties of mangoes, but keeps the final product separate in 250 gram transparent plastic bags marked with the variety name. There is no quality control at the Farm. All processing is done by rote in accordance with the procedures mandated by the German importer, namely the slice thickness, the pretreatment and the drying time and temperature. The processor does not test for moisture level and Brix of the final product. Three varieties of dried mango were collected from the farm to test moisture and Brix level, and sulfur content.

After Nawazabad Farms purchases 20 dryer for the 2011 production year, as informed by the manager Nawazabad farms, they will be able to process about 1.5 to 2.0 tons of mangoes per day. This estimate is based on 20 dryers of 25 trays each and a loading capacity of 1.61 kg of fresh mango slices per tray. The capacity of the 20 dryers is 800 kg of fresh slices. The fresh slice drying ratio is about 4:1, or a 25% yield of dried mango from a fresh slice. Therefore total

production is about 200kg per day of dried mangoes. The yield of fresh slices from 50 kg of raw mangoes was 21 kg from which the yield of dried mangoes was 5.1 kg for a total yield of about 10% based on fresh. At PCISR, yield was about 49% from 40kg of mango. At a drying ratio of 4:1, the final yield of dried mangoes is 4.9 kg or a yield of about 12%. The Nawazabad results are considered more significant and form the basis for this cost study. At Nawazabad the product was consistently dry. The PCSIR product appeared to have much higher moisture content than Nawazabad product, especially the 2 centimeter thick slices. Peel thickness of the Chaunsa is very thin compared to the Sensation variety processed at Nawazabad Farms. This partially accounts for the differences in yield between Nawazabad and PCSIR. Also the mangoes at Nawazabad were smaller than the Chaunsa processed at PCSIR. The larger mango has a higher flesh to pit and peel ratio than smaller mangoes, so the yield will be higher. This study is based on a conservative yield of 11.25%.

Initial production of 100 to 150 kg per day of dried mangoes at a 10% to 12% yield requires about 1 tons per day of fresh mangoes. Assuming a pit and peel waste of about 50%, the fresh mango slices are about 500 kg. At a drying ratio of 4:1, the dried product is 125 kg per day. These numbers may vary depending on the variety of mango. At a tray loading of 16 kg per square meter of slices, about 31 square meters of tray space is required for 500 kg of slices. It is suggested that a tunnel dryer that can hold five trolleys each with 15 trays, 1m x 1m, be built on site. There is enough excess tray capacity to allow variations in yield due to variety differences. The tunnel design is described in detail in ANNEX III.

At 300 gm per mango and a peeling rate of 35 mangoes per person per hour and allowing for fatigue, the effective work day is 6 hours. Each peeler processes about 80 kg per day. For 1000 kg, estimate that 12 peelers are required. At a ratio of 2 peelers to one slicer, 6 slicers are required. The slicers will have excess time and can assist the peelers. In addition, one person is required to manage the drier. Intermittent drying is not permissible. Once a trolley is fully loaded, it is placed in the tunnel and remains there until the mangoes are dried, probably about 6 hours. The manager of the drying tunnel will start work later and work later than other persons involved in this function.

When the last trolley of mangoes is dry, the manager will leave them outside the tunnel to cool. The next morning, the packaging crew will unload the trays and place the dried mangoes in plastic crates for tempering. Those mangoes that are already tempered are then dumped on stainless steel tables, weighed and filled in polyethylene packages with 5 kg of mangoes. Before packaging, the dried mango slices may be pressed flat between two rollers if it is felt necessary to improve appearance. Each bag is then heat sealed and placed 4 each in corrugated cardboard cartons. The cartons are labeled with mango variety, date packaged and weight as well as any marketing information required by the buyer. Normally, supplier name, address and contact, either phone number or email address, plus date produced and use-by date are sufficient. The cartons are

palletized. When the pallet is full, about 25 cartons, it is either strapped or wound with polyethylene plastic to prevent the cartons from spilling during shipping. There are only about 5 to 6 cartons prepared per day. Two persons can do this job, including the palletizing of the cartons, in about 4 hours. A manual hydraulic lift is used to move the pallets around and to load them on trucks for transport.

For purposes of this cost/revenue study, the following assumptions apply:

- Cost of raw material: 15 Rs per KG
- Cost of Harvesting, Handling and Transport to Processing Center: 10% of raw material cost: 1.5 Rs per KG
- Cost of Unskilled Labor: 7000 Rs per month which is the minimum wage
- Administrative and Overhead Costs: 10% of direct labor costs
- Electrical Consumption @ 6.73Rs per KWH.
- Gas Consumption@ 452 Rs per 10 Therms
- Packaging Materials: 20 Rs per 20 KG packed
- Pallet Costs: 1000 Rs per 25 cartons packed (each carton 20 Kg)
- Yield: 100 kg of dried mangoes per ton of raw material
- Sale Price: 600 Rs per KG, FOB (export market)
- Sale Price: 400 Rs per Kg, FOB (domestic market)
- Market size/share: 70% export, 30 % domestic
- Unskilled labor per farm: 21 person

Annex VII gives a three year projection of the total industry based on the following assumptions. In year one, ten farms are selected for processing one ton per day each. In Year two, these same ten farms increase production to 2 tons per day. In year three, five additional farms are selected to

process two tons per day, for a total of 15 farms processing 2 tons per day each for a total processing rate of 30 tons per day of raw material. The total output in year three of dried mangoes is 3 tons per day. Operating costs as a percentage of total sales revenue are projected as 50.17%. Net profit before taxes is projected 23.53%. Foreign exchange earnings are estimated as 0.5 million for year 1. These projections are subject to adjustment either up or down depending on the success of the marketing program. The increase in production from one ton to two tons per day of raw material does not require any additional capital investment if tunnel dryers are built to specifications provided. The farms that will be selected for this program are already participating in the fresh mango program and have or are in the process of obtaining GlobalGAP certification.

Annex VIII gives three year projections of per farm based on the same assumptions mentioned above.

Capital Costs for Various Dryers (Descriptive Brochures in Annex IV)

Cabinet Dryer, Complete, US
Capacity 1 ton fresh mango slices. **$131,700**[2]
Electrical Load: 10.26 kw/hr
Heat Load: 400,000 BTU's

Continuous Belt Drier, China
Capacity, 250 kg of fresh mango slices **$38,000**[3]
Electrical Load: Two fans and drive motor
about same as cabinet dryer.
Heat Load: 400kg/hr, steam

Tunnel Dryer, Local construction,
Capacity, 3 ton of fresh mango **$15,000**[4]
Electrical Load: 10 kw/hr
Heat Load: 600,000 BTU's

Cabinet Dryer, Complete, US **$87,000**[5]
Capacity: 120 kg of fresh mango
Electrical Load: 5.6 kw/hr

[2] Expensive, but probably less cost than Nawazabad Farms cost for 20 dryers with a total capacity about the same. Source is an experienced dryer manufacturer who understands the pitfalls of cabinet drying. A very good machine
[3] Capacity is estimated. Depends on belt speed and drying time/temperature. Boiler required. Allow another $10,000 for the boiler.
[4] Cost is estimated based on Pakistan construction costs. See Annex III for a complete description of tunnel operation and a pictorial showing construction.
5 Same manufacturer as the more expensive cabinet dryer.

Heat Load: 160,000 BTU's

Cabinet Dryer, Complete, US **$12,000**
Capacity: 50 kg of fresh mango
Electrical Load: 65 kw/hr
Heat Load: 3,520 watts

Solar/Hot Air dryer **$6000**[6]
Capacity: 40 kg
Heat Load: Varies, depending on weather.

Each dryer has desirable characteristics. The belt dryer is expensive, but suitable for any operator that can afford it. It is especially suitable for someone who plans to dehydrate vegetables during the mango off season and needs product dried to the 5% moisture level. The solar hybrid is good for a small farmer with minimum capital. The small cabinet dryer is good for a small farmer who has sufficient capital to afford it and who wants to have ease of operation and management. The other two cabinet dryers are for larger enterprises that want ease of management and operation. As these cabinet dryers are sold complete, installation is also easy. A complete description of these dryers with pictures is contained in Annex IV.The homemade tunnel dryer is a high capacity unit that is constructed on sight. As it is a continuous type of dryer, the operation requires continuous attention. The capacity can be easily increased by making the tunnel longer and wider. The tunnel dryer is the ideal choice for the large commercial operation and is recommended. See Annex III for details.

6 This is a hybrid dryer that is solar operated, but without sun, it has a boiler attached for hot air drying.

Marketing Strategy - Domestic Market

A domestic market for dried mangoes does not exist. To introduce this product to market requires two major activities and several minor activities in connection with the primary activity. The primary activities must take place simultaneously. These are promotion to introduce the new product to potential consumers and shelf space to make the new product readily available to potential consumers.

The supporting activities to implement a new product are varied in type and scope. Perhaps some of the more successful activities may result from thinking outside of the box. The basics do not change. The potential market must be defined on paper. Because of the high retail price of the dried mango--800 to 1000 rupees per kg--the upper middle income neighborhoods of the large cities are the target markets. Once these neighborhoods are identified, stores within that neighborhood must be identified. These stores should be in areas of high foot traffic or those with large crowded parking areas for grocery shoppers. The stores specializing in the sale of dried fruits should also be considered. Initially, identify only five or six stores in one city as potential outlets. Approach these stores not only with samples but with a promotional plan to sell the product. No store is going to sacrifice shelf space for a product that doesn't generate income. Note that in some countries, shelf space for new products come at a price. In the US, that price may be six figures for the super market chains. I do not know the practice in Pakistan, but shelf space is at a premium and one way to acquire space is to pay.

The traditional promotional activities are radio and TV advertising. Note the many ads on TV for food products of various kinds. TV advertising is expensive and is only effective if the product already has wide distribution. For a new product, the effectiveness of such advertising is in doubt. Keep this type of promotion in mind as a future activity.

In store promotion may be the best approach. In identifying stores as potential outlets, obtain agreement to allow in-store promotional activities. Such activities might include but are not limited to the placement of posters showing children, families etc. enjoying the dried mangoes. These posters may be cardboard cutouts placed near the entrance of the store or other prominent place with dried mangoes available within view of the in-store poster. Another promotional activity is passing out free samples somewhere near the sale point of the mangoes. In this case, the sales point should be established for promotional purposes in high traffic area of the store. If the store is in a mall, set up a small sales stand outside of the entrance to the store for selling small sample packages of dried mangoes possibly in conjunction with free samples.

Taste panels are another promotional activity that also provides consumer information on the good and bad points of the product. To identify those persons who have sufficient disposable income to purchase dried mangoes and to gather them together in one area for a tasting is virtually

impossible. It is suggested therefore, that a questionnaire be devised with great care--no leading questions and very simple answers. A marketing consulting firm in Pakistan could help with this requirement. In a high foot traffic area near one of the identified stores, solicit people to taste the mango and fill out the form. Many people will refuse, so this activity takes patience, but it is workable.

There may be other activities that are not mentioned here, but the most important thing is to connect the promotional activities to the sell point of the mangoes and to enlist the cooperation of the store in implementing the promotional activities. After all, it is to the advantage of the store as well as the processor of mangoes to develop a market. One final point, do not start these activities during the fresh mango season. People who like mangoes are not going to buy the dried product if fresh mangoes are available.

Marketing Strategy - International

There is a well established international market for dried mangoes, but it does not include dried mangoes from Pakistan. The FAO is the primary statistical source, but it does not publish statistics for dried fruit, only fresh. The statistical information on market size from the US is good. From the EU and Middle East, it is sketchy. Based on information available, the size of the US market is outlined below.

In 2008, US imports by country were as follows:

Country	US Imports (tons)	US imports by Country (%)
Philippines	1566	45
Thailand	1079	31
Mexico	661	19
Columbia	139	4
Other	35	1
Total	**3480**	**100**

The total value of the imports is estimated at more than $10,000,000. There is not enough information available to estimate market growth, but even without significant growth, the market is large enough to allow for new entries if the price and quality are equal to or superior to other market contenders. The high quality Philippine mango with a Brix of 15 to 18 degrees and moisture content of 16 to 17% is the biggest seller. At a warehouse store such as Costco, Philippine mangoes sell for $10.69 for 850 grams. That is equivalent to a price of $12.57 per kg. Assuming a 30% gross profit, the purchase price is about $9.67 per kg. Packaging costs typically run about 10% for the laminated plastic bags. Handling and transportation charges add another 15% to the processors sell price for a net sale price of about $7.74 per kg. Conservatively, estimate a sell price of 600 Rs per kg.

To gain access to the US market, the same rules apply about acquiring shelf space. In this case, there is already shelf space dedicated to the dried mango. It is not likely that stores will willingly add additional shelf space for the same product. It is necessary to give the store reason to add more shelf space or to displace that product that already occupies the shelf space. The reason may be price, better presentation in the form of appealing packaging or possibly quality although quality of the existing product on the shelf is satisfactory, or it would not be there. It may be necessary to sell product at little or no profit in order to gain market entry.

It may be that cost of the Pakistan mango is low enough to compete although the production costs in the Philippines are also low, so that is a questionable approach. The primary promotional activity in the large warehouse stores such as Costco is giving away free samples. Even well established products such as Starbucks gives away free samples from time to time. The Philippine mangoes are frequently on the free sample list at Costco. It should be noted that these warehouse stores have a nationwide network as well as an international network and represent a significant marketing opportunity to the middle and upper middle class shoppers. The dried mangoes are an expensive product among the dried fruit options and will appeal primarily to those shoppers with sufficient disposable income. Costco is a membership store and most products are sold in relatively large quantities. There are only a minimum number of lower income persons who have membership and those that do, buy staples, not dried mangoes which are a luxury good. In addition to Costco, there is also Sam's Club which is also a nationwide warehouse store that is owned by Wal-Mart and is a direct competitor to Costco.

The large supermarket chains such as Safeway and Krogers are not good prospects. These large chains charge for shelf space and the fees are high. The stores such as Wal-Mart, K-Mart and Target are possibilities. These stores sell groceries on price and compete well with the supermarkets. Gaining shelf space is based on cost and volume of cells. Dried fruit in general is not a high turnover item, but interest should be investigated.

There are other possibilities. Private labeling is perhaps the best opportunity. Stores such as Costco may be interested in selling dry mangoes under their own brand name, Kirkland, which is the home town in Washington State for their headquarters. The Safeway chain of supermarkets also sells under their own name, Safeway, and encompasses several other chains that Safeway owns.

Another possibility for co-packing is Mariani Bros. This company has its own drying facilities, but because of lost sales in the US market due to inroads by the Turks and in an effort to broaden their marketing base, Mariani is packaging various kinds of dried fruit. This company already has shelf space in the warehouse stores and some of the supermarket chains. If they can be encouraged to package mangoes from Pakistan, the sales will be substantial. The same is true for the large co-operative, Sun-Maid. Although they are best known for their raisins, they also sell various dried fruits under their own brand, again in an effort to broaden their marketing base. With the increased competition from abroad, especially Turkey, the dried fruit companies are searching for opportunities to compete. Certainly, dried tropical fruits are an opportunity for them.

Although a small scale sales opportunity, the farmer's market is a possible promotional activity. No special packaging is required. Small polyethylene bags of dried Pakistan mangoes priced at about the retail level can be introduced to the consumer at the many farmers markets around the country. During the summer months, these markets thrive. The opportunity is regional, not nationwide, but a large farmer's market such as the ones in San Francisco or in Santa Monica in California is replicated in many places. Targeting a few of them in high population density regions of the country may be an effective means of promotion. There would have to be retail outlets that handle the Pakistan dried mangoes in the same area as the farmers market in order to increase the effectiveness of the promotion.

Not to be overlooked is the importer/broker. These persons or firms usually operate on a small commission out of an office. The telephone is their main marketing aid. These brokers have their own set of customers which is different than the chain stores or the big box stores that do not rely on middlemen. These persons function in two ways. They can sell in bulk to the small packers who usually represent a number of retailers and package goods for them or they can broker the retail packages directly into the retail chain. The brokers give access to the small independent retailers without the marketing costs associated with trying to market directly.

To take advantage of the marketing opportunities in North America, the dried fruit processors should form an association with the sole responsibility of representing their interests in the North American market. The association would appoint an agent to represent them in the target market. The costs could be shared among the members of the association. The end result is much reduced marketing costs in a price sensitive environment. The ability to compete with the existing suppliers to the North American market would be greatly enhanced.

One of the most effective ways to introduce products is the Food Shows. These are held in Europe, North America and Japan on an annual basis. Among the attendees at these shows are buyers for various organizations as well as independent buyers/ brokers who are looking for sales opportunities for their own accounts. A food show offers wide exposure at a single venue at a minimal cost per contact. These shows are open to the public, but at significant cost. Exhibitors and their invited guests pay little or no admission fee. This policy limits the visitors to these shows to interested parties, not persons looking for the abundance of free samples offered at these shows.

Similar approaches in the EU and Middle East may be effective. The big box stores such as Metro are German based. As they have outlets in Pakistan as well as many of the former Soviet Bloc countries, their marketing reach is long and wide. Ram store, a Turkish owned retail outlet is also strong in the former Soviet Bloc countries and is a good prospect to approach. Although the Turks are a major producer of dried fruits, there are no tropical fruits in Turkey, so dried mangoes would supplement their product line rather than compete. In Dubai, Omaid Bahar is an international distributor of food products that represents Nestle, Wrigley's and other international food companies. The company has been in business for over 100 years. The owner of the company, Mustafa Sadiq (email: hewad90@hotmail.com), lives in Afghanistan, but travels frequently to Pakistan, Dubai and other countries. He supplies several thousand retail outlets. The story is not different for these outlets--shelf space. If the product is on the shelf and the promotional activities are effective, the consumer will buy. If the consumer does not buy, the shelf space will be lost.

Start Up Incentives

Before implementing selling strategies, it is necessary to have something to sell. The analysis of the operating costs of a dried mango operation suggests that the profitability is adequate to make entry into the industry feasible. Drying mangoes offers the opportunity to turn a waste stream into a revenue stream. A three pronged approach is recommended.

In the first case, the large farms with good harvesting and handling practices are ready made for the industry. These farms have their own fresh mango packing facilities and have the washing, grading and sorting equipment in place. With experience and some guidance from the research institutes, the operators of the fresh mango processing facilities can learn to grade out mangoes suitable for drying. A series of stainless steel tables, approximately 1M x 2M, are purchased for the peeling, slicing, pitting and packaging operations. It is recommended that initial production levels be targeted at one ton per day of raw material. For this level of production, a gas operated tunnel dryer is appropriate. Either LPG or natural gas can be used as the heating source. Diesel fuel is not a consideration because it leaves residues on the fruit. A good tunnel dryer is an investment of about $20,000 to $40,000 if imported from the West. From India or China, the cost should be considerably less. The recommendation is to build your own tunnel in accordance with

the drawing and description in Annex III. Stainless steel tables are available locally and the stainless steel knives for peeling and slicing are also available locally. To maintain the one centimeter slice thickness, a stainless steel slicer with a one centimeter wide opening is recommended. Building a covered pole shed to house the peeling, slicing and drying is necessary if a space limitation in the fresh fruit operating facility is an issue.

The pulp processors are also readymade for the industry. They have sources for raw material. The grading, sorting and washing facilities are in place. The finishers to recover pulp from the pit after slicing are in place. In our experiments at PCSIR, this recovery was about 4% of the initial weight of the raw material. For a one ton per day facility, this would be 40 kg of pulp per day. The only investment would be stainless steel tables, stainless steel knives and a dryer. The tunnel dryer is recommended. Tunnel dryer operation is best controlled in an open air environment because of the high volume air intake and discharge. A pole shed adjacent to the pulp processing building is a good choice.

The small and medium size growers should not be overlooked. It is difficult to justify their entry into the industry on a standalone basis because of the capital costs, the land area required for a processing facility and the maintenance of a consistent supply of suitable raw material. To enter the dried fruit industry, the small and medium size growers need to form associations for the purpose of processing mangoes. The advantage of an association is lower costs associated with larger scale, versatility acquired by gaining access to more varieties, less waste because of more processing opportunities, shared cost in making capital expenditures and increased strength in taking advantage of marketing opportunities. It is suggested that an association consider investment in grading, washing and sorting equipment for fresh market mangoes and use the same equipment in preparing mangoes for drying, pulping and cold storage. In other words, and association, over time, would be in a position to make capital investments in pulping, drying, and fresh mango processing. The formation of an association presents another set of problems in gaining agreement among potential members who have to give up some of their own independence and contribute time, money and experience to the organization. It is recommended that a consultant in the area of developing farmer organizations be hired to assist. For the dried mango portion of such an association, one ton per day of fresh is a good starting point.

Market Research

It is not possible to be all things to all people, so the approaches to the markets, both domestic and international, must be focused to gain the most benefit for the money and effort put forth. A market research team consisting of an outside consultant should be hired to offer guidance and professional researchers from a local organization. The outside consultant should be someone with extensive marketing experience, preferably with market entry and market development experience. There are local Pakistani consulting firms that specialize in marketing. Such a firm would be

useful in developing domestic markets through the usual tools of demographic studies, income distribution studies, organization of tasting panels, evaluation of results through questionnaires, design of questionnaires, identification of channels of distribution and methods of distribution.

The local Pakistani marketing consultant may be less useful for the international markets. Much more reliance on the outside consultant is required for the international market. Finding a good agent or broker in the target country may be one solution. Hiring a marketing consultant in the target country is also a solution, but it may be quite expensive. The best solution is working the food shows in target markets. The feedback from these shows provides the information necessary in planning for market entry.

Labeling

The label for retail products is in two sections. One section gives the name and physical address of the processor/producer/distributor, email address, country of origin, net weight of contents, bar code and nutrition of contents. The nutrition portion is prescribed by regulation in the US and EU. It is basically the same for both areas and includes, portion size, number of portions per container and amount of fat, protein, transfatty acids, and carbohydrates. The fat is broken down into polysaturated fats, mono saturated fats and unsaturated fats. Carbohydrates are broken down into sugar and fiber. Samples of the nutrition portion of the label are available in most markets that handle imported foods from either the US or EU.

The marketing portion of the label contains a logo, brand name and some colorful language describing the contents as delicious, good for health etc. Care must be taken not to make any false health claims on the label. Any language used to describe the product should be reviewed by a lawyer familiar with US and EU regulations regarding health or other claims on the label.

Opportunities for Women

The peeling, slicing and pitting of mangoes differs from kitchen work at home only in quantity. Women are ideally suited for this type of work. It follows that the women doing the slicing also place mangoes on trays and place the trays on trolleys. Although the trolleys are heavy, there is no reason that women could not wheel the trolleys to the dryer and place inside. In other countries where there are no cultural barriers to women working full time, this type of work is often relegated to women. Also, it is seasonal work. The housewife may want to supplement family income by assuming a seasonal job that men would rather not pursue. If women have other means of financial support and are not mobile because of family obligations, they will most likely be willing to come back to the job season after season. To the processor, this means no loss of experience when the season ends. This line of thinking applies to other fruits and vegetables that require manual preparation and may be dried in the same facility using the same equipment. The

time off between processing seasons for other fruits and vegetables may also be welcomed by part time women employees. Providing women with intermittent employment is an opportunity not only for the employer, but also for the women.

There are also women who are managing orchards for their husband or other family members or who are sole owners of farms. Among the women interviewed, the interest was high in developing new business. This interest can be directed to areas related directly or indirectly to mango drying. The same standards apply as far as GlobalGap certification or compliance is concerned. There are also women's organizations that can be approached to both stimulate and capitalize on interest in the business of drying mangoes. This interest may be drying, supplying other dryers, processing, packing, shipping, and marketing. There are a number of related jobs connected with the development of a new industry that may be of interest to female entrepreneurs.

Environmental Considerations

It is recommended that the packaging material should be biodegradable. This will serve two-fold benefits. Firstly, biodegradable packaging would be more appealing to environmentally-conscious customers since it will be differentiating the product from competitor products, which are not known to have biodegradable packaging. Secondly, using biodegradable packaging would assist penetration into the US and particularly European market where member countries are promoting environmental friendly products and developments.

The peel and pit waste from the plant is usable. The pits can be run through a finisher to recover any clinging flesh. The recoverable pulp is then used for making jam, confections, juice and other products normally produced from pulp. As the production is small, it may be desirable to make an agreement with a pulp processor to take the pits before removing the pulp or to take the pulp to the pulp plant after it is removed by the dried fruit processor. The pits after the excess flesh is removed are good for producing mango oil. One of the pulp producers used the seeds for planting new trees in his nursery. The peels have a lot of nutritional value because of the pulp that is removed with the peel during the peeling process. The peels are good for cattle feed. As the peels are biodegradable, they may also be used for producing compost to be used as fertilizer.

A further consideration is water conservation. Water is a precious commodity and every effort should be made to conserve water during the processing of mangoes. The areas of concern are washing and cleanup. The water usage during washing of the mangoes can be carefully controlled by limiting the makeup water to 10%. Clean up of trays, the drier and the environment uses relatively large amounts of water. The use of a high pressure sprayer limits water usage. Water is only released for washing purposes when a lever is depressed to allow water flow at high

pressure. When released, the water flow stops. All hoses should also be equipped with a similar device to prevent water from flowing when the hose is not being used for cleaning purposes.

Recommendations

Recommendations have been already incorporated in the relevant sections of the report. Following is the summary of the recommendations presented in the report:

- Target production points with good handling and harvesting practices for initial processing and marketing support built around exports
- Encourage collaboration of entrepreneurs and domestic brokers with primary processors to develop domestic market for the dried mango. Note that the marketing requirements are different than for the export market. The dried mango already is an accepted product on the international market. It is a new product on the domestic market. Acceptance has to be tested and demand met.
- Deliver all fruit to the processing point in plastic crates
- Use only sound fruit for drying, i.e. no diseased, bruised or rotting fruit
- Production points that already have washing, grading, and sorting equipment in place are suitable for initial processing.
- Develop interest among small and medium enterprises that have the financial resources to enter this business or to cooperate with those who do have the resources in supportive roles such as shipping, marketing, packaging, warehousing, and supplying processors or in by products such as, juice, fruit rolls and other products from puree recovered from pits..
- Use only motorized vehicles for transporting mangoes to processing point.
- Follow good sanitation procedures throughout the process using only food grade materials and enforcing personal hygiene standards
- To the extent practical maximize the use of women in the peeling, slicing, pitting and packaging operations
- Use Chaunsa varieties as raw material while available. Substitute Sindri or other high Brix, good color variety when Chaunsa not available.
- Produce two basic products, a brightly colored slice with SO_2 added to preserve color and the blanched mango with no preservatives for the health conscious market.
- Large and medium size processors should plan on one ton of raw material per day and use the tunnel dryers.
- Small processors who dry less than one ton of raw material per day should use the hybrid solar/hot air dryer or a cabinet dryer from an experienced manufacturer.
- Industrial package is four 5kg polyethylene packs in a corrugated cardboard carton or buyer's specifications.
- Retail packages are 250 or 500 gm packs or buyers specification. For market research purpose retail packages should also be available in small packets i.e. 75 to 100 gm.

- All plastic packaging should be biodegradable material.
- Moisture content should be 15% or less for food safety reasons
- Sulfur residues per buyer or importing country's specifications
- Information section of label in accordance with buyer's specifications or importing country's regulations
- Hire graphic designer for assistance in designing label and logo
- Hire consultant for market research in domestic market
- Appoint an agent in each of the major importing area--Japan, EU, US and Middle East--with incentive pay and very restrictive expense controls
- Participate in Food Shows in EU, US, Japan and Middle East.
- Hire consultant to guide small farms in forming associations for processing and marketing.
- Large processors should build own drying tunnels in accordance with instructions in Annex III.
- Control waste disposal and conserve water in accordance with good environmental practices.

ANNEX I

CODEX HYGENIC STANDARDS DRIED FRUIT

ECOMMENDED INTERNATIONAL CODE OF HYGIENIC PRACTICE FOR DRIED FRUITS (CAC/RCP 3-1969)

SECTION I – SCOPE

This code of practice applies to all fruits that have been dried by natural or artificial means or a combination of both. The fruit is dried to the extent that the greater part of the moisture has been removed, and in addition the fruit may be subjected to a safe and appropriate treatment in preparation and packing, to permit marketing in normal trade channels. Fruits covered by this code include apples, apricots, peaches, pears, nectarines, prunes, figs, dates, and vine fruits such as raisins and currants. Fruits other than vine fruits prior to drying, if desired, and applicable for the particular fruit, may be cored, or pitted, sliced, diced, quartered, halved, or otherwise subdivided. This code does not apply to fruits commonly known as "dehydrated fruits" with a moisture content not exceeding 5%.

SECTION II – DEFINITIONS

None considered necessary for this code of practice.

SECTION III - RAW MATERIAL REQUIREMENTS

A. <u>Environmental Sanitation in Growing and Food Production Areas</u>

(1) **Sanitary disposal of human and animal wastes**.

Adequate precaution should be taken to ensure that human and animal wastes are disposed of in such a manner as not to constitute a public health or hygienic hazard and extreme care should be taken to protect the fruit from contamination with these wastes.

(2) **Sanitary quality of irrigation water**.

Water used for irrigation should not constitute a public health hazard to the consumer through the fruit.

(3) **Animal, plant pest and disease control**.

Growing areas should be kept free from rotten or decomposing fruit that is attractive to insects, rodents and birds. Where control measures are undertaken, treatment with chemical, biological or physical agents should be done only in accordance with the recommendations of the appropriate official agency, by or under the direct supervision of personnel with a thorough understanding of the hazards involved, including the possibility of toxic residues being retained by the fruit.

B. Sanitary Harvesting and Food Production

(1) **Equipment and product containers**.

Equipment and product containers should not constitute a hazard to health. Containers which are reused should be of such material and construction as will facilitate thorough cleaning, and should be so cleaned and maintained as not to constitute a source of contamination to the fruit.

(2) **Sanitary techniques**.

Harvesting and production operations, methods and procedures should be clean and sanitary.

(3) **Removal of obviously unfit materials**.

Unfit products should be segregated during harvesting and production to the fullest extent practicable and should be disposed of in an appropriate manner. The harvested fruit should be examined by competent persons to ensure that it is fit for further processing into food.

(4) **Protection of product from contamination**.

Suitable precautions should be taken to prevent the raw fruit from being contaminated by animals, insects, vermin, birds, chemical or microbiological contaminants or other objectionable substances during handling and storage. The nature of the fruit and the methods of harvesting will indicate the type and degree of protection required. The raw or dried fruit should be moved to suitable storage, or to the processing area for immediate processing, as soon as possible after harvesting or drying. Where fruits are likely to have become infested with insects or mites during or after harvesting or drying as a preventive measure, suitable treatment such as fumigation should be applied. Fruit held for processing should be stored in closed containers, buildings, or under suitable type of covering that protects it from rodents, insects, birds, debris and dust. Fumigation methods and chemicals used should be approved by legal authorities having jurisdiction.

(5) **Drying yards**.

Where fruit is dried by the sun in drying yards, such yards should be recognized as food processing yards whether drying is carried out on a grower's property or as a commercial operation. Such yards should as far as possible comply with such of the provisions of Section IV of this code as are applicable, and in particular with the following requirements.

(a) ***Location***.

Drying yards should in all cases be located a sufficient distance from cattle feed lots, settling pods and/or other waste collection areas to prevent contamination from these sources. They should also be so located that they have proper and adequate drainage.

(b) ***Construction***.

The drying yard should be so surfaced that it will permit maintenance of clean yard surfaces and prevent contamination of drying fruit. The drying yard should be fenced, where necessary, to keep out animals as far as practicable, and the area around the drying yard should be kept clean, free from weeds and other debris that can blow into the yard. Cutting sheds in which fruit is pitted, cut or otherwise prepared and spread on trays for drying should preferably be closed buildings with screened windows that do not permit access by rodents, insects, or birds. Where cutting is done in open sheds, adequate precautions should be taken to protect against insect, rodent and bird contamination or harborage. The sheds should be adequately lit and ventilated, and adequate, clean toilet and hand-washing facilities should be provided. Both fresh fruit for processing and the dried fruit should be stored in areas where it is protected from rodent, insect and bird depredations, and storage time should be kept to a minimum consistent with good manufacturing practice. There should be an adequate supply of clean potable water for hand-washing, equipment cleaning, and raw product washing. Standards of portability shall not be less than those contained in the "International Standards for Drinking Water", World Health Organization, 1971.

(c) ***Hygienic operating requirements***.

Drying trays, cutting equipment, and storage bins should be kept clean and free from fruit residue and foreign substances that may cause contamination of the fruit.

C. Transportation

(1) **Facilities**.

Conveyance for transporting the harvested crop or raw product from the production area, place of harvest or storage should be adequate for the purpose intended and should be of such material and construction as will permit thorough cleaning and should be so cleaned and maintained as not to constitute a source of contamination to the fruit.

(2) Handling procedures

All handling procedures should be such as will prevent the product from being contaminated. Extreme care should be taken in transporting perishable products to prevent spoilage or deterioration. Special equipment - such as refrigeration equipment - should be used if the nature of the product or distances involved so indicate. If ice is used in contact with the fruit, it should be of sanitary quality as required in Section IV - A (2c).

SECTION IV - PLANT FACILITIES AND OPERATING REQUIREMENTS

A. Plant Construction and Layout

(1) **Location, size and sanitary design**.

The building and surrounding area should be such as can be kept reasonably free of objectionable odors, smoke, dust, or other contamination; should be of sufficient size for the purpose intended without crowding of equipment or personnel; should be of sound construction and kept in good repair; should be of such construction as to protect against the entrance or harboring of insects or birds or vermin; and should be so designed as to permit easy and adequate cleaning. In areas experiencing high concentrations of air-borne pollutants, equipment should be used to remove pollutants from the air blown across or through the product.

(2) Sanitary facilities and controls

(a)***Separation of processes***.

Areas where raw materials are received or stored should be so separated from areas in which final product preparation or packaging is conducted as to preclude contamination of the finished product. Areas and compartments used for storage, manufacture or handling of edible products should be separate and distinct from those used for inedible materials. The food handling area should be completely separated from any part of the premises used as living quarters.

(b) ***Water supply***.

An ample supply of cold water should be available and an adequate supply of hot water where necessary. The water supply should be of potable quality. Standards of portability shall not be less than those contained in the "International Standards for Drinking Water", World Health Organization, 1971.

(c) ***Ice***.

Ice should be made from water of potable quality and should be manufactured, handled, stored and used, so as to protect it from contamination.

(d) ***Auxiliary water supply***.

Where non-potable water is used - for such purposes as fire control - it must be carried in completely separate lines, identified preferably by color and with no cross- connection or back-siphonage with the lines carrying potable water.

(e) ***Plumbing and waste disposal***.

All plumbing and waste disposal lines (including sewer systems) must be large enough to carry peak loads. All lines must be water-tight and have adequate traps and vents. Disposal of waste should be effected in such a manner as not to permit contamination of potable water supplies. The plumbing and the manner of waste disposal should be approved by the official agency having jurisdiction.

(f) ***Lighting and ventilation***.

Premises should be well lit and ventilated. Special attention should be given to the venting of areas and equipment producing excessive heat, steam, obnoxious fumes or vapours, or contaminating aerosols. Good ventilation is important to prevent both condensation (which may drip into the product) and mould growth in overhead structures - which growth may fall into the food. Light bulbs and fixtures suspended over food in any step of preparation should be of the safety type or otherwise protected to prevent food contamination in the case of breakage.

(g) ***Toilet-rooms and facilities***.

Adequate and convenient toilets should be provided and toilet areas should be equipped with self-closing doors. Toilet rooms should be well lit and ventilated and should not open directly into a food handling area. They should be kept in a sanitary condition at all times. There should be associated hand-washing facilities within the toilet area and the notices should be posted requiring personnel to wash their hands after using the toilet.

(h) ***Hand-washing facilities***.

Adequate and convenient facilities for employees to wash and dry their hands should be provided wherever the process demands. They should be in full view of the processing floor. Single-use towels are recommended, where practicable, but otherwise the method of drying should be approved by the official agency having jurisdiction. The facilities should be kept in a sanitary condition at all times.

B. **Equipment and Utensils**

(1) **Materials**.

All food contact surfaces should be smooth; free from pits, crevices and loose scale; non- toxic; unaffected by food products; and capable of withstanding repeated exposure to normal cleaning; and non-absorbent unless the nature of a particular and otherwise acceptable process renders the use of a surface, such as wood, necessary.

(2) **Sanitary design, construction and installation**.

Equipment and utensils should be so designed and constructed as will prevent hygienic hazards and permit easy and thorough cleaning. Stationary equipment should be installed in such a manner as will permit easy and thorough cleaning.

(3) **Equipment and Utensils**.

Equipment and utensils used for inedible or contaminating materials should be so identified and should not be used for handling edible products.

(4) **Drying equipment**.

Equipment used for drying should be so constructed and operated that the product cannot be adversely affected by the drying medium.

C. Hygienic Operating Requirements

While additional and more specific requirements may be established for certain products, the following should apply as minimal in all food production, handling, storage and distribution:

(1) **Sanitary maintenance of plant, facilities and premises**.

The building, equipment, utensils and all other physical facilities of the plant should be kept in good repair and should be kept clean and maintained in an orderly, sanitary condition. Waste materials should be frequently removed from the working area during plant operation and adequate waste receptacles should be provided. Detergents and disinfectants employed should be appropriate to the purpose and should be so used as to present *CAC/RCP 3* no hazard to public health.

(2) **Vermin Control**.

Effective measures should be taken to protect against the entrance into the premises and the harborage on the premises of insects, rodents, birds or other vermin.

(3) **Exclusion of domestic animals**.

Dogs, cats and other domestic animals should be excluded from areas where food is processed or stored.

(4) **Personnel health**.

Plant management should advise personnel that any person afflicted with infected wounds, sores, or any illness, notably diarrhea, should immediately report to management. Management should take care to ensure that no person, while known to be affected with a disease capable of being transmitted through food, or known to be a carrier of such disease microorganisms, or while afflicted with infected wounds, sores, or any illness, is permitted to work in any area of a food plant in a capacity in which there is a likelihood of such person contaminating food or food contact surfaces with pathogenic organisms.

(5) **Toxic substances**.

All rodenticides, fumigants, insecticides or other toxic substances should be stored in separate locked rooms or cabinets and handled only by properly trained personnel. They should be used only by or under the direct supervision of personnel with a thorough understanding of the hazards involved, including the possibility of contamination of the product.

(6) Personnel hygiene and food handling practices

(a) All persons working in a food plant should maintain a high degree of personal cleanliness while on duty. Clothing including suitable headdress should be appropriate to the duties being performed and should be kept clean.

(b) Hands should be washed as often as necessary to conform to hygienic operating practices.

(c) Spitting, eating and the use of tobacco or chewing gum should be prohibited in food handling areas.

(d) All necessary precautions should be taken to prevent the contamination of the food product or ingredients with any foreign substance.

(e) Minor cuts and abrasions on the hands should be appropriately treated and covered with a suitable waterproof dressing. Adequate first-aid facilities should be provided to meet these contingencies so that there is no contamination of the food.

(f) Gloves used in food handling should be maintained in a sound, clean and sanitary condition; gloves should be made of an impermeable material except where their usage would be inappropriate or incompatible with the work involved.

D. **Operating Practices and Production Requirements**

(1) Raw material handling

*(a) **Acceptance criteria**.*

The raw material should not be accepted by the plant if known to contain decomposed, toxic or extraneous substances which will not be removed to acceptable levels by normal plant procedures of sorting or preparation.

(b) *Storage*.

Raw materials stored on the plant premises should be maintained under conditions that will protect against contamination and infestation and minimize deterioration**.**

(c) Water.

Water used for conveying raw materials into the plant should be from such a source or suitably treated as not to constitute a public health hazard and should be used only by permission of the official agency having jurisdiction.

(2) **Inspection and sorting**.

Prior to introduction into the processing line, or at a convenient point within it, raw materials should be inspected, sorted or culled as required to remove unfit materials. Such operations should be carried out in a clean and sanitary manner. Only clean, sound materials should be used in further processing.

(3) **Washing or other preparation**.

Raw materials should be washed as needed to remove soil or other contamination. Water used for such purposes should not be re-circulated unless suitably treated to maintain it in a condition as will not constitute a public health hazard. Water used for washing, rinsing, or conveying final food products should be of potable quality.

(4) **Preparation and processing**. Preparatory operations leading to the finished product and the packaging operations should be so timed as to permit expeditious handling of consecutive units in production under conditions which would prevent contamination, deterioration, spoilage, or the development of infectious or toxigenic microorganisms.

(5) Packaging of finished product

*(a) **Materials**.*

Packaging materials should be stored in a clean and sanitary manner and should not transmit to the product objectionable substances beyond limits acceptable to the official agency having jurisdiction and should provide appropriate protection from contamination.

(b) ***Techniques***.

Packaging should be done under conditions that preclude the introduction of contamination into the product.

(6) Preservation of finished product.

Methods of preservation or treatment of the finished product should be such as to kill any insects or mites remaining after processing and to result in protection against contamination, deterioration, or development of a public health hazard. The finished product should be of such moisture content that it can be held in the localities of origin and distribution under any normally foreseeable conditions for those localities without significant deterioration by decay, mould, enzymatic changes, or other causes. In addition to applicable drying, the finished product may be treated with chemical preservatives at levels approved by the Codex Alimentarius Commission, as referenced in the Codex Commodity standards, heat processed and/or packed in hermetically sealed containers so that the product will remain safe and will not spoil under normal non-refrigerated storage conditions.

(7) Storage and transport of finished products.

The finished products should be stored and transported under such conditions as will preclude the contamination with or development of pathogenic or toxicogenic microorganisms and protect against rodent and insect infestation and deterioration of the product or of the container.
The product should be stored under suitable conditions of time, temperature, humidity, and atmosphere, to prevent significant deterioration.
Where dried fruits are stored under conditions in which they may become infested by insects and mites, appropriate methods of protection should be used regularly. Dried fruits should be stored in such a manner, that they can be fumigated in situ or so stored that they can be removed elsewhere for fumigation in special facilities (e.g. fumigation chambers, steel barges, etc.). Cold storage can be used, either to prevent infestation in localities where insects are likely to be present in ordinary storage or to prevent insects damaging the fruit.

E. <u>Sanitation Control Program</u>

It is desirable that each plant in its own interest designate a single individual, whose duties are preferably divorced from production, to be held responsible for the cleanliness of the plant. His staff should be a permanent part of the organization and should be well trained in the use of special cleaning tools, methods of disassembling equipment for cleaning, and in the significance of contamination and the hazards involved.

Critical areas, equipment for cleaning and materials should be designated for specific attention as part of a permanent sanitation schedule.

F. Laboratory Control Procedures

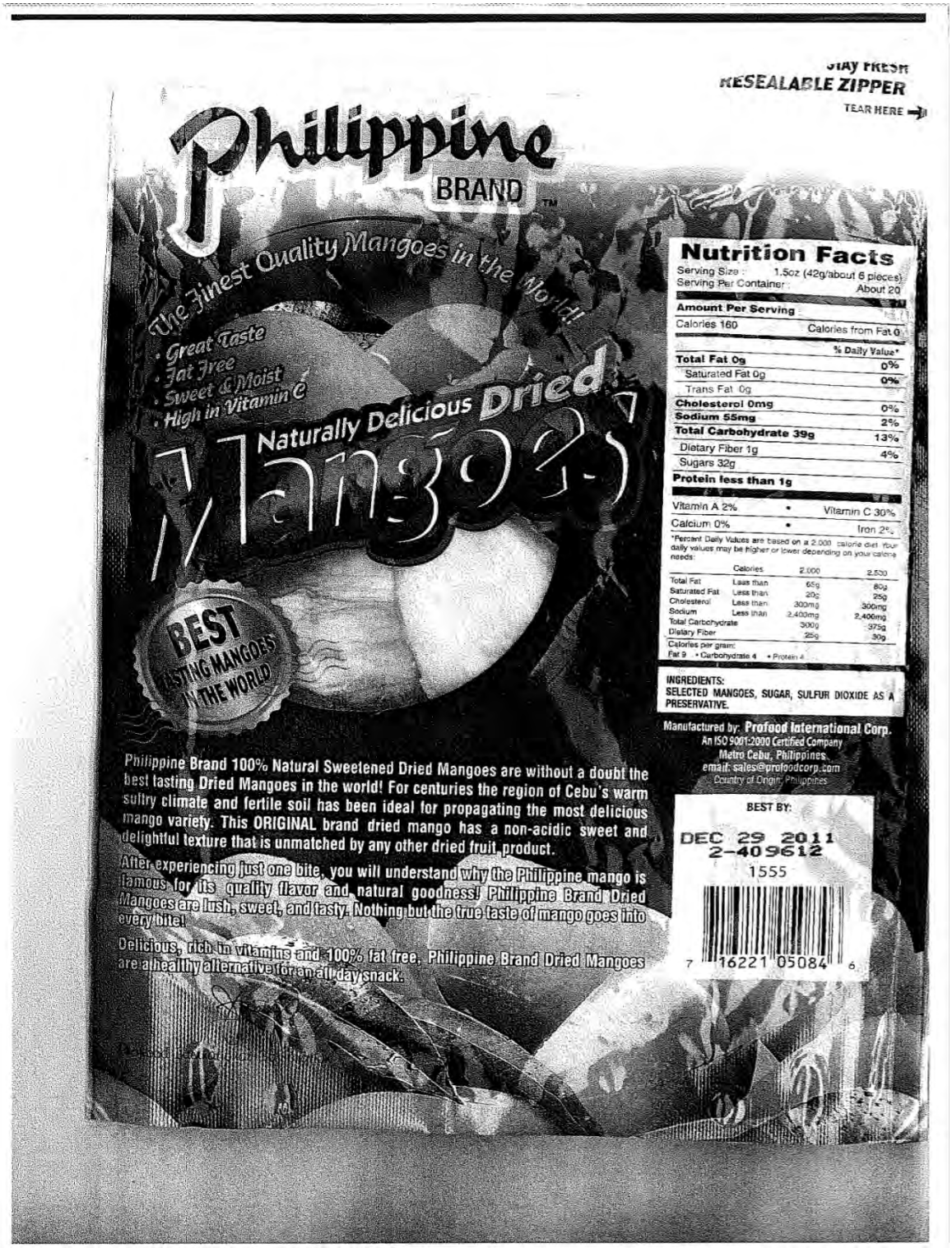
In addition to any control by the official agency having jurisdiction, it is desirable that each plant in its own interest should have its own or access to laboratory control of the sanitary quality of the products processed. The amount and type of such control will vary with the fruit as well as the needs of management. Such control should reject all fruits that are unfit for human consumption. Analytical procedures should follow recognized or standard methods in order that the results may be readily interpreted.

SECTION V - END PRODUCT SPECIFICATIONS

Appropriate methods should be used for sampling, analysis, and determination in the following specifications.

- To the extent possible in good manufacturing practice the products should be free from objectionable matter.
- The products should not contain any pathogen microorganisms or any toxic substance originating from microorganisms.
- The products should comply with the requirements set forth by the Codex Alimentarius Committees on Pesticide Residues and Food Additives as contained in permitted lists or Codex commodity standards.

ANNEX II – US Labeling Requirements


STAY FRESH
RESEALABLE ZIPPER
TEAR HERE
Philippine
BRAND
The Finest Quality Mangoes in the World!
• Great Taste
• Fat Free
• Sweet & Moist
• High in Vitamin C
Naturally Delicious Dried
Mangoes
BEST
TASTING MANGOES
IN THE WORLD
Nutrition Facts
Serving Size 1.5oz (42g/about 6 pieces)
Serving Per Container About 20
Amount Per Serving
Calories 160 Calories from Fat 0
% Daily Value*
Total Fat 0g 0%
Saturated Fat 0g 0%
Trans Fat 0g
Cholesterol 0mg 0%
Sodium 55mg 2%
Total Carbohydrate 39g 13%
Dietary Fiber 1g 4%
Sugars 32g
Protein less than 1g
Vitamin A 2% • Vitamin C 30%
Calcium 0% • Iron 2%
*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:
Calories 2,000 2,500
Total Fat Less than 65g 80g
Saturated Fat Less than 20g 25g
Cholesterol Less than 300mg 300mg
Sodium Less than 2,400mg 2,400mg
Total Carbohydrate 300g 375g
Dietary Fiber 25g 30g
Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4
INGREDIENTS:
SELECTED MANGOES, SUGAR, SULFUR DIOXIDE AS A PRESERVATIVE.
Manufactured by: Profood International Corp.
An ISO 9001:2000 Certified Company
Metro Cebu, Philippines
email: sales@profoodcorp.com
Country of Origin: Philippines
BEST BY:
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7 16221 05084 6
Philippine Brand 100% Natural Sweetened Dried Mangoes are without a doubt the best tasting Dried Mangoes in the world! For centuries the region of Cebu's warm sultry climate and fertile soil has been ideal for propagating the most delicious mango variety. This ORIGINAL brand dried mango has a non-acidic sweet and delightful texture that is unmatched by any other dried fruit product.
After experiencing just one bite, you will understand why the Philippine mango is famous for its quality flavor and natural goodness! Philippine Brand Dried Mangoes are lush, sweet, and tasty. Nothing but the true taste of mango goes into every bite!
Delicious, rich in vitamins and 100% fat free, Philippine Brand Dried Mangoes are a healthy alternative for an all-day snack.

ANNEX III
TUNNEL DRYER

DESIGN REVIEW—DRYING TUNNELS

Drying tunnel design is in accordance with the principals outlined below. The wall thickness of the tunnels is estimated to be about 10 cm. The actual thickness depends on the material used to construct the tunnels. Ideally a fireproof block with insulating qualities is used. These are usually made of cement mixed with some insulating or composite materials. Suggest consulting with an architectural engineer to determine the best material for construction. In no case, allow an advisor on construction to put steel or other metals inside the tunnel. The heat retention characteristics of the metals make the tight temperature control required for a fruit drying operation impossible to achieve. Wood is also a material that is not suitable. The wood is too porous and harbours bacteria. The heat inside the tunnel is not enough to kill the bacteria.

The size of each tunnel is designed to conform to the trolleys which will be used for the operation. The requirement is that the trays must be evenly spaced and that the spacing between the trolley and the walls and ceiling be equal to or less than the spacing of the trays on the trolley. A spacing of not more than 5 cm is reasonable. It allows enough room for the fruit and an air passage over the fruit. Greater spacing reduces the capacity of the system and reduces air velocity because the fan puts out a given amount of air. The more space the air has to travel through the tunnel, the slower it will go. By maintaining tight spacing, the air has less volume to move and must therefore move faster. Also, the cost of heating the air and moving it through the tunnel is a little less when the spacing is tight, but the dwell time is much longer because of the reduced air velocity; therefore the cost of drying will increase when the spacing is too loose. 5 cm more or less is typical among most drying operations. As the trays are 3 cm thick and the spacing is not more than 5 cm, the supports for the trays should be spaced at 8 cm plus an allowance for the thickness of the tray supports.

The lower level of the tunnel is where the trolleys are placed to dry the fruit. At each end of the tunnel are steel doors. These doors are kept closed during operation of the tunnel. They are opened only to remove or to push another trolley into the tunnel. The doors typically have a strip welded to one of the doors that overlaps the edge of the other door when closed. The doors are held shut by a simple closing device that can be operated by hand.

Because of the tight tolerances inside the tunnel and the lack of space at either end of the tunnel, the trolleys are moved on tracks. The tracks are normally just pieces of angle iron tacked to the floor with concrete bolts. The wheels of the trolley must conform to the angle iron tracks. The tracks run through the tunnel. Turntable completes the loop allowing the trolley to run through the fruit preparation area for unloading and loading before repeating the process.

The upper level of the two story tunnel is where the air is heated and forced through the tunnel at high velocity. The trolleys are each 2 meters long and placed end to end are flush against each other in the tunnel. . When the trolleys are centred in the tunnel, there is a space of about 1.25 meters at each end of the tunnel that is not occupied. In the floor of the second level or conversely, in the ceiling of the first level, openings of 90 cm by 80 cm are constructed at each end of each tunnel. These openings function as the hot air intake and the used air exhaust for the system.

At the fresh air intake end of the upper level, the length of the upper level is shortened enough so that the end of the upper level is approximately one meter away from the opening for the used air exhaust. This is in order to build a ducting system to send the exhaust air through the roof into the atmosphere. In order not to restrict the air flow, the ducting for the exhaust system must be as wide as the 80cm by 90 cm exhaust outlet in the tunnel. Since it is a very short distance to the roof and the air velocity is still high, any allowance for the expansion of the exhaust air as it cools upon leaving the tunnel is not a serious consideration.

At the exhaust end, overhead roll up doors are built into the upper level. A separate door is built for each tunnel in order to allow them to be operated independently. These doors enable the operator to control the amount of fresh air coming into the system and to control the humidity of the exhaust air. If the doors are open wide, the air flow is increased and the humidity of the exhaust air is decreased. If the opening of the doors is decreased, less air enters the system and the efficiency of the fans is decreased because of the increased back pressure on the fans and the humidity increases because the air flow decreases. Any change in air flow is a change in air velocity. Normally, an air velocity of 2 meters per second over the fruit is considered to be the minimum. It is not necessary to measure the air flow, but the initial fan selection should take this parameter into consideration. The humidity is normally maintained at 60% or less at the discharge end. A sensor mounted in the tunnel at the discharge end with a remote readout that can be installed on a nearby wall is the best way to monitor humidity. Note that if the humidity goes too high, the drying time is extended. If it goes to low, there is a danger of case hardening. Case hardening is a combination of air velocity and low humidity. The drying tunnel operators usually recognize danger signs through experience with the particular kind of fruit being dried. The air is heated by a gas burner located about one meter inside the tunnel from the sliding doors. Typically, there is an opening under the gas burner and slightly behind the flame that allows used air to re-enter the system, thus conserving energy. In this case, that opening is eliminated because of space limitations. If installed in the correct location, the opening would be over the trolley and would short circuit the air flow over the fruit causing uneven drying.

The gas burner must be equipped with adjustable air gas mixture to insure complete combustion. When the gas burns steadily with a nice blue flame, the combustion is complete. Anything less is an energy loss. The gas burner must also be controlled by a remote thermostat that automatically adjusts the amount of gas being burned in order to adjust the temperature of the air. The

thermostatic sensor is placed inside the tunnel at the hot air inlet. The readout is placed on a nearby wall next to the readout for the humidity. In today's world, these readouts are usually digital, although analogue readouts are still available and may cost slightly less, they are not as durable as the digital readout.

For most dried fruits, a temperature of 65 to 70 degrees at the hot end of the tunnel is a good starting point. Depending on the fruit, this temperature may have to be raised or lowered. Some experimentation is required. The objective is to determine the temperature that will give the lowest dwell time with minimum negative impact on the fruit. Keep in mind that every minute that the system operates is a cost that cannot be passed on to the consumer.

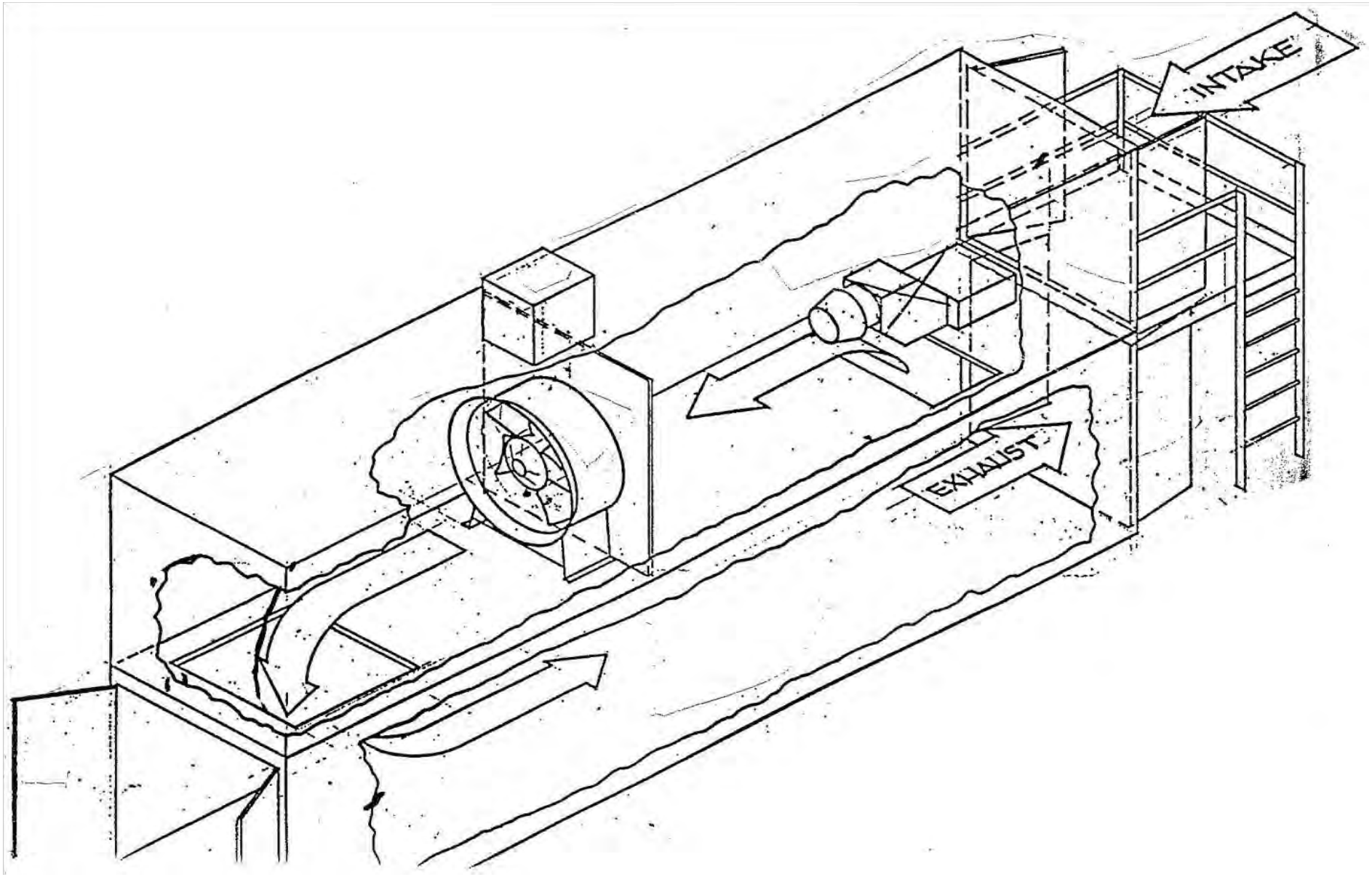
Finally, fan selection and placement must be considered. The area between the gas burner and the fan is the surge area where the air is heated. Normally, the fans are placed at a distance from the gas burner of about one fourth to one third of the distance between the hot air inlet and the air intake. For a short tunnel, it is estimated that the fans should be placed about half the distance between the inlet and the gas burner. This distance should allow enough surge area to heat the air without burning excess gas and far enough away from the hot air inlet to avoid excessive turbulence of the air or require too much energy to heat the air.

The tunnels follow these design principles as summarized below:

- The trolley design is just a flat structure on wheels. The trays are stacked 15 high on the trolley.
- The second floor of the tunnel is as long as the first floor. It is not shortened.
- An air return is installed below the burner but behind the flame to allow some of the used air to re-enter the system thus saving some energy.
- The doors at the exhaust end of the tunnel are left partly open to allow exhaust air to escape into the atmosphere. The tunnels are outside, so the exhaust air does not re-circulate through the system.
- Only one tunnel is recommended initially. Additional tunnels can be built as needed. The tunnels stand independently.

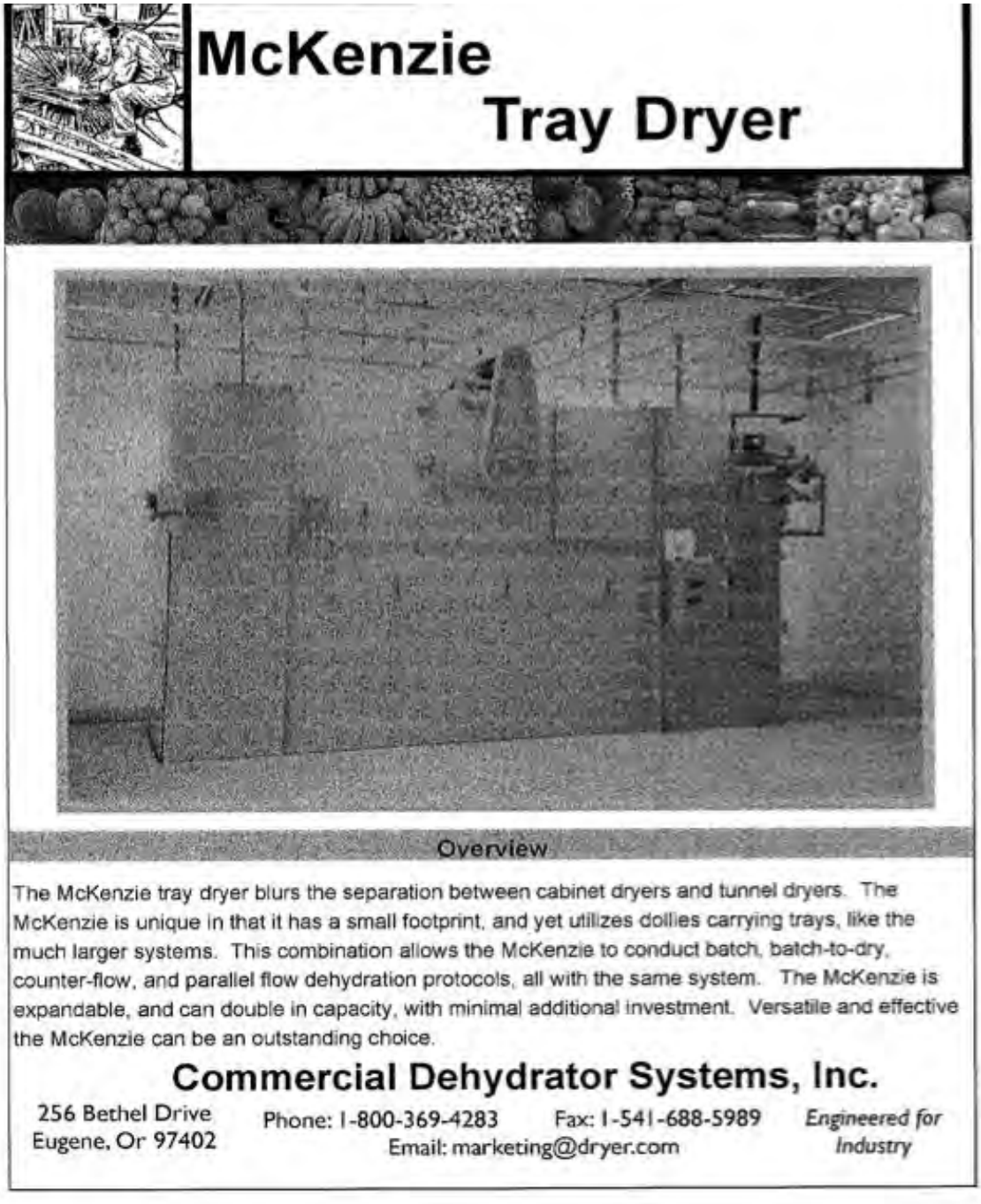
For a short, narrow tunnel, it is estimated that a 24 inch to 30 inch fan will deliver the 500 to 700 cubic meters per minute required to operate the tunnel efficiently. If purchased from a US source such as Cool Air in Florida, the company can furnish a fan, fan housing, and 50 hz, 240/380 volt, three phase motor to meet your requirements. Specify electrical requirements when ordering fans from the US. Note that fans in the US are rated in cubic meters or cubic feet per minute and the propeller size is measured in inches. The fan housing must fit in the tunnel and should be extended as necessary to block any air from going around the fan rather than through the fan. A 500 k-cal burner is more than adequate. It probably will not be operated at maximum capacity and the operating cost is only the energy actually consumed.

The main points in any drying operation are 1) air velocity 2) dwell time 3) humidity and 4) temperature. There are no other considerations. Varying these four points to cover different fruits, different ambient conditions and different stages of maturity is as much an art as a science. The teacher is experience. Never be afraid to experiment in order to obtain the best results. There is almost always room for improvement. Any questions concerning these recommendations concerning these recommendations should be directed to my attention, ejvalentine@gmail.com


INTAKE
EXHAUST

ANNEX IV

Brochures for Dryers



McKenzie Tray Dryer

Features/Benefits

- Expandable to grow with your business
- Your choice of Stainless or Carbon steel construction to fit your needs.
- LED Displays of real time **Temperature** with set-point control.
- Capable of drying a large range of products from curing and jerking meat and fish to fruits, fruit leathers, vegetables, nuts, herbs, and seeds to name only a few.
- Standard 10 HP fan motor for high air velocity and longevity.
- Engineered and proven design for even and consistent drying.
- High density dolly for more capacity optional
- Commercial quality construction for many years of use.
- 1,512 square feet of drying surface area for standard model (high density dolly).

Specifications

- Thermostatic Temperature Control (from ambient to 230ºF
- Powerful fixed speed fan
- Direct fired gas burner
- Adjustable fresh air inlet (humidity control)
- Steel tubing construction for easy relocation if necessary

Dryer Dimensions

HEIGHT: 12 Feet
WIDTH : 18 Feet 6 Inches
DEPTH: 6 Feet 4 Inches

McKenzie Dryer Capacity W/Stainless Steel Trays

Dryer	Tray Size	Sq.Ft.P/Tray	#Trays	Drying Area	Wt.Cap. @ 5Lb.P/Sq.Ft.	Wt.Cap. :1.5Lb.P/Sq.Ft.	Wt.Cap. :3Lb.P/Sq.Ft.
McKenzie	18"x26"	3ft.	504	1,512sq.ft.	756lb. (343kg)	2,268lb. (1,029kg)	4,536lb. (2,058kg)
W/1 Addition	18"x26"	3ft.	672	2,016sq.ft.	1,008lb. (457kg)	3,024lb. (1,372kg)	6,048lb. (2,743kg)
W/2 Additions	18"x26"	3ft.	840	2,520sq.ft.	1,260lb. (572kg)	3,780lb. (1,715kg)	7,560lb. (3,429kg)
W/3 Additions	18"x26"	3ft.	1,008	3,024sq.ft.	1,512lb. (686kg)	4,536lb. (2,058kg)	9,072lb. (4,115kg)

McKenzie Capacity W/High Temperature Plastic Trays

Dryer	Tray Size	Sq.Ft.P/Tray	#Trays	Drying Area	Wt.Cap. @ 5Lb.P/Sq.Ft.	Wt.Cap. :1.5Lb.P/Sq.Ft.	Wt.Cap. :3Lb.P/Sq.Ft.
McKenzie	27"x38"	6.5ft.	204	1,326sq.ft.	663lb. (301kg)	1,989lb. (904kg)	3,978lb. (1,808kg)
W/1 Addition	27"x38"	6.5ft.	272	1768sq.ft.	893lb. (406kg)	2,652lb. (1,205kg)	5,304lb. (2,410kg)
W/2 Additions	27"x38"	6.5ft.	340	2,210sq.ft.	1,105lb. (502kg)	3.315lb. (1,506kg)	6,630lb. (3013kg)
W/3 Additions	27"x38"	6.5ft.	412	2,652sq.ft.	1,326lb. (602kg)	3,978lb. (1,808kg)	7956lb. (3,343kg)

Klamath Operation Costs

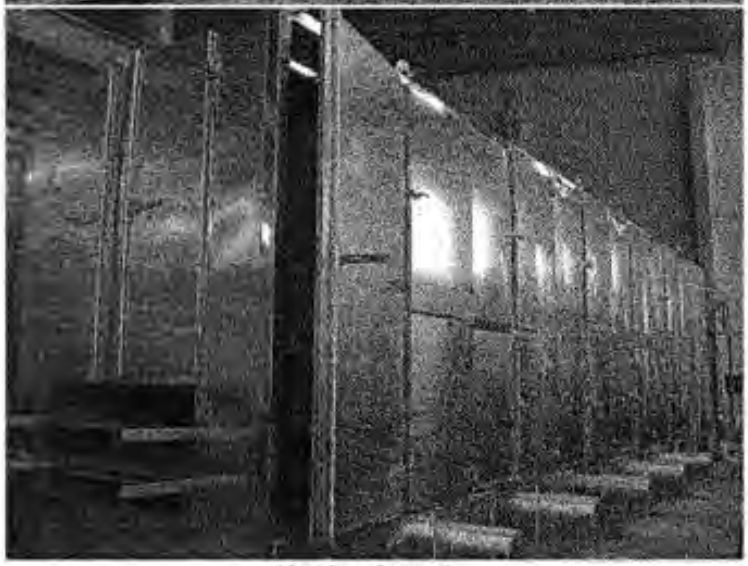
Dryer	Fan Motor HP/ Amps	Heat Type, Max load	Average Electrical Load (Fan	Average Heat Load	Average Hourly Cost Fan/Heat
Mckenzie	10 HP 28 Amps	Gas Burner, 1 Million BTU's	10.26 kw/hr	400,000 BTU's	10.26 kw x $0.09=$0.92 4 therms x $1.15=$4.52

*Notes: All heating loads were computed based on a 40% consumption rate. This is an average figure, and may not accurately represent all applications. Energy costs will vary per Therm and Kilowatt. Check rates for your area

Changzhou Yibu Drying Equipment Co., Ltd
Address：Zhajiawan, Zhenglu, Changzhou, Jiangsu, P.R.China
Tel: +86-519-88910618, Fax:+ 86-519-88902818
Email: gedongqiu@yibu.com , eunice.ge@yaboo.com
http://en.yibu.com (English), http://www.yibu.com (Chinese)

Offer of DW3-1.2-8 Mesh-belt Dryer
(Quotation no.:20100701E)

Date: 2010-07-01
Expired date: 2010-08-01



(Just for reference)

1. Price

No.	Description	Model	Unit price (USD)	Qty	FOB Shanghai (USD)
1	Mesh-belt Dryer	DW3-1.2-8	37,059	1	37,059

YIBU-DW-1

Changzhou Yibu Drying Equipment Co., Ltd
Address：Zhajiawan, Zhenglu, Changzhou, Jiangsu, P.R.China
Tel: +86-519-88910618, Fax：+86-519-88902818
Email: gedongqian@yibu.com , eunice.ge@yibuo.com
http://en.yibu.com (English), http://www.yibu.com (Chinese)

Total	37,059

Remark:

1) **Leading time**: 80days within the date of receiving the advanced payment.
2) **Payment**: 30percent advanced payment, 70 percent before delivery.
3) **Documents**: Commercial Invoice, Packing list, Bill of Lading, Operation Manual.

2. **Terms and Conditions**

Installation, Commissioning and Training

1.1. The Seller shall delegate one team consists of one chief installers and one or two assistants for supervising the installation on the Buyer's written request.
1.2. Qualified laborers, pipe layers, electrician, welders, etc shall be provided by the Buyer.
1.3. The electrical wiring between switch cabinet and the equipment shall be provided by the Buyer.
1.4. All foundation work on building side shall be provided by the Buyer according to the Seller's foundation plans.
1.5. All necessary installation material for installation shall be prepared by the Buyer.
1.6. The complete responsibility for the proper execution of installation shall be carried by the Seller's chief installer.
1.7. For the commissioning and instruction of the Buyer's personnel, the Seller shall delegate one processor (or/and one electrician) on the Buyer's written request.
1.8. During the entire commissioning period, the Buyer shall make available maintenance personnel (mechanic, electrician), as well as a process engineer and operating personnel.
According to requirement, installation personnel (mechanic and welder) shall also be made available by the Buyer.
1.9. During the entire installation and commissioning period, according to requirement, interpreter, as well as lift crane and other tools or machine which is necessary for installation or commissioning, shall also be made available by the Buyer.
1.10. Expenses
1.10.1. The Buyer shall bear all the expenses incurred in the trip of the Seller's delegation for installation, commissioning and training, including air tickets, meal, hotel accommodation (3 star hotel) and local transportation.
1.10.2. Personal allowance should be calculated as 20USD (for the chief installer) / 15USD (for the assistants).

Guarantee and Warranty

1.1. The Seller guarantees that the Contract Equipment shall be in safe and suitable operation.
1.2. Period and Remedies
1.2.1 The Warranty Period of the Contract Equipment shall be 12 months from the date of completion of the installation and commissioning of the Contract Equipment, but not later than 18 months from the date of delivery. In case the Contract Equipment is found defective in the Warranty Period, the Seller shall promptly supply the parts and components (free of charge) upon the receipt of the Buyer's notification, which is needed for repairing the Contract Equipment.
1.2.2. After the Warranty Period and within 5 years after the date of delivery, if there's any fault with the Contract Equipment, the Seller shall promptly supply the parts and components (charge only the basic cost) upon the receipt of the Buyer's notification, which is needed for repairing the Contract Equipment.

YIBU-DW-2

Changzhou Yibu Drying Equipment Co., Ltd
Address：Zhajiawan, Zhenglu, Changzhou, Jiangsu, P.R.China
Tel: +86-519-88910618, Fax:+ 86-519-88902818
Email: gedongqian@yibu.com , eunice.ge@yahoo.com
http://en.yibu.com (English), http://www.yibu.com (Chinese)

1.2.3 If the Buyer requests the Seller dispatching personnel for repair, the Buyer shall bear all the expenses incurred in the trip of the Seller's personnel including air tickets, meal, hotel accommodation and local transportation.

3. Generation descriptions

This machine is a continuous penetrating flow drying equipment applied for drying pieces of strip and particle state materials with good ventilation. The machine is suitable for many materials, such as chip from seaweed, dewatering vegetable, herbal medicine of traditional Chinese medicine and others, for which the water contents are high and high drying temperature is not allowed. The machine owns the advantages of fast drying speed, high evaporation capacity and good product quality. De-watered & filtered cake state paste material should be made into particles or strips before drying process.

Principle:

The materials are uniformly distributed on the mesh-belt by the material feeder. The mesh-belt generally adopts 12-60 mesh stainless steel mesh and it is drawn by a transmission device and move inside the dryer . The dryer is composed of several sections. For each section, the hot air is circulated separately. Part of exhausted gas is exhausted by a special moisture exhaust blower. The waste gas is controlled by an adjustment valve. The hot air passes through the mesh-belt covered with bring water material away. The mesh-belt moves slowly, running speed can be freely adjusted according to the material property. The final products after the drying process will fall into the material collector continuously. The top and low circulation units can be freely equipped according to the user's requirements. The number of section might be selected according to the production demands.

Application

Chip from seaweed, De-watering vegetable, shredded coconut, sliced or diced fruit, feed particle, gourmet power, organic dye, compound rubber, medicine product, plastic product, aging and solidification for the electronic component and device.

4. Technical and Equipment parameters

1. Name of material: mango (δ2cm)
2. Drying temperature: 65-70℃
3. Loading capacity: 250kg
4. Initial moisture content: 85%
5. Final moisture content: 20%
6. Water evaporation capacity: 205kg/h
7. Effective width of mesh: 1.2m
8. Effective length of mesh: 8m*3 (layers)
9. Steam consumption: 400kg/h.

5. Base configuration

Item	Name	Material	Supplier
1. Main body	Interior frame of heat insulation	CS	Changzhou Yibu
	Interior wall 1.2mm	CS	Changzhou Yibu
	Exterior wall 1.2mm	CS	Changzhou Yibu
	Heat insulation layer 80mm	Super fine glass wool	Changzhou Yibu
	Lock and hinge door	CS	Changzhou Yibu
	Sshape seal of door	Silicon rubber	Changzhou Yibu
	Driving chain	CS blackening	Changzhou Yibu
	Support rod	Galvanized CS	Changzhou Yibu
	Driving shaft	CS	Changzhou Yibu
	Shaft Pin	CS	Changzhou Yibu

Changzhou Yibu Drying Equipment Co., Ltd
Address：Zhajiawan, Zhenglu, Changzhou, Jiangsu, P.R.China
Tel: +86-519-88910618, Fax:+ 86-519-88902818
Email: gedongqian@yibu.com , eunice.ge@yahoo.com
http://en.yibu.com (English), http://www.yibu.com (Chinese)

2. Driving section	Chain wheel	CS	Changzhou Yibu
	Chain cover sheet	SUS304	Changzhou Yibu
	Material stop board	SUS304	Changzhou Yibu
	Pressing sheet	SUS304	Changzhou Yibu
	B=1215：12mesh	SUS304	Changzhou Yibu
	Reducer	Outsourcing parts	Guomao Guotai
	Bearing with seat	Outsourcing parts	Dongwan Bearing Factory
3. Circulation and humidity exhaust section	Circulation fan	CS	Changzhou Huasheng
	Humidity exhaust fan	CS	Changzhou Huasheng
	Humidity exhaust ducts δ1.5	CS	Changzhou Yibu
	Air valve	CS	Changzhou Yibu
	Inlet air filter	Aluminum mesh+ Non-woven cloth	Changzhou Yibu
	Heat exchanger	CS aluminum pin	Changzhou Yibu
	Steam angle seat valve	---	Burket, Germany
4.	Feeding device, discharge port	SUS304	Changzhou Yibu
5. Control cabinet	Control cabinet shell	CS spray-paint	Changzhou Yibu
	Main control components	---	Shanghai Changjiang
	Temperature Control meter	---	Yuyao factory
	Temperature meter PT100	---	Yuyao factory

Note:
Changzhou YiBu refers to Changzhou Yibu Drying Equipment Co., Ltd; CS refers to Carbon Steel; SUS304 refers to stainless steel SUS304.

6. Remarks

1. Confidential

The contents in the offer are confidential, may be legally privileged, and are for the intended recipient and Purpose only. The recipient may disclose it to those employees and/or third parties who need to know the information for the Purpose of this offer only. Access, disclosure, copying, distribution, or reliance on any of this offer by anyone else is prohibited and may be a criminal offence.
Please delete it if obtained in error and email confirmation to the sender.

2. Amendments

To advance the system, and according to availability of the market of the manufacturer's country when to manufacture the equipment, there might be slight changes with the plant.

Harvest Saver Tray Dryer

Overview

The Harvest Saver is an ideal machine for taking that first step into commercial dehydration. The Harvest Saver is a compact dryer, and one of our most popular. The Harvest Saver has the ability to dry a wide variety of products like jerky, wild flowers, fruit, health bars, and the list keeps growing! This kind of versatility, makes the Harvest Saver a great fit for most applications and an excellent choice for pilot projects, lab research, and food innovation centers.

Commercial Dehydrator Systems, Inc.

256 Bethel Drive
Eugene, Or 97402

Phone: local 541-688-5281 Toll Free 1-800-369-4283
Fax: 1-541-688-5989
Email: marketing@dryer.com

Engineered for Industry

Harvest Saver Tray Dryer

Features/Benefits

- Stainless Steel construction
- LED Displays of real time **Temperature** and **Humidity** measurements.
- Temperature range: From ambient to 200°F
- Programmable "Ramp and Soak" advanced dehydration
- Capable of drying a wide range of products from Curing and Jerking meat and fish to fruits, fruit leathers, vegetables, nuts, herbs, seeds and more!
- Engineered and proven design for even and consistent dehydration.
- Larger capacity saves time loading one dryer vs. multiple "hobby style" dehydrators.
- 24 Hour Timer for continuous drying
- Commercial quality construction for many years of use.
- Integrated Wheels for easy placement and mobility.
- High resale value
- Operates on 220 volt, single phase power

Harvest Saver R-5 Controller

The Honeywell UDC 2500 accurately controls temperature and displays both process air humidity and temperature levels.

Harvest Saver Capacity Chart

Dryer	Tray Size	Sq.Ft.P/Tray	#Trays	Drying Area	1/2 lbs product per square foot	1 1/2 lbs product per square foot	3 lbs product per square foot
R-5	24"x38"	6.33	14	88sq.ft.	44lb. (20kg)	132lb. (60kg)	264lb. (120kg)

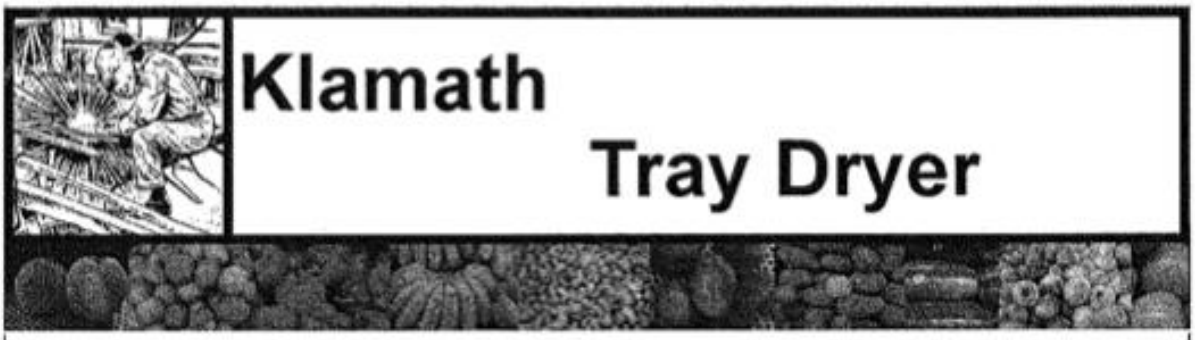
Options and Accessories

- Telfon Liners
- Digital Thermometer
- High Output heater (Double output to 18,400 watts)
- Choice of Data logger or Chart Recorder
- Tray Cart
- Extra set of trays (solid or perforated)

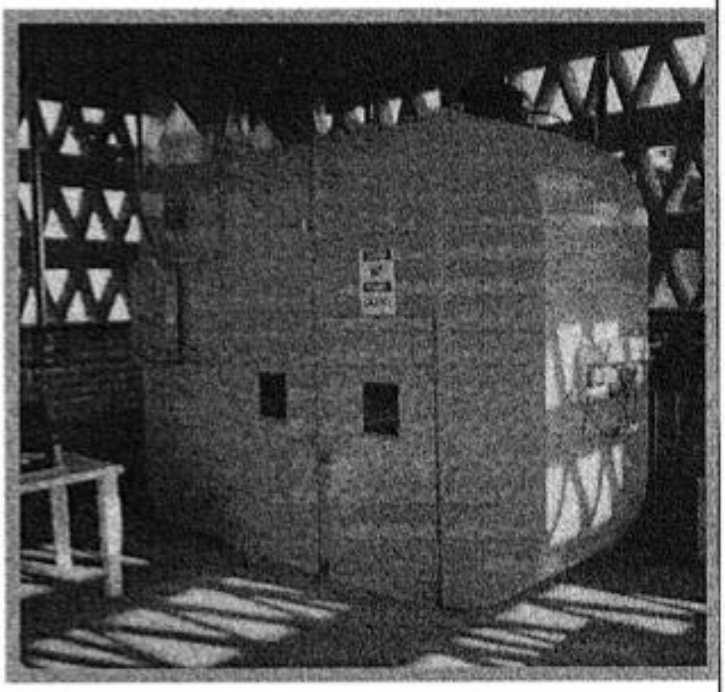
Harvest Saver Operation Costs

Dryer	Fan Motor HP/ Amps	Heat Type, Max load	Average Electrical Load (Fan	Average Heat Load	Average Hourly Cost Fan/Heat
R-5	3/4 HP, 3.2 Amps	Electric Coils, 9,200 watts	.65kw/hr	3,520w	.65 kw x $0.09=$.06 3.5 kw x $0.09=$0.32

*Note: The Harvest Saver uses 220 volt, single phase power. All heating loads were computed based on a 40% consumption rate. This is an average figure, and may not accurately represent all applications. Energy costs will vary per Kilowatt. Please check utility rates or your area.



Klamath Tray Dryer



Overview

The Klamath Tray Dryer is an outstanding example of the classic cabinet style dryer, with a twist, it is expandable! Uniform and consistent dehydration is a result of a combination of a powerful fan and a direct fired gas burner. The Klamath is an excellent fit for the emerging company with a rapid growth potential. Through the use of additional sections, the Klamath can double its capacity and double it again at a minimal cost. For a quality tool that grows with your business, ask for the Klamath Tray Dryer.

Commercial Dehydrator Systems, Inc.

256 Bethel Drive
Eugene, Or 97402

Phone: 1-800-369-4283
Email: marketing@dryer.com

Fax: 1-541-688-5989

Engineered for Industry

Klamath Tray Dryer

Features/Benefits

- Expandable to grow with your business
- Your choice of Stainless or Carbon steel construction to fit your budget
- LED Displays of real time **Temperature** with set-point controls.
- Capable of drying a large range of products from Curing and Jerking meat and fish to fruits, fruit leathers, vegetables, nuts, herbs, and seeds to name only a few.
- 2" Inch Insulation for efficiency
- Standard 5HP fan motor for high airflow and longevity.
- Commercial quality construction for long useful life.
- 198 square feet of drying surface area for

Specifications

- Thermostatic Temperature Control (from ambient to 260°F
- Powerful fixed speed fan
- Direct fired gas burner
- Adjustable fresh air inlet (humidity control)
- Steel tubing construction for easy relocation if necessary

Dryer Dimensions

HEIGHT: 9 Feet
WIDTH: 6 Feet 7 Inches
DEPTH: 3 Feet 5 Inches

Standard unit shipping weight: 4,500 LBS

Klamath Dryer Capacity W/Stainless Steel Trays

Dryer	Tray Size	Sq.Ft.P/Tray	#Trays	Drying Area	1/2 lbs product per square foot	1 1/2 lbs product per square foot	3 lbs product per square foot
Klamath	18"x26"	3ft.	66	198sq.ft.	99.00lb. (45kg)	297.00lb. (135kg)	594lb. (269kg)
W/1 Addition	18"x26"	3ft.	132	396sq.ft.	198lb. (90kg)	594lb. (269kg)	1,188lb. (539kg)
W/2 Additions	18"x26"	3ft.	198	594sq.ft.	297lb. (135kg)	891lb. (404kg)	1,782lb. (808kg)
W/3 Additions	18"x26"	3ft.	264	792sq.ft.	396lb. (180kg)	1,188lb. (539kg)	2,376lb. (1,078kg)

Klamath Capacity W/High Temperature Plastic Trays

Dryer	Tray Size	Sq.Ft.P/Tray	#Trays	Drying Area	1/2 lbs product per square foot	1 1/2 lbs product per square foot	3 lbs product per square foot
Klamath	27"x38"	6.5ft.	24	156sq.ft.	78lb. (35kg)	234lb. (106kg)	468lb. (212kg)
W/1 Addition	27"x38"	6.5ft.	48	312sq.ft.	156lb. (71kg)	468lb. (212kg)	936lb. (425kg)
W/2 Additions	27"x38"	6.5ft.	72	468sq.ft.	234lb. (106kg)	702lb. (319kg)	1404lb. (638kg)
W/3 Additions	27"x38"	6.5ft.	96	624sq.ft.	312lb. (141kg)	936lb. (425kg)	1872lb. (850kg)

Klamath Operation Costs

Dryer	Fan Motor HP/ Amps	Heat Type, Max load	Average Electrical Load (Fan	Average Heat Load	Average Hourly Cost Fan/Heat
Klamath	5 HP 15.2 Amps	Gas Burner, 400,000 BTU's	5.6 kw/hr	160,000 BTU's	5.6 kw x $0.09=$0.50 1.6 therms x $1.15=$1.84

*Notes: All heating loads were computed based on a 40% consumption rate. This is an average figure, and may not accurately represent all applications. Energy costs will vary per Therm and Kilowatt. Check rates for your area

Malnutrition Matters
FOOD TECHNOLOGY SOLUTIONS

Good

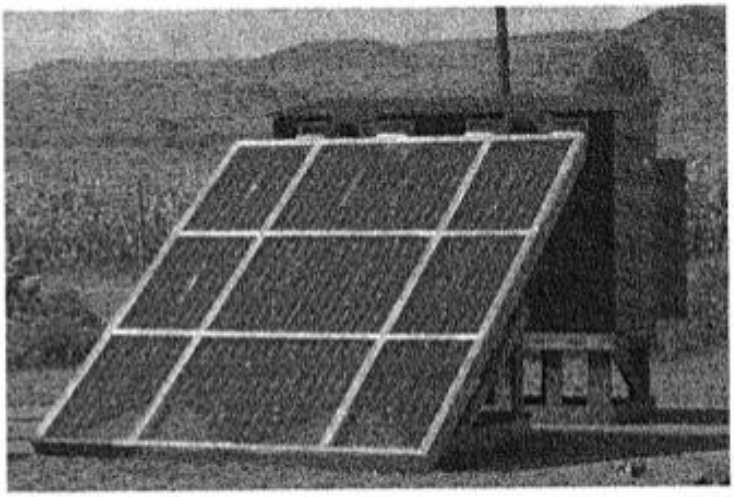
SolarFlex
Dryers & Heaters

SolarFlex Fruit and Vegetable Dryer

May 2008

Established in 2000, Malnutrition Matters is a registered Canadian Non-Profit Organization. MM is experienced internationally in food processing technology for micro-enterprise and medium-scale projects and social feeding interventions. In 2005, MM's VitaGoat food processing system was recognized with an award from the Tech Museum of Innovation in California. Projects have been developed in 16 countries in Africa and Asia in partnership with local and multinational organizations, including Africare, UNIDO and World Bank. MM specializes in soybean, fruit and vegetable processing and cooking, with or without any electricity, and solar food drying techniques, with or without additional biomass-fueled drying.

The new SolarFlex system is a solar fruit and vegetable dryer with an optional multi-fuel boiler and radiator system for drying on cloudy days or at night. It operates without electricity, as the circulating fan is powered by a car battery, which is recharged by a small photovoltaic panel. A pilot project in India is supported by the World Bank Development Marketplace. Technology transfers to South Africa and India have also been started with local private sector partners. Both will provide regional production, distribution, and technical support services, later in 2008.



"Beta" model of SolarFlex Fruit and Vegetable Dryer at test site in South Africa

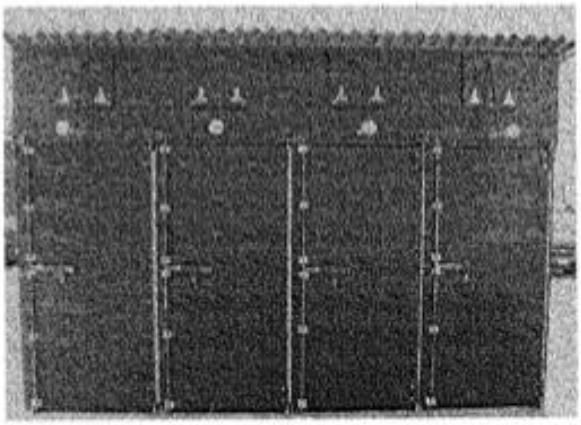
The SolarFlex system has a flexible design and is inexpensive to manufacture. Drying fruits and vegetables with this system is a cost-effective long-term food storage solution that requires no external electricity.

The ability to dry fruits and vegetables is a crucial element in achieving the long-term food security of many communities, where certain crops may be abundant during harvesting season, but the lack or high cost of canning and refrigeration facilities makes these foods unavailable at other times. The system can work with or without an optional boiler and radiator: this allows for the flexibility to dry at night or to supplement the heat produced on cloudy days.

Additionally, this system will be of interest to entrepreneurs looking to provide dried food products in markets where food security is not an issue. The very low production costs associated with dried foods make this method highly cost-competitive compared with foods preserved through other methods.

Dried fruits and vegetables are also regarded as premium specialty foods in many markets. The system can also process many other kinds of food products, such as dried fish and herbs.

The system offers approximately 32 square meters of drying space (340 square feet). Component setup can be accommodated to specific site requirements or preferences, including the separation of the solar array from the dryer cabinet. This allows for an interior installation of the dryer cabinet, with ducting passing through a wall to an exterior installation of the solar array. Alternatively, the solar array can be installed directly against the dryer cabinet.



Front of dryer with fresh air / humidity vents at top. Each compartment holds 15 drying racks.

Pineapple, mango, banana and tomato before and after drying

The target sale price is about $4,500 USD for the base system, and $1,500 extra for the optional multi-fuel boiler and radiator. Comparable capacity commercial dryers, which are generally all metal, sell for $20,000 to $40,000. Most are electric or gas and without a solar option.

The entire system is intended to be fabricated and transported in "kit" form, for assembly at the final site. For transport economy and protection, the solar array and most principal components fit inside the reinforced shell of the cabinet, which is then used as a shipping container.

MM is also developing smaller scale and lower cost dryer systems. A DVD providing an overview of the SolarFlex system is available upon request.

Solar Air Heating: The existing solar array can be detached from the dryer cabinet and positioned beside a building to provide space heating during the seasons when drying is not viable. In addition, various other solar air heating options are being developed in cooperation with SolarFlex Inc.

Website: www.malnutrition.org
E-mail: matters@malnutrition.org

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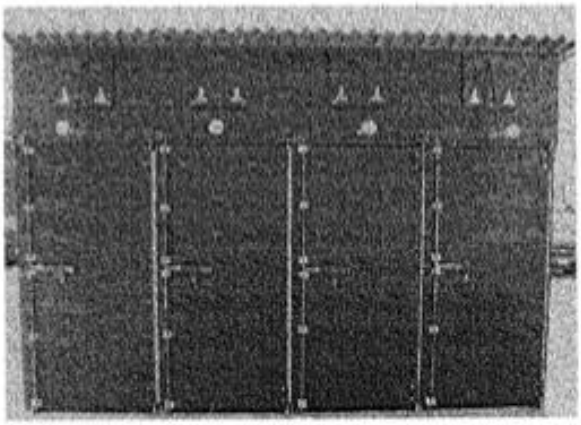

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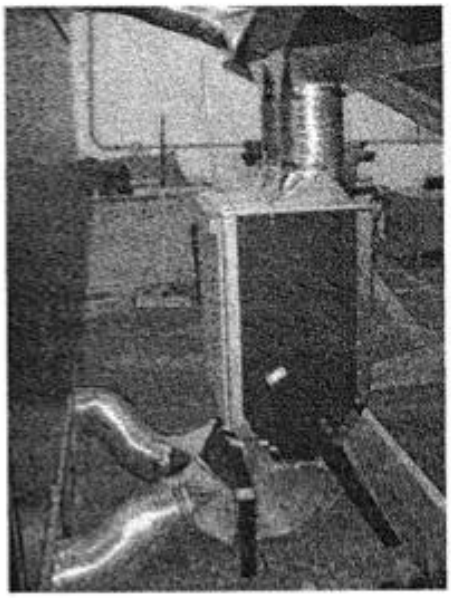
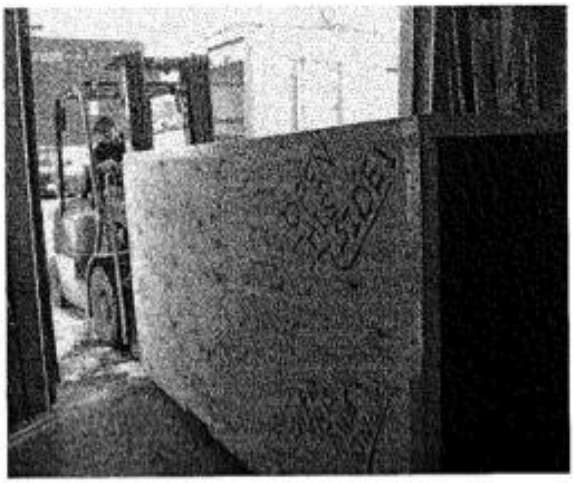
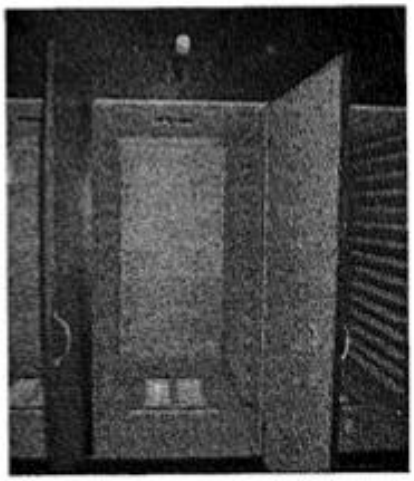


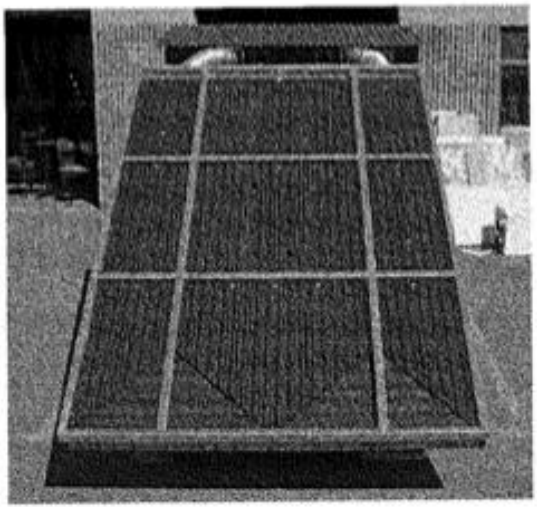
Fan / radiator manifold and ducting between solar array and dryer cabinet.



Beta system "kit" being shipped in reinforced dryer cabinet. Dismantled solar array fits inside.



Detail of cabinet section interior. Hot air enters at the bottom. Air exits through the controllable outlet at the top. Controls send the air either out of the system or recycling back to solar array.



Ducts from the cabinet at top recirculate air to the solar array. Ports beside the ducts are controllable to allow excess humidity to be vented.

ANNEX V

Draft of Standards Philippine Dried Mango

SCOPE

This standard shall apply to dried mango of varieties conforming to the characteristics of Mangifera spp. treated or processed and packed in suitable containers.

DEFINITION OF TERMS

For the purpose of this standard, the following terms shall mean:
Container – any form of packaging material, which completely or partially encloses the food (including wrappers). A container may enclose the food as a single item or several units or types of prepackaged food when such is presented for sale to the consumer.
Current Good Manufacturing Practices (cGMP) – a quality assurance system aimed at ensuring that products are consistently manufactured, packed or repacked or held to a quality appropriate for the intended use. It is thus concerned with both manufacturing and quality control procedures.

- Drying – the removal of water by natural means, i.e., by sun-drying.
- Dehydration – the removal of moisture by artificial means and in some cases in combination with sun-drying sufficient to ensure quality and shelf life stability at ambient conditions.
- Food – any substance, whether processed, semi-processed or raw, which is intended for human consumption, and includes drink, chewing gum and any substance which has been used in the manufacture,
- 1preparation or treatment of ~~f~~food" but does not include cosmetics or tobacco or substances used only as drugs.
- Food Additives – any substance the intended use of which results or may reasonably be expected to result, directly or indirectly, in its becoming a component or otherwise affecting the characteristics of any food (including any substance intended for use in producing, manufacturing, packing, processing, preparing, treating, packaging, transporting, or holding food; and including any source of radiation intended for any such use), if such substance is not generally recognized, among experts qualified by scientific training and experience to evaluate its safety, as having been adequately shown through scientific procedures to be safe under the conditions of the intended use (R.A. 3720, Food, Drugs and Cosmetic Act).
- Food Standard – a regulatory guideline that defines the identity of a given food product (i.e. its name and the ingredients used for its preparation) and specifies the minimum quality factors and, when necessary, the required fill of the container. It may also include specific labeling requirements other than or in addition to the labeling requirements generally applicable to all prepackaged foods.
- Ingredient - any substance including food additive, used as a component in the manufacture or preparation of a food and present in the final product in its original or modified form.

- Label – includes any tag, brand, mark, pictorial, or other descriptive script, written, printed, marked, embossed or impressed on, or attached to the container.
- Labeling – any written, printed or graphic matter (1) upon any article or any of its container or wrappers and/or (2) accompanying the packaged food.
- Lot – food produced during a period of time and under more or less the same manufacturing condition indicated by a specific code.
- Moisture content - the percentage weight of water in relation to the dry weight of the product.
- Packaging – the process of packing that is part of the production cycle applied to a bulk product to obtain the finished product. Any material, including painted material, employed in the packaging of a product including any outer packaging used for transportation of shipment. Packaging materials are referred to as primary or secondary according to whether or not they are intended to be in direct contact with the product.
- Sweetening agent – includes one or more of the sugars, honey, high intensity sweeteners and artificial sweeteners.
- Water Activity – the ratio of vapor pressure of water in the product to the water vapor pressure of pure water at the same temperature. It is also a measure of water available for the growth of microorganisms.

DESCRIPTION OF PRODUCTS

Product Definition

Dried mango is the product prepared from sound and mature ripe fruit of varieties of Mangifera spp. processed by drying either by the sun or other recognized methods of dehydration, with or without added sweetening agent and food additives.

Styles

The product may be presented in any one of the following dried forms:

(a) Halves
(b) Sliced
(c) Cubes/Diced
(d) Slabs - consisting of portions of sound, ripe mangoes of characteristic color, irregular in shape, size and thickness and excluding whole fruit.
(e) Chunks, chips and strips
(f) Other forms

Other Styles

Any other presentation of the product shall be permitted provided that the product: (a) is sufficiently distinctive from other forms of presentation laid down in this standard such as mango leather, sheets

or rolls (b) meets all relevant requirements of this standard; and, (c) is adequately described on the label to avoid confusing or
misleading the consumer.

ESSENTIAL COMPOSITION AND QUALITY FACTORS

Raw materials Mango

Fruit to be used shall be fresh, sound, and clean and mature from any cultivated variety conforming to the characteristics of the fruits of Mangifera spp. of the Mangiferae family. It shall conform to specifications stated in PNS/BAFPS 13:2004 Fresh Fruit – Mango- Specifications.

Optional Ingredients

(a)Sweetening agent - one or more of the sugars, honey, high intensity sweeteners or artificial sweeteners.

(b)Other ingredients - all other ingredients to be used shall be of food grade quality and conform to all applicable food standards.

Quality Criteria

Maturity Characteristics

Mango shall show development characteristics of properly matured fruits, as indicated by proper color and texture for the varietal types defined in PNS/BAFPS 13:2004.

Moisture Content

The product shall have moisture content of not more than 15%.

Water Activity (aW)

The product shall have a maximum water activity of 0.70 at 25^0 C.

Sensory Properties

The product shall have the characteristic color, aroma, and flavor of mango. Dried mango halves, slices, cubes, slabs and leathers/rolls shall have a chewy texture. Mango flakes shall have a flaky, crispy texture. The dried products shall be free from any objectionable sensory characteristics.

Grading

The product shall be graded according to: a) Premium – obtained from the thickest portion of the flesh (–cheek") on both sides cut parallel to the seed of the fruit b) Regular – obtained from the remaining flesh after cutting the –cheeks" including the fibrous portions of the fruit

Types of Defects

(a) Foreign matter - The presence in the sample unit of any matter, which has not been derived from mango, does not pose a threat to human health and is readily recognized without magnification or is present at a level determined by magnification method or any equivalent method that indicates non-compliance with good manufacturing practices and sanitation practices.

(b) Odor/flavor/color -A sample unit, affected by objectionable odors or flavors indicative of decomposition and unacceptable color.

Classification of "Defectives"

A container that has any of the type of defects set in 4.3.6 shall be considered as –defective".

Lot Acceptance

A lot shall be considered as meeting the applicable quality requirements when the number of –defectives", as defined in sub- section 4.3.6, does not exceed the acceptance number of the appropriate sampling plan.

FOOD ADDITIVES

Food additives when used shall be in accordance with the regulations established by the Bureau of Food and Drugs (BFAD) (Bureau Circular No.2006-016, Updated List of Food Additives) and/or the Codex Alimentarius Commission.
The following food additives listed in, but not limited to, Table 1, may be used for the manufacture of dried mango products.

Food Additive	Maximum Level
Acidifying agent Any permissible acidifying agents as specified by BFAD	GMP
Antioxidants Ascorbic acid Sodium erythorbate	GMP
Humectants Any permissible humectants agents as specified by BFAD	GMP
Sulphites	3,000 mg/kg

Others - all others not included in the above list shall be allowed as carry-over, provided they are approved by the BFAD regulation and shall be in accordance to Section 5.2 of the –Principle Relating to the Carry-Over of Food Additives into Foods" (CAC/Vol. 1 1991).

HYGIENE

It is recommended that the product covered by the provisions of this standard be prepared and handled in accordance with the appropriate sections of the Recommended International Code of Practice – General Principles of Food Hygiene - Guidelines, Current Good Manufacturing Practices in Manufacturing, Packing, Repacking or Holding Food and processed according to the Recommended Code of Practice for the Processing and Handling of Dried Tropical.

When tested by appropriate methods of sampling and examination, the product Shall be free from filth that may pose a hazard to health; shall be free from parasites which may represent a hazard to health; shall not contain any substance originating from microorganisms in amounts which may represent a hazard to health; shall be free from microorganisms capable of development under normal conditions of storage; and shall be free from container integrity defects which may compromise the hermetic seal.

LABELING

Each container shall be labeled and marked with the following information in accordance with BFAD's Labeling Regulation:

(a) The name of the product shall be –Dried Mango". In addition, there shall appear on the label as part of the name or in close proximity to the name, any form of presentation listed in 3.2 or 3.3 and grading listed in 4.3.5.
(b) The complete list of ingredients and food additives used in the preparation of the product in descending order of proportion.\
(c) Products using artificial sweetener/s shall have statement/s referring to its low and/or reduced caloric value and the possibility of hypersensitivity to some of its components
(d) The net quantity of content by weight in the metric system. Other systems of measurement required by importing countries shall appear in parenthesis after the metric system unit.
(e) The name and address of the manufacturer, packer and/or distributor of the food.
(f) Open date marking The words –Best/"Consume Before indicating end of period at which the product shall retain its optimum quality attributes at defined storage conditions.
(g) Lot or code number identifying product lot.

(g) The words –Product of the Philippines" or the country of origin if imported. (i)Additional requirements A pictorial representation of fruit(s) on the label should not mislead the consumer with respect to the fruit so illustrated.

Nutrition Labeling

Nutrition labeling shall conform to established regulations of BFAD.

METHODS OF ANALYSIS AND SAMPLING

Determination of Moisture Content (Vacuum Oven Method)

According to the AOAC Official Methods of Analysis, 16th ed., 1995. Method No. 934.06.

8.2 **Determination of Water Activity**

According to the AOAC Official Methods of Analysis, 16th ed., 1995. Method No. 978.18.

8.3 **Method of Sampling**

Sampling shall be in accordance with the FAO/WHO Codex Alimentarius Sampling Plans for Prepackaged Foods - CAC/RM 42- 1969, Codex Alimentarius Volume 13, 1994.

9. REFERENCES

A.O. No. 153 s. 2004. Guidelines, Current Good Manufacturing Practice in Manufacturing, Packing, Repacking or Holding Food. Bureau of Food and Drugs. Department of Health. Alabang, Muntinlupa City, Philippines.

Association of Analytical Chemists. Official Methods of Analysis Manual. 16th ed., 1995. AOAC International. 481 North Frederick Ave., Suite 500, Gaithersburg, MD 20877-2417. U.S.A.

B.C. No.2006-016. Updated List of Food Additives. Bureau of Food and Drugs. Department of Health. Alabang, Muntinlupa City, Philippines.

FAO/WHO Codex Alimentarius Commission Manual. 1995. Codex Alimentarius Commission. Food and Agriculture Organization. Viale delle Terme di Caracalla, 00100 Rome, Italy.

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Philippine National Standards No. 991:1993. Agricultural and Other Food Products – Bottled Drinking Water Specifications. Bureau of Product Standards. Department of Trade and Industry. Makati City, Philippines.

PNS/BAFPS 13:2004. Philippine National Standard for Fresh Fruits – Mangoes – Specification. Bureau of Agriculture and Fisheries

Product Standards. Department of Agriculture. Diliman, Quezon City, Philippines.
R.A. 3720. Food, Drugs and Cosmetic Act. Bureau of Food and Drugs. Department of Health. Alabang, Muntinlupa City, Philippines.

ANNEX VI
PCSIR Test Results/Reports

CHAUNSA MANGO SLICES

(TECHNICAL / PRE-FEASIBILITY REPORT)

BY

DR. SAKHWAT ALI
DR. IJAZ AHMAD
MR. IMRAN-UL-HAQ
DR. SHAHJAHAN BAIG

Year : 2010

FOOD AND BIOTECHNOLOGY RESEARCH CENTRE
PAKISTANCOUNCIAL OF SCIENTIFIC AND INDUSTRIAL RESEARCH, LABORATORIES COMPLEX, FEROZEPUR ROAD, LAHORE

Page 1 of 8

CHAUNSA MANGO SLICES

(TECHNICAL / PRE-FEASIBILITY REPORT)

BY

DR. SAKHWAT ALI

DR. IJAZ AHMAD

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Year : 2010

Submitted to:

1. **FIRMS Projects, Lahore**
2. **Head, FBRC, PCSIR, Lahore**
3. **ILO, PCSIR, Lahore**
4. **Director (P&D), PCSIR, Lahore**

No. of Pages: 08

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TECHNICAL REPORT/ PRE-FEASIBILITY REPORT

ILO No: 242 / 15-07-2010 **Dated: July 23, 2010**

In respect of :	**Technical Report/ Pre-feasibility Report of Chaunsa Mango Slices**
Centre / Division / Section:	**Food and Biotechnology Research Centre**
Company Name & Address:	**M/s FIRMS Projects, 44-C-1, Gulberg-III, Lahore**

Technical details of Pre-feasibility Report of Chaunsa Mango Slices

Mango variety chaunsa summer bahisht - at color break stage was selected for the preparation of mango slices. All the steps of activity were performed according to Annexure-I.

SAMPLE PREPARATION

The details of different steps evolved in the preparation of sample are given below:

STEP-1:	Mangoes (45 kg) were purchased from local market.		
	Total weight of mangoes	=	40 kg
STEP-2:	Mangoes blanched at 50 °C for 30 minutes separately	=	5 kg
	Mangoes were peeled and sliced after blanching.		
	Brix° of mangoes before blanching	=	25.5
	Brix° of mangoes after blanching	=	19
STEP-3:	Persons engaged to peel and pit the 40 kg mangoes	=	4
	Weight of peel	=	7.3 kg
	Weight of pit after pulping	=	7.1 kg
	Weight of pulp recovered after pitting	=	4.4 kg
	Time required for peeling	=	50 min.
	Time required for pitting	=	26 min.

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STEP-4: Man hour required for peeling and pitting = 76 min/40 kg/ 4 persons.

STEP-5: Brix° of mangoes = 25.5

STEP-6-9: Theses steps were performed according to Annexure-I of activity proforma.

Thickness of mango slice	Total weight of slices (Kg)	Weight of each slice (g)
1 cm	9.10	32.6
2 cm	7.45	71.4

PRETREATMENT:

STEP 10 – 12: These steps were preformed according to activity proforma Annexure-I.

RESULTS:

Divided both groups (1 cm slice and 2 cm slice) into 4 lots each (total 8).

Weight of 1 cm slices in each lot / sample = 2.275 kg

Weight of 2 cm slices in each lot / sample = 1.86 kg

DRYING:

STEP-13-17: Selected three sets of trays and pretreated mango slices were placed on the trays. Material after each treatment was placed on separate set of trays. Dehydration was done at 70°C.

TEMPERING:

STEP-18 – 21:

	1 cm slices	2 cm slices
Time required for drying	6 hr	8.30 hr
Moisture after drying	7.25 %	11.40 %

Brix after drying 1 cm slices

	Sample-1	Sample-2	Sample-3	Sample-4
Brix°	64.8	64.0	74.0	61.2

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Comparison of Brix : **Fresh slices vs Dried Slices**

Brix of fresh slices was 25.5 degree. The brix increased as a result of dehydration.

Step-22:

Weight of dried samples

	1 cm slices	2 cm slices
Sample-1	555.8 g	613.8 g
Sample-2	544.9 g	609.0 g
Sample-3	704.2 g	667.4 g
Sample-4	591.4 g	654.5 g
Total weight of dried samples	**2.4 kg**	**2.5 kg**

Step-23: Comparison with the weight of fresh slices

Total weight of dried slices	=	2.4 + 2.5	=	4.9 kg
Total weight of fresh slices	=	9.10 + 7.45	=	16.55 kg
Percentage recovery of 1 cm slices			=	45.5 %
Percentage recovery of 2 cm slices			=	37.25 %

STEP-24-26:

All the samples were placed in Zip lock polythene bags and handed over to FIRMS PROJECTS. Icing sugar was applied to all the samples to avoid stickiness.

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SUMMARY OF RESULTS:

Total weight of mangoes = 40 + 5 = 45 kg

Recovery of fresh slices:

	Weight of slices	Recovery % age
1 cm slices	9.1 kg	45.5
2 cm slices	7.45 kg	37.25
Total slices	16.55 kg	41.37

Recovery of dry slices:

	Weight of slices	Recovery % age
1 cm dried slices	2.4 kg	26.37
2 cm dried slices	2.5 kg	33.55
Total dried slices	4.9 kg	29.6

Pulp recovered = 4.4 kg (11 % of fresh fruit)

Weight of pit = 7.1 kg

Pit may be used to recover the oil which may be used for soap preparation.

Weight of peel = 7.3 kg

Peel may be used for animal feed.

It was also observed that 2 cm slices were not dehydrated properly, particularly inner portion of slices. 2 cm slices contained more moisture that is why they exhibited more recovery.

END

Report prepared by:

Ahmad

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Process Steps for Mango Samples

Variety Chaunsa Summer Bahisht - At color break stage

Sample Siz 45 Kg (40kg + 5kg)
5 Kg for blancing (Separated from the 40 kg sample size)

Sample Preparations*

Step 1 Weigh Mangoes and record weights (40 kg)
Step 2 Put 5 kg for blanching at 50C for 30 minutes. Keep it separate from the 40 kg sample size
Step 3 Peel and pitt
Step 4 Record man hours required for peeling and pittting
Step 5 Measure Brix level and record
Step 6 Divide mangoes (40 kg sample size) into two portions/ groups. Group 3 (5 kg) is for blenched mangoes

	Group 1	Group 2	Group 3 (blenched mango)
Step 7	Cut the mango in 1 cm Slice	Cut the mango in 2 cm Slice	Cut the mango into 1 cm slice
Step 8	Weigh 1 cm slice and record	Weigh 2 cm slice and record	
Step 9	Weigh group 1 and record	Weigh group 2 and record	

Pretreatment

Steps 10 Prepare three solutions

Solution 1	Solution 2	Solution 3
1% ascorbic acid	0.5 % ascorbic acid and 0.5% sodium metabisulfite	40 degree brix suger and 1% ascorbic acid

Step 11 Divide both groups (1 cm slice and 2 cm slice) into 4 lots each. (total 8)

	Group 1 (1 cm slice)				Group 2 (2 cm slice)				Group 3 (blenched mango)
	SAM 1	SAM 2	SAM 3	SAM 4	sam 1	sam 2	sam 3	sam 4	
Step 12	Put SAM 1 in Solution 1 for 15 min	Put SAM 2 in Solution 2 for 15 min	Put SAM 3 in Solution 3 for 15 min	DO NOT treat SAM 4.	Put sam 1 in solution 1 for 15 min	Put sam 2 in Solution 2 for 15 min	Put sam 3 in Solution 3 for 15 min	DO NOT treat sam 4.	No Pretreatment

***Note: Blanching is propsed only to to find out whether it preserves enzymatic browning, so the 5 kg of sample mangoes will be treated separately. Process step 3 will be done seprately for 5 kg. No pretreatment will be done with blanched mangoes and it will be put in a drier after slicing.**

Process Steps for Mango Samples

Annexure-I

Drying

Step 13 Choose three trays in dehydrator (SS trays)

Step 14 Place Teflon Mash/ or other sheet available with PCSIR in all trays

Step 15 Place slices on trays the following way:

Tray 1	Tray 2	Tray 3
Place Group 1 (1 cm slices) on Tray 1 - SAM 1, 2, 3, & 4	Place Group 2 (2 cm slices) on Tray 2 - sam 1, 2 ,3 & 4	Place Blenched mango slices

Step 16 Set the operating temperature of the dryer at 70° degree centigrade

Step 17 When the mango slices are pliable, but slightly leathery, remove them from the drier

Tempering

	Group 1 (1 cm slice)	Group 2 (2 cm slice)	Group 3 (blenched mango slice)
Step 18	Record the time required for drying	Record the time required for drying	No action required
Step 19	Measure moisture level of the sample	Measure moisture level of the sample	
Step 20	Measure the Brix level	Measure the Brix level	
Step 21	Compare to the Brix of raw material (Step 3)	Compare to the Brix of raw material (Step 3)	
Step 22	Weigh 1 cm dried mango slice	Weigh 2 cm dried mango slice	
Step 23	Compare to the weight of fresh slice (step 6)	Compare to the weight of fresh slice (step 6)	

Step 24 Place each lot of dried mango (8 samples) in Separate open containers and observe any color Change over time of about two weeks.

Step 25 Place the lot of blenched mangoes (5 kg) in a separate container and observe any color change.

Step 26 Add Sugar, if necessary, to avoid stickiness

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DRIED MANGO SLICES

(PROCESS / TECHNICAL REPORT)

BY

DR. SAKHWAT ALI

DR. IJAZ AHMAD

DR. M. KHALID SAEED

DR. SHAHJAHAN BAIG

Year : 2010

FOOD AND BIOTECHNOLOGY RESEARCH CENTRE

PAKISTANCOUNCIAL OF SCIENTIFIC AND INDUSTRIAL RESEARCH, LABORATORIES COMPLEX, FEROZEPUR ROAD, LAHORE

DRIED MANGO SLICES

(PROCESS / TECHNICAL REPORT)

BY

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Year : 2010

Submitted to:

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No. of Pages: 05

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PROCESS / TECHNICAL REPOPRT

ILO No: 515 / 26-07-2010 **Dated: August 09, 2010**

In respect of :	**Process / Technical Report of Dried Mango Slices**
Centre / Division / Section:	**Food and Biotechnology Research Centre**
Company Name & Address:	**M/s FIRMS Projects, 44-C-1, Gulberg-III, Lahore**

Technical details of Process of Dried Mango Slices

Mango variety chaunsa summer bahisht and Fajri at color break stage were selected for the processing. Desi mangoes were also used for the preparation of slices. However, Desi magoes were un-riped and color break stage was not yet started. All the steps of process were performed according to Annexure-I.

SAMPLE PREPARATION

The details of different steps evolved in the preparation of sample are given below:

STEP-1: Prepared three samples (each 5 kg) as mentioned in Annexure-I.

STEP-2: Each mango variety was peeled separately

STEP-3: Mangoes were cut into 1 cm thick slices

Brix° of fresh mango slices:

Brix° of chaunsa SB	=	22.6
Brix° of Fajri	=	20.3
Brix° of Desi	=	12.0

PRETREATMENT:

STEP-4: Prepared solution of 1 % sodium metabisulfite

STEP-5: Each sample was placed in solution for 5 minutes in separate pot.

DRYING:

STEP-6-8: Mango slices of each variety were placed on separate set of trays. These trays were placed in trolly and put the trolley in twin tunnel dehydration unit at 70°C for 6 hours.

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STEP-9-10:

	Chaunsa SB	Fajri	Desi
Moisture %	14.86	15.21	12.07
Brix°	70.00	72.00	30.00
Total sugar %	68.57	70.58	28.00

STEP-11: Few slices were pressed to observe the change in texture.

STEP-12: Each variety was placed in Ziploc bag and labeled.

STEP-13: Organoleptic evaluation

	Chaunsa SB	Fajri	Desi
Color	8	7	6
Taste	8	7	6
Flavor	8	8	6
Texture	8	7	4
Overall acceptability	8	7.25	5.5

Scale of scores:

Extermely poor..... 1
Very poor 2
Poor 3
Below fair above poor 4
Fair 5
Below good above fair 6
Good 7
Very good 8
Excellent 9

END

Report prepared by:

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Annexure-I

Process/ Dried Mango Slices	
Varieties of Mango	Chaunsa SB Fajri Desi
Sample Size	15 kg (5 kg each variety)
Sample Preparation Step 1	Prepare three samples (each 5 kg)

Sample A	Sample B	Sample C
Chaunsa SB	Fajri	Desi

Step 2	Peel and pit each variety /sample separately
Step 3	Cut the mango into 1 cm thick slice
	Measure brix of each sample:
Pretreatment Step 4	Preparation of solution 1% sodium metabisulfite
Step 5 **Note**	Place each sample in the solution for 5 minutes Each sample must be placed in the solution separately
Drying Step 6 Step 7 Step 8	Place each variety on a separate tray and place in a dryer at 68 to 70 degrees for 6 hours. Remove the samples from dryer when texture is pilable and leathery. Let cool the samples outside dryer for -- hour
Step 9 Setp 10 Note Step 11 Step 12 Step 13 Step 14	Measure total sugar of each sample Measure Moisture level of each sample (This must be measurement not a calculation) Pressing of each sample slice Place each variety in a ziploc bag and label Organolaptic Test Prepare a written report on the results and submit it to FIRMS Projects.

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TEST REPORT

Report No: FBRC/IA/ANAL./REP./ 515 **Dated: July 27, 2010**

Name & Address of Client: M/s FIRMS Projects, 44-C-1, Gulberg-III, Lahore

Request Ref. # : - **Dated: 20-07-2010** **Sheet No: 1 of 1**

Description of Sample: Dried Mango Slices **No. of Sample(s): One**

ILO Log # & Date: 515 / 26-07-2010 **Ref. / Code # : 12 / 07**

Method used / Specifications: i. Pearson's Composition and Analysis 1999 ii. PSQCA 2000

Temp. & Humidity: -

Statement of Non-compliance: Nil **Testing Date: 26-07-10 to 27-07-10**

RESULTS

Sample No.	Type	Results	
		Total Sugar (%)	Sulfur Residue (ppm)
Sample 1	Sindhri Slices	74.07	32
Sample 2	Lal Badsha Slices	73.62	NA
Sample 3	Chaunsa Slices	72.73	38.4
Sample 4	Philippines	68.18	6.4
Sample 5	Phase I Blanched	75.00	NA
Sample 6	Phase II Chaunsa	NA	35.2

◆END◆

This test report is based solely on the particular sample(s) supplied by the client and should not be reproduced in part.
Sampling has not been performed by the PCSIR Labs. and the PCSIR does not accept the responsibility that the sample(s) supplied is/are truly representative sample(s) of any batch or stock or entire production.
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The party shall assume full responsibility for the ethical use of the results in the test reports and the laboratory shall be held free from any and all claims, which may result from the use of such data by the client or others.
After completion of the report the sample will be preserved for one month until negotiated otherwise.
The contents of this report cannot be, in any manner, used for the publicity of the product or any advertisement.

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HEAD
Food & Biotechnology Research Centre

Countersignature

Director General 10/8/10

PCSIR LABORATORIES COMPLEX LAHORE 515 DT 10/08/10

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Doc. # LLC/QMR/FF/030 | Issue Date: Nov 01, 2006 | Issue. # 01 | Rev. #: 01

TEST REPORT

Report No: FBRC/IA/ANAL./REP./ 515 **Dated:** August 11, 2010

Name & Address of Client: M/s FIRMS Projects, 44-C-1, Gulberg-III, Lahore

Request Ref. # : - **Dated:** 20-07-2010 **Sheet No:** 1 of 1

Description of Sample: Dried Mango Slices **No. of Sample(s):** Four

ILO Log # & Date: 515 / 26-07-2010 **Ref. / Code # :** 01 / 08

Method used / Specifications: Pearson's Composition and Analysis 1999

Temp. & Humidity: -

Statement of Non-compliance: Nil **Testing Date:** 21-07-10 to 23-07-10

RESULTS

Parameters	Dreid Mango Slices from Nawaz Abad Farms			
	Chaunsa	Sindhri	Lal Badsha	Philippines
Brix°	74.00	75.00	75.00	70.00
Moisture %	12.66	19.41	17.15	20.34

◆.....◆END◆.....◆

This test report is based solely on the particular sample(s) supplied by the client and should not be reproduced in part.
Sampling has not been performed by the PCSIR Labs. and the PCSIR does not accept the responsibility that the sample(s) supplied is/are truly representative sample(s) of any batch or stock or entire production.
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The party shall assume full responsibility for the ethical use of the results in the test reports and the laboratory shall be held free from any and all claims, which may result from the use of such data by the client or others.
After completion of the report the sample will be preserved for one month until negotiated otherwise.
The contents of this report cannot be, in any manner, used for the publicity of the product or any advertisement.

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ANNEX VII
Cost/Revenue Study

Summary Cost Revenue Study - 3 Year Projections - Industry								
Projections		**Yr 1**		**Yr 2**		**Yr 3**		
Sales Revenue	**Price per unit per KG (PKR)**							
Domestic	400.00	12,540,000.00		25,080,000.00		37,620,000.00		
Export	600.00	43,890,000.00		87,780,000.00		131,670,000.00		
Total sales revenue			**56,430,000.00**		**112,860,000.00**		**169,290,000.00**	
Operating Costs			**28,310,500.00**	50.17%	**54,238,000.00**	48.06%	**81,040,500.00**	47.87%
Gross Profit			**28,119,500.00**	49.83%	**58,622,000.00**	51.94%	**88,249,500.00**	52.13%
Total Overhead/Office Expenses			**14,842,500.00**		**29,615,000.00**		**44,475,000.00**	
Net Profit Before Taxes			13,277,000.00	23.53%	29,007,000.00	25.70%	43,774,500.00	25.86%

Dried Mango Cost/ Revenue Study - Industry

	Yr 1	Yr 2	Yr 3
No. of farms/processors	**10**	**10**	**15**
Mangoes for drying (KG)	1,100,000	2,200,000	3,300,000
Packaging/processing losses (KG)	5,500	11,000	16,500
Net available dried product (KG)	**104,500**	**209,000**	**313,500**

Market Size	
Domestic Market	30%
Export Market	70%

Y -1

Sales Revenue		**Price per unit per KG (PKR)**	**Quantity (KG)**	
	Domestic	400.00	31,350.00	12,540,000.00
	Export	600.00	73,150.00	43,890,000.00
Total Sales Revenue				**56,430,000.00**
Operating Costs				
Raw Mango Procurement		15.00	16,500,000.00	
Cost of harvesting etc.		1.50	1,650,000.00	
Cost of unskilled labor	7000 per month		7,350,000.00	
Packaging			522,500.00	13,200.00
Pallet Costs			209,000.00	
Gas Cost			1,683,000.00	
Electricity Cost			396,000.00	
Total Cost				**28,310,500.00**
Gross Profit				**28,119,500.00**

Overheads			
Admin + overhead	10% of Direct LC	735,000.00	
Marketing & Advertising	25% of Total Sales Revenue	14,107,500.00	
Total Expenses			**14,842,500.00**
Net Profit Before Taxes			13,277,000.00

Dried Mango Cost/ Revenue Study - Industry

		Yr 1	Yr 2	Yr 3
No. of farms/processors		**10**	**10**	**15**
Mangoes for drying	KG	1,100,000	2,200,000	3,300,000
Packaging/processing losses		55,000	11,000	16,500
Net amount available for dried product		**1,045,000**	**209,000**	**313,500**

Market Size	
Domestic Market	30%
Export Market	70%

Y -2

Sales Revenue	**Price per unit per KG (PKR)**	**Quantity (KG)**	
Domestic	400.00	62,700.00	25,080,000.00
Export	600.00	146,300.00	87,780,000.00
Total sales revenue			**112,860,000.00**

Operating Costs

Raw Mango Procurement		15.00	33,000,000.00
Cost of harvesting etc.		1.50	3,300,000.00
Cost of unskilled labor	7000 per month		14,000,000.00
Packaging			1,045,000.00

Pallet Costs		418,000.00	
Gas Cost		1,683,000.00	
Electricity Cost		792,000.00	
Total Cost			**54,238,000.00**
Gross Profit			**58,622,000.00**
Overheads			
Admin + overhead	10% of Direct LC	1,400,000.00	
Marketing & Advertising	25% of Total Sales Revenue	28,215,000.00	
Total Expenses			**29,615,000.00**
Net Profit Before Taxes			29,007,000.00

Dried Mango Cost/ Revenue Study - Industry

		Yr 1	Yr 2	Yr 3
No. of farms/processors		**10**	**10**	**15**
Mangoes for drying	KG	1,100,000	2,200,000	3,300,000
Packaging/processing losses		55,000	11,000	16,500
Net amount available for dried product		**1,045,000**	**209,000**	**313,500**

Market Size	
Domestic Market	30%
Export Market	70%

Y -3

Sales Revenue	**Price per unit per KG (PKR)**	**Quantity (KG)**	
Domestic	400.00	94,050.00	37,620,000.00
Export	600.00	219,450.00	131,670,000.00
Total sales revenue			**169,290,000.00**
Cost of Raw Material Manufactured			
Raw Mango Procurement	15.00	49,500,000.00	
Cost of harvesting etc.	1.50	4,950,000.00	
Cost of unskilled labor	7000 per month	21,525,000.00	
Packaging		1,567,500.00	
Pallet Costs		627,000.00	
Gas Cost		1,683,000.00	
Electricity Cost		1,188,000.00	
Total Cost			**81,040,500.00**
Gross Profit			**88,249,500.00**

Overheads			
Admin + overhead	10% of Direct LC	2,152,500.00	
Marketing & Advertising	25% of Total Sales Revenue	42,322,500.00	
Total Expenses			**44,475,000.00**
Net Profit Before Taxes			43,774,500.00

Annex VIII

Cost Revenue Study per Farm/Processor

Summary of Projections Per Farm/Processor								
Projections		**Yr 1**			**Yr 2**		**Yr 3**	
Sales Revenue	**Price per unit per KG (PKR)**							
Domestic	400.00	1,254,000.00			2,508,000.00		3,762,000.00	
Export	600.00	4,389,000.00			8,778,000.00		13,167,000.00	
Total sales revenue			**5,643,000.00**			**11,286,000.00**		**16,929,000.00**
Operating Costs			**2,831,050.00**	50.17%		**5,423,800.00**	48.06%	**8,086,550.00** 47.77%
Gross Profit			**2,811,950.00**	49.83%		**5,862,200.00**	51.94%	**8,842,450.00** 52.23%
Total Overhead/Office Expenses			**1,484,250.00**			**2,961,500.00**		**4,445,750.00**
Net Profit Before Taxes			1,327,700.00	23.53%		2,900,700.00	25.70%	4,396,700.00 25.97%

Dried Mango Cost/ Revenue Study - Per Farm

		Yr 1	Yr 2	Yr 3
No. of farms/processors		**1**	**1**	**1**
Mangoes for drying	**KG**	110,000	220,000	330,000
Packaging/processing losses		550	1,100	1,650
Net available dried product		**10,450**	**20,900**	**31,350**

Market Size	
Domestic Market	30%
Export Market	70%

Y -1

Sales Revenue	**Price per unit per KG (PKR)**	**Quantity (KG)**	
Domestic	400.00	3,135.00	1,254,000.00
Export	600.00	7,315.00	4,389,000.00
Total Sales Revenue			**5,643,000.00**
Operating Costs			
Raw Mango Procurement	15.00	1,650,000.00	
Cost of harvesting etc.	1.50	165,000.00	
Cost of unskilled labor	7000 per month	735,000.00	
Packaging		52,250.00	13,200.00
Pallet Costs		20,900.00	
Gas Cost		168,300.00	
Electricity Cost		39,600.00	
Total Cost			**2,831,050.00**
Gross Profit			**2,811,950.00**

Overheads			
Admin + overhead	10% of Direct LC	73,500.00	
Marketing & Advertising	25% of Total Sales Revenue	1,410,750.00	
Total Expenses			**1,484,250.00**
Net Profit Before Taxes			1,327,700.00

Dried Mango Cost/ Revenue Study - Per Farm

		Yr 1	Yr 2	Yr 3
No. of farms/processors		**1**	**1**	**1**
Mangoes for drying	KG	110,000	220,000	330,000
Packaging/processing losses		5,500	1,100	1,650
Net amount available for dried product		**104,500**	**20,900**	**31,350**

Market Size	
Domestic Market	30%
Export Market	70%

Y -2

Sales Revenue	**Price per unit per KG (PKR)**	**Quantity (KG)**	
Domestic	400.00	6,270.00	2,508,000.00
Export	600.00	14,630.00	8,778,000.00
Total sales revenue			**11,286,000.00**

Operating Costs

Raw Mango Procurement		15.00	3,300,000.00
Cost of harvesting etc.		1.50	330,000.00
Cost of unskilled labor	7000 per month		1,400,000.00
Packaging			104,500.00
Pallet Costs			41,800.00

Gas Cost		168,300.00	
Electricity Cost		79,200.00	
Total Cost			**5,423,800.00**
Gross Profit			**5,862,200.00**
Overheads			
Admin + overhead	10% of Direct LC	140,000.00	
Marketing & Advertising	25% of Total Sales Revenue	2,821,500.00	
Total Expenses			**2,961,500.00**
Net Profit Before Taxes			2,900,700.00

Dried Mango Cost/ Revenue Study - Per Farm

		Yr 1	Yr 2	Yr 3
No. of farms/processors		**1**	**1**	**1**
Mangoes for drying	KG	110,000	220,000	330,000
Packaging/processing losses		5,500	1,100	1,650
Net amount available for dried product		**104,500**	**20,900**	**31,350**

Market Size	
Domestic Market	30%
Export Market	70%

Y -3

Sales Revenue	**Price per unit per KG (PKR)**	**Quantity (KG)**	
Domestic	400.00	9,405.00	3,762,000.00
Export	600.00	21,945.00	13,167,000.00
Total sales revenue			**16,929,000.00**

Cost of Raw Material Manufactured			
Raw Mango Procurement		15.00	4,950,000.00
Cost of harvesting etc.		1.50	495,000.00
Cost of unskilled labor	7000 per month		2,135,000.00
Packaging			156,750.00
Pallet Costs			62,700.00
Gas Cost			168,300.00

Electricity Cost		118,800.00	
Total Cost			**8,086,550.00**
Gross Profit			**8,842,450.00**
Overheads			
Admin + overhead	10% of Direct LC	213,500.00	
Marketing & Advertising	25% of Total Sales Revenue	4,232,250.00	
Total Expenses			**4,445,750.00**
Net Profit Before Taxes			4,396,700.00

Annex VIII
Contact List

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