PN ABR-567

STUDY ON REFRIGERATION TECHNIQUES FOR GHERKIN POST HARVEST, HANDLING AND PROCESSING

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For

COMMERCIAL SMALL FARM DEVELOPMENT PROJECT

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Colombo, Sri Lanka

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Financed with resources provide by USAID/Sri Lanka
Cooperative Agreement No.383-0101-A-00-0062

October 1993

acdi

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No 3, McLeod Road
Colombo 4, Sri Lanka

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Gherkin Refrigeration Study

Scope of Work

Purpose: The purpose of this short-term consulting assignment is to study the gherkin harvesting, field grading and sorting, transport to factory, factory grading prior to brining/pickling and recommend refrigeration applications that would result in improved quality at the factory with minimal cost increases.

Specific Tasks:

1. Visit gherkin growing areas supplying product to Pickle Cultivators to observe harvesting and gherkin handling prior to delivery to the collection center.

2. Visit gherkin collection center to observe arrival and sorting, grading and handling at collection center.

3. Observe transport and handling of gherkins from farm to collection center to the Puttalam factory.

4. Observe arrival, handling and grading of gherkins at the factory in Puttalam.

5. Collect gherkin delivery statistics by collection center to understand the volumes being received, sorted and graded at each PCL collection center.

6. Recommend refrigeration applications at the collection centers and for the factory that will result in improved quality and reduced loss. Applications to be considered would be hydrocooling, use of crushed or flake ice, refrigerated transport, etc.

7. Prepare a technical report with technical recommendations, a simple design, BOQ, and cost projections for the preferred cooling system recommended. Use of locally available equipment, machinery, etc. should be a priority as importing expensive cooling equipment would be another non-start.

It must be noted that the gherkin industry is highly competitive and any system that results in a significant increase in cost per kilo of gherkins processed is a non-start. Items to be considered, for example: if hydrocooling or use of ice results in additional cost, perhaps the hand grading and sorting at the factory can be eliminated thereby offsetting the refrigeration cost increase with reduced labour charges at the factory.

PROPOSAL FOR COOLING GHERKINS

A. Requirement:

To cool gherkins after harvest but prior to arrival at processing center in Puttalam cooling is best achieved immediately after harvesting to minimize weight loss, prevent temperature increase due to respiration and hence spoilage of the product as well as minimize deterioration due to injury caused to the gherkins during harvesting.

B. Data Provided:

1. Farms: Small holdings each producing a few kilograms per day.

2. Collecting centers: Farms deliver to collecting centers of which there would be six to eight in operation.

3. Processing centers: The processing center is in Puttalam and is fed by the collecting centers.

4. Harvesting times: Harvesting in the field is carried out twice a day from 6:00 a.m. to 10:00 a.m. and 3:00 p.m. to 6:00 p.m.

5. Daily product output: Each collecting center will collect upto approximately 1.0 metric tons/day although two or three may receive 4-5 metric tons and as there are 6-8 collecting centers, total input to the processing center is upto 15-20 metric tons/day at peak season.

6. Grading on farm: Preliminary weighing and grading is done at the collecting centers according to four sizes.

7. Grading at processing center: The gherkins are regraded by hand and then machine graded into approximately 8 different sizes.

8. Time lapse between harvest and the product reaching the processing center: 18 - 24 hours.

9. Processing center operating hours: The processing center starts operating at 6.00 a.m. daily and continues till input from collecting centers are processed.

10. Weight loss of product: The weight loss of product due to dehydration in between harvest and arrival at processing center could be as much as 10 to 15 per cent. This is when no cooling whatsoever is done on the product. Also, grade loss and putrefaction is a

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factor contributing to losses and reduced quality.

C. Solution:

1. Cooling location: It is apparent that cooling must be provided to prevent weight loss and minimize spoilage. The preference is that cooling be provided immediately on harvesting. However, in the application, due to the small quantities produced by each farm, this is not practical. The alternative is to cool the gherkins at the collecting centers and transport the cool product to Puttalam.

2. Methods of cooling: Cooling of the product can be achieved in three main ways:

   - Forced air circulation in cold room;

   - Vacuuming, lowering pressure in container and hence its saturation temperature;

   - Hydro-cooling: Cooling by either chilled water or flake/crushed ice close to its melting point.

3. Hydro-cooling: Of the 3 main methods hydro-cooling is the most suitable and practical for gherkins. Cooling by chilled water is preferred to ice due to the following disadvantages of the latter -

   (a) The refrigerating system has to work at a lower evaporating temperature for ice making. Hence for the same duty, a large refrigerating plant is required.

   (b) As the evaporating temperature is lower on an ice making plant, compared with a chilled water plant, the power consumed for equal capacity will be higher for ice making.

   (c) If ice is used to pack the gherkins this could cause physical damage to the product. Flake ice with its sharp edges could cut into the gherkins while crushed ice, if not finely crushed, could damage the gherkins by its weight.

   (d) Flake or crushed ice is produced continuously throughout the day and therefore an insulated (and refrigerated) storage bin is required. This of course, adds to the cost.

4. Method of hydro-cooling: Hydro-cooling using chilled water could be achieved by either immersing or spraying the product. Flooding the product is not practical with gherkins, particularly as transport after cooling is involved.

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The disadvantage of spraying the product is that there could be a considerable loss of chilled water even if methods (with extra costs) are provided to collect excess spray water.

Reference is therefore for an immersion type hydro-cooling system.

5. Refrigeration plant: A reasonably economical refrigerating system could be designed to allow for hydro-cooling the gherkins. This could be a complete packaged unit with its own electricity generating set. The capacity of the refrigeration plant will depend on the time taken to cool one ton of gherkins. For example, if this is cooled in two hours, a 10 Hp (7.5 kw) refrigeration compressor set will be required.

September 16,1993

ADDENDUM TO SECTION TWO

Sorting and Collecting Centers

We were advised that normally sorting of the gherkins was done at the collecting centers. However, there are some centers which are collection centers only and where no sorting is executed and gherkins are forwarded directly to the factory.

Appendix Three lists the sorting and collecting centers.

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SECTION THREE

REPORT ON VISIT TO PUTTALAM TO STUDY EXISTING GHERKIN HARVESTING & PROCESSING PROCEDURE, WITH A VIEW TO IMPROVE QUALITY BY REFRIGERATION TECHNIQUES AS MAY BE CONSIDERED NECESSARY

3.1 DATES OF VISIT: 5th to 7th October 1993

3.2 VISIT TO FARMS

Three gherkin growing farms were visited with the intention of observing growing areas, harvesting methods, ambient air temperatures, gherkin temperatures, storage and transport methods on the farm and other related matters.

3.2.1 Daluwa

The first growing area visited was in DALUWA, just 25 minutes by car, south from the Pickle Packers circuit bungalow. Harvesting was in progress and it was noted that:

- The soil was very sandy.
- Gherkins were being harvested into small plastic containers.
- Area under cultivation was relatively small, about one half acre.
- Farm was operated by a family and no outside labour was being hired.
- Watering of the vine was in progress.

Ambient temperatures as well as the temperatures of the four grades of gherkins, immediately after harvest, were measured and recorded. The temperatures of the of gherkins were measured at the core, using a piercing probe. As requested, soil temperatures were taken in the shade in both dry and watered areas.

The farmer does not sort the gherkin according to size, this being done in the sorting/collecting center.

We were advised that harvesting commenced at about 8 a.m. and would go on until 4 p.m. to 5 p.m., when the gherkins would be taken to the collecting center in used fertilizer bags.

The visit to this farm commenced at 8:30 a.m.

3.2.2 Nawakkaduwa

We met the agent for this area but could not see any harvesting in progress. We were advised that, as it was the end of the season, no more harvesting would be carried out. We, therefore, proceeded to Mampuri.

3.2.3 Mampuri

The area is at the Southern end of the Puttalam lagoon, on the road to Kalpitiya. Harvesting was in progress and conditions were very similar to Daluwa, the soil again being very sandy.

Temperatures were taken and recorded as for Daluwa. As we arrived here at 10:25 a.m. we were able to see gherkins which had been harvested up to around three hours earlier. These were stored in the field in old fertilizer bags.

We were advised by the farmer that the day's harvest would be taken to the collecting center at about 6 p.m., when sorting and weighing would commence.

3.3 VISIT TO COLLECTING CENTER

The collecting center which we visited was in Daluwa. The farm visited in the morning, sends its gherkins to this center.
The collecting center was very basic, being in the front varandah of a hut, at which a table of approximately 2.0 meters x 1.0 meters was used to sort the gherkins, for grades, damage and irregular or oversized product. Sorting was done by six girls around the table, the surface of which was roughened by usage.

Grading was achieved by visual inspection of size and separated out into plastic crates each approximately 570 mm x 330 mm x 260 mm high. Each container weighed 1.0 kg empty and held about 20 kg of gherkins.

Gherkins arrived at the collecting center in old fertilizer bags, onion bags and sugar bags each holding about 50 kg of gherkins. They were delivered on the back of bicycles, in hand pushed carts and two wheeled tractor-trailers. Unloading was directly onto the ground and we witnessed one bag spilling its contents when dropped from the cart while in other cases the bags were allowed to fall to the ground. Obviously, unnecessary damage was caused to the product, resulting in rejections.

There were two types of plastic containers in which some gherkins were received at the collecting center. They were both suitable and more acceptable than the bags being used.

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We were advised that three lorries transport the gherkin, from all the collecting centers in the Puttalam region. One lorry is assigned to collecting centers along Kalpitiya Road.

Each lorry covers approximately 150 km travelling from center to center and finally to the processing factory. The lorries also transport the women employees from Puttlam town for sorting at the collecting centers. After collecting the gherkins in both bags and plastic containers from the collecting centers the lorries arrive at the processing factory from around midnight onwards.

3.4 PROCESSING FACTORY

We arrived at the processing factory just a few minutes away from the circuit bungalow, at 4:30 a.m. Sorting of the gherkins had already commenced. There was a light rain and the ambient dry bulb temperature was 26.7° C.

3.4.1 Sorting

Sorting by hand was undertaken around six tables with four women per table. The tables were not much bigger than the one at the Daluwa collecting center and the condition of the tables was much the same.

Other employees were engaged in weighing the incoming bags/crates and delivering these to the four tables for sorting and storing/stacking the empty crates.

Possible physical damage to the gherkins in the factory was noted in the following operations:

- sacks dragged off lorry
- sacks pulled off weighing scale
- bruising on rough surfaced sorting tables
- throwing of the sorted gherkins into the crates which are at floor level.

It should be mentioned that on more than one occasion factory supervisors warned the staff not to drag the bags of gherkins along the floor.

During the inspection it was noted that supplies received from Bingiriya were particularly in poor condition.

3.4.2. Haylanka Supplies

Haylanka supplies only grade 1 gherkins to Pickle Packers Ltd. The lower grades are supplied to competitors. Their deliveries began arriving just before 6:00 a.m. All gherkins arrived in plastic crates and temperatures of several samples were taken and ranged from 24.3° C to 26.4° C, generally 3° C to 5° C lower in temperature than all other gherkins received.

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It is understood that usually the Haylanka gherkins are dipped in vats holding water cooled by dumping blocks of ice into it. However, we were informed that at the time of our visit, the water was not being cooled by ice. Haylanka cools the gherkins after sorting at their collecting center, ie, prior to despatch to the factory.

As the Haylanka supplies arrive at the factory after 6:00 a.m. on the day following harvesting, hydro-cooling is done about 20 hours after harvesting commences. Any weight loss occurring from time of harvest until sorting in the collecting center is regained by hydro-cooling. The effect on retardation of spoilage is minimal as hydro-cooling is carried out so long after harvesting. However, the advantage of weight gain is beneficial to the supplier.

Haylanka supplies (approximately 2.0 M tons) after weighing are also delivered to the sorting tables just as for all other suppliers. As the product arrives in plastic crates, damage in the factory is minimized.

3.4.3 Post Sorting Activity

After sorting, the product in crates is taken to a mechanical washer into which the gherkins are unloaded from the crate. Washing time is approximately one minute per batch of four crates. The gherkins are then transferred to a second vat from where they are loaded to the conveyor leading to the mechanical sorter according to sizes specified by the overseas clients. Manual sorting at the collecting centers and the factory into only four grades would therefore appear to be only for payment purposes to the out growers.

3.5 ICE PLANTS

As the possibility of using block ice or flake ice for hydro-cooling falls within the scope of work, visits to ice factories in the Puttalam region were considered.

3.5.1 Ceylon Fisheries Corp. Ice Factory- Puttlam

This ice factory which is a few minutes drive South of the Pickle Packers Factory was visited.

The rated output of this factory was stated to be 105 x 50 kg blocks per day (5.25 M.T. day). However, on inspecting the ice it was noted that the core of the ice block was hollow, indicating that the ice had been harvested before the ice had fully formed. It is estimated that each block would not weigh more than 35 kg. The quality of ice in the store was also very poor.

The ice making equipment showed lack of maintenance, and reliance on regular supplies from this factory would be a

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mistake. This is the only ice factory in Puttlam.

3.5.2 Ice Factory in Kurunegala

There is doubt of the existence of an ice factory in Kurunegala which is about 120 km from Puttalam.

3.5.3 Ice Factory in Battuluoya

There is an ice factory belonging to the Ceylon Fisheries Corporation in Battuluoya about 50 km South of Puttlam on the road to Chilaw. This plant produces 5.0 M tons of ice in 25 kg blocks but is not conveniently located as far as ice requirements for Pickle Packers Ltd.

3.6 GHERKIN DELIVERY STATISTICS

To understand volumes of gherkins arriving at the various collecting centers and being delivered at the Processing Factory, it was necessary to collect delivery statistics.

3.6.1 Statistics

Statistics were available at the office of Pickle Packers, Ltd., next to the circuit bungalow. They were studied for both August and September '93 as these were stated to be the peak production months. From the statistics it was evident that production was greater in August and hence this month's figures were studied more closely.

As statistics were kept on a weekly basis, average figures were obtained for each day. The tabulated results are shown in Appendix Two, in Section Five. From the statistics it is derived that:

(i) There are three main collecting districts - Puttalam, Kurunegala, Bakamuna.

(ii) Number of collecting centers in each district:

Puttalam	21
Kurunegala	13
Bakamuna	3
Total	37

(iii) Some interesting statistics derived from the information given are tabulated below:

	PUTTALAM	K'GALA	BAKAMUNA	TOTAL
Average Daily Collection kg.	8,643	3,705	3,608	15,956
Total Monthly Collection "	267,943	114,846	111,852	494,638
Total Monthly Rejection "	17,215	7,358	16,651	41,224
Total Processed in Month "	205,726	107,488	92,201	453,414
% Rejects	6.4 %	6.4 %	14.9 %	8.33%
% of Collection (of total)	54.2 %	23.2 %	22.6 %	100.00%

It will be noted that:

a) Puttalam district accounts for approximately half the total collection and the balance is equally shared between Kurunegala and Bakamuna district.

b) Rejects are worst from Bakamuna district (14.9 %) while Puttalam and Kurunegala are the same at 6.4 % each.

c) Rejects include spoilage. damage, crookeds and nubbins. Breakdown figures for rejects due to spoilage alone were not available. As sorting is undertaken in the collection centers, rejections of crookeds and nubbins at the factory are expected to be minimal. This indicates high percentage for spoilage and damage.

d) No figures were available for rejects at the collecting centers.

e) The lowest percentage of rejects was from gherkins supplied by Haylanka at 1.69 per cent (or 1.27 M.T. of 75.5 M.T. supplied in August 93).

f) The highest percentage rejects was for supplies from Galawela at 16.3 per cent (1.1 M.T. of 6.8 M.T. supplied). This exclude Thabbowa and Maho where totals supplied for the month were less that 1.2 M.T. and rejects were as high as 60% per cent.

3.7 OBSERVATIONS

Pertinent observations following visits to the outgrowers farms, collecting centers and processing factory could be categorized as follows:

3.7.1 Time period from harvesting to processing.

Harvesting	8:00am to 6:00 pm
Delivery collection center	5:00pm to 7:00 pm
Sorting at collecting center	6:00pm to 12:00 midnight
Delivery at proocessing time	1:00am to 6:30 pm
Sorting at processing factory	4:00am to 2:00 pm*
Processing in factory	7:00am to 3:00 pm*

* at peak periods

From the above the time taken from harvesting to having the gherkins ready for processing can be deduced.

eg. 8 am on day 1 to 4 am on day 2 = 20 hours
6 pm on day 1 to 2 pm on day 2 = 20 hours

The time taken to have the gherkins ready for despatch from the collecting center after weighing and sorting, from time of harvesting is:

Maximum 8 am to 12 midnight same day = 16 hours
Minimum 5 pm to 12 midnight same day = 7 hours

As we have stated previously, cooling of vegetables should be carried our immediately after harvesting for optimum results. Cooling requirements depend on the degree of the ripening of the product and the ambient temperature at time of harvesting. Gherkins and other members of the cucumber family are less perishable than vegetables such as cauliflower, bean and leafy vegetables. Therefore, if the product could be taken to the processing center within a much reduced period, refrigeration may not be required at all.

3.7.2 Injury of the product

Injury to the surface of the product will accelerate spoilage and thus it is essential that injury should be prevented. At present injury to the product is produced in several ways:

On the vine.- In the region visited, the gherkins are grown is very sandy soil. During the windy season, (if this coincides with the growing period) the sand particles could cause injury to the tender tissue.

At harvesting.- When the gherkins are transferred to the sacks, in the field.

Transport to collecting center.- Dumping on the sorting table, rough-surfaced sorting tables, throwing into sorting containers, repacking into sacks and loading into lorry (crates preferred).

At processing factory.- Unloading from lorry, dragging to weighing scale and pulling off weighing scale, when in sacks, dumping on sorting table, throwing into crates after sorting.

3.7.3 Ambient Temperature

The visit was in the early October when ambient temperatures were comparatively low (see Appendix 1 for temperatures recorded). During the hot season temperatures in the mid to upper 30's can be expected.

3.7.4 Harvested Quantity

The maximum daily average weight of product delivered to the factory in August'93 was 16 M tons, whereas during the visit, total input was about one third of this.

3.7.5 Product Temperatures Prior to Processing

The product temperatures measured at various stages prior to processing are indicated in Appendix 1. It varies from between 27.1° C to 32° C (except Haylanka for which see below).

3.7.6 Haylanka Supplies

Haylanka supplies were the best in the following respects:

- least rejects
- lower temperature (24.3° C to 26.4° C).
- all arrived in crates
- good sorting at collecting center

We understand that, at the time of inspection, Haylanka was not using ice in water bath for hydro-cooling but dipping the gherkins in water. The lower temperature being due to water temperature being lower than ambient. Dipping in water has little advantage to prevent spoilage as this is done nearly 20 hours after harvesting. However, it does add weight to the product giving the supplier a monetary advantage.

3.7.7 Transport Arrangements

It is understood that three lorries are engaged in the Puttalam district in transporting the sorters to the collecting center and then taking the product to the processing factory, collecting the gherkins by travelling from collecting center to collecting center.

As there appears to be 21 collecting centers in the Puttalam district on an average, each lorry will cover 7 collecting centers and transport 5 to 6 M tons per day at peak harvests. Travelling from collecting center to collecting center increases the time in which the product is in transit and therefore subject to possible injury.

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SECTION FOUR

RECOMMENDATIONS

Following the inspection and observations recorded herein, the following recommendations are made.

4.1 CRATES VS SACKS

It is recommended that the use of sacks be discontinued completely in all stages from harvest to process.

There are two types of plastic crates being used. They are both suitable but we suggest that one type be made the standard for uniform stacking.

4.2 COLLECTION TIMES

At present, delivery at the collecting centers is at around 6:00 pm including product harvested at 8:00 am.

We recommend that two collections per day be made, one at 12 noon and the other at 6:00 pm. This will mean <u>two deliveries to the factory, which will result in better usage of factory equipment.</u>

Admittedly, there will be some increase in transport costs, but it is believed that some of it will be offset by reduced rejections and by the use of smaller vehicles.

Another factor, is that we were informed that some farms do not harvest in the afternoon. It will be good to obtain some feed back on what proportion of the farms harvest only in the morning session. These farms will be keeping their product out in the open from around noon till 6:00 p.m. for delivery to the collection center.

Please see 4.6 "Transport Arrangements" below.

4.3 SORTING AT COLLECTING CENTERS

Sorting at the collecting centers takes in the region of 6 hours or more (5:00 p.m. to midnight) and is a major reason for the delay int the product reaching the processing factory, from time of harvest.

We would like to see this delay eliminated completely considering the overall high rejection of 8.3 percent at the factory. However, it is appreciated that the out growers will require some indication of the proportion of the four different grades he supplies, to be able to ascertain his actual income.

One possible way to overcome this is to take only a sampling of the gherkins delivered to the collection and sortiong centers in by each outgrower and assume that

this is a representative sample of the total supply. This alternative, will of course, require agreement from the outgrowers.

The omission of full scale grading at the collecting center will also result in less damage to the product by reduced handling. It will also accelerate the delivery time to the factory.

We were told that Aitken Spence and Hayleys, deduct a flat 3.0 per cent from the weighed supply, on the basis that this percentage will be rejected due to various reasons.

Few outgrowers, if any, wait at the collection centers till their product is sorted and re-weighed.

4.4 SORTING AT FACTORY

The sorting at the factory is time consuming and subjects the product to damage. It is recommended that a conveyor belt system be employed to reduce sorting time. Space for this is available in the factory. It is recognized that manual sorting is necessary, to ensure spoilt product, crookeds and nubbins are rejected. The sorters could sit on either side of the conveyor (preferred to present standing) which could either be in-line or "U" shaped.

The belt itself should be of the same material and type as used at the infeed of the mechanical sorter.

Manual grading (into 4 grades) of the gherkins at the factory should be eliminated as the automatic mechanical grading unit performs its function most satisfactorily. This will reduced the number of employees at the factory and contribute to the reduction of costs. From the present 50 or so employees, the work force could be reduced by more than half, if manual grading is eliminated at the factory.

This will also help reduce the time between harvest and actual processing, again resulting in reduced spoilage.

Please see Appendix Six for proposed layout of sorting conveyor in relation to weighing station and mechanical grader.

4.5 WASHING EQUIPMENT

The existing washing equipment (after sorting) is a batch system and requires much manual labour, apart from the fact that it is a bottle neck in processing even at present. It will be more of a bottle neck if the semi-automated process recommended is adopted.

A relatively simple in-line washing arrangement is possible and this could be located in-between the weighing station for the incoming product and the start of the sorting conveyor belt. The product could be dumped into a concrete washing trough from where an inclined conveyor will lead the product to the sorting conveyor.

4.6 TRANSPORT ARRANGEMENTS

We recommend that smaller and an increased number of vehicles be used to transport the product from the collecting centers to the processing factory. This will reduce the time the product is in the lorry travelling from center to center on roads which are far from ideal. More importantly, it will reduce the time taken for the product to arrive at the factory from the time of harvest.

4.7 REFRIGERATION

If all the above proposals are implemented, we believe that investment in mechanical refrigeration employed for hydro-cooling may, in fact, not be necessary.

It is envisaged that the time period from harvesting to the product being ready for processing in the factory could be reduced from 20 hours to 8 hours.

If refrigeration is to be used, hydro-cooling is the most practical for this application, as explained in SECTION TWO of this report.

However, we must not lose sight of the fact that refrigeration can only retard spoilage. It cannot improve a product or reverse the process of spoilage, if this has already commenced. In other words refrigerating a spoilt product will not make it fresh again.

It is for this reason, that it has been necessary to study how damage to the product and spoilage could be reduced by changing the present methods of transport, handling and sorting.

If refrigeration is to be used, this should be accomplished as soon as possible after harvesting. Two alternative methods of hydro-cooling are recommended below, keeping in mind that any system should be cost effective.

4.7.1 Option "A" Melting Ice

Use ice to lower the temperature of water in an open rectangular container, which should be insulated on all four sides and the bottom. The tank dimensions will be approximately 2.5 m long x 0.8 m wide x 0.5 m high. The

tank is to be made of mild steel to make it portable, so that it could be moved from one collecting center to another as required.

The tank will hold 8 plastic crates each with 20 kg of gherkins. Chilling from 35° C to 15° C or so can be achieved in 15 minutes, giving a total output of 640 kg or about 1000 kg in 1.5 hours.

The quantity of ice required per batch of 8 crates is 50 kg. As a 50 kg block of ice cost Rs. 60.00, the cost of chilling per batch is Rs. 60.00 or Rs. 375.00 per 1000 kg, excluding transport costs and handling.

Apart from Haylanka, the other centers which have collections in the region of 2.0 M tons per day are Bakamuna and Medagama. This system could be tried out at either of the two centers. The cost of the insulated tank is estimated to be Rs. 35,000.00 ex Colombo.

This is a very simple arrangement that has been proposed, as costs have to be kept to a minimum. It will be noted that it is proposed to retain the gherkins in the crates during the chilling process. Ideally, agitation of water, for example by blowing compressed air upwards, is preferred. In this case some agitation can be obtained by moving the crates in the water.

The whole crate will be just immersed in water and if some of the gherkins tend to float out of the crate, they can be kept in place by a simple perforated cover over each crate during the chilling process.

The tank should be fitted with timber bottoms at the base and guide rails for the crates.

Please see Appendix Four for further information and calculations.

4.7.2 Option "B" Ice Bank System

This system builds up a bank of ice around a set of pipe coils immersed in a tank of water. When required, the water at about 1° C is pumped into the hydro-cooling tank which is partially filled with mains water to give a mix temperature of around 10° C to 12° C. The refrigeration plant is designed to operate for about 12 hours per day, outside the actual hydro-cooling period, to build up the bank of ice. Once the ice bank has been formed the plant is stopped and water drawn off as required.

This system is designed to cool up to 2000 kg of gherkins in just over three hours. If the refrigeration plant is run for longer hours, a bigger ice bank can be obtained and a larger quantity hydro-cooled, within limits of course.

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The ice bank principle allows the use of a smaller compressor operating for longer hours and hence reduces the capital cost of the plant.

A direct cooling system as opposed to an ice bank system operates only for the hours that cooling is required and lies idle for the rest of the day.

The hydro-cooling tank used for this system will be identical to that proposed for Option "A" and the hydro-cooling arrangement will also remain unchanged.

By installing the refrigerating system it will not be necessary to rely on outside ice suppliers. The ice bank system will require approximate a 5 kw generating set at 0.8 power factor, if an adequate 400v - 3ph - 50 Hz power supply is not available.

The total cost for this system for budgetary purposes would be as follows:

Ice bank unit installed	Rs. 1,500,000
Hydro-cooling tank	Rs. 35,000
Generator set	Rs. 200,000
Total	Rs. 1,735,000

Please see Appendix Five for design details and calculations for the in bank refrigeration system.

PRIORITY IN IMPLEMENTATION OF RECOMMENDATIONS

The essence of this report is that for an improved final product, damage due to excessive or improper handling should be eliminated and the time between harvest and processing be reduced to the very minimum. Refrigeration is to be utilized where distances between the farms, collecting centers and processing factory are excessive.

Having the above in mind, the order of priority in implementation of the recommendation is given below:

1. CRATES:

   ELIMINATE THE USE OF SACKS AT EVERY STAGE OF COLLECTION AND TRANSPORT. PROVIDE ONLY PLASTIC CRATES OF ONE OR THE OTHER OF THE TWO TYPES BEING PRESENTLY USED.

2. SORTING:

   (A) AT COLLECTION CENTER: REDUCE TO SAMPLING ONLY

   (B) AT PROCESSING FACTORY: ELIMINATE MANUAL GRADING BUT INSTALL CONVEYOR WITH WASHING ARRANGEMENT FOR SORTING OF SPOILT PRODUCT, CROOKED AND NUBBINS.

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3. TRANSPORT

CONSIDER TWO COLLECTIONS PER DAY IF OVERALL COST INCREASE IS NOT EXCESSIVE. THIS COULD PERHAPS BE TRIED OUT AT THE COLLECTION CENTER CLOSEST TO THE PROCESSING FACTORY.

4. MELTING ICE

INSTAL PILOT INSULATED TANK AT ONE COLLECTING CENTER PREFERABLY FURTHEST FROM FACTORY WHERE EXISTING REJECTION RATE IS HIGH AND TOTAL SUPPLIES WARRANT IT.

Note:

THE INSTALLATION OF A COMPLETE MECHANICAL REFRIGERATION PLANT IS NOT CONSIDERED VIABLE WITH THE LARGE NUMBER OF SMALL FARMS AND MANY COLLECTION CENTERS.

IN CONCLUSION

Mr. D.M.P. Abeyawardena accompanied the writer throughout this inspection while Mr. Kumaragamage and Mr. Vasantha took us round the farms and collecting center.

Mr. Ahilleswaran at the factory gave us information on the processing procedure while Mr. Thambirajah compiled the statistics on gherkin intake and processing, which are used in this report.

The writer wishes to thank all these gentlemen for the assistance so readily given and the patience in answering all the questions raised.

End

APPENDIX ONE

PICKLE CULTIVATORS (Pvt) LTD

Temperatures of gherkins ambient air and soil

6th & 7th October 1993

		DALUWA	MAMPERI	FACTORY
Date		06–Oct–93	06–Oct–93	07–Oct–93
Time		9:30 A.M.	10:25 A.M.	4:30 A.M.
Ambient Dry Bulb Temp	° C	29.2	30.8	
CORE TEMP. OF GHERKINS				
(just harvested)				
No 1 Grade	° C	27.3	29.5	–
No 2 Grade	° C	27.1	31.0	–
No 3 Grade	° C	27.1	30.1	–
No 4 Grade	° C	27.1	32.0	–
CORE TEMP. OF GHERKINS				
(3 1/2 hours after harvest)				
No 1 Grade	° C	–	30.1	–
No 2 Grade	° C	–	29.2	–
No 3 Grade	° C	–	29.3	–
No 4 Grade	° C	–	29.4	–
SOIL TEMPERATURE		–		
Dry (in shade)		28.8	27.5	
Water (in shade)		28.8	27.5	
Dry (in direct sunlight)		–	30.8	
Water (in direct sunlight)		–	29.7	
AT COLLECTING CENTER				
Time		6:30 P.M.	–	
Ambient Dry Bulb Temp	° C	27.9		
CORE TEMP OF GHERKINS				
(on sorting table)				
No 1 Grade	° C	27.3	–	–
No 2 Grade	° C	28.7	–	–
No 3 Grade	° C	28.7	–	–
No 4 Grade	° C	28.7	–	–
AT PROCESSING FACTORY–PUTTALAM				
Ambient Dry Bulb Temp		–	–	26.7
CORE TEMPERATURE OF GHERKINGS				
(undetermined source)				
No 1 Grade	° C	–	–	27.1
No 2 Grade	° C	–	–	28.4
No 3 Grade	° C	–	–	29.9
No 4 Grade	° C	–	–	29.2
TEMPERATURE OF GHERKINS				
(Ex Haylanka)		–	–	24.3
No 1 Grade		–	–	To 26.4

Notes:

1. Temperature of gherkings taken at core using piercing thermometer with "K" Type thermo–couple.
2. Haylanka supply only No 1 Grade. First lorry arrived at 5:58 AM.

APPENDIX TWO

STATISTICS OF GHERKIN COLLECTIONS

IN AUGUST 1993

MONTHLY CROP FIGURES
AUGUST 1993

APPENDIX TWO

REGION	1-6 Aug-93	Avg. p/day	7-13 Aug-93	Avg. p/day	14-20 Aug-93	Avg. p/day	21-27 Aug-93	Avg p/day	28-31 Aug-93	Avg p/day	Total	Rejects	GROSS TOTAL	Per cent rejects
PUTTALAM														
Hay Lanka	16231	2705	18693	2669	16889	2413	14933	2134	7464	1866	74206	1272.5	75478.5	1.7%
Thalawila	2973	496	4474	639	5851	836	6808	973	4191	1045	24297	851	25138	3.4%
Samaragama	-	-	-	-	294	42	874	125	570	143	1738	227	1965	11.6%
Kandathoduwawa	1349	225	1365	195	1585	226	1777	254	808	202	6884	1074	7958	13.5%
Poonapitiya	1311	219	876	125	649	93	318	45	247	62	3401	235	3636	6.5%
Nawakkadu	1358	226	2554	365	3012	430	2856	408	1791	448	11571	1889	13460	14.0%
Rathmalgahawawa	3749.5	625	3046	435	1423	203	147	21	-	-	8367.5	737	9104.5	8.1%
Thabbowa	-	-	-	-	-	-	-	-	66	17	66	99	165	60.0%
Nagollagama	3699	617	4611	659	4382	626	2980	426	956	239	16628	554	17182	3.2%
Inginimitiya	1263	211	1838.5	263	1614	231	985	141	149	37	5849.5	540	6389.5	8.5%
Hiripitiya	7160	1193	5513	788	4684	669	2375	339	740	185	20473	1346	21819	6.2%
Mahauswewa	1268	211	2424	346	2942	420	2123	303	812	203	9569	746	10315	7.2%
Rajanganaya T 15	749	125	1482	212	1955	279	1382	197	555	139	6123	713	6836	10.4%
• T 8	665.5	111	998	143	1052	150	786	112	370	93	3871.5	493	4364.5	11.3%
• L Bank	1031	172	1796	257	3009	430	2832	405	1680	420	10348	1123	11471	9.8%
Yapahuwa	3326	554	6463	923	6971	996	5164	738	2011	503	23935	1384	25319	5.5%
Beliya Kanda/Dewahuwa	812	135	2204	315	4253	608	5227	747	3965	991	16461	1991	18452	10.8%
Galewela	1274	212	1181	169	1192	170	1332	190	692	173	5671	1105	6776	16.3%
Madawachchiya	-	-	24	3	292	42	455	65	-	-	771	193	964	20.0%
Maho	-	-	67	10	370	53	61	9	7	2	505	642	1147	56.0%
KURUNEGALA														
Wariyapola	2246	374	4796	685	4880	697	4309	616	2019	505	18250	352	18602	1.9%
Medagama	15196	2533	14535	2076	11647	1664	7042	1006	2256	564	50676	4006	54682	7.3%
Meeliyadda	2444	407	3100	443	2962	423	3093	442	2403	600	14002	834	14836	5.6%
Mawathagama	76	13	170	24	158	23	101	14	83	20	588	90	678	13.3%
Madahapola/Kolongolla	34	5	-	-	-	-	-	-	-	-	34	2	36	5.6%
Pangolla	215	36	136	19	108	15	79	11	-	-	538	76	614	12.4%
Hippola	739	123	2726	389	3829	547	2858	408	1346	337	11498	726	12224	5.9%
Pilasoa	147	25	901	129	1346	192	1153	165	640	160	4187	367	4554	8.1%
Rathwita	118	20	221	32	281	40	755	108	810	202	2185	354	2539	13.9%
Kotikapola	218	36	763	109	1179	168	1353	193	801	200	4314	359	4673	7.7%
Gangoda	83	14	369	53	67	10	-	-	-	-	519	75	594	12.6%
Naiiya	74	12	395	56	229	33	-	-	-	-	697	117	814	14.4%
Padaviya	961	160	1292	183	316	45	326	47	-	-	2885	446	3331	13.4%
Bakamuna	12246	2041	16576	2368	24601	3514	23440	3348	11364	2840	88227	15511	103738	15.0%
Embilipitiya	-	-	1035	148	1479	212	-		1575	394	4089	674	4763	14.2%
	83016	13836	106606.5	15230	115500	16500	97931	13990	50361	12590	453414.5	41203.5	494618	8.3%

S U M M A R Y

*(All quantities in Kilograms)

														% of total
Padaviya, Bakamuna and Embilipitiya	13207		18893		26396		23766		12939		95201	16651	111852	14.9%
Puttalam	48219		59601.5		62419		53422		27064		250725.5	17214.5	267940	22.6%
Kurunegala	21590		28112		26685		20743		10358		107488	7358	114846	54.2%
TOTALS	83016		106606.5		115500		97931		50361		453414.5	41223.5	494638	23.2%
														8.3% 100.0%

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APPENDIX THREE

LIST OF SORTING AND COLLELCTING

CENTERS

PICKLE CULTIVATORS (PVT) LTD.

[illegible] SORTING & COLLECTING CENTRES

	Sort	Collection		Sorting	Col.
Haylanka	x	x	Samaragama	-	x
Thalawila	x	x	Kandathoduwawa	-	x
Poonapitiya	x	x	Navatkadu	-	x
Rathmalgasweve	x	x	Thambowa	-	x
Nagollagama	x	x	Inginimitiya	x	x
Hiripitiya	x	x	Mauswewe	x	x
Rajanganaya T/25	x	x	Yapahuwa	x	x
- do - T/08	x	x	Beliyakando	x	x
-do - L/B	x	x	Dewahuwa	x	x
Galewela	x	x	Maho	-	x
Medewatthiya	x	x	Refugeas	-	x
Bingiriya	x	x	Rambepitiya	x	x
Wariyapola	x	x	Medigama	x	x
Meeliyadde	x	x	Mawathagama	x	x
Madapola	x	x	Kolangolla	x	x
Pangolla	x	x	Hippola	x	x
Pillaseo	x	x	Rathwita	x	x
Kotikapola	x	x	Ganagoda	x	x
Nailiya	x	x			
Padaviya	x	x	Bakamoona	x	x
Dabilipitiya	x	x	Koshena	x	x

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To: The Chief Executive Officer, Attn: Mr. [illegible] M.P.Abeyaberdane,
Pickle Cultivators Ltd.

From, C.Thambirajah
Pickle Cultivators
Puttalam.

Date. October 1993.

APPENDIX FOUR

DESIGN FOR HYDRO-COOLING GHERKINS UTILIZING MELTING ICE RATE OF 640 KG/HR

DATA

Dimensions of plastic crate	:	570mm x 330mm x 260mm
	=	22½ in x 13 in x 10¼ in
Capacity of gherkin/crate	:	20 kg (N° 2 100/kg)
Incoming gherkin temperature	:	35° C
Final gherkin temperature (recommended)	:	15° C
Specific heat of gherkin	:	0.97 kcal/kg° C
Film co-efficient of heat transfer (estimated)	:	200 Kcal/hr m^2

Highest daily collection during August '93:

Haylanka	:	2435 kg
Medagama	:	1764 kg
Bakamuna	:	3345 kg

Recommended batch chilling capacity	:	8 x 20 kg crates
	=	160 kg
Estimated chilling time/batch	:	15 minutes
Hourly chilling rate	:	640 kg

CALCULATIONS

Cooling load/batch	:	160 kg x 0.97 kcal/kg°C x (35-15)°C
	=	3104 kcal
Latent heat of Ice	=	80 kcal/kg of ice
Quantity of ice required	=	3104 : 80 = 38.8 kg
Allow safety margin for losses		20 %
Quantity of ice reqd/batch	=	38.8 x 1.2
	=	46.56 kg
	=	50 kg
Kg gherkin cooled/kg of ice	=	$\frac{160}{50}$ = 3.2 kg
Time required to cool 1000 kg of gherkins	=	1000 kg : 640 kg/hr
	=	1 hr 34 min
Chilled water tank dimensions	=	3m x 1m x 0.5m
tank construction	=	4.5mm thick mild steel sheet epoxy coated
Insulation thickness (rigifoam)		50mm
Outer sheathing of tank	=	16g m.s. epoxy coated steel
Arrangement of crates in tank	=	2 wide x 4 long
Mix temperature of water & ice	=	0°C to 12°C

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ESTIMATED COST OF TANK (INSULATED)

Ex Colombo		Rs. 35,000.00
Cost of 50 kg block of ice	=	Rs. 60.00
Blocks of ice reqd/1.0 MT gherkins	=	$\frac{1000}{160}$ x 1 block
	=	6.25 block
	=	6.25 x Rs 60.00
	=	Rs. 375.00

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APPENDIX FIVE

DESIGN FOR HYDRO-COOLING GHERKINS UTILIZING AN ICE BANK TYPE REFRIGERATING SYSTEM FOR 2000 KG IN THREE HOURS

DATA

Data detailed in appendix Four apply equally to this refrigerating system.

CALCULATIONS:

Cooling load/batch:

= 160 kg x 0.97 kcal/kg°C x (35-15)°C = 3104 kcal
Cooling load/hour = 12,412 kcal/hr
Time required to cool 2000 kg = $\frac{2000}{160x4}$ = 3.125 hours

Total Cooling load for 2000 kg:
= 12,412 kcal/hr x 3.125 = 38,788 kcal
Add 20% contingency margin for losses = 38,788 x 1.2
Total cooling load = 46,545 kcal
Compressor running time = 12 hours
Compressor capacity reqd:
= 46,545 kcal : 12 hours = 3879 kcal/hr
Latent heat of fusion of ice 80 kcal/kg
Qty. of ice to be built up 46,454 : 80 = 581 kg

Say = 600 kg.

Chilled water temp off ice bank	: 1.5°C
Mains water temp	: 30°
Mix temperature required	: 10-12°C
Required compressor capacity	: 3879 kcal/hr
	= 4512 watts
	= 1.29 tons R
Condenser of refrigerating system	: Air cooled
Evaporating temp	: minus 3°C
Ambient air temp	: 36°C
Refrigerant	: R22
Type of Compressor	: Semi-hermetic/open
Required power supply	: 400v-3PH-50Hz
Anticipated compressor motor power	: 3.0 kw
Air compressor (for air agitation)	: 0.5 kw
Water pump (for transferring chilled water)	: 0.5 kw

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BRIEF SPECIFICATION OF EQUIPMENT:

The air cooled condensing unit is to have a capacity of not less than 3900 kcal/hr with a saturated suction temperature of minus 5°C and air on condenser at 36°C when operating on R22 refrigerant.

The ice bank tank shall be of minimum 4.5 mm thick m.s. plate suitably stiffened and insulated. The insulation shall be protected with an outer sheeting of 20g stainless steel. The coil inside the tank shall be type K or equal copper pipe of sufficient length to build an ice bank of 600 kg to a thickness of not greater than 32 mm. An air compressor shall be provided for air agitation and a centrifugal water pump for transferring the chilled water to the hydro-cooling tank.

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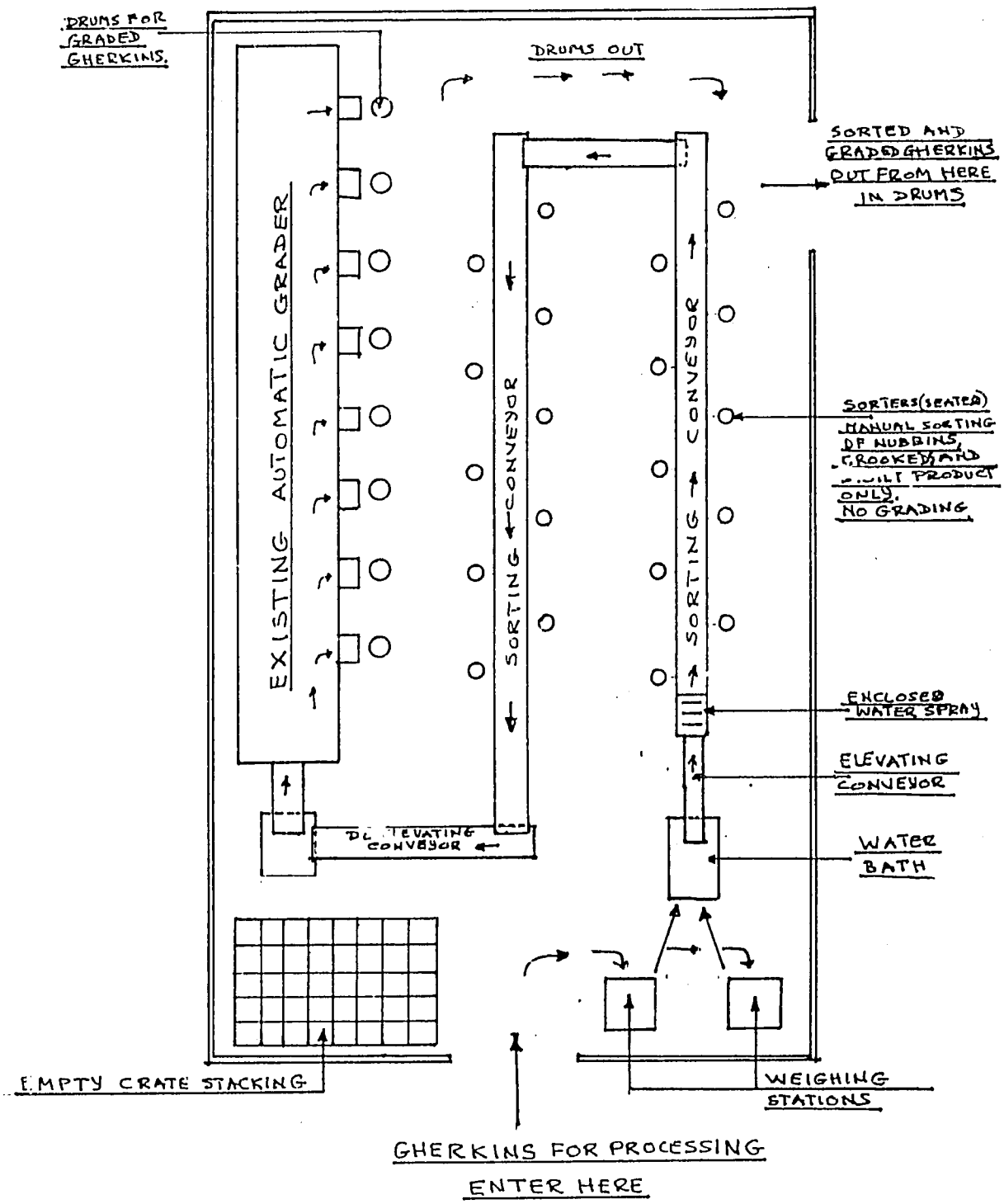
PICKLE CULTIVATORS (PVT.) LTD.
PROPOSED LAYOUT FOR FACTORY.

APPENDIX 6



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