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05218

Distr. [illegible]
ID/WG.171/[illegible]
[illegible] February 1974
ORIGINAL: ENGLISH

United Nations Industrial Development Organization

International Consultation on
Agro-Industrial Development

Novi Sad, Yugoslavia, 13-1[illegible] May 1974

FACILITIES FOR HANDLING AND STORAGE OF HORTICULTURAL PRODUCE 1/

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id.74-01[illegible]

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1. INTRODUCTION

In most developing countries, agriculture is still the mainstay of the economic structure and it is likely to remain so for some time to come. Hence the decisive importance of technical advancement and modernization in the agricultural industry, in tune with contemporary economic trends. Transformation in the mode of marketing seems to present the most outstanding aspect. Since far-reaching technological changes are not practicable without a suitable background of social and economic development, this subject also calls for consideration.

No amount of improvement in the production of agricultural crops will be of much avail unless it can be ensured that the produce will reach the market in proper condition. This applies more particularly to horticultural produce, on account of its perishable nature. The problem boils down to being able to supply the produce to the market at the right time and in satisfactory condition. The way in which the produce is handled determines to a great extent its market value, especially so with most kinds of fruit. The handling of fruit right up to the marketing stage is accordingly given special attention in this paper. Properly planned marketing is impossible without adequate storage facilities; a special section is therefore devoted to modern storage techniques and their application.

Various aspects of processing of horticultural produce are discussed, special attention being paid to processing enterprises within the framework of rural cooperation schemes.

The planning and design of projects concerned with handling and processing of horticultural produce represent one of the many professional fields in which IPD affiliates are active. Their competence is based on long and varied experience, both in Israel and in developing countries.

2. PLANNING CONCEPTS

Although the fundamental planning concepts apply to most horticultural produce, their exposition will be simplified if we confine the more detailed discussion to the handling of fruit.

In many countries, the fruit growing industry is undergoing a rapid development. Probably the most critical phase in this process consists in the transformation of basic marketing concepts. In the past, with most of the fruit grown on small plots near the grower's home, any available surplus was sold on the local market. The general trend today leads to relatively large, intensively cultivated plantations, with regular pest control measure, application of fertilizers and irrigation facilities, the fruit being destined primarily for the commercial market, often situated at a great distance. As a result of the rising standard of living, there is an expanding class of consumers who are willing and able to pay for produce of high quality. Cleanliness and appearance become an important consideration and fruit is often washed and disinfected so that it may be eaten without qualms. In large cities, the growing number of supermarkets and large retail stores provides a demand for modern consumer packages.

Comprehensive planning is necessary to enable the fruit industry to adapt itself to the rapidly changing conditions. One of the major problems of the industry in many countries is the periodical occurrence of periods of excessive supply, associated with low prices, alternating with periods of scarcity when high prices can be commanded. The problem is rooted in the lack of control over the various phases of handling the fruit on its long way from the tree to the consumer.

Release from dependence on the seasonal periodicity and vagaries of nature, based on control over the destiny of the produce, can only be achieved with the provision of suitable facilities, especially for packing and storage. With judicious utilization of such facilities, fruit can be safely kept through glut periods and dispatched to the market at a time when satisfactory prices can be secured. Experience in many countries, under widely varying conditions, has shown that the higher income thus obtained, not only covers the expense involved in the provision of modern packing and storage facilities but also ensures profits on the capital invested.

It cannot be emphasized too strongly that correct picking is prerequisite to the success of all subsequent operations. The fruit must be handled gently and carefully through all the stages of harvest and indeed throughout the long journey from the orchard to the ultimate consumer. It is the duty of the horticultural extension officers to instruct the growers in correct picking techniques. The planner steps in at this stage to determine the type of container best suited for the particular kind of fruit. In recent years, the use of bulk containers has become increasingly widespread. The bulk bin has greatly gained in popularity with the innovation that the fruit could be floated out by immersing the container in water. However, the economic and technical aspects of this technique need careful evaluation with regard to any particular kind of fruit. It should be borne in mind that the use of bulk bins, containing 300 to 400 kilograms of fruit each, necessitates suitable mechanical equipment that may be rather expensive. Beside other considerations, the ultimate destination of the fruit would obviously have to be taken into account in planning, as the requirements would vary according to whether the fruit be destined for fresh marketing or canning, for direct sale or cold storage, etc.

To ensure integrated development, essential for an economically viable, modern fruit industry, it is necessary to consider the industry as a whole in terms of unified planning, wherein the growing of the fruit is but one link - albeit a vital one - of a complete chain of production. In such unitized planning, it is necessary to take into consideration a wide range of factors. To begin with the orchard, a detailed production schedule would be worked out for the various kinds of fruit, varieties, ripening dates and quantities involved. An efficient organization of the harvest would take into account all the technical elements of local significance; it would also incorporate detailed transport schedules, etc. The planner cannot ignore the geographic attributes of the area concerned. Thus, for instance, a fertile area, eminently suited for fruit production, may be beset with serious transportation difficulties; and then the most practicable solution might consist in setting up local dehydration or canning facilities. It should be realized that any such decisions are liable to bring in their wake other problems such as power supply, availability of trained manpower, consumer habits, marketing arrangements, etc.

In broad outline, unitized planning would aim at setting up a series of agro-industrial centers, preferably situated in important fruit producing areas. Beside ensuring competent and efficient handling of the produce, the centers envisaged would also provide productive employment for the surplus labour force which often afflicts predominantly rural districts and would be instrumental in raising the living standards. Ideally, this plan would cover an entire area and would comprise a series of packing houses. These would naturally have to be adapted to the various kinds of fruit produced in the region and, as far as possible, also capable of coping with locally grown vegetables. Each packing house would be connected on a contract basis with a certain number of growers to ensure

a steady flow of fruit. An important function of the packing house would consist in disseminating technical information and instructing the growers as to correct timing of the harvest an proper handling of the fruit.

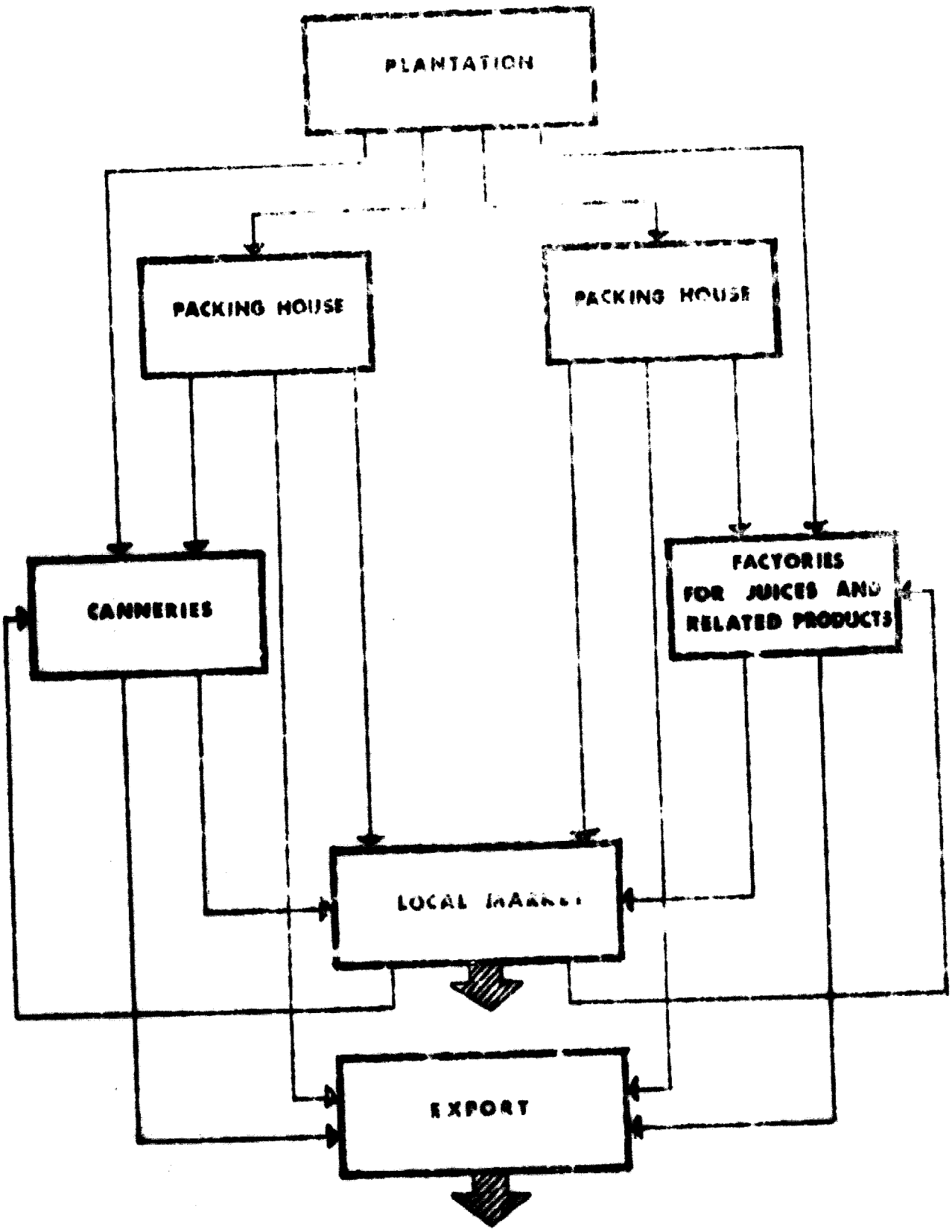
As regards storage facilities, there are various possibilities, ranging from a cold store directly attached to the packing house, to a complex of centralized cold storage plants, each one servicing a number of packing houses. The packing houses can be owned privately or cooperatively. One of the most exacting tasks of the planner is to strike a balance between the expected performance of the packing houses and the cold storage capacity. Alternative uses for the available storage space are to be considered. Thus the cold stores may possibly be used during off-periods for storing eggs, vegetables or dairy products, so as to ensure utmost exploitation of the available storage capacity.

The fruit leaving the packing house is dispatched to the market or is put into cold storage for marketing at a later date. One of the tasks of the planner is to recommend the most suitable packaging, so that the fruit should reach the market in prime condition.

An important subject to be explored would be the possibility of setting up a canning factory for fruit and vegetables, taking into consideration geographic factors, nature and composition of the produce, etc. In some countries, especially those with a warm climate, fruit juice adjuncts may perhaps be given priority. The cannery would receive its raw materials from packing houses in the area; it could also partly utilize the available cold storage facilities, thus contributing towards extension of their operating season.

The canneries also have to be planned in accordance with anticipated produce supply, length of season, consumer preferences, etc.

To sum up, under unitized planning there is no room for the setting up of a packing house or a cold store without considering the inter-relationship between the various factors involved in the long and complex process extending from growing to marketing. Each stage of the process must be coordinated with the others and integrated into the over-all plan. Each plan has to be designed according to the particular conditions and requirements of the project on hand. Approaching the whole process as a unit and coordinating all the relevant functions, with due consideration of all possible variables, it becomes possible to design a fully unitized plan. In the last resort, the merit of any plan will of course be judged by the measure of its economic success.



MARKETING FLOW CHART

3. PACKING HOUSES FOR FRESH FRUIT

In this section a brief outline is presented of recent advances in the organization and technique of packing and related operations. References are made to some of the striking developments which have taken place in recent years, and certain aspects of this subject which bear directly on development schemes in developing countries are indicated.

The exacting demands relating to the production, packing and marketing of fruit, have made it necessary to mechanize most of the operations and greatly increase their efficiency. The demands pertain mainly to ensuring undamaged fruit, extending the marketing period as far as possible beyond the harvest season, and supplying the market, both local and foreign, with fruit of high quality, enhanced by attractive appearance and packaging.

3.1 Picking and transporting from the orchard

Experience has shown that some of the most extensive and serious damage to the fruit occurs in the course of picking and transportation. Such damage detracts from the quality of the fruit and thus lowers its market value. It is therefore of utmost importance to reduce damage during these operations as much as possible.

Deciduous fruit, citrus, avocado, etc. are picked by hand and placed in special picking containers. The pickers use widely aluminium ladders to get at the fruit which cannot be reached from the ground. In recent years, increasing use is being made of mobile hydraulic ladders, and it seems likely that these may eventually replace the conventional aluminium ladders. The hydraulic ladders have by now attained a high degree of efficiency. Two types, both of which have proved their worth

in service, are equally suited to picking, pruning and thinning. One of them carries four workers and is tractor-drawn and powered, while the other is a one-man self-propelled machine. Providing well trained workers and good organization, these implements, beside speeding up and lowering the cost of harvest, can also make an important contribution towards minimizing damage to the fruit.

The efficiency of handling the fruit in the orchard, in transport, in storage and in the packing house, is greatly enhanced by the use of bulk bins. It is indeed becoming a widely current practice to transfer the fruit from the picking containers into bulk bins. Proper design and manufacture of these bins should enable their use even for vulnerable produce such as peaches, apricots, etc.

It may be mentioned in this connection that there has also been much progress in recent years as regards mechanization of the vegetable harvest. Mobile picking aids for pepper, tomatoes, melons and watermelons have come into use. Efficient, high-capacity combine-harvesters have been developed for potatoes, carrots, onions, etc.

Special implements are being introduced for the transportation of produce from the field or the orchard to the packing house. Variously adapted trailers, which may be drawn by tractors or other vehicles are becoming increasingly popular for transportation of horticultural produce. Trailers with a conveyor-type, p.t.o. - powered floor are proving very useful in vegetable transportation, while others, capable of self-loading and unloading action with bulk bins, are especially suited for fruit. Trailers with special tyres have also been built to cope with mud and prevent soil compaction. They have been used with excellent results for banana transportation in wet conditions. It has been found that the use of specialized trailers facilitates work organization and

[illegible] in both orchard and packing plant, while greatly reducing [illegible]

3 The packing plant

The packing plant normally comprises a packing house and a cold storage plant. In the packing house the produce is graded, sized, washed, waxed and packed [illegible] market specifications. The cold storage prolongs produce life. The produce may be stored for periods of varying duration, depending on marketing considerations.

The packing houses differ in size and capacity. The larger ones may have a capacity of some 30 tons per hour (citrus fruit, potatoes), while the smallest can handle about 2 tons per hour (vegetables). Most commonly, the packing house capacity ranges from 5 to 10 tons per hour (deciduous fruit, avocado, bananas, etc.).

The desirable degree of mechanization in the packing house will depend on the kind of produce, capacity required, total quantity to be handled and specific considerations such as kinds of fruit, available manpower, etc. Judicious evaluation and choice of equipment is necessary to ensure lowest possible packing costs while satisfying the functional requirements. These requirements include adequate capacity, efficient grading, accurate sizing, correct packing and gentle handling - all this to ensure that the produce shall meet the demands of the market. The fulfilment of these requirements is, of course, conditioned by the type and size of the various components of the equipment. The choice of the components naturally influences the over-all layout of the house. A good layout is indispensable for efficient work organization. This includes not only the machinery and its working space, but also the holding areas for incoming and packed fruit, packaging materials, etc.

3.3 Receiving the fruit and feeding the packing line

The fruit mostly arrives at the packing house in bulk bins. Small boxes are still in use, especially in the smaller packing houses, and they may arrive on pallets. In the packing house, the fruit is moved either to an intermediate storage area or to the feeding point by means of fork lifts or pallet transporters. These are used again later for moving the packed fruit. The fork lift moves the bins to a special track on which a reasonable backlog of bins is accumulated to ensure even feeding of bins to the dumper. In big packing houses the fork lift may move the bins stacked in columns of three to a special device which unstacks them preparatory to dumping. The method of dumping the produce by overturning the bins and pouring the contents onto a moving belt (if necessary with moving sidewalls) is used mainly for citrus and potatoes. Otherwise dumping is effected by submersion. Here the bin is submerged in water and the fruit is floated up and then carried by a stream of water, through a channel, onto a sloping elevator which feeds the packing line, while the empty bin is removed. This system was first introduced for apples and pears, where it has gained almost universal acceptance, and is now also coming into use with peaches, avocado and bananas. Submersion dumping has the following advantages :

- In marked contrast to other feeding systems, there is practically no damage to the fruit.
- The water channel acts as an intermediate store and enables continuous feeding of the fruit to the packing line.
- Soaking in water renders the cleaning and brushing of the fruit easier and more effective.
- The water channel can be utilized for pre-sizing fruit such as apples.

Undersize fruit, having no commercial value, should be removed in an early phase of the packing line. The modern solution to this problem is a hydropresizer, an Israeli innovation which consists essentially of a rubber net with square holes that allow the passage of undersize fruit only. As the net descends into the water trough in the direction of the flow, the undersize fruit passes through the holes and rises to the surface of the water in the center of the hydropresizer, whence it is removed by an elevator. The remaining fruit rises to the surface of the water after the passage of the hydropresizer and continues its flow towards the trough outlet. The use of a presizer imparts a number of advantages :

- The separation of undersize fruit does not demand extra space; it is more accurate and complete than with earlier methods and is achieved without damage to the fruit.

- Much of the useless foliage is removed together with the small fruit.

- When not in use, the presizer is raised above the water by rotating its rear axle so that it does not interfere with the flow of the fruit in the water trough.

3.4 Grading

Meticulous grading must be ensured if the fruit is to meet the demands of the market or to remain sound in storage, as the case may be. In contrast to other operations in the packing house, grading has to be done by hand and its standard therefore depends mainly on the quantity of the workers. To facilitate their job, proper grading tables and adequate working conditions should be provided.

The grading table to be found in most packing houses is a roller conveyor. The cylindrical rollers are affixed at their ends to a chain and they rotate on their axes while moving along with the chain. Upon arriving on the grading table, the fruit gets in between the rollers and is turned about by them in the passage. The graders, seated at both sides of the grading table, inspect the fruit as it passes by and remove any fruit that does not come up to the required quality standard. The culls undergo grading in the same operation by appropriate placement on belt conveyors above and/or below the table, which will take them to their destination.

In a well designed packing house, the grading table is so constructed that the workers can rest their feet underneath it, which makes for comfortable sitting. Lighting arrangements are suited to the fruit handled, correctly placed and supplying illumination of sufficient intensity but with no glare on the tables and in their immediate vicinity.

When grading apples and other round fruit, the cylindrical rollers may be exchanged for grooved ones. With these, the fruit suffers less from friction and mutual collisions. Also, owing to the grooves, the fruit tends to array itself in rows, which facilitates inspection and thus raises the throughput of the graders. In the so-called "frontal system", which has recently been introduced in some of the big packing houses, the grader is so seated that the fruit approaches him head-on and not from the side as in older systems. This appears to provide a greater throughput and more accurate grading.

The various transfers from one section of equipment to another, account for much of the mechanical injury sustained by some kinds of fruit. To mitigate the danger of damage occurring as the fruit comes off the conveyor, rotating brushes and rotating rubber rollers are installed at the end of roller conveyors and belt conveyors, respectively. Braking curtains are mounted above the critical junction points to control the movement of the fruit and arrest its gravitational rolling.

The best solution would, of course, consist in cutting down the number of transfers to the barest minimum. Thus, for instance, the introduction of the hydropresizer obviates the need for a presizing transfer. Another step in this direction is joining the roller elevator which raises the fruit from the water, straight to a grading table of similar construction.

3.5 Sizing

The market demands accurate sizing (usually 4 - 5 mm between sizes); and the price difference between sizes can be considerable. There may be up to six sizes or more. The sizing machine may be considered the "heart" of the packing line. The points to be considered in selecting a sizing machine would include capacity, accuracy, gentleness (minimum injury), price, and ease of incorporation in various layouts. Some sizing machines are specific to one kind of produce (carrots, for example). Most sizers, however, are fairly flexible and capable of dealing with different kinds of produce, which facilitates their use in multi-purpose packing houses.

Most commonly used in the big citrus packing houses is the volumetric sizer working on the [illegible] principle, with grooved rollers. Packing houses for deciduous fruit employ a wide range of variously conceived machines. Most popular are the multi-row sizer and the single-row sizer which operate on the principle of a pair of sizing belts and sizing rollers. They are noted for their gentle handling of the fruit and they are not expensive considering their capacity. To meet special requirements, some packing houses use sizers based on a diaphragmatic system, while others employ weight sizers.

3.6 Supplementary fruit treatments

Brushing and drying of the fruit is normally done by a machine equipped with revolving brushes and rubber sponge rollers. The advance of the fruit is usually effected by means of progressor rods. The machine is constructed of materials which ensure thorough drying of the fruit with minimum damage. Recently introduced brushing devices, to cope with fruit particularly susceptible to injury, employ brushes that revolve on their axes while advancing in a closed cycle. A waxing device is incorporated when desired. It may be noted that the distinct sheen of waxed fruit enhances its market value; the practice of waxing is therefore gaining widespread acceptance.

Washing with detergent materials, a widely accepted practice in the case of citrus fruit, has also been found to be of value for other produce, e.g. deciduous fruit and tomatoes.

Anti-scald treatment is designed to protect the fruit against scald injury in cold storage. It is mostly done by the brushing machine, but is sometimes carried out at the end of the grading table by applying from above a stream of anti-scald solution.

3.7 Packing

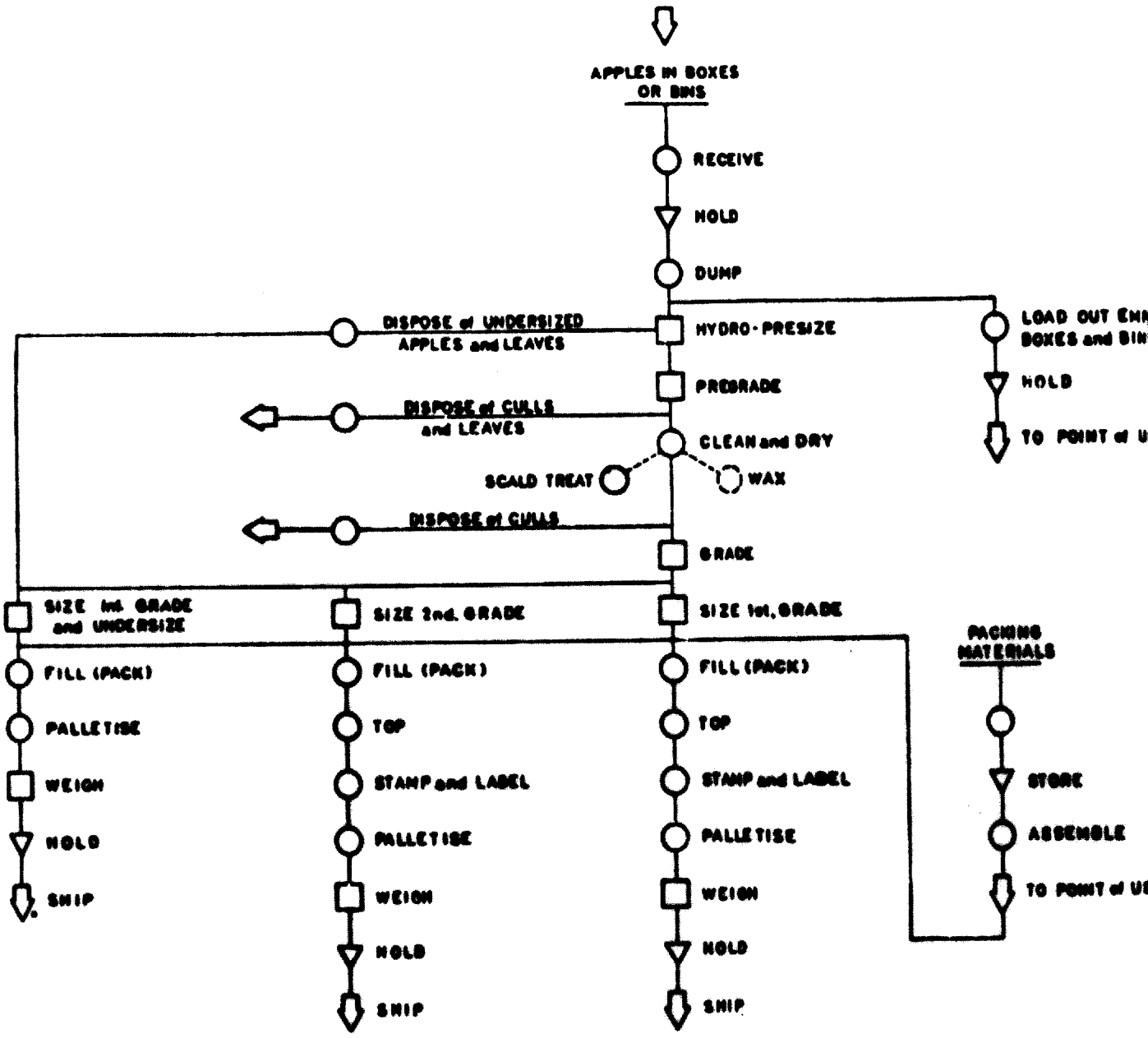
The clean, sized fruit is usually assembled on rotating tables and reversible belts before packing. The actual packing is done by hand or by means of automatic box-fillers, into cartons or wooden boxes. There may be automatic packing for retail sale.

Citrus fruit is conveyed from the sizer to special packing trays by means of distributing apparatus. Difficulties arising from unexpected variations in size distribution are countered, in the case of trays and belts, by adjustable sidewalls and deflectors and, in the case of rotating tables, by attachment of additional mobile tables. The packing of citrus fruit is done by hand. Mechanization has so far made little progress, largely because of the exacting standards prescribed, especially by the export market. This places a premium on efficient organization of work in the packing house Output, appearance of the package and prevention of fruit blemishes are all equally important. The first models of automatic packing machines have recently appeared; they wrap the fruit while packing or else pack unwrapped fruit. Packing of various kinds of fruit and vegetables, while vibrating the package to ensure even filling, is under intensive study.

The packed boxes or cartons are closed or nailed. In big packing houses this is mostly done by automatic machinery; in smaller ones by hand. After closing, the containers are placed on pallets prior to being dispatched to the cold store or to the market. This, again, is a manual job although, in this case too, first steps are being taken towards mechanization.

Conveyors are widely used in the packing house, as they enable full exploitation of the floor space and efficient work organization. The packing materials are usually brought to the packers by overhead conveyors; they can thus be prepared and stored outside the packing house proper. Chain conveyors are used to assemble the fruit packed in cartons or boxes for control before sealing and transfer to the pallets. The packed fruit is finally transferred by fork lifts either to cold storage or to trucks for delivery to the market.

It is important to realize the extent to which the economics of horticulture can be influenced by proper choice of equipment and well designed layout. To ensure success, it is necessary (a) to analyse the conditions pertaining to any specific case; (b) to obtain the most suitable technical equipment; (c) to fit the equipment into a layout that will enable efficient organization of the work. Israeli experts are rightly reputed to be among the best in this field.



LEGEND

- OPERATION
- STORAGE
- INSPECTION
- TRANSPORTATION
- OPTIONAL OPERATION

PACKING HOUSE

FLOW - CHART

4. COLD STORAGE

It should be borne in mind that all fresh fruits and vegetables are still alive after [illegible] throughout the period of storage and marketing. As live organisms, they are affected by ambient conditions. They continue [illegible], while absorbing oxygen, they consume the food stored up during their growth period and transform it into carbon dioxide, water and energy (heat). Respiration and the attendant chemical processes induce changes in the appearance and quality of the produce and finally bring about its deterioration (senescence). The rate of deterioration is greatly advanced by desiccation and the action of pathogenic micro-organisms. The deterioration processes cannot be stopped completely, but they can be considerably retarded by suitable storage methods.

Thus, good storage conditions are such that will minimize deterioration of perishable produce and will keep it sound and in good condition until marketing.

The rate of deterioration of horticultural produce can be much reduced by lowering the storage temperature. The optimum temperature level varies with different kinds of produce and even with different varieties. Generally speaking, the best results are obtained at the lowest temperature that a given commodity can tolerate without "chilling injury". Desiccation must also be prevented as it causes loss of weight and shrivelling of the produce, and it impairs its taste and consumer appeal.

Cooling of the store is accomplished by means of air coolers. These are usually equipped with two-speed, high-efficiency fan units that circulate air at a high rate on full speed for pull-down duty, and at reduced rate

for holding duty. In the case of produce stored in bulk bins, adequate ventilation is essential and proper stacking of the bins must be ensured.

There has been a tendency lately to construct cold stores from prefabricated elements or sandwich construction units consisting of inner and outer layers of rust-resistant steel profile sheets or fiber-reinforced polyester, with insulation layers between. This may be very helpful when erecting cold stores in areas distant from industrial or building centers, and where skilled labour is scarce or unavailable.

Refrigeration alone is on the whole insufficient to maintain the keeping quality of the produce for long periods. The controlled atmosphere (CA) system is designed to prolong the storage life of fruit and vegetables by inhibiting the respiration and other biochemical processes which lead to deterioration. The oxygen content in CA rooms is reduced while the carbon dioxide content is raised to predetermined levels, according to the requirements of the various commodities. With this system, apples and pears put into storage in August, look and taste like freshly picked fruit when marketed in May or June of the following year. CA storage has been found to be particularly useful in the case of produce susceptible to chilling injury.

The CA system necessitates the construction of specially designed rooms. In addition to the normal requirements of cold storage, arrangements have to be made to provide for :

(a) Gas tightness
(b) Removal of excess CO_2 from the atmosphere
(c) Control of the oxygen level
(d) Maintenance of suitable relative humidity
(e) Adjustment of atmospheric pressure
(f) Supply of normal air for emergencies

It is necessary to control the [illegible] tightness before use. In Israel this is usually done by raising the internal pressure to approximately 25 mm water gauge. The time required for the pressure to drop from 25 mm to 12 mm should be not less than 50 to 60 minutes, according to the size of the room.

As it is possible to effect a change of atmosphere composition only after sealing a complete storage unit, the economical capacity has been found to be between 50 and 250 tons, depending on the type of product and available transport facilities. In determining the dimensional aspects of the design of a modern storage room, it is advisable to adopt the standard pallet and the standard bulk bin as points of reference. It is also important to ensure sufficient manoeuvrability for the fork lift trucks.

The temperatures in CA rooms are controlled by means of thermostats with sensing elements located at strategic points. The differential obtainable in practice in larger rooms is plus/minus 0.5°C. The temperatures of the produce are measured by means of suitably placed distant-reading thermometers.

The excess of CO_2 produced by respiration of the stored produce is removed by means of scrubbers. The dry lime scrubber is considered at present to be the most economical; it is particularly suitable for atmospheres with a low oxygen content. Gas concentration measurements are taken once or twice daily by means of an "Orsat" analyser; in larger stores they are obtained by centralized recording equipment.

As a general rule, to obtain the best results with storage of horticultural produce, it is desirable to harvest, pack and put in store on the same day, to ensure rapid cooling to the required storage temperature.

4.1 Refrigerated transport

If spoilage of horticultural produce is to be prevented, a continuous chain of refrigeration must be kept up from harvesting right up to delivery to the consumer. With this in view, refrigerated transport has been developed, using mechanical or chemical refrigeration systems, or a combination of both. Mechanical refrigeration units are most widely used at present, but chemical refrigeration is rapidly gaining ground as it often gives much better results and does not require heavy or complicated machinery. Liquid nitrogen refrigeration may be particularly convenient for prolonged export shipments.

Along with refrigerated trucks, trains, ships and airplanes, refrigerated transport containers are now making headway. Their great advantage consists in the ease of combining various modes of transport (land, sea or air) and simplicity of transfer from one to another without removing the produce from the CA conditions or breaking the refrigeration chain.

4.2 Special fruit treatments

Some special treatments are designed to prolong the marketing life span of various kinds of fruit and to facilitate regulation of the market.

(a) Ripening

Artificial ripening is mostly resorted to early in the season when supply is scarce. The fruit is ripened by means of raised temperature and humidity, and by application of gases, such as ethylene, which accelerate the process of ripening.

(b) Degreening

The treatment is applied to enhance the appearance of early fruit which is already ripe and fit for consumption, but is still green in colour. This is done because the public prefers fruit with the characteristic "ripe" colour.

Degreening is widely practiced with citrus fruit. If properly executed, degreening has no detrimental effect on fruit quality. Degreening can only be done with fruit which has reached the required stage of maturity; this being determined by objective criteria such as juice and soluble solids content and ratio of soluble solids to acid. The scope of the treatment is also circumscribed by the capacity and efficacy of the degreening rooms. The required duration of degreening varies considerably.

The degreening rooms must have refrigerating or evaporative cooling installation, as well as arrangements for heating in cold weather. Precise temperature regulation during the degreening process is very important as deviations from the norm may have a deleterious effect on the fruit. Relative humidity must also be carefully controlled to avoid shrinkage of the fruit or else unsightly, mouldy rind. This is only possible

if fruit is properly stacked, with ample space between the stacks.

The respiration rate of citrus fruit is very high and might easily result in excessive and injurious accumulation of carbon dioxide and other gases. The atmosphere of degreening rooms and storage chambers must therefore be under constant control, and adequate ventilation has to be provided to remove the excess of harmful gases.

5. PLANNING AND ORGANIZATION OF CENTRALIZED FACILITIES

To promote the economic and social advancement of rural population, it is necessary to develop additional sources of employment beyond the scope of a single village. Only in this way is it possible to achieve equalization of standards in the various services with those available in the city and to bring up the rate of income growth in the rural areas to that prevailing in urban centers.

Rural cooperation provides an appropriate framework for integration of services and productive enterprises with the farming economy. An important asset of centralized facilities for the handling and processing of produce consists in the reduction of marketing and brokerage expenses. Within the framework of regional organization, a group of farming communities can set up large-scale joint enterprises that would justify the introduction of technological innovations and the employment of highly skilled manpower.

The joint enterprises can be conveniently divided in the following strata of rural organizations:

(a) Village group centers;
(b) Regional centers;
(c) Inter-regional centers.

The village group centers are intended to serve as focal points for the provision of personal, public and economic services to a number of farmers or cooperatives. These centers accomodate social institutions which could not be operated at an acceptable standard within a single village (e.g. schools, clinics, sport installations, culture centers, youth clubs, etc.) The economic services are limited in

scope and facilities (e.g. vegetable sorting sheds, egg sorting stations, etc.).

The regional centers contain public and economic services of a much higher standard. At this level we also find produce handling and processing enterprises. Between 10 and 20 communities are served by such a regional center.

The inter-regional centers do not supply public or economic services to the individual but rather serve as focal points for intensification of production. The enterprises set up in these centers are mostly those that require a substantial farming hinterland. The number of communities connected with an inter-regional center ranges between 25 and 50, although it may occasionally exceed the higher figure.

The functional differentiation between the various levels of rural co-operation is largely determined by the relative weight of three elements, namely public services for the individual, economic services, and enterprises for the handling and processing of farm produce. The enterprises are mainly concentrated at the regional and the inter-regional level. The bigger the enterprise and the broader the farming hinterland it requires, the higher the level at which it would be set up. This is evident from the tabulated data which are based on a number of inter-regional development schemes implemented in Israel.

ENTERPRISES DEALING WITH AGRICULTURAL PRODUCE AND
ITS PROCESSING AT THE VARIOUS STRATA OF RURAL COOPERATION

Type of Enterprise	Size or production volume	Strata of rural cooperation		
		Village-group	Regional	Inter-regional
Handling agricultural produce				
Cold storage houses	All sizes		1	1
Fruit sorting and packaging	All Sizes		1	1
Packaging of citrus fruits			1	
Vegetable sorting shed		1		
Sorting of potatoes & onions	Medium		1	
Sorting of potatoes & onions	Large			1
Sorting and packing of bananas				1
Egg sorting		1		
Milk receiving station		1		
Processing of produce				
Cotton gins			1	
Cotton gins				1
Alfalfa drying			1	
Alfalfa drying				1
Drying of fruit and vegetables			1	
Fruit and vegetable conserves				1
Poultry slaughterhouse			1	1
Ice-cream factory			1	
Margarine factory			1	
Production and supply to the farm				
Feedmills	Rural expanded	1		
Feedmills	Medium		1	
Feedmills	Large			1
Drying of orange rinds				1
Compost production				1
Heavy equipment			1	

The table presents a classified list of enterprises set up at the various levels of rural cooperation. It can be seen that enterprises established in village group centers are few in number and limited in scope, whereas plants for the handling and processing of produce and manufacture of farm supplies belong mainly to the higher strata of cooperation.

The enterprises in the village group center are of modest size and they mostly replace similar installations which were previously located in the villages and proved to be unviable at that level.

The disposition of enterprises between the regional and inter-regional centers is partly a matter of function and partly of size as, for instance, in the case of potato sorting plants of feedmills which are to be found in both.

APPENDIXES

GRADING AND PACKING EQUIPMENT

A. APPLES

A standard line is capable of grading and sizing an average of 3-4 tons of fruit per hour. The actual performance will depend on the quality of the fruit, grading and sizing requirements, and efficiency of operators.

The equipment is designed for the wet system and includes a stop scalding unit. Different combinations can be planned for a dry system or a combination of the two.

Power demand : 20-25 H.P.

Operators : 45-60 per day.

F L O W D E S C R I P T I O N

Incoming fruit, in big containers, is placed on a roller conveyor.

From the conveyor, the container is moved to a hydraulic apparatus which soaks the container and fruit in a special tank.

Continuous circulation of water in the tank forces the fruit up to the surface and pushes it on towards the presizer and the elevator at the other end of the tank.

The presizer is designed to separate the undersize apples and the foliage from the rest. These are withdrawn from the main line by a special conveyor. The presizer acts also as a flow coordinator.

An elevator pulls up the fruit from the soaking tank and moves it onto the grading table.

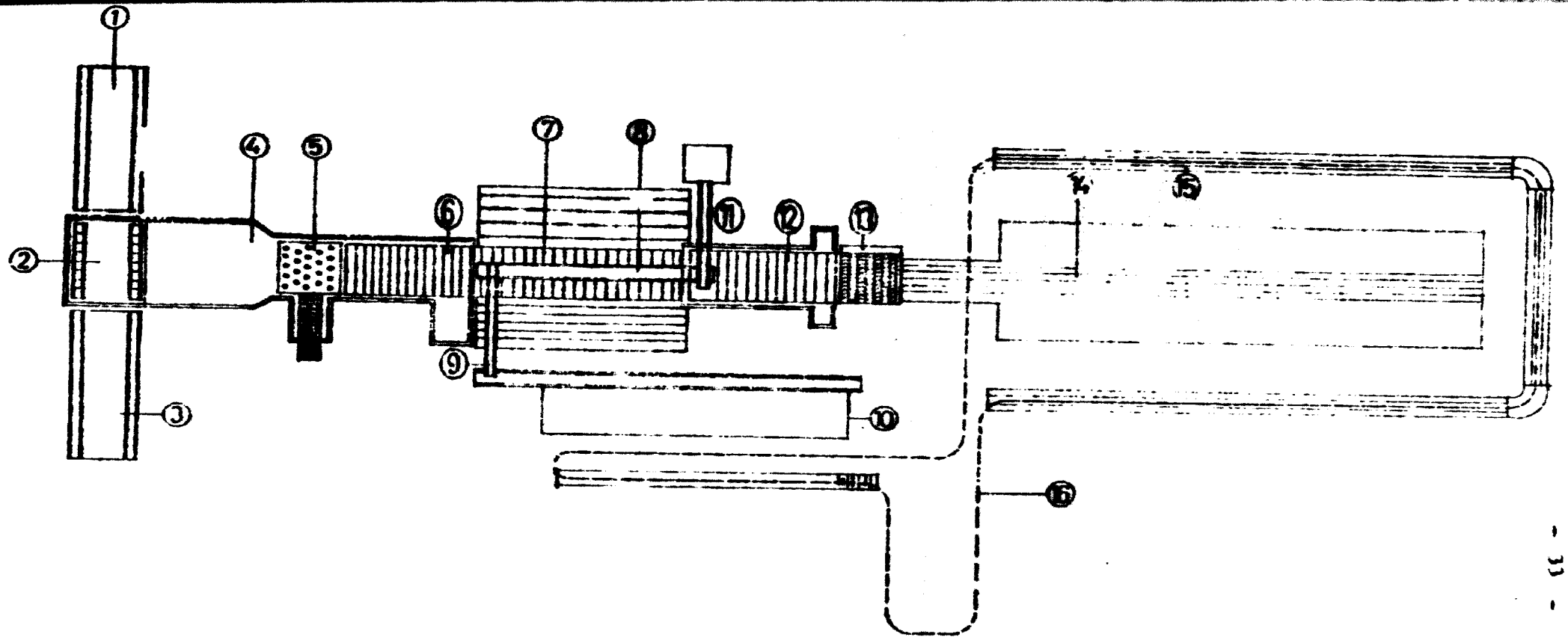
The grading table has three storeys. The main story is designed to carry grade A apples. The two other storeys, in the form of an overhead two-storey conveyor, are reserved for grades B and C. Grade C is delivered to a special container at the upper end of the grading table. Grade B goes to a one-line sizer for assortment.

The grade A apples are delivered from the grading table to the stop scalder, an apparatus for special disinfection treatment to prevent scald in cold storage.

The next station is the water eliminator, where the fruit is brushed and dried.

Now the apples move on the main sizer; from here each size finds its way to a special bin.

Out of the bins, the apples are packed in standard boxes or cartons and are then taken by a special conveyor to a stacking site.



LEGEND

1 Heavy Roller Conveyor
2 Hydraulic Jack
3 Roller Conveyor
4 Soaking Tank
5 Pre-Sizer
6 Elevator
7 Grading Table
8 Two Story Conveyor
9 Conveyor
10 One Line Sizer
11 Conveyor
12 Stop Scalder
13 Water Eliminator
14 Two Line Sizer
15 Conveyor
16 Overhead Monorail

APPLES

GRADING AND PACKING EQUIPMENT

B. C I T R U S

A standard line is potentially capable of handling an average of 80-100 tons of fruit per 8-hour shift, but actual performance depends to a considerable extent on the variety and quality of the fruit, the efficiency of workers, and other factors.

Sizing can be done in a central volumatic sizer; it is much more precise than the regular sizer, as it measures each single fruit at four points.

Various additions and modifications are possible. Each case calls for a special study and the design of the line has to be adapted to specific conditions.

Power demand : 35-40 H.P.

Operators : 80 - 120 per day.

F L O W D E S C R I P T I O N

The fruit is poured from bins or field boxes, mechanically or by hand, onto a transporting belt.

The transporting belt delivers the fruit to the first grading table, where the preliminary culling is done.

The pre-wash station is designed to clean the fruit before disinfection treatment.

The fruit is now passed through a 12 m long disinfection tank in which the fruit is submerged into a hot solution of suitable chemicals.

The disinfected fruit is raised by a special elevator to the main washing machine, where it gets a thorough scrubbing.

After washing, the fruit is moved to a water eliminator which is a combination of special sponge rubbers and wringers.

The fruit is now moved to a waxer to get a wax cover for better preservation.

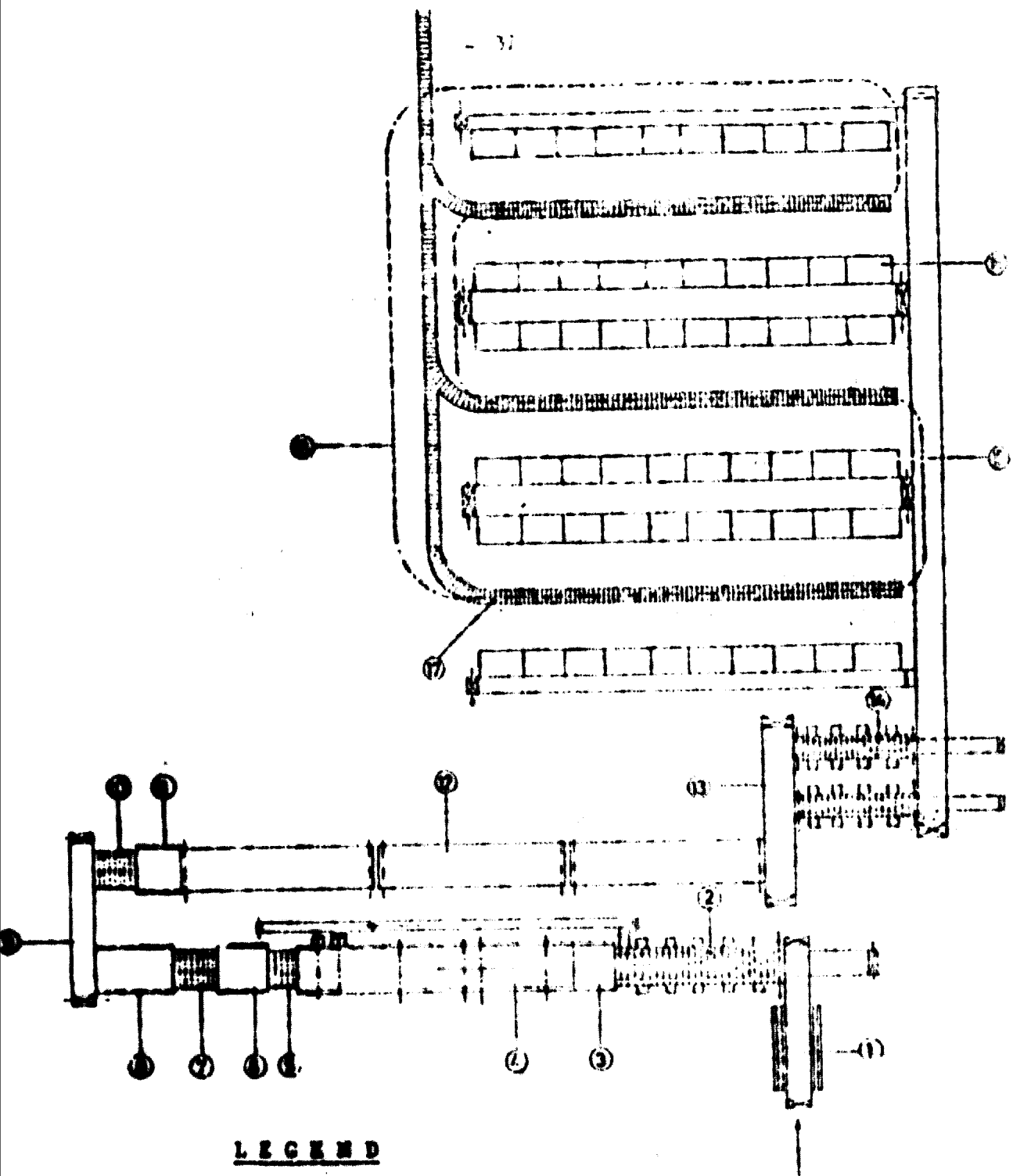
After waxing, the fruit enters a long tunnel, equipped with special fans, for drying.

And now a second grading station consisting of two or three tables, where final grading is done.

Following the grading, the fruit is passed on to the sizers for assortment according to size.

The various sizes go into separate bins. Here the packers are stationed and pack the fruit in boxes.

The packed boxes are carried by a conveyor to a stacking area.



LEGEND

1	Transporting Belt	16	Elevator
2	Grading Table	11	Wax Applicator
3	Prewasher	12	Dryers
4	Desinfection Tank	13	Distrib. Fruit Belt
5	Elevator	14	Grading Tables
6	Washing Machine	15	Main Belt
7	Elevator	16	Belt & Roll Sizing Mach.
8	Water Eliminator	17	Box Conveyors
9	Belt Conveyor	18	Overhead Conveyor

CITRUS

GRADING AND PACKING EQUIPMENT

C. PEACHES

A standard line is capable of grading and sizing 2-3 tons of fruit per hour. The same line can also be used for grading apples and pears.

The layout described is suitable for a village of medium size or a big farm.

Alterations in the layout or in the equipment can be made, if desired, with a view to increasing the capacity or reducing manual work.

Power demand : 8-10 H.P.

Operators : 20-30 per day.

F L O W D E S C R I P T I O N

The incoming fruit is dumped by special hand dumpers to a feeding conveyor which carries the fruit to the grading table.

The empty boxes are carried away by a roller conveyor.

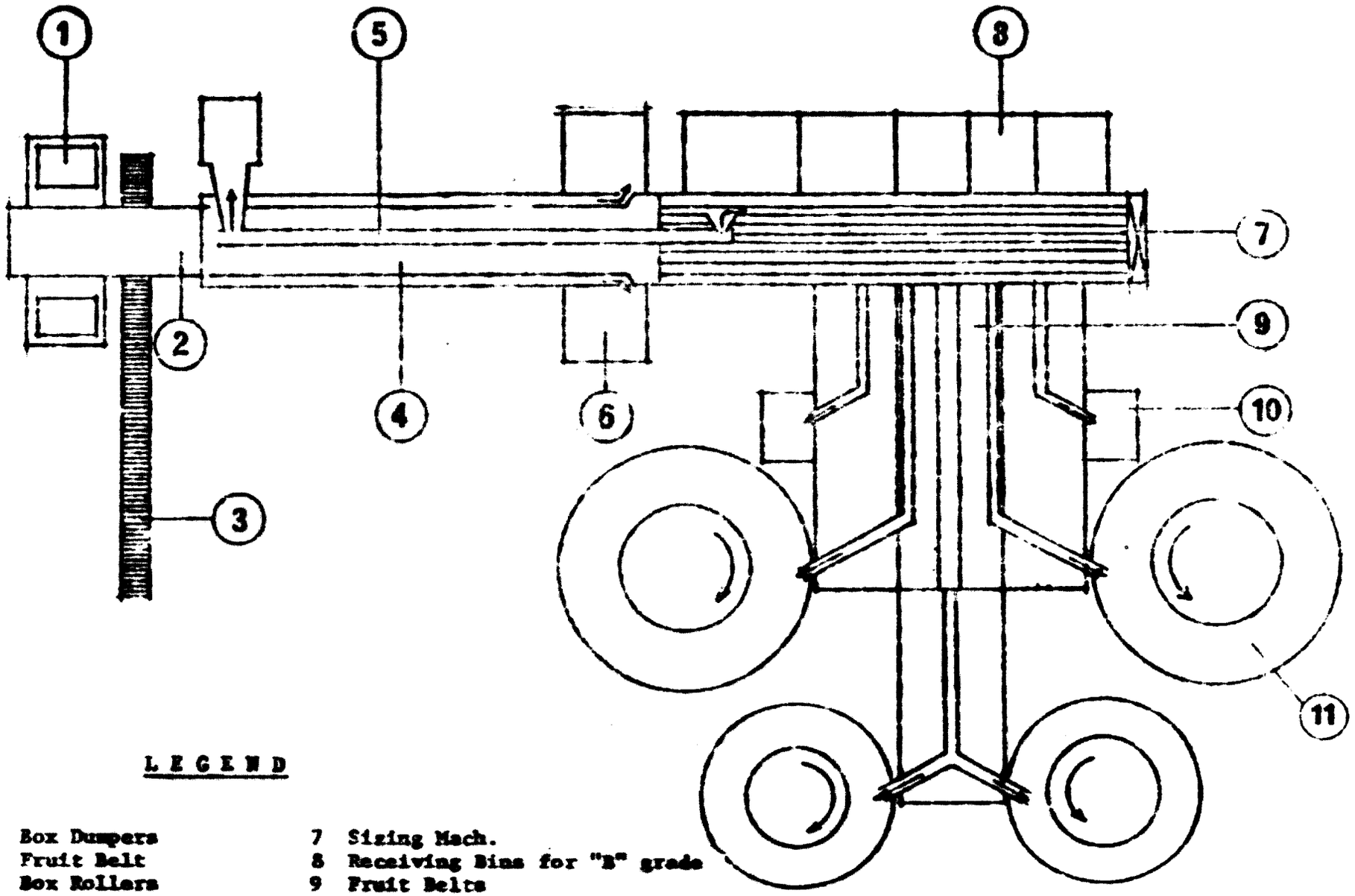
The grading table consists of moving belts with divisions for each grade. Grade A is placed on the middle zone of the main belt. The culls are carried by the same belt but are separated from grade A.

Grades B and C go onto a special overhead belt suspended at the middle of the table.

From the grading table, the fruit is moved to a four-way sizing machine. Three ways are reserved for the sizing of grade A, while the fourth is set apart for grade B.

After sizing, grade B fruit is gathered in special bins. Grade A is carried by special belts to revolving discs which collect the different sizes.

Packing is done either manually or by special machines.
The packed boxes are placed on pallets.

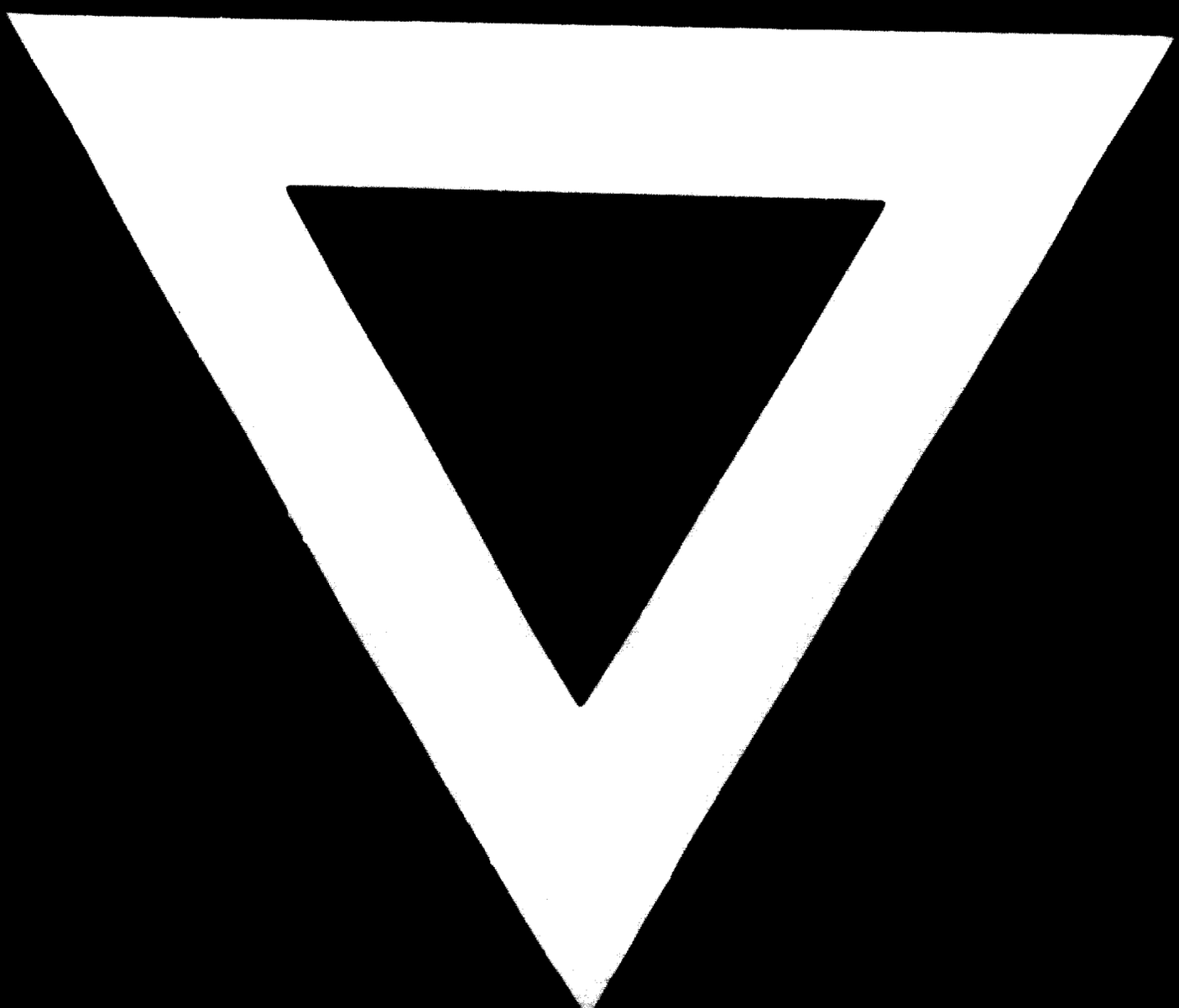


LEGEND

1	Box Dumpers	7	Sizing Mach.
2	Fruit Belt	8	Receiving Bins for "B" grade
3	Box Rollers	9	Fruit Belts
4	Grading Table	10	Collecting Bins for oversize fruit
5	Upper Belt Conveyor	11	Rotating Discs, collecting for packing
6	Containers for Culls		

PEACHES

GRADING AND PACKING EQUIPMENT



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