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Notes on the Development of the Korean Frozen Fruit and Frozen Vegetable Industry

PART I

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Introduction

Much interest has been shown in the recent past in the development of frozen fruit and vegetables for export and domestic markets. Stimulus to these thoughts has come from many different sources such as,

i) The desire to increase export sales

ii) Knowledge that urban population growth will modify present systems of food distribution

iii) The desire to provide better levels of income and empolyment in certain rural areas

iv) The desire to provide year round availability of seasonal crops to both home and export markets

v) Recognition that unsold frozen products do not deteriorate as fresh products will, and losses do not occur from seasonal surpluses if they can be frozen immediately after harvest.

These, and other, considerations have led various investigators, study groups and consultants to include in their reports the recommendation that freezing should be considered as one way of solving the problems they were asked to study.

That this agreement exists among so many experts cannot be ignored, and experience in developed and developing nations all over the world has shown that a healthy frozen foods industry goes a long way towards meeting these objectives. However, a modern and efficent freezer is not a Yeuy-Ju and the purpose of these notes is to try to identify some of the requirements of a profitable business venture and anticipate the pit-falls in advance.

Development of Freezer Types

The freezer design and manufacturing industry offers a wide choice of freezer types that have been developed over the years to meet the changing needs of the food industry and the history of these changes is instructive.

The early freezers used throughout the food industry were nothing more than cold rooms with an extra capacity to remove heat from the product placed in them. The result for almost all fruit and vegetables proved to be unsatisfactory, as slow freezing causes poor quality of the defrosted product and high weight losses occur.

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Notable exceptions are blackcurrants, redcurrants and gooseberries, these fruits are high in juice content and frequently leave the field sticky with juice from broken fruit, stuck with leaves and with stalks and calexes intact.

Washing soft ripe blackcurrants and redcurrants causes further damage and a very high loss of juice. As these fruits are usually processed into soft drinks, jelly pie-fillingsetc. juice loss is unacceptable. Most processors now freeze the berries slowly in the field trays, this avoids bursting the fruit and produces a hard, juice filled berry that can be separated mechanically and passed through machines to remove stalks, calexes, leaves and debris without further juice loss. Whilst gooseberries arenot so easily damaged when soft, they will burst if frozen too rapidly and a similar method of freezing and cleaning is used.

The next historical step in the advancement of freezer design was the air-½blast freezer in which a much faster freeze was attained by subjecting the product to rapid air movement and, as techniques improved, lower air temperatures. These freezers were a distinct improvement on the cold room but had two major disadvantages, firstly the product had to be loaded in trays, baskets or cartons and was frozen into a block. Secondly, complicated racks, trollies, air distribution baffles and deflectors were required to ensure that all the product received equal treatment and air did not "by-pass" the product.

As domestic acceptance of frozen vegetables grew it was obvious that "Consumer Packs" would have to be produced in ever increasing numbers so that the housewife purchased her requirements in packs containing the amount to be cooked for one family meal. Packing these small cartons into a blast freezer was a very labour intensive proceedure and much damage and losses occurred. Due to the flexible nature of the pack, shape reten tionwas poor and the small cartons packed badly into the larger boxes used for storage and delivery. When wet vegetables are filled into small cardboard cartons they leave air spaces and this has an insulating effect, freezing times were long and freezers were made larger and took much valuable floor space in the factories.

Most of the disadvantages of blast freezers handling consumer packs were overcome when multi station, horizontal plate freezers came into general use. In this type of freezer a series of refrigerated plates can be opened and loaded with flat trays containing the packages, the plates are then closed so that each layer of packages is compressed slightly and refrigerant is circulated through the centre of the plates themselves. This double contact produced regular shaped packages and freezing times were reduced to about half. The early plate freezers still had two big disadvantages, firstly they were manually loaded, this meant that product coming off a fully automatic packaging line had to be collected into batches and transported at regular intervals to the freezers and hand loaded. It was then unloaded, returned to the dackaging line and fed back for boxing and marking. This batch process had to be very carefully supervised to ensure that a batch of unfrozen product did not spend too long waiting for a freezer, and, once in the freezer the full freezing time was completed.

Secondly, plate freezers could only handle vegetables and fruit that had already been packaged and this meant that a heavy investment was required in packaging machines as the entire crop of a particular product had to be packed during its harvesting season. This packaging equipment was then idle for most of the winter.

The first disadvantage was overcome when automate plate freezers were designed and built. These machines were inserted into the production and packaging lines and were able to acoept a continuous flow of packages and discharge them continuously after freezing.

As the consumption of frozen vegetables and fruit rapidly increased it became obvious that the enormous quantities of some products, such as peas, that could be sold throughout the year could never be economically packed into consumer sized cartons in the few weeks in which they were harvested. It became necessary to find a way to freeze continuonsly after processing and store in bulk, so that bulk stock could be taken from cold storage all through the year and re-packed, in a frozen state, by a packaging line working 12 months per year. This was obviously the right way to get full value from the money invested in packaging machines and it also allowed changes in presentation of the product, (pack size, price marking, packaging material etc.) at any time during the year.

These requirements were met in total by the arrival of, first, the belt freezer and then the first of the truly I.Q.F. (Individually Quick Frozen) freezers. The belt freezers were only on the scene for a short time and are not important for these notes as they were very quickly replaced by the I.Q.F. freezers.

Before discussing I.Q.F. freezers let us clearly understand the meaning of the phrase "Individually Quick Frozen". The word "Frozen" was never misunderstood, but the words "Individually" and "Quick" have, at times, taken a rather flexible meaning. Fortunately the last ten years brought the introduction of some first class I.Q.F. freezers and the consumers have grown accustomed to the equally high quality of the rapidly frozen products comingfrom them. By freezing such products as strawberries, peas, diced carrots, cut green beans, mushrooms, cut sweet corn, brussels sprouts, french fried potatoes etc., as separated single items the freezing time is kept to an absolute minimum, as the heat from the centre of each small piece has only to travel a few millimeters to the outer edge of that piece before it is removed. (compare this with the time it would take if that same small piece were in the centre of a package in a plate freezer, where that same quantity of heat would have to travel outwards through all the other small the other small pieces, and the carton or package, before it could be taken away by the cold plates.)

Designers realised that if they could stop the small pieces of the product sticking together on a wire mesh belt and run a single layer of product onto that belt, they could produce separated pieces, rapidly frozen, by blowing cold airthrough the belt. This in fact is how the first I.Q.F. freezers worked. It was only a short step then to increase the thickness of the layer of product It was only a short step then to increase the thickness of the layer of product and blow more air through, so that the air itself agitated the product to stop it sticking together as it froze. These freezers are sometimes called "Fluidised" freezers but are more correctly called "Semi-Fluidised" or "Fluidise dBelt" freezers for reasons made clear in the next few paragraphs.

Before going further, it is interesting to consider what "fluidising" really means. If we make a long, narrow tray, with many small holes in the base of it, and sides, say, 30cm high we have the basic part of a truly fluidised freezer. If we now pour into the tray a 10cm deep layer of, for example, blanched and cooled diced carrots they will lay in the bottom of the tray until we start to blow air through the holes in the bottom. As we gradually increase the amount of air blowing through between the pieces we will notice that the air starts to separate the pieces and the depth of the layer will start to increase from 10cm to about 12cm. Further increases in the amount of air flowing through will start to move the pieces a little and the level will rise still further in the tray. When the air speed is around 170 metres/minute the tray will contain a mixture of air and moving pieces of carrot in a layer about 15 to 20cm deep. This mixture of air and small cubes of carrot will behave exactly like a liquid. For example, a solid object, which would rest on the top of the original 10cm layer of carrots, will sink to the bottom of the 20cm layer of carrot and air mixture. Likewise, if we scrape a hole in the 20cm layer of carrot and air mixture it will fill in again immediately. In other words the diced carrot is "fluidised" and will flow.

If we had made our long narrow tray with one end only 20cm high and all the other sider sides 30cm high, we could pour in more carrots at the high end and, exactly like a tank of water, the level would rise all along the tray until the carrots flowed over the 20cm end and out of the tray. The more we poured in at one end, the more would come out at the other. If the air blowing through was could enough the carrots would be frozen by the time they flowed out, and we would have made a fluidised tray feezer.

Of courese, the technology required and the development experience needed to make such a freezer are very great indeed and only one company has successfully produced a fluidised tray freezer.

The agitation of the product by the air will keep each piece separate as itfreezes and no belt is needed to move the product through the freezer.

The output from fluidised belt and fluidised tray type freezers is totally separated and can be stored in one ton "palletainers" which are large cardboard boxes lined with polythene sheet. These are stacked up to 5 high in-29°C cold stores until required for re-packing. When required, the palletainer is opend and the contents poured into special packaging lines which automatically weigh and fill the type of pack required. Cardboard cartons are no longer required and almost all the free-flowing fruit and vegetables are sold to the housewife and restaurant trade in simple polythene bags.

Since the fruit and vegetables are not packed until they are required, it is not necessary to find a buyer for the final product atthe time of harvest, and many farmes co-operatives are freezing their own crops and selling later in the year when out of season prices have steadied.

The I.Q.F. freezers discussed, so far, have utilizedcold air to freeze the product and this represents the major production of all frozen fruit and vegetables. Small quantities of high value products which are difficult to freeze successfully in air (such as corn-on-the-cob) are also frozen by direct contact with liquid refrigerants such as Freon 12, CO_2 and Liquid Nitrogen. These freezers are expensive to operate and are generally only justified when they are used for long operating seasons freezing products which command a premium price on the market.

Selection of Freezer Type

Most of the freezers described in the previous section are still available and continue to be purchased and used. The selection of the right freezers for the developing Korean industry will depend upon many factors and it is important to understand the influence that each factor has on final choice.

Consider, for example, the requirements of export markets. To successfully penetrate an established market in a country such as the U.S.A. the product offered for sale must meet two prime requirements, firstly the quality must be as high as the home produced alternatives and, secondly, the price including transport must be competitive with the home produced alternatives. These two requirements affect the choice of freezer in two ways. The first, and obvious, influence is the matter of quality, thus the freezer must be efficient, hygenice and produce a well frozen and attractive product. Less obvious is the way in which the competitiveness of the finished product affects the freezer choice. For example, it is unlikely that Korea could export I.Q.F. peas to the U.S.A., as the American crop is grown on an extremely large scale, mechanically harvested and mechanically processed with a correspondingly low costper kilo. But, on the other hand, crops which require a high labour involvement to grow or process them reflect the high American labour costs in their final price. It might be decided, for example, to base a Korean export campaign on frozen asparagus, which requires much hand work to grow and harvest and a corresponding amount of careful handling in the processing and freezing line. If the presentation of the frozen product was to be in consumer packs then a plate freezer might be chosen. If bulk purchase in 50 kilo boxes was made for further processing, then a truly I.Q.F. product would be required and a specially adapted belt freezer could be the answer.

In this example can be seen the first pitfall. A special freezer might be chosen for a particular product, or method of packaging, which is unlikely to produce good results on any other fruit or vegetable. The asparagus season is short, so that any special equipment would remain un-used from one year to the next, with the result that the total yearly financial charges are carried by a few weeks production. The economic effect would then be that the Korean labour cost advantage would be considerably offset by the capital charge caused by under-utilised investments.

This line of thinking brings us towards consideration of the so-called "general purpose" freezers which are typified by the fluidised

operating hours/yare	annuity $	power cost $	maintenance cost $	labour cost $	total yearly cost $
500	23,400	1,900	1,230	1,000	27,530
1000	23,400	3,800	1,840	2,000	31,040
1500	23,400	5,700	1,840	3,000	33,940
2000	23,400	7,600	2,460	4,000	37,460
2500	23,400	9,500	3,070	5,000	40,970
3000	23,400	11,400	3,690	6'000	44,490

tray or fluidised tray or fluidised belt freezers which have a trolley section mounted alongside. This arrangement allows totally individual quick freezing of all the products that will flow as small pieces (which is done in the tray or on the belt) but also allows larger products, or packaged products such as leaf spinach, to be frozen in the trollies when the fluidised section is not in use.

Unless there is an extremely strong and reliable market for a single product that can be processed almost all year round, (such as french fried potatoes) single purpose freezers are almost certain to be economic failures.

Freezer Costs and Freezing Costs

The capital cost of installing freezers and refrigeration plant is always high. If good quality equipment, that can be fully used for most of the year, is purchased then the cost is even higher, but we must relate this cost to the value of the frozen product before we can say whether it is too high. It is generally accepted that the cost of freezing should be between 1 and 5 percent of the processed value of the product. This freezing cost should incude the yearly overhead charge of the capital invested, interest charges on any and the full operating and supervision costs of the freezer and plant.

As an illustration of the way in which freezer and plant costs affect the cost per unit weight of the frozen product, let us consider the economics of two small plants operated over varying numbers of hours per year, as follows;-

Plant A. Nominal Capacity=1 ton per hour

Total cost, freezer and plant, say, U.S. $123,000 14% interest, 10 year depreciation =19% per year annuity=US $23,400 Total horsepower absorbed, say, 150=112KW At 17₩ per KW hr=US $3.80 per operating hour Operator cost=US $2.00 per hour Maintenance costs, 1% to 3% of investment per year

Then, the total yearly costs to be charged to a freezing operation vary with the hours of operation as shown in the following table:-

To relate these total yearly costs to the total product frozen, we must make some allowance for the fact that the freezer output will vary with the product processed, for example, a freezer with 100% capacity on peas will process only 90% of cut sweet corn, 85% of diced carrot or cut green beans, 90% mushrooms and 59% of strawberries. So, if we assume that the increasing number of hours der year is obtained by processing a wider range of products we should "De-

oeprating hours/year	tons/hr	yearly tons	total yearly cost	cost $ per ton	cost ¢ per pound
500	0.95	475	27,530	58.0	2.64
1000	0.90	900	31,040	34.5	1.57
1500	0.85	1,275	33,940	26.6	1.21
2000	0.80	1,600	37,460	23.4	1.06
2500	0.75	1,875	40,970	21.8	0.99
3000	0.75	2,250	44,490	19.8	0.9

operating hours/year	annuity $	power cost $	maintenance cost $	labour cost $	total yearly cost $
500	42,000	3,500	2,210	1,000	48,710
1000	42,000	7,000	3,315	2,000	54,315
1500	42,000	10,500	3,315	3,000	58,815
2000	42,000	14,000	4,420	4,000	64,420
2500	42,000	17,500	5,525	5,000	70,250
3000	42,000	21,000	6,630	6,000	75,630

operating hours/year	tons/hour	yearly tons	total yearly cost	cost per ton $	cost in ¢ per pound
500	1.9	950	48,710	51.2	2.32
1000	1.8	1,800	54,315	30.2	1.37
1500	1.7	2,550	58,815	23.1	1.04
2000	1.6	3,200	64,420	20.1	.91
2500	1.5	3,750	70,250	18.7	.85
3000	1.5	4,500	75,630	16.8	.76

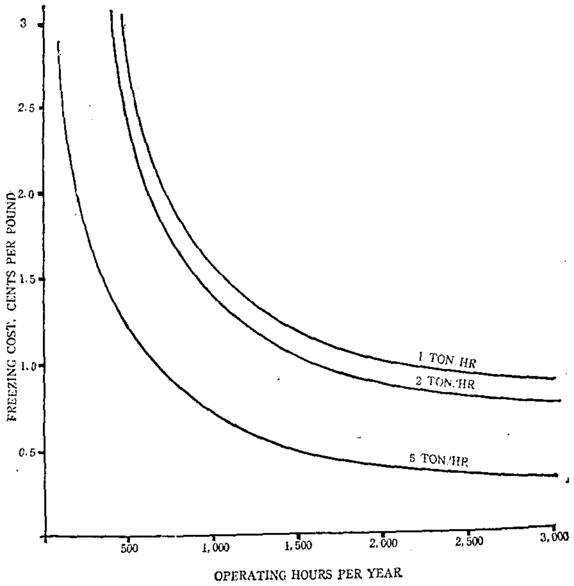
Rate" the freezer progressively. A reasonable assumption is shown:-

Consider, now an installation of twice the capacity:-Plant B. Nominal Capacity=2 tons/hr Total cost, freezer and plant=say, US $221,000 19% annuity (as plant A)=US $42,000 Total horsepower absorbed, say, 270, =202KW At 17₩ per KW=US $7.00 per operating hour Operator cost, US $2.00 per hour Maintenance cost, 1% to 3% of investment cost per year. Using the same basis for calculation as for plant A, The yearly costs then become, as follows:- and, similarly, the cost per unit weight, as follows:-

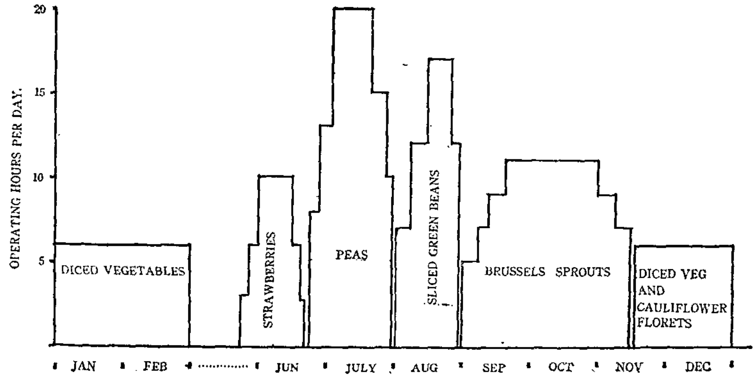
Similar calculations can be made to show the cost per pound of product frozen for much larger freezing plants and this information is summarised on the graph below

It should be remembered that the two small freezers, 1 ton/hr and 2 tons/hr are very small by international standards and freezers of 5 to 8 tons per hour are quite common, with standard units available up to 12 tons per hour.

Economics of Freezer Operation



Graph 1. Cost per pound of product frosen



UTILIZATION DIAGRAM. 4 TON FREEZER

Diagram 3. Utilization Diagram, 4 ton freezer

From the graph above it can be seen that an optimum target for any size of freezer is an operating level of not less than 2,000 hours per year.

If we assume that the freezing cost of a certain product which sells for 50 cent/pound should be approximately 2% of the processed cost, then from the graph we see that a five ton per hour freezer need only operate about 650 hours per year to acheive a 1 cent/lb freezing cost, but a two ton per hour freezer needs to operate 1,600 hours and a one ton freezer over 2,000 hours to each the same freezing cost per pound.

Notes on the Development of the Korean Frozen Fruit and Frozen Vegetable Industry

PART 2

Following from the previous general notes, regarding the development of various freezer types and their application, it is interesting now to relate those conclusions to the production problems we can anticipate in Korea.

It will be remembered that the general conclusions to be drawn from theose notes were:-

i) A high standard of quality is essential for acceptanc of new products, particularly in established export markets.

ii) Equipment to obtain the required standards is available, but intial investment costs are high.

iii) High investment costs are recoverable if production throughputs are maintained through an adequate period of the year.

iv) The total cost of investment and operation, divided into the tonnages processed, should give a freezing cost per kilo of between 1% and 5% of the processed value of the product.

v) The larger the processing/freezing plant the more economic is the operation fora fixed utilization period.

It is obvious, from these conclusions, that the ideal installation should be so located that an adequate supply of suitable raw material is available, in good condition, for the longest possible harvest period.

Few freezers will handle every agricultural product and the general purpose freezer

product	hours/year	tons/hour	tons of product
peas	630	4	2,520
sliced beans	448	2.6	1,060
B. sprouts	525	2.6	1,360
diced vegetables	270	3.2	865
cauliflower	180	2	360
strawberries	154	2.2	340
Total	2,267		6,500

provides what is probably the best compromise. To illustrate a typical utilization of a fluidised tray type freezer in western Europe the following Diagram shows the seasonal variations with vegetables and strawberries on a nominal 4 ton/hour freezer. The hourly operation and product throughputs for this freezer are indicated in the following table, the tons/hr figures are fixed by the freezer capacity on products which are less easily fluidised.

From this example two important points can be clearly seen, firstly, the freezer has been chosen for its high efficiency on the primary, short season, product which is peas. (over 1/3 rd, of the total tonnage goes through in the six week pea season) secondly, the freezer type chosen has a good range of efficencies on other vegetables available in the area, thus enabling a 2,000 hours per year target to be maintained.

In this instance a fluidised tray type freezer

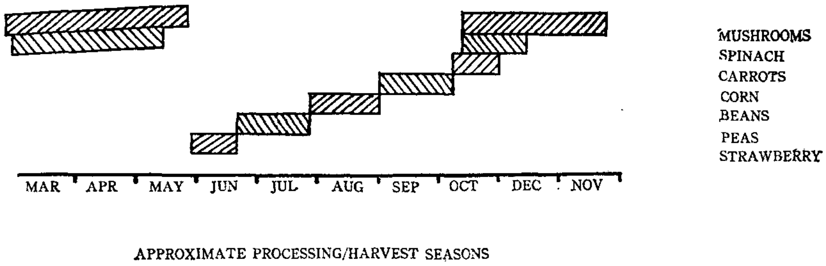


Diagram 4. Approximate/Harvest Seasons

Diagram 5. Vegetables only

was chosen, however, if the secondary products available in the area were, say, spinanch and broccoli instead of beans and sprouts then a fluidized belt type freezer with a rack freezing section might have been chosen for roughly the same total investment.

Freezing Plant Location

One of the largest single influences single influences on product quality is the speed with which the product is brought from harest location to the processing line. The frozen food factory is the classic example of the "GIGO" principle. (Garbage In-Garbage Out) and the final product quality is totally dependant upon the raw material qualty, The deterioration that starts after harvest in the field must be kept to an absolute minimum and the time spent transporting the product to the factory is critical, In the case of vegetables such as peas, which are harvested when they are immature and still in the period of high metabolic rate, the time elapsing between harvest and processing is particularly important. When mobile pea viners are used the peas are removed from the pods in the fields and the peas are loaded immediately into pea tanks on lorries and driven at once to the factories.

In the older type of operation the vines are taken from the fields to a vining station where the peas are removed and prepared for transit, in this case the peas are frequently pre-cooled by air or chilled water to retard the metabolism in transit to the factory. Top icing is also employed. These examples serve to illustrate the importance of rapid and controlled collection and delivery to the factory.

Experience in Europe and the U.S.A. has shown a positive move in locating processing plants and bulk cold stores right in the rowing areas. This practice is now almost universal and has many advantages. Whilst it is an obvious advantage to process close to the field, this location of cold store, packaging etc. has also shown other good economies, for example.

a) construction costs. Land values in rural areas are lower, large singl storey buildings are much more economic to build and operate than multistorey cold stores, but require more land area.

b) Traffic pattern. Large open sites can provide good access for vehicies, allowing speedy loading, unloadingand a rapid turn-round.

c) Labour. Rural labour is available which is accustomed to handling food products, and local employment is maintained as the traditional "farm" employment decreses due to mechanization.

Freezer Selection

The product mix traditionally available in a certain area will often influence the type of freezer selected, let us consider a totally theoretical example. If we assume that there is a potential export customer who is prepared to contract for the purchase of frozen strawberries for jam making from an imaginary supplier in, say, Jeonla-Nam-Do province, we can make an interesting brief study. The statistical records for 1973 show the following tonnages of products, that would be suitable for frozen exports, were grown in that province.

spinach	— 4,529 tons
Carrot	— 574 tons
Green Beans	— 1,032 tons
Peas	— 53 tons
Strawberries	— 1,090 tons
Mushrooms	— 3,279 tons
Sweet Corn	— 517 tons

Since the frozen strawberries are required for jam making they would probably be acceptable frozen into blocks, or alternatively I.Q.F. The freezer type would then depend very much upon the other crops processed for the remainder of the year. The tonnages available of sweet corn, peas, beans and carrots are relatively small, but spinach and mushrooms are produced in significant quantities. When the approximate harvest seasons are considered, the pattern becomes clear.

The choice must be made between spinach or mushrooms as the "winter" crop because the tonnages avaiable of other products are not significant.

Choice 1

If spinach is chosen the product will almost certainly be frozen in consumer packs in leaf form. The ideal freezer for this duty is a plate, or contact, freezer. This means that the strawberry crop would also have to be frozen in block form, and the remaining crops such as peas, beans, corn and carrots could not be processed, as they would not be generally acceptable frozen in block from.

Thus the installation could be designed for a "two crop" usage with block frozen outputs in both cases. A freezer and plant for this duty would be less expensive but the processed value of the factory output would also be low, as block frozen strawberries are only acceptable for further processing and leaf spinach is a low value product even when out of season.

Choice 2

If mushrooms are chosen, then the whole range of products listed are suitable for I.Q.F. processing and bulk handling. In this case one of the more eepensive fluidized tray or fluidized belt freezers would be justified. It should be noted that the more expensive fluidised freezer will also handle the high value products and produce the best final, I. Q. F., results. This means that the best of the short strawberry crop could also be processed for the high value part of the market, and a longer operating season could be maintained by processing a wider range.

Storage and Transport

As has been mentioned already, the ideal place for the bulk store is in the growing area, generally near to the freezing plants although this is not essential. A cold store which serves different branches of the frozen foods industry, producing a wide of range of products, will be much bet ter utilized than an owner/producer store. For example, the storage requirements of a privately owned store which is part of a frozen vegetable operation will have a utilization as indicated in Diagram 5.

Since storage costs are dependant upon the initial investment and running costs, two significant points are worth noting. Firstly the full storage volume must be usefully used for as long as possible and, secondly, capital costs and running costs, per unit of storage volume, decrease dramatically with an increase in size of store.

So, we may say that overall storage costs can be reduced by finding overlapping seasonal products to ensure that the store is well used throughout the year, and building the largest store possible in relation to the storage demand that can be anticipated or generated. The vegetable storage requirem-ent, shown in Diagram 5 as a monthly percentage of the maximum, runs almost exactly contrary to the requirements of the ice cream industry which builds up stocks during winter and Spring that are run down as the demand ȷor vegetable space increases. Similar contrasts exist with butter and fish. Diagram 6 shows the relative percentagere rquirements, for these four products, through a typical storage year.

This approximate store loading indicates the way in which, by good management, a large store can be kept between 100% and 75% full on four basic commodities, by the selective encouragement of other business, such as meat, the overall utilization can be further improved.

With storage temperatures, in currents use in Europe and Scandinavia, of minus 30°C there is little risk of microbial cross contam-ination but in some cases odours and flavours can still be transferred, particularly with aromatic fruits and fish adjacent to dairy products. For this reason even the largest −30°C stores will still have partitioned rooms with odour tight membrance or dividing walls. The cost of building and equipping single storey cold stores in western Europe in 1974 is given in the following table for a range of sizes. The cost per unit volume in the last column is a measure of the greater economy as the scale of the operation is increased

These prices included all building work, insulation, electrical equipment, refrigera-tion plant, loading dock and concrete apron. Not included are fork trucks and pallets etc.

The relative operating costs are similarly proportional to the store size, for example, compared to a 28,000 cu. m. store of 5,000 cu. m. would cost almost twice as much to

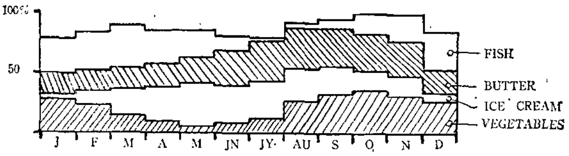


Diagram 6. Mixed Storage

Store Size cu. m.	Total Cost US$	US$/cu. m.
1,700	130,000	76.5
2,800	182,000	65.0
5,600	303,600	54.2
14,000	630,000	45.0
28,000	1,084,000	38.7

operate per ton stored; whereas, a 100,000 cu. m. store would operate at half the cost per ton.

From these figures it can be understood why the trend in the U.S.A., Europe and Scandinavia has been towards large bulk cold stores in rural areas with distribution stores adjacent to the large population areas. It is interesting to note that the "in city" cold stores are slowly disappearing, even dockside and harbour stores are proving less ecomic if they are in large cities. A fishing port would be an exception as other factors are involved.

To build large bulk stores within the boundaries of a major city would mean, for reasons of scarcity of land, multi storey buildings with limited vehicle space. Thus both first cost and operating costs become unrealistically high. Additionally, strong objections are raised to the constant traffic though city centres of the large refrigerated vehicles that are an essential part of an economic cold chain.

The pattern that has emerged is very much based upon economicuse of refrigerated transport. The bulk stores are located (with or without processing or packaging facilities) in rural areas adjacent to trunk roads which connect to the large urban areas. Korea is well served with such roads and there seems to be an ideal situation existing for such a bulk distribution system.

On arrival at the boundary of the town or city it is usually the case that the large vehicles unloed into a distribution store of much smaller size where the products are "broken-up" into smaller mixed lots for local deliveries by smaller vans. A smaller vans. A smaller vans. A small buffer stock is held at the distribution store but the operation is essentially a break-up one.

An interesting recent development has been the introduction of the so called "satellite distribution" system. In this form of operation the distribution store is dispensed with. To the range of services provided by the large bulk store is added the break-up service, and the large trunk vehicles deliver their goods in pre-assembled small lots. On arrival at the city boundary transfer is made to the waiting small vans. This methed requires good organization, communications and timing, but little more than a parking lot at the city boundary. A variation of the system is to provide a ramp with canopy so that the large refrigerated vehicle may be a semi-trailer which arrives in the early morning, uncouples the loaded trailer at the ramp and couples up to the empty trailer from the previous days delivery and returns to the large store.
Since the trailer is indepedently refrigerated loading from it may continue all day. This system could well be used in establishing a storage and distribution system in Korea.

without the construction of distribution stores at every urban concentration. However it would also mean that the bulk stores must be carefully sized, designed and sited.

When break-up operations are provided at a bulk cold store one of the high cost activities is taken from the usual chain of events. Goods in store that have been inloaded from the original owners, (importer, producer etc.) may be sold to a wholesaler with out being re-handled and moved to a distribution store for break-up. Change of ownership does not need to entail change of location. This is a double saving as handling costs are avoided and storage costs are those of the more economic large store, rather than the expensive small wholesale store.

In the case of the growth of the Korean frozen food industry it must be clearly understood that all aspects; production, supply to factory, processing, freezing, storage, transport and distribution are all totally dependant upon each other. One weak link in the cold chain makes the whole chain weak.

The first market to be exploited by the Korean frozen foods industry will probably be the export market, but as the urban populations increase in numbers and sophist ication there will be a growing domestic demand for prepared and semi-prepared foods in addition to out-of-season foods. As the domestic market for frozen foods develops it must be supplied with good quality products at economic prices. It would be frustrating and expensive to discover, at this point in the industry's development, that the first moves and developments were made based upon short term considerations, and that unneccessary additional investment has to be made that could have been avoided by good planning in the early days.