Project Planning for Small and
Medium Scale Industries No.32

Freeze-dried Foodstuff Manufacturing Plant

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JAPAN CONSULTING INSTITUTE

This technical brochure was compiled to help in the drafting of a suitable plan for the construction of a Freeze-dried Foodstuff Manufacturing Plant.

The production scale and manufacturing process have been described in this brochure on the basis of a typical instance.

The profitability was estimated by fixing certain required conditions which may differ from country to country.

We hope that the data contained in the brochure will help you to draw up the most suitable plan for the industrialization of your project.

In case a government or public organization requests the Japan Consulting Institute to conduct a feasibility study of the above industry for the purpose of establishing the most suitable plan, it is possible for us to carry this out free of charge.

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1. Introduction

In recent years freeze-dried food market is expanding rapidly in developed countries. There may be various reasons for that. For instance, the desire to obtain off-season foods, the needs of acquiring the ingredients of instant foods, and the diversification of the ingredients used for cooking and making cakes. In other words, it may be due to the diversification of cookery and of the methods of preparing cakes and beverages.

The freeze-dried food market is showing a tendency to increase gradually in developing nations as well.

In case products can be put up for sale in such freeze-dried food markets, it will lead to making profits by way of supplying highly value-added products on one hand and also by making use of the seasonal foodstuffs in surplus without wasting them. If export can be made to overseas markets, it will become a means of bringing about foreign currencies.

The freeze-drying method which is taken up in this brochure was used in the research of biology and medicine beginning the 19th century, and the study results came to be used by the middle of the 20th century for drying serum, plasma and various vaccines as well as for preserving tissues and specimens of animals and plants, and for preserving microbes. The freeze-drying method is employed at present for preserving antibiotics and other medicines as well as various enzymes that are unstable under normal temperature.

During the Second World War the United States and Germany studied the application of freeze-drying method to foodstuffs used in airplanes and submarines, but could not put it into practice. Positive studies of putting the freeze-drying method to practical use were carried out after 1950 mainly in the United States and Europe, and freeze-dried foodstuffs were made in about 1965 by using relatively large freeze-dryers. The distinctive characteristics of freeze-dried foodstuffs were highly evaluated when various kinds of freeze-dried foodstuffs were used in the Apollo No. 5, the manned spaceship of the U.S.

This success has encouraged food processors to produce freeze-dried foodstuffs based on new ideas of their own one after another.

2. Freeze-dried Foodstuff

2.1 Outline

There are two drying methods, hot-air drying and freeze-drying. In this brochure, explanation will be made on the latter which can keep the freshness of food. Some of the freeze-dried farm products can be eaten as they are. Freeze-dried foodstuff can generally be restored to their original conditions by merely adding water and can be cooked quite easily. In addition, powdered products are used as ingredients for making bread, cake, ice cream, sherbet, etc. It can also be used for making fresh juice by addition of water. The utilization of freeze-drying method varies according to a country concerned because of different local conditions, and their eating habits are unlike one another. Hence, some of the utilizations of freeze-drying method in Japan will be mentioned here for reference.

① Instant coffee

Instant coffee, most widely taken in the world is produced by the freeze-drying technology. In addition, it has also been introduced in the fields of black tea and green tea.

② Vegetables

Dried leek, onion, spinach, cabbage, chinese cabbage, honewort, carrot, burdock, radish, potato, sweet corn, 'shiitake' (a kind of mushroom), mushroom are shred and used as ingredients of instant noodles and soups.

③ Fruits

Orange, lemon, grapefruit, apple, pineapple, strawberry are put out in the form of powder and flake to be used for drinks and frozen cake such as ice cream, sherbet.

④ Bread and cake

Powdered pumpkin, sweet potato, potato, carrot are mixed with flour and are baked into pumpkin pie, carrot cake and so forth which are popular as healthy foods.

⑤ Fermented foods

Bean paste, soy and 'natto' (fermented soybeans) are made using freeze-dried soybeans as raw material.

⑥ Processed foods

'Aburage' (fried soybean curd), 'tempura', 'tofu' (bean curd), 'kamaboko', 'hampen' (pounded fish cake) are freeze-dried as ingredients of instant noodle soup, 'miso' soup, 'suimono' (a kind of consomme) and soup. Besides, freeze-dried 'udon' (a kind of noodle) and buckwheat noodles are produced.

⑦ Healthy foods

Powdered royal jelly, soft-shelled turtle soup, herb, herb medicines are produced by freeze-drying method.

⑧ Weaning diet

For the use of weaning diet of babies who take a little quantity of food at a time powdered spinach, carrot, pumpkin are made.

⑨ In addition, meat, fish and seaweed can be freeze-dried.

2.2 Characteristics

In the freeze-drying method materials to be dried is frozen first. And then water is removed by sublimation under vacuum. Products thus obtained have the following characteristics.

① No shrinkage from drying

Fine crystal ice formed in the raw material is removed by sublimation, and porous products retaining the original shape before drying can be obtained.

② Natural tissue structure is not destroyed.

The moisture contained in the raw material is removed to the extent of 10 to 15% in a temperature range of $-30°C$ to $0°C$ and to 2 to 3% in a range of $0°C$ to $40°C$. Namely, since drying is almost made at a temperature lower than $0°C$ and under vacuum no change occurs in coloring matter, aromatics, tasting elements, vitamins, minerals. Consequently, the products will keep original color tone, taste, and nutritive value of the foods before drying.

③ Products regain their original shape when water is added.

The dried foods being porous, they instantly regain the original shape when they are dipped into water or when water or hot water is poured onto them.

④ Being well dried, the products can be preserved for a long time at normal temperature.

As moisture is reduced to 2 to 3%, the products thus dried can be preserved for a long time at normal temperature if they are packed for preventing moisture and oxidation.

⑤ That moisture is cut down to 2 to 3% means that hygroscopicity is high. Therefore, the inspection, selection and packing of the dried products must be done in a dry atmosphere having 20 to 30% relative humidity. The packing material must have high moisture proof and oxygen interruptivity. Flaky products are vulnerable to impact, vibration and compression from the outside. Accordingly, consideration must be given to some products so that they do not get damaged.

3. Freeze-drying System

3.1 Principle of Freeze-drying

In the freeze-drying water in the food becomes vapor directly from the state of ice without passing through the state of liquid and is removed. This is the principle of the freeze-drying system.

When ice is put under the condition lower than 0°C and 4.579 Torr vapor pressure, it becomes vapor directly without passing through the state of water. This phenomenon is called sublimation.

The freeze-drying system is in short a drying method whereby the sublimation of ice is skillfully utilized. However, as was mentioned in the foregoing paragraph, ordinary drying method of evaporating water in a temperatures range of 0°C to 40°C is utilized in the final stage of drying. The vapor which is sublimated from the frozen food is collected in the state of ice or water by cold trap or steam ejector.

3.2 Composition of Freeze-drying System

Sublimation is a simple physical phenomenon. This phenomenon is applied to chemically and physically complicated foods to put out high-quality dried foods efficiently and economically. For this purpose, the following devices are necessary.

① Freeze-drying chamber (drying chamber, cooling and heating shelf, cold trap, tray)
② Shelf heating device (heat medium heater, heat exchanger, heat medium cooler, heat medium circulating pump, heat medium expansion tank)
③ Vacuum making system (rotary oil vacuum pump, mechanical booster pump)
④ Freezing facilities (refrigerator, cooling tower, water cooling pump)
⑤ Control system (control panel, temperature and pressure controllers and recorders, vacuum gauges)

Pre-freezing is necessary for raw materials before they are put into the freeze-drying chamber. Its speed will greatly influence the product quality. As raw material contains soluble elements, their freezing temperatures differ depending on their kind. Hence, the pre-freezing must be done at a temperature lower than the eutectic point. It is generally done in a range of −35°C to −40°C.

There are two pre-freezing methods, one is to freeze in a separate freezing chamber and the other is a self-freezing method, in which the moisture in the raw material is evaporated by vacuum making in a drying chamber, and cooling and freezing are done by evaporation latent heat. Which method is to be adopted depends on the shape and properties of the raw material to be used.

(1) Freeze-drying chamber

① Chamber

There are two types of a drying chamber, one is a horizontally cylindrical type and the other horizontally cubicle type, of which the latter type is mostly used, because it has such merits as the layout is easy, the dead space in the chamber is small, and piping is done in good order.

The raw material sometimes scatters, adhereing to the tank walls. Especially in the case of food, there are many kinds of raw materials, whose constituent and composition are various. It is therefore necessary to adopt the one, the inner structure of which is as simple as possible so that washing and cleaning can be done easily. The material made of stainless steel is commonly used.

② Tray

The trays used for freeze-drying are required to be light in weight, and good sanitary and high heat conductivity are also needed. The trays made of aluminum are therefore mostly used. The ones made of stainless steel are also used from corrosion resistant point of view. The trays carrying raw material being heavy and many in number, and saving of time for transfer

from other pre-freezing chamber being needed, a wagon and monorail are used so that the trays can be transferred collectively.

③ Cold trap

For eliminating aqueous vapor, there are two methods, one is to use a steam ejector and the other a cold trap. The former has such merits that its structure is simple and causes little trouble. It needs, however, large quantities of steam and cooling water for operation. The latter has such merits that although it needs a refrigerator, it does not require a large space, and its operating expense is small. Because of these merits, the latter is often adopted for use.

As for its cooling tube, there are fin type, coil type, multitubular type and plate type; of which the fin type is mainly employed because it has a wider cooling space against its outer dimension. In adopting either of them, what is important is that the ice that soldifies on the cooling surface forms uniform layers and that the melted ice and water can easily be taken off.

(2) Shelf heating device

In sublimating 1-kg ice in the raw material, some 700 kcal heat must be supplied. In the freeze-drying, heat supply is made on the heating shelf, and in order to shorten the drying time and cut down the operating expenses, consideration must be given to the point that the highest allowable temperature is to be applied to the frozen part and dried part of the raw material.

In heat supplying there are two methods, one is to put the tray directly on the heating shelf, making the contact heating, and the other is to insert and fix the trays in the space between the heating shelves, and heat the raw material by radiant heat. In the case of food, the radiant heating system is generally adopted.

The radiant heating system has such merits that it is not affected by the flatness of the contact surface between the shelf and the tray, and uniform heat can be supplied to the raw material, and many trays can collectively be put into or taken out from the drying chamber in a short time.

For the heating shelf, plane plates and tubes are used, but in any case they must be so arranged that uniform temperature can be distributed for the whole heating shelf. For that purpose, a heat medium that was heated by a heat medium system is circulated in the inside of the heating shelf. It is also necessary that the heat medium can cool the heating shelf according to the progress of drying of the raw material.

(3) Vacuum making unit

In case a cold trap is used for the freeze-drying device, it needs a vacuum pump. Rotary oil vacuum pump is said to be most appropriate for the vacuum pump. Considering capacity and cost, a large pump is used in combination with other booster pump.

The exhausting time (the time for exhausting from atmospheric pressure to operating pressure) is limited so that the frozen raw material does not melt when exhausting starts. Hence, it needs to select the one having a capacity suitable for said purpose.

The vacuum pump is commonly used by the following combination.

① Rotary oil vacuum pump
② Mechanical booster pump and rotary oil vacuum pump
③ Mechanical booster pump and air ejector and hydraulic vacuum pump
(This combination is used for exhausting the one that contains corrosive gas.)

(4) Refrigerating unit

For the refrigerating unit, it is advisable to select air cooling system which does not require cooling water, and consequently, the system does not need cooling water pump and cooling tower. Thus the system seldom

goes wrong and its maintenance can be done easily. As the freezing temperature is required to be lower than −35°C, it needs a two-stage compression system, and R-502 is used for refrigerant.

(5) Control system

It is necessary to put the raw material into the drying chamber and to take out the product in a short time. Also the control of temperature and pressure while drying is being made must be done precisely and efficiently. It needs therefore to install a pressure and temperature controller, and each valve should be operated automatically, Fig. 1 shows the composition of freeze-drying system.

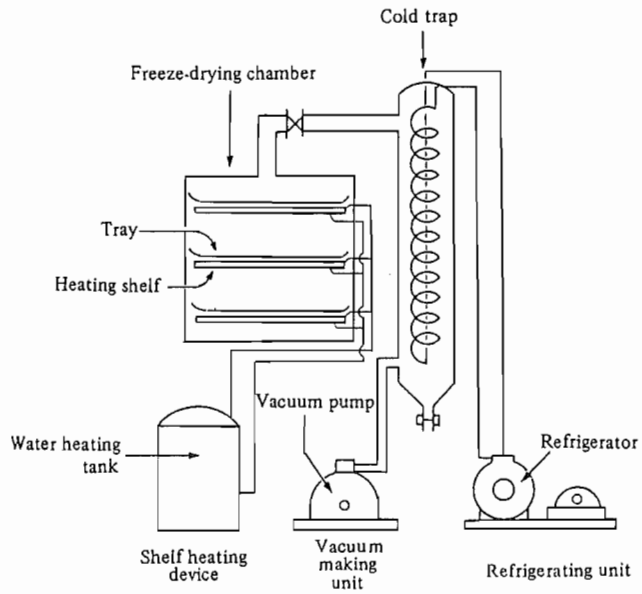

Fig. 1 Composition of Freeze-drying System

4. Outline of Model Plant

Of the agricultural products being used as raw material for freeze-dried foodstuff, vegetables are used mostly. Table 2 shows examples of raw materials and products.

In this brochure sweet potato will be taken up as the raw material to be used in the model plant.

Table 2
Examples of Freeze-dried Products made from Vegetables

Raw material	Shape	Utilization
Sweet potato	Flake, powder	Ice cream, sherbet, chip candy, bean jam candy, 'kinton' (mashed sweet potato), weaning diet
Yam	Powder	'Tororo' (grated yam), 'okonomi-yaki' (pancake), buckwheat noodles
Carrot	Flake, powder	Ice cream, sherbet, material for making bread, cake, candy, cooking, pasta, weaning diet
Radish	Flake, powder	'Daikon oroshi' (grated radish), material for cooking
Burdock	Flake	Material for cooking
Spinach	Powder	Ice cream, sherbet, material for making bread, cake, weaning diet, pasta
Tomato	Powder	Ketchup, puree, juice, material for cooking
Garlic	Flake, powder	Spice
Pumpkin	Flake, powder	Ice cream, sherbet, for making bread, cake, jam, pasta, weaning diet
Potato	Flake, powder	For making salad, material for cooking, chip candy

4.1 Kinds of Product and Production Scale

The following shows the kinds of product and production scale.

(1) Kinds of product: Flake and powder of sweet potato.
(2) Production sacle: 25 kg per day (Water content 5%) 6,250 kg per year.
(3) Operation: 24-hour continuous operation a day. The number of working days a year is 250 days.

4.2 Manufacturing Process

Fig. 2 shows the manufacturing process of of this model plant, and explanation thereon.

Process	Outline
Raw material	------- Sweet potato
Pre-treatment	------- Washing, peeling, slicing of raw material.
Freezing	------- Quick freezing is made with a refrigerator at temperature of −30 to −40°C
Drying	------- Ice sublimation is done at a vacuum level 1 to 0.01 Torr and at 50 to 80°C drying plate temperature. Water content at the time of charging: 75% Water content at the time of taking out: 5%
Post-treatment	------- Product inspection and grinding. It is necessary to keep the relative humidity in the room at 20 to 30%.
Packing	------- Packing is made to prevent moisture and oxidation.
Storage	------- Product is stored in a cold storage room.

Fig. 2 Manufacturing Process

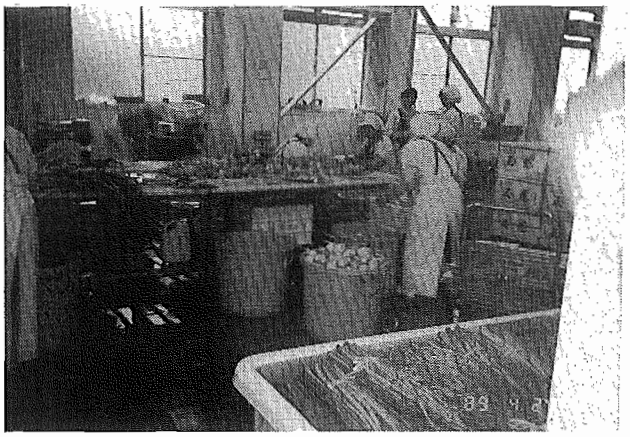

Photo 1 Raw Material Pre-treatment

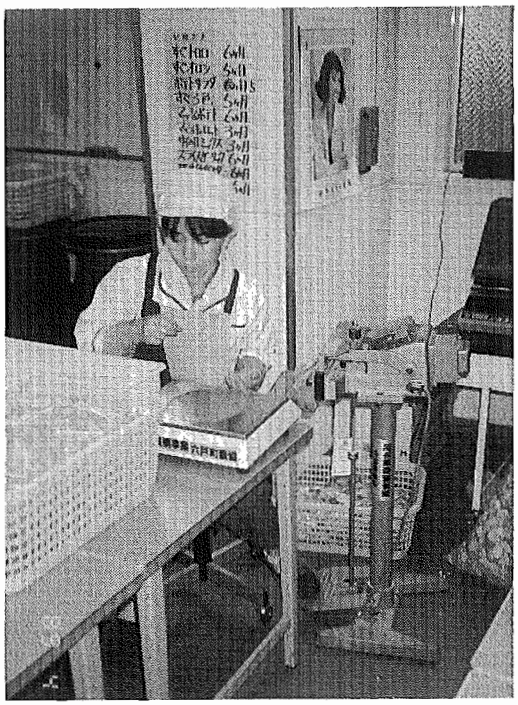

Photo 2 Weighing and Sealing

4.3 Machinery and Equipment

(1) Conditions for designing facilities

Raw material: Sweet potato
Tray space: 24 m²
Treating temperature:
Range of shelf temperature adjusted: Normal temperature to + 85°C (max.)
Vacuum level: Vacuum level in operation: lower than 0.5 Torr
Initial exhausting time (at no-load): about 15 minutes to 1 Torr.
Trap moisture to be collected:
Max. 500 kg/batch (24 hours)
Defrost: Water or hot water shower
Shelf plate cooling time:
+25°C to −25°C
About 3 hours (at no-load)

(2) List of machinery and equipment

Freeze-drying chamber	
Chamber	1
Cubicle type with shelf	
Front-door type	
Tray contacted heating and cooling method	
Cooling and heating shelf	13
Cold trap	1
Tray	48
Spare tray	48
Wagon	2
Shelf heating device	
Line heater	1
Water cooling heat exchanger	1
Heat medium cooler	1
Heat medium circulating pump	1
Heat medium expansion tank	1
Vacuum making system	
Oil hydraulic pump	2
Mechanical booster pump	1
Refrigerator	1
Two-stage compression direct expansion type	
Refrigerant fron R-502	

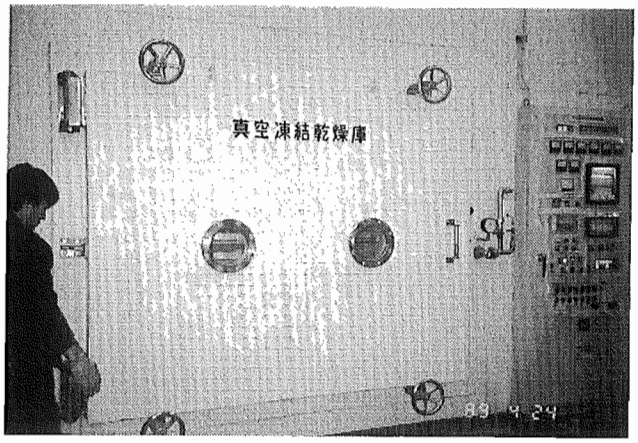

Photo 3 Freeze-drying Chamber

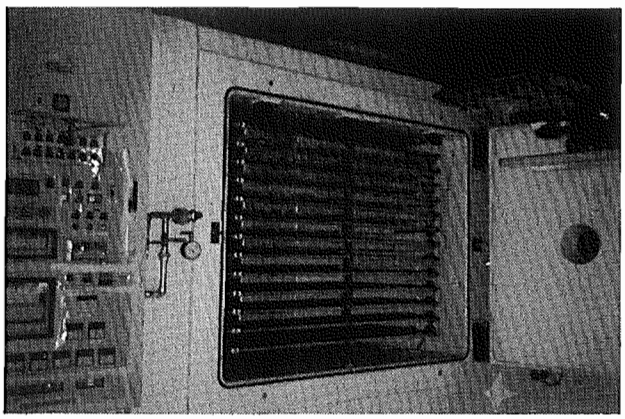

Photo 4 Freeze-drying Chamber

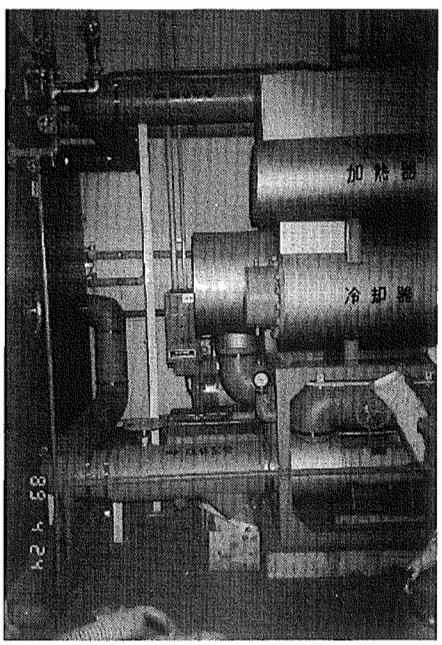

Photo 5 Heater and Cooler

Cooling tower	1
Control panel	1
Temperature and pressure controller	
Temperature and pressure recorder	
Vacuum gauge	
Air compressor	1

4.4 Cost of Machinery and Equipment

The cost of machinery and equipment of the projected plant is as below.

Freeze-drying device:	US$ 593,000
Refrigerator:	US$ 28,000
Other equipment:	US$ 78,000
Total:	US$ 699,000

4.5 Raw Material and Packing Material Requirement

The following shows the required quantities of raw material and packing material.

(1) Raw material: 500kg x 250 = 125,000kg
(2) Packing material: One bag contains 20gr.
25kg ÷ 20gr./p. x 250 = 312,500p.

4.6 Utilities Requirement

Required quantities of utilities are as below.

(1) Electricity: 1,800kWh/day
450,000kWh/year
(Breakdown) Freezer 19 kW
Line heater 12 kW x 3
Others 20kW
(2) Industrial water:
190m^3/day
475,000m^3/year

4.7 Manpower Requirement and Placement

Table 3 shows the manpower requirement and placement.

Table 3 Manpower Requirement and Placement

Work	Staff	Male	Female	Total
General management	Factory manager	1		1
Production control	Managerial staff	1		1
Test, inspection	Engineer	1	1	2
Machine, electricity, maintenance	Skilled worker	3		3
Pre-treatment	Skilled worker	1		1
	Odd-job woman		6	6
Drying, freezing	Engineer	1 x 3		3
	Skilled worker	1 x 3		3
Packing	Odd-job woman		2	2
Products handling	Unskilled worker	2		2
Total		15	9	24

4.8 Area of Plant Site and Buildings

(1) Area of plant site:
30.0m x 50.0m = 1,500.0m²

(2) Buildings: 20.0m x 21.0m = 420.0m²
(Breakdown)
Pre-treatment room:
12.6m x 7.5m = 94.5m²
F.D. front room:
4.2m x 7.5m = 31.5m²
F.D. machine room:
8.4m x 7.5m = 63.0m²
Post-treatment, packing room:
12.6m x 5.0m = 63.0m²
Storage: 8.4m x 5.0m = 42.0m²
Product handling space:
10.0m x 8.4m = 84.0m²
Packing material room:
5.0m x 4.2m = 21.0m²
Office, testing room:
5.0m x 4.2m = 21.0m²

4.9 Plant Layout

Fig. 3 shows the plant layout.

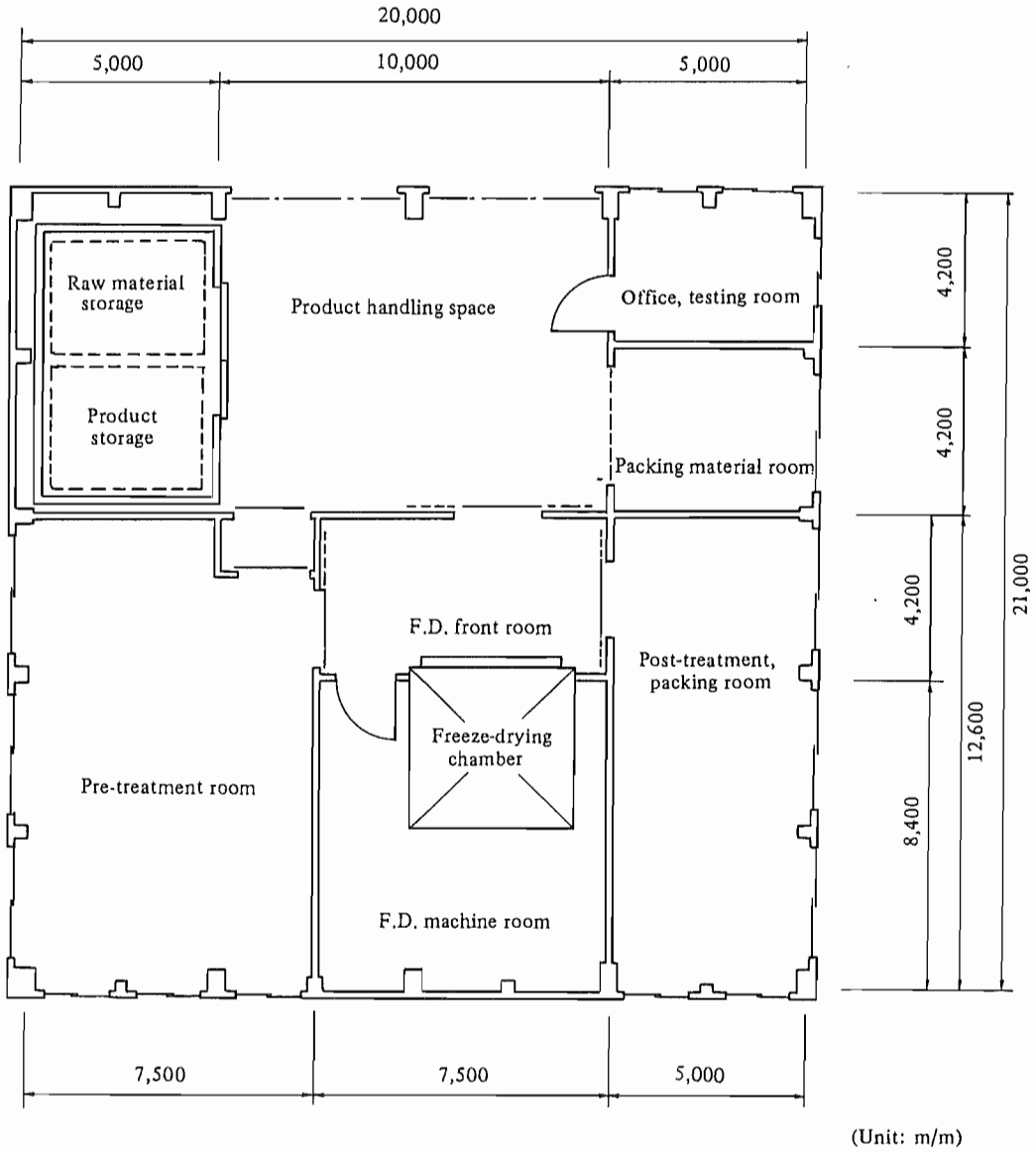

Fig. 3 Plant Layout

5. Production Cost and Profitability

In calculating the production cost, it needs to take into account the real conditions of each country concerned. However, it being difficult to do so, calculation in this brochure will be made on the following precondition.

5.1 Precondition for Calculation

(1) Fixed capital
- (a) Land price is not included.
- (b) Unit construction cost of factory and office buildings is assumed to be US$ 500/m^2.
- (c) Cost of machinery and equipment is estimated at FOB Japan in 1990.
- (d) Spare parts cost is assumed to be 5% of the FOB price of machinery and equipment.
- (e) Freight and insurance cost is assumed to be 10% of the FOB price of machinery and equipment.
- (f) Erection cost is assumed to be 10% of the FOB price of machinery and equipment.
- (g) Civil engineering cost for foundation is assumed to be 5% of the FOB price of machinery and equipment.
- (h) Supervision cost is assumed to be 10% of the FOB price of machinery and equipment.
- (i) Commissioning cost is assumed to be 3% of the FOB price of machinery and equipment.
- (j) Training cost is assumed to be 3% of the FOB price of machinery and equipment.
- (k) Contingency is assumed to be 10% of the FOB price of machinery and equipment.

(2) Working capital
- (a) Raw material inventory: for two-day (500 kg x 2)
- (b) Product inventory: for 15-day

(3) Production cost
- (a) Raw material and packing material cost
  Raw material: On the basis of producers' prices in Japan, it is supposed to be US$ 0.154/kg.
  Packing material: US$ 0.08/p. for one bag containing 20 gr.
- (b) Unit price of utilities
  Electricity: US$ 0.06/kWh
  Industrial water: US$ 0.20/m^3
- (c) Labor cost
  Annual labor cost is assumed to be as follows.

Factory manager:	US$ 15,000
Managerial staff:	US$ 8,000
Engineer:	US$ 8,000
Skilled worker:	US$ 4,000
Unskilled worker:	US$ 2,000
Odd-job woman:	US$ 500

- (d) Maintenance cost is assumed to be 3% of the FOB price of machinery and equipment.
- (e) Depreciation cost
  Straight-line method will be adopted for depreciation.
  Depreciation of machinery and equipment will be:
  (Fixed capital – buildings construction cost) x 7%
  Depreciation of buildings will be:
  Buildings construction cost x 3%
- (f) Insurance cost
  Insurance cost is assumed to be 0.5% of fixed capital.
- (g) Selling and administration cost
  Selling and administration cost is assumed to be 3% of annual sales.
- (h) Interest
  A half of the fixed capital is to be covered by a long-term loan and its annual rate of interest is 10%.
- (i) Exchange rate
  The exchange rate of the US dollar to the Japanese Yen is assumed to be US$ 1 = ¥130.

5.2 Capital Required

(1) Fixed capital

	US$
Land price:	Not included
Factory and office buildings construction cost:	210,000
Machinery and equipment cost:	699,000
Spare parts cost:	34,950
Freight and insurance cost:	69,900
Erection cost:	34,950
Civil engineering cost for foundation:	69,900
Supervision cost:	69,900
Commissioning cost:	20,970
Training cost:	20,970
Contingency:	69,900
Subtotal:	US$ 1,300,440

(2) Working capital

Raw material inventory:	US$ 154
Product inventory:	US$ 11,344
Subtotal:	US$ 11,498

(3) Capital required

(1) + (2) US$ 1,311,938

5.3 Annual Sales

Unit selling price of the product was set as below according to the market price in Japan.

Sweet potato (flake and powder): US$ 80/kg

Annual sales:

US$ 80/kg x 6,250 kg US$ 500,000

5.4 Production Cost

(a) Raw material and packing material cost

Raw material: US$ 0.154/kg x 500 kg x 250 US$ 19,250

Packing material: US$ 0.08/p. x 1,250 p. x 250 US$ 25,000

Subtotal: US$ 44,250

(b) Utilities cost

Electricity: US$ 0.06/kWh x 450,000 kWh US$ 27,000

Industrial water: US$ 0.20/m^3 x 47,500 m^3 US$ 9,500

Subtotal: US$ 36,500

(c) Labor cost

Factory manager:	US$ 15,000 x 1	US$ 15,000
Managerial staff:	US$ 8,000 x 1	US$ 8,000
Engineer:	US$ 8,000 x 5	US$ 40,000
Skilled worker:	US$ 4,000 x 7	US$ 28,000
Unskilled worker:	US$ 2,000 x 2	US$ 4,000
Odd-job woman:	US$ 500 x 8	US$ 4,000
Subtotal:		US$ 99,000

(d) Maintenance cost:

US$ 699,000 x 3 US$ 20,970

(e) Depreciation cost

Machinery and equipment: US$ 1,020,540 x 7% US$ 71,438

Buildings: US$ 279,900 x 3% US$ 8,397

Subtotal: US$ 79,835

(f) Insurance cost:

US$ 1,300,440 x 0.5% US$ 6,502

(g) Selling and administration cost

US$ 500,000 x 3% US$ 15,000

(h) Interest:

US$ 1,300,440 x 1/2 x 10% US$ 65,022

Total: US$ 367,079

5.5 Profitability

When the profitability of the model plant is estimated according to the above conditions, it will become as below.

Rate of return on sales: 26.6%
Rate of return on investment: 10.1%

6. Conclusion

The dried products to be put out in the plant under consideration are not only suitable as foods for schools and hospitals and for weaning diet but also appropriate for storing in public organizations and general households as emergency foods to be used at the time of a poor harvest due to a drought and other causes. Dried products can easily be restored to the original foods and can be eaten when merely seasoned. Hence, they can be fully utilized in homes in general.

In developing countries where agricultural products are generally put out abundantly, they may sometimes find it difficult to adjust the shipment of crops particularly at the peak of a harvest. Accordingly, if they process their surplus farm produce in the plant described in this brochure, they will be able to make use of natural resources effectively and increase their income by adding value to their crops. When they come to manufacture high-quality products, they will surely be able to export them.

The quality of freeze-dried foodstuff is largely affected by the percentage of their moisture. There are many kinds of agricultural products that can be used as raw material, and their constituent and composition differ according to the soil and weather conditions in each area under cultivation. It needs therefore to make tests to find out the optimum conditions for freeze-drying their agricultural products before they start freeze-drying.

In selecting a plant site, it is necessary to confirm that the raw materials can be obtained stably and cheaply, labor power can be secured enough, industrial water is well available for manufacturing process. And it is necessary to confirm whether an export network can be formed when they come to consider the export of their products.

Project Planning for Small and Medium Scale Industries

No. 1 Rice Milling Plant and Rice Bran Oil Manufacturing Plant
No. 2 Plastic Woven Bag Manufacturing Plant
No. 3 Container Board Manufacturing Plant
No. 4 Plastic Blow Bottle Manufacturing Plant
No. 5 Concrete Block Manufacturing Plant
No. 6 Glassware Manufacturing Plant
No. 7 Galvanized Iron Sheet Manufacturing Plant
No. 8 Fishing Net Manufacturing Plant
No. 9 Ice Making, Refrigeration and Cold Storage Plant
No.10 Starch and Syrup Manufacturing Plant
No.11 Instant Noodle Manufacturing Plant
No.12 Surimi and Surimi-Based Food Manufacturing Plant
No.13 Polyethylene Shopping Bag Manufacturing Plant
No.14 Retreading Tire Manufacturing Plant
No.15 Husk Fired Thermal Power Plant
No.16 Fishmeal Manufacturing Plant
No.17 Assorted Aninial Feed Manufacturing Plant
No.18 Sanitary Napkin Manufacturing Plant
No.19 Sanitary Ware Manufacturing Plant
No.20 Toilet Tissue Manufacturing Plant
No.21 Powder Milk Manufacturing Plant
No.22 Mosquito Coils Manufacturing Plant
No.23 Solar Pond Power Generation Plant
No.24 Manufacturing Plant of Textile Products for Medical Use
No.25 Ceramic Tableware Manufacturing Plant
No.26 Manufacturing Plant of Ethanol for Medical Use
No.27 Match Manufacturing Plant
No.28 Wind Power Generation Plant
No.29 Concrete Pole and Pile Manufacturing Plant
No.30 Insulator Manufacturing Plant
No.31 R. PVC Corrugated Sheet and Plate Manufacturing Plant
No.32 Freeze-dried Foodstuff Manufacturing Plant

Project Planning for Small and Medium Scale Industries No. 32

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