Project Planning for Small and
Medium Scale Industries No. 17

Assorted Animal Feed Manufacturing Plant

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This technical brochure was compiled to help in the drafting of a suitable plan for the construction of a Assorted Animal Feed 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.

CONTENTS

1. Introduction

Livestock is one of the precious resources of protein necessary for human-being to live.

For the last few years, increase in demand for livestock production in developing countries is remarkable compared with that of advanced countries.

Total demand for livestock production in advanced countries shows tendency to remain on the same level for these few years, because that an increasing ratio in population is below one percent per annum and moreover consumption ratio of livestock per capita have reached almost higher level.

However in developing countries, demands for livestock, milk and egg are steadily increasing because of rapid expansion in population at a rate of more than two percent per annum, and increase of income per capita and also improvement of food life.

At present in developing countries, main ingredient of assorted animal feed is by-products of cereal milling process and recently begin introducing cereals itself into animal feed mixture.

With increasing demand for feedstock production, as shown in Table.1, assorted animal feed consumption in developing countries has become double in a decade from the latter of the 1960's to the 1970's.

Table. 1 Assorted Animal Feed Consumption in the World

(Unit: Million tonnes per annum)

Year / Area	1966 - 1970 Mean value of 5-years	1976 - 1980 Mean value of 5-years
In developing countries	97	174
In advanced countries	423	548
World total	520	722

Source: FAO

And also in developing countries, as shown in Table.2, mixed rate of cereals itself into assorted animal feed is increasing, compared with that of by-products of cereal milling process.

In developing countries, it is very troublesome work to prepare well-balanced nourishment for feedstock because that it is still a typical practice to use mono-ingredient or in-farm mixed mixture of some ingredients as animal feed.

At present in developing countries, the greater part of these assorted animal feed are imported from advanced countries.

In future, for effective feedstock feeding, demand for well-nutrious assorted animal feed will be increased more and more.

It seems to be useful to develop animal feed industry in developing countries, manufacturing the assorted animal feed for import substitution and moreover utilizing local national resources as possible.

In this paper, description will be made on the outline of animal feed and animal feed manufacturing plant.

Photo 1. Assorted Animal Feed

Table. 2 Change in Percentage of Main Ingredient of Assorted Animal Feed

(Unit: percent)

Year	1966 – 1970 Mean value of 5 – years			1976 – 1980 Mean value of 5 – years		
Ingredient / Area	Cereals	By-products of milling	Oily seed cake	Cereals	By-products of milling	Oily seed cake
Latin-America	76	16	8	73	14	13
Middle-East	67	25	8	70	20	10
Asia	29	57	14	45	44	11
Africa	40	40	20	43	43	14
Developing Countries, Means	46	43	11	55	34	11
Advanced Countries, Means	81	9	10	81	8	11
World, Means	75	15	10	75	14	11

Source: FAO

2. Outline of Assorted Animal Feed

The assorted animal feed consists of well-balanced nutrious ingredients for nourishing livestock and poultry.

With feeding it, livestock and poultry can be grown-up speedily. And they can produce milk and lay eggs efficiently.

2.1 Kind of Animal Feed

The kinds of animal feed is indicated as follows;

- Animal feed
  - Roughage feed
  - Concentrated feed
    - Ingredient
    - Mixed feed
    - Assorted feed

(1) Roughage feed

Roughage feed is a bulky feed which contains a plenty of fibrous ingredients and have few digestible nutrients.

By feeding roughage, animal bowels are stimulated and then relieve constipation.

(2) Concentrated feed

Concentrated feed contains few fibrous ingredients and have a plently of digestible nutrients.

Main ingredients used for concentrated feed are cereals, brans, pollards, oily seed cake, animal matters and by-products of agro-processing.

(a) Ingredient

Ingredient is a straight type animal feed and can be fed directly to livestock.
And also it is used as components of mixed feed and assorted feed.
(Example; Maize, Pollard, De-oiled rice bran, Beet pulp etc.)

(b) Mixed feed

Mixed feed is a mixture of a few (two or three) kinds of ingredients and so its nutrient is apt to be partial to specific one side.
To ensure balanced nutritive value, the mixed feed is usually fed to the livestock, jointly with other ingredients.
(Example; Rolled maize and wheat bran, Rolled milo and wheat bran, etc.)

(c) Assorted feed

Assorted feed is a mixture of many kinds of ingredients and some kinds of additives, and so its nutrient is well-balanced for nourishing livestock and poultry.
(Example of mixtures of assorted feed is shown in Table.7)

2.2 Form of Animal Feed

Forms of animal feed are classified into four groups.

(1) Mash

Mash is a powdered feed of single ingredient and have a uniformity of constituent.

(2) Pellet

Pellet is a pelletized feed of powdered ingredient or assorted feed, and have distinctive features such as easy handling, improved feed efficiency with its higher density and preventive effect of scattering of fine powders.

(3) Crumble

Crumble is a crushed feed of pellet and usually is fed to chick or young fish.

(4) Flake

Flake is a rolled grain. If the grains are fed to livestock in whole grain with no-processing, they are apt to drop into dung as shape as they are without digestion.

By rolling grains into flake, grains become digestible and the feed efficiency of grains is improved.

2.3 Raw Material of Animal Feed

Principal raw materials of animal feed are shown in Table.3.

Kind of available raw materials are differed by each country or each region respectively.

Table.3 Main Ingredients of Animal Feed

Group	Name of Ingredients
Cereals	Maize, Milo, Barley, Wheat, Rye, Oat, Broken-rice, Millet, Japanese millet.
Brans & Pollards	Pollard, Wheat bran, Rice bran, De-oiled rice bran, Maize bran.
Oily seed cake	Soybean oil meal, Groundnut meal, Sun-flower cake, Cotton seed cake, Rape-seed meal, Sesame meal, Coconut oil meal, Linseed meal, Kapok meal.
Animal matter	Fish meal, Meat & bone meal, Feather meal, Blood meal, Skim milk.
By-products of Agro-processing	Starch cake, Corn gluten meal, Corn gluten feed, Yeast, Brewer's grain, Corn germ meal.
Root and Green fodder	Dried cassava, Alfalfa meal, Beet pulp, Giant ipilipil, Sugar cane top.
Inorganic matter	Calcium carbonate, Calcium phosphate, Shell, Bone meal, Rock salt.
Liquid material	Molasses, Vegetable oil & fat, Animal oil & fat, Fish soluble.
Mineral & others	Various kind of Vitamins, Minerals, Amino-acid, Anti-disease medicine, Anti-oxidizing agent.

Therefore, it is very important to grasp available kinds and quantities of raw materials before carrying out the plan of animal feed manufacturing plant.

2.4 Nutritive Value of Animal Feed

Nutritive values and kinds of nutrient required are differed by each kind of livestock and each stage of growth.

The feeding standard which specifies a guiding principal of required nutritive value is established in each country according to their actual circumstances of livestock industry.

In accordance with the feeding standard, available raw materials should be mixed so as to ensure required nutritive value.

For example, Japanese feeding standard for dairy cow and poultry are shown in Table.4 and Table.5.

Table.4 Feeding Standard for Dairy Cow (Example)

(Required value, per head, per day)

Weight (kg)	Age in Weeks (Weeks)	Gain in Weight (kg)	Amount of Feeding (kg, dry)	Crude Protein CP (g)	Digestible Crude Protein DCP (g)	Total Digestible Nutrients TDN (kg)	Digestible Energy DE (Mcal)	Calcium Ca (g)	Phosphor P (g)	Vitamin A (1000IU)	Vitamin D (IU)
45											
50											
75											
100											
150			Abbreviated.								
200											
250											
300											
350											
400											
450											
500	104	0.42	9.5	915	495	5.2	22.9	27	21	21	–
550	121	0.22	9.9	830	430	4.8	21.2	26	20	23	–
600	154	–	10.2	810	405	4.6	20.0	24	18	26	–

Source: Japanese Feeding Standard,
Ministry of Agriculture, Forestry and Fisheries

Table. 5 Feeding Standard for Poultry (Example)

(Required value, per head, per day)

	Usages / Nutrients		Crude Protein CP (%)	Total Digestible Nutrients TDN (%)	Metabolic Energy ME (kcal)	Calcium Ca (%)	Phosphor P (%)	Others (%)
Layer	Chicken Starter	0 – 4 weeks	20	68	2,800	0.8	0.6	–
Layer	Chicken middle-grower	4 – 10 weeks	16.5	68	2,800	0.75	0.6	–
Layer	Chicken Grower	10 – 20 weeks	Abbreviated.					
Layer	Layer	above 20 weeks						
	Breeder							
Broiler	Starter	0 – 4 weeks						
Broiler	Finisher	above 4 weeks						

Source: Japanese Feeding Standard
Ministry of Agriculture, Forestry and Fisheries

3. Manufacturing Process

Assorted feed is a mixture of main raw materials (i. e. maize, milo, cassava etc.), sub raw materials (i. e. cotton seed cake, soy beans oil meal, pollard, de-oiled rice bran, fish meal etc.) and few quantities of minerals and vitamins.

Mixing-ratio of each raw materials is decided in accordance with the formula of feeding standard, and when necessary some additives such as molasses, oil and fat are mixed.

Final forms of production are mash, pellet or crumble.

Manufacturing of assorted animal feed is classified into two methods, one is mixing-crushing method and another is crushing-mixing method, in accordance with difference of processing sequence.

3.1 Mixing - Crushing Method

In mixing-crushing method, at first all materials are weighed in accordance with the formula and mixed each other so as to have uniformity and then crushed into small pieces. And further, mixed and crushed raw materials are processed into final forms of products.

This method has characteristic features as follows;

(a) Uniformity of all nutrious mixtures is attained, because that crushing of all raw materials is carried out after mixing of them.

(b) Procedures of crushing and sieving of individual ingredient by each are not necessary, and so number of distribution bins are reduced and process is simplified. As a result, the investment cost of the machinery and equipment become moderate and easy operation can be expected.

3.2 Crushing - Mixing Method

In crushing-mixing method, at first each raw material is crushed and sieved into uniform small size, and stored in individual distribution bins.

And then all raw materials are weighed in accordance with the formula, and then they are mixed each other.

With this method, product of uniform sized ingredient mixture is obtained.

However, this method requires large number of distribution bins and it derives higher investment cost. And for operation, special attention have to be paid on mixing time and mixing degree.

3.3 Method for Making Assorted Mixture

There are two processes for obtaining assorted mixture, one of them is continuous and another is batch process.

(1) Continuous process for weighing and mixing

In continuous process for weighing and mixing, screw feeders are utilized for measuring scales of individual raw materials. And each raw material is fed continuously in specified flow rate by individual screw feeders and is mixed continuously in line.

In case of continuous process, mass-production is possible with comparatively simplified equipments.

However this process is not suitable for the factory producing many kind of products because it takes a plenty of time for changing-over or cleaning operation of feeding and mixing line, and for controlling of newly set-up flow rate.

(2) Batch process for weighing and mixing

In batch process for weighing and mixing, a hopper scale of accumulated adding type is utilized for measuring raw materials.

In accordance with the formula, each raw material is fed into the scale from hopper, and after weighing all materials are mixed together in batch operation.

For medium and smaller-scale manufacturing plant, this batch process is usually applied with their special features of higher accuracy of weighing, mixing-rate and easy changing-over operation for different kinds of products.

4. Outline of Model Plant

When planning assorted animal feed manufacturing plant, it is very important to select the most suitable manufacturing process, in accordance with the circumstances and conditions of the countries or districts located, among the various manufacturing processes which are described in chapter.3.

In this paper, model plant of the assorted animal feeds for dairy cow and chicken is described. And for manufacturing process, the mixing-crushing method (batch process for weighing and mixing) is adopted, because the plant of this process requires lower investment cost and can be operated easily.

4.1 Production Scale

(1)	Product	36,000 t/y (3,000 t/m)
(a)	For dairy cow	18,000 t/y (1,500 t/m)
	Calf early weaner meal	1,800 t/y (150 t/m)
	Calf meal	6,000 t/y (500 t/m)
	Dairy meal	10,200 t/y (850 t/m)
(b)	For chicken	18,000 t/y (1,500 t/m)
	Broiler starter	720 t/y (60 t/m)
	Broiler finisher	9,600 t/y (800 t/m)
	Chicken starter	960 t/y (80 t/m)
	Chicken grower	720 t/y (60 t/m)
	Layer	6,000 t/y (500 t/m)

(2) Operating hours and days

(a)	Operating hours	8 hr/d
(b)	Operating days	300 d/y

(3) Capacity of plant 15 t/hr

4.2 Outline of Manufacturing Process

Manufacturing process of assorted animal feed is as shown in Fig.1 and its gist is explained. (Number in ○ show the number of equipment in Fig.1.)

(1) Raw material storage and pretreating section

(Receiving and selecting)

- Raw materials are transfered by truck, tractor or bull-car and then unloaded to receiving screw conveyor. ⑥
- Obstacles such as stones and stem are removed by vibrating sieve. ②
- After separating iron flenges by magnetic separator, raw materials are sent to storage silos. ③

(Receiving silo and pretreatment) ①～⑤

- Raw materials of large size such as corn and millet, stored in storage silo, are sent to distribution bins after crushing roughly by hammer mill. ⑤
- Other raw materials such as oily seed meal and fish meal, which are not necessary to crush, are sent directly to distribution bins from storage silo.

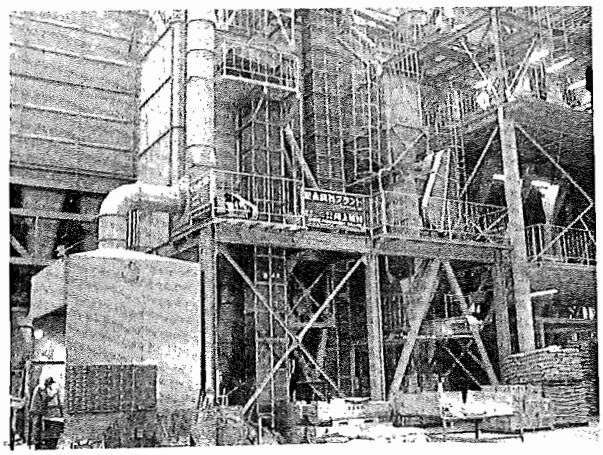
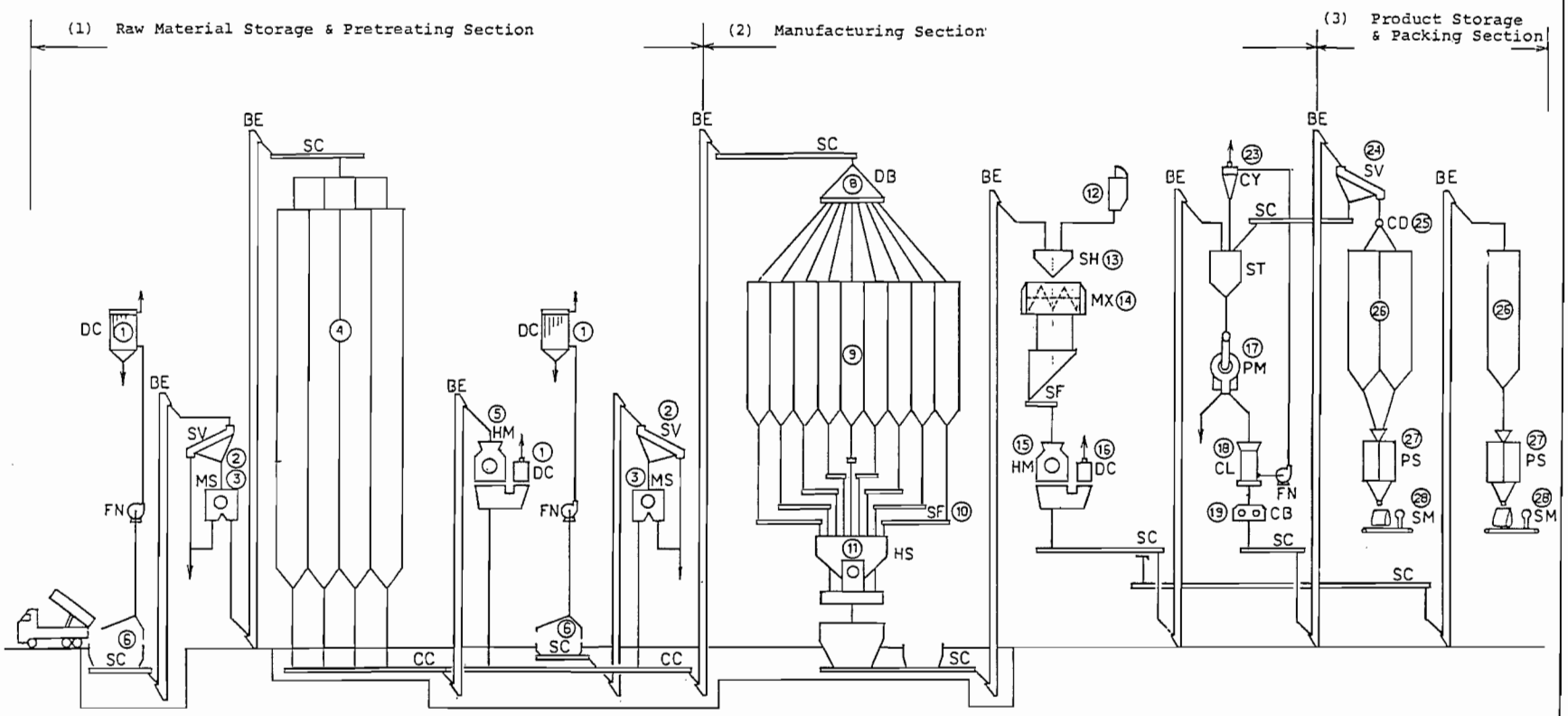


Photo 2. Inner Part of Plant

(2) Manufacturing section

(Weighing and mixing)

- Each raw material are stored in individual distribution bins. ⑨
- In accordance with the formula of feeding standard, each main and sub raw material is weighed by accumulated add-



BE	Bucket Elevator	DC	Dust Collector	PS	Packer Scale
CB	Crumbler	FN	Fan	SC	Screw Conveyor
CC	Chain Conveyor	HM	Hammer Mill	SF	Screw Feeder
CD	Changing Dumper	HS	Hopper Scale	SH	Scale Hopper
CL	Cooler	MS	Magnet Separator	SM	Sewing Machine
CY	Cyclone	MX	Mixer	ST	Service Tank
DB	Distributor	PM	Pellet Mill	SV	Vibrating Sieve

Fig. 1 Manufacturing Process of Formulated Assorted Feed

ing type hopper scale. ⑪

- After weighing all raw materials, they are mixed together by batch mixer. ⑭
- When necessary, some additives such as pre-mix, molasses, oil and fat are mixed in the mixing stage in accordance with the formula. ⑫
- Mixed raw materials are crushed into small pieces by the hammer mill. ⑮

(Forming)

- Mixed and crushed raw materials are pelletized by the pellet mill. ⑰
- Pellet are sent to the vertical type cooler and cooled down by air.
- Cooled pellets are sent to the vibrating sieve where powdery parts are separated. ⑱

- In case of mash feed, a part of mixed and crushed raw materials are sent directly to the product storage bins.

- In case of crumble feed, a part of pellet are crushed again by the crumbler and classified into same sized crumble by the vibrating sieve. ⑲

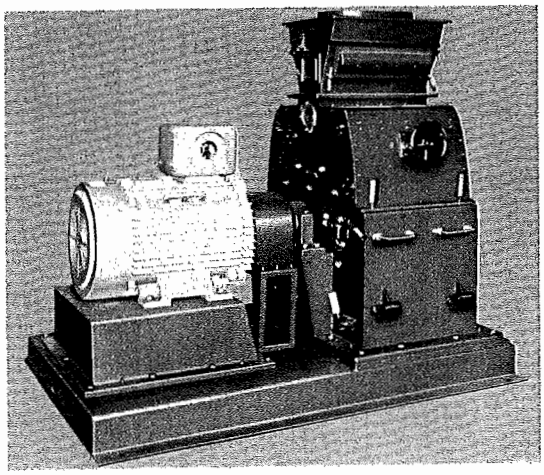


Photo 3. Crusher

(3) Product storage and packing section

- Each type of final product (pellet, mash and crumble) is stocked into product storage bins separately. ㉖
- Products are weighed by packer scale. ㉗
- Weighed products are packed into bag and the bag is sealed by a bag sewing machine. ㉘

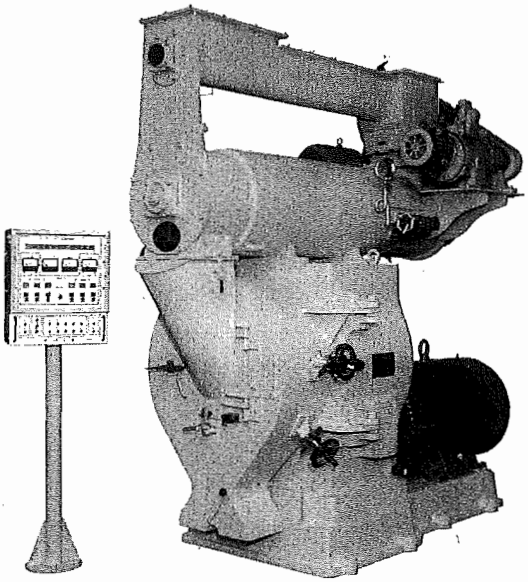


Photo 4. Pellet Mill

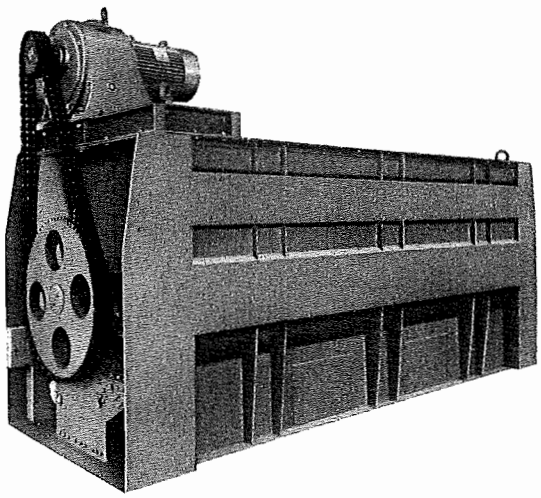


Photo 5. Mixer

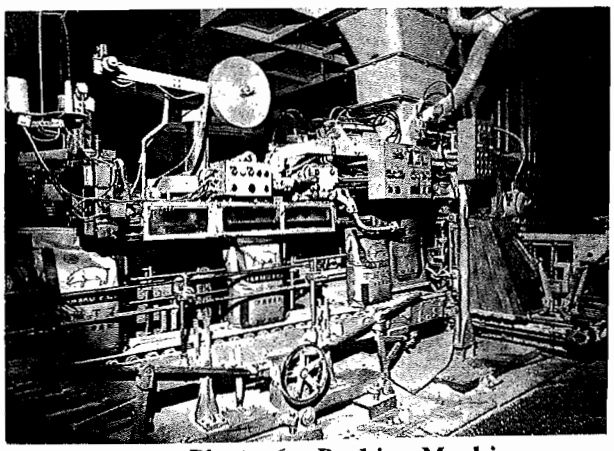


Photo 6. Packing Machine

4.3 Raw Materials Required

Cereals		17,982 t/y
Maize	12,328 t/y	
Milo	3,242 t/y	
Barley	2,412 t/y	
Oily seed cake		3,434 t/y
Corn germ meal	538 t/y	
Soybean oil meal	1,233 t/y	
Cotton seed cake	1,359 t/y	
Sun-flower cake	304 t/y	
Animal matter		1,551 t/y
Fish meal	1,367 t/y	
Meat and bone meal	184 t/y	
Brans and pollards		9,005 t/y
Pollard	4,727 t/y	
Maize bran	3,750 t/y	
De-oiled rice bran	528 t/y	
Calcium carbonate		891 t/y
Alfalfa meal		1,962 t/y
Molasses		864 t/y
Rock salt		115 t/y
Other additives		196 t/y
	Total	36,000 t/y

4.4 Required Machinery and Equipment

(Raw material storage and pre-treating section)

①	Dust collector	80 m³/min.	3 sets
②	Vibrating sieve (2-kinds)	60 t/hr	2 sets
③	Magnet separator	60 t/hr	2 sets
④	Raw material storage silo	150 t	6 sets
⑤	Hammer mill	8 t/hr	1 set
⑥	Screw conveyor		1 set
⑦	Bucket elevator		1 set

(Manufacturing section)

⑧	Distributor	60 t/hr	1 set
⑨	Distribution bin	15 t	9 sets
⑩	Screw feeder		1 set
⑪	Hopper scale	2 t/batch	1 set
⑫	Liquid additive supplier		1 set
⑬	Service hopper		1 set
⑭	Mixer	2 t/batch	1 set
⑮	Hammer mill	15 t/hr	1 set
⑯	Dust collector	80 m³/min.	1 set
⑰	Pellet mill	15 t/hr	1 set
⑱	Cooler	7.5 t/hr	2 sets
⑲	Crumbler	7.5 t/hr	2 sets
⑳	Steam boiler	1 t/hr	1 set
㉑	Screw conveyor		1 set
㉒	Bucket elevator		1 set
㉓	Cyclone separator		1 set

(Product storage and packing section)

㉔	Vibrating sieve		1 set
㉕	Changing damper		1 set
㉖	Product storage bin	15 t	8 sets
㉗	Packer scale	800 bag/hr	2 sets
㉘	Sewing machine		2 sets

(Others)

㉙	Molasses supplying tank		1 set
㉚	Oil and fat supplying apparatus		1 set
㉛	Work shop machine (Lathe, drilling machine, shaper, welder)	each	1 set
㉜	Air compressor		1 set

4.5 Machinery and Equipment Cost

Raw material section	US$	277,800
Manufacturing section	US$	1,572,200
Product storage section	US$	433,400
Others	US$	244,400
Total	US$	2,527,800

Note: 1. Price for FOB Japanese port as of 1986
2. The exchange rate of the US doller to the Japanese yen is assumed to be US$ 1 = ¥180

4.6 Utilities Required

(1) Electricity 1,176,000 kWh/y
490 kWh/hr x 8 hr/d x 300 d/y

(2) Fuel oil 213 kl/y
89 l/hr x 8 hr/d x 300 d/y

(3) Industrial water 2,640 t/y
1,100 kg/hr x 8 hr/d x 300 d/y

4.7 Number of Workers and Placement

Number of workers required and placement are as shown in Table.6.

4.8 Layout of Plant and Buildings

(1) Area of plant (Battery limit) 9,800 m²

(2) Buildings 1,772 m²

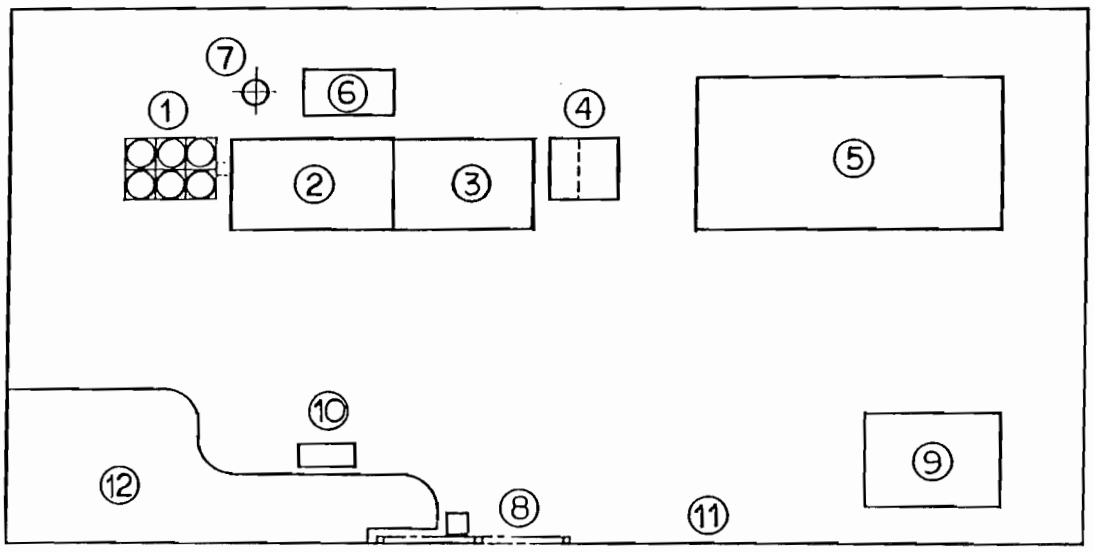
Warehouse for raw material	252 m²
Factory buildings	216 m²
Warehouse for product	800 m²
Electricity and boiler room	72 m²
Office,2 - stories	432 m²

(3) Plant layout

Layout of the assorted animal feed manufacturing plant is as shown in Fig.2.

Table. 6 Number of Workers and Placement

	Male	Female	Total
Factory manager	1		1
Assistant manager	1		1
Office worker		2	2
Group leader	2		2
Receiving & selecting	3		3
Weighing & mixing	2		2
Crushing	2		2
Pelletizing	2		2
Packing	6		6
Boiler man	2		2
Electrician	1		1
Total	22	2	24



① Silos for main raw material
② Warehouse for raw material
③ Factory building
④ Storage bins for product
⑤ Warehouse for final product
⑥ Boiler & electricity house
⑦ Tank for liquid raw material
⑧ Gate
⑨ Office (2–stories)
⑩ Truck scale
⑪ Parking area
⑫ Green zone

Fig. 2 Layout of Plant

5. Production Cost and Profitability

In order to estimate the profitability of a assorted animal feed manufacturing plant, it is necessary to calculate the production cost.

Usually the basis of calculation differs by each country and district. In this paper, the profitability will be calculated on the basis of the following assumption.

5.1 Basic Condition

(1) Fixed capital

(a) Land price — Not included

(b) Building cost — US$ 250/m²

(c) Machinery and equipment cost
FOB Japanese port as of 1986

(d) Spare part cost
10% of the FOB price of machinery and equipment

(e) Freight and insurance
10% of the FOB price of machinery and equipment

(f) Civil engineering cost for foundation
10% of the FOB price of machinery and equipment

(g) Erection cost
10% of the FOB price of machinery and equipment

(h) Guidance and supervision fee
10% of the FOB price of machinery and equipment

(i) Commissioning cost
2% of the FOB price of machinery and equipment

(j) Education and training cost
3% of the FOB price of machinery and equipment

(k) Contingency
10% of the FOB price of machinery and equipment

(2) Working capital

(a) Raw material cost for one month

(b) Products in stock for half-month

(3) Production cost

(a) Raw material cost

The following figures are applied correspondingly to the international trading price.

Cereals	
Corn	US$ 122/t
Milo	US$ 83/t
Barley	US$ 92/t
Oily seed cake	
Corn germ meal	US$ 56/t
Soybean oil meal	US$ 111/t
Cotton seed cake	US$ 100/t
Sun-flower cake	US$ 133/t
Animal matters	
Fish meal	US$ 472/t
Meat and bone meal	US$ 239/t
Brans and pollards	
Pollards	US$ 56/t
Maize bran	US$ 56/t
De-oiled rice bran	US$ 56/t
Calcium carbonate	US$ 28/t
Rock salt	US$ 56/t
Alfalfa meal	US$ 28/t
Molasses	US$ 17/t
Other additives	US$ 556/t

(b) Sub raw material cost

Bag	US$ 0.7/pc

(c) Utilities cost

Electricity	US$ 0.06/kWh
Fuel oil	US$ 200/kl
Industrial water	US$ 0.2/m³

(d) Labor cost

Factory manager	US$ 15,000/y
Engineer	US$ 8,000/y
Skilled worker	US$ 4,000/y
Unskilled worker	US$ 2,000/y
Odd job man	US$ 500/y

(e) Maintenance cost
3% of the FOB price of machinery and equipment

(f) Depreciation
Straight-line method is adopted.

- Machinery and equipment
[Fixed capital--building and silo cost] x 7%

- Building and silo
[Building and silo cost] x 3%

(g) Insurance cost
0.5% of the fixed capital

(h) Selling and administration expense
3% of the annual sales revenue

(i) Interest

One-second of the fixed capital is assumed to be covered by a long-term loan and its annual rate of interest is 10%.

Note : The exchange rate of the U.S. dollar to the Japanese Yen is assumed to be US$1=¥180.

5.2 Capital Required

(1) Fixed capital

Land price	Not included
Silo	US$ 666,700
Factory building	US$ 443,000
Machinery and equipment	US$ 2,527,800
Spare parts	US$ 252,800
Freight and insurance	US$ 252,800
Civil engineering for foundation	US$ 252,800
Erection	US$ 252,800
Guidance and supervision	US$ 252,800
Commissioning	US$ 50,600
Education and training	US$ 75,800
Contingency	US$ 252,800
Total	US$ 5,280,700

(2) Working capital

Raw material cost	US$ 312,000
Products in stock	US$ 181,040
Total	US$ 493,040

(3) Capital required

Capital required is the sum of the fixed capital and the working capital.

Capital required	US$ 5,773,740

5.3 Annual Sales Revenue

The following unit selling prices of products are applied correspondingly to the international trading price.

Total annual sales revenue of this plant is US$5,288,640 in accordance with following calculation.

(a) Calf early weaner meal US$ 199,800
US$ 111/t x 1,800 t/y

(b) Calf meal US$ 636,000
US$ 106/t x 6,000 t/y

(c) Dairy meal US$ 1,132,200
US$ 111/t x 10,200 t/y

(d) Broiler starter feed US$ 103,680
US$ 144/t x 720 t/y

(e) Broiler finisher feed US$ 2,131,200
US$ 222/t x 9,600 t/y

(f) Chicken starter feed US$ 149,760
US$ 156/t x 960 t/y

(g) Chicken grower feed US$ 72,000
US$ 100/t x 720 t/y

(h) Layer feed US$ 864,000
US$ 144/t x 6,000 t/y

Total US$ 5,288,640

5.4 Production Cost

(a) Raw material cost US$ 3,742,000

(b) Sub raw material cost US$ 37,000

(c) Utilities cost US$ 113,690

Electricity
US$ 0.06/kWh x 1,176,000 kWh/y
= US$ 70,560

Fuel oil
US$ 200/kl x 213 kl/y
= US$ 42,600

Industrial water
US$ 0.2/m³ x 2,640 m³/y
= US$ 530

(d) Labor cost US$ 86,000

Factory manager
US$ 15,000 x 1 US$ 15,000

Engineer
US$ 8,000 x 2 US$ 16,000

Skilled worker
US$ 4,000 x 8 US$ 32,000

Unskilled worker
US$ 2,000 x 11 US$ 22,000

Odd job man
US$ 500 x 2 US$ 1,000

(e) Maintenance cost US$ 75,830

(f) Depreciation US$ 325,260

Machinery and equipment US$ 291,970
Building and silo US$ 33,290

(g) Insurance cost US$ 26,400

(h) Selling and administration expense US$ 158,660

(i) Interest US$ 264,040

Total US$4,828,880

5.5 Profitability

The expected profitability of the plant, calculated on the basis of the above conditions, will become as follows:

Annual sales revenue	US$ 5,288,640
Selling cost	US$ 4,828,880
Profit	US$ 459,760

The rate of profit against annual sales 8.7%
(US$ 459,760/US$ 5,288,640 x 100)

The rate of profit against capital 8.0%
(US$ 459,760/US$ 5,773,740 x 100)

The above financial indicators show that the profitability of the present project can be considered fairly good.

6. Other Technical Matters

6.1 Location of Plant Site

The following consideration should be taken when selecting a candidated plant site of the assorted animal feed manufacturing plant, because they are the industry of treating and processing a quite large volume of agricultural raw materials.

① It is indispensable to get the availability of main and sub raw materials which are gathered from neighbouring area.

② Plant site location should be near by products market (feedstock farm zone), for lowering distribution cost.

③ Existing of stable labor source in the neighbourhood.

④ Proper distance between plant site and residence area should be taken for preventing noise and dust pollution.

6.2 Raw Materials

The following considerations should be taken for selecting the raw materials.

(1) Characteristic of nutrients

It is essential to know the nutrious characteristic of raw materials to be used.

Compositions of nutrients differ by harvesting years, harvesting seasons, the places of production and varieties of raw materials.

Occasionally, compositions of nutrients differ by each production lot even if all conditions were same.

Accordingly it is advisable that typical and impartial samples should be applied as possible for the analysis of the nutrious composition of raw materials.

And also mean value of several analysis data should be used for the basis of formula calculation.

Next, it is also essential to select kinds of raw materials to be used for mixture.

There are some exemptions of raw material usages by each kind of animal. For example, the cotton seed cake is widely used for animal feed.

However, it can not be used for layer feed because it contains a very small amount of gosipole which gives sterile affection to the layer.

And also be careful about excessive feeding of specified nutrient which undermines feedstock's health.

For example, the rock salt is indispensable nutrient for all feedstocks, however its excessive feeding causes loose bowels or diarrhoes and in serious case disagrees with feedstock.

And moreover in case of introducing unknown raw materials for the first time, it is necessary in particular to check in advance the safety and adaptability of them.

(2) Price of raw material

Prices level of raw materials fluctuate usually by season or by year.

So it is indispensable to select acceptable raw materials of the lowest price as possible in accordance with the variation of feeding standard.

(3) Standard or grade of raw material

There are various standards or grades of raw materials which are established by official organization or private organization by each country.

In these standards and grades, are specified the size, appearance and quality of raw materials and in some cases are specified the allowable limit of foreign substance and grade of deterioration.

So it is desirable to refer these standards and grades for actual formulation design of animal feed.

(4) Physical characteristics of raw material

There are various physical characteristics of raw materials as follows;

① Easy to crushing or hard to crushing

② Dusty material or not dusty material

③ Easy to mix or hard to mix

④ Tasting for feedstock or distasting for feedstock

⑤ Having strong smell or faint smell

In deciding the formulation of the animal feed, these physical characteristics of raw materials should be recognized in advance and the advantages of them should be utilized for making better animal feed as possible.

6.3 Design of Formulation

(1) Important factor for deciding formulation

When planning the formulation of animal feed the important factors, as shown in Fig.3, should be taken into consideration.

(2) Example of formula

Typical examples of formula of the assorted animal feed for chicken and dairy cow are as shown in Table.7.

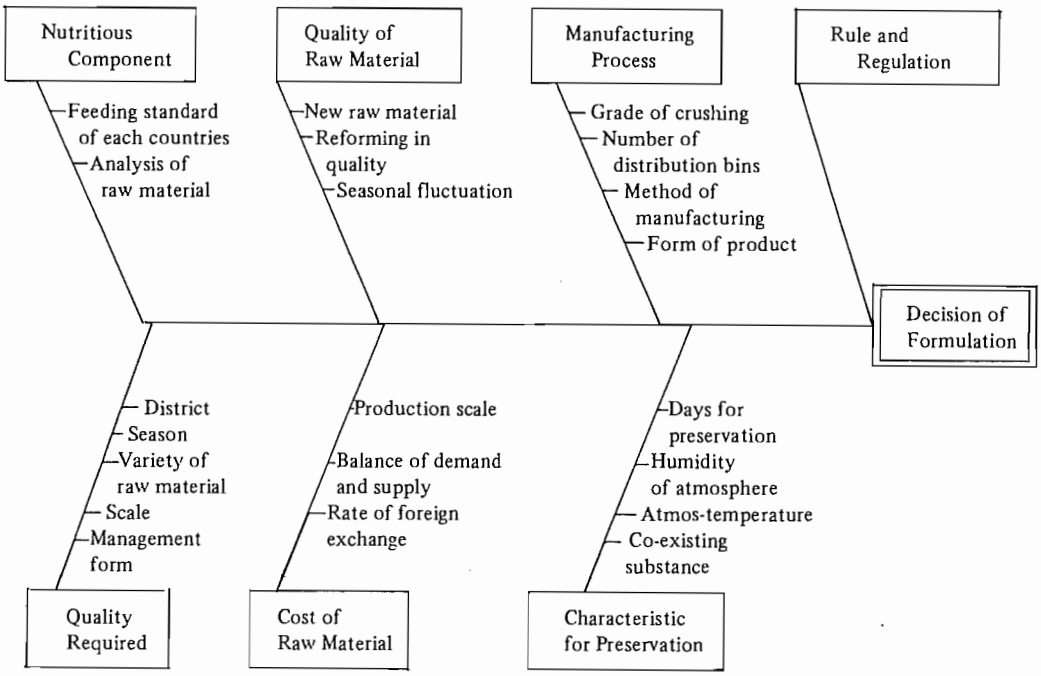


Fig. 3 Allow Diagram for Important Factors of Animal Feed Formulation

Table. 7 Examples of Formula for Assorted Animal Feed

(Unit: %)

	Chicken starter feed	Chicken grower feed	Layer feed	Broiler starter feed	Broiler finisher feed	Calf early weaner meal	Calf meal	Dairy meal
Maize	23.5	10.7	18.3	51.6	60.0	48.0	27.6	22.3
Milo						10.5	23.0	16.4
Barley							13.0	16.0
Pollard	30.0	30.0	30.0	21.7	18.6	3.4	7.0	
Corn germ meal	30.0	15.6	2.3					
Maize bran		30.0	30.0					17.0
De-oiled rice bran							3.7	3.0
Soybean oil cake						29.7	4.5	4.2
Cotton seed cake	7.8	10.0		10.0	10.0		3.0	
Sun-flower cake		0.5	5.0					
Fish meal	6.0		5.8	14.9	8.9			
Meat & bone meal	1.1	1.6	1.1		1.0			
Calcium carbonate	1.5	1.4	7.3	1.7	1.4	0.8	1.6	1.7
Alfalfa meal						2.0	10.0	13.0
Molasses						2.0	5.0	5.0
Other additives	Trace	Trace	Trace	Trace	Trace	2.1	1.1	0.9
Rock salt	0.1	0.2	0.2	0.1	0.1	0.5	0.5	0.5

6.4 Others

Other important items concerning to the assorted animal feed are as follows.

(1) Nutrients of animal feed (Six nutrients)

Animal feed consists of six principal nutrients as follows :

(a) Water moisture

(b) Crude protein (CP)

(c) Crude fat

(d) Nitrogen free extract

(e) Crude fiber

(f) Crude ash

All of these nutrients participate to the nourishing metabolism of feedstock and poultry.

(2) Digestible Nutrient

Digestible nutrient is a digestible part of nutrients and is absorbed as nourishment by feedstock and poultry.

Value of digestible nutrient is expressed as total digestible nutrients (TDN).

TDN is the sum of digestible parts of each nutrient and is calculated by the following algebraic expression.

$$TDN = DCP + DCFa \times 2.25 + DNFE + DCFi$$

Where;

TDN	: Total digestible nutrients (%)
DCP	: Digestible crude protein (%)
DCFa	: Digestible crude fat (%)
DNFE	: Digestible nitrogen free extract (%)
DCFi	: Digestible crude fiber (%)

(3) Energy value

Energy contained in the animal feed is expressed by energy value. And there are two kinds of expression for energy value, one is the digestible and another is the metabolism energy.

(a) Digestible energy (DE, kcal/100g)

Digestible energy is the value which is deducted the energy released to bowels from the total energy of animal feed.

(b) Metabolism energy (ME, kcal/100g)

Metabolism energy is the value which is deducted the energy released to bowels, to urine and to metane gas from the total energy of animal feed.
And the metabolism energy shows the actual energy which is absorbed as nourishment by feedstock and poultry.

Correlation among the TDN, DE and ME is calculated by the following algebraic expression.

$$DE = TDN \times 4.41$$
$$ME = TDN \times 4.1$$

(4) Nutritive ratio (NR)

Nutritive ratio shows the ratio of the energy value of animal feed to the digestible crude protein of animal feed.

The nutritive ratio is calculated by the following algebraic expression.

$$NR = TDN/DCP - 1$$

With the value of the nutritive ratio, rough standard of feed efficiency is conjectured.

Rough standards are as follows:

$NR < 5$: Animal feed of low feed efficiency with high-protein and low-calorie.

$5 \leqq NR \leqq 8$: Animal feed of medium feed efficiency with balanced protein and calorie.

NR>8 : Animal feed of high feed efficiency with low-protein and high-calorie.

When designing the formulation of animal feed, it is necessary to pay attention to the balance between protein content and calorific value.

(5) Feed efficiency

When feeding animal feed to the growing feedstock, the weight of feedstock is increased.

The ratio of the weight increase of feedstock to feeding amount of animal feed is called as feed efficiency.

The feed efficiency is calculated by the following algebraic expression.

$$FE = WI/FA \times 100 \ (\%)$$

Where;

FE : Feed efficiency (%)

WI : Weight increase (kg)

FA : Amount of feeding (kg)

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 Animal Feed Manufacturing Plant

Project Planning for Small and Medium Scale Industries No. 17

Japan Consulting Institute (JCI)

Sumitomo Fudosan Kudanshita Bldg. 3 F
Kanda-Jinbocho 3-5, Chiyoda-ku Tokyo
101-0051 Japan

TEL +81-3-3222-8100
FAX +81-3-3222-8101
URL : http://jci-plant.or.jp

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