per pig, including costs of a baby pig, feed, veterinary medicine, hog pen depreciation, labour and contingencies.

The output value has been calculated to be Kshs.1,210 per pig, at the unit sale price to a baconer of Kshs.22 per kg applied to the carcass pork of about 55 kg, which is 65% of the liveweight of 85 kg. The net return is thus Kshs. 624 per pig.

One sow usually weans about 16 pigs per year so that the net return per sow per year is estimated to be about Kshs.9,984. If 500 sows are raised at a breeding center, the total net return will be about Kshs. 5 million (K£ 250,000) per year. The initial investment costs will be recovered in less than five years.

(4) Beneficiaries and executing agency

The beneficiaries of the project are firstly the contract farmers and other independent farmers who raise pigs and sell them to the center and secondly the executing agency of the project. Allocation of benefits depends on the sales prices of baby pigs and hogs for slaughter as well as market hogs. Due to pioneering nature of the pig industry in the Region with risks involved and needs for proper management of the complexity of the project with the contract farming system as well as extensions/training, the Lake Basin Development Authority should take the initiative as the executing agency at least for initial establishments.

(5) Organization and management

The organization and management should be set-up for the project by LBDA. Details of the proposed organization structure should be worked out prior to the project implementation. A proposed organization and management set-up is shown in Figure 2.8.

2.5 Conclusion and Recommendations

The project is considered technically feasible, socially desirable and economically viable. A large number of small farmers will benefit from the project. The project is expected to improve the food self-sufficiency and nutritional conditions of the people in the Region.

The project will create new employment opportunities in rural areas and will greatly improve family incomes, the national balance of trade and some infrastructural development in the project area.

The following are finally recommended.

1) The first pilot pig breeding center should be established in the nearest future with the installation of modern design and facilities.

2) The first pilot pig breeding center should import improved pig breeds such as Large white, Hampshire and Duroc from overseas countries.

3) Before starting this project, livestock specialists of executing agency should be trained in pig farming techniques from advanced countries, particularly for project coordination, management,. marketing, processing and breeding.

4) A market research should be undertaken at the initial stage of the project, covering possibilities of export market. Pig skin and leather processing will also be considered at that time.

5) The possibility of feed crop cultivation in the Narok district which has fertile and vast crop lands should be considered in further future.

6) Establishment of a training for extension officers at the level of animal health assistance should also be considered in the Region.

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Table 2.1 Pig Population by Province

Province	1980	1981	1982	1983	1984
Rift Valley	15,287	18,200	21,050	22,630	14,732
Central	41,799	34,900	41,700	49,400	49,667
Eastern	5,109	9,700	9,160	10,020	6,949
Western	6,400	7,200	8,300	6,500	6,947
Nyanza	600	700	1,000	1,200	2,140
Coast	581	800	600	930	814
Nairobi	4,300	3,300	4,280	4,000	3,847
Total	74,070	74,800	91,090	94,660	85,096

Source: Livestock Development Division, Ministry of Agriculture and Livestock Development, Annual Report, 1984

Table 2.2 Examples of Some Pig Feed Formulation

Ingredients	Sow Gestation & boar		Sow Lactation Ration		Pig Starter Ration		Pig Grower Ration		Pig Finisher Ration	
Maize or Sorgum	20	15	35	40	42	40	45	45	54	15
Dried Cassava	6.5	5	3	5			5	10	15	11
Dried Banana	6	5	5	6	11	10	5	10	14	20
Rice bran	20	50	20	20	15	17.5	12	10.3		30
Wheat middlings	10									
Cane molasses	5				4		10		20	5
Sugar						3				
Meat & bone meal	5	2	5	5	2	1	2.5	1	0.3	0.4
Soybean oil meal	1.5	10	8	10	18	20	13.5	17	8	6
Sunflower oil meal	1.5	3	3	2.2	3	6.5	5	3	4	5
Fish meal	2		2.5		4					
Distillers dried silubles	2.5	2	3.2					2		
Leucaena leaf meal Lucern leaf meal Cassava leaf meal	19	6	10	10						5
Salt	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Dicalcium phosphate		1	0.7	0.8		1.0	1.0	0.7	1.7	1.6
Total (%)	100	100	100	100	100	100	100	100	100	100

Source: Compiled by JICA Study Team based on "Pig Production in Tropics"

Table 2.3 Physical Production Data on the Pig Breeding Center (Estimate)

Farrowing/Weaning		
Conception rate (at first attempt)	75-80	%
Number of pigs born alive per litter	10	heads
Number of pigs weaned per litter	8	heads
Number of pigs weaned per sow per year	16	heads
Percent death loss	15-20	%
Growing/Finishing		
Age at weaning	5-7	weeks
Average liveweight of hogs sold	85-90	kg
Average age to market	170-180	days
Feed conversion rate (efficiency) (Average in weaning to finishing)	3.5-4.0 to 1	
Breeding		
Crossbred of Landrace and Large White for mother breed Hampshire or Duroc for terminal sire.		

Note: * Most market hogs are three way cross.
Souce: Assumptions made by JICA Study Team

Table 2.4 Pig Industry Projection

Projection Year	1st Year	5th Year	10th Year	15th Year	20th Year
No. of Sows	500	2,500	5,000	7,500	10,000
Boars 1/	50	250	500	750	1,000
(Total)	(550)	(2,750)	(5,500)	(8,250)	(11,000)
No. of Pigs 2/ Weaned/Year (A)	8,000	40,000	80,000	120,000	160,000
Replacement 3/					
Gilts	200	1,000	2,000	3,000	4,000
Boars	25	125	250	375	500
(Total) (B)	(225)	(1,125)	(2,250)	(3,375)	(4,500)
Expanding Breeders					
Gilts	625	625	625	625	625
Boars	63	63	63	63	63
(Total) (C)	(688)	(688)	(688)	(688)	(688)
Market Hogs (A) - (B) - (C)	7,087	38,187	77,062	115,937	154,812
Cull Breeders					
Sows	200	1,000	2,000	3,000	4,000
Boars	25	125	250	375	500
(Total)	(225)	(1,125)	(2,250)	(3,375)	(4,500)
Cull Expanding					
Gilts	125	125	125	125	125
Boars	13	13	13	13	13
(Total)	(138)	(138)	(138)	(138)	(138)
Pork Production (MT)					
1. Market Hog @ 55 kg	390	2,100	4,238	6,377	8,515
2. Gull Breeders @ 130 kg	29	146	293	439	585
3. Cull Expand Breeders @ 55 kg	8	8	8	8	8
(Total) 4/	(427)	(2,254)	(4,539)	(6,824)	(9,108)
Approximately Pork Total Production/Year (MT)	427	2,254	4,539	6,824	9,108

Notes: 1/ 10 sows or gilts per boar.
2/ 16 pigs weaned per sow per Year.
3/ Assumed replacement rate is 40% for sows and 50% for boars.
4/ Assumed liveweight of market hogs is 85 kg, carcass dressing percentage is 65%. Cull breeders liveweight is 200 kg, carcass dressing percentage is 65%. Cull expanding breeders are the same as market hogs.

Source: JICA Study Team

Table 2.5 Future Development of the Project (Year 2005, Projection)

Province	District	No. of Breeding Centers	No. of Contract Farmers	No. of Breeders Sow Level (head)	Potential for Pork Production (M.T.)
Nyanza	Kisii	5	600	2,500	2,275
	S/Nyanza	2	240	1,000	910
	Kisumu	2	240	1,000	910
	Siaya	2	240	1,000	910
	Total	11	1,320	5,500	5,005
Western	Kakamega	5	600	2,500	2,275
	Bungoma	2	240	1,000	910
	Busia	2	240	1,000	910
	Total	9	1,080	4,500	4,095
Grand Total		20	2,400	10,000	9,100

Source: JICA Study Team

Table 2.6 Initial Cost Estimate (One complete complex unit)

Items	
Breeders sow level	500 heads
Pork out put per year	427 M.T.
	Estimated Cost (K£)
Breeding center, building and equipment	200,000
Bio gas generator plant	60,000
Manure disposal plant for fertilizer	15,000
Feed mill plant	50,000
Small scale hog slaughter house	350,000
Extension and training center	50,000
Vehicles and others	440,000
Total	1,165,000

Source: JICA Study Team

Table 2.7 Estimated Hog Production Costs - from farrowing to finishing (1/2)

(1) Feed requirement and cost

	Kg	Estimate Unit Price	Total Cost
Sow Gestation & Others (Crude protein - 12.5%) 295 days 2.0 kg/day	590	1.3 Ksh./kg	767 Kshs.
Sow Lactation (Crude protein - 15%) 70 days 5.0 kg/day	350	1.8 Ksh./kg	630 Ksh.
Total	940 kg		1,397 Ksh.
Boar Rations (Crude protein - 12.5%) 365 days 2.2 kg/day	803	1.3 Ksh./kg	1,044 Ksh.
Creep Feeder Ration (Crude protein - 18%) Birth to 15 kg.	8	2.5 Ksh.	20 Ksh.
Starter Ration (Crude protein - 16%) 15 kg to 30 kg, Feed Conversion ratio 2:1	30	2.0 Ksh.	60 Ksh.
Grower Ration (Crude protein - 15%) 30 kg to 60 kg, Feed conversion ratio 3:1	90	1.5 Ksh.	135 Ksh.
Finisher Ration (Crude protein - 14.4%) 60 kg to 85 kg, Feed conversion ratio 4:1	100	1.3 Ksh.	130 Ksh.
Total	228 kg		345 Ksh.

(2) Estimated baby pig production cost (at birth)

Items	Kshs.	Remarks
Sow Gestation Feed Cost	767	295 days x 2.0 kg/day x @Kshs. 1.3/kg
Sow Latation Feed Cost	630	70 days x 5.0 kg/day x @Kshs. 1.8/kg
Boar Ration	104	One boar 365 days x 2.2 kg x @Kshs. 1.3/kg will serve 10 sows or gilts per year.
Veterinary and Medicine	20	Vaccine and other drugs.
Hog Pen Depreciation	360	One hog pen cost Ksh. 8,000, 10% salvage value, 20 years straight line on bildings.
Building Maintenance Cost	36	10% of depreciation cost
Labor Cost	244	10 minutes/day/sow, 1 hour labor cost about Kshs. 4/hour (61 hours)
Sub total	2,161	
Other Cost	108	5% of subtotal cost (Contingencies)
Total	2,269 Kshs.	

* One sow weans 16 pigs per year.
Baby pig production cost at birth: Kshs. 141.4 = (Kshs. 142)

Table 2.7 Estimated Hog Production Costs - from farrowing to finishing (2/2)

(3) Market hog (baconer) production cost

Items	Kshs.	Remarks
Baby Pig Cost (at birth)	142	See baby pig production cost at birth
Feed Cost	345	Creep feed 8 kg x @Kshs. 2.5 Starter feed 30 kg x @Kshs. 2.0 Grower ration 90 kg x @Kshs. 1.5 Finishing ration 100 kg x @Kshs. 1.3
Vet. medicine cost	5	Iron, Vaccine, Antiparasitic agent etc.
Hog pen depreciation	6	Hog pen cost about Kshs. 1,500/pen. 6 month use with 8 market hog. 10% salvage value, 15 years straight line on buildings.
Labor cost	60	5 minute/day/hog. 180 days = 900 minutes. = 15 hours. 1 hour labor cost Kshs. 4
Sub total	558	
Other cost	28	5% of sub total cost (Contingencies)
Total cost	Kshs. 586	
Out put	Kshs. 1,210	Liveweight 85 kg, carcass dressing percentage 65%, current average carcass price is 22 Kshs. for baconer.
Net return:	Kshs. 624	

* One sow weans 16 pigs per year.

One sow net return estimate: Kshs. 9,984
If 500 sows are raised, total net return will be Kshs. 4,992,000 (K£249,600)

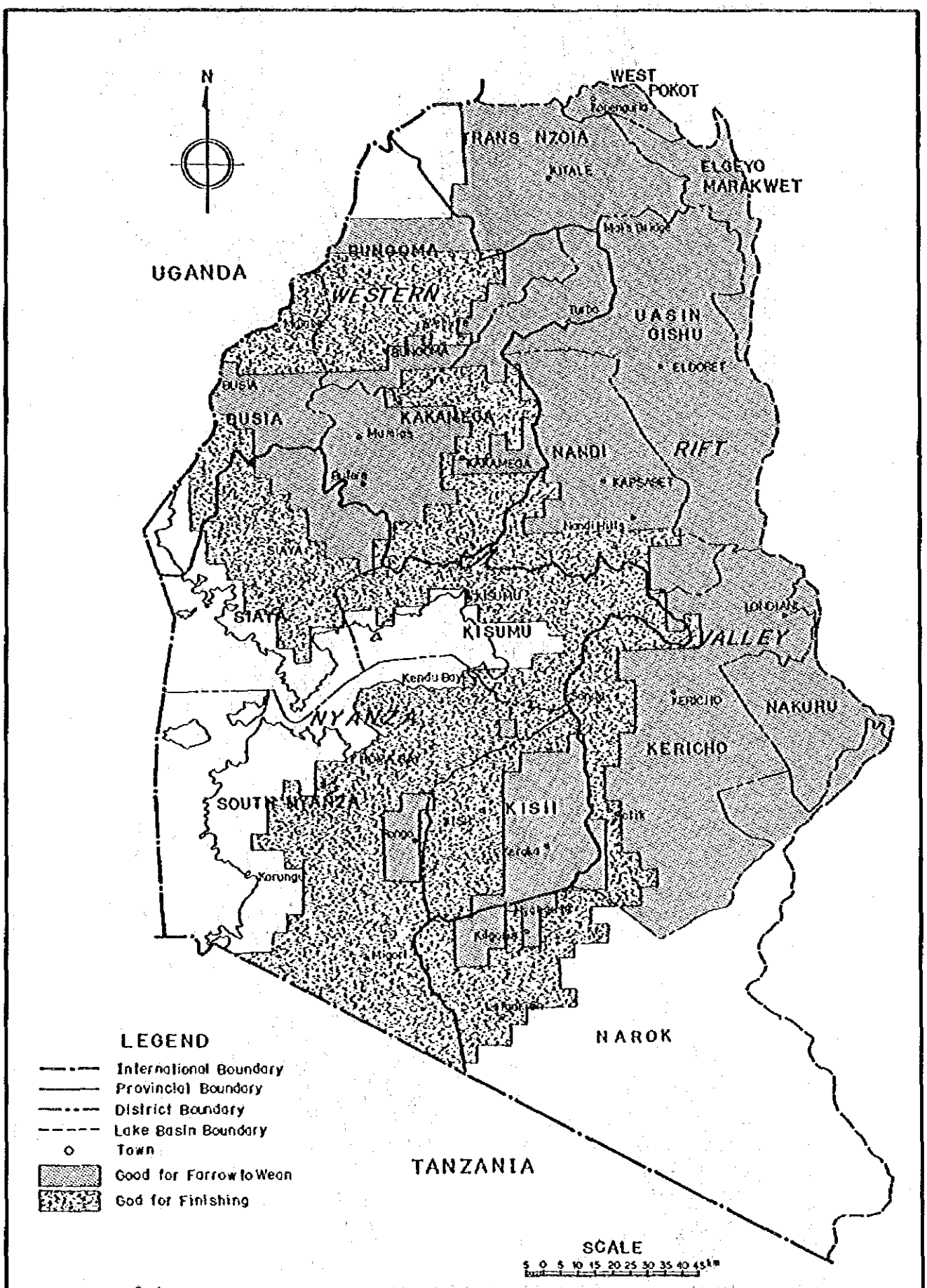

Figure 2.1 Ecological Zones Suitable for Raising Fattening Pigs under Natural Conditions

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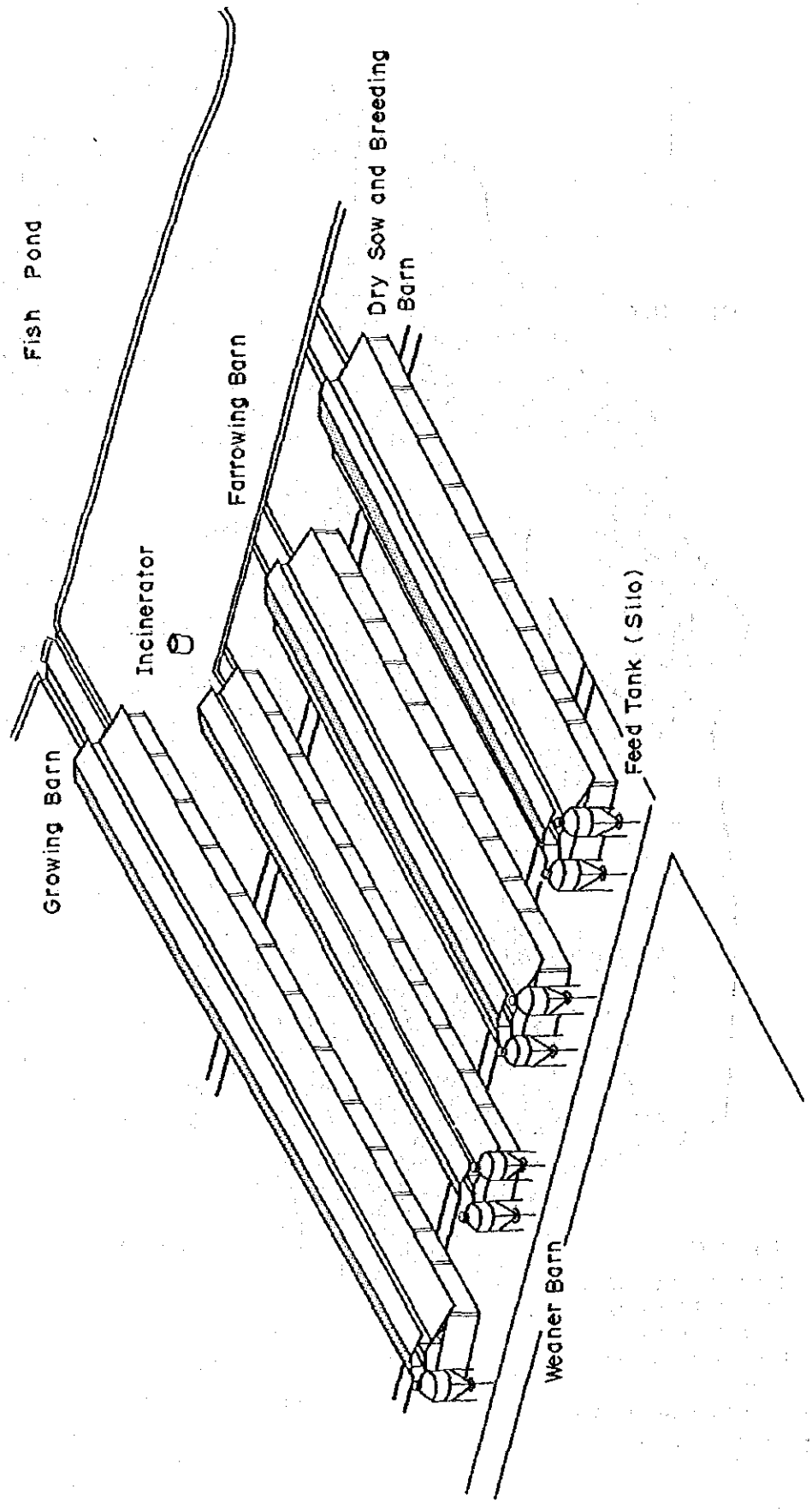

Figure 2.2 Illustration of the Pig Breeding Center Farrow to Growing Operation (Capacity: 100-150 Breeder Sow Level)

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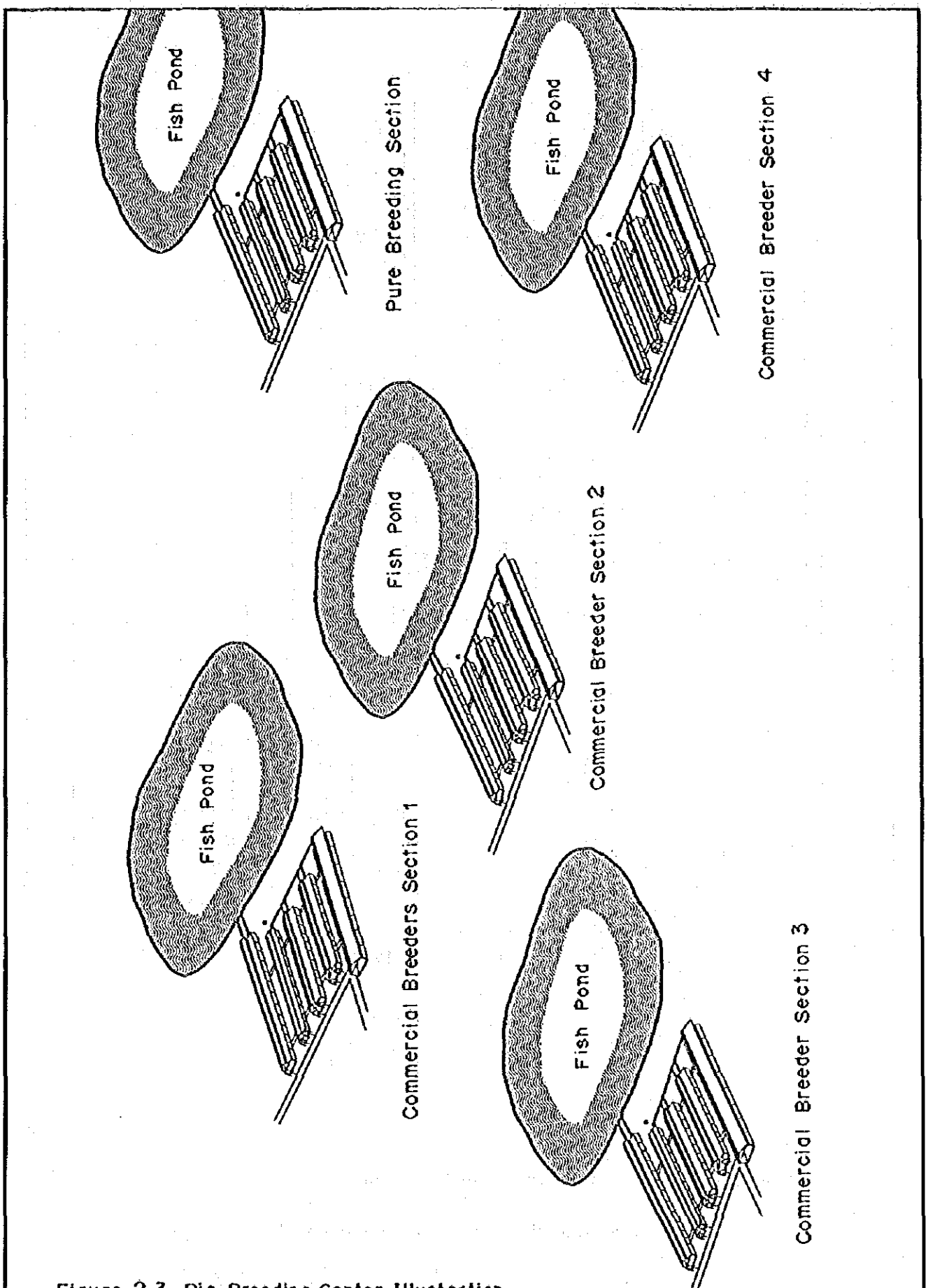

Figure 2.3 Pig Breeding Center Illustration
(500 Breeder Sow Level)

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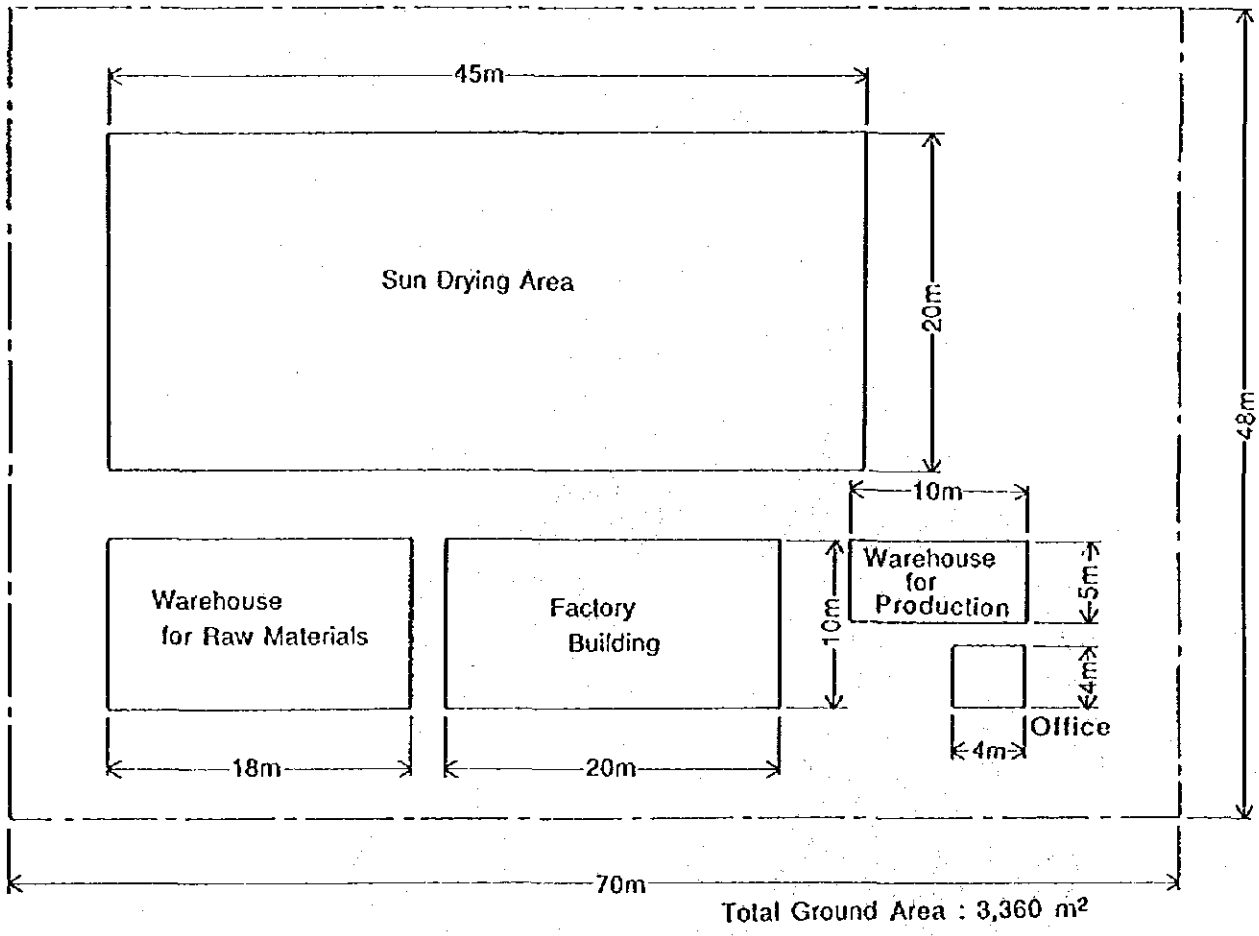

Figure 2.4 Layout of the Pig Feed Mill Plant

(utilizing with dried cassave and banana)

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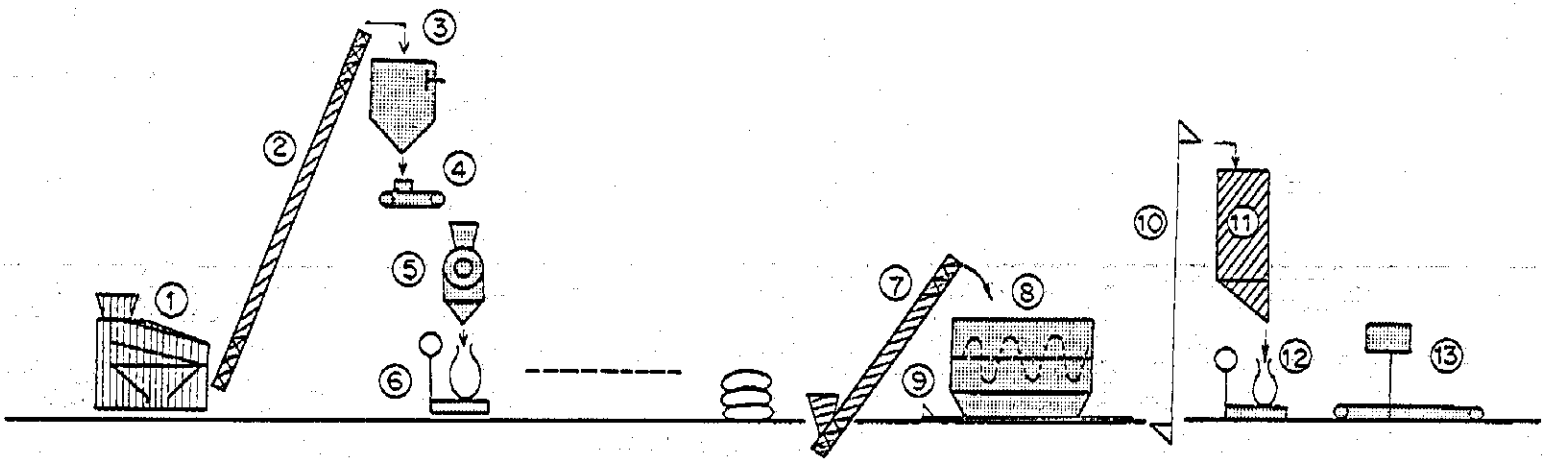
Figure 2.5 Mash Feed Manufacturing System



Pretreatment Process for raw materials

For Cassava : raw materials → roughing comminution → sun drying → storage with bag

For Corn and others : raw materials → screening → comminution → storage with bag

: materials → mixing → solidifying → bagging

Solidifying Process

①	Vibrating Filter	⑧	Mixer
②	Screw Lift	⑨	Chain Conveyor
③	Service Tank	⑩	Bucket Elevator
④	Belt Feeder	⑪	Packer Tank
⑤	Hammer Mill	⑫	Balance
⑥	Balance	⑬	Sewing Machine and Conveyor
⑦	Screw Lift		

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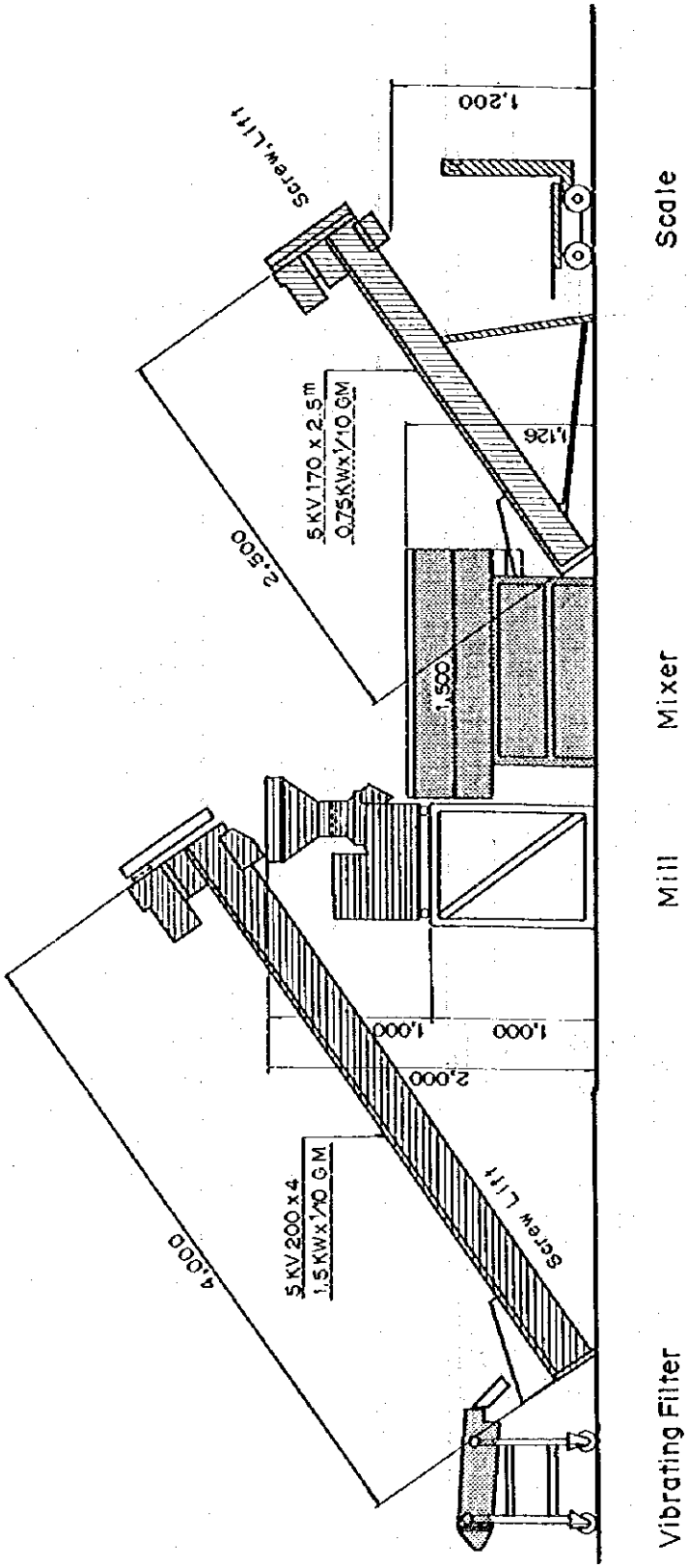

Figure 2.6 Simple Small Scale Feed Mill (10 tons/day or more)

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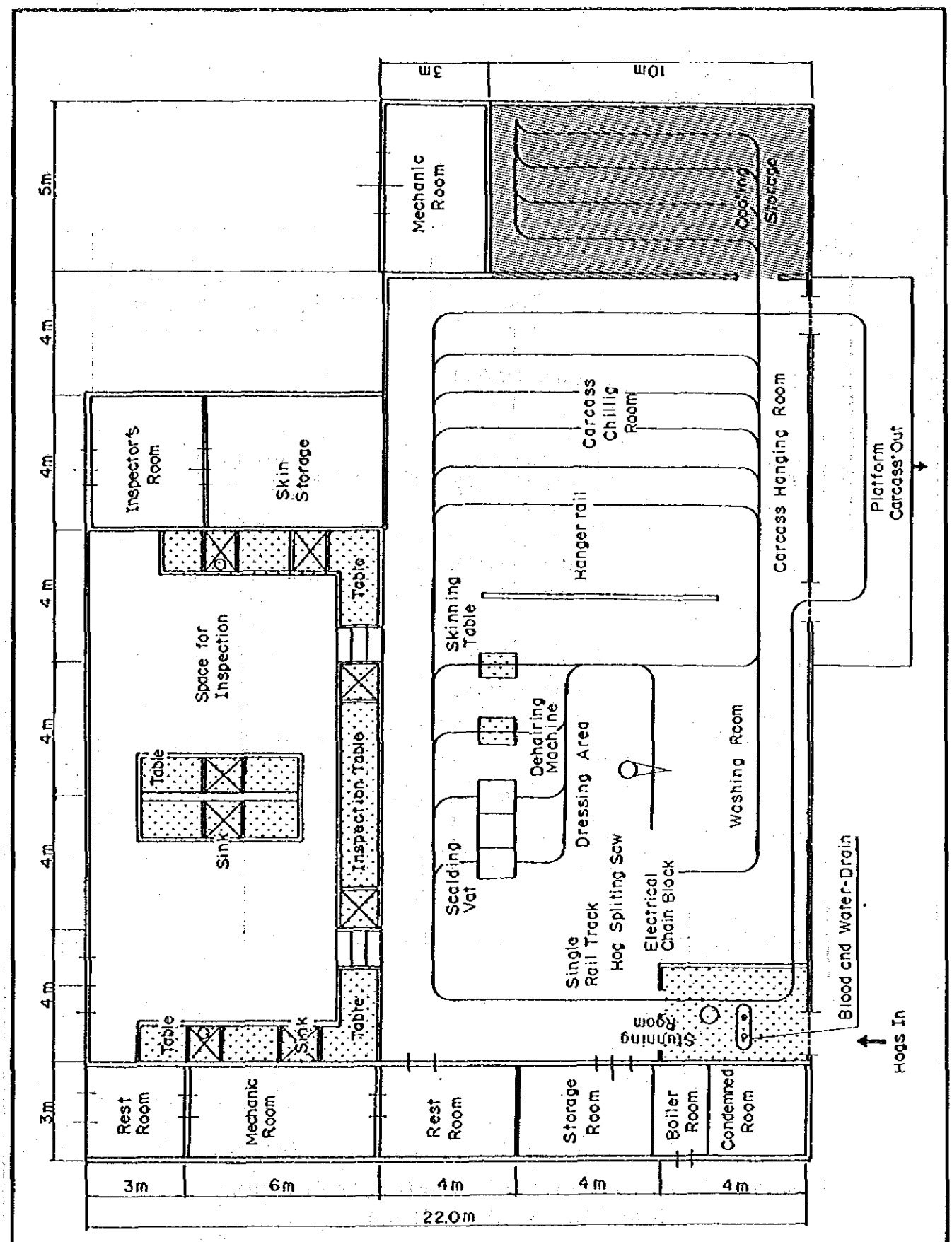

Figure 2.7 Layout of the Small Scall Hog Slaughter House (Capacity : approximately 40 hogs /day)

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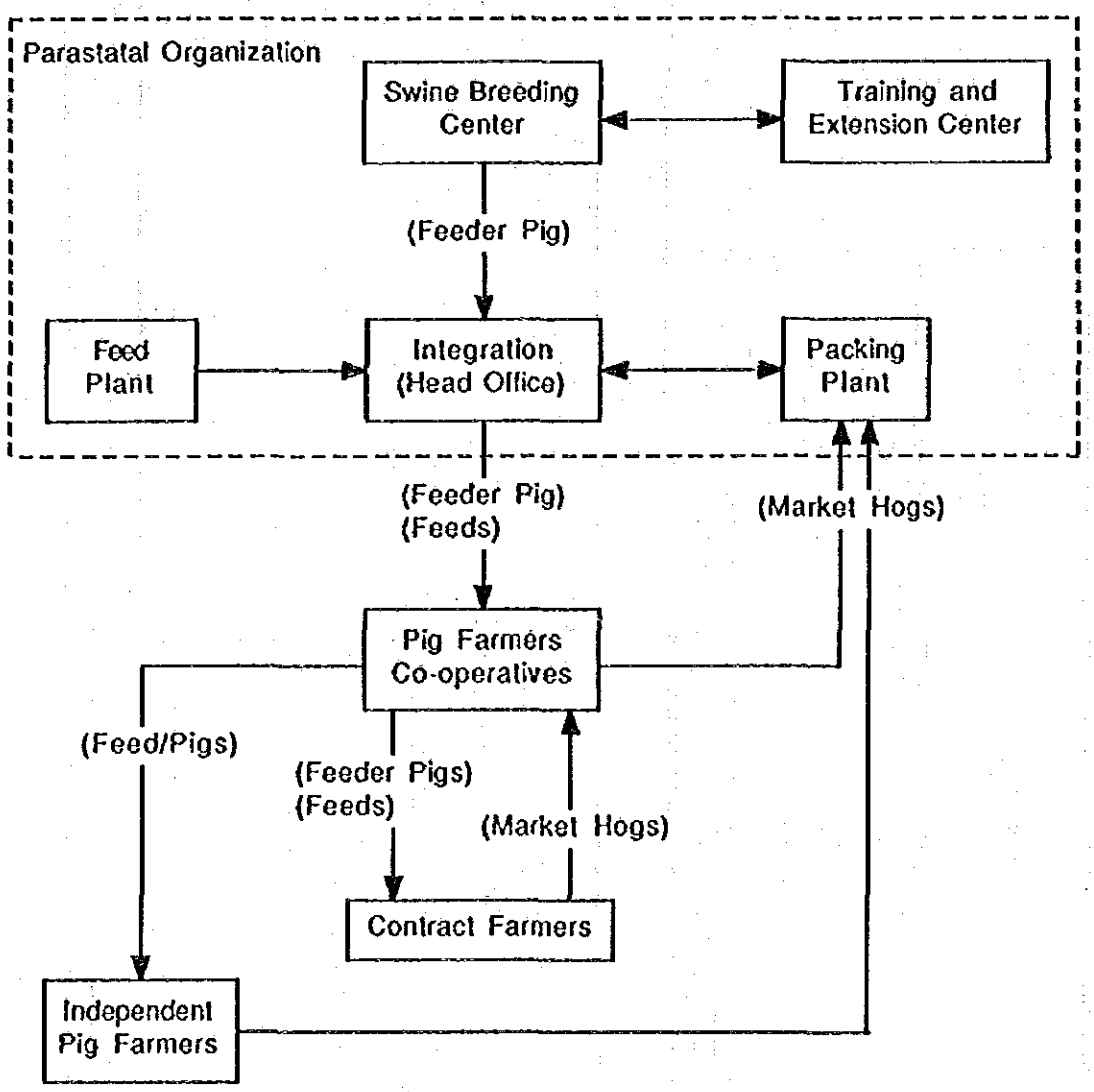

Figure 2.8 Inter-relationship of Pig Industry Complex Components
(Pig Integration Systems)

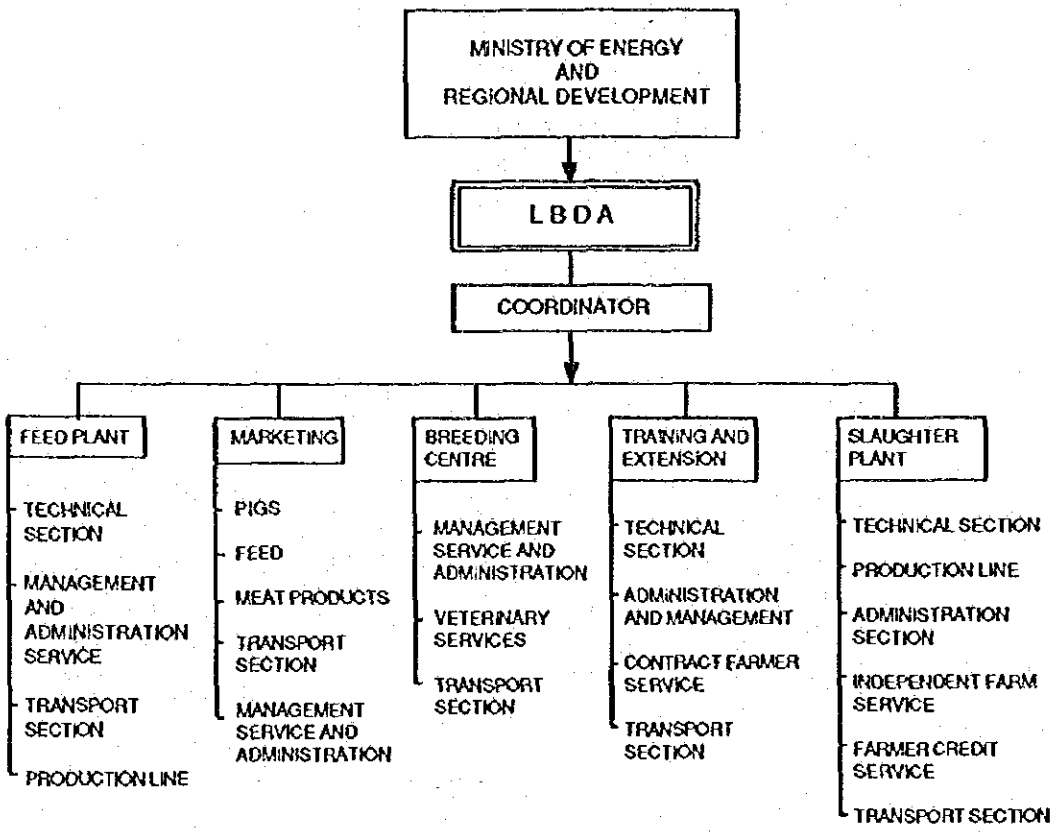

Figure 2.9 Organization and Management Chart

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Chapter 3 ANIMAL FEED INDUSTRY PROJECT

Chapter 3 ANIMAL FEED INDUSTRY PROJECT

Contents

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Figure

3.1 Introduction

(1) Background

The animal feed industry project has been selected from among all the priority project identified/formulated by the Integrated Regional Development Master Plan study for the LBDA region. It is an important component of both the fishery complex project and the pig industry complex project, two of 27 Master Plan projects.

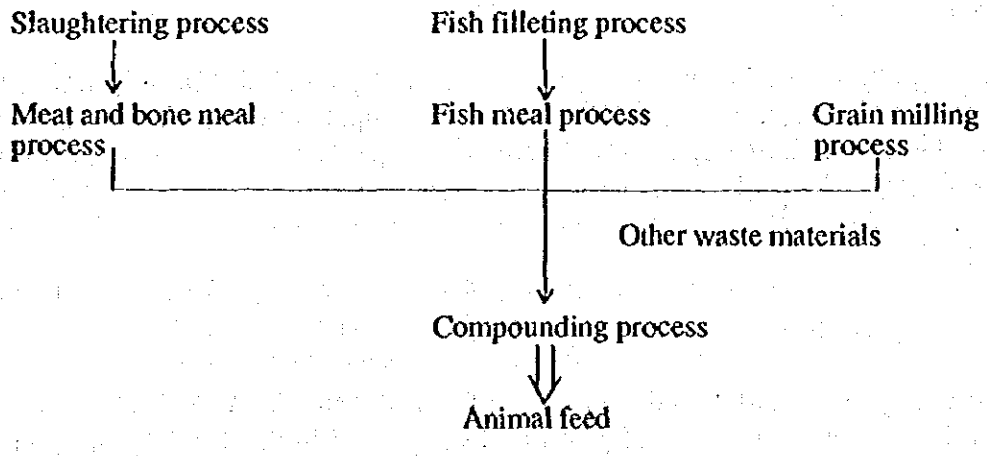
The selection of this project is based on the following reasoning. First, the potential market seems to be very large, as there exists no feed mill plant in the Region producing the animal feed in sufficient quantity and quality and large increases in livestock production and fish production by feeding culture are envisaged by the Master Plan. Second, the project can utilize agricultural residues and other wastes which are mostly unutilized at present, and thus contribute to reducing environmental problems caused by the discharge of organic materials. Also the project will contribute to foreign exchange savings, increases in employment opportunities and regional incomes without much consuming additional resources.

This project is strongly related to two other industries also expected to be introduced in the near future. First, a fish filleting factory is planned to be established in the nearest future ("Feasibility Study on Fish Filleting and Processing Plant", 1985). Second, the pig industry complex project will expand the meat production in the Region and centralized slaughter houses are planned associated with it. These projects would facilitate the establishment of the animal feed industry project by supplying essential animal proteins.

(2) Scope of the study

As indicated above and also illustrated in the following figure, the animal feed industry is a downstream activity of slaughtering, fish filleting and grain milling processes.

The analysis in this chapter covers all of these processes so that the procurement of raw materials, measures to protect environment from organic wastes and the overall effects of the industry on the Region's economy can be examined within a consistent framework.



The viability of the animal feed industry depends critically on the collection of raw materials. Collection of animal wastes would be comparatively easier, if the planned fish filleting project and the pig industry complex project with centralized slaughter houses are effectively utilized. More difficult will be the collection of agricultural residues, which are distributed all over the Region. In order to formulate such a project scheme that can overcome this difficulty and produce the animal feed at reasonable costs, the following scope is set for the study.

First, for the animal wastes, the planned fish filleting and pig industry complex projects should provide the basis for estimating availability and collectability of raw materials. Second, the production of high quality feed is aimed at to minimize the need for widely collecting various agricultural residues. Third, the protein content of such high quality feed should be high enough to be applied directly to fish culture and also poultry. Fourth, the possibility and methods of utilizing the high quality feed for larger animals including cattle should be sought.

3.2 Conditions for Development

(1) Market

The potential market for the animal feed in the Region is considered very large including demand for both livestock and fish. Feed requirement for pig is estimated as follows (Chapter 2, Sector Report).

Year	Feed requirement (tons/year)
1990	26,000
1995	78,000
2000	130,000
2005	182,000

Feed requirements for poultry and cattle are forecasted to be over 100,000 tons and 10,000 tons, respectively.

Future production of fish will depend substantially on aquaculture, primarily feeding culture. Its success will very much depend on the supply of fish feed. In order to produce 18,000 tons of fish mainly by feeding culture and partly by manure culture, some 30,000 tons of fish feed would be required.

(2) Raw materials

Composition of feed

Quality requirements for feed vary among fish and different kinds of animals. Fish feed requires the highest contents of protein. As explained in Section 3.1, this study aims at formulating such a project scheme for producing high quality feed. For this purpose, the

following feed composition is assumed, which is suitable for fish and poultry as it is and can be applied to other animals by mixing with more agricultural residues.

Raw materials	% composition (on weight basis)
Fish meal	10
Meat and bone meal	20
Cotton seed cake	20
Soybean/groundnut/sunflower cake	30
Wheat flour/bran/vitamin and mineral additives/other cereals	20
Total	100

The composition ratios of fish meal and wheat flour and others are the minimum. If more of these raw materials are available and used, the ratio of soybean and others will be reduced.

Feed for other animals requires lower composition ratios of fish, and meat and bone meals. A typical composition of pig feed is the following.

Contents	% composition (on weight basis)	Raw materials
Protein	4-5	Fish, meat and bone meals
Cake	10-15	Cotton/soybean cakes
Cereals	80-85	Broken cereals, bran
Total	100	

Blood powder, a by-product from slaughtering process, brewery's waste and molasses can also be used as raw materials.

Fish meal

According to the sector report on fishery, some 3,000 tons of fish meal will be produced in 2005 from the fish filleting industry capable of handling 30,000 tons of fresh fish. If other raw materials are available in the required proportions, about 30,000 tons of high quality feed can be produced. This is just enough to meet the requirements for aquaculture, but more feed would better be produced to meet other requirements. Possible options are:

1) Collection of larger volume of fish waste materials by improving fish processing and distribution channels;
2) Substitution of meat and bone meal for fish meal; and
3) Import of fish meal.

Meat and bone meal

A typical composition of products from cattle is as follows.

Products	% composition	Uses
Meat and bones	50	For distribution
Bones, blood and meat	15	Input to meat and bones meal
Internal organs	10	
Leather	10	
Remains	15	
Total	100	

Internal organs and remains are unsuitable as inputs to meat and bone meal. At present, the part to be used as the raw material for meat and bone meal is only 15% of cattle body. If the meal habit changes to a direction that the people enjoy meat without bones, raw materials would increase to about 30% of cattle body.

Based on the production plan of livestock meat in the Region, along with the composition ratios given above, the potential volume of raw materials for meat and bone meal is projected as follows.

Year	Raw materials for meat and bone meal (tons)
1985	16,800
1990	20,100
1995	24,200
2000	36,200
2005	43,400

Note: The part to be used as raw materials is taken to be 15% of the cattle body up to 1995 and 25% thereafter).

The input-output ratios for meat and bone processing are as follows.

Outputs	% composition
Finished meat and bone meal	30
Oil	15
Moisture	55
Total	100

Applying these ratios, the potential production of meat and bone meal is projected as follows.

Year	Meat and bone meal (tons)	Oil (tons)
1985	5,046	2,520
1990	6,030	3,010
1995	7,260	3,630
2000	10,860	5,430
2005	13,020	6,510

The table indicates that the volume of meat and bone meal is large enough to produce 43,00(tons of high quality feed, if other agricultural materials are available. The major constraint however, is collection of waste materials from butcheries scattered in towns and trade centres.

Other raw materials

Soybean, groundnut, and sunflower cakes can be supplied in large quantity to produce over 100,000 tons of high quality feed. Moreover, they are easily raised as by-products of edible oil industry, especially if the latter is expanded as planned.

It is very difficult to collect broken cereals and bran from households cultivating these crops for self-consumption. Only realistic source, therefore, is large scale millers. The volume which may be raised is estimated for different kinds of cereals as given in the table below.

(Unit: 1000 tons)

Cereal	Sale volume from farmers to millers (Kenya, 1983)	LBDA regions share (%)	Estimated milled volume in the Region
Wheat	242	71	172
Maize	637	46	293
Rice	34	30	10
Total			475

If the composition ratio of broken cereal and bran is 16%, the total volume of broken cereal and bran is estimated to be 76 thousand tons.

Vitamin and mineral additives will have to be imported from other regions.

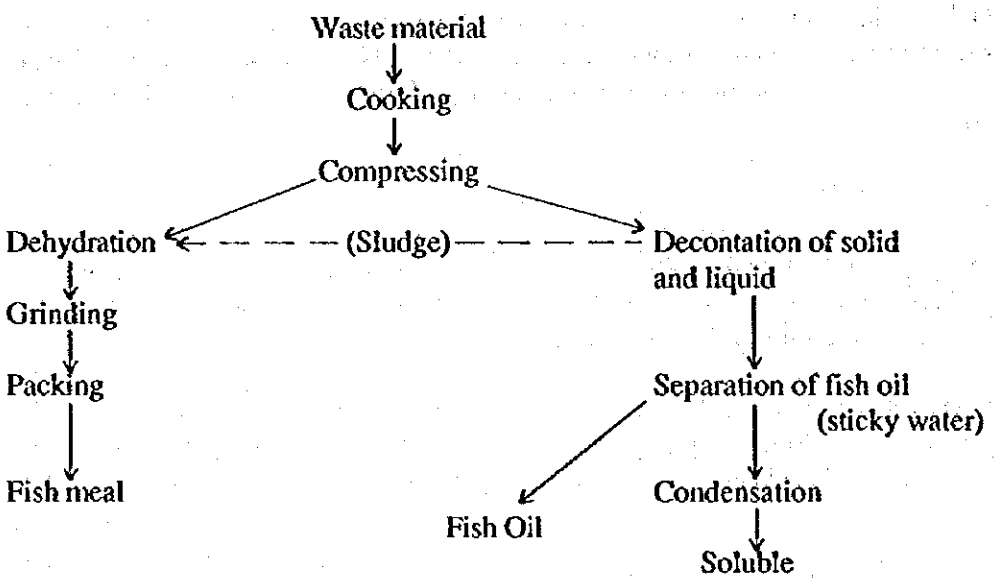
From the above analysis, it is clear that the procurement of fish meal and bone meal will become the determining factor for the production capacity of the feed.

3.3 Production Process and Initial Investment

(1) Fish meal

Production process

The production process for fish meal is illustrated by the chart below.



The composition ratio of waste materials from a fish filleting process is 60% of the fish. From 1 kg of the waste material, about 0.17 kg of fish meal and 0.03 kg of fish oil can be produced.

Initial investment

The cost of plant including affluent water treatment facility, but excluding a factory building is roughly estimated as follows.

Capacity (tons of raw materials/day)	Cost (million US $)
50	1.6
200	2.5

The total initial investment cost, including not only a fish filleting and fish meal plant but also other related facilities, has been estimated for production capacity of 70 to 90 tons per day on raw material basis.

Cost element	Estimated cost (million US $)
Building	1.2
Machinery and effluent water treatment facilities	1.8
Vehicles	0.2
Total	3.2

(Source: "Feasibility Study on Fish Filleting and Processing Plant", 1985)

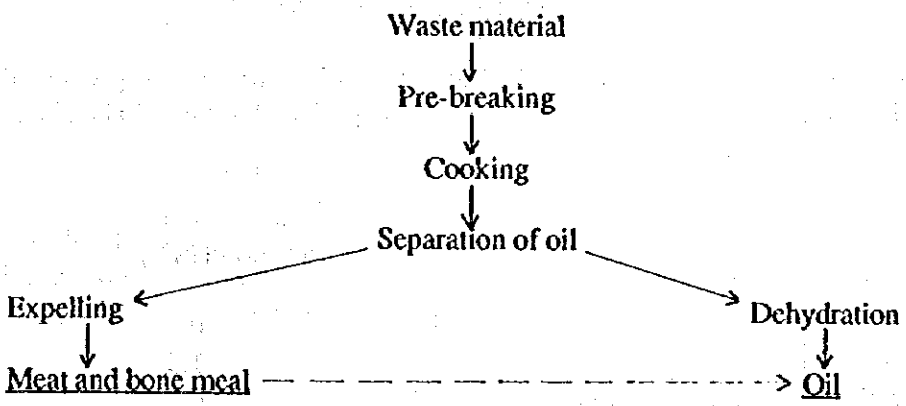
In addition, the following utility costs are incurred.

Utility	Annual use	Annual cost (1000 US $)
Electricity	310 MWh	17.7
Water	5,300 tons	13.3

(2) Meat and bone meal

Production process

The production process for meat and bone meal is illustrated below.



Out of 1 kg of waste material, about 0.3 kg of meat and bone meal and 0.15 kg of oil can be produced.

Initial investment

The cost of equipment, excluding a boiler and a factory building is roughly estimated as follows.

Capacity (tons of raw materials/day)	Cost (million US $)
50	1.25
100	1.60

Other facility costs have been estimated on the following assumptions.

1) The costs are allocated 20% to the meat and bone meal process and 80% to the butchery process.

2) With the allocated costs as well as costs of other facilities and operation attributed, the butchery process can make the financial balance.

The following give the results.

Cost element	Estimated cost (million US $)
Effluent wastewater treatment facilities (1,400 tons/day)	1.1-1.2
Building	1.2
Vehicles	0.2

The cost for wastewater treatment facilities varies widely depending on the degree of treatment. Also the cost of civil work accounts for a large portion of the total cost, which can be substantially reduced if local materials and labour are used.

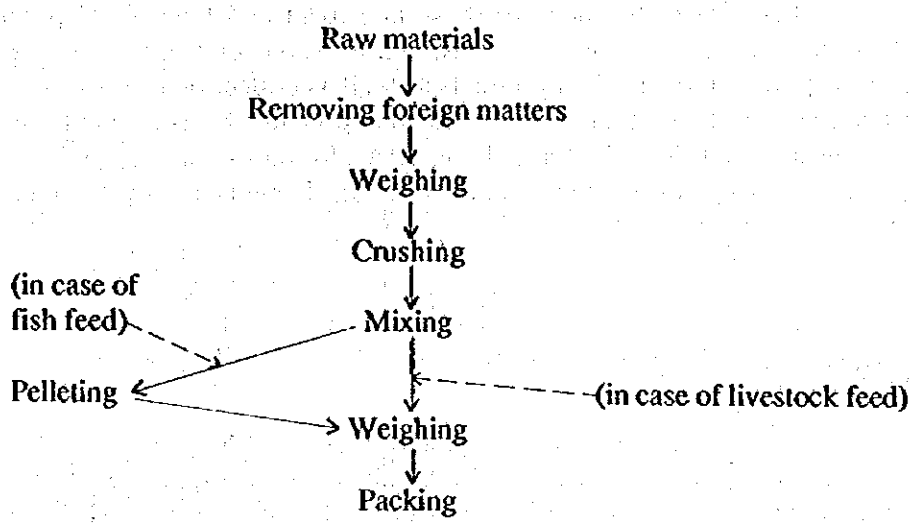
The initial investment costs of meat and bone meal plant which can process the waste materials from the butchery process with the daily capacity of about 200 heads of cattle or equivalent are estimated as follows.

Cost element	Estimated cost (million US $)
Building	0.2
Machinery	1.1
Wastewater treatment facilities	0.2
Vehicles	-
Total	1.5

(3) Compounding

Production process

The compounding process to make finished feed is illustrated below.



Initial investment

The cost of equipment is roughly estimated as follows.

Capacity (tons of feed/month)	Estimated cost (million US $)
3,000	6.3
5,000 - 8,000	9.4 - 12.5

Assuming that the plant is operated in three shifts for efficiency of the boiler used for pelleting, the initial investment cost for the compounding process is roughly estimated as below for 3,000 tons/month production capacity.

Cost element	Estimated cost (million US $)
Building	0.1
Machinery	2.0-3.0
Total	2.1-3.1

3.4 Location

(1) Factors to be considered

Fish filleting and fish meal processes should be installed at the same location, as they take place in series. Locational decision for these and meat and bone meal processing is dominated by the collection of raw materials, and location for compounding process is affected by transportation of finished products as well as collection of broken cereals and bran. The fish filleting - fish meal processes should in principle be located at fishery centres expected to be established along the Lake shore. Exact locations, however, may be selected closer to consumption areas along the main distribution channels of fish (Chapter 3, Sector Report).

(2) Candidate locations

Fish meal plants

Candidate sites for fishery centres are Usenge and Asembo in Siaya district, Kisumu, and Kendu Bay, Homa Bay, Mbita and Karungu in South Nyanza district. New fish fillet - fish meal plants should find their locations one in Siaya and another in South Nyanza, and the existing fish filleting plant in Kisumu should be expanded to make also fish meal.

The Feasibility Study of Fish Filleting and Processing Plant proposes that the plant with the capacity of 20,000 tons/year of fresh fish be located at Kisumu. It would not be easy, however, to collect fresh fish in this quantity at one central plant. It would also be more desirable from the viewpoint of equitable development that a few plants be located along the Lake shore.

Meat and bone meal plants

Centralized slaughter houses with the meat and bone meal processing are proposed at the following sites: Kericho, Kisii or South Nyanza, Nandi or Uasin Gishu, and Busia, Siaya or Kakamega.

Construction of a new slaughterhouse in Kisumu, costing Kshs.19.2 million, was recently announced to replace the existing one and to cope with the increasing demand. The location seems favourable, close to the market. However, the sites proposed above have been selected by paying more attention to the supply side of raw materials in order to reduce transportation costs and to improve accessibility by farmers.

Compounding plants

There exist compounding plants at Kisumu and Eldoret. In addition, a new plant in South Nyanza or Kisii and another one in Bungoma or Busia should be established. The former will cover markets in the southern part of the Region and the latter the northern part.

The proposed locations of slaughter houses with meat and bone meal processing, the fish filleting plants with fish meal processing, and compounding plants are indicated in Figure 3.1.

3.5 Evaluation

(1) Projection of output

Basis for projection

The Feasibility Study on Fish Filleting and Processing Plant proposes that the project should be started as early as possible and the operation would reach its maximum in the third year (presumably 1989), and no expansion is planned thereafter. The planned capacity of 70 tons of fresh fish per day is far short of supplying sufficient raw materials for the animal feed industry. Besides, the collection of even this amount of fish at one central processing plant is questionable.

The Feasibility Study on Commercial Fish Farming in the Lake Basin Area proposes the following plan for expanding fish production by aquaculture.

		Demand for Fish Feed (tons)	Production of Tilapia (tons)	Water Surface (ha)
Year	1	324	-	23.6
	2	1,278	201.5	78.4
	3	1,686	800	108.0
	4	1,986	1,053	108.0
	5	3,372	1,241	207.1
	6	3,372	2,078	208.0
	7	3,372	2,078	208.0

These figures refer to the total of four potential sites for fish farms examined by the study. It is expected that the production level shown above will be attained in any case within several years. Still the total production is far short of the amount required for the animal feed industry, and no expansion is suggested.

The observations above indicate that these existing studies can not be used as the basis for drawing up a plan for the animal feed industry, which will be expanded as the availability of fish increases by 2005. Thus the output of the animal feed industry is projected here by referring to the production plan of fish fillet as well as planned increase in meat production worked out in respective sector plans of this Master Plan (Chapters 2 and 3, Sector Report). In this way, the animal feed industry can be planned in the way consistent with other related activities.

Projected output

According to the sector report on fishery, about 3,000 tons of fish meal can be produced in 2005 from fish filleting plants located at a few fishery centres on the Lake shore. From the expansion plan for meat production in the sector report on livestock, it is estimated that 13,020 tons of meat and bone meal can be produced at maximum in 2005. If only 60% of the latter or 7,800 tons can actually be used, the total amount of raw materials available as animal protein sources is calculated to be 10,800 tons in 2005.

These animal wastes should constitute 30% of the high quality feed as explained in Section 3.2. Therefore, the animal feed of about 36,000 tons can be produced in 2005 by mixing these animal wastes with agricultural residues and other wastes. This is sufficient to cover the entire demand for feed required by aquaculture planned in the Region, and a small quantity will be left for other animals.

Once the animal feed industry is successful established in the Region, more meat and bone meal may become available by importing from other regions: e.g. from Rift Valley Province, where a large number of cattle are raised, but the demand for high quality feed may not be so high since no substantial aquaculture is expected there. Therefore, the amount of high quality feed available for larger animals may be more than indicated by the calculation above.

(2) A financial analysis

Present feed prices

The price of fish feed was estimated to be Kshs.2.2 per kg in 1984 ("Feasibility Study on Commercial Fish Farming in the Lake Basin Area,"). Assumed quality of this feed is not clear. According to the survey conducted at this time, the feed prices in 1986 vary in the range of Kshs.2-6 per kg, depending on the quality (mainly protein contents and pelleted or not).

Since the animal feed at present is produced at large millers, where sizeable amounts of broken cereals and bran are available, the prices do not reflect the full cost of production. Moreover, the external diseconomy due to discharge of organic wastes is clearly not reflected in the price structure, as the slaughtering process is external to the operation at millers, which is simply a compounding process.

Therefore, from the view point of real economic cost of animal feed manufacturing, the feed prices should be at least on the high side of the range of present prices, if not higher than them.

Unit cost of feed

The total cost of the entire process is estimated, including fish filleting, fish meal process, meat and bone meal process and compounding process. The cost covers construction, replacement, purchase of raw materials, labour and others.

The details are given in the Appendix to this chapter and summarized in Table 3.1 Estimated construction costs are given in Table 3.2. The total of construction cost an operating expenses for 20 years has been calculated to be K£.360 million at 1986 constan price. The total revenue from the sales of fish and animal oil and fish fillet is calculated t be K£ 278 million over 20 years to make the balance K£ 83 million (Table 3.3). The tota production of animal feed is calculated to be 560,000 tons over 20 years. Therefore, th unit production cost to be attributed to the feed is calculated to be K£ 148 per ton o Kshs.3.0 per kg.

The price of animal feed to be produced will probably be in the range of Kshs. 3.5-4.0 pe kg adding a profit margin and a sales tax. Still the price is judged competitive, considerin that this product is of high quality. The protein content is about 45% for this product, whil for the products currently available in markets the protein content is only a little higher tha 20%. If the compounding process proposed in this study is utilized to produce the anima feed of the quality comparable to the currently available products, the unit production cos becomes Kshs. 3.4 per kg, including the sales tax (Table 3.14). The higher price i primarily due to the fact that agricultural by-products would have to be purchased.

Another difference in quality between the products from proposed animal feed industry an the marketed ones is the forms of products. The marketed products are not pelleted i different sizes to meet requirements for animals at different breeding stage. Efficiency o non-pelleted feed is lower than the pelleted one.

3.6 Alternative Formulation for Compounding Process

Wide application of animal feed would depend on the collectability of raw material especially agricultural wastes and by products distributed all over the Region. In t formulation of animal feed industry given in previous sections, the production of high quali feed is aimed at, utilizing as animal protein sources the wastes from the planned fish filleti and pig industry complex projects. In this way, requirement for collecting agricultural b products would be minimized. An implication of this formulation is that the feed for oth animals requiring lower protein contents would be prepared by combining the products of t planned animal feed industry with locally available agricultural byproduts.

Alternatively, small scale feed compounding can be done by farmers themselves or at sma stock feed mills to be established. These possibilities are pursued in this section, aiming applying the animal feed more widely especially to cattle. Two alternatives will be examine (1) feed compounding at farmers' level, and (2) small stock feed mills at secondary towns.

(1) Feed compounding at farmers' level

Features

The production capacity is assumed to be 0.5 ton per day or 150 tons per year. If mechanized compound processing is adopted, such equipment as vibrating filter, hamm mill and balance as well as a building for them would be required. In addition, a generat may be necessary if the access to public electricity supply is difficult. The installation cost

estimated to be K£ 10,000 - 20,000, which would be excessively large for most farmers. Therefore, the adoption of manual operation with instruments that most farmers already have is assumed, and only a new building will be constructed for this operation. In the case that a mechanized processing is adopted, group management and operation are recommended.

Animal protein sources are assumed to be the planned slaughterhouses and fish filleting plants as presented in this chapter (see also Chapter 2 of this report, and Chapter 4, Sector Report). Depending on how much agricultural residues can be raised by farmers themselves, two alternative cases are formulated and examined below.

Production cost

The production cost of animal feed by manual compounding consists of labour cost, raw material cost and other cost. The labour cost is estimated at K£ 840 per year (= Kshs. 4/hour x 7 hours x 2 persons x 300 days).

The cost of raw materials is estimated as follows for the two alternative cases.

Case 1: All the agricultural residues raised by farmers
K£2,630 per year (= Kshs. 7/kg x 150 tons x 5%) for animal wastes

Case 2: Some agricultural residues purchased
K£ 2,630 per year for animal wastes
K£ 9,750 per year (=Kshs. 1.5/kg x 430 tons) for agricultural residues
K£ 12,380 per year in total

Other costs are assumed to be 10% of the sum of labour and raw material costs for each case.

Case 1: K£ 350 per year
Case 2: K£ 1,320 per year

The unit production cost is obtained as follows by dividing the total annual cost with the total annual production of 150 tons.

Case 1: Kshs. 0.5/kg
Case 2: Kshs. 1.9/kg

The unit production cost depends much on the collectability of agricultural residues, but in either case the cost is much lower than the case examined in the previous section based on the compounding process formulated in Section 3.3

(2) Small stock feed mills

Features

The production capacity is assumed to be 3,000 tons/year. The production process is basically the same as planned associated with the pig industry complex project (Figure 2.5 in Chapter 2), except for the following points:

- The process will be manually controlled;
- Raw material bins and compound bins will be omitted or substituted with simple ones; and
- Pelleting will not be included.

Production cost

The construction cost is estimated at K£ 60,000, consisting of K£ 20,000 - 25,000 for equipment and K£35,000 - 40,000 for buildings. The operating fund is estimated to be K£ 500,000, covering the purchase of raw materials and labour for one year. All the raw materials are assumed to be purchased. The capital for construction and operating fund is assumed to be borrowed at the annual interest rate of 10% for five years including two years grace period. Assuming the operation by a private enterprise, the profit and sales tax are also added to the ex-factory price of the feed.

The calculation of unit production cost per kg of feed is summarized in Table 3.5. As seen from the table, the ex-factory price of the feed would become Kshs. 3.7/kg, higher than the base cases presented in the previous section. This is mainly due to the relatively high raw material costs, profit and sales tax, and commercial terms of loans which offset the lower construction cost. If the sales tax is excluded, the unit production cost, including the profit, would become Kshs. 3.2 per kg of feed, lower than the unit cost of compounding by the system presented in the previous section.

3.7 Conclusions and Recommendation

(1) Conclusions

The proposed animal feed industry can produce about 40,000 tons of high quality feed in 2005, when its operation reaches the maximum. The product is more than sufficient to meet the requirements for fish culture both in quality and quantity, and the balance can be used for other animals such as poultry and cattle. In addition, a system of small scale feed compounding examined in this study can supplement the feed supply especially for cattle. Two alternatives for this are feed compounding by farmers themselves and the establishment of small stock feed mills at secondary towns.

The unit production cost has been estimated at a preliminary level. For the high quality pelleted feed with some 45% protein content, the unit production cost is calculated to be Kshs. 3.0 per kg. The sales price is most likely in the range of Kshs. 3.5-4.0 per kg, which is judged quite competitive. The lower quality feed with the protein content slightly higher than 20%, which meets the requirements for cattle, can be produced by farmers themselves at the cost of Kshs. 0.5 or Kshs. 1.9 per kg, depending on how much agricultural residues they can collect by themselves. Alternatively, if a small stock feed mill is established by the private sector, the sales price of the feed is likely to be around Kshs. 3.7 per kg.

The proposed animal feed industry will capitalize on the fish filleting plants and the pig industry complex projects to be established in the Region in the nearest future, according to

the Master Plan. Taking account of implementation timing and planned expansion of these projects, the first animal feed mill can be established around 1990 with the production capacity of about 10,000 tons per year. The location should be selected from among the candidate sites for fishery centres: i.e. Usenge and Asembo in Siaya district, Kisumu and Kendu Bay, Homa Bay, Mbita and Karungu in South Nyanza district.

(2) Recommendation

Pricing

The viability of the project depends heavily on the availability and purchase prices of raw materials. A proper pricing system should be established for all the goods and materials related to this project, including fresh fish, fish fillet, fish wastes, animal wastes, agricultural residues and industrial wastes as well as animal feed. The following provide general guidelines.

1) Purchase prices of fresh fish on beach and at farmgate for aquaculture should be stable and high enough to give incentives to fishermen and farmers within the capacity of general consumers, but low enough to prevent over-exploitation especially of Lake fish.

2) The high prices of fish fillet for export market should be maintained to warrant the viability of fish filleting plants, which in turn would reduce the unit production cost of animal feed.

3) Prices of animal feed should be determined as the parity between the prices of fish fillet and fresh fish to be produced by feeding culture.

4) Prices of animal wastes should be set high enough to give local butchers incentives to bring in their waste meat and bones.

5) Prices of agricultural residues and industrial wastes should be only slightly higher than the transportation costs to discourage middlemen to intervene in the trade.

Other measures

In order to secure stable supply of fish for filleting and fish meal production, existing fishermen's cooperatives should be made instrumental (see Chapter 3, Sector Report for more specific measures to be taken). Rural cooperatives may play a role in establishing and operating the small stock feed mills suggested in this chapter.

Before a decision is made for implementing the project, the following points should be checked with higher accuracy:

1) Production cost of both Lake fishery and aquaculture
2) Efficiency of applying feed of varying quality,
3) Market prices and transportation costs for raw materials and products, and
4) Unit production cost.

Roles of LBDA

For successful implementation of the project, LBDA is expected to fulfill the following.

1) LBDA is expected to persuade related government agencies and organizations to consolidate the existing fisheries cooperatives.

2) LBDA is expected to plan the centralized slaughterhouses suggested in this chapter.

3) LBDA is expected to give advice for establishing a system of small stock feed mills also suggested.

4) LBDA is expected to take initiative in organizing entities which will promote, install, operate and manage the entire process associated with the project, including fish filleting, fish meal processing, meat and bone meal processing, centralized slaughter houses, compounding and wastewater treatment. The entities may be private enterprises, cooperatives and LBDA itself.

REFERENCES

1. LBDA, Fish Filleting and Processing Plant, 1985, Republic of Kenya

2. LBDA, Feasibility Study on Commercial Fish Farming in the Lake Basin Area, March, 1985, Republic of Kenya

3. Japanese Documents and Papers Related to Fish Meal Processing, Rendering Processing and Waste Water Treatment (Unpublished).

4. LBDA, Sector Reports on Agriculture, and Livestock, Integrated Regional Development Master Plan for the Lake Basin Development Area, 1987, Republic of Kenya.

Table 3.1 Rough Estimate of Financial Balance of the Proposed Animal Feed Industry Project (Summary)

(1) Financial balance, except the revenue from the fish feed, and the sales tax on it, for the 20 year period.

(unit: 1000 k£ at 1986 constant price)

(A)	Cost	
	Interest on construction costs and operating fund	20,880
	Depreciation	8,220
	Replacement cost	9,130
	Costs of raw materials	240,480
	Labour cost	19,220
	Other costs	62,300
	Total cost	360,230
(B)	Revenue	
	Fish and animal oil	37,580
	Fish fillet	240,000
	Total revenue	277,580
(C)	Balance	-82,650

(2) Unit production cost of the animal feed.

K£ 148 per ton = ksh. 3.0 per kg

Source: JICA Study Team

Table 3.2 Rough Estimate of Construction Costs

(Unit: US$/K£ 10^3, 1986 constant pric

	Fish fillet & Fish meal 3/	Meat and bone meal 4/	Compound process 5/	Total 1/ US$	Total 1/ K£ 2/
1987	1,200	1,070		2,270	1,820
1988	2,000	2,940	200	5,140	4,110
1989			4,000	4,000	3,200
Total	3,200	4,010	4,200	11,410	9,130

Notes:
1/ Excluding land cost and assuming that electricity and water facilities are available at the factory sites.
2/ 1US$ = 16 Kshs = 0.8 K£
3/ Two factories, and one head quarter building
4/ (1) Four factories, and a head quarter building
(2) 20% of the construction costs of building and waste water treatment facilities which are common to the slaughtering process is allocated to the meat and bone meal process.
5/ Two factoris, and one head quarter building

Source: JICA Study Team

Table 3.3 Rough Estimate of Revenue

(A) Fish and animal oil

(a) The price of fish and animal oil is estimated to be Kshs 9.6 per kg including the import price (C.I.F) and the transportation cost etc, which is set to 20% of the import price.

(b) Total revenue from the fish and animal oil for 20 years:
K£ 37,580 x 10^3 (= 9.6 Kshs/kg x 78,290 tons for 20 years)

(B) Fish fillet

(a) The price of fish fillet is set to be Kshs 20 per kg, taking into account:
- Price of fresh fish (Kshs 5 - 4 per kg)
- Composition of fillet: 40%
- Processing cost and others

(b) Total revenue from the fish fillet for 20 years:
K£ 240,000 x 10^3

Table 3.4 Rough Estimate of the Price of Marketed Fish Feed, Using the Proposed Compound Process Facilities

(A) Condition

(a) Protein content: a little more than 20%

(b) Purchasing price of the agricultural by-product:
1.5 Kshs/kg.

(c) Purchasing price of fish meal: 7.0 Kshs/kg

(d) No operating fund

(B) Cost for coming 20 years (unit: 1000 K£ at 1986 constant price)

Interest on construction cost	2,160
Depreciation	3,020
Replacement cost	3,360
Costs of raw materials	49,000
Labour cost	7,000
Other costs	30,800
Total	95,340

(C) Unit production cost
K£ 170 per ton = KSh. 3.4 per kg

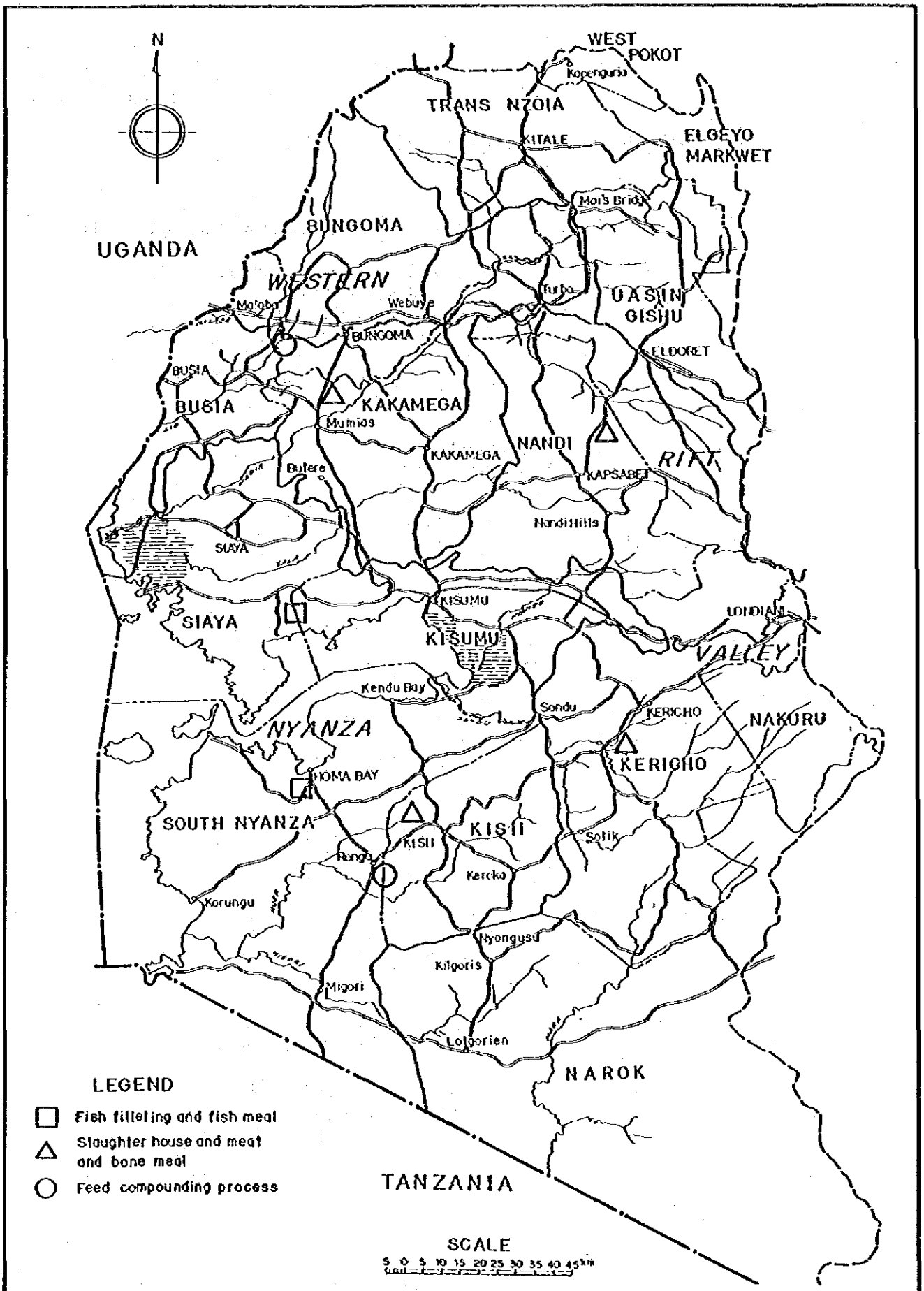


Figure 3.1 Approximate Locations of Plants Related to Animal Feed Industry Project

REPUBLIC OF KENYA LAKE BASIN DEVELOPMENT AUTHORITY
THE STUDY OF INTEGRATED REGIONAL DEVELOPMENT MASTER PLAN FOR THE LAKE BASIN DEVELOPMENT AREA
JAPAN INTERNATIONAL COOPERATION AGENCY

Appendix to Chapter 3:

Rough Estimate of Financial Costs of the Proposed Animal Feed Industry Project

1. Interests

(1) Interest on the total construction cost

(A) Assumed lending conditions:
- Term: 20 years
- Grace period: 5 years
- Annual interest rate: 4%

(B) Formula:

$$I = Z \times Y^P - X^I \quad - \quad (1)$$

I	:	Total interest for the loan term
Z	:	Annual amount of repayment (including the annual payment of interest)
Y^P	:	Repayment period (years)
X^I	:	Total construction cost.

$$Z = X^G \times (1 + r)^{Y^P} \times \frac{-r}{1-(1+r)^{Y^P}} \quad - \quad (2)$$

r	:	Annual interest rate
X^G	:	Total investment cost at the end of the grace period (including the interest during the grace period).

$$X^G = \sum_{t=1}^{Y^C} X^I_t \times (1 + r)^t + Y^C - 1 \quad - \quad (3)$$

X^I_t	:	Investment in year t during the construction period
Y^C	:	Construction period (years)

(C) Calculation of the interest on the total construction cost:
(unit: 1000 K£ at 1986 constant price)

$$X^G = 1,820 \times (1 + 0.04)^7 + 4,110 \times (1 + 0.04)^6 + 3,200 \times (1 + 0.04)^5 = 11,490$$

$$Z = 11{,}490 \times (1 + 0.04)^{15} \times \frac{-0.04}{1-(1+0.04)^{15}}$$

$$= 11{,}490 \times 1.80094 \times \frac{-0.04}{-0.80094}$$

$$= 1{,}033$$

$$I = 1{,}033 \times 15 - 9{,}130$$
$$= 6{,}370$$

(2) Interest on the initial operating fund

(A) Assumed lending conditions:

- Term: 10 years
- Grace period: 5 years
- Annual interest rate: 10%
- The fund is assumed to be raised from domestic financial market. Usually the annual interest rate on the public loan is 14%; however, 10% is assumed in this study from the standpoint of promotion of this project.

(B) Calculation of the interest on the operating fund:
(unit: 1000 K£ at 1986 constant price)

$$X^G = 15{,}570 \times (1 + 0.1)^4$$
$$= 22{,}800$$

$$= 22{,}800 \times (1 + 0.1)^5 \times \frac{-0.1}{1-(1+0.1)^5}$$

$$= 22{,}800 \times 1.61051 \times \frac{-0.1}{-0.61051}$$

$$= 6{,}015$$

$$I = 6{,}015 \times 5 - 15{,}570$$
$$= 14{,}510$$

(3) Total interest on the construction cost and the operating fund for 20 years.
(unit: 1000 K£ at 1986 constant price)

On construction cost	6,370
On operating fund	14,510
Total	20,880

2. Depreciation

(A) Assumptions:
- Life of the facilities: 20 years
- Scrap value of the facilities at the end of the life : 10% of the book value

(B) Total depreciation allowance for 20 years:
(1000 K£ at 1986 constant price)

$9{,}130 \times (1.0 - 0.1) = 8{,}220$

3. Replacement cost

(A) Assumption:
- Annual replacement cost is 5% of the initial investment.

(B) Total replacement cost over 20 years:
(1000 K£ at 1986 constant price)

$9{,}130 \times 0.05 \times 20 = 9{,}130$

4. Costs of raw materials

(1) Cost of meat and bone meals to be imported

(a) Total volume of the import for 20 years

1990 - 2005	0	metric tons
2006 - 2009	4,800	metric tons
Total	4,800	metric tons

(b) Price: 7 Kshs/kg

(c) Total cost for 20 years: K£ $1{,}680 \times 10^3$

(2) Costs of fresh fish to be purchased

(a) Total volume to be purchased for 20 years
600,000 metric tons(= 30,000 x 20)

(b) Price: 6 Kshs/kg (higher than the present price of about 5 Kshs/kg, 1986)

(c) Total cost over 20 years: K£ $180{,}000 \times 10^3$

(3) Costs of agricultural byproducts to be purchased

(a) Total volume of products to be purchased for 20 years

1990 - 2005	280,000 metric tons
2006 - 2009	112,000 metric tons
Total	392,000 metric tons

(b) Price: 3 Kshs/kg

(c) Total cost for 20 years: K£ 58,800 x 10^3

(4) Total costs of raw materials for 20 years
(Unit K£ 10^3, at 1986 constant price)

Raw materials to be imported	1,680
Fresh fish to be purchased	180,000
Agricultural by-products to be purchased	58,800
Total	240,480

Note: No charge on the inputs to the fish meal, and meat and bone meal processes is assumed.

5. Labour cost

(A) Fish fillet and fish meal factories

(a) Annual labour costs

Headquarters	K£45 x 10^3
2 factories	K£305 x 10^3

(b) Total labour cost for 20 years
K£ 7,000 x 10^3

(B) Meat and bone meal process factories

(a) Annual labour costs

Headquarters	K£ 45 x 10^3
4 factories	K£ 216 x 10^3

(b) Total labour cost for 20 years
K£ 5,220 x 10^3

(C) Compound process factories

(a) Annual labour costs

Headquarters	K£ 45 x 10^3
2 factories	K£ 305 x 10^3

(b) Total labour cost for 20 years

K£ 7,000 x 10^3

(D) Total labour costs for 20 years

(Unit: 1000 K£ at 1986 constant price)

Fish fillet and fish meal	7,000
Meat and bone meal	5,220
Compound process	7,000
Total	19,220

(Source: Feasibility Study on Fish Filleting and Processing Plant, 1985)

6. Other costs

(A) Fish filleting and fish meal factories

(a) Packing materials

- The cost of packing materials accounts for 5% of the price of the finished goods.
- The total cost of the packing materials for 20 years:
  K£ 12,000 x 10^3

(b) Transportation cost, electricity and water

- The cost per 1 MT of raw materials is estimated to be Kshs. 600, the most part of which is the transportation cost.
- The total cost for 20 years:
  K£ 18,000 x 10^3

(B) Meat and bone meal factories

(a) Packing materials: negligible

(b) Transportation cost, electricity and water

- The cost is estimated to be the one-twelveth (1/12) of the cost for the fish filleting and fish meal factories.
- The total cost for 20 years:
  K£1,500 x 10^3

(C) Compound process factories

(a) Packing materials

- The cost of packing materials per bag (20 kg/bag) is assumed to be Kshs 10, taking into account that pack with relatively high quality is required to keep the fish feed in good condition.

. The total number of bags to be shipped for 20 years

1990 - 2005	$20{,}000 \times 10^3$ bags
2006 - 2009	$8{,}000 \times 10^3$ bags
Total	$28{,}000 \times 10^3$ bags

The total cost for 20 years. K£ $14{,}000 \times 10^3$

(b) Transportation cost, electricity and water

. The cost per 1 MT of the finished goods is estimated to be Kshs.600.

. The total production volume for 20 years

1990 - 2005	400,000 metric tons
2006 - 2009	160,000 metric tons
Total	560,000 metric tons

. The total cost for 20 years K£ $16{,}800 \times 10^3$

(D) Total other costs for 20 years
(unit: 1000 K£ at 1986 constant price)

Packing materials	26,000
Transportation cost, electricity and water	36,300
Total	62,300

(Source: Feasibility Study on Fish Filleting and Processing Plant)

7. Operating fund

(a) It is assumed that an operating fund should be raised corresponding to the costs generated in 1990, i.e the first year of the operation.

(b) The costs is estimated to be incurred in 1990:
(unit K£ 10^3, at 1986 constant price)

Interest on the construction cost	-
Depreciation	-
Replacement	460
Cost of raw materials (fresh fish and agricultural byproducts)	10,050
Labour cost	960
Other costs	2,130
Sales tax	1,970
Total	15,570

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