



MINISTRY OF AGRICULTURE
LIVESTOCK AND FISHERIES
STATE DEPARTMENT OF LIVESTOCK



Dairy Production Structures Manual

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1.0 Introduction

1.1 Structures in a smallholder dairy production context

Various structures are required in dairy rearing systems, including animal housing, feeding and feed storage structures. Dairy structures are useful for:

- i. Promoting easy handling of animals (using the crush)
- ii. Confining animals to keep them away from crops
- iii. Providing clean and hygienic conditions (e.g. for milk production)
- iv. Close monitoring of animal status
- v. Controlling/monitoring exposure to disease and disease vectors
- vi. Reducing feed wastage
- vii. Enhancing security of the animals
- viii. Enhancing manure collection
- ix. Safekeeping of feed

This manual describes the various types of dairy structures: zero grazing units, milking parlours/sheds, calf pens, crush pens, including feed, water and mineral troughs. It also describes benefits and the resources needed for their construction.

1.2 Challenges

Smallholder dairy farmers normally work with limited resources including land. This poses challenges related to space for construction of dairy structures. The mainly resource-poor farmers also face limitations in terms of meeting costs associated with putting in place the required dairy structures. Most smallholder farmers also lack technical skills that are necessary to optimally work with their little resources to provide the appropriate dairy structures. This is because most technical manuals feature standard recommendations that are not convenient in the context of smallholders.

1.3 Objective

The objective of this manual is therefore to provide simple, applicable and appropriate technical information for use by farmers and extension agents in choosing, designing and using smallholder dairy structures. The manual does not extensively address the aspects of farm planning. Towards this end, it is suggested that farmers can seek individual farm-specific advice and plans from the livestock extension agents.

2.0 Zero Grazing Unit

2.1 Description of a zero grazing unit

Under the zero-grazing system, cattle are confined in one place where feed and water are brought to the animals. Other animal husbandry activities such as animal health, are also carried out under zero grazing. Zero-grazing is a good system for keeping dairy cattle in densely populated, high potential areas, where land per farm family is small. Other dairy cattle rearing systems which also require housing are semi-zero grazing and free grazing. Different dairy cattle rearing systems have different requirements for housing although they share some common needs.

In this booklet, explanations are given about the layout and construction of a zero-grazing unit. The guidelines contained here are mainly for farmers in high potential areas of Kenya. Because of climatic difference between the Coastal strip and the highland areas, a separate booklet has been prepared for farmers at the Coast.

2.1.1 Parts of a zero grazing unit

The basic parts in a semi-zero-grazing system are the feed and water troughs and the milking place. The cubicles and walking area are optional. These options, in both zero-grazing and semi zero-grazing systems, are necessary when the farmer has inadequate finance and cannot meet the labour and high skills demanded by the zero-grazing option.

The parts of a zero grazing unit can best be summarized in a table form as follows:

Table 1: Parts of a zero grazing unit

Basic (Essential) parts:	Basic (Essential) Parts
1. The cubicles	7. The store
2. The walking area	8. The manure storage
3. The feed and water troughs	9. Fodder cutter
4. The milking place	10. Roof water catchment
5. The calf pen	11. Water tank
6. The fodder chopping area	12. A holding crush

2.1.2 Cubicles (resting area)

Each cow has her own place in the resting area, called cubicle. The cubicles must be covered with a roof of mabati (iron sheets), grass thatch or makuti. A roof must be high enough so that it cannot be eaten by a cow if it is made of grass or if hay is stored under it. The measurements of the cubicle are very important. It should not be too small for the cow or too big to allow the cow to turn around inside the cubicle. The cubicle should be constructed such that the cow remains clean all the time.

One should construct a number of cubicles enough to be occupied by animals most of the time. Unoccupied cubicles are a waste of space and money. For a given number of cows to a unit, extra cubicles are required to house young-stock (heifers). If young bulls are to be kept inside the unit (although this is not recommended), then they must be provided with cubicles. When the bull matures, it is better to house it away from the unit.

Below is a list of the recommended number of cubicles for a given number of cows (including followers – heifers or bulls):

Table 2: Number of cows and corresponding cubicles

Number of Cows:	Number of cubicles:
1 cows	2 cubicles
2 cows	3 cubicles
3 cows	5 cubicles
4 cows	6 cubicles
5 cows	7 cubicles
6 cows	9 cubicles

A mineral box can be fixed at the head of each cubicle for individual mineral supply to each cow. This can limit fighting among cows and between cows and young stock for access to the mineral. The recommended measurements for a cubicle are based on pure breed cows (Friesians and Ayrshires). The reason for this is because pure breeds give the highest economic returns in a zero-grazing system. They are therefore used as the standard. A cubicle has a length of 210 cm (7ft) and a width of 120 cm (4 ft). Cubicles are separated from each other by two timbers. If the cows are small in size (i.e. Jerseys), the measurements can also be smaller (6'6" x 3'7"). However, it is much better to use the above standard measurements for a cubicle because the size fits most animals. The standard cubicle can also be adjusted to fit smaller breeds whenever necessary. They can therefore be used for both larger and smaller breeds as need arise.

The floors of the cubicles are raised and filled with plain soil such as murrum. A soft bedding provides comfort to a cow and prevents wounds on its skin. In this way, the animal has a comfortable place which is cheap and easy to maintain. Do not make the floor of a cubicle with concrete. If this is done, then fill the cubicles with saw dust. The resting area is roofed to provide shelter against rain and sunshine. A neck-pole is fixed across the cubicle. This prevents the cow from entering too far into the cubicle and ensures that the urine and dung will drop on the walking area. The cubicle and the cow then remain clean. Young animals should be separated from the milking cows. This will ensure no fighting occurs between young animals and cows. Cubicles for young animals should be adjusted according to their size by moving the neck-poles backwards to make the cubicles shorter. An extra timber can also be added lengthwise to make each cubicle narrower.

2.1.3 Walking area

The walking area is about 3 meters wide i.e. between the resting area and there the feed and water troughs are located. No roofing is required for this area except under very hot conditions like in the Coastal region. The floor of the working area is made of concrete. This makes it possible to collect urine and manure. The floor and the cows are also kept clean. The surface of the floor should be rough so that animals cannot slip on it. But it should be easy to clean. The floor should slope from the milking place towards urine and dung collecting pit located at one end of the walking area. The slope should allow for easy cleaning of the milking and walking area.

2.1.4 Feed and water troughs

The feed troughs should run along the length of the walking area with a water trough in the middle. The total length of the feed trough should be such that each cow or heifer has two and a half to three (2.5-3) feet to itself. The water trough should be placed such that both the young stock and the mature cows have access to it instead of constructing separate trough for each side (the unit divided to separate young and mature stock). Fighting between young stock and cows will not occur due to the boundary created between them. Fighting can also be prevented to constructing vertical poles along the inside of the feed trough at intervals of 2.5 to 3 feet. A horizontal line of timber is nailed along the vertical ones at 3 feet above the feed trough. Each cow then has its own feeding space.

The trough can be made of timber or stones. For water, a half drum can be used, each for two cows, instead of constructing a trough. For more than two cows more drums are used as necessary so that water and enough space for each animal is available. If sufficient funds are available both feed and water troughs can be made of bricks and cement (assuming that concrete is more costly in relation to costs of drums and timber). The choice of the materials used for making troughs depends on the costs and availability of materials.

The inside measurements of the feed trough should be 60 cm (2 ft) wide at the bottom and should be raised at least 15 cm (1/2 ft) above the ground level of the walking area. The feed trough should not be too deep or cows will have difficulty reaching feed at the bottom. If it is too shallow, spillage and wastage of feed will occur. The trough is constructed such that its outside is raised to prevent spillage of feed. A mineral box should be placed centrally in the walking area if not already placed at the head of the cubicle for each animal. This will make it easy for all animals to reach the mineral box.

2.1.5 Milking area

The milking area should be constructed next to the cubicles. It should also be of same dimensions as cubicles i.e. 120 cm (4 ft) by 210 cm (7 ft). The floor should be flat and made of firm concrete and slope towards the walking area. The direction of slope of the floor would ensure that dirt collected from the floor can flow through the walking area onto the manure pit.

There should be a feed trough at head of milking area for feeding the cows during milking. The milking area should be kept clean. Noise during milking may disturb the cow making it hold back some of her milk. For a zebu cow, a calf pen should be constructed next to the milking area. This is because most zebu cows let milk down only-when they see their calves. A head yoke is constructed to restrain the animal during milking. Milking area is not optional under semi-zero grazing system. If a farmer chooses to make it optional, then clean milk production is not guaranteed.

2.1.6 Calf pen

Calf housing is recommended where free suckling is not permitted like in the case of zero-grazing system. The calf pen is situated opposite the milking place. It has a floor surface of 120 cm by 150 cm (4x5 ft). A calf pen can also be situated on the side of a cubicle or milking place. This depends on the type of unit and whether zebu, cross breeds or pure dairy cattle are kept. The floor of the calf pen should be slatted and raised by half to one (1/2-1) foot above the concrete floor. The raised and slatted floor makes it easier to clean the calf pen floor and the concrete under it. The floor under the slats can be concrete or not.

The sides should be open to allow for free air flow around the calf pen. They should also be high enough to contain the calf inside. The calf pen can be movable or fixed. The advantage of a movable calf pen is that it can be taken to the family house, for example when the weather is too cold. Beddings are not recommended for a calf pen. They can encourage parasites resulting to disease condition and/or infection of the calf.

2.1.7 Fodder-chopping area

This place is for a fodder chopping equipment (chaff cutter) and the chopped fodder. It is situated opposite the store next to the calf pen. It is also placed under the roof. The fodder chopping area floor can be made of concrete to avoid the feed getting mixed with soil.

A fodder chopper is recommended if there are more than three cows in the unit and where labour on the farm, is generally inadequate. One can chop napier grass or any other fodder in an open space next to the unit, therefore, a fodder-chopping area is optional.

2.1.8 Store

If required, a store can be attached to the zero-grazing unit next to the milking place and opposite the fodder-chopping area. In this way, concentrates, minerals, milk utensils and other small equipments can be stored near to the animals. A store is optional where finances are inadequate. It can however be built later-on when funds are available. Inputs like dairy meal and drugs are kept in the living house before a store is built. When building a store, rainwater collection facilities and cemented floor are optional.

2.1.9 Slurry pit (manure collection)

The slurry can be stored in a small pit dug out of the soil. The pit may or may not be cemented. Manure can also be stored as compost made from dung, urine and plant materials. In this case the compost is heaped next to the unit. Compost may be covered with soil or plastic. The dairy or livestock extension officer will provide the right measurements for the size of the pit to hold slurry (manure) for at-least two days for any number of cows in the unit.

2.2 Advantages of zero grazing

The main advantages of the zero-grazing system are:

- Cows are confined and therefore use most of the energy from feeds for growth and milk production.
- Saves land for other enterprises by allowing the use of high yielding fodder crops like napier
- Clean milk production is possible.
- Good calf rearing is possible
- Manure can be easily collected for the benefit of fodder crops
- The animals are better protected against diseases, especially tick-borne diseases.
- Close observation of the animals is possible, making heat detection and attendance to animals easier and faster.
- The animals are kept inside which is more secure and protect them from attack by predators
- Little or no time is spent on herding the animals. Therefore labour for other farm tasks is saved.

2.3 Disadvantages of zero grazing

The disadvantages of the zero-grazing system are:

- Much labour is required to take feed and water to the animals.
- Much capital is required for construction of a 'zero-grazing unit.
- The possibility that animals are stressed because of too much confinement inside the zero grazing unit is introduced by the National Dairy Development Project (NDDP) consists of the following parts listed below, some of which are optional.

Zero-grazing system requires intensive (a lot of) labour for cutting and carrying napier grass, milking and a carrying water and other feed materials to the animals. This means that the tasks of some of the family members may increase. Proper planning is therefore required before starting a zero-grazing system. This will enable the farmer to appreciate the high financial and labour demands of zero-grazing before getting involved.

Because zero-grazing requires a lot of money (capital) for the construction of the unit, it can be done in steps by first constructing the essential parts of a zero-grazing unit. Other parts can be added later-on as money becomes available. One option is starting with semi-zero grazing as a first step before turning to full zero-grazing unit. This can be the case where farm size is large enough to allow for range grazing.

2.4 Considerations for construction of a zero grazing unit

The following are strongly-recommended as considerations during construction of a unit:

- i. Ensure that the fundi (constructor) is supervised by a Livestock Extension Officer during the construction of the unit. This is necessary because some parts (ie walking area, troughs) once constructed are permanent. Mistakes made during construction can be very costly.
- ii. Ensure that the correct site, considering the direction of wind, is chosen for the unit. The choice of site influences the security and protection of animals from rain, sunshine and other weather effects.
- iii. The unit should be closer to the house and on the opposite side of the wind. The location of the unit in relation to the house should ensure minimal smell from manure pit. It should be noted that it is more important to protect an animal from the rain than from wind or sunshine.
- iv. Use of local materials for construction of the unit will reduce cost.
- v. Finally, one should as much as possible, carry out regular maintenance of the zero-grazing unit while in use. This is usually very important for the walking area.

2.5 Construction plans and designs of a zero grazing unit

i. Plan view – zero grazing units with 3 cubicles

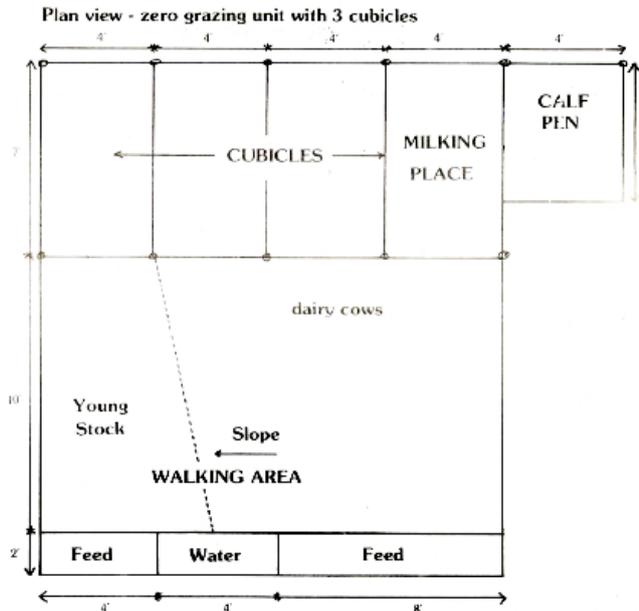


Figure 2.1 Plan view – zero grazing unit with 3 cubicles

ii. Plan view – zero grazing unit with 5 cubicles

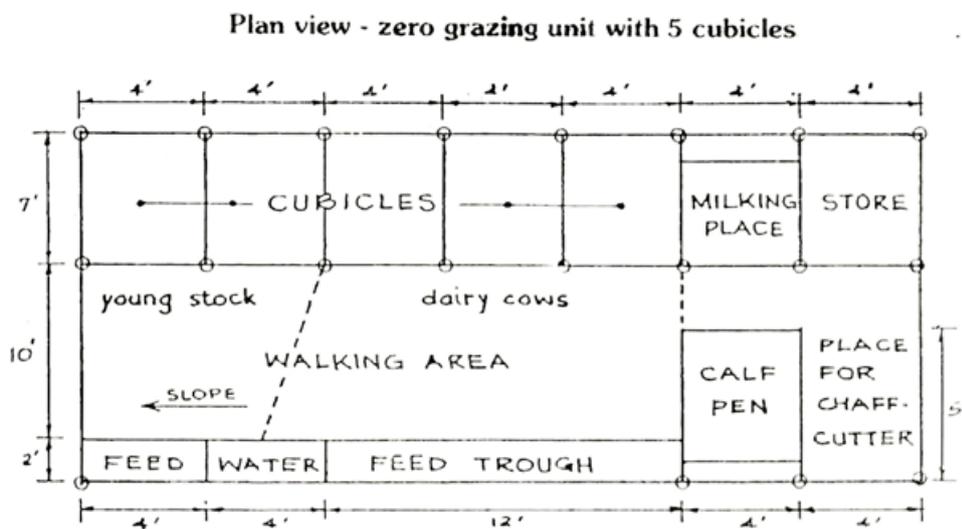


Figure 2.2 Plan view – zero grazing unit with 5 cubicles

iii. Side view-zero-grazing unit

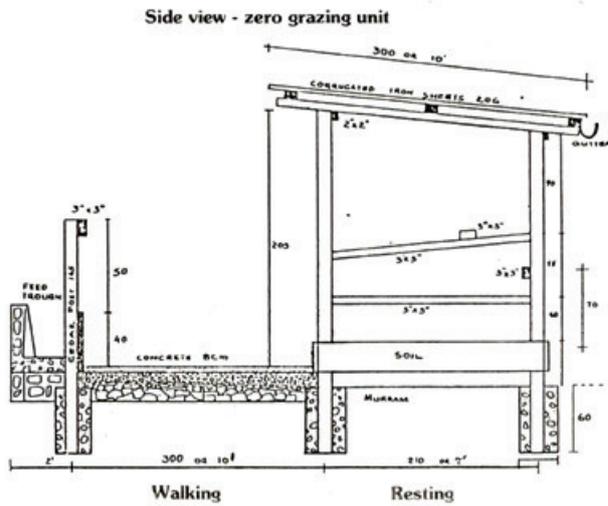


Figure 2.3 Side view-zero-grazing unit

iv. The view of a head Yoke

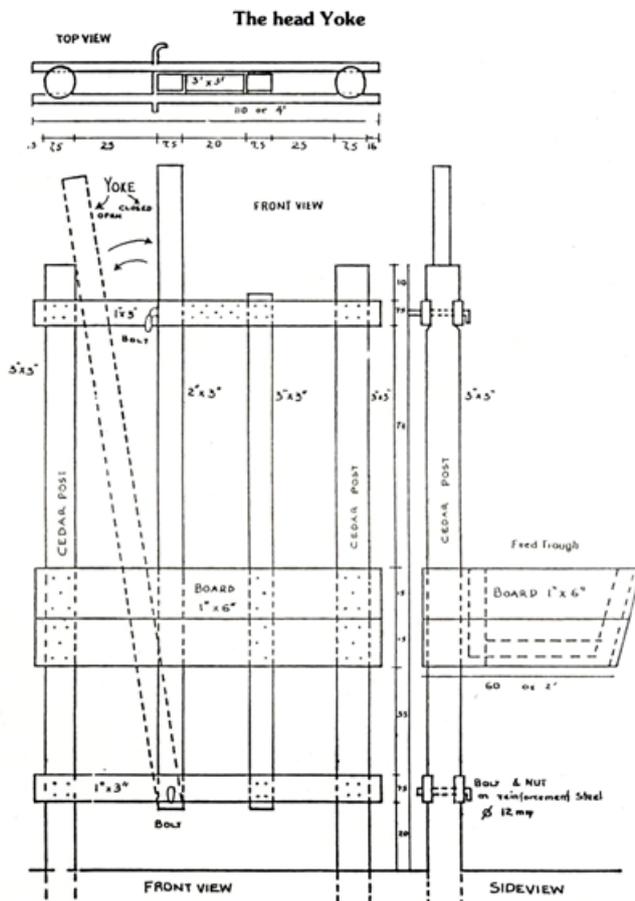


Figure 2.4 View of a head Yoke

v) The view of a calf pen

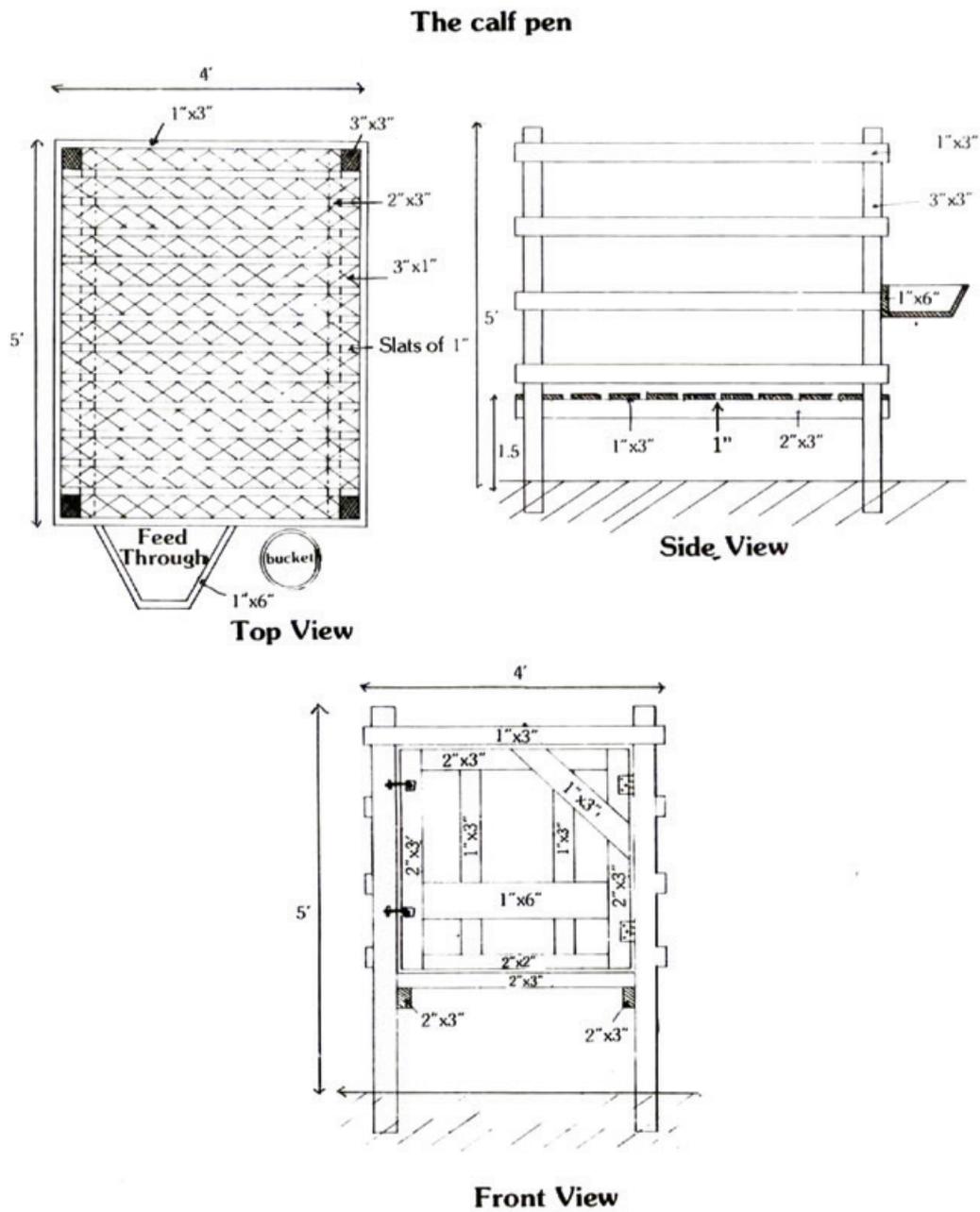


Figure 2.5 View of a calf pen

2.6 Construction materials required for of a zero grazing unit

Table 2.3 Materials for a zero grazing unit

Material	Quantity	
	3 cubicle	5 cubicle
Strong posts (FT)		
10	3	3
9.5	3	3
9	8	10
8.5	6	8
6	5*	6*
Timber (RFT)		
4"x2"	190	250
3"x2"	330	370
2"x2"	100	100
3"x1"	13	13
8"x1"	15	15
Cement (Bags)	12	15
Iron Sheet (3M)	13	17
Ballast	4m ³ (1/2Lorry Load)	4m ³ (1/2Lorry Load)
Hardcore	3m ³ (1/2 Lorry Load)	3m ³ (1/2 Lorry Load)
Sand	3.5m ³ (1/2 Lorry Load)	3.5m ³ (1/2 Lorry Load)
Nails (Kg)		
4"	3.5	3.5
3"	3.5	3.5
2"	2	2
Roofing nails	2	2
Additional materials for unit with roofed feeding area		
Strong posts		
7 ^{FT}	2	3
6.5 ^{FT}	3	5
Timber		
3"x2"	52	80
Iron Sheet	2	3

* For a unit with a roofed feed area only 3 of the 6^{FT} posts are required.

The Coastal region is very different climatically from the high potential areas where zero-grazing system is practiced. For this reason a specific booklet giving guidelines for the construction of a zero-grazing unit is available for farmers at the Coast. To prevent high investment costs, it is advisable to make use, as much as possible, of local materials and where possible from the farm. The cows will not notice the difference and will be equally productive.

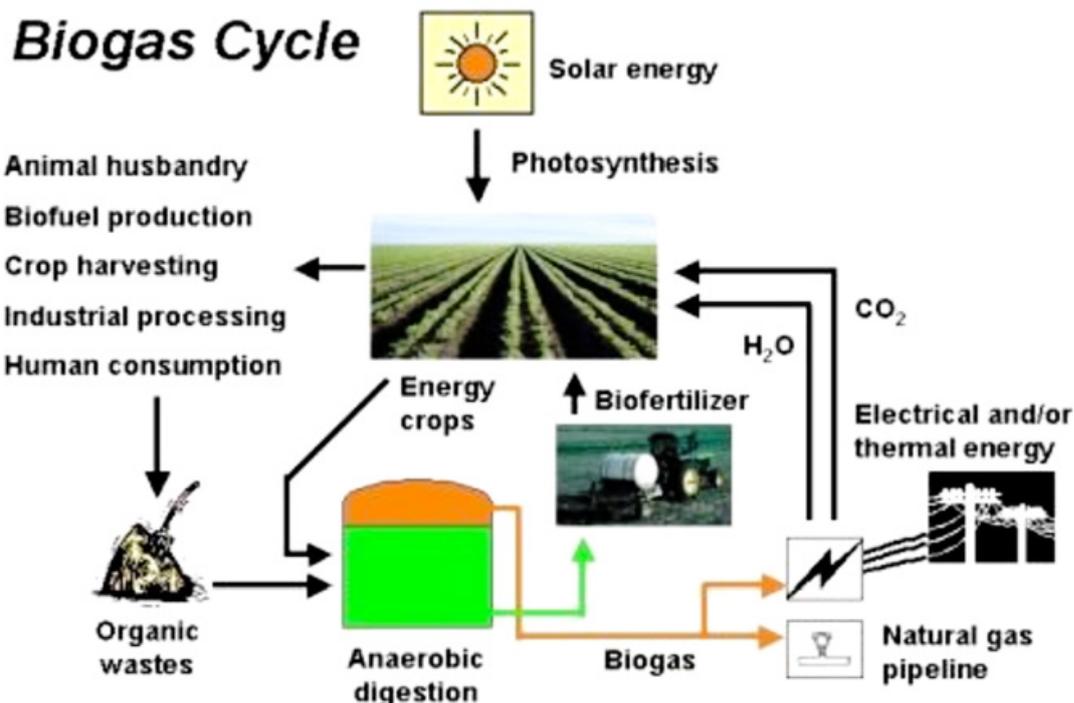
2.7 Biogas technology

2.7.1 Description of biogas unit

Biogas is the gaseous emissions from anaerobic degradation of organic matter (from plants or animals) by a consortium of bacteria. Biogas is principally a mixture of methane (CH₄) and carbon dioxide (CO₂) along with other trace gases. Methane gas, the primary component of natural gas (98%), makes up 55-90% by volume of biogas, depending on the source of organic matter and conditions of degradation.

2.7.2 Importance

Biogas is used for cooking to minimise use of firewood and helps in minimising on environmental degradation through tree cutting. It can also be used for lighting in houses. The slurry can be used as an organic fertilizer on the farm after it has produced the gas.



2.7.3 Design

The biogas designs commonly used in Kenya are fixed dome, floating and plastic biodigesters. The choice of design and size of biogas unit depends on the financial ability of the farmer and the quantity of feeder material (primarily dung) available on the farm. The fixed dome design is most popular among smallholder dairy farmers due to its relative durability and physical security.

2.7.4 Materials and costs

No	Sizes	6M ³	8M ³	10M ³	12M ³	16M ³
	No. of cows	2-3	3-4	4-5	5-6	10 and above
	MATERIALS					
1	Cement bags (Bamburi)	20 bags	22 bags	24 bags	26 bags	30 bags
2	River Sand	6 tons	7 tons	7 tons	7 tons	10 tons
3	Bricks (4x6x9)	1,000	1,200	1,350	1,500	1,800
4	Ballast (1/2"+3/4")	2 tons	3 tons	3 tons	3 tons	4 tons
5	Water Proof cement (England)	6Kg	8 Kg	10 Kg	10Kg	14 Kg
6	PVC waste pipe 4" medium gouge	1pcs	1pcs	1pcs	1pcs	1pcs
7	Dome pipe	1pcs	1pcs	1pcs	1pcs	1pcs
8	Timber 2"x 2"	6ft	7ft	8ft	9ft	12ft
9	R6	3pcs	3pcs	3pcs	5pcs	6pcs
10	Y8	2pcs	2pcs	2pcs	2pcs	3pcs
11	Y10	3pcs	3pcs	3pcs	3pcs	3pcs
12	Weld mesh	2pcs	2pcs	2pcs	2pcs	2pcs
13	G.I Pipe ¾"	1pcs	1pcs	1pcs	1pcs	1pcs
14	3ply	1pcs	1pcs	1pcs	1pcs	1pcs

15	Binding wire	2Kg	3Kg	3Kg	3Kg	4Kg
16	Ball corks 1" (Pegler)	1pcs	1pcs	1pcs	1pcs	1pcs
17	Ball corks ½" (Pegler)	1pcs	1pcs	1pcs	1pcs	1pcs
18	Gas cooker (double)	1pcs	1pcs	1pcs	1pcs	1pcs
19	Average Excavation Costs					
20	Technical Labour					
21	Appropriate Total Cost Depending On Areas					

Piping: No. of pipes and its fittings depends with distance of Biogas plant to the kitchen

3.0 Milking Parlour/Sheds

3.1 Description of a milking parlour

This is where a cow is restrained for milking. It can be fixed in a zero grazing unit or in the open field (or under a semi-zero grazing system) where cows are milked from. It can also be mobile/movable. A good milking parlour/shed should be easy to clean and should be constructed along the prevailing wind direction.

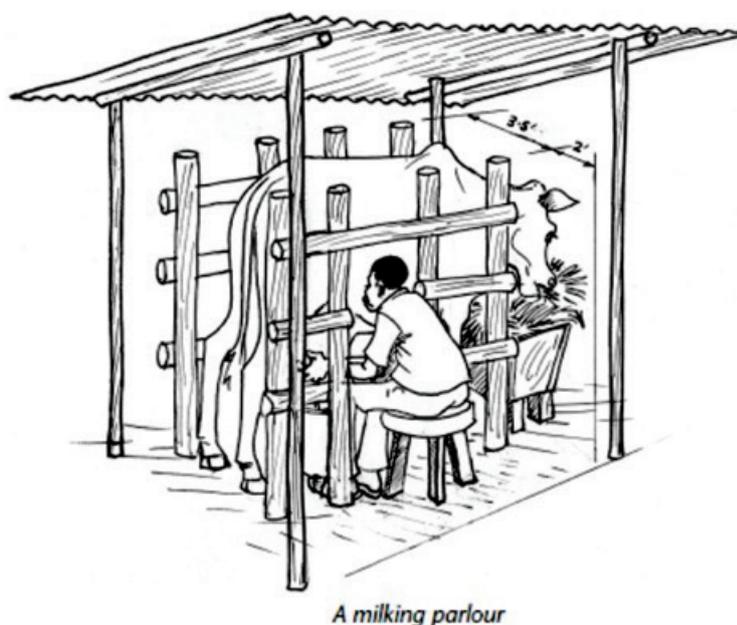


Figure 3.1 Milking parlour

3.2 Importance

- Facilitates easy and faster milking process.
- Enhances clean milk production
- Milking can be done even during rains

3.3 Materials and costs

Costs for a fixed milking parlour within a zero grazing unit can be worked out according to the materials using the estimated quantities given below. The farmer should consult a local artisan to estimate requirements for a given milking parlour plan.

Table 3.1 Bill of quantities

S/NO	Item	Unit	Quantity	Unit Price	Total Cost
1	Posts	10 Feet	2		
2	Posts	8 Feet	2		
3	Timber 3x3	Feet	35		
4	Timber 2x2	Feet	15		
5	Iron Sheets (3m Gauge 30)	No	2		
6	Cement	Bags	1		
7	Ballast	Wheelbarrows	3		
8	Sand	Wheelbarrows	2		
9	Ordinary Nails 3"	Kg	0.5		
10	Ordinary Nails 4"	Kg	0.5		
11	Roofing Nails	Kg	0.25		
12	Hard Core	Wheelbarrows	5		
13	Timber For Neck Yoke (3"X2")	Feet	20		
14	Bolt	No	2		
15	Feed Trough (12"X1")	Feet	15		

NOTE

1. Concrete mixing ratio:1 bag cement+2 wheelbarrows sand+3 wheelbarrows ballast.
2. Movable parlour: exclude cement , ballast, hard core and sand.

4.0 Calf Pens

4.1 Description

This is a specially designed unit to house a growing calf. It can be fixed (within or separate from the zero grazing unit) or movable (common in ranches and free grazing systems). A calf pen allows close and frequent monitoring of the calf, eases planning and monitoring of the feeding regime and supports high standards of hygiene and disease control. However, it is a labour-intensive choice, since the calf is fully dependant on the stockowner for feed and water.

4.2 Importance

- i. Protection from adverse weather conditions and predators,
- ii. Avoid internal and external parasites
- iii. Control feeding and management.
- iv. Allows monitoring by close observation

When it is not possible to have individual calf pens then group housing can be done though there are several disadvantages including:

- i. Difficulty in feeding and management.
- ii. Disease control is difficult.
- iii. Decreased growth rate due to fights among calves
- iv. Calves suckling each other which could lead to ingested hair (tend to form hairballs).

4.3 Siting

- i. It is normally placed inside the roofed and walled section of the zero grazing units.
- ii. can be situated on the side of the cubicle or opposite the milking place
- iii. It may be permanent or movable.
- iv. Can also be build as a separate structure away from milking cows where calves are many
- v. Should face away from the winds but allow free air circulation

4.4 Materials

- i. A calf pen should be constructed where possible from locally available materials.
- ii. The sides (walls) can be made of concrete or wooden poles or steel poles
- iii. Floor for fixed pens should be of concrete with bedding or wooden slats
- iv. Movable pens can have a raised slatted floor (or an earth floor if the site has good drainage)
- v. Roof: should be of corrugated iron sheets or thatch.
- vi. Walls: wooden poles from farm timber or steel poles

4.5 Design

Should allow for:

- i. Approximately 2 m² (1.2 X 1.5m) space per calf
- ii. Proper draining or bedding
- iii. Proper lighting (artificial or natural).
- iv. Proper ventilation; be at least 1 foot from the ground.
- v. Enough strength against predator invasion.
- vi. Ease of cleaning ;especially when a new is introduced

The required minimum internal dimensions for an individual calf pen are

- i. 1200 by 800mm for a pen where the calf is kept up to two weeks of age,
- ii. 1200 by 1000mm where the calf is kept to 6 to 8 weeks of age and
- iii. 1500 by 1200mm where the calf is kept from 6 to 14 weeks of age.
- iv. Three sides of the pens should be tight to prevent contact with other calves and to prevent draughts. Draughts through the slatted floor may be prevented by covering the floor with litter until the calf is at least one month of age.

The front of the pen should be made so that the calf can be fed milk, concentrates and water easily from buckets or a trough fixed to the outside of the pen and so that the calf can be moved out of the pen without lifting.

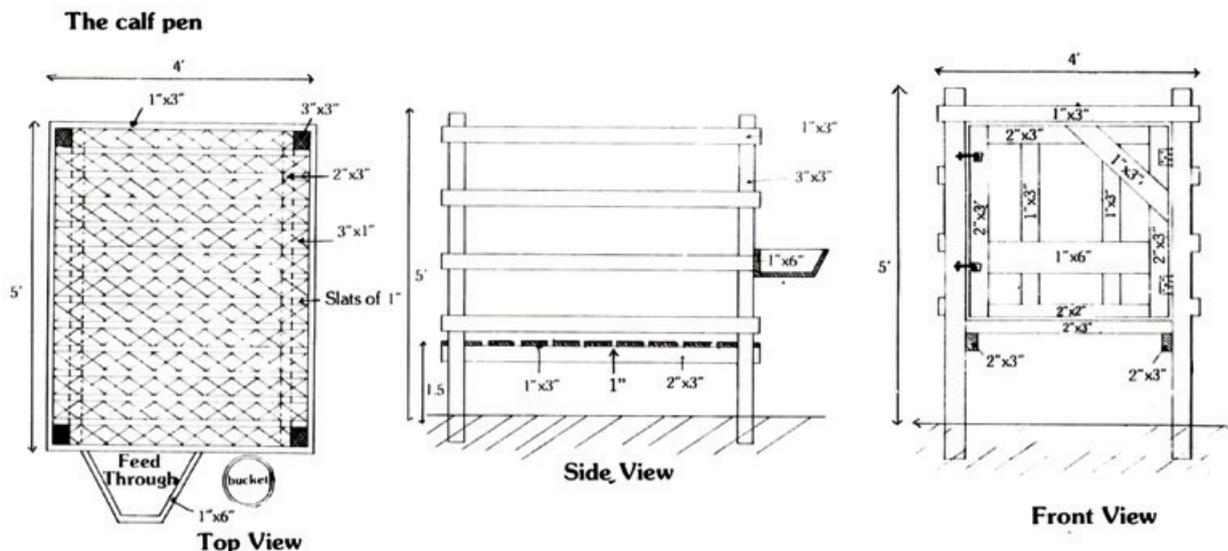


Figure 4.1 Calf pen plans



Figure 4.2 Illustration of a calf pen

4.6 Economics

Costing for the calf pen can be worked out according to the available materials and labour. For example, the BQs for one calf pen can be as below:

Materials	Size	Quantity
Timber	5cm x 5cm (2"x2")	6 meters
Timber	5cm x 2.5cm (2"x1")	30 metres
Offcuts	Average 305cm (10ft)	1 piece
Iron sheets	91.5 cm (3ft) wide	1 or 2metres (30gauge)
Nails	7.6cm (3")	0.5kg, Handful of roofing type
Hard cores		5 wheelbarrows
Ballast	2.5cm (1")	3 wheelbarrows
Cement		1 bag
Sand		2 wheelbarrows
Concrete mixing ratio: 1 bag cement 2 wheelbarrows sand 3 wheelbarrows ballast		

5.0 Crush Pens

5.1 Description

This is a separate place for restraining an animal so that regular management practices (e.g. administering injections, deworming and hand spraying with insecticide) can be undertaken safely. Crush pens can be erected within or outside the zero grazing unit. Crush pens allow the stockowner to have close contact with the animal without risk of injury. It is also easier to make observations (external and internal organs) and administer drugs. However, the maintenance/repair costs will be high if constructed using fragile materials.

5.2 Importance.

- i. Restraining of the animal for easy handling by the owner or the livestock attendance that allows for;
 - Administration of drugs e.g. dewormers and other oral drugs,
 - De worming, hoof trimming, ear tagging, branding etc,
 - Easy handling during calving,
 - Inspection /examination of the cow both externally and internally,
- ii. Breeding purposes(A.I. and Bull service),
- iii. Disease control (Spraying, vaccinations and treatment),
- iv. Safe-guarding the livestock owner or handler from risk of injuries.

5.3 Sitting

- i. The crush should be way from the Zero grazing unit on the leeward side.
- ii. Construction of the Crush pen to be done in to the direction of the wind.
- iii. It should be over 40m from the homesteads/neighbours.
- iv. It should be away from the milking area because milk is a good absorber of odour from the surrounding.

5.4 Materials and costs

Always use locally available materials. These include poles (roundish),frames ,Nails etc.

No.	MATERIAL	SIZE	QUANTITY	UNIT COST (Kshs)	TOTAL COST (Kshs)
1	Timber	3"x2"	48 Rft of 6 pieces		
2	Poles	6"x6'	10		
3	Nails	4"	0.5 kg		
4	Hard core	Assorted	4 wheelbarrows		
5	Ballast	2,5cm(1")	4 wheelbarrows		
6	Cement	-	1 bag (50kg)		
7	Sand	-	2 wheelbarrows		
8	Transport costs	-	-		
9	Labour	-	-		
Total costs					

Note: Costs of materials vary from place to place and from time to time. The farmer is advised to use locally available materials to save on cost of construction.

Assumptions

- i. Cedar posts are locally available but may use treated poles.
- ii. It is recommended that the floor be firmed (cemented) for durability.

5.5 Design

There are two types of designs. The V-shape and vertical shape.

V-shape structural designs as shown below:

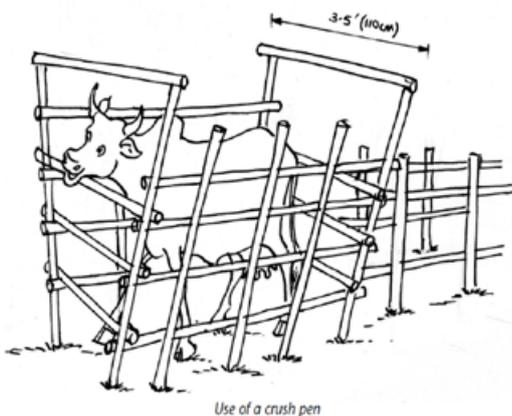


Figure 5.1 Illustration of a crush pen

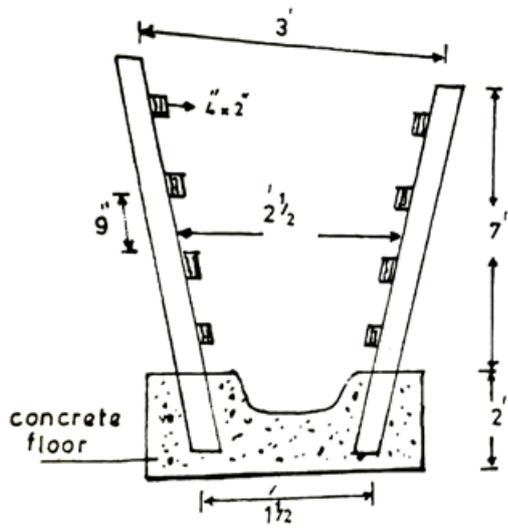


Figure 5.2 Side elevation of a crush pen

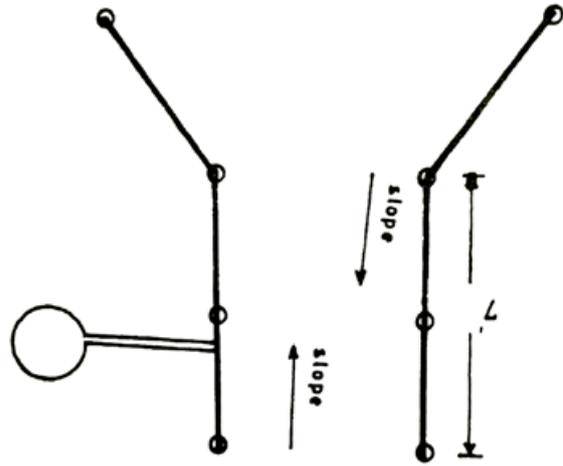


Figure 5.3 Floor plan of a crush pen

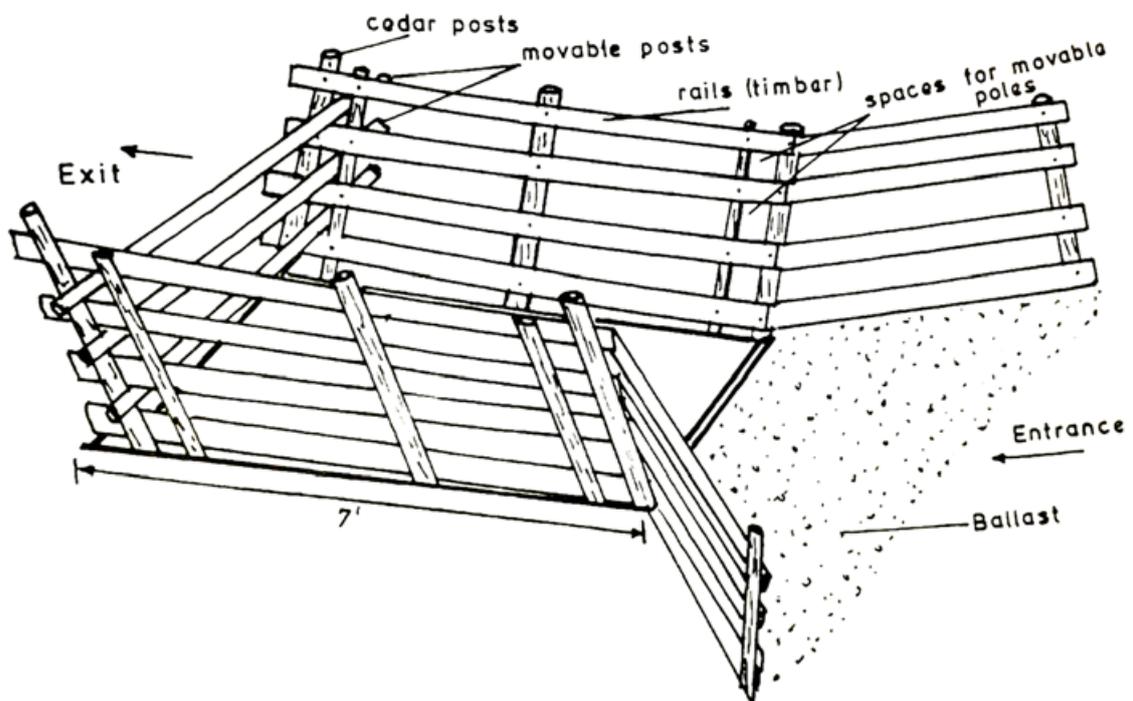


Figure 5.4 Vertical structural design of a crush pen

Note

- i. The V-shape design allows for comfort of animal and the handler
- ii. Vertical shape more restraining but discomfort to the co

6.0 Storage Structures

6.1 Hay Barn

6.1.1 Description

A hay barn is used to store hay in (bales or loose), it is a simple structure constructed using locally available materials. A hay barn is useful to farmers who have a lot of grass and expect to use grass to feed cows later. It is also important to keep integrity of harvested hay so that cows are fed high quality dry forage.

6.1.2 Importance

- i. Protects hay against direct sunlight and rain
- ii. Reduces loss of hay
- iii. Maintains quality of hay
- iv. Enables feed planning
- v. Prolongs the shelf life of hay
- vi. Provides security to hay

6.1.3 Siting of hay barn

Hay barn should be sited on a raised ground with good drainage and access to road. It should be situated close to zero grazing units. The ground and surrounding should be kept clean to avoid vermin such as rodents. Adequate space should be allowed for other farm implements i.e. tractor, lorry hand cats etc. and emergency equipments in case of fire. The open end should face away from the direction of wind. Hay barn should be located at least 75 ft from surrounding structures.

6.1.4 Design

Hay barns are relatively simple structures to construct. The size depends on amount of hay to be stored. Most hay barns are post-frame construction made of wood and posts and trusses. The floor is raised to 3ft above the ground and slatted.

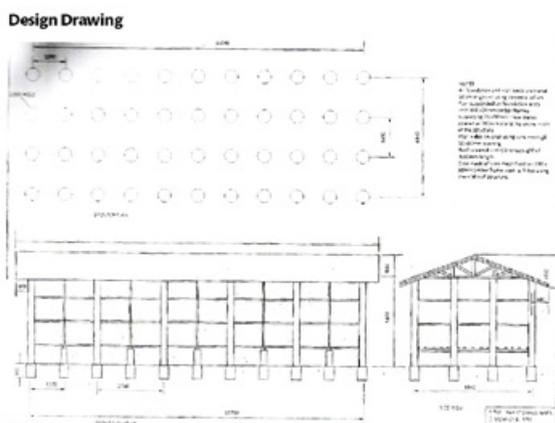


Figure 6.1 Design of a hay barn

6.1.5 Materials

As a rule of the thumb, hay barn should be constructed from locally available materials. Depending on the size and design, one would need posts, corrugated iron sheets, nails and timber. It is recommended that the walls be well ventilated and made up of cheap but convenient materials such as off-cuts

6.1.6 Economics for standard hay barn to house 600 bales

One Acre of land, under good management can yield approximately 200 bales of Rhodes grass hay per harvesting each weighing approximately 15kg. A farmer would therefore, achieve 600 bales from three harvests in a year.

Table 6.1 Material estimates for a 600-bale hay barn

	ITEM DESCRIPTION	UNIT	QUANTITY	RATE (KSH)	COST (KSH)
1	SITE CLEARING AND LEVELING				
	a. Clearing of vegetation, grass and tree stumps and removal of the same for safe disposal	M ²	60.83	0	0
	b. Site marking and layout	Sum	1	3000	3000
2	FOUNDATION				
	a. Foundation holes				
	Excavation of foundation holes to a depth of 50cm and diameter 35cm at 125 x 148cm spacing to accommodate foundation posts	No	48	50	2400
	b. Termite prevention and control				
	Apply anti termite pesticide in the dug foundation and wall posts holes using the correct concentration	L	1	1800	1800
	c. Contrete collars				
	Prepare 1:3:6 concrete mix and pour in the foundation and walling holes.	M ³			
	Ballast	ton	3.5	2500	8,750
	Sand	ton	1.5	2500	3000
	Cement	bags	11	850	9,350
	Foundation posts				
	Insert foundation timber treated posts 25cm diameter x 150cm lenght vertically in the fresh concrete filled holes.	No	28	900	25,200

3	SUSPENDED FLOOR				
	Prepare 4.4m x 13.70m suspended slated timber floor of 7.5 x 5cm hard wood section spaced at 20cm and fixed on 10 x 5cm timber section frames using the following materials				
	Timber 7.5cm x 5cm	m	264	75	19,800
	Timber 100 x 50mm	m	48.4	90	4,356
	Ordinary nails 150mm	kg	8	160	1,280
	Ordinary nails 125mm	kg	20	160	3,200
	Wire mesh 3.6 x 2.1 m	No	10	2000	20,000
4	WALLING The wall is made of timber posts anchored firmly 50cm deep in the ground using concrete collars				
	Timber treated posts 25cm diameter x 410cm length	No	20	1,050	21,000
	Timber 50 x 50cm	m	137.6	64	8,807
	Wall plate 150cm x 50cm	m	34.4	90	3,096
	Wire mesh GI 100cm x 1000cm	Roll	12	4000	48,000
	U nails	kg	12	200	2,400
	Ordinary nails 100mm	kg	6	160	960
5	ROOF				
	Prepare cable roof with timber framework and corrugated iron sheets				
	Timber trusses of 100mm x 50mm	m	150	90	13,500
	Timber purlins 75 x 50mm	m	96	75	7,200
	Ridge caps GI G30 1500mm	no	10	450	4,500
	Corrugated galvanized iron sheets G30 300cm x 80cm	no	40	1000	40,000
	Roofing nails	kg	10	200	2,000
	Fascia board	m	40	160	6,400
	Ordinary nails	kg	8	160	1,280

6	FITTING AND FINISHING				
	a. Door				
	Fit double timber framed with (wire mesh) door size 180 x 210cm with suitable hinges				
	Timber frame 10 x 5cm	m	20.4	94	1,918
	Weld mesh 120 x 240cm	no	2	800	1,600
	Door hinges 7.5cm	no	6	100	600
	Butler 15cm	no	1	200	200
	Butler 10cm	no	4	100	400
	Padlock	no	1	300	300
	b. Stair case	M	4.2	120	504
	Timber 150 x 25mm	kg	100	150	150
	Ordinary nails 75mm				
	c. Painting				
	• All timber surfaces except fascia board should be painted with 3 layers of wood preservative.				
	• The fascia board and access door should be applied with double layers of undercoated plus gloss paint.				
	Wood preservative	1	20	150	3,000
	Paint brush 15cm	no	2	200	400
	Under coat paint	1	20	180	3,600
	Gloss paint	1	20	200	4,000
	Turpentine	1	20	150	3,000
7	Firefighting equipment, Fire extinguisher to be fitted on nearby building to counter fire risks	No	10,000	10,000	10,000
	Fire extinguisher.				
8	Transport				5,000
9	Labour	sum	1	20,000	20,000
	Total				315,951

Note: The costs used above are for illustration purposes only and may vary from time to time and from place to place

6.2 Silo

6.2.1 Description

A silo is used to store and secure silage. It is an air-tight and water-proof structure. A silo is an airtight place or receptacle for preserving green feed for future feeding on the farm. Silos can be either underground or above ground, the qualification being that the silo must allow compaction and be air tight. Five types are described here: tube, pit, above-ground, trench and tower. Silage can be made in large plastic sacks or tubes. The plastic must have no holes to ensure no air enters. This is popularly referred to as tube silage. Silage can also be made in pits that are dug vertically into the ground and then filled and compacted with the silage material.

6.2.2 Importance

The silo protects silage from air and water, which are the greatest enemy. It also enables feed planning since it is made in definite dimensions.

6.2.3 Types of silos

Trench silo- Suitable for well-drained and sloppy areas
Pit silo- Usually dug on the ground
Above the ground/tower silo:-suitable for swampy areas

Diagram need to be clarified

6.2.4 Siting of silos

Silos are usually sited based on their types. Generally, a silo should be situated close to the point of use of the silage i.e. Zero grazing unit and away from other farm structures to avoid disturbance.

6.2.5 Design

Designs of silos depend on the sloppiness/gradient of the farm and site of the silo. The different types of silos have different designs.

6.2.6 Materials

Apart from the above ground/tower silo, other types of silos do not need any materials since they are dug on ground. To construct a tower silo one needs timber and nails. The amount of material needed depends on the material to be ensiled. As a general consideration, 1 acre of napier grass yields 7 tons per cutting and would require 5m x 3m x 1m silo. Pit and trench silos need labour to excavate ground to create the silo. Tower silo would need timber and nails. 5m x 3m x 1m silo would need 240 pieces of timber 6" by 1" each of 10 ft long and 8 kg of nails (4").

7.0 Feed and Water Troughs

7.1 Description

These are containers used to hold feed, water and minerals. They can be fixed (part of the animal shed) or movable (common in ranches and free grazing systems; large ones are sometimes pulled by draft power). Troughs reduce wastage, ensure high standards of hygiene and the farmer can monitor the amount of feed/water given to the animals per day, but he/she will have to buy some of the materials for trough construction.

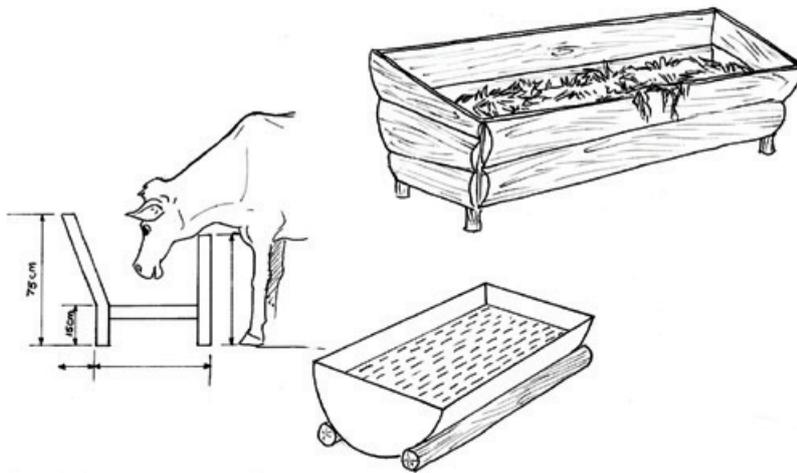


Figure 7.1 Feed and water trough

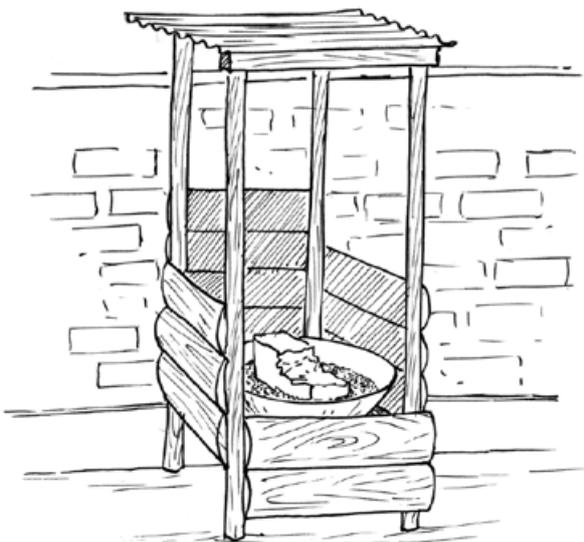


Figure 7.2 Mineral box

7.2 Materials

Feed trough: concrete, wood. Water trough: concrete, drum-shaped metal or plastic containers that can be cut lengthwise. Mineral box: small roofed wooden compartment or cutaway containers into which mineral lick or block can be placed.

7.3 Cost

The costs can be worked out according to the materials below, but generally concrete troughs will be more expensive than wooden ones or cutaway containers. Materials required for the construction of a trough for five adult cows are given below.

Table 7.1 Table of material estimates for construction of a trough

Materials	Size	Quantity
Wooden trough (used for feed only)		
Timber	7.6cm × 5cm (3 × 2inch)	10 metres
Timber	5cm × 2.5cm (2 × 1inch)	30 running metres
Off cuts	Average 305 cm (10ft)	16 pieces
Nails	7.6 cm (3 inch)	0.5 kg A handful of roofing type
Posts (for fixed trough)	244 cm (8ft) length	6 pieces
Concrete trough (used for feed or water)		
Hardcore		3 wheelbarrows
Ballast	2.5 cm (1inch)	2 wheelbarrows
Sand		2 wheelbarrows
Cement (ordinary)		1 bag
Waterproof cement (for water trough) The waterproof cement is bought ready-made.		1 kg



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