



**KENYA MARKET-LED DAIRY PROGRAMME**

**HANDBOOK MODULAR COW BARN DESIGN**

**FOR**

**SMALLHOLDER DAIRY ENTREPRENEURS**



**Design, Management and Profitability**

**Nairobi, Kenya**  
**1<sup>st</sup> edition, February 2016**



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***The SNV - Kenya Market-led Dairy Programme  
is funded by  
The Embassy of the Kingdom of the Netherlands  
Nairobi, Kenya  
<http://kenia.nlembassy.org>***



## **INTRODUCTION**

SNV Netherlands Development Organisation – for the past 50 years - provides capacity development services for stakeholders engaged in social and economic development in 36 countries worldwide. SNV Kenya implements the Kenya Market-led Dairy Programme (KMDP), which is funded by the Netherlands Embassy in Nairobi. The project runs from July 2012-December 2016.

KMDP works across the Kenyan dairy sector, with smallholders, medium and large scale dairy farmers, with dairy cooperatives who collect and market raw milk, with dairy processors, with input suppliers and service providers, with training institutes and with policy makers and regulatory bodies.

In Kenya, an estimated 80% of the 5 billion litres of milk produced annually is supplied by smallholder farmers, with on average 3-8 cows on 1-10 acres of land. As regards to the smallholder dairy supply chain, KMDP works with 19 dairy societies across Kenya's major milksheds, with in total about 30,000 active members.

Within this amorphous group of smallholders an increasing number is commercializing fast and practice dairy farming as their core business. These smallholder dairy entrepreneurs have adopted zero grazing as the preferred system of production, and invest amongst others in physical structures (i.e. cow and hay barns, stores), herd improvement and expansion, and in fodder production and preservation.

A cow barn requires a considerable investment and a proper design is crucial for cow comfort and health, optimal production and profitability of the enterprise. Hence this Handbook for modular cow house design.

The Handbook is to support smallholder dairy farmers or entrepreneurs with good practice cow house design and business planning. However due to the technical nature of the Handbook, this will be mostly indirect through dairy consultants, architects, building contractors, dairy cooperatives, training institutions and other stakeholders.

It provides the reader with a set of 6 modular cow barn designs, ranging from 3-18 mature cows plus young stock, based on the basic principles of good cow house design in a Kenyan context. This implies optimum cow comfort, hygiene and health, labour efficiency, flexibility & scalability (modular). Environmentally sound, simple and cost efficient.

The cow barn designs are modular, which means that the design is expandable to allow farmers to increase their herds gradually, as they continue to invest in their dairy business. Provided that there is a proper site plan with "space to grow", each module can be enlarged easily at minimum costs and adjustments (or even demolition) of existing structures.

The modular cow barn designs also offer ample opportunities for application of renewable energy solutions, notably solar lighting & water heating, and biogas production for domestic use. If well designed and managed, these can give considerable cost savings as compared to using conventional energy sources (i.e. kerosene, firewood, charcoal and electricity supplied by the national grid or diesel generators). For more information on this subject the reader is referred to: <http://africabiogas.org/africa-biogas-partnership-programme>.

The Handbook is structured as follows:

Chapter One summarizes and explains the basic principles of good cow barn design. In Chapter Two, six smallholder cow barn modules are presented (each in wood and steel version), and it includes the technical description, cost estimates and bills of quantity. Chapter Three contains the financing plan for the cow barn (IRR/Pay Back Period).

Annex 1 shows the technical drawings i.e. floorplans, 3D-images, sections and details in A4 size. These drawings can be downloaded from the SNV Kenya and the CowSoko websites in A3-size at scale 1:100.

The Handbook was prepared by Fieten Ltd in cooperation with Perfometer Agribusiness Ltd (both from Kenya) and Vetvice from the Netherlands. Contributions to the Handbook were provided by SNV Kenya's dairy experts.

Nairobi, Kenya  
1<sup>st</sup> edition, February 2016

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CowSoko - <http://cowsoko.com>



# CHAPTER ONE COW BARN DESIGN PRINCIPLES

(Derived/adapted from Vetvice CowSignals Cow Barn Design [www.vetvice.com/barn-design](http://www.vetvice.com/barn-design))

## 1.1 Overview of Existing Barn Designs

The first step in the assignment to prepare this handbook was to gather information on available and existing smallholder cow barn designs in Kenya.

This was done with a view of learning from previous designs, and gathering details of how such designs differed from the principles of good cow barn design, documented in paragraph 1.2 below. The following designs were reviewed:

- a) Smallholder Cow House Design from the Danish Agricultural Center.
- b) Zero grazing series from the Ministry of Livestock Development in Kenya.
- c) Zero grazing series from the Agricultural Information & Resource Center (AIRC), Kenya

The analysis of these barn designs revealed that important principles such as cow comfort, labour efficiency, structural soundness and expandability are not always adequately observed.

In addition, they reveal that dairy animals and the farm workers are exposed to adverse conditions that hinder their optimal productivity, leading to reduced efficiency and safety. Listed below are some of the deficiencies noted in the existing designs:

- Low roofing level, preventing comfortable movement by cows and workers and limiting air movement/ventilation in the barn. This significantly contributes to heat stress.
- Inadequate width of the walking alley. This results in cow discomfort arising from obstructed flows, as group of cows force their way through others in the crowd. This also contributes to injuries caused by the barn's structure (abrasion).
- Lack of roof cover in some key areas of the barn, especially over feed alleys/troughs. This leads to feed losses through heating & rotting when exposed to rain and sun.
- Inappropriate dimensions for the sleeping cubicles: either too small or too wide.
- Inappropriate dimensions for various barn components such as the feed fence and neck rail height, water trough dimensions etc. These are dependent on the size and breed of the cow being designed for.
- Inadequate manure handling infrastructure within and outside the barn.
- Inappropriate positioning and quality of support facilities, including fodder chopping machine and area, concentrates store, milk equipment storage and calf pens
- Lack of or inadequate rainwater harvesting and storage facilities.
- Limited provisions for possibilities of future growth and expansion of the cow barn.

## 1.2 Basic Principles of Cow Barn Design

The 4 principles for good cow barn design are universal and can be summarized as follows:

### 1. Cow comfort

Provide adequate space, feed, water, ease to rest and move, fresh air and light.

### 2. Flexible and expandable

Think and build in straight lines for the separation of different flows and to allow easy expansion at minimum costs and interruption of these principles.

### 3. Simple, robust and economical

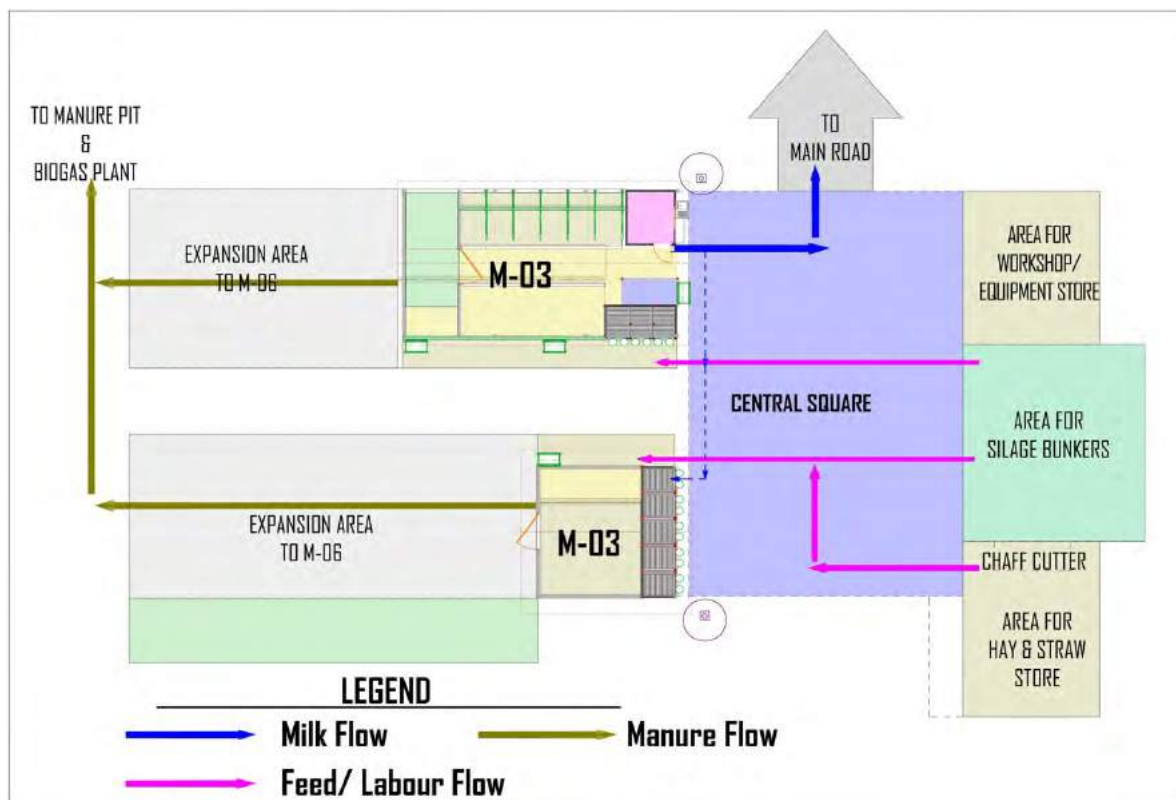
Create simple and robust structures that are durable, require minimum maintenance, and offer safe and comfortable working conditions for farm workers.

### 4. Optimization of movements/flows and labour efficiency

Assure separation of the six different flows in and around the cow barn: (1) cow flows, (2) feed flows, (3) manure flows, (4) work flows, (5) milk flows and (6) information flows.

## 1.3 Site Plan

The 4 basic principles, in particular expandability and separation of flows, require a good survey of the site and a proper site plan. The importance of this cannot be emphasized enough, as this forms the basis for future growth and expansion and separation of clean and dirty flows (milk, feeds, manure). An example of this is given in the figure below.





## **1.4 Basic Principles Further Explained**

### **1. Cow Comfort**

- (a) Feed and water: every cow/young stock needs to have access to palatable feed of the right composition and clean water for at least 22 hours per day.
- (b) Light: all animals need to experience a day-night rhythm. During day light there must be enough light in the areas where cows are for people to work comfortably.
- (c) Air: all animals should continuously breathe fresh air.
- (d) Rest: all animals should be able and willing to lay down as much as they prefer: 12-14 hours per day for confined dairy cows. There must be no social stress or stress caused by people working and/or in contact with the cows.
- (e) Space: all animals should be able to walk around comfortably (safe and stress-free) and have enough space to exercise their body.
- (f) Health: no animals should be suffering from wounds, infections or diseases. The barn design must support a high level of hygiene and biosecurity (walk and work lines, direct and indirect contact with other bovines, etc.).

### **2. Flexibility and expandability**

Simplicity of the design and set up are very important. Straight lines and dedicated areas are essential for expandability (and labour efficiency). In the design and planning process, this corner stone can be managed by taking into account the space and lay-out of next module(s). By doing so the farmer anticipates on future growth of the herd and the dairy enterprise. He/she should explore various growth scenarios.

In relatively compact barn set-ups, multi-tasking is an important fact. The working environment must be open and easy to clean.

### **3. Simple, robust and economical**

The barn and support structures should be functional and durable for the estimated number of years it is planned to be in use, and commensurate with the type of building materials used. It is however a pitfall to start with this cornerstone, as it should be the last phase of the design and planning process. Quite often there are pay-offs when one chooses for a certain option, for example to build in steel or wood. Make a list of all pay-offs and evaluate these regularly before coming to final conclusions.

### **4. Optimization of movements/flows and labour efficiency**

- (a) Feed flow: movement of all feed ration components (storage, feeding, mixing, cutting, etc.), feed push-ups, cleaning of feed troughs.
- (b) Manure flow: movement of manure/urine and dirt from cleaning of floors to be separated from clean flows (milk and feedstuffs).
- (c) Cow flow: movements of all animals during the day, during the year/seasons and during their lives.
- (d) People flow/work flow: movements of people during all the work they need to do in and around the barn.
- (e) Materials flow: storage, use, handling, maintenance and disposal of all materials and equipment used in the barn.
- (f) Information flow (incl. farm recording): how people communicate with each other, how information is registered and transferred from one person to the other, how people can easily pick up information they need in a certain situation and for a certain task.

## 1.5 Specific Aspects for Kenyan Cow Barn Design

### Roofing

Roofing is only needed for shading, protection from rain and to collect rain water.

### Ventilation and climate control

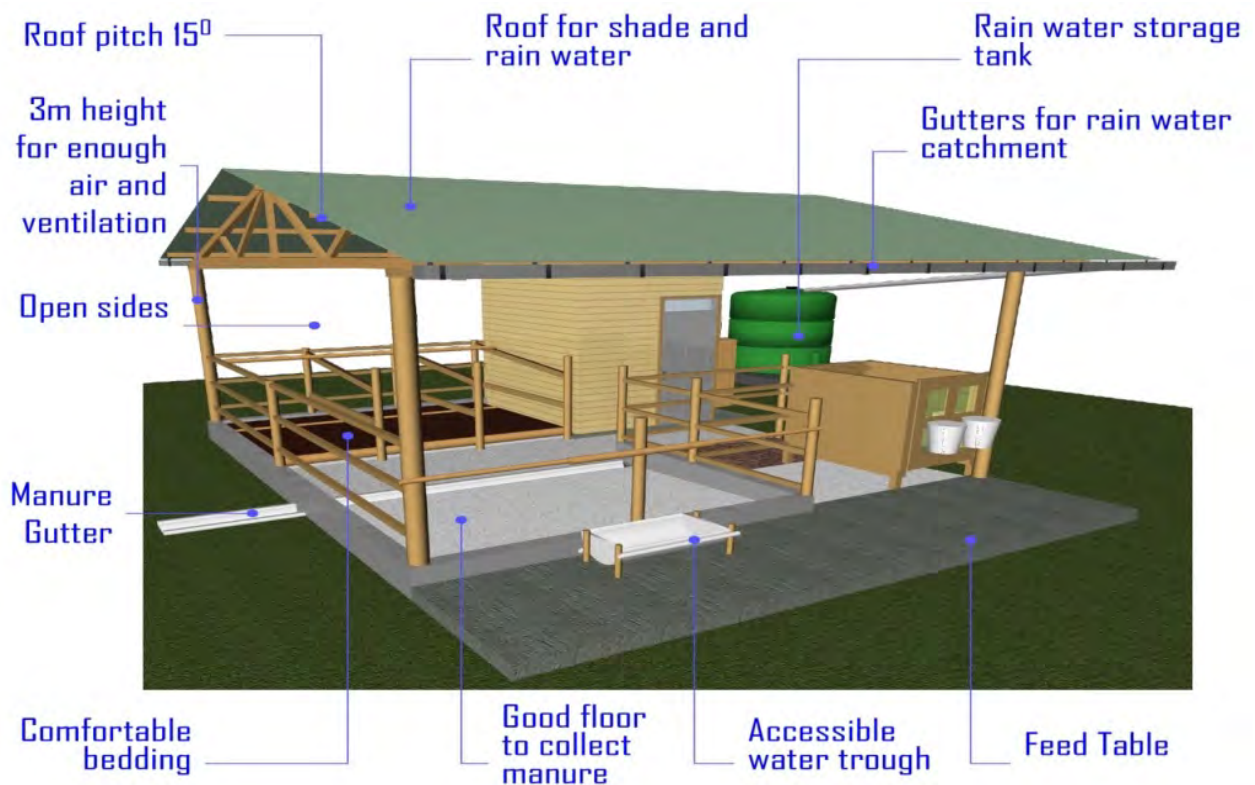
Extreme cold temperatures (below zero Celsius) are not an issue in Kenya. Therefore only ventilation (getting fresh air in continuously) and heat must be managed. Natural airflow (wind) is useful for this, as it goes through the barn horizontally. This concept is called natural cross-ventilation. Essential for this are open sides. Nothing should block the air flow and the wind. If possible, build the barn on a higher part of the farm, with no nearby structures, trees or shrubs that block air flow. The roof needs to have a slope, as flat roofs provide less ventilation and rain water catchment is more difficult.

### Security

This is relevant for keeping predators and scavengers out. In most cases safety is managed by putting up a fence around the premises, and through locked gates and doors.

**In summary**, in Kenya a cow barn can be very simple, with basic components to observe:

- A roof for shade and rain water.
- No side walls, only bars to keep the animals in.
- Good flooring to collect manure and to ensure cows can walk safely and comfortably.
- Comfortable stalls (beds): soft flooring/bedding, good head-swing space.
- Accessible water points.
- Comfortable feed tables: easy to clean and for the cow to eat from.



## CHAPTER TWO SMALLHOLDER COW BARN MODULES

### 2.1 Six Modules

In this Handbook six modules are presented for smallholder cow barn design – each in a wood and steel version.

The designs are modular, which implies that the design is expandable to allow farmers to increase their herds gradually and in a planned manner, as they invest in their dairy business. Each module can be enlarged easily at minimum costs and with minimal adjustments, or need for demolition of other structures in the farm.

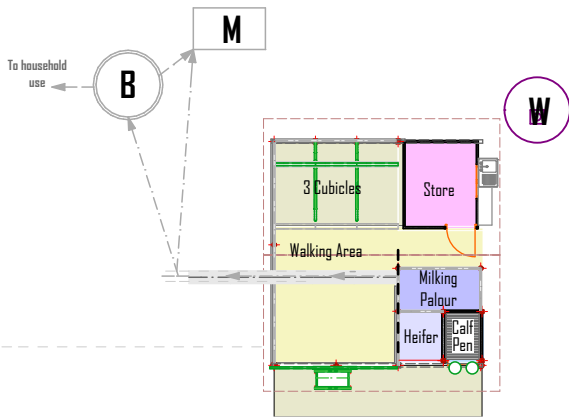
In the following paragraphs, an overview of the floorplans of the six modules (2.2), the technical description (2.3) and cost estimates and bills of quantities are provided (2.4 and 2.5). Annex 1 contains floorplans and 3D images for each module (in steel and wood). The scale of these drawings is 1:100, but only if printed on A3. The A3-size drawings can be downloaded from the SNV Kenya and CowSoko websites.

The six modules, and the total cost per module, are listed in the table below. The cost for each module is based on average 2015 prices for building materials and labour in the Kenyan market.

<b>CODE</b>	<b>NAME MODULE</b>	<b>HERD SIZE</b>	<b>COST IN KSHS</b>
M01 W	Module 1 Wood	3 mature cows + 2 young stock	258,000
M01 S	Module 1 Steel	3 mature cows + 2 young stock	333,500
M02 W	Module 2 Wood	6 mature cows + 9 young stock	430,000
M02 S	Module 2 Steel	6 mature cows + 9 young stock	567,800
M03 W	Module 3 Wood	8 mature cows + 14 young stock	609,100
M03 S	Module 3 Steel	8 mature cows + 14 young stock	796,000
M04 W	Module 4 Wood	13 mature cows + 16 young stock	956,000
M04 S	Module 4 Steel	13 mature cows + 16 young stock	1,252,000
M05 W	Module 5 Wood	18 mature cows + 20 young stock	1,270,800
M05 S	Module 5 Steel	18 mature cows + 20 young stock	1,672,000
M06 W	Module 6 Wood	18 lactating cows + 9 dry cows combined with 26 young stock	1,458,600
M06 S	Module 6 Steel	18 lactating cows + 9 dry cows combined with 26 young stock	1,881,800

## 2.2 Overview of Floorplans for all Modules

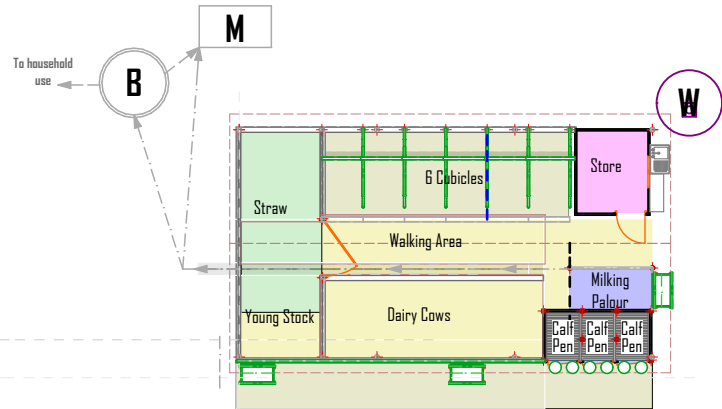
**M 01**



**Module's herd capacity**

- 03 Cows
- 01 Heifers
- 01 Calf

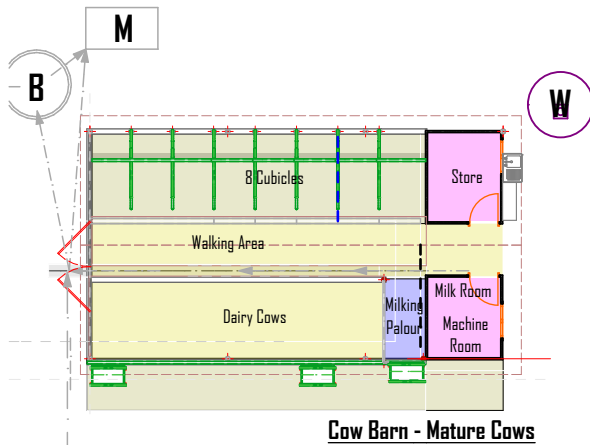
**M 02**



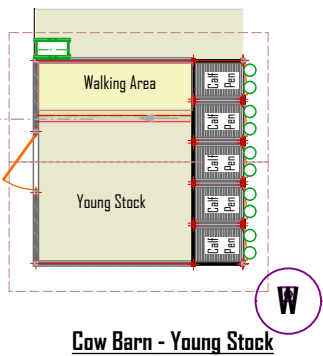
**Module's herd capacity**

- 06 Cows (Including dry cows)
- 03 Heifers
- 03 Calves

**M 03**



**Cow Barn - Mature Cows**

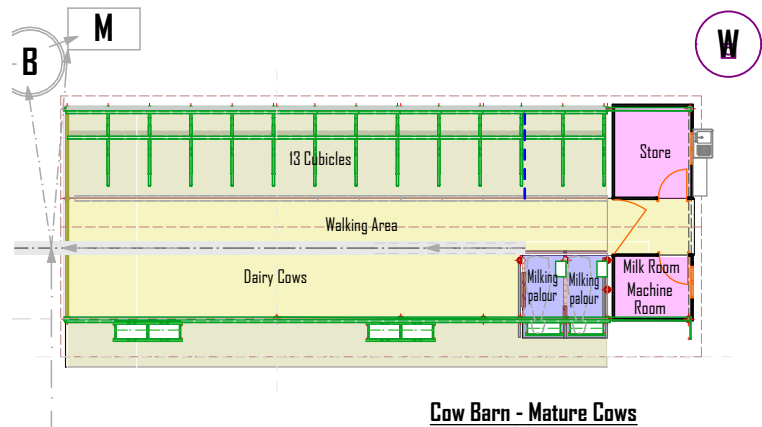


**Cow Barn - Young Stock**

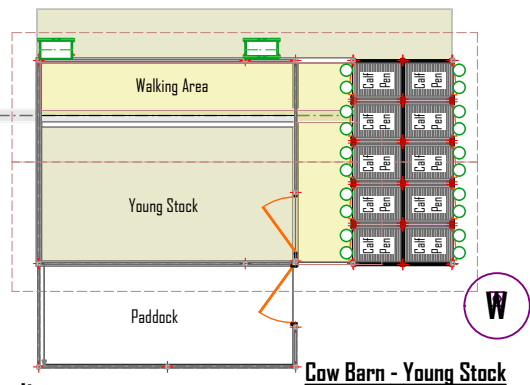
**Module's herd capacity**

- 08 Cows (Including dry cows)
- 09 Heifers
- 05 Calves

**M 04**



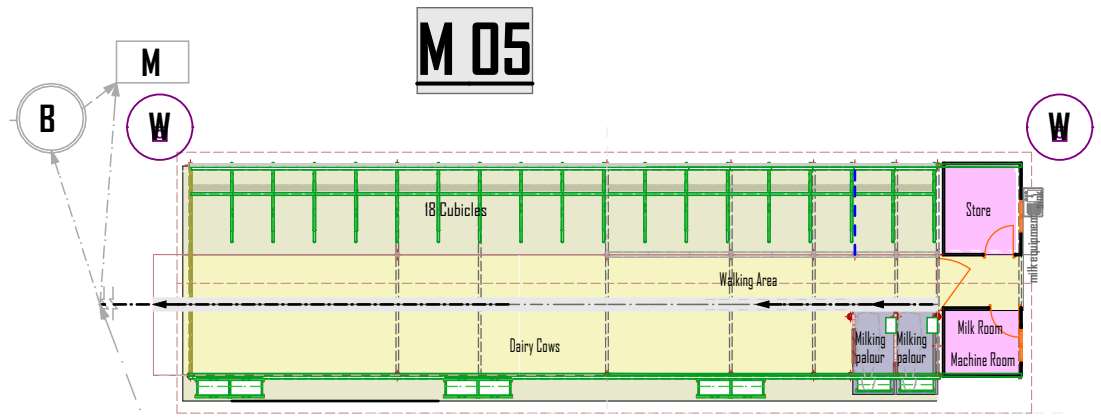
**Cow Barn - Mature Cows**



**Cow Barn - Young Stock**

**Module's herd capacity**

- 13 Cows (Including dry cows)
- 06 Heifers
- 10 Calves



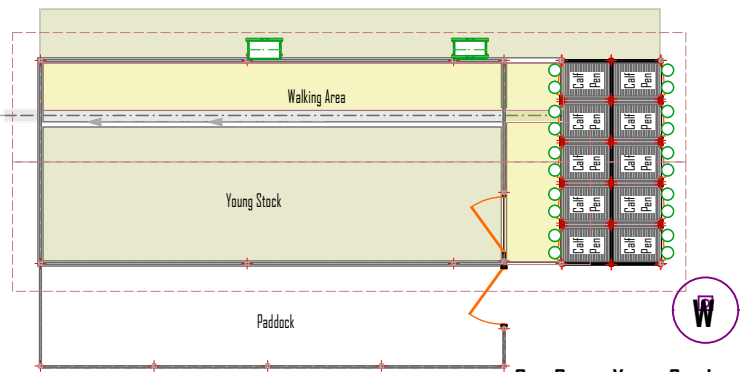
**Cow Barn - Mature Cows**

**Module's herd capacity**

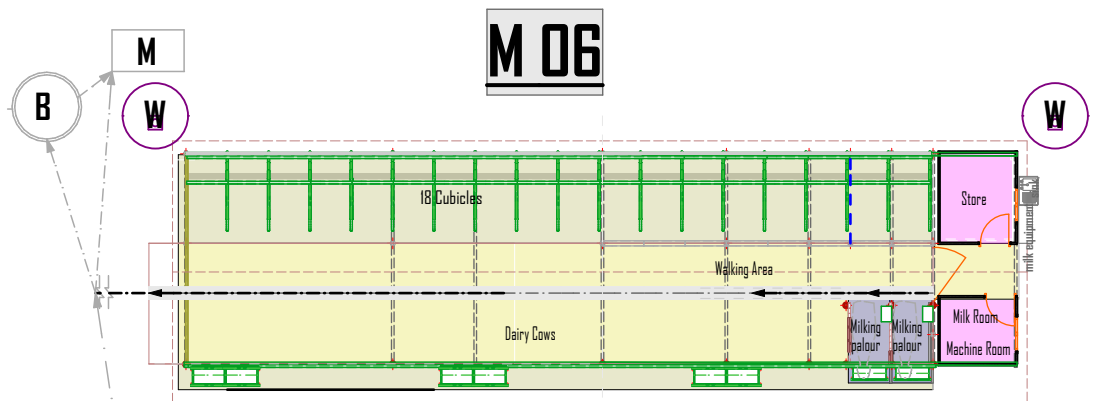
- 18 Cows (Including dry cows)
- 10 Heifers
- 10 Calves

**KEY [M01 - M06]**

- W Water storage tank
- M Manure pit
- B Biogas unit



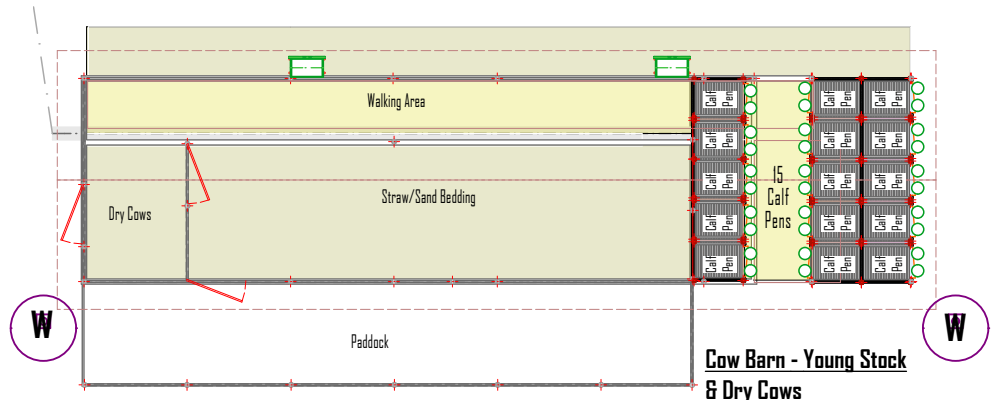
**Cow Barn - Young Stock**



**Cow Barn - Mature Cows (Lactating)**

**Module's herd capacity**

- 18 Milking Cows
- 09 Dry Cows
- 11 Heifers
- 15 Calves



**Cow Barn - Young Stock & Dry Cows**

## 2.3 Technical Description

### a) Site preparation – substructure

The area to be constructed should be prepared in the standard way to create appropriate levels and a firm ground base, onto which the concrete floor will be laid. Unstable ground leads to a short life span of the concrete floor through cracking and disintegration, caused by differential settlement of the ground below. Cotton soil, top vegetable soil and any other loose soil material, should be removed and replaced with appropriate back-fill material - such as hard core - and compacted well to form a stable floor base.

### b) Proposed construction materials

#### Wood

- 150 mm thick mass concrete- with BRC mesh reinforcement (Cement: Sand: Ballast 1:2:4) finished in diamond pattern groves; 12mm wide by 5mm deep and 60mm apart, plus associated short walls up to 20cm high in areas defined in the detailed design drawings.
- Treated wooden posts of 15 feet long and 15 cm in diameter on average for structure construction.
- Treated sawn timber grade 2"x4" (50mmx100mm) sections, edges planned to bevel for cow comfort, proposed for fences, cubicle dividers and gates.
- Galvanized corrugated iron (g.c.i) sheets, pre-painted gauge 30. Roof cover on timber structure complete with associated accessories.
- To match structural strength of wood, grids of 2.4 meter and 3.6 meter intervals - center to center combined - to form an equivalent single grid of 6 meters as used in steel, are recommended.

#### Steel

- 150 mm thick mass concrete- with BRC mesh reinforcement (Cement: Sand: Ballast 1:2:4) finished in diamond pattern groves; 12mm wide by 5mm deep and 60mm apart, plus associated short walls up to 20cm high in areas defined in the detailed design drawings.
- 4" diameter 3mm thick mild steel columns/posts; height and anchorage as per the drawings.
- 2" diameter 3mm thick mild steel pipes bended to shape to details for fences, cubicle dividers, gates.
- Galvanized corrugated iron (g.c.i) sheets, pre-painted gauge 30. Roof cover on mild steel structure to fabricator's specs complete with associated accessories.
- Grids of six (6) meters center to center for structural steel posts/columns forming the structure of the cow barn unit are adopted. This is to match standard steel members in the market. It is also a reasonable multiple of the standard width of a cubicle (1.2 meters).

### c) Floors

Floor construction and detailing is the same irrespective of the choice of materials (wood/steel) for other barn elements. Floor construction is concrete in all walking and feed alley areas. Concrete is the most commonly used material of choice for building floors, pavements, driveways, sidewalks, steps, basements/pits and industrial floors. It is relatively inexpensive to install and provides an attractive, durable surface that is

easy to maintain. Proper attention to the standard practices and procedures for constructing exterior or interior concrete, can yield a concrete surface that will provide long-lasting, superior performance.

For the best results and quality concrete in construction projects the following procedures are of great importance:

- Remove all vegetation, soft soils and rocks so that support for the slab is uniform. If possible, place concrete on undisturbed, firm soil (stable ground).
- Set forms so that the concrete slab surface slopes a minimum of two percent, or 1/4 inch per foot, this provides adequate drainage.
- Use a poker vibrator to drive-off trapped air and increase bonding ability in addition to a scratch template, typically, a piece of 2-by-4 or 2-by-6 lumber equal to the specified slab thickness, with stakes attached to the top surface at each end, or a string line across the top of the forms to ensure proper slab thickness.
- Do not use high-slump concrete. Control water additions at the truck. A good slump for most flatwork placed by hand: 5 inches. For slabs struck off with mechanical equipment: 2 to 4 inches. Even high slump caused by admixtures can be detrimental as the paste content (and shrinkage) of the upper portion of the slab, can be greater than the lower portion of the slab leading to increased warping.
- Strike off the surface while keeping a small amount of concrete in front of the straightedge to fill in low spots. This helps to prevent birdbaths in the finished surface.
- Do not perform any finishing operation while bleed water is present on the surface. Do not dust dry cement on the surface to soak up bleed water.
- Use a groover (i.e. a machine to make grooves) to make contraction joints in the fresh concrete. Make sure the groove depth is one quarter of the slab thickness. Or use expansion joints at predetermined spacing, or saw joints using either an early-cut saw or a conventional saw. Early jointing helps prevent cracking.
- Do not steel trowel concrete that contains more than 3% entrained air. Hard trowelling of air-entrained concrete may cause surface deterioration.
- Start curing the concrete immediately after completion of finishing operations.

#### Flooring of walk ways

- Construct high quality concrete walk ways, resistant to erosion and able to withstand a high load (i.e. manure scraping with tractors).
- Assure sloping towards the direction of the manure dump: 1 to 2%.
- Assure sloping towards the centre of the walkway: 1 to 2%, with the lowest point  $\geq 2$  m from the feed fence and  $\geq 1$  m from the curb of the beds.
- Provide enough grip for the cows to walk: don't polish.

#### Instruction for constructions of walk ways for cows

- All walk ways should be constructed of good quality concrete (15 cm thickness), with an iron concrete grid (diameter: 6 or 8 mm, grid distance: 15 cm).
- All longitudinal walk ways should be on a slope of 1.5 to 2.5% (1.5 to 2.5 cm per 100 cm) in two directions: towards the centre and towards the manure dump.

- For easy cleaning, the holding pen can be built on a slope of 3-5 % away from the milk parlour towards the manure dump.
- To provide sufficient grip for the cows, the concrete must not be polished. And in most cases grooving is necessary. In barns with sand bedded stalls, usually it is not needed to groove the concrete.

#### Options for grooving

- Use a wooden block with copper or iron pipes of 2.5 cm diameter around it, at a distance of 7.5 cm ("jitter bug"). The jitter bug is pulled longitudinally over the concrete after it has hardened for about 2 hours, so that grooves are made of 1.0 – 1.5 cm wide and 2.5 cm deep, at a distance of 7.5 cm.
- Cut grooves after the concrete has completely hardened, with a diamond concrete cutter. The best option is to make a diamond-shaped pattern, with grooves of 2.5 cm wide, 1.0 - 1.5 cm deep, at a distance of 7.5 cm.
- Pull a special designed plate over the wet concrete to make grooves of 1.0 – 1.5 cm wide, 1.0 cm deep, at a distance of 5.0 cm between the grooves.

#### Sleeping/resting areas

Sleeping areas are rammed earth with suitable bedding material. Stalls/cubicles floor should be comfortable enough for high lactating cows to lay down at least 12 hours per day in zero-grazing systems. The most important aspect of a stall is the flooring, this should be soft and dry. It should also be non-skid to avoid slipping and falling when the cow lies down or gets up. By far the best bedding material is sand. Second best, close to sand, are deep bedding materials such as saw dust, (chopped) straw, rice hulls, dried manure solids and other dry materials that do not lead to formation of hard lumps when used in the cubicles.

#### **d) Structural posts anchorage**

Anchorage of the posts could take either of the details described below. Further, the part of the post 40 cm just above the floor, should be protected from water and cow urine to check corrosion for steel and rotting in wood. This is achieved through encasing the posts in concrete.

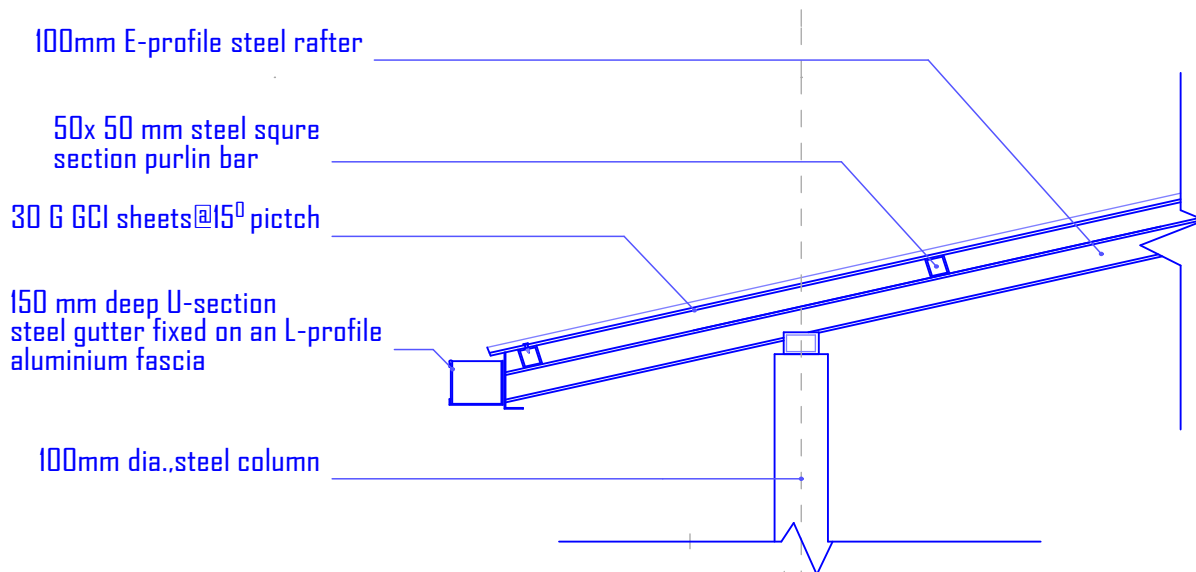


#### **e) Roof structure and roof covering**

The structure should be such that the lowest part (eaves) height is a minimum of three meters high and the pitch (roof slope) is 15<sup>0</sup> degrees. This allows for sufficient aeration and ventilation.

Roof covering should be brightly coloured galvanized corrugated iron sheet. Dull coloured sheets absorb and retain solar heat contributing to cows heat stress. Ordinary corrugated sheets of minimum gauge 30 are recommended.





**f) Manure collection drain and manure bunker/pit**

The handling of cow manure is a very important operation of a dairy farm and requires much attention. Manure must be collected daily and put in a storage facility or bunker whose design depends on the volume, usage and destination of the manure.

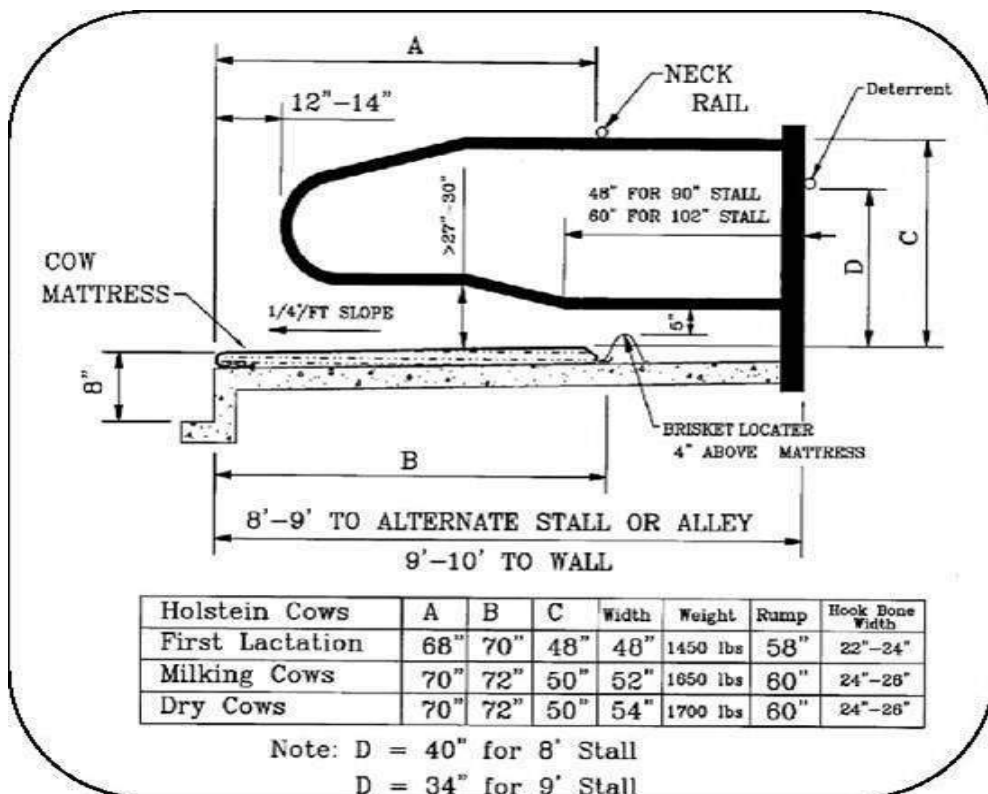
Manure (or biogas slurry, if the manure is first used to generate biogas) is stored over a longer period of time in a pit or bunker (preferably of concrete and with a cover), from where it is distributed periodically to agricultural land as an organic fertiliser. This is the recommended practice for integrated dairy farms with sufficient land to grow their own fodder. The frequency of manuring the land depends on the soil fertility, demand per crop and availability of land. The duration of cropping season and rainfall patterns also determine how much manure needs to be stored over a certain period of time. In Kenya this period would be between 3 and 6 months.

**g) Free stall cubicles**

Sufficient head space for the cow to swing her head when she lies down or gets up is an important consideration. The stall or cubicle needs a width of minimal 115 cm for a 135 cm high cow. Bigger cows need wider stalls. Optimal dimensions for modern HF cows (700 kg adult weight): 122 cm wide, 255 cm long, open head space, neck-rail and brisket locator adjustable in position.

Cows in the herd and in groups can get bigger, smaller, longer and shorter over time. Variation in dimensions of animals within a group can have big impact on the use of stalls. When barns are too small, the large cows will not lay down enough and may lay with their hind parts outside the stalls. Diagonally laying down is a clear signal that the resting area is too short, that there is not enough head space at the front, or that the neck rail is too far backwards. When stalls are too big, the smaller animals are likely to deposit manure and urine in the stalls.

Therefore, at least once a year there should be an assessment whether the cows still fit well in the stalls and whether the stalls are still comfortable enough. When there is much variation in cow size within a group, one can divide the group into a large-cow group and a small-cow group, and to suit the stall dimensions for each group.



### Cubicle maintenance

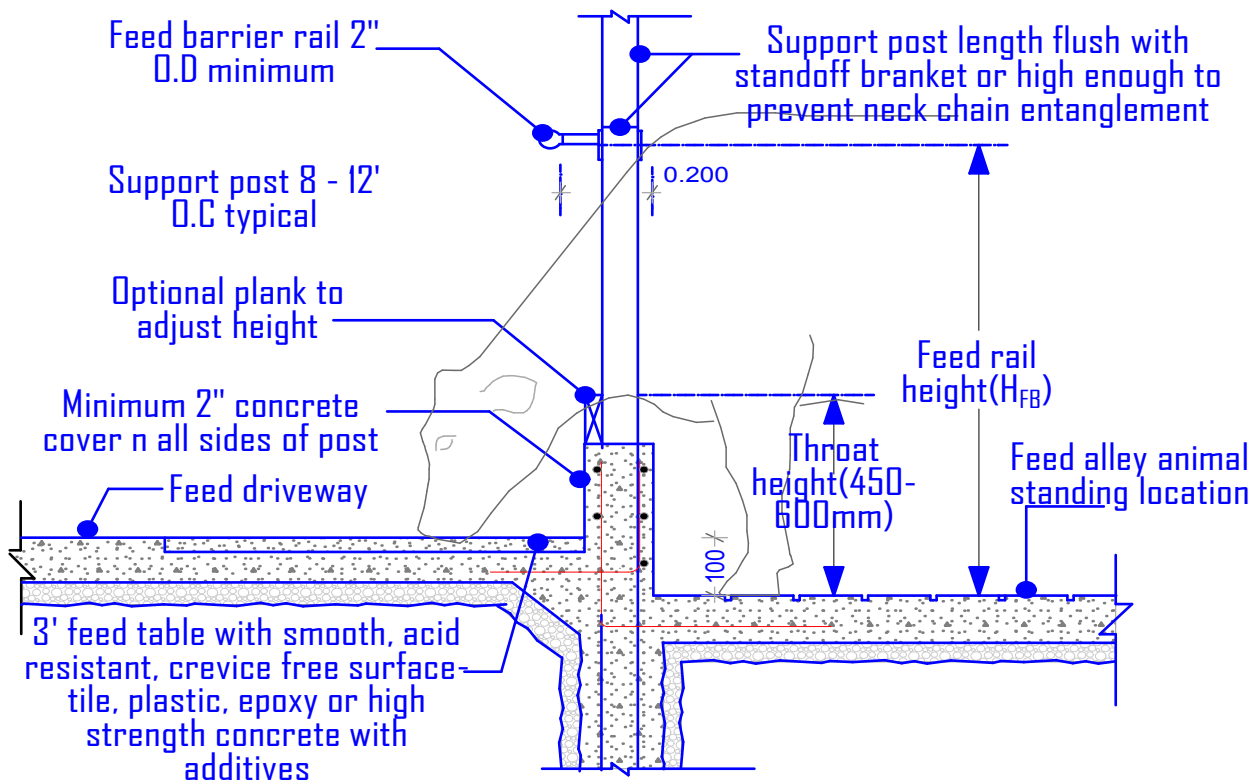
- Deep bedding: i.e. sand, rice hulls, chopped straw, sawdust, manure solids.
- Fill the stalls weekly or minimal once every 14 days.
- Keep the level of the bedding above curb level.
- Inspect the stalls minimal three times a day: remove wet bedding and manure, flatten the surface.

### Checkpoints

- All cows should be able to stand straight with four feet down in a stall. If not, move the neck rail forward. When there is much variation in cow size in a herd causing dirty stalls, split the herd in a small-cow group and a large-cow group. Adjust stall dimensions accordingly.
- All cows should be able to lie down straight in a stall. When too many cows lie diagonally, move brisket locator forward.
- Clean out manure and wet bedding from the stall 3-4 times per day.
- Ensure that the top 2-3 cm of the last meter of the stall bedding is dry.
- Level of bedding should not be lower than the curb. If so, the bedding should be flattened. When there is not enough bedding for this, bedding should be added.

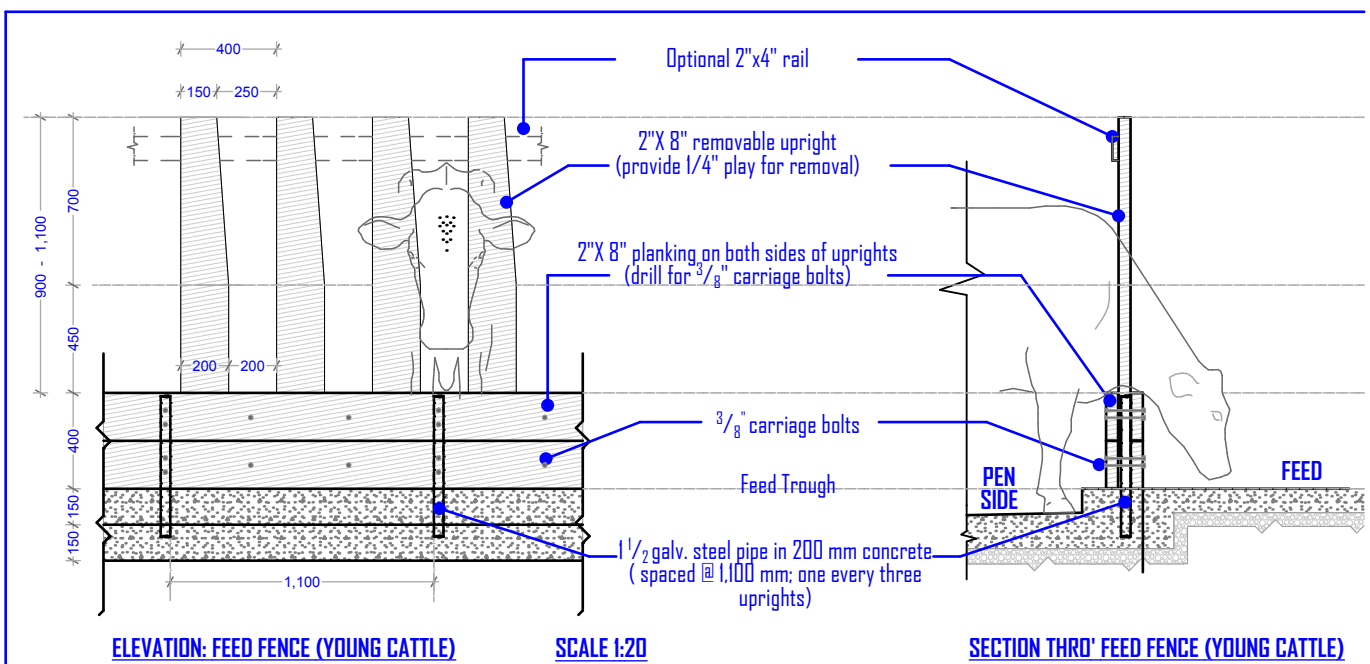
### **h) Feed fence**

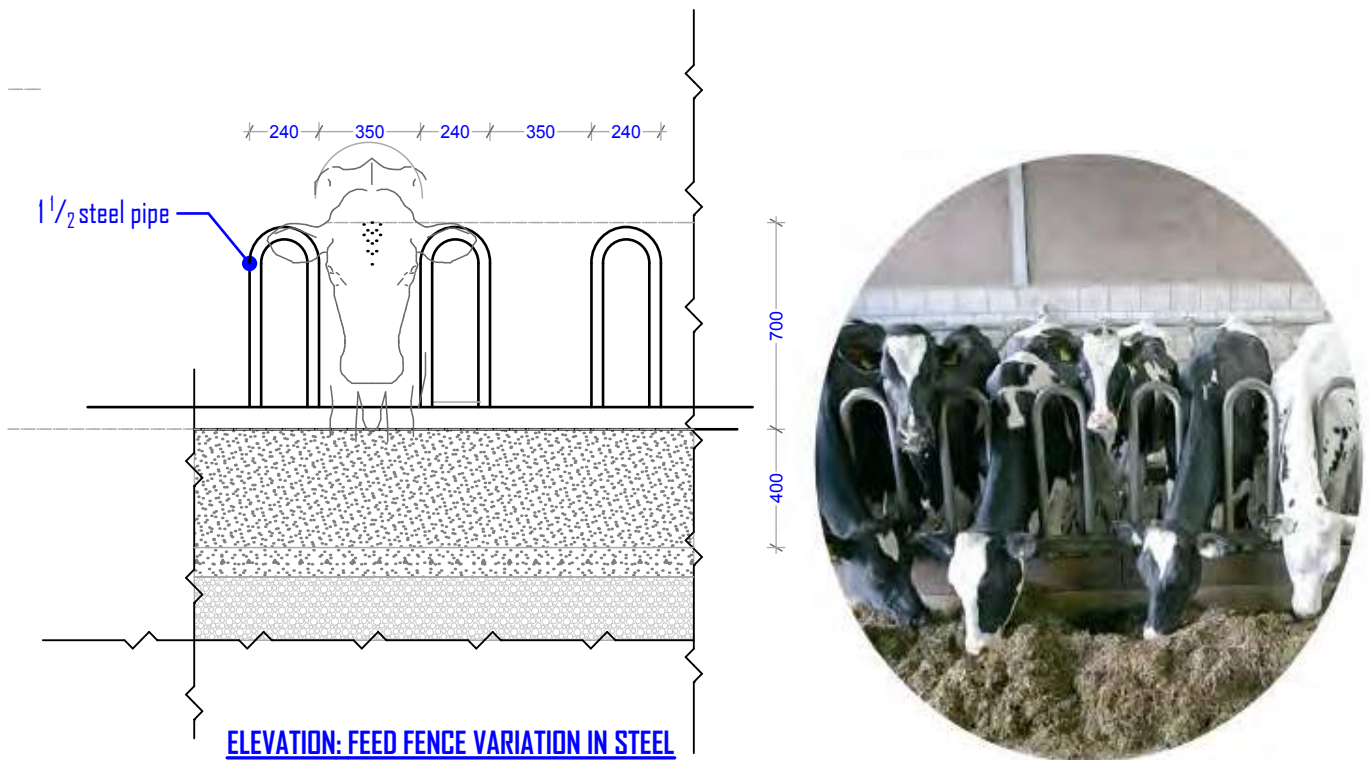
The main purpose of a feed fence is to stop cows from stepping into the feed. Feed fences should be adapted to the dimensions of the cows. If not, the cows will develop bumps and wounds. The figure on the next page shows the various dimensions that should be observed for cow comfort at the feed fence.



A Swedish feed fence never touches the neck of the cow, but stops the animals at the shoulder. This feed fence matches with cows of almost all sizes. The only issue is with young calves that might step through it. Neck rails almost always give rise to the development of shoulder bumps. See examples of a Swedish feed fence in the figures below.

#### TOMBSTONE/ SWEDISH FEED FENCE FOR YOUNG STOCK





A self-locking feed fence is used to catch cows and to fixate them for treatments. The feed fence includes a neck rail (post-and-rail barrier). A self-locking feed fence is a good investment for farms with larger herds of cows, as it reduces time to catch cows and facilitates handling of groups of cows.

**i) Feed alley**

This area consists of the feed table and the farmer's movement area when feeding the cows. Both areas should be sheltered from sun and rain, as this supports both cow and labour comfort.

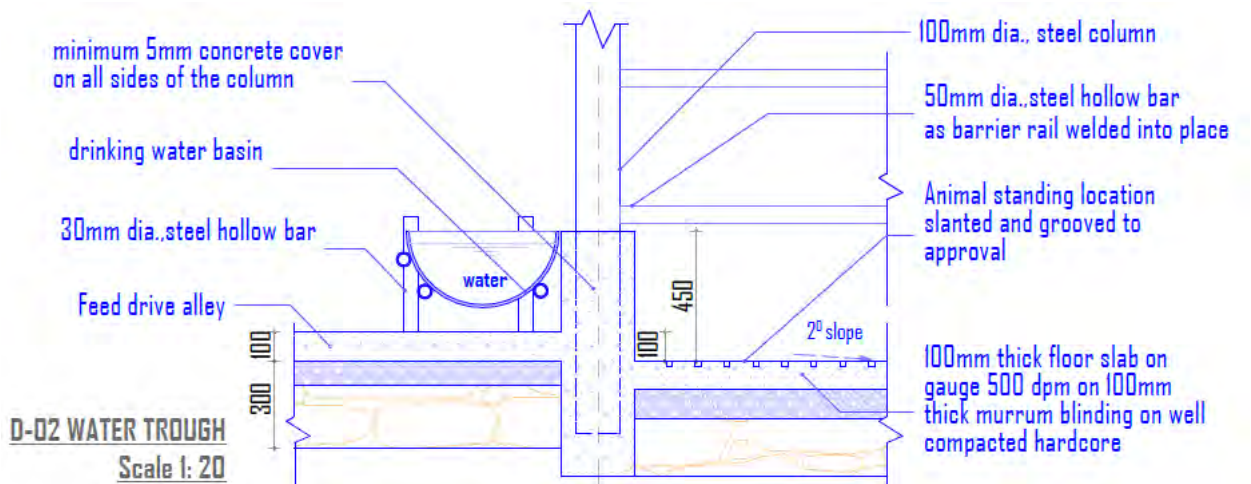
**j) Water troughs**

A guaranteed supply of good quality water is important to provide cattle with their daily water requirement and for cleaning. Watering points should be easily accessible to all cows in the herd. For mature cows, the height of the trough should not exceed 90 cm above the floor where the cow stands. A height of 60 cm is satisfactory for young stock.

For a smallholder barn, water troughs made out of a half-cut plastic drum, supported by a steel or wooden structure, can be used as a good alternative for a permanent and more expensive concrete structure. The figure on the next page shows such a system located along the feed table.

**k) Electrical grounding of iron-works**

All iron should be grounded well! Meaning that the maze in the reinforced-concrete, cubicle dividers, steel posts, feed-fence, and most certainly the milking parlour are connected with the electric ground cable of the electrical wiring system. This ensures that there will be no problem with stray voltage and it increases safety for everybody, including the cows.



### l) **Rainwater harvesting**

A guaranteed supply of good quality water is important to provide cattle with their daily water requirement and for cleaning. Rain water catchment may be used to provide part of this, but it will not be sufficient to guarantee sufficient volumes year round. It is advised that the farm be connected to a piped water supply system, or if necessary sinks a deep-well or borehole. Water storage tanks with sufficient storage capacity need to be present, in the event that the water supply gets temporally disrupted. As a rule of thumb, the water storage capacity should be equal to a minimum of two days water requirement of the cows plus water needed for cleaning.

### m) **Maintenance**

- *Roof gutters* should be cleaned periodically, especially before rains to ensure rainwater collected in tanks is clean and free of contaminants.
- *Floors* should be maintained in good repair condition to ensure safety for the cows and people working in the barn. Any damaged concrete floor surfaces should be repaired early to avoid extended damage to the entire floor area.
- *Wooden and steel members* such as structural posts and cubicle partition posts, should be protected from long exposure to water and cow urine. Keeping steel and wooden posts dry most of the time prevents them from rusting and rotting, thus guarantying a longer life span of the cow barn.

## 2.4 Cost Estimates

MODULE	MODULE DESCRIPTION	COST ESTIMATES IN KENYA SHILLINGS (KSHS)									
		Concrete works	Barn posts/ columns	Roofing structure + G.C.I roofing sheets covering	Cubicle dividers & fences and barrier rails	Timber for calf pen	Timber for store sidings	Rain-water harvest system	Miscellaneous	Labour	TOTAL
<b>M1 - W</b>	3 Cubicles  1 Milking parlor, 1 Calf pen, store and straw bed space 1 heifer	49,000	12,000	42,400	25,000	8,000	18,000	50,000	8,000	46,000	<b>258,400</b>
<b>M1 - S</b>	3 Cubicles  1 Milking parlor, 1 Calf pen, store and straw bed space 1 heifer	49,000	32,000	58,000	50,000	8,000	18,000	50,000	9,500	59,000	<b>333,500</b>
<b>M2 - W</b>	6 Cubicles  1 Milking parlor, 3 Calf pens, store and straw bed space for 3 heifers	90,000	21,000	84,000	48,000	24,000	18,000	50,000	13,000	82,000	<b>430,000</b>

<b>M2 - S</b>	6 Cubicles, 1 Milking parlor, 3 Calf pens, store and straw bed space for 3 heifers	90,000	48,000	108,300	96,000	24,000	18,000	50,000	18,000	115,500	<b>567,800</b>
<b>M3 - W</b>	8 Cubicles, 1 Milking parlor, and store PLUS Separate young stock barn; 44.5m <sup>2</sup> (5 Calf pens area+ 9 heifers)	119,000	32,000	124,100	63,000	40,000	36,000	100,000	13,000	82,000	<b>609,100</b>
<b>M3 - S</b>	8 Cubicles, 1 Milking parlor, and store PLUS Separate young stock barn; 44.5m <sup>2</sup> (5 Calf pens area+ 9 heifers)	119,000	80,000	161,500	126,000	40,000	36,000	100,000	18,000	115,500	<b>796,000</b>
<b>M4 - W</b>	13 Cubicles, 2 Milking parlors, and store PLUS Separate young stock barn; 89m <sup>2</sup> (10 Calf pens area+ 6 heifers)	192,000	48,000	201,000	98,000	80,000	36,000	100,000	27,600	174,000	<b>956,600</b>
<b>M4 - S</b>	13 Cubicles, 2 Milking parlors, and store PLUS Separate young stock barn; 89m <sup>2</sup> (10 Calf pens area+ 6 heifers)	192,000	112,000	262,000	196,000	80,000	36,000	100,000	37,500	236,500	<b>1,252,000</b>

<b>M5 - W</b>	18 Cubicles, 2 Milking parlors, and store PLUS Separate young stock barn; 133m <sup>2</sup> (10 Calf pens area+ 10 heifers	256,000	64,000	276,000	133,000	80,000	36,000	150,000	37,800	238,000	<b>1,270,800</b>
<b>M5- S</b>	18 Cubicles, 2 Milking parlors, and store PLUS Separate young stock barn; 133m <sup>2</sup> (10 Calf pens area+ 10 heifers	256,000	144,000	359,000	266,000	80,000	36,000	150,000	52,000	329,000	<b>1,672,000</b>
<b>M6 - W</b>	18 Cubicles, 2 Milking parlors, and store PLUS Separate young stock barn; 177.6m <sup>2</sup> (15 Calf pens area+ 11 heifers + 9 dry cows	278,200	72,000	312,400	140,000	120,000	36,000	200,000	49,000	251,000	<b>1,458,600</b>
<b>M6- S</b>	18 Cubicles, 2 Milking parlors, and store PLUS Separate young stock barn; 177.6m <sup>2</sup> (15 Calf pens area+ 11 heifers + 9 dry cows	278,200	160,000	406,600	280,000	120,000	36,000	200,000	61,000	340,000	<b>1,881,800</b>



Notes to the cost estimates:

1. Rainwater harvesting for modules coded *M1-W, M1-S, M2-W and M2-S* comprises of plastic water tank capacity 5,000 liters, gutters/downpipe and basic concrete plinth for the tank.
2. Rainwater harvesting for modules coded *M3-W, M3-S, M4-W, M4-S, M5-T and M5-S* comprises of two plastic water tanks each of capacity 5,000 liters, gutters/downpipe and basic concrete plinth for the tank.
3. Rainwater harvesting for modules *M5-W and M5-S* comprises of three plastic water tanks each of capacity 5,000 liters, gutters/downpipe and basic concrete plinth for the tank.
4. Rainwater harvesting for modules *M6-W and M6-S* comprises of four plastic water tanks each of capacity 5,000 liters, gutters/downpipe and basic concrete plinth for the tank.
5. Young stock in cow barn modules *M1-W, M1-S, M2-W and M2-S* are housed within the lactating cow bays.
6. Young stock in cow barn modules *M3-W, M3-S, M4-W, M4-S, M5-W, M5-S, M6-W and M6-S* are housed in separate young stock barns expanding in 6 meters bays, opposite the main cow barn.
7. The cost estimates for the structures referred to in modules under item 6 above, incorporates both the main barn and the separate young stock barns described in details in the drawings
8. Rates for the unit costs used in generating the cost estimates, are summarized in the table below:

<b>QUANTITY DESCRIPTION</b>	<b>UNIT</b>	<b>RATE PER UNIT (in Kshs)</b>
Concrete floor area	M <sup>2</sup>	1,250.00
Structural columns	Piece: Wooden : Steel	1,200.00 8,000.00
Roof Structure and G.C.I sheet covering	M <sup>2</sup> :Wooden structure Steel structure	730.00 950.00
Fence, barrier rails and gates	LM: Wooden Steel	1,000.00 2,000.00
Wood for store construction	M <sup>2</sup>	3,000.00
Calf pen construction in wood	Item	8,000.00
5,000 litres rain water storage tank plus associated accessories	Item	50,000.00

9. Manure pit/store and biogas plant costs are not included in the calculation of cost estimates

## 2.5 Bills of Quantity

### MODULE M01

QUANTITY DESCRIPTION	UNIT	QUANTITY
Total barn floor area	M <sup>2</sup>	48
Concrete floor area	M <sup>2</sup>	39
Rammed earth floor area	M <sup>2</sup>	9
Structural columns	No	6 (in Wood) 4 (in Steel)
Roof area	M <sup>2</sup>	58
Fence and gates	LM	20
Dairy cows feed fence	LM	3.6
Milk parlour bays	No	1
Water troughs(Rectangular type)	No	1
Store construction and finishing works	M <sup>2</sup>	6
Calf pen(s)	Item	1
5000 litres rain water storage tank plus accessories	Item	1
Manure storage	M <sup>3</sup>	36
Biogas plant (7-12m <sup>3</sup> )	Item	1

### MODULE M02

QUANTITY DESCRIPTION	UNIT	QUANTITY
Total barn floor area	M <sup>2</sup>	96
Concrete floor area	M <sup>2</sup>	70
Rammed earth floor area	M <sup>2</sup>	26
Structural columns	No	10 (in Wood) 6 (in Steel)
Roof area	M <sup>2</sup>	114
Fence and gates	LM	36.5
Dairy cows feed fence	LM	9
Milk parlour bays	No	1
Water troughs(Rectangular type)	No	2
Store construction and finishing works	M <sup>2</sup>	6
Calf pen(s)	Item	3
5000 litres rain water storage tank plus accessories	Item	1
Manure storage	M <sup>3</sup>	72
Biogas plant (7-12m <sup>3</sup> )	Item	1

### MODULE M03

QUANTITY DESCRIPTION	UNIT	MAIN BARN QUANTITY	YOUNG STOCK BARN QUANTITY	TOTAL QUANTITY FOR MODULE
Total barn floor area	M <sup>2</sup>	96	44.5	140.5
Concrete floor area	M <sup>2</sup>	70	25	95
Rammed earth floor area	M <sup>2</sup>	26	19.5	45.5
Structural columns	No	10 (in Wood) 6 (in Steel)	6 (in Wood) 4 (in Steel)	16 (in Wood) 10 (in Steel)
Roof area	M <sup>2</sup>	114	56	170
Fence and gates	LM	36.5	10.5	47
Dairy cows feed fence	LM	9	4.5	13.5
Milk parlour bays	No	1	-	1
Water troughs (rectangular type)	No	2	1	3
Store construction and finishing works	M <sup>2</sup>	12	-	12
Calf pen(s)	Item	-	5	5
5000 litres rain water storage tank plus accessories	Item	1	1	2
Manure storage	M <sup>3</sup>	72	36	108
Biogas plant (7-12m <sup>3</sup> )	Item	1	-	1

### MODULE M04

QUANTITY DESCRIPTION	UNIT	MAIN BARN QUANTITY	YOUNG STOCK BARN QUANTITY	TOTAL QUANTITY FOR MODULE
Total barn floor area	M <sup>2</sup>	144	89	233
Concrete floor area	M <sup>2</sup>	105	48.5	153.5
Rammed earth floor area	M <sup>2</sup>	39	40.5	79.5
Structural columns	No	14 (in Wood) 8 (in Steel)	10 (in Wood) 6 (in Steel)	24 (in Wood) 14 (in Steel)
Roof area	M <sup>2</sup>	168	107	275
Fence and gates	LM	52	21	73
Dairy cows feed fence	LM	13.5	7.5	21
Milk parlour bays	No	2	-	2
Water troughs (rectangular type)	No	2	2	4
Store construction and finishing works	M <sup>2</sup>	12	-	12
Calf pen(s)	Item	-	10	10
5000 litres rain water storage tank plus accessories	Item	1	1	2
Manure storage	M <sup>3</sup>	108	36	144
Biogas plant (7-12m <sup>3</sup> )	Item	1	-	1

**MODULE M05**

<b>QUANTITY DESCRIPTION</b>	<b>UNIT</b>	<b>MAIN BARN QUANTITY</b>	<b>YOUNG STOCK BARN QUANTITY</b>	<b>TOTAL QUANTITY FOR MODULE</b>
Total barn floor area	M <sup>2</sup>	192	133.5	325.5
Concrete floor area	M <sup>2</sup>	138	66.5	204.5
Rammed earth floor area	M <sup>2</sup>	54	67	121
Structural columns	No	18 (in Wood) 10 (in Steel)	14 (in Wood) 8 (in Steel)	32 (in Wood) 18 (in Steel)
Roof area	M <sup>2</sup>	220	158	378
Fence and gates	LM	68	27	95
Dairy cows feed fence	LM	19.5	13.5	33
Milk parlour bays	No	2	-	2
Water troughs (rectangular type)	No	3	2	5
Store construction and finishing works	M <sup>2</sup>	12	-	12
Calf pen(s)	Item	-	10	10
5000 ltr rain water storage tank plus accessories	Item	2	1	3
Manure storage	M <sup>3</sup>	144	36	180
Biogas plant (7-12m <sup>3</sup> )	Item	1	-	1

**MODULE M06**

<b>QUANTITY DESCRIPTION</b>	<b>UNIT</b>	<b>MAIN BARN QUANTITY</b>	<b>YOUNG STOCK BARN QUANTITY</b>	<b>TOTAL QUANTITY FOR MODULE</b>
Total barn floor area	M <sup>2</sup>	192	177.6	369.6
Concrete floor area	M <sup>2</sup>	138	84.6	222.6
Rammed earth floor area	M <sup>2</sup>	54	93	147
Structural columns	No	18 (in Wood) 10 (in Steel)	18 (in Wood) 10 (in Steel)	36 (in Wood) 20 (in Steel)
Roof area	M <sup>2</sup>	220	208	428
Fence and gates	LM	68	33	95
Dairy cows feed fence	LM	19.5	19.5	39
Milk parlour bays	No	2	-	2
Water troughs (rectangular type)	No	3	3	6
Store construction and finishing works	M <sup>2</sup>	12	-	12
Calf pen(s)	Item	-	15	15
5000 litres rain water storage tank plus accessories	Item	2	2	4
Manure storage	M <sup>3</sup>	144	72	216
Biogas plant (7-12m <sup>3</sup> )	Item	1	-	1

## CHAPTER THREE FINANCING PLAN

### 3.1 Success Factors for Profitable Dairy Farming

The success of a dairy enterprise is determined by a number of factors, of which some are external and others are internal. The latter are related to the management skills and knowledge of the owner or farm manager.

As regards to the external factors, these include for example the market dynamics in terms of price levels paid for raw and processed milk and milk products, access to the market (distance, organisation of milk sales and marketing), availability and affordability of quality services and inputs, government policies and weather conditions and soils.

In many cases individual farmers have little influence as regards to these so-called external factors, unless organised in strong and effective producer and/or marketing organisations. Or in case of weather and climatic conditions, by taking timely and appropriate steps as regards to fodder preservation.

Hence, the main factors for success that can also be controlled by the farmer, are his management and dairy production skills, and that of his workforce. These ought to be concerned with a continuous focus on increased productivity and cost price reduction, rather than "dependency and lobbying" merely for higher milk prices or subsidized inputs, as is now often the case in the Kenyan dairy sector. The latter can easily lead to an unwanted situation of subsidizing inefficient farming and milk supply chains, at the cost of the consumer.

The most important attributes of a professional dairy entrepreneur are:

- a) *Herd fertility management and calf rearing*: The farm needs to focus very closely on appropriate breeds, herd turnover, calving intervals, fertility, calf rearing, cow health and all other aspects that determine healthy herd build-up.
- b) *Feeding*: Proper year-round feeding regimes and unlimited access to clean water are the fundamental factors for a healthy, fertile and high producing dairy herd. This also implies investment in on-farm fodder production and preservation and relevant equipment (e.g. a chaff cutter).
- c) *Housing*: Cow comfort and hygiene are crucial for a high performing dairy herd in terms of milk production.
- d) *Management team*: The farm will engage the right people for the right job and shall use Standard Operational Procedures (SOPs) for routine operations. Performance indicators will be developed for the workers who will be closely monitored. Good performance will be acknowledged and rewarded.
- e) *Data and information systems*: The farm will manage its own internal performance through proper farm recording.
- f) *Continuous professional development*: The farm will aim at regular training of its manager(s) and farm workers.
- g) *Quality*: The quality of the milk and of the herd in general, will determine the price and the growth in the sales of milk and heifers.

- h) *Marketing, branding and networking processes*: The farm will work towards responding accurately to the needs of its market. The management will have formal engagements with the market to protect the business operations from short term or frequent oscillations in pricing, quantities and quality.
- i) *Risk management*: The farm will work out a risk profile and endeavours to implement the appropriate measures to mitigate the risks – prevention as well as insurance.

### **3.2 Projected Income Statement and Economic Viability**

In this section (see the table below) a prognosis is made of the Internal Rate of Return (IRR) and the Pay-Back Period (PBP), as measures of economic viability of the dairy enterprise that is investing in the 3, 8, 13 or 18 cow barn module. This prognosis is based on the cost for each module provided in the table in paragraph 2.4 above, and the average production costs and income from sales of milk, bull calves and culls.

The prognosis mainly relies on empirical data from the field, collected and analysed by Perfometer Agribusiness Ltd, in combination with data from a 2011 study by Tegemeo Institute of Agricultural Policy and Development, on the cost/revenue relationships among Kenyan dairy farmers in North Rift, Nyeri and Kiambu regions (Ref. No. WP43/2011: Productivity Trends and Performance of Dairy Farming in Kenya).

In this model the farmer grows his herd through raising of his own heifers, except for the first 3 which are purchased from third parties. Cost for raising heifers born in the farm from birth to calving have been incorporated in the model.

The prognosis works with a production of 20 litres of milk per cow for 300 days/year and an average sales price of KES 35 per litre throughout the year. It is acknowledged that the 20 litre figure is considerably higher than the current average for smallholders in Kenya. However this handbook targets smallholders that have the ambition to perform at this level. Hence the title: "Smallholder Dairy *Entrepreneurs*".

As regards to the sales price of raw milk, this is the average paid by most processors throughout 2015. If the farmer decides and has the opportunity to sell to institutions and end-consumers directly, the sales price is usually much higher (up to KES 50-60 per litre). In the model, the cost of the barn has been included as an expense, as opposed to debiting its depreciation as an annual expense until its book value equals zero. Other assumptions and methods used for calculating the IRR and the PBP are explained in the notes to the table presented on the next page.

The Internal Rate of Return (IRR) is the rate of return on an investment. In this model the interest rate used to benchmark the economic viability of the investment against, is the amount/interest earned by an investor from a fixed deposit. The decision to accept or reject the investment proposal, depends on whether the IRR is higher than the interest rate of the fixed deposit. In other words, the decision criteria for the dairy investment is simple: accept the project if the IRR is higher than the interest on a fixed deposit, or reject if it is lower.

In this case of investing in the modular cow barn design and a herd of high breed dairy cows, the IRR for each module (including initial investment in purchase of 3 in-calf heifers and costs of raising heifers born on-the-farm) is higher, compared to the interest on fixed deposits which is taken here as 10%. The average IRR is 14.07%. In this scenario the investment is economically viable.

As regards to the Pay-Back Period (PBP), the table shows a PBP for the time period required to recoup the investment of the barn only, as well as for the barn plus the purchased heifers and the costs of expanding the herd through natural growth.

**Table: Income Statement Projections (IRR and PBP)**

	Prod/Cow /Day	Valued at	Day-Total	Monthly	Annual	3 Cows	8 Cows	13 Cows	18 Cows	%
<b>Particulars</b>				30	12	3	8	13	18	
<b>Sources of Revenue</b>										
Sale of Milk Produced (Incl. Value of Consumed Milk)	20	35	700	21000	252000	756000	2016000	3276000	4536000	87.5%
Sale of Stock: Average Allocation ( <b>Note 4</b> )			100	3000	36000	108000	288000	468000	648000	12.5%
<b>Total Revenues</b>			<b>800</b>	<b>24000</b>	<b>288000</b>	<b>864000</b>	<b>2304000</b>	<b>3744000</b>	<b>5184000</b>	
<b>Cost Elements</b>	Units	Unit Cost	Total	Monthly	Annually	Increasing number of milking cows				
Transporting cooling/pasteurizing/milk	20	1.5	30	900	10800	32400	86400	140400	194400	4%
Fodder ( <b>Note 1</b> )	10	20	200	6000	72000	216000	576000	936000	1296000	30%
Veterinary & insemination expenses			35	1050	12600	37800	100800	163800	226800	5%
Labour ( <b>Note 3</b> )			40	1200	14400	43200	115200	187200	259200	6%
Maintenance and repair ( <b>Note 2</b> )			60	1800	21600	64800	172800	280800	388800	9%
Tools, equipment, inputs			15	450	5400	16200	43200	70200	97200	2%
Electricity and water			25	750	9000	27000	72000	117000	162000	4%
Concentrates ( <b>Note 1</b> )			200	6000	72000	216000	576000	936000	1296000	30%
Minerals ( <b>Note 1</b> )			30	900	10800	32400	86400	140400	194400	4%
<b>Sub-Total</b>			<b>635</b>	<b>19050</b>	<b>228600</b>	<b>685800</b>	<b>1828800</b>	<b>2971800</b>	<b>4114800</b>	
Add 5% Miscellaneous					11430	34290	91440	148590	205740	5%
<b>Total</b>					<b>240030</b>	<b>720090</b>	<b>1920240</b>	<b>3120390</b>	<b>4320540</b>	<b>100%</b>
<b>Annual Net Profit =Total Revenue-Total Operat Costs</b>			<b>165</b>	<b>4950</b>	<b>47970</b>	<b>143910</b>	<b>383760</b>	<b>623610</b>	<b>863460</b>	<b>17%</b>
Monthly Net Profit (Annual Net Profit/12 Months)						11992.5	31980	51967.5	71955	
<b>Estimated Cost of Cow Barn</b>						<b>3</b>	<b>8</b>	<b>13</b>	<b>18</b>	
Wood						258400	609100	956600	1270800	
Steel						333500	796000	1252000	1672000	
<b>Pay Back Period in Years</b>										
Wood						1.8	1.59	1.53	1.5	
Steel						2.32	2.07	2.01	1.94	
<b>Estimated Initial Cost of Cows</b>		180000				540000				
Pay Back Period in Years on purchase of 3 heifers						3.75	<b>(Note 6)</b>			
Combined PBP (Wood Cow Barn + Cows)						5.55	3.9	3.53	3.36	
Combined PBP (Steel Cow Barn + Cows)						6.07	4.10	3.65	3.44	
Combined Cost of Barn + Cows (Wood)						798400				
Combined Cost of Barn + Cows (Steel)	3 Cows	8 Cows	13 Cows	18 Cows		873500				
Total Cost of Cow Barn (Steel)		333500	796000	1252000	1672000					
Total Cost of In Calf Heifers ( <b>Note 4</b> )		540000	1240000	1940000	2360000					
Total Cost of Chaff Cutter & Milk Machine (8-18 Cows)		140000	340000	340000	340000					
Working Capital 90 days x Cost/Cow/Day - ( <b>Note 5</b> )		168750	457200	742950	1028700					
Total Capital Required		<b>1182250</b>	<b>2833200</b>	<b>4274950</b>	<b>5400700</b>	Av. IRR	The dairy investment will yield return on capital of 14.07%, compared to fixing the capital in the bank, with a return of maximum 10% annually.			
<b>Internal Rate of Return (IRR)</b>		12.17%	13.5%	14.6%	16.0%	<b>14.07%</b>	The investment is viable.			

**Notes to the table:**

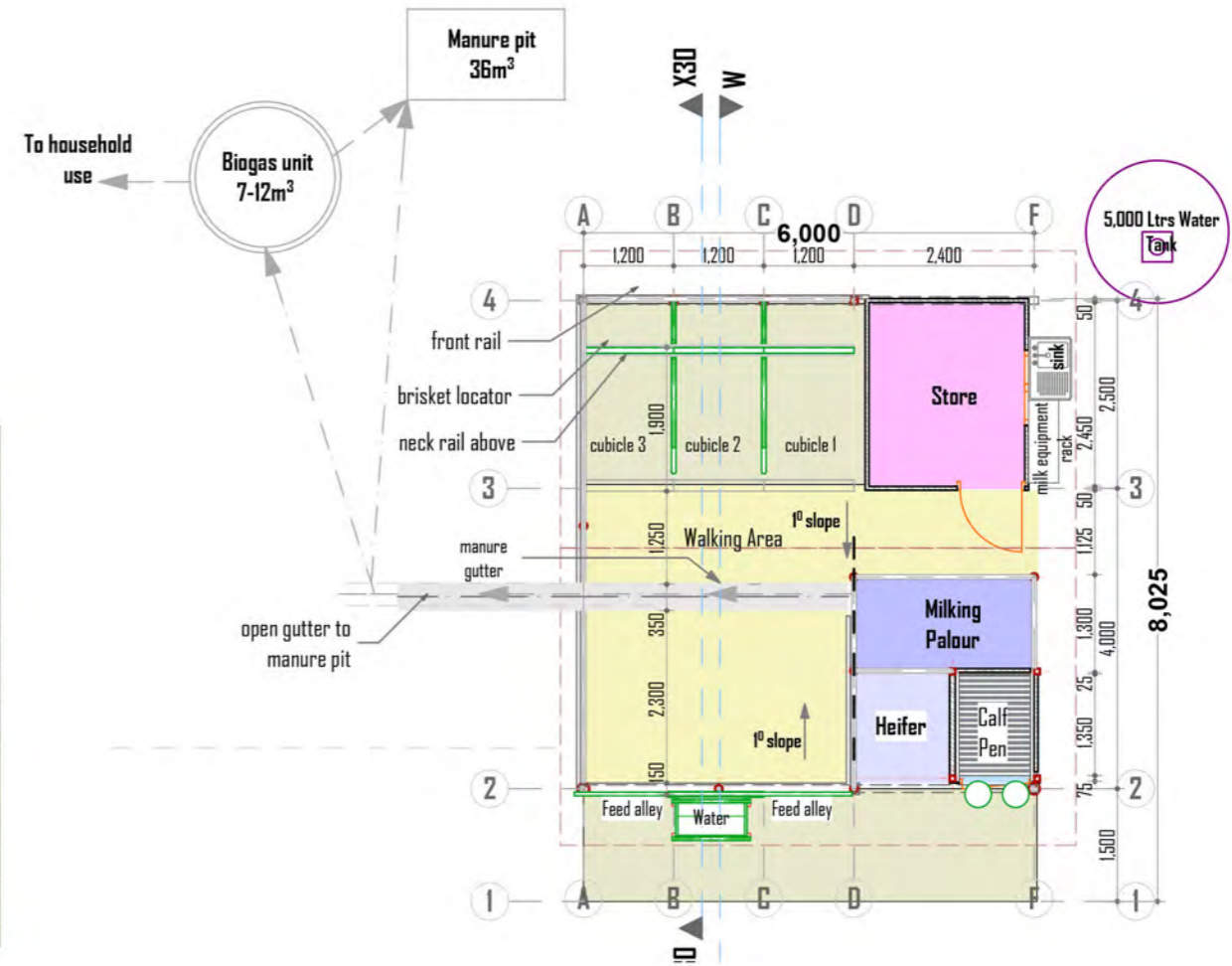
1. a. The total cost of feeding in this model is adding up to 64%, which agrees with many studies done in Kenya. This % is the sum total of forages 30%, concentrates 30% and minerals 4%. Dairy farmers feed more concentrates to complement forage with low feeding value, such as low quality hay, overgrown and non-fertilised Napier grass and other grasses, maize stovers, low leaf/high stem content lucern hay.
- b. The 10 units of fodder in column 2 refers to 10 kgs of dry matter intake per day and applies to all the livestock units in the farm. The dry matter for the young stock is therefore taken care of in this calculation.

2. The repair/maintenance of equipment includes the cow barn (floor, walls, roofs and where applicable the milk lines).
3. The labour expense refers to paid labour and not to family labour. The assumption is that most dairy farmers with 2-3 cows only require a parttime labourer and therefore at 3 cows, the annual labour costs of Ksh. 43,200. However at 4 cows given that the dairy farm owners are the older generation, most farms are likely to have the first full-time labourer. The annual cost of labour rises to Ksh. 115,200. This implies a total Ksh. 67,600 per full time worker per year (or 188 per day), this is a common wage level for a worker who is housed and fed by the farmer. In most cases this level of workers are semi-literate, unskilled and have no specific knowledge of dairy, but they learn by doing. Their performance largely depends on the quality of instruction given by the supervisor/owner.
4. The model takes into account that the farmer will build up his herd through natural growth. As such, no heifers (female calves) will be sold during the time of building up the herd. This means that the sale of stock reflected in the table refers to sales of bull calves and culls only. The farmer in this case chooses to grow his own herd rather than to buy all the required cows at the beginning, in order to reduce the required start-up capital. Heifers in the Kenyan market are currently priced based on prevailing demand instead of the cost of production.  
The figure used of Ksh. 140,000 per heifer as the cost from birth to first calving, is obtained from one of the Kenyan farms that is well known for good practices in calf rearing and above average feeding efficiency. The cost of raising a heifer is however cheaper in the case of free grazing systems.
5. Working capital has been calculated as the daily consolidated cost keeping one cow for 90 days. Therefore, the higher the number of cows the higher the working capital.
6. For herd build-up, it is estimated that 5 new heifers will be introduced to the initial herd of 3 in three years adding up to 8. In another 5 years, the herd of 8 (at a birth rate of 3 calves per year) will yield 12 new calves, with a possibility of 7 heifers where no sexed semen is used. This means that the herd will grow to 15 cows in 10 years. In this scenario, the farmer having started with 3 in-calf heifers will grow the optimal herd of 18 in 10-12 years. Buying the entire or part of the herd is an option, but this requires a different calculation. It would be more capital intensive from the onset, but will see earlier returns as regards to sales of milk and young stock, to offset the higher capital investment and the operational expenses.



## **ANNEX 1. FLOORPLANS, SECTIONS AND DETAILS (A4)**

*Please note that the scale of the drawings in this annex is 1:100 but only if printed on A3. The A3-size drawings, sections and details can be downloaded from the SNV Kenya KMDP and CowSoko websites*



Scale 1: 100

**Module's herd capacity**

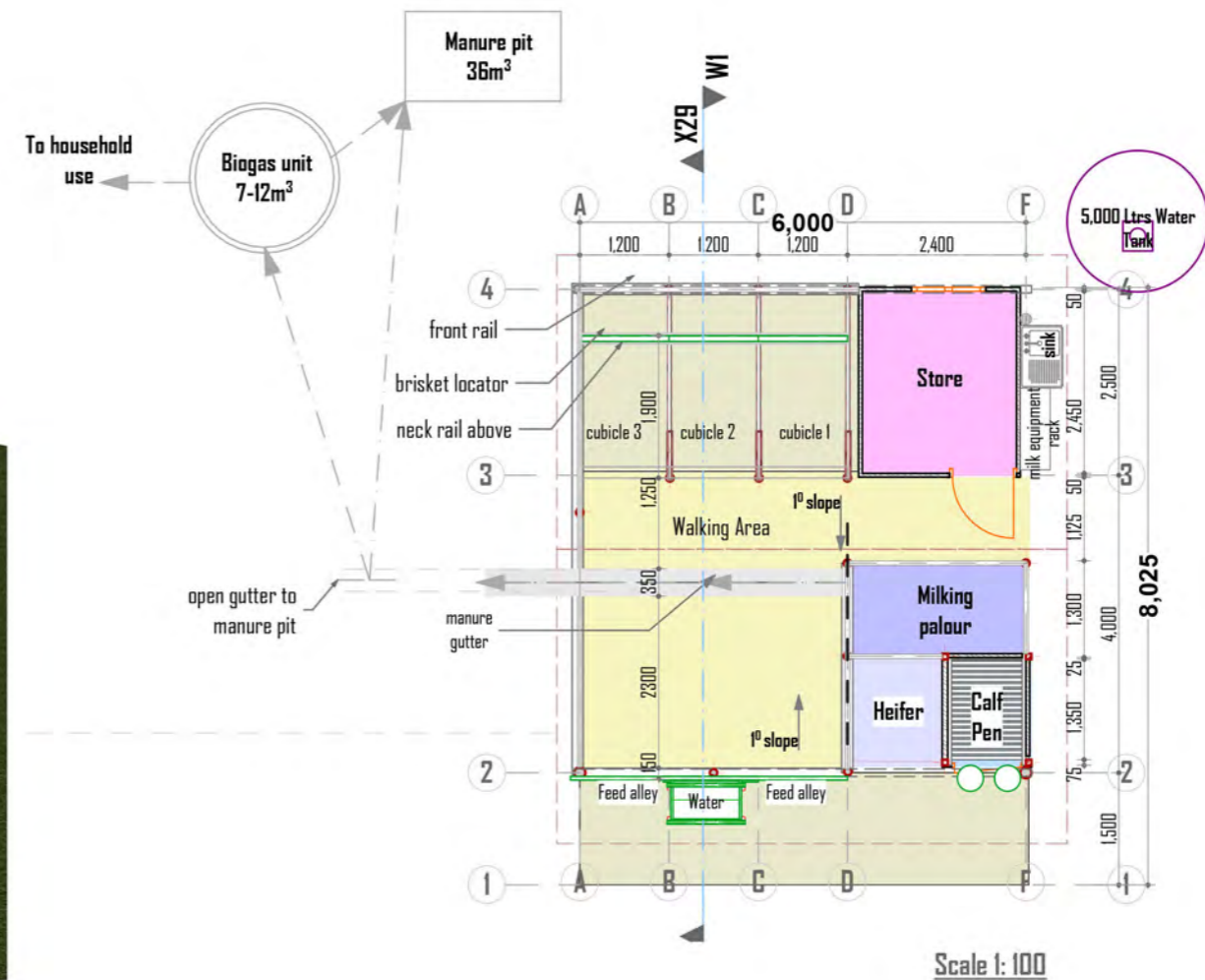
- 03 Cows
- 01 Heifers
- 01 Calf

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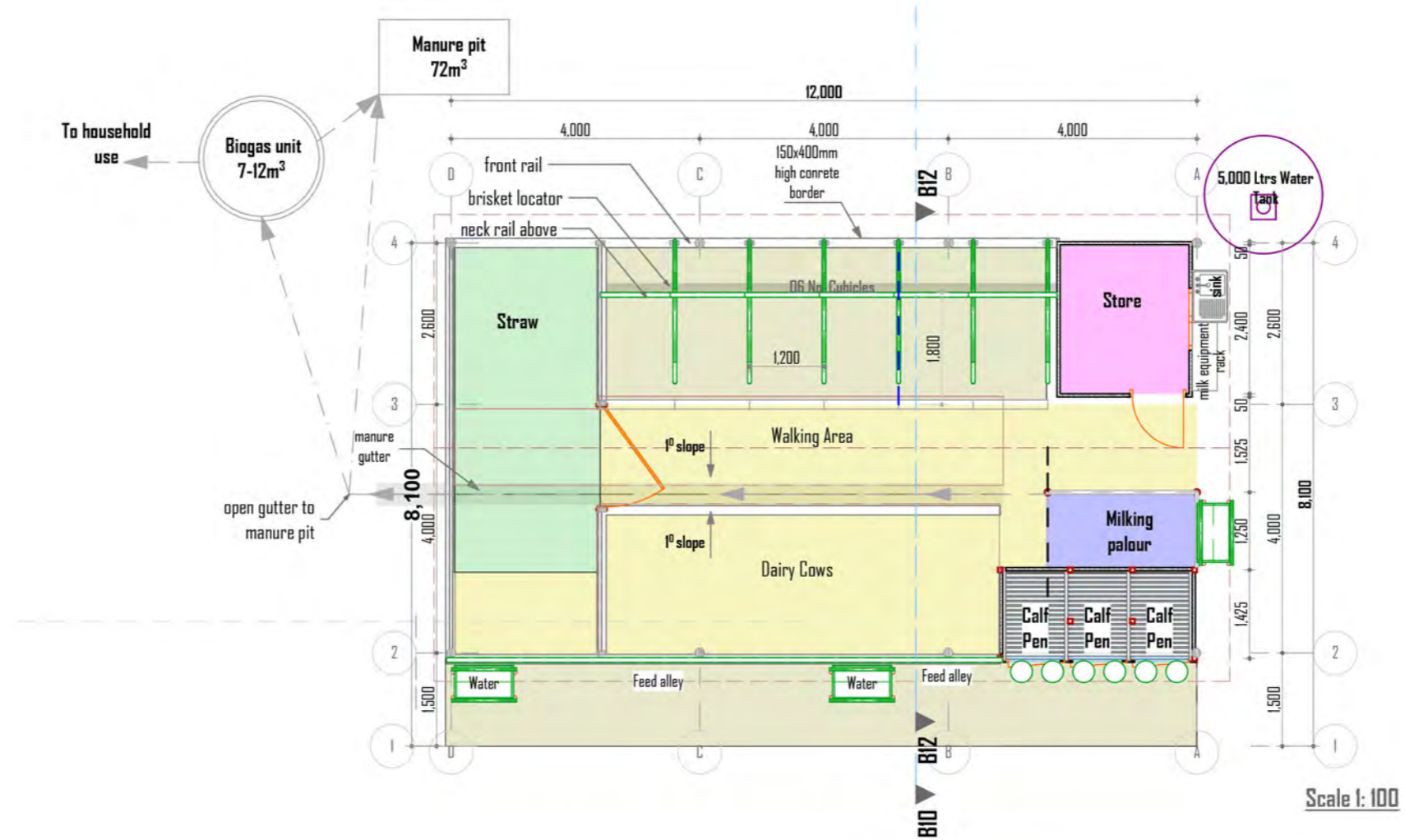
**Module's herd capacity**

- ☐ 03 Cows
- ☐ 01 Heifers
- ☐ 01 Calf

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**Module's herd capacity**

- 06 Cows (Including dry cows)
- 03 Heifers
- 03 Calves



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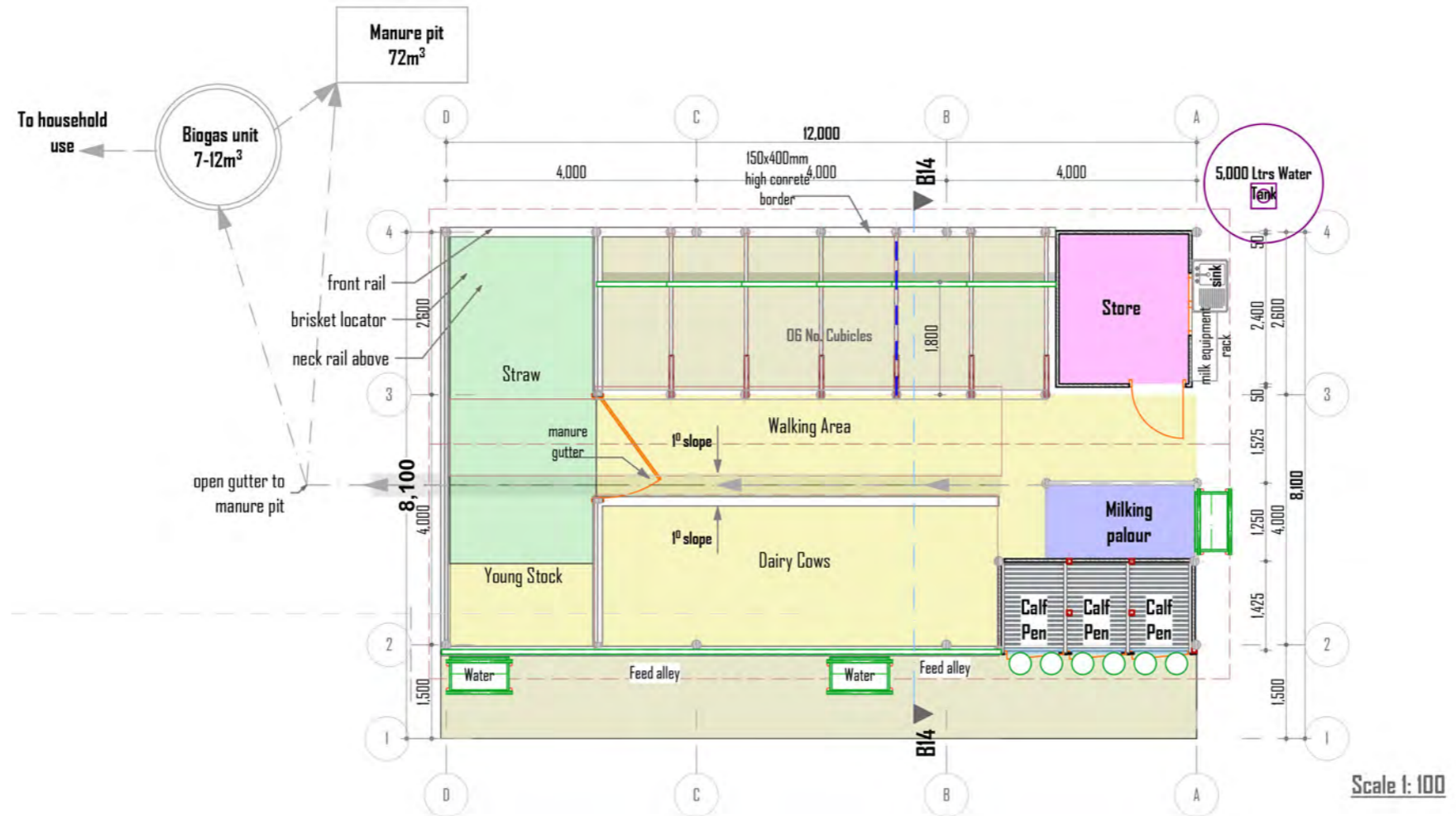
**SNV SMALLHOLDER COWBARN MODULE 02 - STEEL CONSTRUCTION JAN. 2016**

**PERFORMETER**  
 DAILY GROWING DAIRY

**SNV**

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**Module's herd capacity**

- 06 Cows (Including dry cows)
- 03 Heifers
- 03 Calves



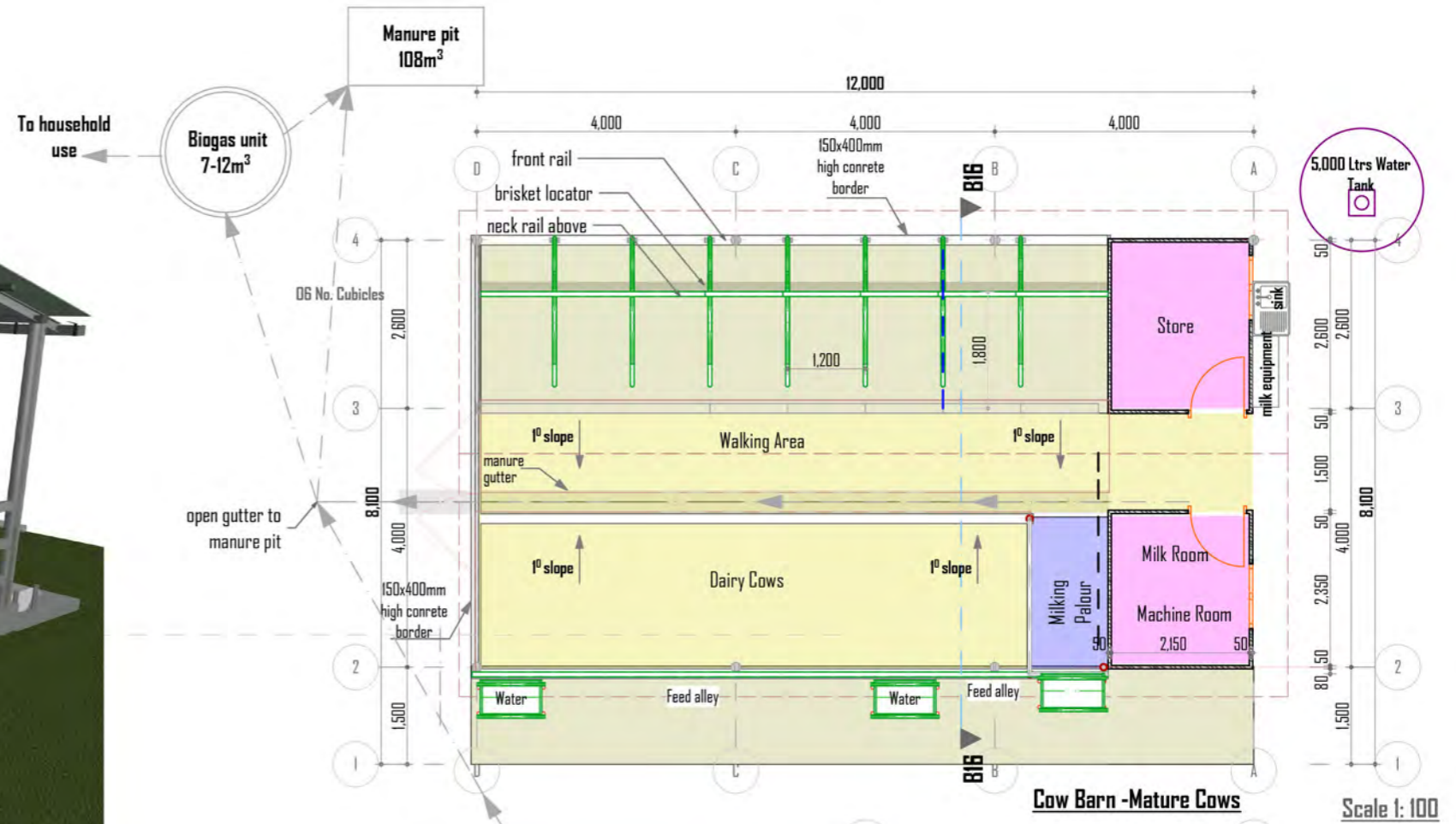
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**SNV SMALLHOLDER COWBARN MODULE 02 - WOOD CONSTRUCTION JAN. 2016**

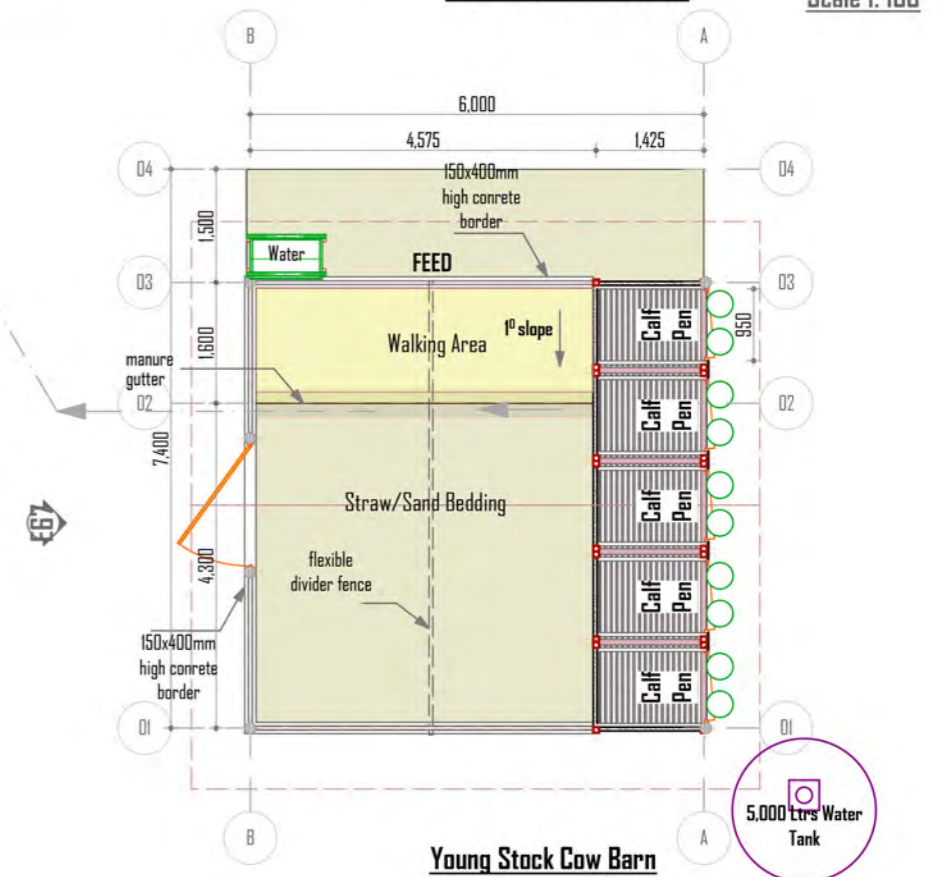
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**Module's herd capacity**

- 08 Cows (Including dry cows)
- 09 Heifers
- 05 Calves



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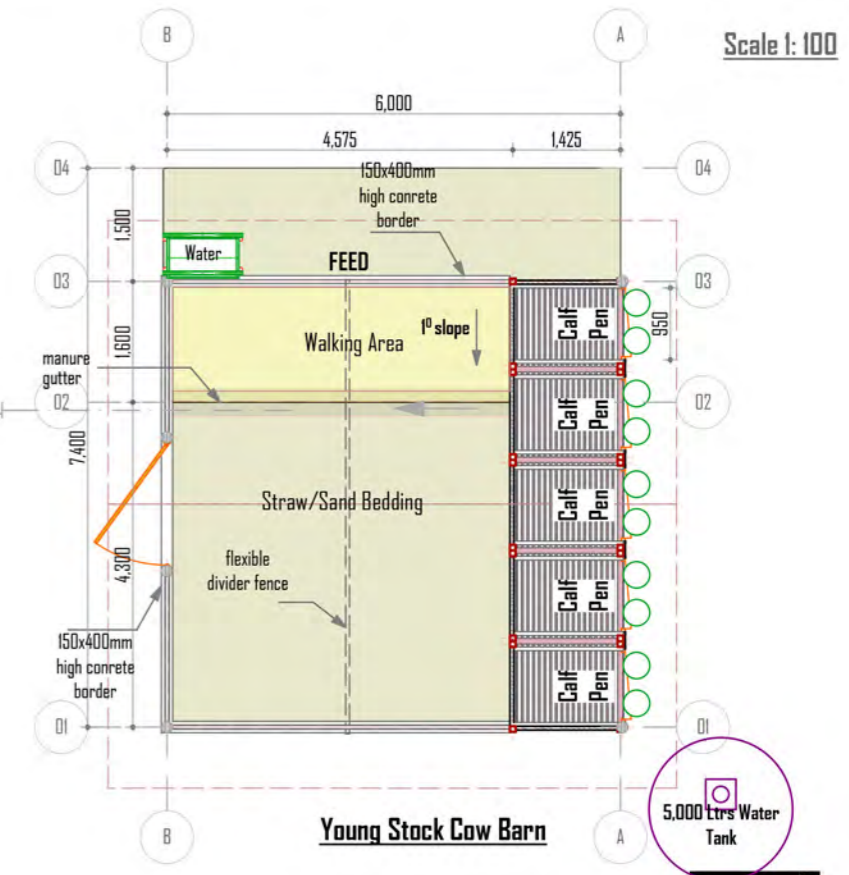
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**Module's herd capacity**

- 08 Cows (Including dry cows)
- 09 Heifers
- 05 Calves



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SNV SMALLHOLDER COWBARN MODULE 03 - WOOD CONSTRUCTION JAN. 2016

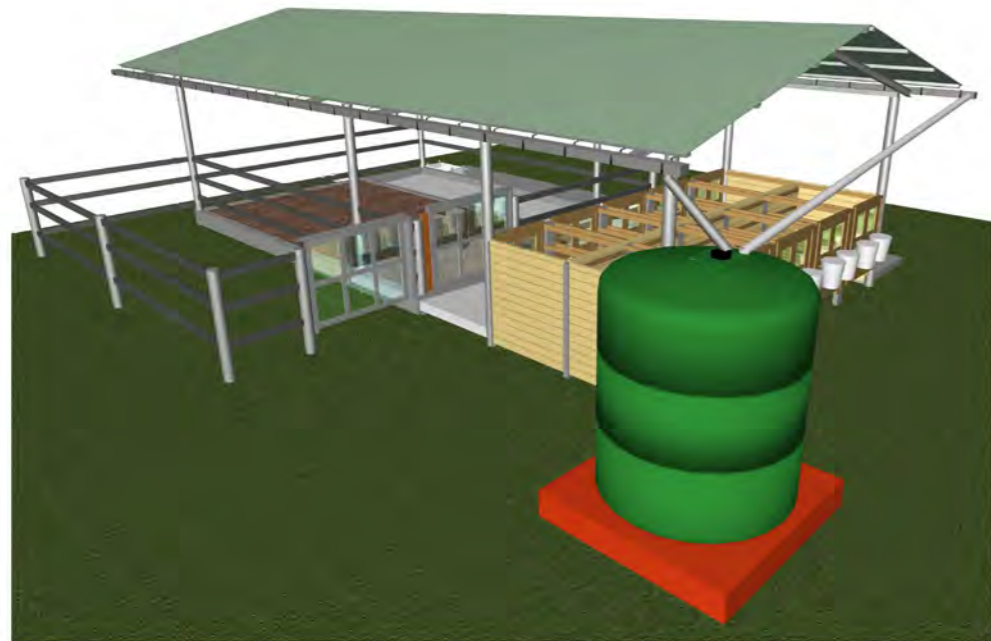
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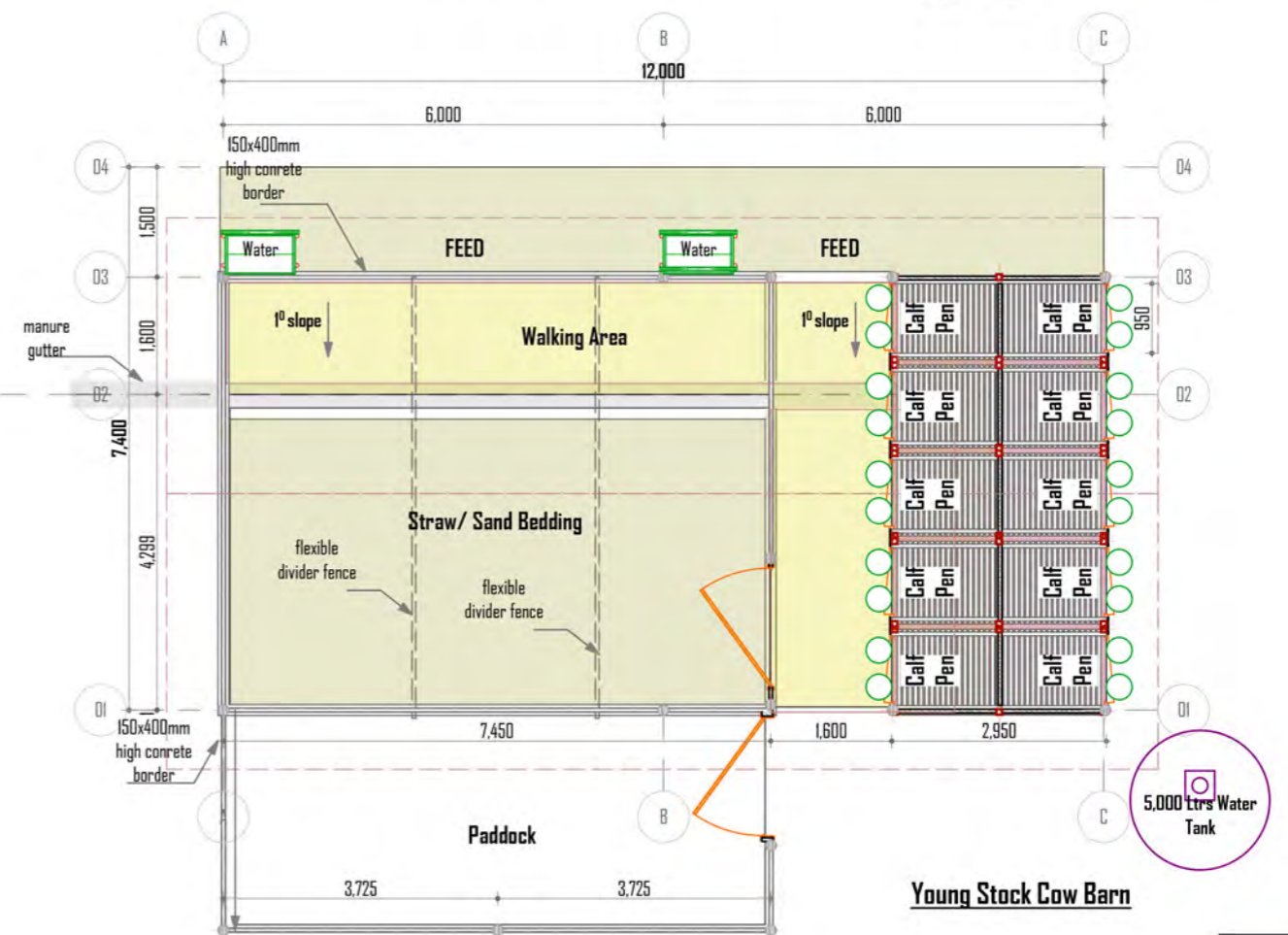
**Module's herd capacity**

- 13 Cows (Including dry cows)
- 06 Heifers
- 10 Calves



**Cow Barn - Mature Cows**

Scale 1:100



**Young Stock Cow Barn**

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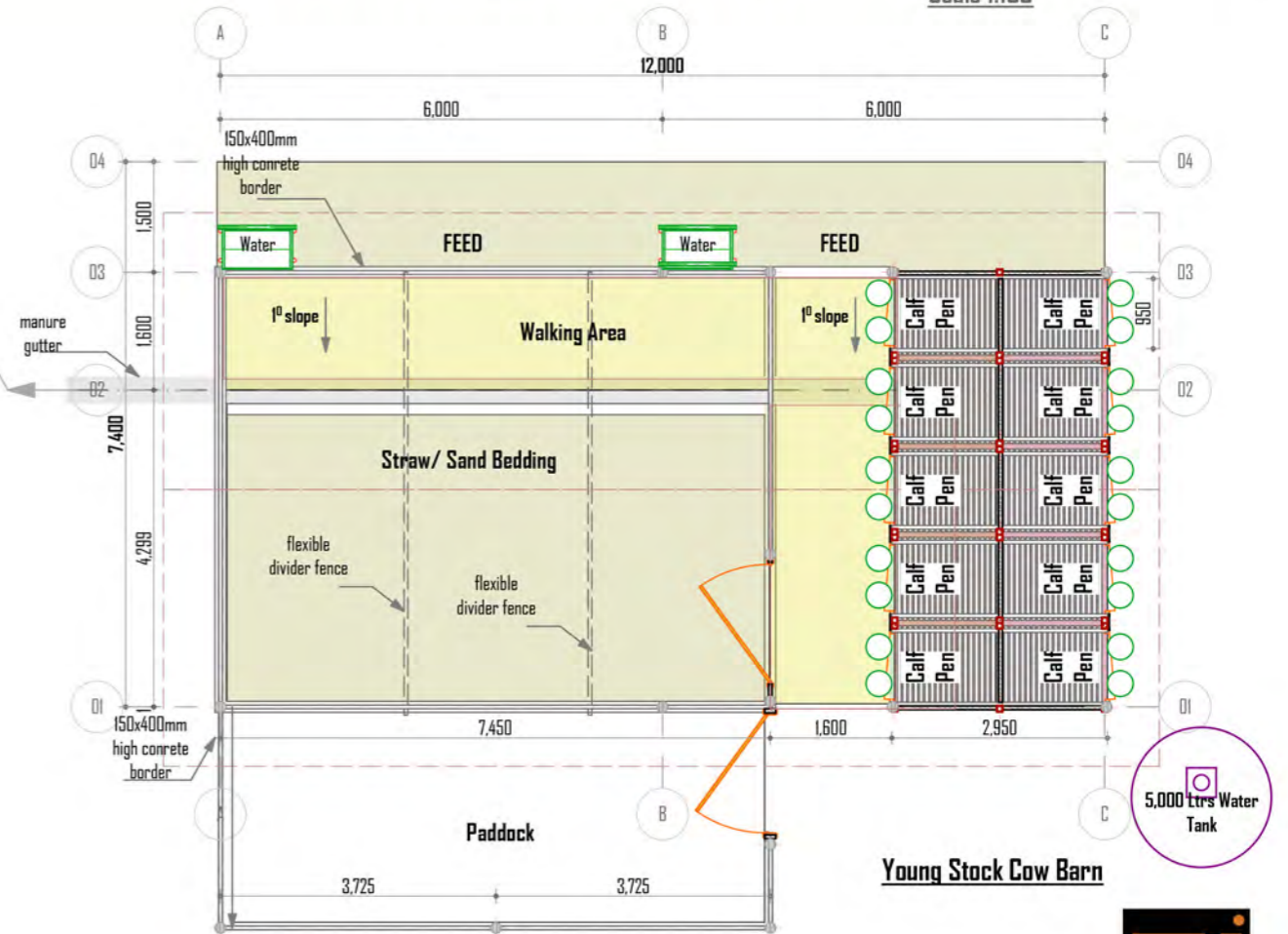
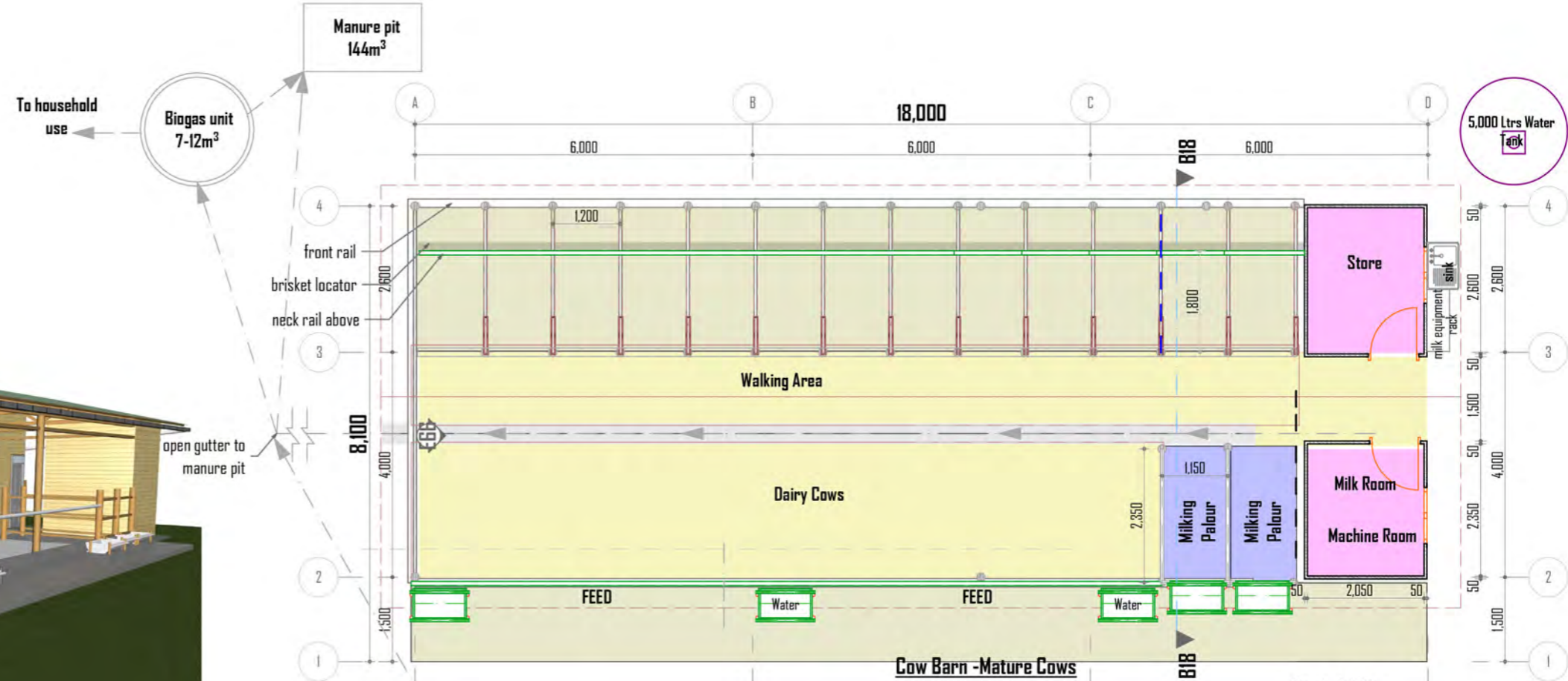
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**Module's herd capacity**

- 13 Cows (Including dry cows)
- 06 Heifers
- 10 Calves

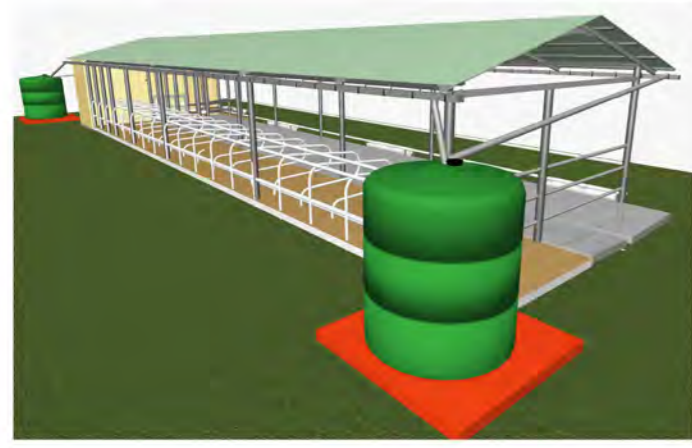
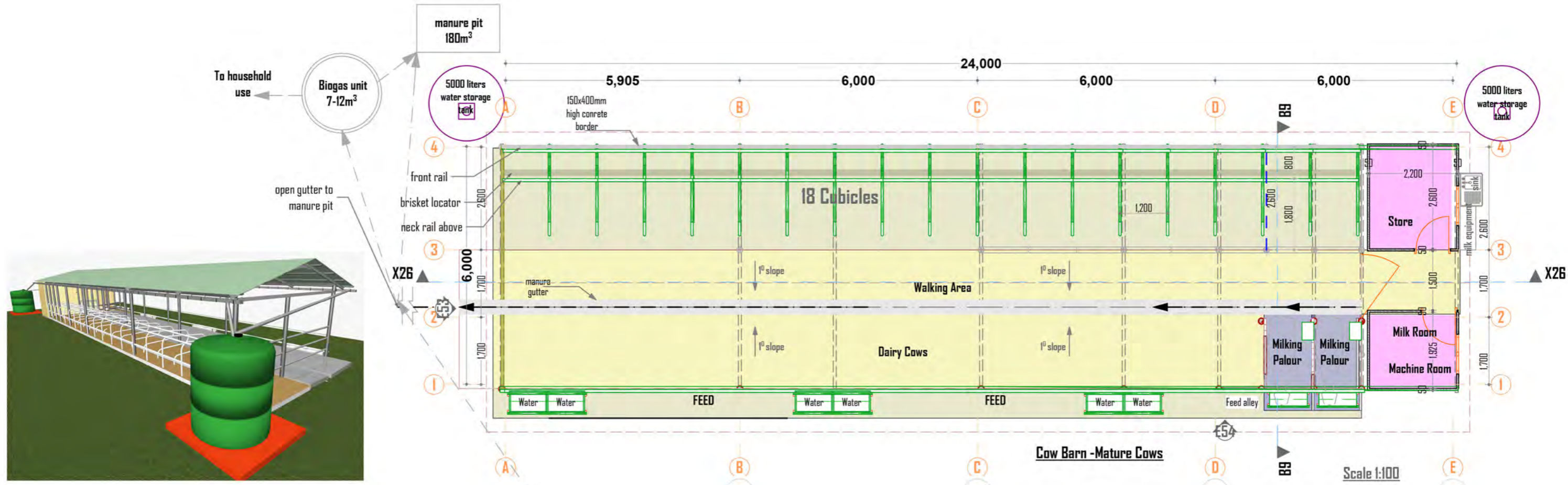


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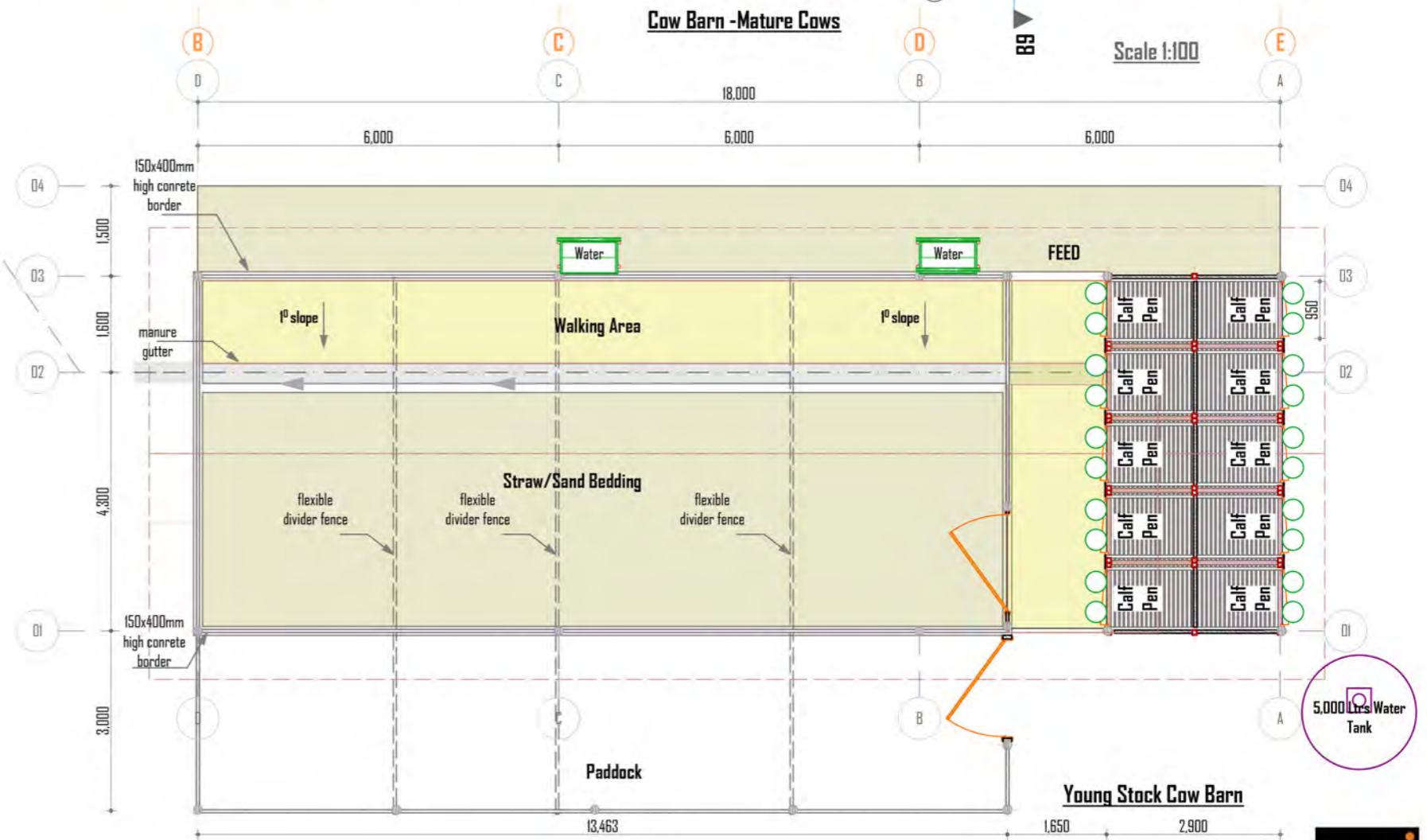
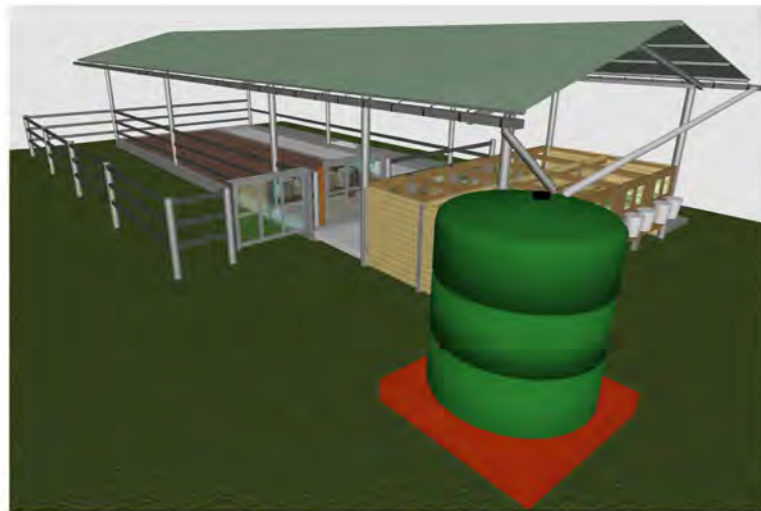
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**Module's herd capacity**

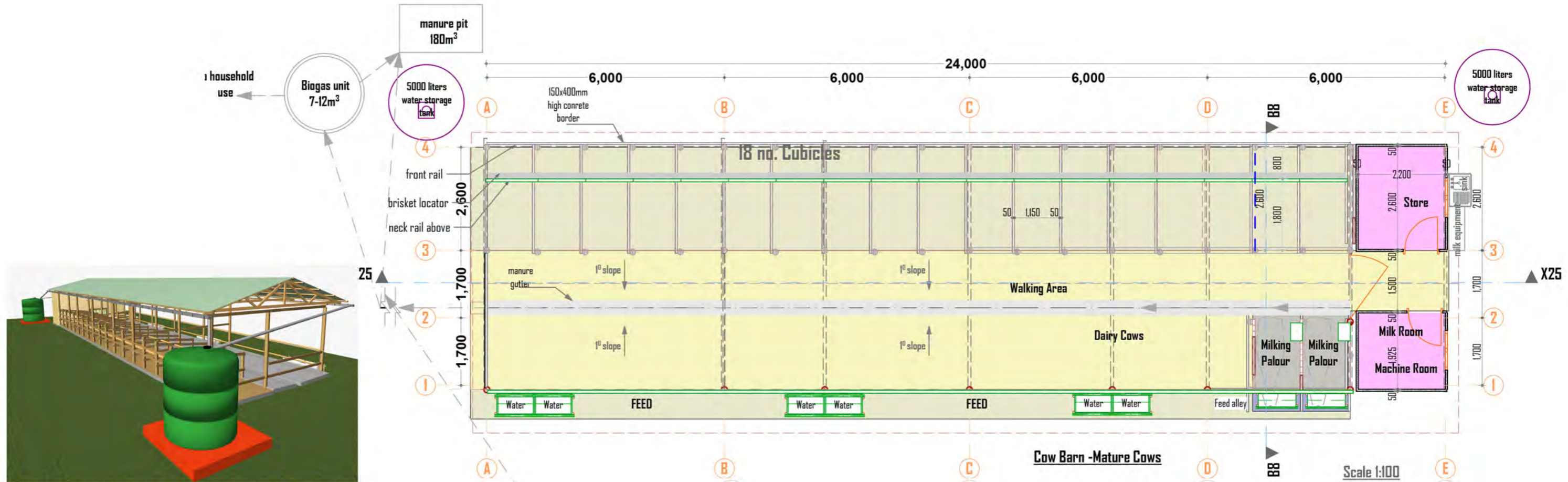
- 18 Cows (Including dry cows)
- 10 Heifers
- 10 Calves



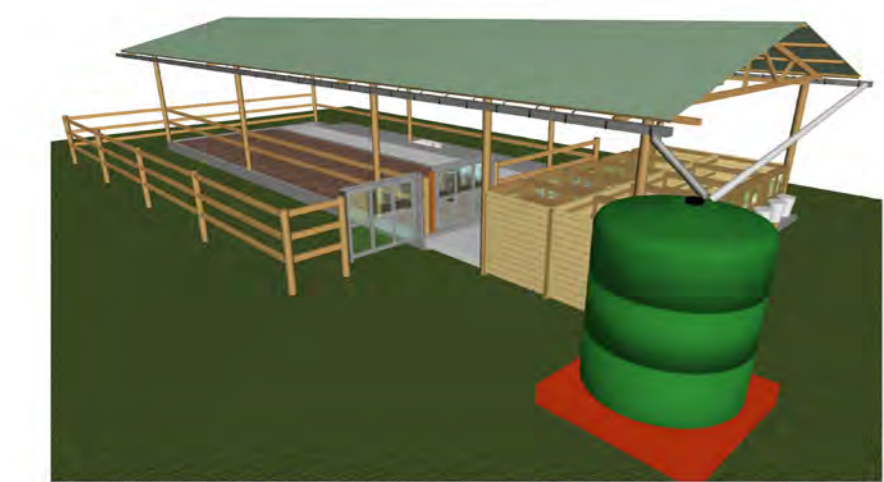
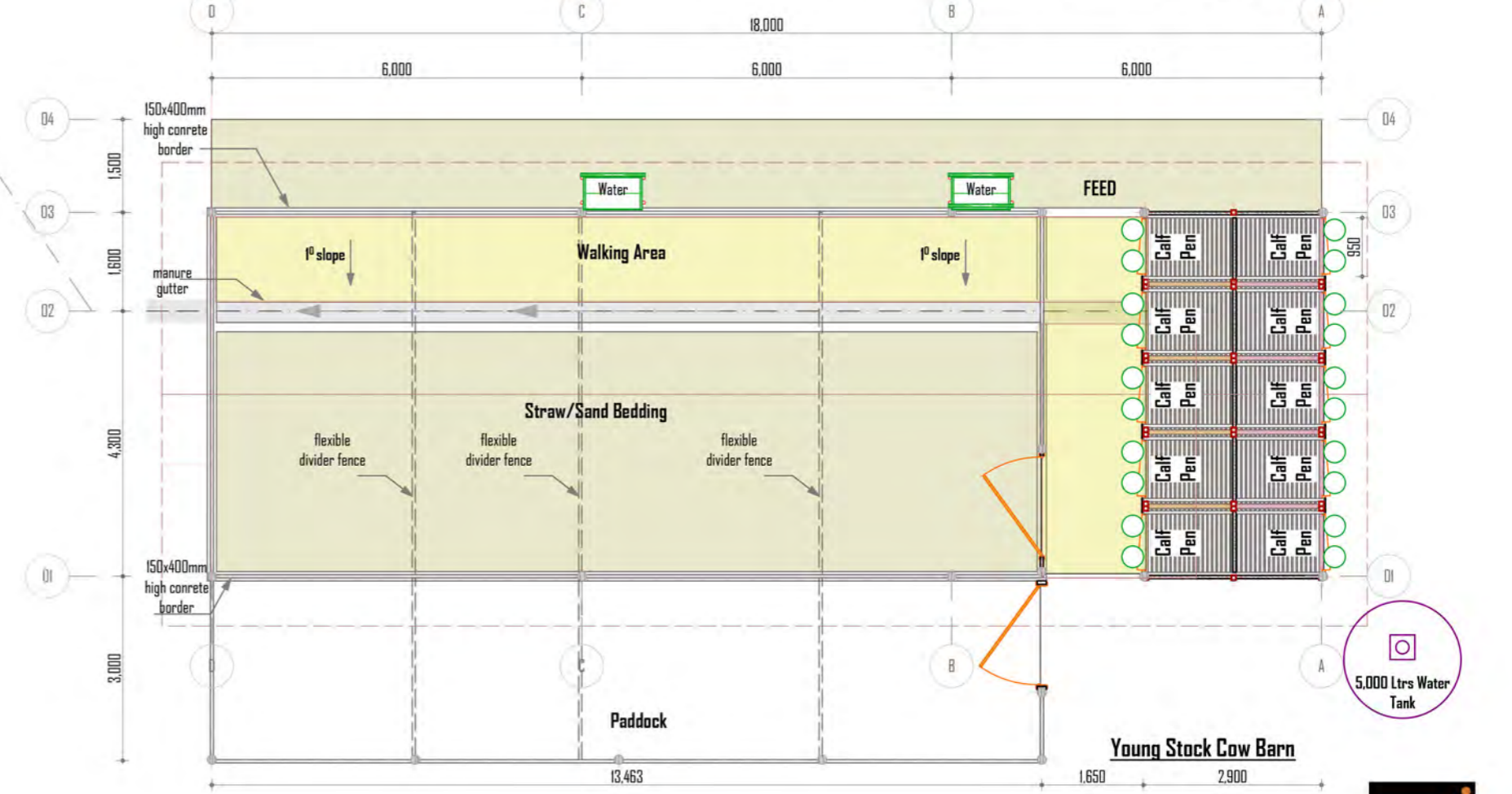
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- Module's herd capacity**
- 18 Cows (Including dry cows)
  - 10 Heifers
  - 10 Calves



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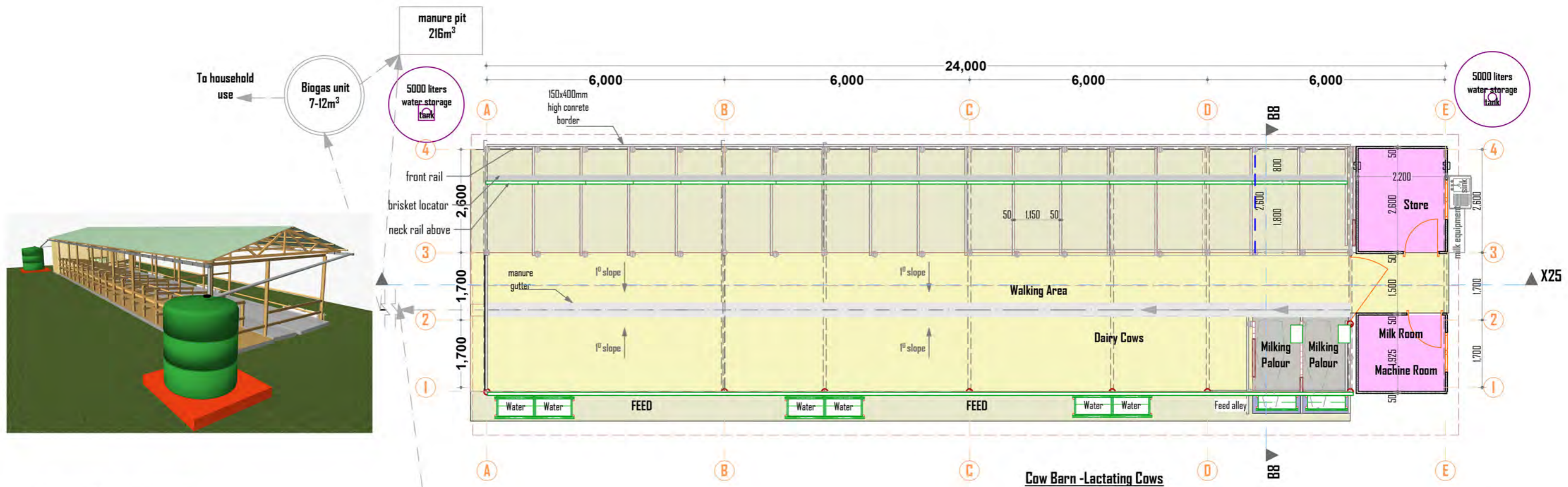


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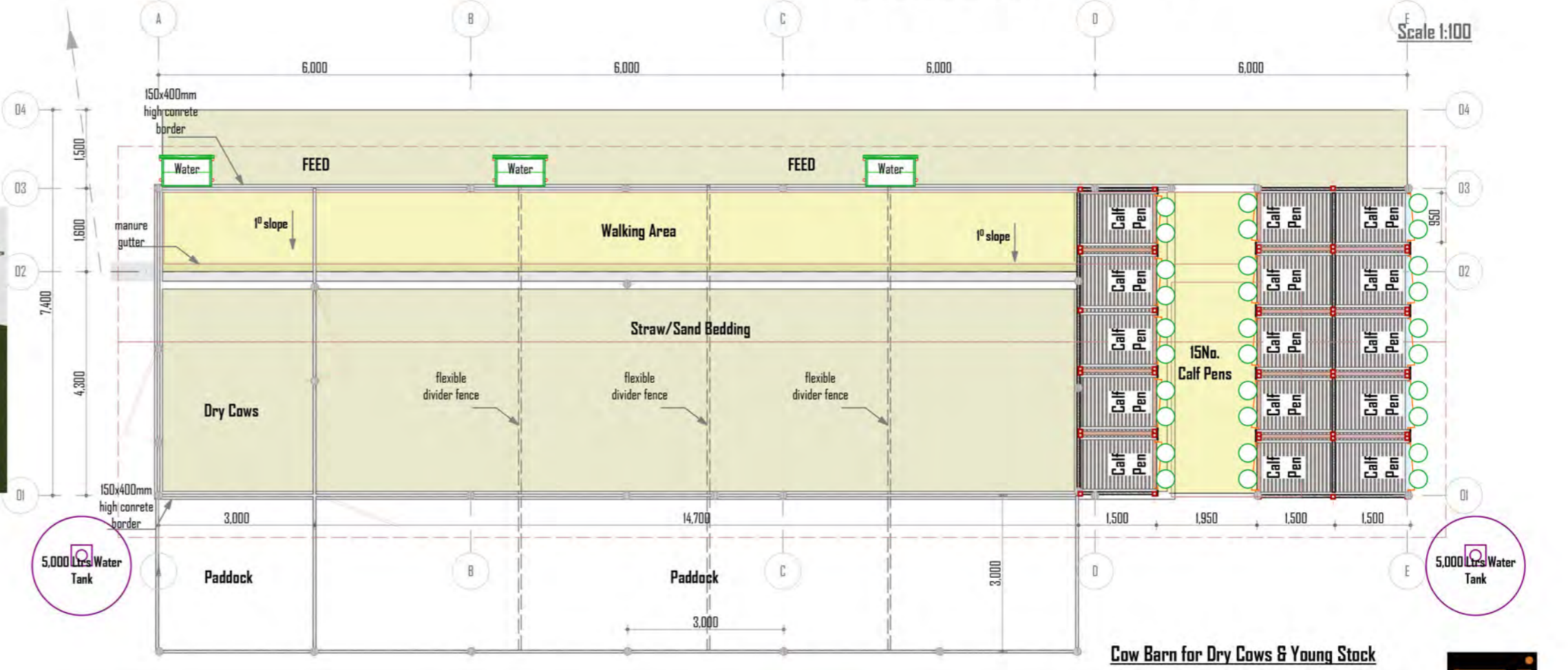






**Module's herd capacity**

- 18 Milking Cows
- 09 Dry Cows
- 11 Heifers
- 15 Calves

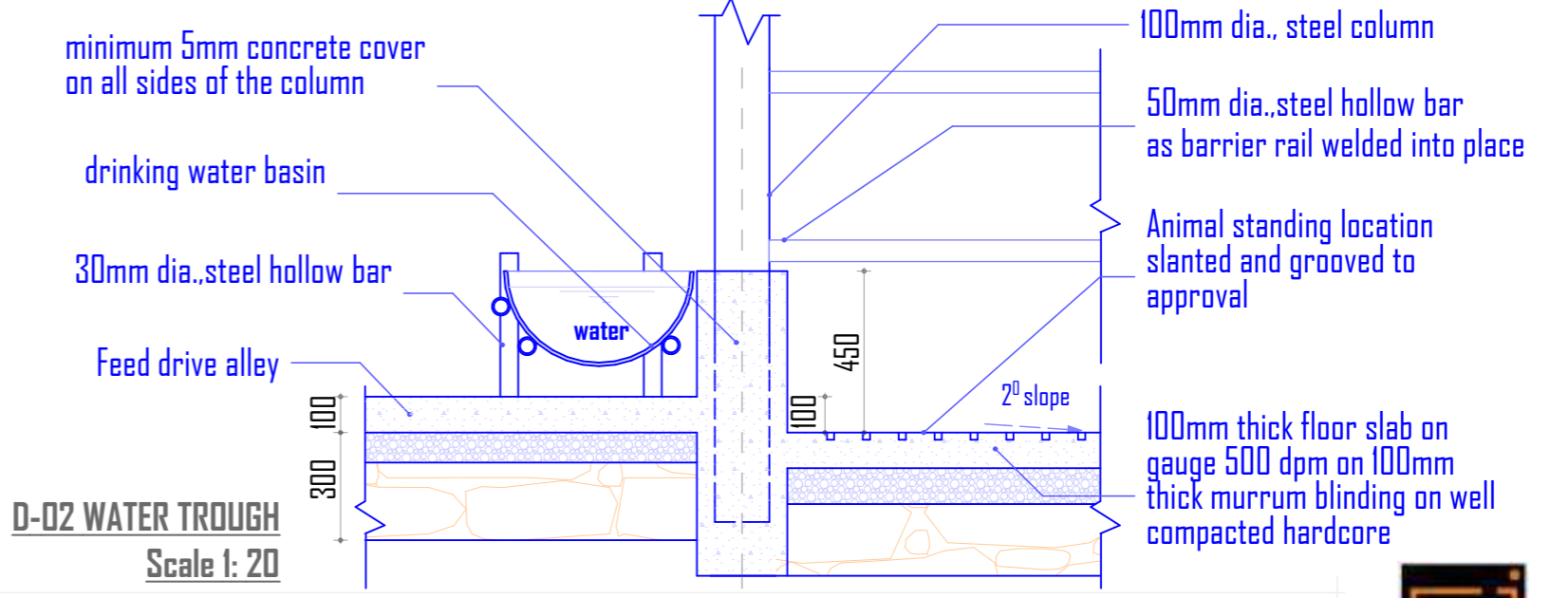
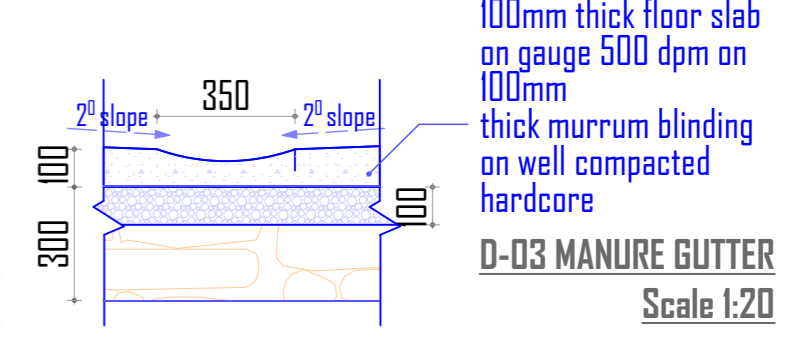
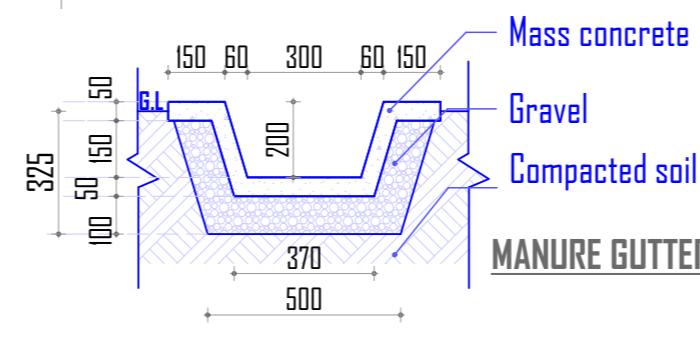
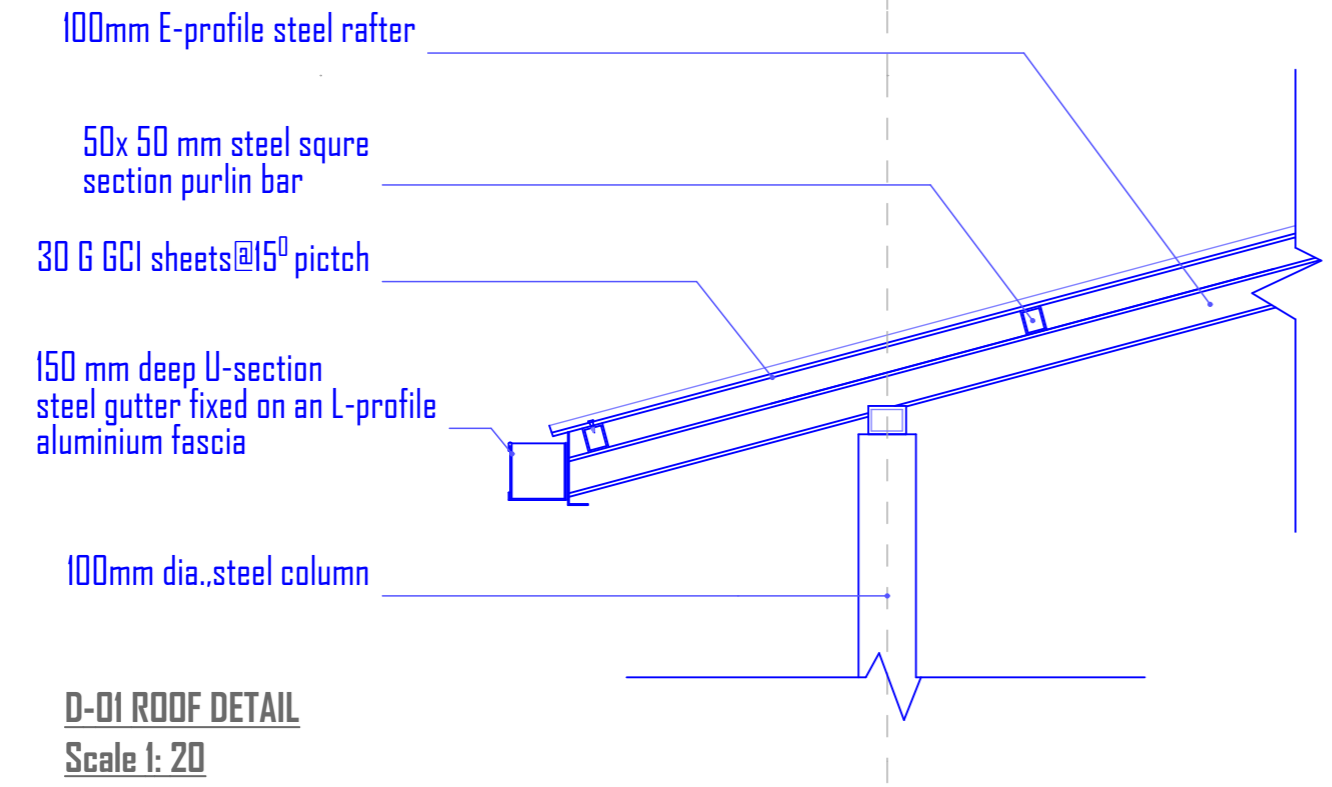
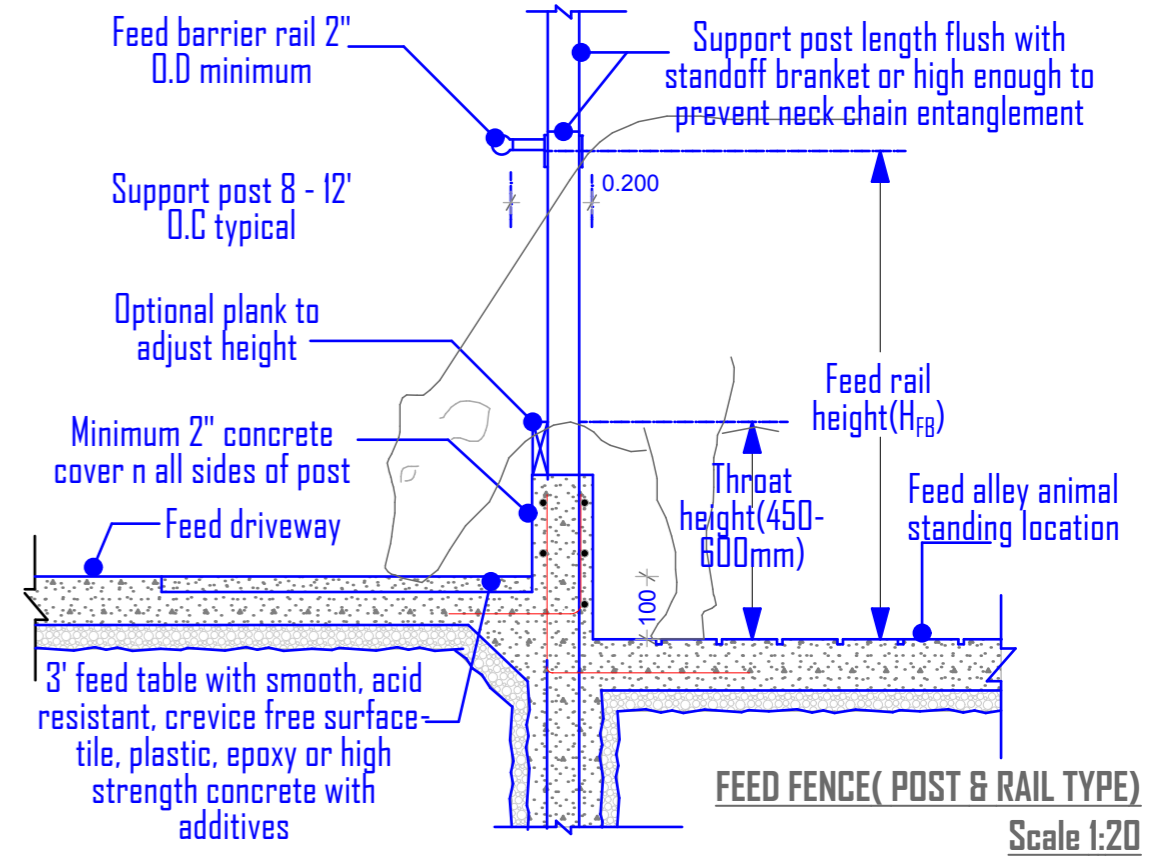
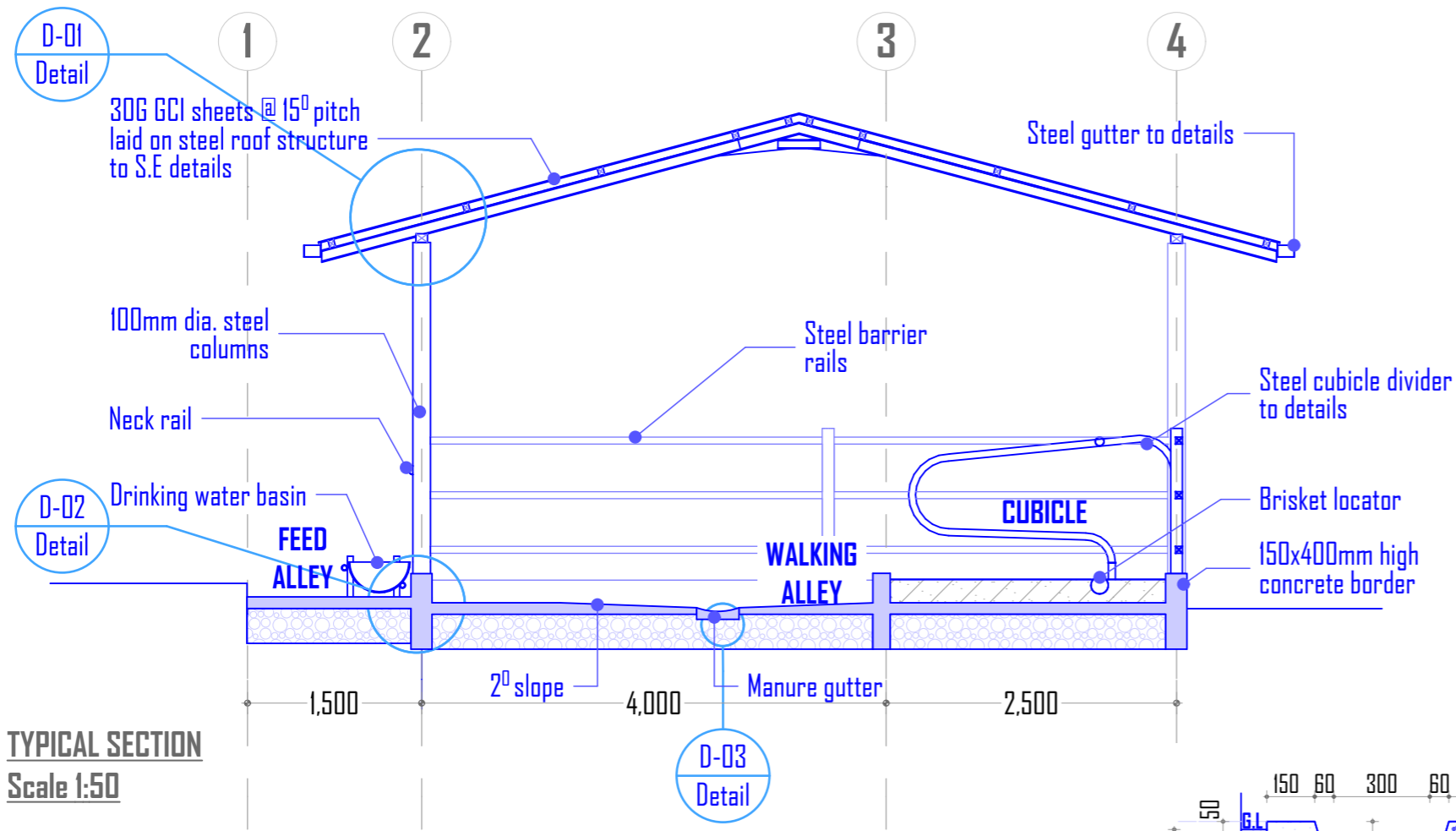


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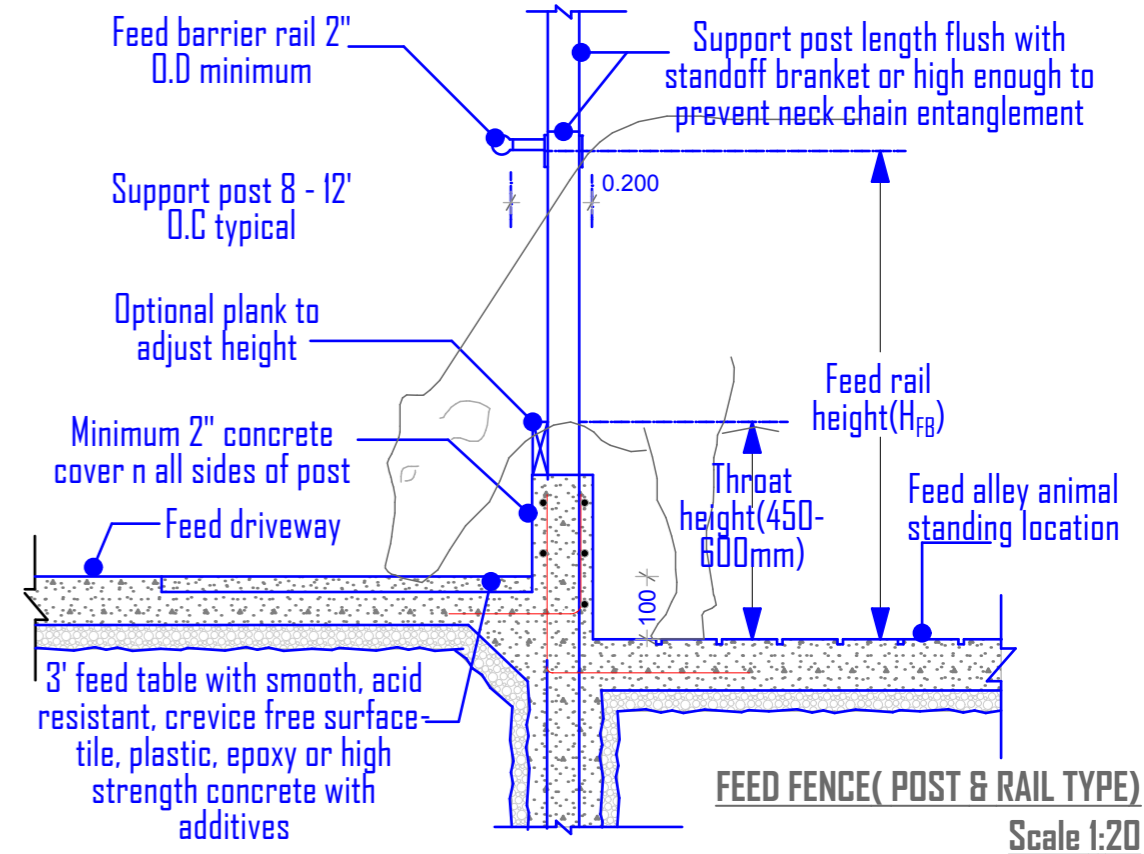
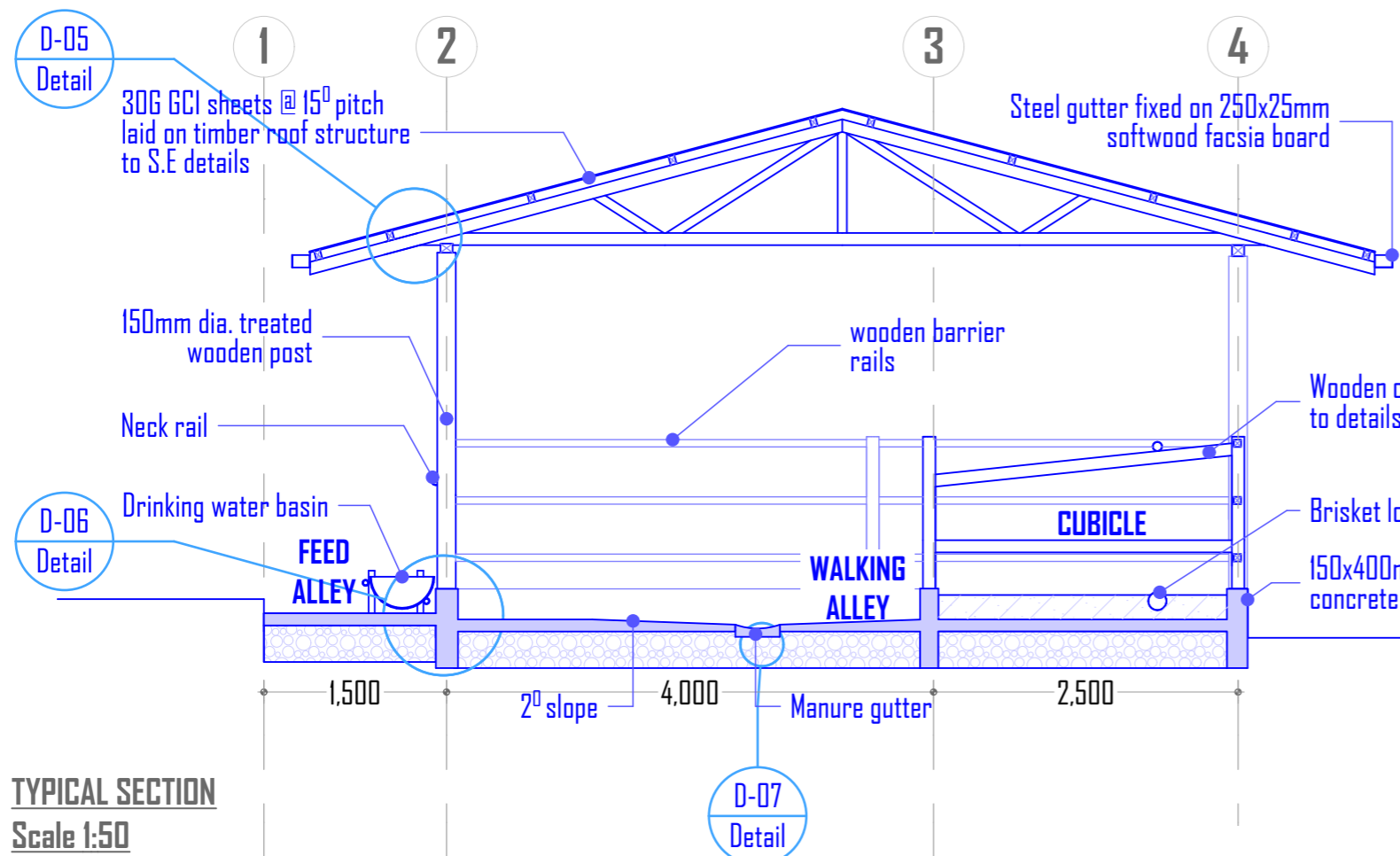
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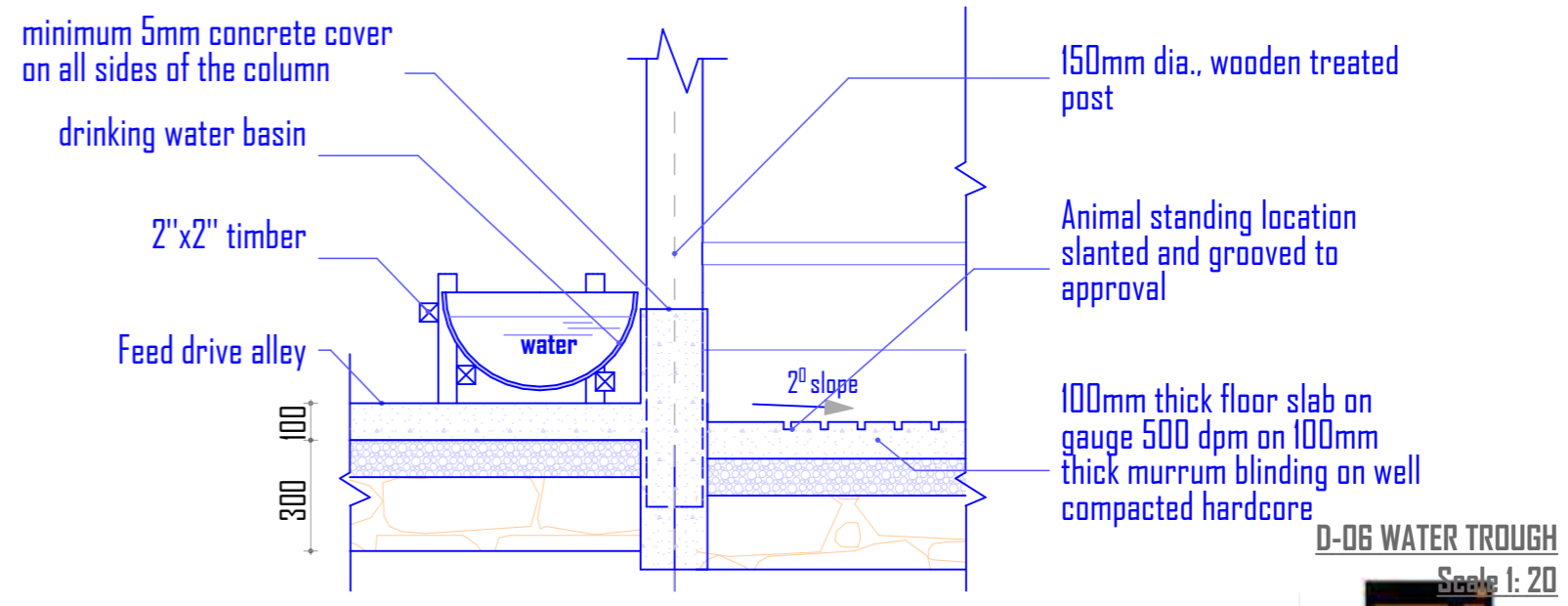
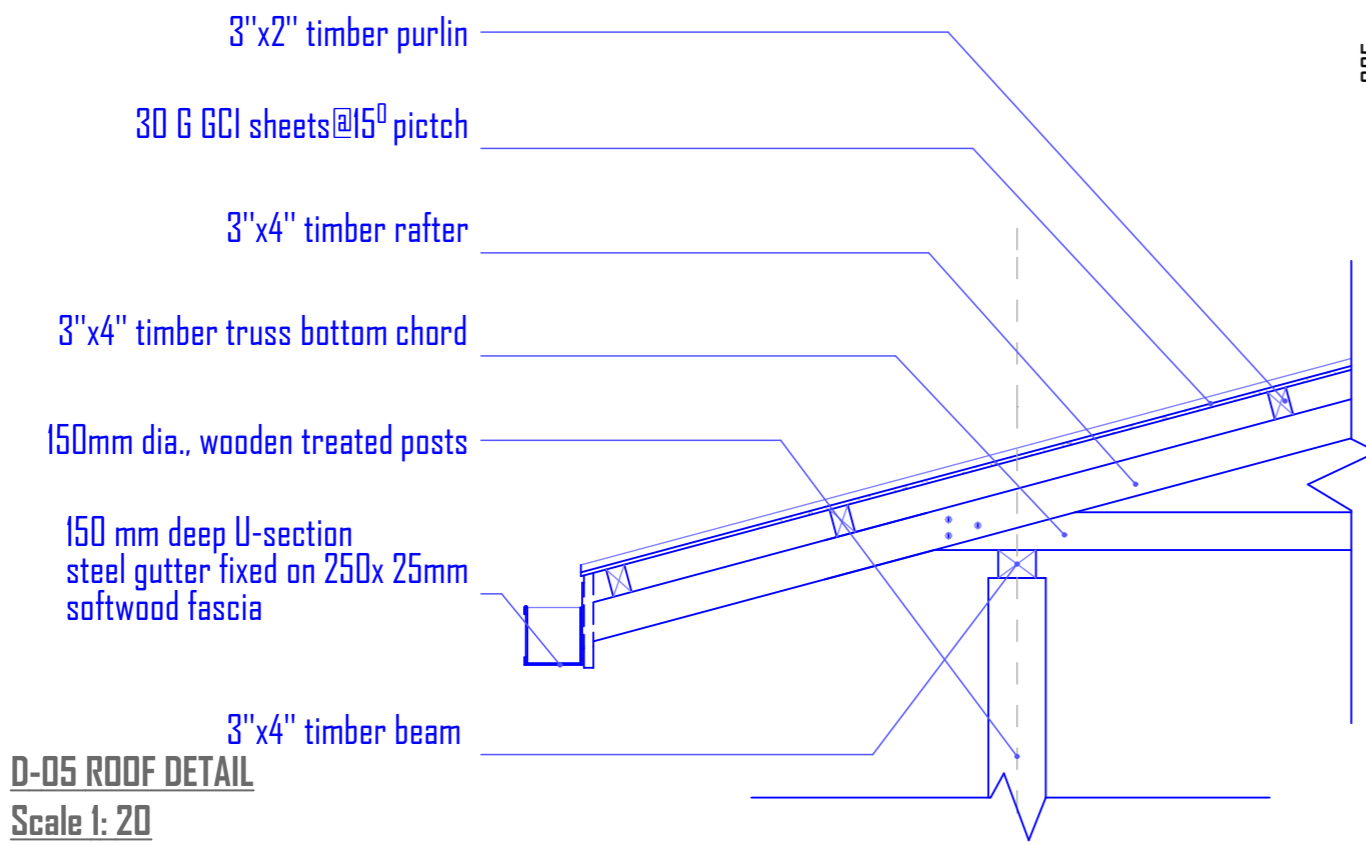
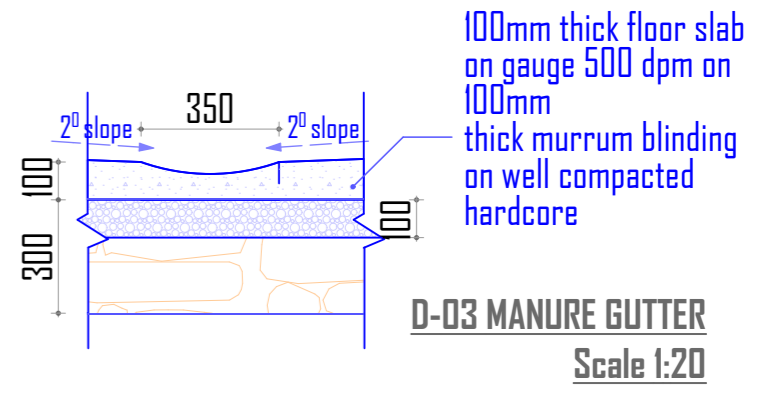
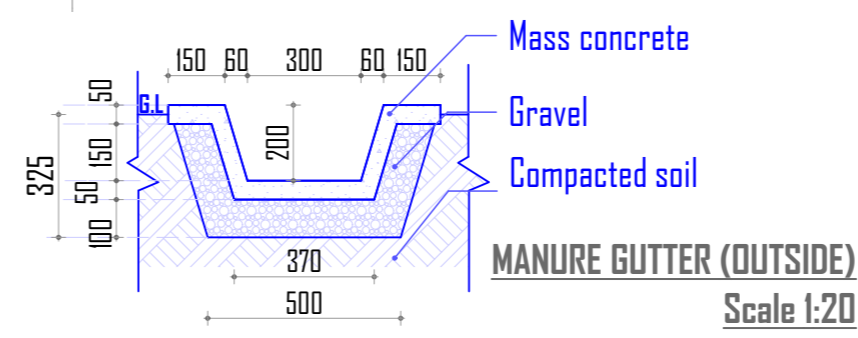


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**TYPICAL SECTION**  
Scale 1:50



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**SNV Kenya – [www.snvworld.org](http://www.snvworld.org)**

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