TRAINING PACKAGE ON LIVESTOCK HUSBANDRY UNDER SEMI-INTENSIVE MANAGEMENT

TECHNICAL MANUAL

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TABLE OF CONTENTS

LIST OF ACRONYMS

AI	Artificial Insemination
CH_4	Methane
CHO	percent of methane
CM	Cent meter
DM	Dry matter
EARO	Ethiopia Agricultural Research Organization
FAO	Food and Agricultural Organization
GHG	Green House Gases
ILCA	International Livestock Center for Agriculture
Kg	Kilogram
M^2	Square Meter
ME	Metabolisable energy
M	Metabolisable
MIRG	Managed Intensive Rotational Grazing
MJ	Mega Joules

INTRODUCTION

Livestock production is an integral component of rural development, contributing towards enhanced agricultural productivity; improved rural livelihoods; as well as ecological services (CALPI, 2005). Integration of crops and livestock, which is an important characteristic of agricultural intensification, has been a major driver of economic growth in rural areas of many countries. Apart from food, livestock forms a major capital reserve for farming households, providing social security, fuel, transport as well as being an important basis for generating cash and value addition with multiplier effects. Furthermore, integration of livestock and crops offers opportunities for farm enterprise diversification, year-round cash inflows, in addition to spreading risk. Hence livestock production has been considered an important tool for poverty alleviation and for improving the livelihoods of resource-poor farmers (Devendra and Thomas, 2002).

The livestock population of Ethiopia is believed to be one of the largest in the world and the largest in Africa totalling up to 13,4 33 million animals. The livestock sector has been contributing a considerable portion to Ethiopia's economy, and still promising to rally round the economic development of the country. It contributes about 43.5% of the GDP and 61% of total export. Industry contributes to 13.4% and services 43.1% of GDP.

Although Ethiopia owns a significantly large livestock population, the sector has remained underdeveloped and its potential has not been efficiently and effectively used. In the crop–livestock system of the highland agro-ecology, the sector is an essential component of the overall farming system, being a major source of traction power, food, cash income, fuel and organic fertilizer. In the pastoral and agro pastoral areas, the livelihoods of the people entirely depend on livestock.

The large human population the country owns and its proximity to potential export markets offer great opportunities for market-oriented development of the sector. Despite the huge livestock resource and the important role of livestock in agriculture, the livestock resource of the country is characterized by low productivity and production levels. The major constraints for livestock development in Ethiopia can be broadly categorized into technical, organizational, institutional, infrastructural, and environmental and policy aspects. However, the extent to which livestock will continue to play these important roles in development, in a sustainable way, will depend on the changes taking place in the livestock production systems.

Currently, the worlds' livestock production falls under three production systems, depending on the mode of feeding, degree of market dependence and the intensity of stocking. Based on these criteria, scientists have categorized livestock production systems into:

1. **Extensive grazing Livestock Production System:** These are systems where animals have the freedom to roam outdoors, and where the animals have some autonomy over diet selection (through grazing), water consumption and access to shelter. The extensive grazing systems can impact on the environment through soil compaction, overgrazing, loss of pasture biodiversity and decrease in soil fertility linked to increased soil erosion, and low water infiltration.
2. **The semi-intensive crop livestock mixed production system:** is a closed system, the largest and the most recommended by agriculturists and environmentalists. This system facilitates proper nutrient balance and retention since all the wastes (manure and crop residues) are recycled within the system. It is systems where animals are exposed to any combination of both intensive and extensive husbandry methods, either simultaneously, or varied according to changes in climatic conditions or physiological state of the animals.

These systems have developed and evolved over time as a result of various factors. Factors that have accelerated the development of livestock production systems include increased consumer demand for livestock products and technological advances resulting from research (Boyazoglu, 1998). Technological advancements have led to improved feed conservation, better milking and feeding techniques, and expansion of intensified livestock farming stimulated by genetic improvement. On the other hand, a global trend of increasing population and incomes, combined with expanding urbanization, has given rise to increased demands for animal products. This has in turn stimulated intensification of systems in a bid to increase production and productivity as well as to shorten production cycles.

3. **The intensive livestock production system,** where cattle are in confinement and are fully dependent on humans to provide for basic animal needs such as food, shelter and water on a daily basis. Production in this system is mainly through stall feeding (zero and semi zero grazing). It is the industrial system, mainly used in the production of monogastric livestock that contributes to 43% of global meat production (FAO, 2007). A general definition for an intensive livestock husbandry operation is any concentrated, confined animal growing operation for meat, milk or egg production located in pens or houses wherein the animals are provided with externally sourced feed. Definitions are also sometimes expressed in terms of exceeding a threshold of animal units per unit area.

MODULE 1: UNDERSTANDING SEMI-INTENSIVE MANAGEMENT OF LIVESTOCK IN THE CONTEXT OF WATERSHED MANAGEMENT

There are many ways of keeping cattle for milk production. The one we choose will depend very much on local conditions, most importantly climate, infrastructure, land availability and local traditions. In Africa in general and Ethiopia in particular, dairy farming is traditionally based on a mixed farming system with grazing of natural pastures and along roadsides. In Asia the traditional system is 'cut and carry', which also offers landless farmers the opportunity to keep dairy cattle.

Extensive farming most commonly refers to sheep and cattle farming in areas with low agricultural productivity, but can also refer to large-scale growing of wheat, barley and other grain crops. An example of extensive dairy farming would be one where the cows are given no buildings or extra feed, only lots of land to roam around and eat on. This system has less milk per cow but requires a lot of grazing land to provide enough grass for the animals.

Semi-intensive mixed crop-livestock production system is a closed system, the largest and the most recommended by agriculturists and environmentalists. This system facilitates proper nutrient balance and retention since all the wastes (manure and crop residues) are recycled within the system. In this system the animals graze during the day in paddocks on natural or improved pasture, are tethered or tied on privately owned or communal land or are herded on communal land or along roadsides. Usually they are stabled at night.

1.1 Reasoning for changing livestock husbandry to semi-intensive system

The reasons for changing husbandry from an extensive to semi-intensive farming system in a watershed are many but among the major are:

A. Animal feed problem in the watershed

The concentration of the animals in the water shed creates a feed shortage, and devastates the soil and water conservation structure. Due to this managing forage production and livestock husbandry is the most important task. Keeping large herds of ill-nourished sickly goats, sheep, and cattle which freely roam around is not advisable.

B. Impact of grazing livestock

Livestock activity that may lead to impaired uses falls into three categories: **hoof impact, heavy grazing** and **livestock waste concentration**.

Hoof impacts can destroy stream bank vegetation cover and physically breakdown stream bank. This impact occurs when livestock concentrate repeatedly or in large number in small area for water, shade, or other streamside attraction. Unstable stream banks may slough off into the stream channel. In addition to adding sediments to the water course, this may lead to channel widening or down cutting. Channel widening and down cutting can result in shallower and warmer streams degrading aquatic habitat and destroying important streamside wildlife habitat.

Overgrazing has an adverse effect on vegetation, soil stability and quality and quantity of water yields. Overgrazing incapacitates the plant, depriving it of all its growth potential. Due to loss of foliage and disturbance of roots, plants are neither able to synthesize food nor absorb water and nutrients for their existence. No seed is formed, natural regeneration is checked, and plants lose their vigor and are unable to stand the adverse climatic and edaphic factors. Desirable plants are preferred; but these are disappearing, allowing the undesirable ones to overtake. Later on, undesirable plants also vanish. Whatever is left is uprooted for heating and cooking.

Areas near water points are generally the most affected and grazing lands are dominated by unpalatable plants. Soils are under risk of degradation with reduced infiltration, low permeability and a reduction in the water holding capacity. The result is a decrease in the ability of the soil to support plant production.

If a large number of animals keep visiting the same site every year the soil gets compacted, retarding growth of vegetation. In low rainfall zones cattle break the soil loose which ultimately either gets washed down or is blown away by wind, exposing parent material in the process. Bare soil is exposed to incessant direct impact of rain resulting in accelerated runoff initiating sheet, rill and gully erosion. To get a few quintals of grain, the people cultivate precipitous slopes. When the rains come, the bulk of the soil along with crops goes "down the drain."

As overgrazing destroys plant cover there is a decrease in both interception and infiltration, leading to enhanced surface runoff. Since there is no humus layer, the water holding capacity of soil is reduced. There is no vegetation to retard the-flow of water carrying large quantities of sediment in its wake. The consequences are flash floods, deteriorated water quality, increased sediment load, silting up of costly storage dams and reservoirs, and damage to livestock, human populations, crops, habitation, and communication systems.

Heavy Grazing removes vegetation that covers the soil. Vegetation protects the soil from the erosive energy of rain drops. Vegetation acts as a sediment trap. Vegetation increases infiltration rate, getting water into the ground where it can do some good rather than running off as overland flow that can erode soil. Sediment is detached in the uplands by surface runoff and may eventually find its way to a stream, or it may settle in a new location and be stabilized by vegetation. Sediment is also detached from flowing water or the collapse of unstable banks. Loss of streamside vegetation may result in increased heating of the stream, resulting in thermal pollution that adversely impacts cold water fish.

Figure 1: The situation leads to feed insufficiency, overgrazing and pastureland degradation

Livestock waste concentration can be sources of pathogen and nutrient pollution especially if it concentrates in or near streams. A large proportion of nitrogen (protein) and phosphorus ingested by livestock during feeding returns to the environment in faeces and urine. If these wastes are well distributed in the watershed, there is a better change that natural processes will remove or dilute nutrient and pathogen pollutants. If large amounts of these nutrients centre in a waterway, they can stimulate algae growth that uses up dissolved oxygen, affecting fish and other organism's reproduction and survival.

C Animal feed problems

Feed Quality and Quantity: Natural grazing is the major source of livestock feed, and in the lowlands, livestock production is almost totally dependent on it. However, grazing lands do not fulfill the nutritional requirements of animals, particularly in the dry season, due to poor management and their inherent low productivity and poor quality. In the highlands with the rapid increase of human population and high demand for food, pastures are steadily being converted to farmlands. Marginal lands unsuitable for cultivation such as waterlogged, flooded soils and steep lands are left for grazing and their productivity is very low. Environmental degradation due to deforestation and overgrazing have substantially reduced soil fertility and further reduced productivity.

D. Ecological Deterioration

Due to vegetation clearance many steep areas have become vulnerable to wind and water erosion. During the dry season forage has been wiped out to supply urban fuel and construction wood. Natural grazing land is deteriorating rapidly due to lack of attention and its carrying capacity declining due to high stocking rate which create severe problems for people in grazing lands.

Figure 2: Overgrazing of pasture lands creates (soil compaction and run-off).

As a result of overgrazing many natural grazing lands are invaded by unpalatable weeds and woody plants. In pastoral areas, misunderstanding of traditional knowledge has led to restriction of management with fire. Fire is a natural component of tropical ecosystems; its absence has created bush encroachment.

The annual food and livestock feed deficit of the country is attributed directly to soil erosion and nutrient export. About half of the highlands are vulnerable to water erosion and the remainder has been cultivated without conservation measures for thousands of years.

Lack of Seed and Planting Materials: The absence of quantity and quality seed and seedling production limits the vast expansion of improved pasture and forage development (especially around the dairy farming and fattening areas).

E. Free Grazing system

Free and uncontrolled grazing is the dominant grazing system for example, in the Tigray region. In most parts of the region, grazing lands are common property resources. Most of the grazing lands are grazed and trampled the whole year round without any resting period, resulting in depletion of palatable species and invasion by less palatable or unpalatable ones. Moreover, grazing on crop land contributes to soil compaction and the need for frequent tillage to prepare fields for crops, making practices such as reduced tillage less feasible. In addition to its contribution to the degradation of grazing lands, the grazing system has negative effects on the conservation efforts underway in the region. Physical conservation structures such as stone terraces and soil bunds are damaged by freely roaming livestock. Biological conservation practices such as grass strips and tree plantations are also being destroyed or trampled, reducing the chance for establishment and regeneration.

According to the study and report by Gebregziabher and Gebrehiwot October, (2011), in Tigray and Hararghe, the grazing system has an impact on the health of the animal. For example, to **contagious diseases, internal and external parasites**, **tick born diseases**, **reproductive diseases** such as brucellosis, infectious reproductive diseases, etc.

Communal grazing areas are the main sources of parasites. Internal parasite such as Faciolasis, has a big impact on animal and human health. In free grazing areas near Hashenge Lake, this parasite is a serious problem. It causes high **mortality, emaciation** and **death**. Farmers in Hashenge Tabia of Ofla district reported that they started zero grazing or tethering their animals with the start up of a milk cow package. A few years ago farmers bought milking cows on credit and let them graze on the Hashenge grazing area. They lost their animals due to disease and are paying their debt. Thus to reduce the risk of death of animals purchased on credit they started to tether near their house.

Similarly, farmers in Dibla (Ganta Afeshum District) reported the advantage of zero grazing. They said, before they started tethering, their animals were grazing on the communal grazing lands and were suffering from disease and bloat. Now, such incidences do not take place and the farmers are happy with the zero grazing.

Use of **Anti-Helments** and **acaricides** are the option to control internal and external parasites respectively. However, continuous use of medicines and acaricides could result in resistance of the species. Thus this problem could be minimized by implementing zero grazing. The impact of parasites on livestock productivity and market is clear. Sheep infested with internal parasites are rejected in foreign markets. There is a high rate of rejection of sheep liver due to internal parasites, and rejection of skin and hide due to damage inflicted by external parasites.

Market observation made in some of the study areas indicated the differences in composition and condition of animals coming to market. In Hararghe a number of young bulls, fattened oxen, sheep and goat are available and are in most cases in good body condition. In Wukro (eastern zone) and Shikomayo (southern zone) of Tigray on the other hand, animals coming to market were dominantly in poor body condition, emaciated, old oxen, weak lambs, and ewes with their lamb. This is mainly a reflection of the feed and feeding system experienced by farmers before marketing live animals.

Figure 3: **Market places of Hararghe (left) and Tigray, Wukro (right)**

Figure 4: Livestock husbandry change from free grazing to cut and carry system

1.2 Expected ecological and production benefits from the change

Environmental effects of dairy farming

In many watershed areas farm animals are let loose for open grazing on communal property resources without any control on resource use or any consideration of permissible stocking rates. This phenomenon leads to increased degradation and pressures on the stock of natural resources. This land degradation can be limited and reversed through soil conservation methods, silvopastoralism, and better management of grazing systems, prohibiting uncontrolled burning of land by pastoralists and controlled exclusion from sensitive areas (FAO, 2006).

Intensification, in terms of increased productivity both in livestock production and in feed crop agriculture can reduce greenhouse gas emissions from deforestation and pasture degradation (FAO, 2006). The status and prospects for smallholder milk production – a global perspective, low-yield dairy systems are estimated to have higher carbon footprints per 100 kg of milk produced than high-yield systems (FAO, 2010). Capper *et al*., (2009), in their study that compared the environmental impacts of modern dairy farming and dairy farming in 1944 in the United States also indicated that modern dairy practices require considerably fewer resources than traditional dairy farming, with 21 percent of animals, 23 percent of feedstuffs, 35 percent of the water and only 10 percent of the land required to produce the same one billion kg of milk. Waste outputs were similarly reduced, with modern and semi-intensive dairy systems producing 24 percent of the manure, 43 percent of methane (CHO) per billion kg of milk compared with equivalent milk from historical dairying. The carbon footprint per billion kilograms of milk produced in 2007 was 37 percent of equivalent milk production in 1944.

To fulfil the increasing requirements and demand of the population for dairy products, it is essential to adopt semi-intensive livestock husbandry management practices and technologies that improve efficient productivity, allowing milk production to be increased while reducing resource use and mitigating environmental impacts.
Methane emissions can be reduced through improved diets to reduce enteric fermentation, improved manure management and use of biogas, which also provide renewable energy. Nitrogen emissions can be reduced through improved diets and manure management (FAO, 2006).

Livestock's impact on **erosion, sedimentation** and water regulation can be addressed by measures against land degradation. **Pollution** can be tackled through:-

- Better management of animal waste in industrial production units,
- Better diets to improve nutrient absorption, improved manure management (including biogas) and
- Better use of processed manure on croplands.
- Intensive or industrial livestock production should be decentralized to accessible croplands where wastes can be recycled without overloading soils and freshwater.

Policy measures that would help in reducing water use and pollution include:-

- full cost pricing of water (to cover supply costs, as well as economic and environmental externalities),
- regulatory frameworks for limiting inputs and scale, specifying required equipment and
- discharge levels, zoning regulations and taxes to discourage extensive and large-scale concentrations close to watershed cities, as well as
- the development of secure water rights, markets, and participatory management of watersheds (FAO, 2006).

The change from traditional/extensive farming system to semi-intensive farming systems which are based on technological and technical recommendations have ecological and production benefits. The technological and technical recommendations depict how the intended activity is going to be carried out by farmers to change their existing farming conditions. These can be research findings and/or indigenous knowledge, which have been identified to be valuable over the past generation because of their compatibility with complex farming environments.

The integration of semi-intensive farming with the cut and carry system and zero-grazed, improved dairy cows and small livestock into smallholder production systems results in:

- Increased availability of milk, meat and other animal products,
- Improved soil fertility, and removal of the risk of soil erosion as a result of overgrazing.

In the semi-intensive farming production systems managed Intensive rotational grazing (MIRG), also known as cell grazing, mob grazing and holistic managed planned grazing, can be introduced. This is a variety of systems of forage use in which ruminant and non-ruminant herds and/or flocks are regularly and systematically moved to fresh rested areas with the intent to maximize the quality and quantity of forage growth. Managed intensive rotational grazing can be used with cattle, sheep, goats, and other animals. The herds graze one portion of pasture, or a paddock, while allowing the others to recover. The length of time a paddock is grazed will depend on the size of the herd and the size of the paddock.

In this farming system, resting grazed lands allows the vegetation to **renew energy reserves**, rebuild shoot systems, and deepen root systems, with the result being long-term maximum biomass production. The managed intensive rotational grazing (MIRG) is especially effective because grazers do better on the more tender younger plant stems. Managed intensive rotational grazing also leaves parasites behind to die off minimizing or eliminating the need for de-wormers. Pasture systems alone can allow grazers to meet their energy requirements, and with the increased productivity of managed intensive rotational grazing systems, the grazers obtain the majority of their nutritional needs without the supplemental feed sources that are required in continuous grazing systems.
In general semi-intensive livestock production systems provide modern production elements to get higher production rates at the lowest possible cost and with the least possible effort.

Dairy production is a biologically efficient system that converts large quantities of roughage, the most abundant feed in the tropics, to milk, the most nutritious food known to man. As Walshe et al (1991) pointed out, where there is access to a market, dairy farming is preferred to meat production since it makes more efficient use of feed resources and provides a regular income to the producer. It is also more labour intensive and supports substantial employment in production, processing and marketing. Higher levels of production than those achieved in traditional systems, whether from, cattle, camels or small ruminants, often require the introduction of specialised dairy breeds and increased levels of inputs (nutrition and health care) and good linkages to markets, both for milk sales and input acquisition.

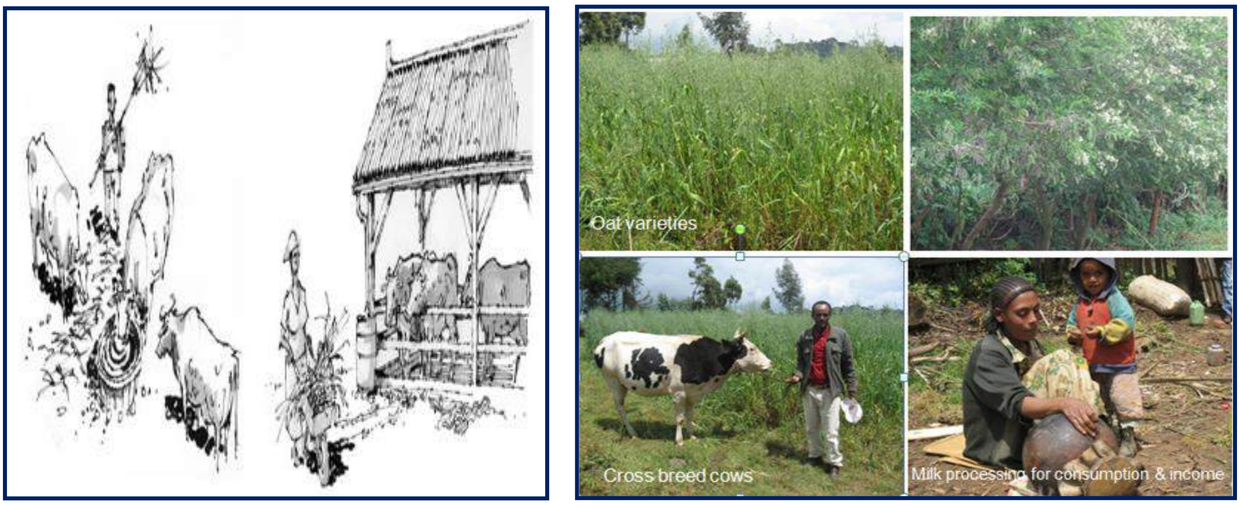

Figure 5: Supplementary feeding after grazing and zero grazing

1.3 The need how to access required support services

There are different needs to be addressed as support services for smallholder livestock husbandry in general and under semi-intensive management in particular. Cultivation of improved forage crops suitable for the different agro-ecological zones and farming systems with accompanied technologies should be encouraged. Smallholder farmers can reduce wastage and cost of feed and increase the intake of crop by livestock through the use of electric or petrol driven choppers where appropriate. Promotion of efficient use of alternative feed sources such as silage, hay, crop and vegetable by-products and local beverage by-products is also essential.

Policies on land usage should take livestock development into account, land for grazing, cultivation of improved forage crops and agro-forestry. Institute control system to limit herd size (stock) as a preventive measure of land degradation through overgrazing by overstocking; this can be achieved through breed improvement to increase productivity per unit animal but keeping fewer numbers of high producing animals.

Designing of appropriate breeding program

Well-designed crossbreeding programs may lead to exploiting desirable characteristics of the breeds or strains involved, and to take advantage of heterosis for traits of economic relevance (López-Villalobos 1998). The issue, however, is how to design sustainable breeding schemes for indigenous breeds under inherent tropical conditions (Rege et al 2011) where resources are limited, feed availability and quality varies greatly depending on the type, geographical location and season, and the demand on animals that are better able to adapt to the ever-changing environment due climate change is increasing. Identification of breeding goal is the first step in designing genetic improvement strategies. Payne and Hodges (1997) stated that breeding goals should match the expectations and values of the community

In Ethiopia, for traditional highland mixed farming and the smallholder dairy farming systems, introduction of exotic genes at 50% level could be considered best (Aynalem 2006). The same author also suggested, it is possible to upgrade to 62.5% with improving management aspects. A draft policy of the Ethiopia livestock development master plan also recommends crossbred cattle whose exotic blood level ranges 50-62.5% to avoid adaptation problems (EARO 2001).

Selecting cows and heifers for breeding

- **Milking ability and feminity:** A cow should have a mild maternal face with bright and alert eyes, good disposition, and quiet temperament. Its udder should be of good size and shape, soft, flexible and spongy to touch. This characteristic is expected to secrete more milk unlike an udder that is flesh like and hard.
- **Age:** In general, beef cows remain productive for 13 years if they start calving at three years of age. They are most productive from four to eight years of age.
- **Breeding ability and ancestry:** Cows that calve regularly are desirable. Calves from cows that do not take on flesh readily do not give much profit. In buying heifers for foundation stock, select those which belong to families which have regularly produced outstanding calves.
- **Types and conformation:** An ideal cow has a rectangular frame. Should be of medium width between the thurls and pins to have necessary frame on which to hang profitable beef. The rump must be long and smooth.

Training selected farmers as trained farmer artificial inseminators will reduce the critical shortage of AI technicians.

Information on innovations can be transferred through the production and distribution of extension bulletins and leaflets. Encouraging and supporting an efficient and operational public and private dairy extension and advisory service provision such as: dairy farm input provision, technology transfer and producer-research-private sector linkage.

There is a need to create conducive environments for the establishment of feed processing plants, provide assistance and put a functional feed quality control system in place. Promotion of the establishment of forage banks in areas where rainfall and feed availability are not reliable is necessary. Putting appropriate operational control and prevention strategies in place for dairy cattle diseases has economic importance. The private sector should be motivated to get involved in the manufacturing and distribution of veterinary drugs.

The provision of credit facilities and insurance for dairy farms should be encouraged and promoted. The development of infrastructure such as roads and cooling facilities is important for the dairy industry.

In general, animal health inputs and services in Ethiopia include:-

- Preventive services and vaccinations
- Education/extension including public health education
- Regulatory services to control occurrence of new diseases
- Clinical services which include diagnosis and treatment of sick animals
- Supply of livestock drugs
- Meat inspection services at abattoirs
- Public health in relation to zoonotic and food-borne disease control, hygiene, food and feed safety and the environment.

1.4 Impacts on socio-economic functions of livestock and on stocking rate/herd size

The study undertaken in Kenya shows that a large number of livestock create a threat to the natural resources. A comparison between livestock feeding strategies between 1997 and 2007 revealed some changes. The semi-intensive methods of livestock feeding, mainly grazing with some stall feeding and has also been increasing.

The implications for these changes to the environment are many. Due to the increase in the number of farmers using only stall feeding, there is a tendency to have more from production of fodder and increased use of concentrates.

Farmers with semi-intensive farming systems have displayed a great range of crop and livestock integration hence can better replenish the nutrients on their farms through application of manure and growing of nitrogen fixing leguminous fodder. The changes in livestock feeding strategies have also been accompanied by changes in cattle breeds. There has been a decrease in the number of local breeds to cross breeds.

Farmers who changed from local to cross breeds did so to meet the objective of increasing milk production and others were acting on advice from extension workers. It was noticed that as farmers have moved towards semi-intensive farming systems, they are likely to replace their less productive breeds (local) to more productive ones like the cross breeds.

Careful waste management is needed to utilize the fertilizing qualities of the manure, urine and other waste; maintain good animal health through sanitary facilities; and avoid pollution of air and water and to provide good hygiene around the farmstead.

Manure management/handling

The method of disposal depends on the type of waste being handled. Solids can be stacked and spread on fields at the optimum time of year, while liquids must be collected in a tank and may be spread from tank. Manure is handled as a solid when the dry matter content exceeds 25 percent. In this condition, the manure can be stacked to a height of 1.5–2 metres. This condition of the manure is obtained only when urine is drained away immediately and a prescribed amount of litter, such as straw or sawdust, is used. The use of 1–2.5 kilograms of litter per cow per day ensures that the manure can be handled as a solid.

The amount of manure and the composition vary depending upon factors such as feeding, milk yield, animal weight, position in the lactation period and the health of the animal. Cattle fed on 'wet' silage or grass produce more urine. Table 1 shows the manure production in relation to the weight of the animals. To estimate the volume of manure and bedding, add the volume of manure from half the volume of bedding used.

Find suitable dimensions for a slurry manure pit with an access ramp/slop, given the following:

- Animals: 5 dairy cows 500 kg
- Storage period: 30 days
- Maximum slope of access ramp: 15%
- Storage capacity *(V)* needed (see Table 10.8);
- Therefore $V = 5 \times 30 \times 0.055 = 8.25\text{m}^3$

Table 1: manure production in cattle

Weight of animal (kg)		Faeces (kg/day)	urine (kg/day)	total manure storage capacity to allow for*	
				(kg/day)	(m3/day)
Dairy cattle					
	50	2.7	1.2	3.9	0.004
	100	5.2	2.3	7.5	0.009
	250	14	6	20	0.025
	400	23	10	33	0.045
	600	35	1 5	50	0.065
Beef cattle					
	350	15	6	21	0.025
	450	19	8	27	0.035
	550	24	10	34	0.045

MODULE 2: TECHNICAL/HUSBANDRY CHANGES AND CONDITIONS REQUIRED FOR SEMI-INTENSIVE MANAGEMENT

2.1 Dairy cattle husbandry

For both economic and ecological reasons, it might be advisable to check on alternative possibilities for investment. In order to make a decision on whether to take up dairy cattle farming, or on how to change your farm management system you should ask yourself the following questions: How is the availability and accessibility of production factors and inputs? These are **land**, **climate, labour**, **veterinary assistance** etc. Dairy cattle require more inputs and more regular labour than beef cattle. What are the local marketing possibilities? Does anyone want to buy your products, milk, meat, hides etc.? Who will sell the products and what will this cost? Can you sell the products all year round or only in a certain period? What do other farmers do: is it an advantage or disadvantage for you to do the same thing, or would it be better to do something else?

2.1.1 Important aspects within a dairy farming system

The cow

The cow is a ruminant, as are sheep and goats. Ruminants are cud chewing animals, with a stomach divided into four compartments. The first compartment, the rumen, is where food is partly digested before being regurgitated to be chewed as cud. This activity is called ruminating. The rumen is very big, with a capacity of 200-300 litres depending of the size of the animal. The rumen is specialized for the digestion of roughage such as grass or hay, feed that is useless to other animals. Grasses and herbs may contain up to 80% of water.

Although cows need a lot of water, roughage contains very little of the valuable substances needed for maintenance or production. Therefore cows need very large quantities of roughage. A big cow, with a big stomach (rumen), may eat more roughage. She needs it because her 'maintenance requirement' is higher, but she can produce more as well.

Although cows are adapted for eating large quantities of roughage, they can also eat other types of feed such as grains, but they need a minimum amount of roughage to maintain the condition of the rumen. Eating and ruminating take up a lot of time.

The animal spends one third (= 8 hours) of the day eating and one third (= 8 hours) of the day ruminating. You can recognize when a cow is ruminating: it chews the cud usually while lying or standing in the shade. The rest of the day is used for social contact with other cows, and for walking and sleeping. These activities are all spread over the whole day.

The calf

A calf's rumen is not yet fully developed. This means the calf cannot yet eat roughage. For this reason the calf needs milk. Milk is an easily digestible food for the calf. Especially in the beginning (first two days after birth) the calf needs the mother's milk, as this contains antibodies which protect the calf from disease. This first milk is called colostrum. When the calf is about weeks old it can start to eat roughage and/or concentrate, in order to get used to it. Try to start with high quality roughage because the calf is not yet used to it, and let it continue to suckle from the mother during this period as well. Crossbred calves can already start with concentrates during their second week in order to achieve optimum growth.

Feeding of the cattle

Animals need water and food in order to live, grow, work and give milk. Even when the cow is not producing, it needs energy to breathe, walk and ruminate, and it needs protein to grow (meat contains a lot of protein). The basic need, which is necessary to maintain a stable condition, is called the 'maintenance requirement'. The maintenance requirement is higher for a big cow than for a smaller one. The type of cow can play an important role in maintenance requirement. A local breed will have a lower requirement than an exotic or crossbred breed. 'Production requirement' is the requirement of extra feed for growth, work and/or milk production.

The protein and energy requirements

Feed contains energy, protein and water. We talk about two parts in the feed: water and the non-water-part, called Dry Matter (=DM). If you are not able to feed a big (exotic) animal properly it might be better to keep a few small animals. The maintenance requirement for a small local cow (weighing approximately 350 kg) is 7 kg Dry Matter a day. A larger cow (crossbred, weighing about 500 kg) needs 10 kg DM/day.

Example: An adult local breed (350 kg) needs approximately 35 kg of grass a day. 20% DM of 35 kg =7 kg DM, the rest: 80% is water = 28 kg. The water requirement is 45 litres. This is partly covered by the grass, which provides 28 litres. Besides this the animal needs an extra 17 litres of water. An adult crossbred animal (500 kg) would need 50 kg/day (10 kg DM) of the same grass and an extra 20 litres of water.

The energy the animal obtains from the feed is measured in mega joules (MJ) per animal per day (and is called Metabolisable Energy (ME)). Protein is measured in grams of crude protein per animal per day. The maintenance requirements for energy, protein, dry matter and water are given in table 1, for animals with two different live weights.

Table 2: Maintenance requirements per animal per day

Animal weight (kg)	Energy (MJ)	Protein (grams)	Dry Matter (kg)	Water (litres)
350	45	341	7	45
500	59	432	10	60

Animals need extra feed to produce power (= traction), milk and offspring, and also to grow. The type of feed an animal needs depends on the kind of production you want. Traction requires energy and therefore the extra feed should contain a lot of energy. Growth requires mostly proteins, and thus growing animals need feed with a lot of protein in it. From milk the animal gets both energy and protein.

Milk production

One week before calving give some extra high quality feed to strengthen the animal, because the animal will not eat very much during the first few days after calving. Once the cow has calved, she can be milked. Cows which have recently calved are very sensitive to nutrient deficiencies. If you supplement this cow with extra feed to stimulate milk production, take care that you do this regularly: preferably every day. You cannot do it by giving some one week and then nothing the following week! After a week with little or no supplementary feed the milk production will drop and will be very difficult to stimulate again. The best period (economically speaking) to supplement with good quality feed is during the first 3 months after calving. The amount of Dry Matter required by a milking cow is 2.5- 3% of its body weight.

Table 3: Dry matter requirements for milking cows

Body weight (Kg)	350	400	450	500
DM Requirement (kg)	9-10.5	10-12	11-13.5	12.5-15

Supplements

Supplements are products given in addition to the roughage in the cow's diet, if the roughage alone cannot satisfy the requirements for maintenance and production. During the dry season in particular, the roughage (straw) provided is usually not enough to cover maintenance requirements, or the animals are unable to eat enough to survive. Also during the rest of the year if you want to maintain a certain level of production, it could be wise to supplement your animals.

Supplements can be divided into three groups. Depending on the purpose of production of your cows you can choose a different supplement:

1. Energy supplements: These supplements contain a lot of energy and can be used for draught-animals (animal traction) or cows which perform other kinds of work.

2. Protein supplements: These are especially used to supplement the diet of growing animals (meat production). This group, made from by-products, contains a high amount of protein and less energy.

3. Balanced energy and protein supplements: These products are good for milk production because they have a balanced energy and protein content. Most cakes are made from the by-products of oil processing, and contain a lot of energy as well as protein

Table 4: three different types of supplements

Energy rich supplement	Protein rich supplement	Energy and Protein rich supplement
corn meal	Animal origin* such as:	Cakes:
cassava chips	blood meal	groundnut cake
cassava flour	fish meal	coconut cake
wheat middling	meat	cottonseed cake
srice bran	bone meal	Others:
molasses	Cake:	brewers grain
fruits	sunflower cake	

Supplementation can take the form of an extra dose of nitrogen (for protein) by treating straw with urea (contains nitrogen) or by providing extra urea (nitrogen) and molasses (energy rich) in a solidified lick-block. You can treat straw by adding 4 kg of urea to every 100 kg of air dry straw.

Dissolve the urea in water and spray this over the straw. Then cover the straw with some plastic sheets. Use the treated straw as soon as possible. As this involves quite a lot of work it is best to make enough to last for several days to a week. The first time the animals may refuse to eat the treated straw because of the ammonia smell, but if this happens it will only last a few days. Be sure that the benefits obtained from this treatment are higher than the costs (the price of urea).

Another possibility is to make a lick-block containing urea and molasses. The block is given in addition to the roughage. These blocks are attractive and palatable to ruminants because of the smell and taste of molasses. To make these lick-blocks see table 5. Cows can consume up to 0.5 kg per day per animal, depending on the size of the animal.

Look at your surroundings to find out which are the best and cheapest supplements to use. Maybe you use supplements which are not mentioned here. Make sure you feed your animals with a variety of different foods, and prevent them from eating too much of one single supplement.

Straw can provide some carbohydrate but is very deficient in other nutrients. Also, because of the high lignin content, digestibility is poor. Methods are available, however, to increase the digestibility of poor quality feeds. One of the most successful procedures to improve digestibility of crude plant material is through treatment with ammonia. This weakens the hard cell walls, allowing better penetration by rumen microorganisms to produce more effective fermentation and liberation of nutrients.

- **Molasses treatment of straw:** mix molasses with twice as much water, sprinkle this on the crop residues. Alternatively; treat only as much straw as you need each day.
- **Urea treatment of straw: f**or 100 kg of dry straw you need 4 kg of urea. Dissolve the urea in water. Do not use more water than the amount of straw: in this case 100 litres. Put some straw in a pit or container and spray some of the urea solution onto the straw. Repeat this after adding some more straw, until you have sprayed all the straw.

The straw is moistened with a urea solution (**2.5 to 5%)** and usually covered for several weeks. Ammonia, released from the urea, weakens the lignified outer wall and increases the digestibility of the straw. Once treated and if properly covered to preserve anaerobic conditions, the urea-ensiled material can be stored for several months.

- Spread a layer of chopped straw on a large, thick plastic sheet and sprinkle it with a mixture of urea and water.
- Add another layer for straw and sprinkle with more urea and water. Repeat for several layers. For 100 kg of straw you will need 20 liter buckets of water and 6 kg of urea. And side of the pile so it is scaled completely.
- Put a stone on it to keep it air tight. And leave for 3 weeks.

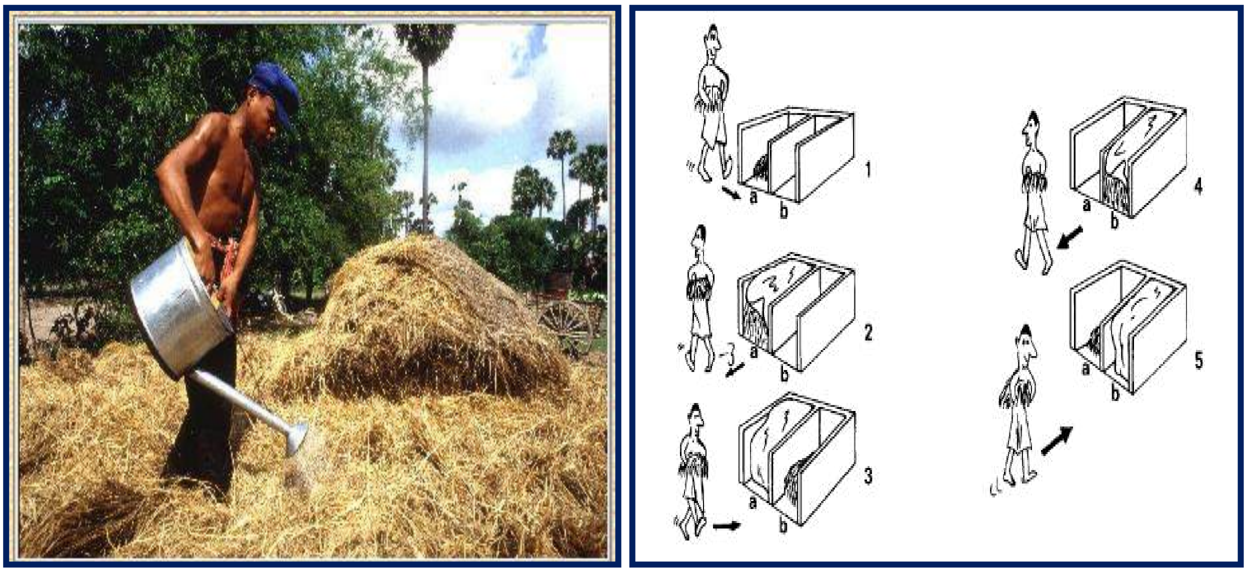

Figure 6: Straw treatment with urea according to the two pits, seven day system (Source: Schiere and Ibrahim, 1985).

Table 5: Making a molasses-urea lick-block

Making a molasses-urea lick-block (measures in kilogramme)	
Ingredients for 30 kg:	
Molasses	15.0
Urea	3.0
Salt	1.5
Cement/quick lime	3.0
Bran	7.5
Total	**30.0**

First make a pre-mixture of salt, cement and a little bit of water and add the other ingredients in the order indicated above. Mix it well using a concrete mixer, or by hand. After mixing properly you can put the mixture in moulds made from plastic sheets. This will make manageable portions. Let them harden for a few days. After drying, remove the blocks from the moulds and give them to the animals. You can also add extra minerals to these blocks to improve the mineral balance. Look at your surroundings to find out which are the best and cheapest supplements to use. Make sure you feed your animals with a variety of different foods, and prevent them from eating too much of one single supplement.

Minerals and vitamins

Minerals and vitamins are no problem if the cow eats a sufficiently well balanced diet (containing balanced concentrates and/or variety in roughage). Problems occur when a particular vitamin or mineral is lacking, or the diet is not balanced. The danger of eating too much minerals or vitamins is very unlikely to occur. If soils lack minerals, then the minerals will also be lacking in the plants growing in that soil, unless a particular mineral is concentrated in the plant, like, for example, calcium in legume-plants. Sometimes a lack of minerals or vitamins is noticeable more quickly in highly productive cows or in young animals. **Changes in climate**, **growth or milk production** can cause a mineral or vitamin deficiency.

Animal health

Taking good care of animal health does not only mean treating an animal when it is sick. It also means helping the animal to avoid becoming ill. It is very important to realize that, even though treatment may eliminate the cause of the disease efficiently, the disease has already hurt the body. The effects of the disease may take longer to heal (if they do at all) than the time needed to eliminate the disease itself. Consequently, production losses may continue to be suffered after the animal has seemingly recovered. Examples of such production losses are retarded growth in calves and reduced milk production of cows after illness.

Preventive treatment

Sometimes we know a certain disease always occurs at the same time of the year. In some cases it can be useful to treat animals with medicine before we actually see the sickness in them. This will prevent them from becoming weak and avoid production losses. For example, preventive treatment against worms can be given before and after the rainy season.

Disease prevention

Most diseases can be prevented by the same measures that enhance production. General preventive measures are:

- **Hygiene:** Cleaning and disinfecting. Remember disinfection is useless without cleaning thoroughly beforehand.
- Water: Always ensure free access to clean and fresh water.
- Good feed and regular feeding.
- Shelter for protection against bad weather (rain, wind and cold or intensive sunshine).
- Regular light exercise.
- A peaceful environment (avoid unrest and stress).
- **Quarantine:** This means isolating sick animals (during their illness) and newcomers (for about six weeks) from the rest of the herd. This measure is often hard to implement, but helps to avoid the spread of contagious diseases to other animals.

Vaccinations

When an animal is vaccinated against a specific disease, the body of the animal will react to it, but the animal does not develop the disease. However, the animal's body has then been prepared to withstand an attack by this specific disease in its real form. Sometimes a vaccination against a disease will protect the animal all its life against this disease, but most vaccinations have to be repeated after a certain amount of time to ensure protection.

Regular observations

Regular observation of cattle at ease is a must, both for health control and for being able to tell whether a cow is in heat. During observation of the animal, check the following points:

- **Behaviour:** Does it react normally to its environment or is it acting strangely?
- **Attitude:** Does it carry its head, ears, body and tail as usual? And gait: is there any change in the way it moves about?
- **Condition:** Is the animal in good condition, and is it well muscled?
- Does it eat, drink and ruminate properly? After eating, cattle older than six months will be seen chewing. After sometime they swallow the ball of food, which you can see as it slides down the neck into the stomach. If you continue to watch carefully, you will see after sometime that another ball of food is going in the opposite direction towards the head. The cow "burps" and starts chewing the new ball that came from the rumen part of the stomach. We say the cow is ruminating. You can measure the rumen's activity by pressing lightly with your fist on the upper part of the left flank. The movement of the rumen expanding can be felt. Be careful not to confuse it with the breathing of the animal and beware of kicks.
- Does it urinate and defecate as usual? If a cow is being milked, the milk yield should be watched. Any sudden drop in milk yield is a sign of discomfort.
- Does anything else abnormal catch your eye?

Housing requirements

Cattle/cow that will produce milk and reproduce more efficiently if they are protected from extreme heat, i.e. temperatures of **25–30 °C,** and particularly from direct sunshine. Thus, providing shade/shelter becomes an important factor. If cattle are kept in a confined area, it should be free from mud and manure in order to reduce hoof infection to a minimum. Concrete floors or pavements are ideal where the area per cow is limited. However, where ample space is available, an earth yard, properly sloped for good drainage, is adequate.

Shade from the sun: A shade structure allowing **2.5–3** square metres per animal (whether for one animal belonging to a smallholder or many animals in a commercial herd), will give the minimum desirable protection for cattle. A 3 metre by 7 metre roof will provide adequate shade for up to eight cows. The roof should be a minimum of 3 metres high to allow air circulation.

If financially feasible, the entire area that will be shaded at some time during the day should be paved with good-quality concrete. The size of this paved area depends on the orientation of the shade structure. If the longitudinal axis is from east to west, then part of the floor under the roof will be in shade all day long. Extending the floor by approximately one-third of its length on the east and on the west, as results in a paved surface being provided for the shaded area at all times.

If the longitudinal axis is north to south, the paved area must be three times the roof area i.e. one third to the east, one-third to the west and one-third underneath. Obviously this means an increase in the cost of paving. When deciding on which orientation to use, the following factors should be considered:

1. With the east-west orientation, the feed and water troughs can be under the shade, which will allow the cows to eat and drink in shade at any time of the day. However, the shaded area should be increased to 3–4 metres per cow. By locating the feed and water in the shade, feed consumption will be encouraged, but more manure will be dropped in the shaded area, which in turn will lead to dirty cows.
2. With the north-south orientation, the sun will strike every part of the floor area under and on either side of the roof at some time during the day. This will help to keep the paved area dry. A shaded area of 2.5–3 metres per cow is adequate if feed and water troughs are placed away from the shaded area.
3. If paving is considered to be too costly, the north-south orientation is the best choice in order to keep the area as dry as possible.
4. In areas where temperatures average 30 °C or more for up to five hours per day during some period of the year, the east-west orientation is the most beneficial.

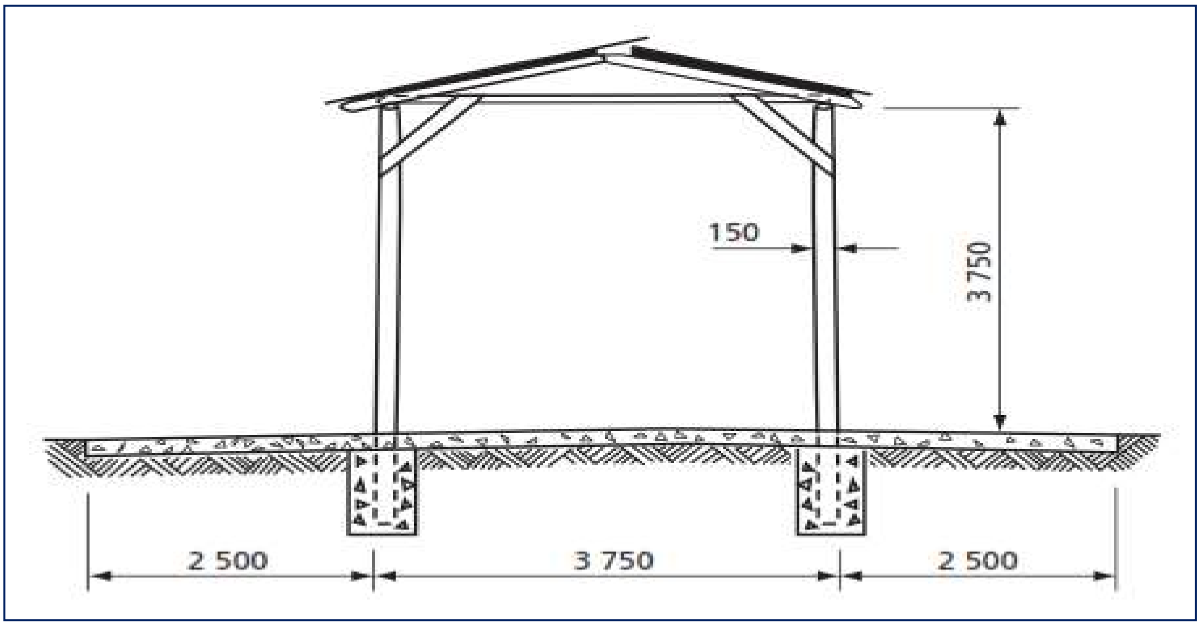

Figure 7: Sunshade with insulated corrugated steel roof

Yards: If space is severely limited and only 4–5 square metres per cow is available, then concrete paving is highly desirable. If 40–60 square metres per cow is available, then unpaved yards should be quite satisfactory, provided that the feed and shade areas are paved and the yard is graded for good drainage.

If the smallholder is unable to afford an improved structure, such as a shade or a paved area for feeding, then conditions can be prevented from becoming intolerable by building mounds of earth in the yard with drainage. Between 20 square metres and 30 square metres per cow will keep the animals out of the worst of the mud. The soil in the mounds can be stabilized by working chopped straw, or straw and manure, into the surface. A number of trees in the yard will provide sufficient shade.

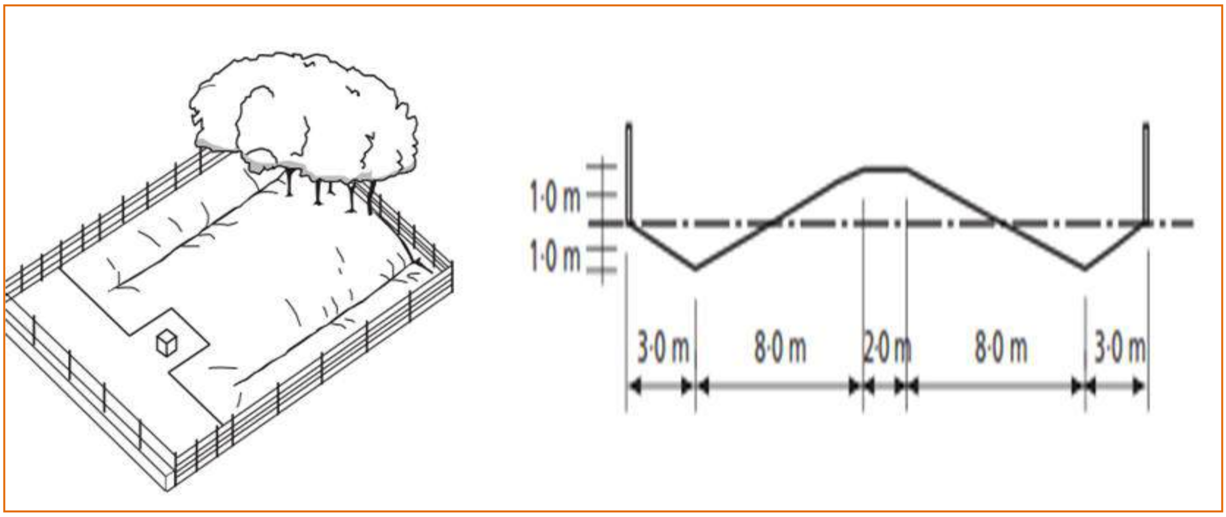

Figure 8: Yard with fence-line feed trough, paved feed area and earth mound and dimensions for an earth mound

Table 6: Area for bedded sheds and dimensions of free stalls

Animal	Age (months)	Weight (kg)	bedded shed area per animal (m^2)		Free stalls dimensions (m)	
			A	B	Length	Width
Young stock	1.5 - 3	70 -100	1.5	1.4	1.2	0.6
Young stock	3 - 6	100 -175	2.0	1.8	1.5	0.7
Young stock	6 -12	175 - 250	2.5	2.1	1.8	0.8
Young stock	12-18	250 - 350	3.0	2.3	1.9	0.9
Bred heifers and small milking cows		400 - 500	3.5	2.5	2.1	1.1
Milking cows		500 - 600	4.0	3.0	2.2	1.2
large milking cows		>600	5.0	3.5	2.3	1.2

A = enclosed and fully covered bedded shed. B = bedded shed in conjugation with exercise yard

2.2 Beef cattle husbandry

Beef cattle production ranges from the beef cow herds that typically graze on pastureland or graze the remaining residue on the land after grain harvest to growing and finishing young cattle in feedlots. The feedlot-housing systems used in beef cattle production typically varies by climate and can range from open earthen lots with very little shelter to open shed and lot or an enclosed confinement building.

Selecting Cattle for Fattening

Selecting the types of livestock which are likely to increase weight and condition quickly is a valuable skill. Some important guidelines are:-

- Give preference to breeds or types which are known to have good growth characteristics. Many lowland cattle of the Boran type are favoured in this respect
- Select animals in Grade 3 condition. Emaciated (Grade 4) animals often take a long time to recover, or have some major health problem. Grade 2 animals usually have higher per kilo prices which limits the potential for increased values.
- The animals should be docile and easy to handle.
- Steers are preferable to bulls as they will fatten more easily.
- If possible, establish the reason for the animals' lean condition. Animals which have just finished ploughing or have been trekked a long distance show better compensatory growth than those which are lean due to under nutrition or poor health.

- Don't buy animals which are too old. Check that the teeth are sound.

If it is necessary to buy some unsuitable animals in a group which is otherwise satisfactory, re-sell the unsuitable ones immediately, even though there will be an apparent loss. This is better than wasting feed on animals which are not suited to the purpose. In addition, the following criteria have to be considered.

Age: Young animals have striking advantages over older cattle. They need less feed for every unit gain in weight because they can masticate and ruminate thoroughly and can consume more feed in proportion to their body weight. Their increase in weight is due partly to the growth of muscles and vital organs. In older cattle the increase is largely due to fat deposits. On the other hand, older animals as feeder stock also have advantages. Generally, a two-year old steer will require a shorter feeding period than a calf or a yearling because the latter grows while it fattens. Calves are choosy when given coarse and stem filled roughage, while two-year old steers utilize large quantities of roughage to produce fat primarily because they have a better capacity to digest. In most cases, they readily relish the feeds ordinarily rejected by the calves.

- **Disposition:** An active yet mild, quiet, and easily-handled steer usually grows fast and fattens easily. Restless, nervous and erratic cattle waste too much energy when they panic even at the slightest provocation.

- **Constitution and Vigour:** These are determined by the size and quality of the vital organs. A large feeding capacity, strong appetite, a large heart girth, well-sprung ribs and a wide, deep and full chest show good constitution and vigour.

- **Sex:** In general, more steers than heifers are available for fattening because some heifers must be retained as herd replacements. If fed for the same period of time, steers gain about 10% faster than heifers and require 10 to 15% less feeds with equal weight gain. On the other hand, young bulls have 20% greater gain in live weight and require 22% less feed to produce a leaner carcass which is nearly of the same quality as that of steers.

- **Health Considerations:** A healthy animal is active, has a soft and smooth hair coat, bright eyes and moist muzzle. Special attention should be given to unsoundness and defects in conformation when selecting feeders. Animals that are blind, lame or with crooked legs, rough skin, and evidence of ectoparasite should be avoided.

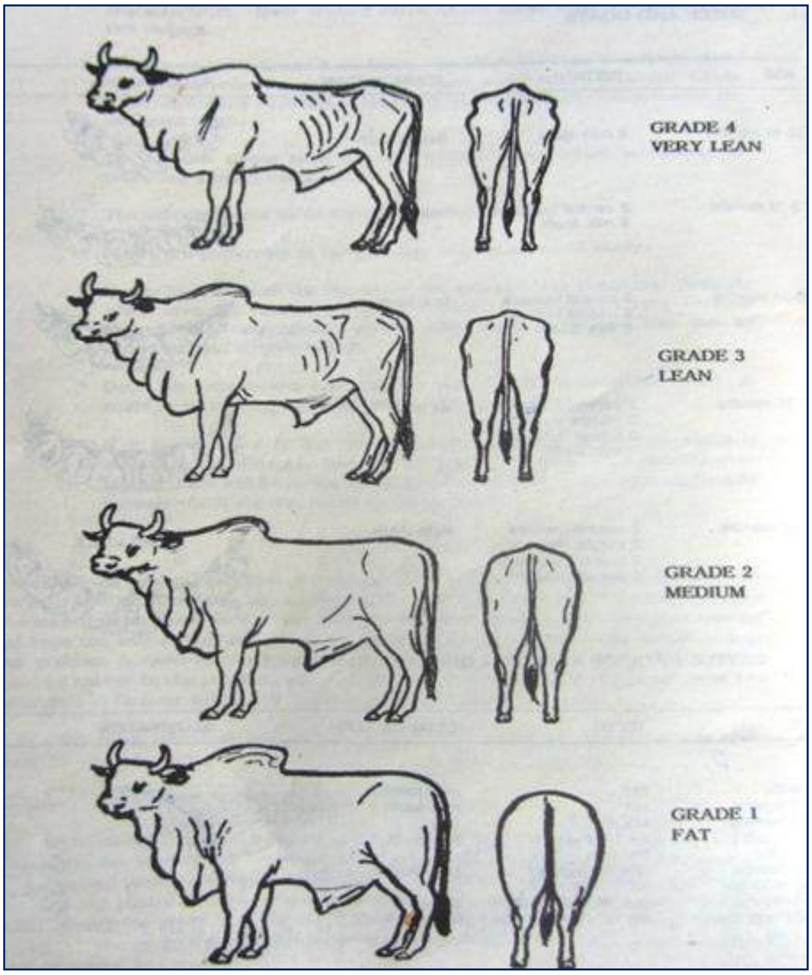

Figure 9: Live cattle condition grades used in Ethiopia

Table 7: Description of live cattle condition grades used in Ethiopia

Grade		Backbone	Hipbones	Ribs	Tail Head	Outline
1	Fat	Not visible	Not visible	Not visible	Slightly bump	Rounded
2	Medium	Not visible	Not visible	Not visible	Recessed slightly	Almost smooth
3	Lean	Visible faintly	Visible	Visible faintly	Recessed slightly	Undulating
4	Very lean	visible	prominent	Clearly visible	Recessed	Irregular

2.2.1 Important aspects within beef cattle farming system

Feeding beef cattle

The feed requirements of livestock depend on the following basic principles:

- the weight and age of the animal;
- growth rate;
- Milk production
- Stage of pregnancy; and
- Work out put.

Beef cattle, like other ruminants, possess a digestive system that includes a multi-compartment stomach that can digest fibrous materials such as grass, corn stalks, cottonseeds, alfalfa and grass hays, etc. Bacteria and protozoa that reside in cattle's stomach make it possible to release nutrients from fibrous feeds that can be utilized by the animal. Unlike most other animals, cattle can consume by-product feeds like corn gluten, distiller's grains, brewer's grains, potato chips, soybean hulls, citrus pulp and other products that are considered waste products.

Cattle are also fed protein sources, such as soybean meal, canola meal, alfalfa and urea, and cereal grains such as corn, sorghum, barley, wheat, and oats. Generally, feedlot cattle are fed predominantly high quality fibrous diets early in their growth periods and high-energy cereal grain diets during the finishing periods. The breeding herd commonly grazes fibrous forages from pastureland, rangeland and from field residues, such as corn stalks.

Site and housing

- Select a well drained site with the proper slop away from the shade shed, the feed bunk, and hay rack with easy access to water.
- Place the hay storage cover and grain storage near the feed bunk, yet with easy access to the road for the convenience of the hay and grain delivery.
- Housing systems for beef cattle in confinement feedlots vary, depending on the climate in the area and topography of the site.
- They include total confinement buildings, open sheds and lots or open lots with windbreaks and/or shades. The lots are usually paved if located in humid climates to minimize mud problems.
- Beef cattle are hearty animals that tolerate a wide range of climatic conditions. Most buildings have open sidewalls and are naturally ventilated. Open sheds and lots are typically positioned to allow for protection from prevailing winds and maximize sun exposure during winter.
- In summer, shades and open areas allow for cooling and air movement. In arid climates, sprinkler systems are used in hot weather for cooling as well as for dust control.

Proper housing is important in successful cattle fattening operation. Adequately protect animals against the adverse effects of weather when they are raised in relatively small areas. Animals in backyard cattle farms are usually tethered along roadsides and in backyards during the day and confined in a shed or corral at night. The permanent type of housing consisting of GI roofing, timber frames, concrete floor, feed trough and water troughs are used in most farms. The shelter is open-sided and is located near the farmer's house or under the shade trees. Building height ranges from 1.79 to 1.9 meters while the width varies from 2.1 to 2.7 meters. Each animal can be allocated from 1.5 to 4.5 sq. meters.

Figure 10: Small scale modern beef fattening feedlot and hay storage for fattening beef cattle

Size: Feedlot size is determined by the number of steers to be penned. As a guide, provide each steer with a minimum of 24 square meters of open space, and 10 square meters of shaded area. Additional space will reduce social stress among the animals.

Water: A plentiful supply of cool, clean, good-quality water is essential. Water should be in a trough and off the ground, to aid in keeping it clean and free of manure and urine. This point cannot be overemphasized especially in hot dry temperatures. Poor-quality water - including contamination by feed, dust, and feces - leads to a reduction in water intake, and slower rates of gain.

Water troughs should be placed in a separate area away from the hay racks and feed troughs.

- Raise them about 70cm above the ground with a 3meter cement base on the ground around the trough.
- That will allow ease of daily manure removal and avoid a mud problem near the water.
- The trough should be large enough to accommodate easy access for the number of steers to be housed.
- It is recommended that the water trough should be 2.5 to 3meter long and at least 60cm wide per 50 head.
- The water trough should be cleaned at least once a day and more often if it becomes contaminated with manure or other dirt.
- The average intake of water per steer per day is about 50 liters (2,500 liter per day for 50 steers, and 20,000 litres per day for 400 steers). However, in hot temperature; the intake will be larger. A dependable water supply is essential.

Troughs or feed bunks:

- Allow a minimum of 25-30 cm of trough space per steer, and place it at the opposite end of the feedlot from the shade shed.

- It is recommended that the feed bunk extend the entire width of the lot or 20 meter long for 50 steers. If more than 50 head are housed together, add 25 cm per head.
- It needs to be long enough that all animals housed in the lot can eat grain at the same time.

  - **Hayracks:** Hay can be successfully fed in hayracks within feedlot pens. Simple racks can be made from wood or pipe. The hayrack should be off the ground at least 60 cm with a tray at the bottom to reduce trampling and waste. A shade roof should also be above the rack to encourage day time eating. The hay rack can be in the pen where steers can consume hay from both sides or along the fence where they can eat from only one side. It needs to be twice as long if feeding from one side. For 50 steers, the hay rack should be 10 meter long if along the fence line, and if in the pen where steers can feed from both sides, 5 meter long.

  - **Feed ration:** The feed ration will contain grain, forage, and necessary minerals such as calcium, phosphorous, salt, and trace minerals. Additional additives may be needed to improve steer weight gain, depending on the quality of the grain and hay. Feed contamination by moulds, dust or rodents is a common reason for low dry matter intakes and poor performance.

  - **Energy:** Oils/fats are energy-rich forms which provide as much as 2.25 times the energy of starch. Unfortunately, levels exceeding 7% in the ruminant diets can lead to a decrease in rumen efficiency.

Table 8: Protein and energy requirements for fattening cull oxen

Life weight in (kg)	Weight Gain (Kg/day)	ME Requirement (MJ/day)	CP Requirement (% of Ration)
200	0.00	27	8
	0.50	41	9
	0.75	47	10
250	0.00	31	7
	0.50	47	8
	0.75	57	9
300	0.00	36	6
	0.50	53	7
	0.75	64	8
350	0.00	40	6
	0.50	58	7
	0.75	70	8

  - **Minerals:** Steers need a range of minerals to maintain good health. Calcium, phosphorous, salt, and trace minerals will be added to the grain mix to balance the needs not provided by the hay and grain. Salt blocks will not provide the salt needed. A steer would have to stand there all day and do nothing but lick salt to get enough sodium.

- **Health and disease:** There are numerous health and disease issues commonly found within a feedlot system. Many are preventable, through vaccinations for common diseases (follow veterinarian's recommendations); vitamin shots when entering the feedlot, proper balanced feed rations, and good daily management. To follow are some of the more common health and/or disease issues found within feedlot systems. The local veterinarian should assist with the diagnosis and management of all health and/or disease related issues. The following steps should be taken to safeguard the health of animals in the fattening programme:-

- Only select animals which are healthy and have no obvious physical defects. This applies to both purchased animals and cull oxen from the owner's herd. Do not select emaciated animals as their condition may not be entirely due to nutritional factors.

- If the vaccination history of the animals is not known with absolute certainty, they should be vaccinated against all of the major endemic diseases (e.g. Rinderpest, CBPP). Vaccination is not expensive, but disease will spread rapidly among unvaccinated animals kept close together.

- Drench the animals with a broad spectrum anthelmintic at the beginning of the fattening period. This is particularly important for sheep fattening.

- Cull non-performing animals. Sick animals should be immediately isolated from the group and veterinary assistance should be obtained. The animals should only be returned after they recover. About 30 days after beginning fattening, the animals should be weighed (or have their weight estimated by girth measurement). Animals which are performing poorly after 30 days are unlikely to improve during the remainder of the feeding period. They should be removed from the programme and sold, even if a loss is incurred. This is better than wasting good feed on an unhealthy animal which is not growing.

- Make sure enough money is available to cover veterinary costs by including an allowance in the budget. Where credit is used, ensure that credit funds can be used for veterinary expenses.

Use of Market information and Seasonality: Understanding and taking advantage of the seasonal pattern of livestock prices is one of the most important factors affecting the success or failure of fattening programmes. It is very difficult for individual farmers or cooperatives to develop this understanding, as they do not have direct access to market data and do not have the analytical skills to interpret it.

Price seasonality varies from place-to-place, depending on climatic cycles and societal customs. It is therefore difficult to generalise about seasonal price patterns. It is better to analyse this for each area where the fattening programme is operating and prepare recommendations which are correct for that situation.

2.3 Sheep and goat production systems in Ethiopia

For many smallholder farmers, livestock are the only ready source of cash to buy inputs for crop production, such as seeds, fertilizers and pesticides. However, the middle and high altitudinal areas are under threat because of shrinking cultivated areas per household, reduced feed availability and land fragmentation. Results of recent studies in sub-humid highlands of southern Ethiopia showed higher feed scarcity thereby difficulty of sustaining large ruminants (Aune *et al.,* 2001; Desta & Oba, 2004), indicating further comparative advantages of small ruminants pertaining to their lower nutrient requirements. As population increases further and land holding decreases, the role of cattle as compared to small ruminants may be reduced (Jahnke, 1982).

There are various factors that should be considered to categorize small ruminant production systems in Ethiopia. In mixed crop-livestock production system which mainly seen in central highland of the country, small ruminant production is characterized by low productivity due to nutritional stress and internal and external parasites. The Pastoral and agro-pastoral systems which are found in the lowlands are characterized by extensive production based largely on the rangeland (Tembely, 1998; EARO, 2000). The existence of private commercial and parastal production systems on limited scope were also reported by Markos (2006).They are forms of modern small ruminant production systems.

Reproductive and growth performance of small ruminant

The reproductive and growth performances of small ruminants are important factors influencing flock productivity. All forms of output including milk, meat, wool and skins depend on these factors. The factors vary mostly between breeds and even within flocks in a given population (ILCA, 1990). Considering reproductive parameters in selection and cross-breeding programs will directly influence the efficiency of milk and meat production and the rate of genetic progress (Mukasa-Mugerwa and Azage, 1991), and the size of the crop for replacement (Kiwuwa *et al*., 1983). These factors are influenced by many factors including genotype, nutrition, diseases and other management practices.

Site Selection for a sheep and goat farm

- Due consideration should be given to the following points in site selection for a sheep and goat farm.
- Drainage: The area should be slightly sloped for effective drainage.
- Wind direction: Animal houses should be partially or totally protected from the direction of strong winds depending on the wind intensity of the area.

In addition, these performance parameters are not a single trait each but the combination of other several traits that determine their expression.

2.3.1 Important aspects within sheep and goat farming system

Essential sheep and goat facilities differ according to the system of management and climatic conditions. In semi-intensive and modern production systems, where large flocks of sheep or goats are raised and managed, facilities to handle sheep and goats are essential for efficient management. Some of these facilities are: Fences, Handling pens, Housing (house/barn – different kinds of buildings), Dipping vats/spraying area, Isolation ward for sick animals, Manure disposal pit (away from the house), and Equipment (feeding and watering troughs, etc.)

Fences: Fences are important not only to protect animals against predators or theft but also to isolate them from other animals. Fences could be constructed from locally available materials with consideration made regarding cost and durability. Materials resistant against termites are most durable. Alternatively, wooden posts of treated eucalyptus could be used. Barbed wire is commonly used but can damage the skin when animals try to squeeze through an opening. Fences require regular supervision and maintenance. In some instances trees or brush may be grown and fashioned into a live fence.

Handling pens: Sheep and goats need to be handled, either in groups or individually, for vaccination, treatment, mating, weighing, etc. Handling pens are useful in reducing injury and stress to animals and workers. An ideal layout for a handling pen includes a receiving pen, forcing pen, crush, sorting gate, foot bath, dip or spray race (long and narrow passage wide enough for only one sheep or goat), draining pens and a holding pen. In particular, the receiving pen should match the number of animals expected to be handled at one time. Under the current smallholder conditions of Ethiopia, one handling pen per village may serve the purpose as long as complications with disease transmissions are minimal.

Housing: The type of housing varies with the production system, the objective of raising sheep and goats and perhaps tradition. Housing can range from very simple structures made of a roof and partial walls to complex structures fitted with automatic feeders and waterers. Animals may be kept either in an area within the family home or in a separate animal shed. A separate house for sheep and goats with a raised wooden floor 30 cm above the ground is observed in some areas (Konso). The animal

- Protect animals from climatic stress (extreme heat, cold, rain, wind, etc.), thus creating an environment suitable for the animals' physiological state;
- Provide protection against losses by predators and theft; and
- Make management easier and save labour.

shed could be located outside the homestead or it could be adjacent or attached to the family home. Despite variation in types, the common purposes of housing are to:

Design of sheep and goat housing

Having an appropriate design for sheep and goat housing is crucial prior to beginning construction. The design should include floor plan, walls, roofing and other additional facilities.
Floor plan: The space requirement of the animals to be housed influences the design of the floor. Table 3 presents the suggested requirements for different classes of sheep and goats. Space requirements vary depending on whether animals are kept in individual or group pens. The space requirement also varies with the size of animals, i.e., bigger animals require larger space than smaller ones.

Table 9: space requirements for sheep and goat housing

	Space (m^2/animal)			
Type of housing	**Breeding female**	**Breeding male**	**Young Stock**	**Additional**
Permanent confinement (Zero grazing)	1.2	2.0	0.8	Exercise yard feed racks and watering trough
Night housing and day time grazing	0.8	1.5	0.5	

Floor design is particularly important in wet climates, where dung and urine on a damp floor make ideal conditions for the multiplication of disease-causing organisms. In particular, kids and lambs are very susceptible to pneumonia and it is wise to avoid damp and poorly ventilated houses. The floor should be sloped, porous or slatted for water drainage. A minimum floor slope of 5% is recommended; that is, for every 1 meter there should be a fall of 5 cm. Houses with raised, slatted floors have a number of advantages including keeping the floor clean and dry. Ventilation is good and dung and urine drop through the floor, preventing build-up and reducing risk of disease spreading. The spaces between slats need to be big enough to allow manure to drop easily, but small enough to prevent feet from passing through. A spacing of 1.5 cm is optimal for adult sheep (slightly narrower for goats). For young lambs, 1.3 cm is enough.

In some cases, mobile wooden slats are placed on floors providing the advantage of easy cleaning. Where slatted floors cannot be constructed and concrete or earthen floors are used, it is important to control temperature of the floor and avoid muddiness. In such cases, bedding materials may be used. Straw or wood shavings or any material that can absorb moisture can be used for this purpose. Floors may be made from stones or bricks. With all floors, ease of manure removal and disposal should be given attention.

Roof: The roof is important as it protects animals against the sun and rain. The under-surface of the roof should remain cool and watertight. To ensure adequate ventilation, the height of the roof and the design should be considered. A high roof encourages air movement but is more likely to be damaged by strong winds. In some cases a design with a chimney or roof vent could be useful to assist ventilation and remove ammonia that could easily accumulate. The following materials are used for roof construction in different locations: <u>Iron sheet,</u> <u>Grass/bushes</u>, <u>Wood,</u> <u>Stone/brick</u>, and <u>Earth.</u>

Walls: In warm climates walls are partially open to allow movement of air through the house. In some cases, however, complete walling is needed to keep out predators. Ventilation is important to remove heat, moisture and pollutants so that animals stay cool, dry and clean. Outer walls protect the animals from external influences while separation walls within the house prevent mixing among the animals. Attention needs to be given to construction of pens within the house. Pens serve as a means of controlling animals and for management purposes, such as controlling breeding. Areas for lambing/kidding and isolation of sick animals should be included. It is always wise to keep in mind the possibility of expansion when building houses for sheep and goats. An appropriate flock development plan has to be made to anticipate future construction needs.

Figure 11: Dipping sheep at Lallo Mama, Woreda, North Shoa (Mobile dipping vat) and Mobile dipping vat demonstrated to trainees

- **Feeding trough and hay racks:** Feed troughs for concentrate and hay racks for forage feeding are required where these practices are conducted. The size of racks and troughs is determined by the body size of sheep and goats and by animal numbers. Approximately 30 to 40 cm per animal space is the minimum. Movable troughs are usually 2 to 4 meter long. Fodder should not be put on the ground for sheep and goats. A feeding rack can be made from wood or other locally available material such as bamboo. The rack should be high enough to prevent adult sheep and goats from putting their heads in it and from jumping into the rack. The bottom should be above normal head height.

It should be noted that the feeding behaviour of goats is different from that of sheep and a barrier is needed to prevent animals from jumping into the trough. In a system called 'tombstone or keyhole barrier', each animal puts its head through an individual wooden barrier to eat without being able to push its body into the trough. Suggested dimensions for a concentrate trough are a width of 30 cm with a depth of 15 cm, with the trough standing on 15 cm legs.

In general, troughs placed directly on the ground are not desirable because mud or soil can get into the trough, and sheep and goats are tempted to put their feet in. When only a limited amount of supplementary feed is given, it is essential that the trough is long enough to allow all animals to eat at once. Some troughs are fitted with a yoke to restrain animals during the short period of supplementary feeding. Such structures allow individual recording of the amount of concentrate consumed by each animal.

Watering trough: The need for watering troughs depends on the size of the flock. For small flocks, water tight tins, buckets or bowls can be adequate. Any type of watering trough used should be easy to clean.

Age determination of sheep and goats by dentition

Indirect ways of determining approximate age of sheep and goats are vital in systems where production records are unavailable. For instance, if the flock structure has to be determined, age of animals needs to be estimated. Application of drugs also requires knowledge of age and/or weight of the animal. A few days after birth, lambs/kids will have milk teeth, also known as temporary incisors, arranged in four pairs in the lower jaw. These are replaced by larger permanent teeth as the age of the animal increases. There is a range of ages at which particular teeth appear because the speed of teeth growth will vary according to health and nutrition of sheep and goats.

The central pair of temporary incisor teeth is shed and replaced by the permanent teeth at approximately 14 months of age. At approximately 20 months, the second pair of milk teeth is replaced by a pair of permanent incisors. At 3 and 4 years, the third and fourth pairs of permanent teeth appear. At 4 years of age the sheep has a "full mouth." When a ewe/doe loses some of her incisor teeth, she is called a "broken mouth."

a. A 10 month old doeling

b. A 32 month old doe

c. Broken mouth

Figure 12: Teeth of goats of different ages

Note that the doeling Figure 8a has her milk teeth fully grown and spread out. The doe in Figure 8b has had three pairs of teeth replaced.

Older sheep and goats that have worn teeth have difficulty in eating and will lose condition, become more prone to diseases and breed less than younger animals. Inspecting the teeth can be a very useful way of deciding when to cull. In an attempt to improve the precision of age determination, the following classes have been suggested (Table 4).

Table 10: Description of dentition with corresponding age estimates

Description	Estimated age
Young without teeth often a new born	New born
With erupted and growing 1^{st} and 2^{nd} pair of milk teeth	1-2 weeks
With erupted and growing 3rd pair of milk teeth	2-3 weeks
With erupted and growing 4^{th} pair of milk teeth	3-4 weeks
With fully grown milk teeth that started to spread out	9 month
The milk teeth have started to wear down, or are fully spread out	12 months
With erupted and growing 1^{st} pair of permanent teeth	14-17 month
With erupted and growing 2^{nd} pair of permanent teeth	18-23 month
With erupted and growing 3^{rd} pair of permanent teeth	24-36 month
With erupted and growing 4^{th} pair of permanent teeth	3-5 years
The four pairs of permanent incisors have started to wear down	4 years
The permanent incisors have worn down and have started to spread out	5 years
Worn down incisors are spread out and few are lost (broken-mouth)	6 years
Most of the incisors have been lost (smooth-mouth) or worn down to the level of dental pad	7 years

Diseases: If lambing/kidding is unattended and appropriate management measures such as dipping the navel cord in iodine are not done, the chance of infection increases. Proper preventive management and attention to health and cleanliness of the rearing area will decrease the chance of acquiring diseases.

Dehydration: If lambs/kids are allowed to join their mothers grazing on the range and travel long distances in their first days of life, they may suffer dehydration. If there is no shelter to protect them from the extremes of weather, they may suffer from heat or cold, especially if in combination with humidity. It is advisable to house the young and the dams for at least the first few days after birth before allowing them to graze with the flock.

MODULE 3: HOW TO PREPARE FOR THE CHANGE AND WHAT ARE THE CHALLENGES TO CONSIDER WHEN CHANGING TO SEMI-INTENSIVE LIVESTOCK MANAGEMENT

Farming methods in Ethiopia have remained unchanged for centuries, cultivation is carried out using oxen drawn traditional ploughs in the highland this demand high dependency on animal power (as an input function). High population growth has forced people to plough more land, which in turn demand more ploughing capacity. Therefore, to fulfil this demand, more ploughing capacity requires the presence of a bigger cattle herd, which creates pressure on grazing land and land degradation that ultimately results in poor economies for farmers. The other economic benefits of livestock are as a source of additional income. Consideration as assets and security are also important, and due to poorly productive indigenous stock it is therefore required to maintain large herd and demand additional area of grazing land.

The major technical constraints or challenges of dairy development in Ethiopia are: (1) Animal health disease (2) Feed and nitration (3) Genotype.

3.1 Changing livestock farming practices (dairy and beef)

In Ethiopia, livestock farming is extensive and traditional. In the traditional ruminant management system, herds have been left to grow spontaneously, with no genetic selection. This results in an excessive number of males, cows without milk and cases of inbreeding. Cows are milked two times a day, calves are weaned very late, and food supplements and veterinary inputs are limited. These factors all lead to irregular growth and uneven milk production, which is aggravated in the dry season, when milk often dries up and cattle commonly lose weight.

Improving existing techniques and introducing semi-intensive livestock farming as accessible alternatives is good which an intensification of production could help in creating added value and thus ease the pressure on the ecosystems that are to be conserved.

The proposed semi-intensive farming techniques support conservation in different ways:

- Some reduce environmental degradation by easing direct pressure on natural resources. For example, developing ponds and building check dams to collect runoff will make more water available and thus lead to a better distribution of livestock in grazing areas.
- Some improve natural resources by making them more productive or richer – for example the reintroduction of suitable fodder species to improve grazing land, and the establishment of fodder banks (monocultures of legume, grain or woody forage species planted to supplement the natural vegetation).
- Some make economies in the use of natural resources by increasing returns from the same resources or achieving the same returns from fewer resources. For example, improvements in product processing systems, especially for milk, will lead to increased yields.
- Some recycle waste into products. For example, the technique of processing straw for cattle feed not only helps to process crop residues into meat but also reduces methane emissions. Similarly, the use of agricultural and agro-industrial by-products as feed supplements during the dry season increases milk production maintains or even improves the physical condition of cows and calves and also increases the quantity and quality of the organic manure used to fertilize the land.

3.1.1 Conditions for change

Capacity building: The training of local people is thus of fundamental importance. Farmers might obtain the most expert technical assistance and advice from regional, zonal and woredas livestock experts and development agents and veterinarians, but for greater effectiveness, livestock extensionists in villages and watersheds or groups of villages should be trained and kept up to date for guaranteed proximity and ongoing support. Capacity building is also needed on environmental issues, economics (trade, marketing).

The consultation and direct participation of the local community often allow local knowledge to be taken into account and responsibility to be shared, so that problems are identified and solutions found at the local level.

Increased productivity per unit area would ease pressure on natural resources, but it is plain that this cannot be achieved solely through the development of conventional resources (natural pasture, local breeds). The livestock sector will increasingly need external inputs, especially high-quality feed, but also more productive species or varieties, better animal health and investment in livestock production techniques in general.

i) Animal health

Animal health and improved management is also one of the major constraints of livestock husbandry development in Ethiopia which cause poor performance across the productive system. Many of the problems result from the interaction among the technical and non-technical constraints themselves e.g. poorly fed animals develop low disease resistance, fertility problem, partly because the animal health care system relies heavily on veterinary measures, poor grazing management systems continue to cause high mortality and morbidity (e.g internal parasites), many of the disease constraints which affect supply are also a consequence of the non-technical constraints e.g. insufficient money to purchase drugs or vaccines.

ii) Feed and nutrition

In highland zones, high population growth and density are causing the shortage of grazing land on which livestock production by small holders depends. In the lowland areas, the shortage of feed and water during the dry season forces animals and livestock keepers to trek long distances in search of food. The quality of feed also deteriorates during the dry season in both the mixed farming and pastoral system (A. Anteneh, 1992).

iii) Genetics

The genetics of Ethiopia's livestock have evolved largely as a result of natural selection influenced by environmental factors. This has made the stock better conditioned to withstand feed and water shortages, disease challenges and harsh climates. But the capacity for a high level of production of milk and meat has remained low.

Another key element in intensification and diversification of production is **market access.** Development of dynamic markets can enable farms to be profitable and thus permits generation of capital for investment in soil and water conservation.

3.2 Sheep and goat production/fattening

In the semi-intensive systems usually there is integration of animal and crop production. Moving from the extensive to the intensive systems of production the performance of animals is improved and higher inputs used with the objective of obtaining a high output of product (Orskov, 1982).

Inadequate nutrition, particularly of energy, depresses the reproductive performance of extensively (H.F.R.O., 1979) or intensively managed sheep (Orskov, 1982). Sexual maturity of sheep and goats is advanced by good feeding (Owen, 1976) and the energy stimulates oestrus activity within the normal breeding season, ovulation rate, fertilization and survival of ova and the maintenance of the resultant embryos to term as viable lambs (Gunn, 1967).

Body condition at mating, achieved over a longer period i.e. the period between one reproductive cycle and the next, has a greater effect on ovulation rate and barrenness than flushing (i.e. increasing the level of nutrition in the immediate pre-mating and mating period) (Owen, 1976; Gunn & Doney, 1975). High producing dairy ewes or goats require a dry period to achieve maximum profligacy.

A multitude of technical, institutional and socio-economic problems constrain sheep and goat productivity. Prevalence of diseases and parasites and the resulting high mortality and morbidity rates are the major problems. High mortality is the major factor for the observed low sheep and goat off-take rates in Ethiopia. Other technical constraints include shortage, seasonal unavailability and low nutritive value of feeds. Lack of, and low adoption rate of improved technologies, unavailability and/or inaccessibility of inputs, inappropriate delivery methods of extension messages are further problems constraining livestock production. Marketing constraints include inaccessibility, lack of market information, lack of market orientation, low prices, and unfair share of profit margins. There is also minimal institutional and regulatory support for farmers to reap their share of the market benefits.

Despite all the constraints there are quite favourable opportunities to increase sheep and goat productivity in Ethiopia.

Reorienting livestock extension service delivery based on farmers/pastoralists needs and perceptions will increase adoption of technologies. Technical interventions include control and prevention of the major diseases which are the major causes of mortality and morbidity affecting off-take rates. This entails assessing alternative health service delivery systems. Interventions to improve fertility and reproductive rates which also affect off-take rates need to be assessed. Development of feed resources and improved feeding practices are the key to increasing per capita animal output.

Support for evolving alternative production systems is another strategic option. The current improvement strategy is largely based on the small-scale/semi-intensive mode of production. Besides improving the small-scale system, emphasis and support should be provided to the development of large-scale/intensive specialized sheep/goat production systems. Large-scale specialized production systems are more conducive to introducing improved production technologies that require high inputs, which has been a limiting challenge to increase productivity and off-take rates under smallholder production systems. Furthermore, the strategy could focus on developing small-scale market-oriented semi-intensive production systems depending on the characteristics of the existing production systems and agro ecologies. Innovative production systems include specialized ranching, commercial feedlot operations, and market-oriented semi-intensive small-scale sheep/goat production under mixed crop–livestock systems.

Development of improved production systems also requires consideration of technical interventions, particularly development of breeding strategies. Breed choice is a major component of the breeding strategy. Under extensive systems with large breeding flocks (pastoral, lowland agro pastoral, and subalpine sheep-based systems) conservation-based selective breeding using local breeds and well-designed and targeted crossbreeding with the objective of producing breeding stock (terminal sires) and fatteners/finishers for the intensive systems could be considered. Under such a breeding strategy, farmers in the semi-intensive and intensive system could cross their few available ewes with terminal sires to produce fatteners, or alternatively buy fatteners from the extensive system. Economically efficient semi-intensive/intensive systems could also be designed based on improved exotic or local meat breeds.

3.3 Accessing support services

The major constraints for livestock development in Ethiopia can be broadly categorized into technical, organizational, institutional, infrastructural, and environmental and policy aspects. With public– private partnerships it is possible to reorientate and re-focus input of supply and accessing support service provision, which is weak at the moment. The government's role in capacity building and regulating has to be strengthened.

The major input services for livestock development include animal genetic resources, feeds and forages, veterinary drugs, vaccines, machinery equipment and utensils as well as knowledge. Most of these inputs have been supplied only by the government or government sponsored projects. Limited credit facilities to support livestock development have been provided by microfinance institutions, food security projects, small scale micro enterprises and NGOs.

Livestock support services play an important role in determining the quality of the animals kept by farmers, hence the quality and quantity of livestock products. These services include credit, extension services, livestock health (veterinary and ethno veterinary) services, and breeding services.

3.4 Marketing

Livestock production in Ethiopia has, for long, remained subsistence with limited market- orientation and poor institutional support. Producing for the market requires re-orientation of the production system and development of a knowledge based and responsive institutional support services. Institutional support services of extension, research, input supply, rural finance and marketing are key areas of intervention that can play a central role in the transformation of subsistence production into semi-intensive production and market orientation.

Livestock prices are affected by many supply and demand factors, and seasonal pattern varies from year –to- year. It is not possible to have strict rules on when and where to buy and sell. The general strategy is to buy cull oxen after the end of the ploughing season when they are reasonably cheap, and sell them in fat condition around Christmas when demand is strong and prices are high. However, buying and selling options should be kept flexible, for example:-

- If cull oxen are too expensive at the normal buying time, it is better not to buy and miss a year than to pay too much and lose money.
- If there is not enough feed to finish all of the animals, some should be sold early in unfinished condition to ensure that the remainder are properly fattened. In a poor season, these properly fattened animals will bring a higher price than usual.
- If livestock are cheap at any time of the year and enough feed is available to maintain them, they can be bought and held on a maintenance ration to until the beginning of the usual fattening period.
- It is risk to sell all the animals at one time. It is better to spread sales over several weeks and more than one location.
- During droughts, livestock prices in the lowlands can be very low. Service cooperatives should consider sending people to these areas to buy livestock or to negotiate with traders to do this for them.

3.4.1 Challenges in the value chain

A series of constraints span the cattle value chain in production, fattening and trading, and commercialization:

Retail and consumption: There is significant potential for demand growth in the medium term, on both domestic markets and potential export markets.

Actions required for raising the number of calves available for marketing coincide largely with those required to improve dairy productivity, which has substantial nutritional and livelihood benefits of its own. Both private investors and dairy cooperatives are viable aggregation actors who can both improve the productivity of smallholder herds from which they source milk (e.g. by leveraging extension to teach feed production, crop residue utilization and herd management) and aggregate male calves for marketing. Four key government actions are required by this recommendation:

Production: Lowland and highland cattle systems have low reproductive performance and off-take, due to: (i) input constraints of feed and water to pastoral herd size and reproduction; (ii) reluctance of pastoralists to commercialize cattle because of social importance and lack of alternative assets; (iii) limited and periodic access to appropriate animal health services; and (iv) competition of draught power with meat for young males lead to aged and low-quality off-take in highlands.

Fattening and trading: Formal trading is constrained by irregular and variable quality in supply of cattle because:

(i) livestock cooperatives are not effective in delivering value added to their members;
(ii) a large proportion of sales are on credit and incur late payment;
(iii) limited transparency on quality, health, and weight;
(iv) the feedlot industry faces severe constraints for feed, water, land, financing, and markets;
(v) formal trade competes with substantial informal cross-border trade due to weak highland lowland linkages and incentives offered by the informal market.

- Invite investment in dairy processing and marketing either by extant cooperatives or by new private agents. Favourable treatment might target investors sourcing from smallholders and assisting in support of animal feeding by various means including animal health or feed provision.

- Assist in aggregation initiatives across a variety of agents, particularly in aggregation of cooperatives in pursuit of scale, diversification and management flexibility. This might also extend to partnerships between existing firms or co-operatives and new investors. Link extension and knowledge dissemination agents to aggregation actors (e.g. cooperatives) to ensure effective extension training for smallholders, on topics such as dairy cow management, feed and forage production, crop residue utilization and cattle fattening practices.

- Support the development of private animal health providers, by offering financing, business management training and streamlined registration to veterinarians wishing to establish a private practice. Better enforce regulations controlling illegal drug and health service providers. A pre-requisite for this development would be the cessation of government routine health care programs, which, by free provision, currently crowd out private involvement.

These efforts should initially concentrate on high-potential areas, and can be expanded once successful models are proven.

MODULE 4: MONITORING OF PRODUCTION AND IMPACTS WHEN PRACTICING SEMI-INTENSIVE LIVESTOCK MANAGEMENT

4.1 Measuring and recording of production parameters

As general rule, the records most needed are those directly related to the aspect of performance which it has been decided to improve, for example milk yield, body size or litter size. In addition, some characteristics require observations which are related to the principal trait. Such additional traits/character may have a bearing on production efficiency or costs and they may themselves change in consequence of changing the primary trait/character.

- **Milk yield and milk composition**: this may present grater difficulties in small-holder herds where problems can arise because of poor educational level of farmers and poor access of the farms to field workers, acting as records. (Less accurate but still factual ways of recording yield may have to do). However, cows which produce more milk often produce milk with a lower proportion of fat and protein. If extra milk quantity is the aim, some measure of milk composition will be useful in addition to total yield if the maximum economic gain is to be made or quality (in terms of milk composition) is not to be lost.
- **Milk yield and body size:** As generalization (not true in every case), cows which yield more milk are often larger than those which produce less. Big cows, however, eat more than small ones and that may not be desirable, or may not be cost-effective. Some records should therefore be taken to note the milk yield/body size relationship and any changes that occur- and perhaps to take account of the relationship in the improvement programme. The relationship of milk yield to body size is also highly relevant when part of the farmer's income from cattle is derived from their use for meat or work, in addition to milk.
- **Milk production and reproduction:** Milk production is related to the regularity of calving. The level of milk production can affect the timing and ability to conceive. Thus, minimum records on calving performance are needed to relate to the changes in milk production. In the same way, records of health, or at least of overt illness, are necessary in order to interpret milk records. A cow with mastitis or other diseases will have reduced milk production.
- **Efficienc**y: In relation to the paramount importance of efficiency of production, it is useful to record those items which contribute significantly to the costs of production. The financial returns from the production process can be gauged by the output – more easily quantified for items which are sold than for items which are used by the farmer.
- **Culling animals:** Performance records can be used as a basis for culling unproductive animals. Such culling improves herd performance and profitability, quite apart from any possible genetic benefits. It is always necessary to relate performance levels to the conditions under which the performance is achieved. Some of the parameters of beef and dairy system are stated as follows.
- **Production parameters for beef cattle:** Calf mortality risk (%), Female/male replacement mortality risk (%), Cow mortality risk (%), Age at first calving (months), Calving rate (%), Milk off-take per lactation (kg), Weight of mature cow (kg), and Weight of mature bull (kg).
- **Production parameters for dairy cattle:** Female calf mortality risk (%), Male calf mortality risk (%), Female replacement mortality risk (%), Male replacement mortality risk (%), Cow mortality risk (%), Calving rate (%),Milk off-take per lactation (kg), Weight of mature cow (kg), and Weight of mature bull (kg).

4.2 Measuring and recording of economic parameters

The dairy sector is a major contributor to economic development, especially among developing countries, both driving economic growth and benefiting from it. As an engine of growth, it provides increased income, employment, food and foreign exchange earnings as well as better nutrition. As income increases with economic development, the share of animal products in the total food budget increases faster than that of cereals. This occurs because of the relatively high-income elasticity of demand for animal products *(*Ehui S. 2008).The dairy industry may be viewed as a distinct sector of the livestock economy.

To resolve the overall food, health and education problems occurring in the world today, international development goals were set that are directly or indirectly associated with the livestock sector and in particular, dairy farming (DFID, 2005). According to the trend analysis done by Cristopher et al. 1999) (annual growth for milk demand has increased from the lowest 0.2% in developed countries to the highest 3.3% in developing world and in sub Saharan Africa 3.8% during the period of 1993-2020. This is generally explained by the fact that the per capita milk consumption will increase to 30 Kg, 62 Kg and 189 Kg for sub-Saharan Africa, developing and developed countries respectively by 2020.

4.3 Measuring and recording socio-economic effects

Productivity of systems is measured according to a single criterion; milk production for dairy animals and beef output for beef animals. However, smallholder cattle farmers in developing countries have multiple goals for their cattle enterprise. The roles that cattle play in the extensive, semi-intensive and intensive farming systems are manifold. Apart from meat and milk production, livestock are closely linked to the social and cultural lives of millions of resource-poor farmers for whom animal ownership ensures varying degrees of sustainable farming and economic stability. These values vary from society to society and largely determine the strategies, interventions, and demand and development opportunities for livestock.

Livestock acts as security assets influencing access to informal credits and loans. They are also considered a common means of demonstrating wealth, cementing relationships through bride price payments and as social links, important in crises. In many smallholder farming systems in developing countries, manure is considered as important as milk, meat or draught power. Romney *et al*. (1994), quote a study in Zimbabwe which recorded that farmers reduced grazing time by keeping cattle penned longer in order to collect more manure even though this meant a reduced feed intake thereby adversely affecting production. In the Kenyan highlands, use of organic fertilizers particularly livestock manure has been on the increase among the smallholder farmers due to its substitutability for inorganic fertilizer as the cost of the latter rises due to market distortions, resulting from physical constraints such as roads infrastructure (Omamo *et al*, 2002; Obare, 2000).

In Kenya, researchers found that the value of manure produced in a small dairy farm may be approximately 30% of the value of milk produced. This value is captured on-farm through the increased value of crop production, resulting from manure application to crops on-farm (Lekasi *et al*, 1998). Large scale dairy producers on the other hand, may have great difficulty capturing this value since quantities of manure produced may be so great that the issue becomes that of disposal rather than use (Staal, 2002).

The income parameters consist of net recurrent cash income, income in kind and non-market socio-economic benefits of cattle. The net recurrent cash income increases as the level of intensification rises, due to a shift to a more market oriented production as the level of intensification rises. The recurrent cash income is important as it offers income used to meet regular household expenses. The recurrent income in kind comprises non-marketed recurrent production that is consumed, exchanged or invested. It includes manure, milk consumed by the household, draught power and value of calves born on-farm.

Non-market benefits of cattle are crucial to the survival and competitiveness or profitability of smallholder cattle production systems. They play a significant role in meeting household needs, more so for resource poor farmers, especially women who do not have alternative avenues to meet these needs.

The benefits of livestock in a livestock production system outweigh costs when non-market parameters are considered in the cost-benefit analyses, and that the rate of return to livestock capital investment is higher than those obtainable from cash in a form of savings that is investable in formal or non-formal financial institutions. Consequently, non-market parameters should be incorporated in evaluating the economic importance of livestock to households engaged in livestock production since this will have a bearing of any policy related interventions whose target is households that are wholly or partially dependent on the livestock economy. Otherwise, unless better, viable and attractive alternatives and substitutes are available, the production systems as they are currently constituted will remain a permanent feature in agriculture that is characterised wholly or partially by the livestock economy.

Contingency upon climatic conditions, risk insurance and recurrent expenditures are important determinants of the type of livestock system that farm households are engaged in. The social roles that livestock play are also important although there are bound to be variations across communities. Appreciation of these roles is necessary if any policy geared towards change in the structure of the systems is to succeed.

Improved integration of livestock keeping households into the market would possibly reduce non-market roles of livestock. However, this will entail deliberate efforts geared towards the development of livestock and livestock product markets. With well functioning and regionally integrated markets the role of cattle as insurance against risk and that of financing unexpected expenditures will decline. This is because functioning markets provide signals for investment decisions. They also provide opportunities for long term planning. In the long run, there may be need to integrate households into financial and insurance markets so as to improve their livelihoods.

4.4 Measuring and recording climate change adaptation and mitigation effects

Responses to climate change include (i) adaptation, to reduce the vulnerability of people and ecosystems to climate changes, and (ii) mitigation, to reduce the magnitude of climate change impacts in the long term. However, neither adaptation nor mitigation alone can offset all climate change impacts. To respond to this threat it will be necessary to focus both on mitigation, to reduce the level of emission of gases contributing to global warming, and on adaptation, to support local communities in dealing with impacts.

Among the vulnerabilities due to climate change identified in the agricultural sector are: decreased production of different crops exacerbated by climatic variability and unpredictability of seasonality; erosion of the natural resource base; and environmental degradation. Average maize yield will decrease by 33 per cent countrywide with an increase in temperature and reduced rainfall, as well as a change in rainfall patterns (NAPA 2007). Climate change may increase the survival and spread of livestock diseases to areas that were previously free of such diseases.

Agro-pastoralists and pastoralists have different strategies to reduce their vulnerability and adapt to, or cope with, current climate variability. These strategies include temporary and permanent migration and keeping different types of livestock, cattle, goats and sheep (Obando *et al*. 2010). Goats and sheep are more adapted to drought than cattle: they can remain alive longer without water and they can browse on shrubs and trees. In the case of temporary migration, during drought periods livestock farmers disperse their herds to different locations depending on the availability of water and pasture.

According to the study undertaken in Tanzania, vulnerabilities experienced in livestock production systems are mainly due to the combined effect of droughts of different magnitudes. Droughts alone account for 72 to 84 percent of the climate shocks as perceived by the pastoralists.

4.4.1 The effects of climate change on livestock

The impact of climate change is expected to heighten the vulnerability of livestock systems and reinforce existing factors that are affecting livestock production systems, such as rapid population and economic growth, rising demand for food (including livestock) and products, conflict over scarce resources (land tenure, water, bio fuels, etc). For rural communities, losing livestock assets could trigger a collapse into chronic poverty and have a lasting effect on livelihoods.

The direct effects of climate change will include, for example, higher temperatures and changing rainfall patterns, which could translate into the increased spread of existing vector-borne diseases and macro parasites, accompanied by the emergence and circulation of new diseases. In some areas, climate change could also generate new transmission models.

Water: - Water scarcity is increasing at an accelerated pace and affects between 1 and 2 billion people. Climate change will have a substantial effect on global water availability in the future. Not only will this affect livestock drinking water sources, but it will also have a bearing on livestock feed production systems and pasture yield.

Land use and systems changes

- **Feed:-** As climate changes and becomes more variable, niches for different species alter. This may modify animal diets and compromise the ability of smallholders to manage feed deficits.
- **Livestock (and human) health: -** Vector-borne diseases could be affected by: (i) the expansion of vector populations into cooler areas (in higher altitude areas: malaria and livestock tick-borne diseases) or into more temperate zones (such as bluetongue disease in northern Europe); and (ii) changes in rainfall pattern during wetter years, which could also lead to expanding vector populations and large-scale outbreaks of disease (e.g. Rift Valley fever virus in East Africa). Thornton et al. (2008) examined some of the direct and indirect impacts of climate change on livestock and livestock systems.

4.4.2 Adaptation and mitigation livestock strategies

Livestock can play an important role in both **mitigation** and **adaptation**. Mitigation measures could include **technical** and **management options** in order to reduce GHG emissions from livestock, accompanied by the integration of livestock into broader environmental services. Livestock has the potential to support the adaptation efforts of the poor. In general, livestock is more resistant to climate change than crops because of its mobility and access to feed. However, it is important to remember that the capacity of local communities to adapt to climate change and mitigate its impacts will also depend on their socio-economic and environmental conditions, and on the resources they have available.

Livestock adaptation strategies

Livestock producers have traditionally adapted to various environmental and climatic changes by building on their in-depth knowledge of the environment in which they live. However, the expanding human population, urbanization, environmental degradation and increased consumption of animal source foods have rendered some of those coping mechanisms ineffective (Sidahmed, 2008). In addition, changes brought about by global warming are likely to happen at such a speed that they will exceed the capacity of spontaneous adaptation of both human communities and animal species.

The following have been identified by several experts (FAO, 2008; Thornton, et al., 2008; Sidahmed, 2008) as ways to increase adaptation in the livestock sector:

- **Production adjustments:** Changes in livestock practices could include: (i) diversification, intensification and/or integration of pasture management, livestock and crop production; (ii) changing land use and irrigation; (iii) altering the timing of operations; (iv) conservation of nature and ecosystems; (v) modifying stock routings and distances; (vi) introducing mixed livestock farming systems, such as stall-fed systems and pasture grazing.
- **Breeding strategies:** Many local breeds are already adapted to harsh living conditions. However, developing countries are usually characterized by a lack of technology in livestock breeding and agricultural programmes that might otherwise help to speed adaptation. Adaptation strategies address not only the tolerance of livestock to heat, but also their ability to survive, grow and reproduce in conditions of poor nutrition, parasites and diseases (Hoffmann, 2008). Such measures could include: (i) identifying and strengthening local breeds that have adapted to local climatic stress and feed sources and (ii) improving local genetics through cross-breeding with heat and disease tolerant breeds. If climate change is faster than natural selection, the risk to the survival and adaptation of the new breed is greater.
- **Market responses:** The agriculture market could be enhanced by, for example, the promotion of interregional trade and credit schemes.
- **Institutional and policy changes:** Removing or introducing subsidies, insurance systems, income diversification practices and establishing livestock early warning systems – as in the case of IFAD-supported interventions in Ethiopia, and other forecasting and crisis-preparedness systems –could benefit adaptation efforts.
- **Science and technology development:** Working towards a better understanding of the impacts of climate change on livestock, developing new breeds and genetic types, improving animal health and enhancing water and soil management would support adaptation measures in the long term.

- **Capacity building for livestock keepers**: There is a need to improve the capacity of livestock producers and herders to understand and deal with climate change increasing their awareness of global changes. In addition, training in agro-ecological technologies and practices for the production and conservation of fodder improves the supply of animal feed and reduces malnutrition and mortality in herds.
- **Livestock management systems:** Efficient and affordable adaptation practices need to be developed for the rural poor who are unable to afford expensive adaptation technologies. These could include (i) provision of shade and water to reduce heat stress from increased temperature. Given current high energy prices, providing natural (low cost) shade instead of high cost air conditioning is more suitable for rural poor producers; (ii) reduction of livestock numbers – a lower number of more productive animals leads to more efficient production and lower GHG emissions from livestock production (Batima, 2006); (iii) changes in livestock/herd composition (selection of large animals rather than small); (iv) improved management of water resources through the introduction of simple techniques for localized irrigation (e.g. drip and sprinkler irrigation), accompanied by infrastructure to harvest and store rainwater, such as tanks connected to the roofs of houses and small surface and underground dams.

Mitigation of livestock GHG emissions

The livestock production system contributes to global climate change directly through the production of GHG emissions, and indirectly through the destruction of biodiversity, the degradation of land, and water and air pollution. There are three main sources of GHG emissions in the livestock production system: the enteric fermentation of animals, manure (waste products) and production of feed and forage (field use) (Dourmad et al., 2008). Indirect sources of GHGs from livestock systems are mainly attributable to changes in land use and deforestation to create pasture land. For example, in the Amazon rainforest, 70 per cent of deforestation has taken place to create grazing land for livestock.
Mitigation of GHG emissions in the livestock sector can be achieved through various activities, including:

- Different animal feeding management.
- Manure management (collection, storage, spreading).
- Management of feed crop production.

The contribution the livestock sector can make to the reduction of emissions varies. Possible mitigation options include (FAO, 2008b).

Selection of faster growing breeds

Improvements could be made to livestock efficiency in converting energy from feed into production and losses through waste products can be reduced. Increasing feed efficiency and improving the digestibility of feed intake are potential ways to reduce GHG emissions and maximize production and gross efficiency, as is lowering the number of heads. All livestock practices – such as genetics, nutrition, reproduction, health and dietary supplements and proper feeding (including grazing) management - that could result in improved feed efficiency need to be taken into account.

- **Improved feeding management:** The composition of feed has some bearing on enteric fermentation and the emission of CH_4 from the rumen or hindgut (Dourmad, et al., 2008). The volume of feed intake is related to the volume of waste product. The higher the proportion of concentrate in the diet, the lower the emissions of CH_4.
- **Better waste management:** Improving the management of animal waste products through different mechanisms, such as the use of covered storage facilities, is also important. The level of GHG emissions from manure (CH_4, N_2O, and CH_4 from liquid manure) depends on

the temperature and duration of storage. Long-term storage at high temperatures results in higher GHG emissions. In the case of ruminants, pasture grazing is an efficient way to reduce CH_4 emission from manure because no storage is necessary. It is possible not only to mitigate GHG emissions but also to create an opportunity for renewable energy.

- **Grazing management:** One of the major GHG emission contributions from livestock production is from forage or feed crop production and related land use. Proper pasture management through rotational grazing would be the most cost-effective way to mitigate GHG emissions from feed crop production. Animal grazing on pasture also helps reduce emissions attributable to animal manure storage. Introducing grass species and legumes into grazing lands can enhance carbon storage in soils.

- **Lowering livestock production and consumption**: Lowering the consumption of meat and milk in areas with a high standard of living is a short-term response to GHG mitigation.

- **Stocking rate management:** Conventional rangeland science suggests that sustainable management of grassland can be achieved by grazing livestock at stocking rates that do not exceed the grassland carrying capacity.

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