Dairy Cattle Feeding and Nutrition management

Training Package for Dairy Extension Workers

August, 2017

SNV

DAIRY TRAINING CENTRE

Developed with
Dairy Training Centre

Dairy Cattle Feeding and Nutrition management

Part I Training manual

Part II Training Guideline

Preface

SNV Ethiopia, through EDGET project (Enhancing Dairy Sector Growth in Ethiopia, 2013-2018), engages in the capacity building, extension services and innovative support to the Ethiopian dairy sector particularly working with smallholder dairy farmers. The aim of the project is to increase milk production and productivity in order to double the income of the smallholder dairy farmers. EDGET is operational in the regions Oromia, Amhara and SNNP, and working with 65,000 dairy farming households.

The project works closely together with livestock regional bureaus and their respective zonal, woreda and kebele staff in delivering extension and other supports. One area of collaboration is the development of practical training and coaching tools and materials for extension workers based on a need assessment.

SNV has engaged the Netherlands based Dairy Training Centre (DTC) for the development of the Training package for extension workers. The documents were more elaborated and validated with the utmost contribution of high level experts from regional Livestock and Fisheries resources Development Bureaus/Agencies and Research Centers from the three operational regions of EDGET.

Overall nine training packages were developed on Breed Improvement and Fertility Management; Dairy Cattle Feeding and Nutrition Management; Dairy Cattle Health Management; Dairy Farm Management; Dairy Housing and Manure Management; Farm Economics; Forage Production and Management; Hygienic and Quality Milk Production; Young Stock Management.

This training package is on **Dairy Cattle Feeding and Nutrition Management.**

SNV, also on behalf of the experts that contributed and DTC, would hope to see the materials widely used outside the project areas by all interested dairy development practitioners. The materials will be available in hard copies and soft copies including on SNV website www.snvworld.org and other relevant websites.

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Abbreviations

ADF	Acid Detergent Fiber
BCS	Body Condition Scoring
CF	Crude Fiber
CP	Crude Protein
DCP	Digestible Crude Protein
DM	Dry Matter
EE	Ether Extract
IOM	Inorganic Matter
NDF	Neutral Detergent Fiber
NFC	Non Fiber Carbohydrates
NFE	Nitrogen Free Extract
NPN	Non-Protein Nitrogen
NRC	National Research Council
OM	Organic Matter
TDN	Total Digestible Nutrients

I. Dairy Cattle Feeding and Nutrition Management Training manual

1. Introduction

Over the last decades an enormous amount of research has been done into the ways in which livestock use feed to maintain life, to grow, to reproduce and to produce all of the animal products which man uses, especially milk.

In Ethiopia animal production is often a secondary activity within the subsistence farming system. However, commercial dairy farming in Ethiopia is expanding due to income increase, rapid urbanization and changing dietary habits.

Dairy cows (and all other ruminants) have the capacity to convert roughages and other by- products from the human food industry, otherwise useless waste products, into valuable products like milk and meat. In this capacity as "waste product utilizers" ruminants contribute to the environment. However also negative impact from managing livestock is there. In Ethiopia overgrazing has caused land erosion and in 2007 the FAO calculated that the livestock sector contributes 18 % of all greenhouse gas emissions which lead to climate change.

Another aspect is the cost of feeding. In virtually all commercial livestock farming systems the purchase of feed and/or the cost of growing fodder is the most expensive item of the production costs. Because of these high costs it is therefore very important that feedstuffs are utilized in the most optimal way. To do so it is very important that one has excellent knowledge and skills with regard to feeding management.

In some cases, due to the "green revolution", farmers are able to produce more and better quality feed and fodder. However, due to the absence of proper skills in feeding management, the extra feed and fodder resources are not utilized in the best way.

Farmers always have to work against limitations which are usually not of their own making or choosing. For example shortages of land, shortages of high quality feedstuffs to offset an abundance of poor quality roughages, climate change, etc. Each of these situations brings different, farmer specific, practical problems, but the nutritional challenge and dairy cattle nutrition management objective remains the same: An attempt to produce a properly balanced diet at the least cost to the farmer without affecting the environment giving the farmer the optimum income from his/her dairy enterprise.

Although this manual will not provide the answer for each and every "specific situation" it does provide the (theoretical) knowledge and guiding principles to help farmers in their feeding management.

2. Dairy Cow Behavior and Impact on Dairy Cattle Nutrition Management

2.1 Dairy Cow Behavior

Dairy cows have evolved from originally ruminating prey animals. Rumination and the fermentation which takes place in the rumen allows dairy cows/ruminants to turn low quality forages and human food by-products into high quality food: milk and meat. Ruminating prey animals forage in open plains with plenty of grazing grass and quickly

return to hiding places in the bush/forest where they lie down at a comfortable and dry place and ruminate protected from predators.

They are social animals and always will graze, lie down and ruminate together. This behavior is still present in the dairy cows today. Dairy cows also use eating and drinking to confirm relationships and dominance in the herd. Dominant cows make it clear that they are the boss and cows lower in the hierarchy indicate that they know their place at eating and drinking places. It is essential behavior which will be expressed.

Prey animals always keep an eye on each other and their surroundings and react immediately to any threats, other animal's reaction and unfamiliar situations. A nervous cow eats more quickly resulting in a lower feed intake. Cows will also stand more in such a situation instead of lying down. Nervousness can be caused by many things such as conflicts with other cows, fear of people, not enough space to lie down or cubicles which are not comfortable (wet/dirty, incorrect dimensions, hard surface, etc.), not enough eating or drinking space causing dominant cows to chase away lower ranking animals, different feeding times (cows need "routine" !), etc.

2.2 Impact of behavior on Feeding Management

The above explained natural behavior has the following implications on Feeding Management:

- The feeding manger should be large enough to allow all cows to eat at the same time! The feeding manger should have feed, preferably of the same quality, 24 hours per day to avoid dominant cows to eat the best. Preferably feed mangers should be 5-10 cm higher than the standing place of the cow (a position similar to the situation of grazing animals). In this position cows will produce more saliva during feeding which improves rumen function. Make sure that the feed fence is comfortable for cows to access, see also the Dairy housing and manure management manual.
- Feed cows always at the same time. Make sure that feed is easily accessible. Cows need/want routine. Feed enough so that the feeding manger will never be empty and accept feed leftovers. Clean the feeding manger at least once a day (feeding mangers with a smooth easy to clean surface also leads to reduced heating up of feed). In this situation cows will eat in small portions throughout the day ensuring that the rumen is always full and functioning well, see also chapter 3.
- Make sure that cows have access to clean and fresh water 24 hours per day. Cows drink 6 to 14 times per day. Usually after milking and after every meal. Preferred temperature should be between 17 – 27 oC. Cows prefer to drink together from an open low trough (50 cm). Make sure that at least 10 % of cows can drink at the same time.
- Make sure that there are enough comfortable cubicles/lying down areas for the cows (cows should lie down at least 12 hours per day). They will spend 8 to 10 hours ruminating.
- Treat cows gently (no shouting, no beating, etc.). Avoid stressful situations.

Figure 1: Enough feed and feeding space ensures a high feed intake

3. The digestive system of ruminants.

3.1 The foregut of the ruminant.

Digestion means the breaking down of the different components of a feedstuff in such a way that they can be taken up by the blood stream and transported to the places in the body where they are needed. The process of digestion in non-ruminants as well as in ruminants takes place under the influence of enzymes. Enzymes are substances which stimulate or facilitate certain chemical processes.

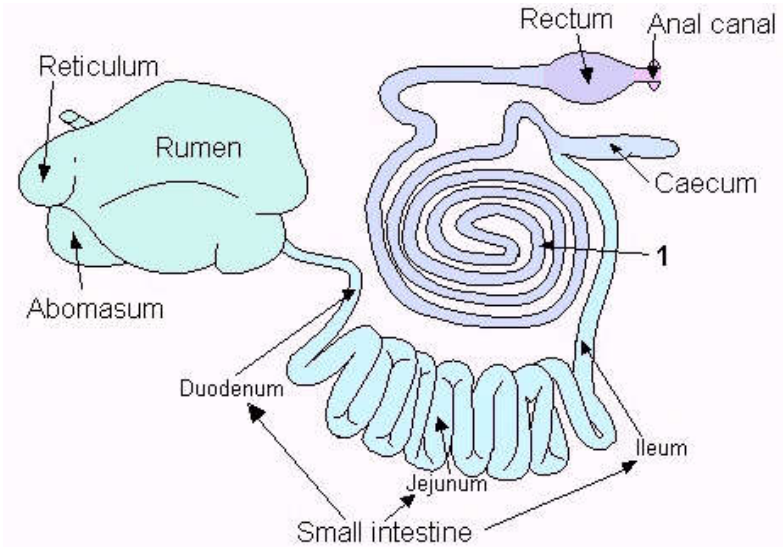


Figure 2: Schematic representation of ruminant's digestive system

The abomasum is comparable to the stomach of non-ruminants; the other stomachs (the so called fore-stomachs) are specific for the ruminant.

Due to the relative large volume and specific action of the fore stomachs, the cow is able to take in quite a lot of bulky vegetable feed. Through breeding the exotic breeds (Holstein Frisian and the Jersey for example) have evolved into cattle breeds having relatively big digestive systems.

A common descriptive term for the rumen is the fermentation vat, as it serves as a reservoir of feed and supports an active microbial fermentation.

Figure 3: Rumen Papillae

The inside of the rumen wall is lined with papillae, small finger-like projections, which increase the rumen's absorptive area (see figure 3). Volatile fatty acids, ammonia and water move through the rumen wall directly to the blood stream. Increasing the rumen available energy content of the diet (starch) will stimulate papillae growth. This in turn improves rumen absorption of volatile fatty acids into the blood stream. The number and size of rumen papillae of cows not receiving concentrates (like dry cows) are therefore less. Just after birth the fore stomachs of the calf are still not developed. The milk which the calf drinks goes directly to the abomasum through the esophageal groove. However, the fore stomachs develop quite rapidly and at the age of 6 weeks the volume of the fore stomachs is about the same size of that of the abomasum. This development is (and should be) stimulated through the feeding of roughage and especially concentrate.

In adult Holstein Frisian cows the volume of the fore stomachs is about 15 times of that of the abomasum. The rumen has then a volume of 100 – 150 liters.

The rumen content is made up of three layers. At the bottom is the liquid layer. On this layer floats a solid mass of roughage particles and in the space above this layer gasses will be present.

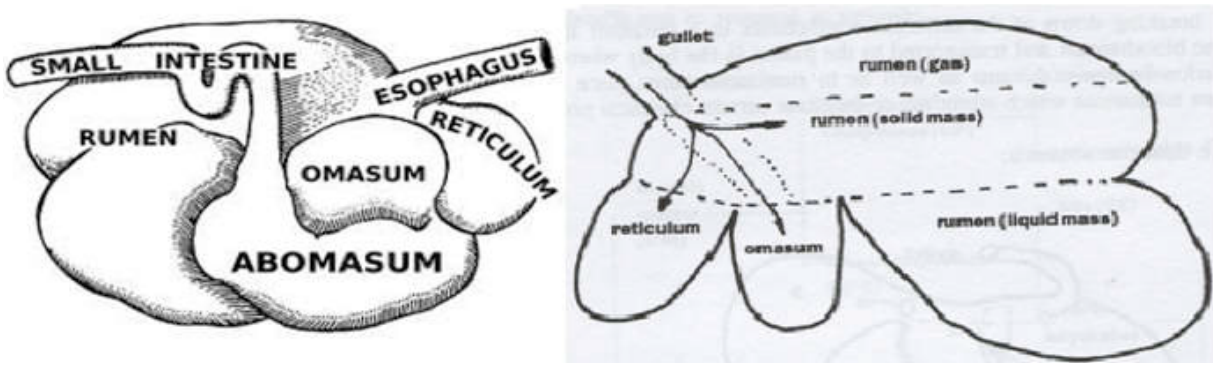


Figure 4: Schematic representation of the fore stomachs.

The rumen will have over two contractions per minute. This mixes the rumen contents, brings bacteria and feed into contact, moves material out of the rumen if it is dense and short, and brings long particles to the top surface for rumination to occur.

The cow spends 8 -10 hours per day ruminating (chewing her cud). The rumination cycle consists of four functions. **Regurgitation** occurs when an area around the esophagus is stimulated with coarse material (scratch effect of fibrous roughages). A handful of coarse material is regurgitated to the mouth by a reverse peristalsis movement.

Once the coarse feed is in the mouth, the second phase (**re-chewing**) occurs, grinding the feed to a smaller particle size which will allow it to pass out of the rumen.

The third phase is **re-salivation**. Saliva contains buffers, which mixed with the regurgitated material will stabilize the rumen pH. A cow produces over a 150 liters of saliva every day when proper rumination occurs.

The fourth phase is when the cow **re-swallows** the cud. If the coarse material has been mechanically reduced through chewing, the material should sink in the rumen and moves to the reticulum. Feed leaves the rumen when the particle size is dense (heavy) and short. Long particles will float in the rumen, forming the forage or hay raft in the top of the rumen and stimulate additional rumination time. If material is too coarse, such as straw, too much time is needed to re-chew the feed, and this reduces overall dry matter intake. When feed is fermenting in the rumen large amounts of methane, carbon dioxide, and other gases are formed and must be expelled (from 30 to 50 liters per hour). Methane and carbon dioxide are important greenhouse gases.

Under normal conditions, distension from gases will stimulate the cow to have a rumen contraction which will clear the esophagus region and allow gas to be belched or eructated. If this area can't be cleared or gas forms a froth, the cow may bloat. If the animal takes liquid feed it will pass directly into the abomasum through the esophageal groove. Digestion continues in the abomasum in the same way as with animals having one stomach (non-ruminants).

The above makes it clear that ruminants are able to digest feedstuffs which are not digestible for animals having only one stomach. These feedstuffs are often waste products from the production of food for human consumption and/or grown on land which is unsuitable for anything else but fodder crops/grass production. As such ruminants are essential in each farming system for optimum utilization of natural resources and waste products and are therefore playing a very positive role in protecting the environment. The greenhouse gas emissions however pose a threat. Increasing milk production per cow is the shortest route to a reduction of these greenhouse gases per liter of milk!

3.2 Digestion of carbohydrates, protein and fat in the fore stomachs.

The feed mixed with some saliva enters the fore stomachs. In the rumen the micro flora (billions of bacteria and protozoa) starts with the digestion process. What happens in the fore stomachs during this process is the following:

a) The breaking down of part of the carbohydrates, mainly into:

- **acetic acid**, which is needed in the butter fat making process; especially cellulose contributes to the formation of acetic acid.
- **propionic acid**, which provides energy to the animal and which is needed for the formation of milk sugar; especially starches and sugars in the feed contribute.
- **butyric acid.**

These volatile fatty acids are for the largest part absorbed through the rumen wall into the blood stream of the cow and transported to the liver, mammary gland, fatty tissue deposits and other tissues. These volatile fatty acids provide 60 – 80 % of the energy requirements of the cow. Fat, carbohydrates not degraded in the rumen and protein provide the remaining energy. The remaining volatile fatty acids produced in the rumen are utilized by the microbes for the production of microbial protein.

Figure 5: Damaged rumen papillae due to rumen acidosis

Under special circumstances also lactic acid can be produced in the rumen. Since this acid is not volatile it can play a negative role in the rumen fermentation, causing acidification of the rumen content and rumen acidosis. Rumen acidosis will cause damaging of rumen papillae (see figure 5).

b) The breaking down of part of the protein of the feed into amino acids. These amino acids are either used in the formation of protein made by the micro flora in the rumen or broken down still further into ammonia, carbon dioxide and volatile fatty acids.

On average around 60 - 70 % of the dietary protein is transformed/ "digested" by the rumen microbes in the rumen. The microbes in the rumen not only use the amino acids from the feed, they are also able to make all necessary amino acids out of non-protein nitrogen (NPN), for example out of ammonia. The non-ruminant animal does not have this capability. The microbes in the rumen will only "produce" amino acids out of urea if certain conditions are met:

- There must be sufficient easily digestible carbohydrates available in the rumen to supply the energy to the micro flora to "produce" amino acids.
- There should be a clear shortage of "natural" protein in the feed.
- The urea should be supplied in small quantities and at regular intervals.

There is a limit to what the dairy cow (in fact her rumen) can "handle" in the form of NPN. Under normal circumstances around 130 g of microbial protein is produced for every 1000 g of digestible organic matter which enters the rumen! In order to achieve this level the rumen fluid should contain 150 g of ammonia per liter.

c) Fat is present at modest levels in diets commonly fed to dairy cattle. Dietary fat and oil are consumed either as triglycerides (three fatty acids attached to a glycerol molecule) or as free fatty acids.

Rumen microbes hydrolyze triglycerides to fatty acids and glycerol (used by microbes as a minor energy source). The fatty acids can be classified as saturated and unsaturated. Rumen microbes partially hydrogenate unsaturated fatty acids, forming more saturated fatty acids with similar carbon length. Fatty acids (such as those in soybeans or fish meal) can interfere negatively with rumen fermentation and lower fiber digestibility.

Unsaturated fatty acid can be toxic to fiber digesting bacteria and coat fiber particles, thereby reducing bacterial attachment and fiber digestion. Rumen inert fats do not affect rumen fermentation. In general fat content in the ration should be limited to a maximum of 5% whereby feeding of fish oil should be minimal. Feed oil seeds whole or coarsely processed to minimize exposing rumen microbes to high levels of unsaturated fatty acids.

Digestibility coefficient.

Not all the feed an animal eats is digested. The part that is not digested will leave the body as feces and is not used by the animal. The digested part of the feed can be expressed as a percentage of the total feed intake. This percentage is called the digestibility coefficient.

Example :

A cow eats 12 kg dry matter per day, of which 3 kg is later found in the feces. This means that 12 – 3 = 9 kg dry matter has been digested. The digestibility coefficient of the dry matter is then 9/12 x 100 = 75 %. In other words 75 % of the dry matter has been digested.

Depending on the feedstuff the digestibility may vary a lot. Some products such as most feeds of animal origin, young grass and other green forages are very easily digested (high digestibility coefficient) while other products such as straw and chaff are difficult to digest (low digestibility coefficient).

Other factors which might influence the digestibility of a feedstuff are:

- The kind of animal (goat, sheep, cow; local or "exotic" breed, etc.)
- The level of feeding (the more feed the animal consumes, the lower the digestion will be)
- The structure of the feed ("fine" feed is digested more easily than "coarse" feed; it is for example not sensible to feed whole grains to cattle).

- The age of the animal; very young and very old animals digest the feed somewhat less efficiently.
- Maturity stage of the plant, early harvested and 50% blooming stage is more digestible and nutritious than matured plants.
- Physical composition of the plant, i.e. leaf to stem ratio of the feed

4.The composition of feedstuffs.

4.1 Water and dry matter.

All feedstuffs consist of water and dry matter. For example if the water content of a feedstuff is 75%, the dry matter (DM) content is 25 %. Although water is very important for cattle, it plays a vital role in functioning of the body, milk production, and the total intake of food. A shortage or uneven supply of drinking water has a direct impact on the dry matter intake and milk production. It is the dry matter which contains the nutrients cattle need.

4.2 Carbohydrates.

Carbohydrates in feedstuffs comprise of sugars, starches (e.g. derived from cereals, tubers and roots) and substances which are part of the plant cell walls, vessels and woody tissues, mainly hemi-cellulose, pectin, cellulose and lignin. Pectin is found in high levels in beet pulp, citrus pulp and legumes and is the most rapidly fermented portion of the cell wall.

Part of the carbohydrates in feedstuffs is called "crude fiber" (CF) and the rest "non fiber carbohydrates" (NFC). The latter consists of sugars, starches and sugar like substances. Sugars and starches are much easier to digest than crude fiber by the rumen microbes.

In the animal body carbohydrates are mainly used to provide the energy covering the direct needs of the animal. If more energy is provided than immediately needed, the surplus is stored as body fat.

Crude fiber is very important for rumination and for the proper functioning of the rumen. The ration for cattle therefore should contain a good quantity of crude fiber. The minimum amount is considered 20%. Because the old system for determining the CF content (boiling of feed with dilute acid and alkali) is considered not so accurate other chemical tests are now also in use:

- **Acid detergent fiber** (ADF). ADF consists of cellulose, lignin and lignified nitrogen components (also called heat damaged protein, or ADF-nitrogen).
- **Neutral detergent fiber** (NDF) consists of ADF (cellulose and lignin) and hemi-cellulose). Another term for NDF is cell wall content. NDF represents the total fiber content of the feed.
- **Effective NDF** (eNDF). eNDF measures the physical form or length of the feed. Values for eNDF are determined by sieving feeds or using screens to separate forage particle size.

4.3 Fats.

Fat or "ether extract" also provide energy. In fact a certain amount of fat provides much more energy (±3x) than the same amount of carbohydrates. Some vitamins (for instance A, D, E and K) are found in the fat fraction of a feedstuff.

Roughages have a low fat content. Concentrates which are by products from the vegetable oil industry (like soybean, sunflower, etc.) have a relatively high fat content. Some fat should be present in the ration given to dairy cattle to ensure the supply of the above mentioned vitamins.

Too much fat in the ration however lowers the feed intake of the ruminant and disturbs the functioning of the rumen. If whole cotton seed cake for example is fed one should not provide more than 2-3 kgs to dairy cows per day. The maximum percentage of fat what a ration can contain in general is 5 %, but depends a lot on the kind of fats.

4.4 Crude protein.

Protein is needed for growth, maintenance, reproduction and production. In general every animal needs a certain minimum amount of protein daily in order to stay healthy and productive. In the case of dairy cows a shortage of protein will eventually result in:

- Small calves at birth
- Low milk production
- Lower protein content in the milk
- Loss of body weight
- Increased risk of infectious and metabolic diseases
- Fertility problems

Crude protein is made up of "true protein" (chains of 20 different amino acids) and of inorganic nitrogen salts, ammonia, urea, amino acids and other substances. These "non protein nitrogen" (NPN) are summarized under the name of "amides"

Ruminants, such as dairy cows, can very well utilize non-protein nitrogen. Hence, instead of feeding dairy cows expensive (true) protein, cheaper sources of nitrogen can be used as well. Urea, which is a relatively cheap chemical product, is such a non-protein nitrogen. However one must be very cautious with adding urea to rations for dairy cattle.

4.5 Inorganic matter or "ash".

Inorganic matter (IOM) is also called ash because the IOM content is determined by burning samples of feedstuffs until they are free of carbon. A high level of ash in a sample often indicates contamination with soil. In the ash are the minerals.

4.6 Summary of the composition of feedstuffs.

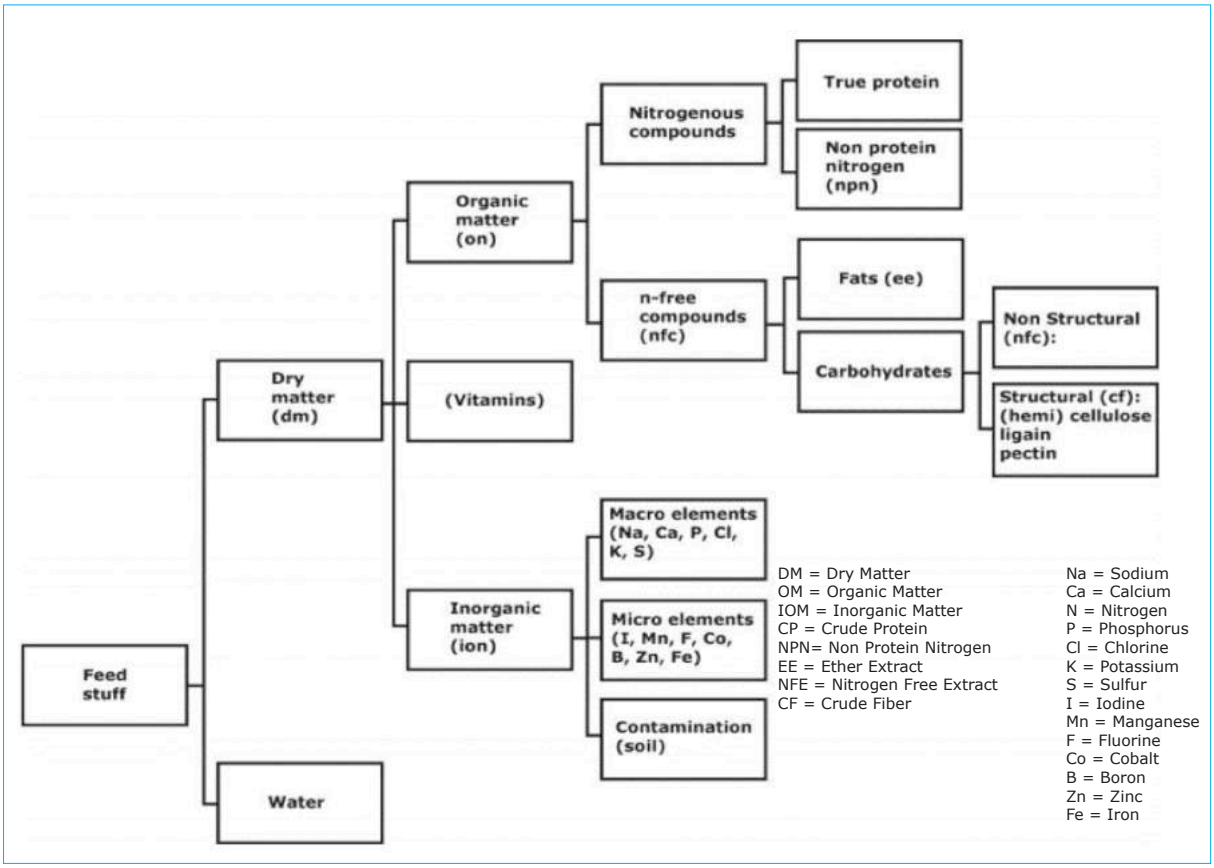


Figure 6: Composition of feedstuff

5. Determination of the feeding value of feedstuffs.

5.1 Methods used to analyze the feeding value of feedstuffs.

The feeding value of a feedstuff is determined mainly by its energy and protein content. To a lesser extent also minerals and vitamins content is important, but are not taken into consideration in this chapter.

To measure the energy and protein content of a feedstuff various methods are used:

The chemical analysis.

In the laboratory the following parts of a feedstuff are determined:

- Dry matter (DM)
- Crude protein (CP)
- Crude fiber (CF)
- Fats (EE)
- Inorganic matter or the ash

The chemical analysis used to determine the above parts is called the "Weende Analysis" or "Proximate Analysis". It is the oldest system used to determine the feeding value of feedstuffs.

In vitro analysis.

In this system feedstuffs are incubated in rumen fluid or in a laboratory solution containing various enzymes for specific periods of time in order to determine the digestibility. For calculation of exact energy and protein contents also the DM, CP and inorganic matter is determined. This method takes more time and labor, but gives a better estimation of the digestibility.

The near infra red spectroscopy (NIRS).

NIRS is a method which is fast, cheap and accurate under well controlled conditions involving only a few feedstuffs. It is based on the extent to which the various feedstuffs absorb certain wavelengths of infra red light. The accuracy is depending a lot on the calibration with standard samples (the data base) of the same feedstuff.

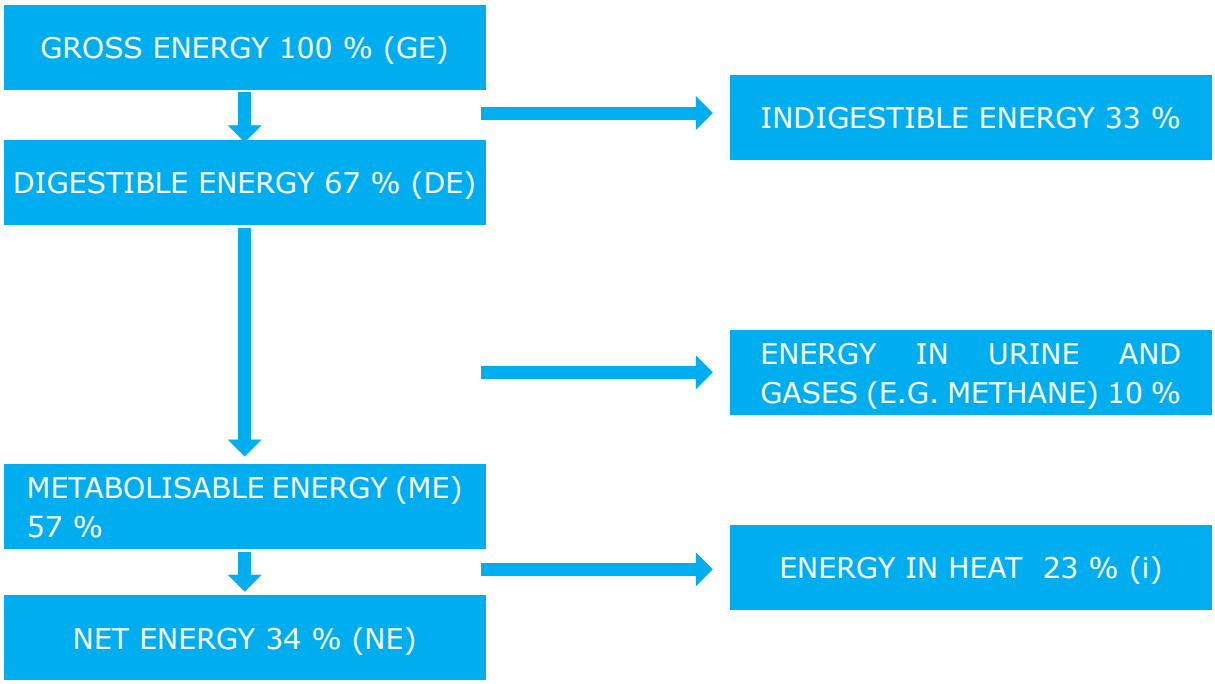
In vivo analysis.

Through incubation of feedstuffs in live animals (the so called "nylon bag method" in which nylon bags with a feedstuff are placed in the rumen through a "whole") research is being done into the degradability of various components of a feedstuff. This is a time consuming expensive method and therefore mostly used by research stations.

5.2 The utilization of energy by a ruminant animal.

The gross energy of a feedstuff can not be used for the full 100 % by the animal for its maintenance and production requirements. It can be compared with the use of petrol by a car. During combustion losses occur and only 20 – 30 % of the gross energy contained in the petrol is effectively used for moving the car.

In the following schedule a general description is shown of the utilization of energy by a ruminant:



Heat losses are due to the energy spent in chewing, rumination, absorption, etc. The losses occurring in the above schedule depend among other things upon the feedstuff, the ruminant category and their production target. In "climate cells" these losses can be measured exactly. This kind of research is however very expensive. For most feedstuffs therefore, especially feedstuffs used in developing countries, hardly any information with regard to "net energy levels" is available.

5.3 Energy evaluation systems.

Each country has often its own system for the determination of feeding values. It is not within the scope of this manual to explain each and every system and therefore energy evaluation systems available will be described in general terms.

The energy evaluation systems are categorized according to the kind of energy (NE, ME or DE) and for which production purpose. In this manual we will only focus on energy evaluation systems for milk production. In this manual we will use the most common system which is used universally, the total digestible nutrients (TDN) system.

In the TDN system the following calculating rules are used:

- 1 kg digestible carbohydrates (made up of digestible crude fiber and digestible non fiber carbohydrates) is assumed to liberate 4000 Kcal when digested.
- The same applies to 1 kg digestible crude protein.
- Digestible crude fat, however, is assumed to liberate 9000 Kcal per kg (we all know that fat is "energy rich" !).

The TDN value of a feedstuff is calculated as follows :

TDN = amount of digestible CP + amount of digestible (CF + NFC) + 2.25 x amount of digestible EE in the feedstuff

or

TDN = amount of digestible OM + 1.25 x amount of digestible EE

Example :

100 kg wheat bran has 11 kg dCP, 6 kg dCF, 42 kg dNFC and 2 kg dEE. The TDN value is then : 11 + 6 + 42 + (2.25 x 2) = 63,5 kg TDN per 100 kg of wheat bran.

The digestibility coefficients are determined through analyzing the composition of the feedstuff and the composition of the feces.

5.4 Protein evaluation systems.

Through the Proximate analysis the nitrogen (N) content of a feedstuff is determined, protein is composed of chains of amino acids. Research has shown that protein contains a fairly constant proportion of 16% of N. Once the N content has been determined the protein content can therefore be calculated as follows:

100/ 16 (%) = 6.25 x gN = protein content.

Based on the above principles the following protein evaluation systems are commonly used:

A. Crude protein system.

The N content of a feedstuff is determined and multiplied by 6.25 as described above. The term "crude" protein is used because the outcome of the calculation is influenced by other feed components which contain N, but are not proteins. For example amino acids, nucleic acids, nitrates, ammonia, urea, etc. These components are called amides and form the non protein nitrogen (NPN). This NPN can be used by the rumen flora and fauna and will result to a certain extend into microbial protein, see also chapter 3.2.

In short crude protein = true protein + amides

In this manual we will work with grams crude protein (g CP) of a feedstuff since this system is also used internationally.

B. Digestible crude protein.

No matter how much protein a food contains it will have no nutritional value for an animal if it is not digestible. Having determined the N content of a feedstuff the figure is corrected for the N content found in the feces. This results in the "digestible crude protein content" or dCP content of a feedstuff.

6. Feed resources in Ethiopia and their characteristics.

6.1 Roughages.

In general roughages have the following characteristics:

- Low TDN content (+ below 65% on DM basis)
- High crude fibre content (30% or above)
- Comprise of long particles which can stimulate rumen function also called "effective fibre".

Roughages in Ethiopia can be grouped as follows :

1. Grass, including range grasses, and grassland products (hay and silage)
2. Legumes (vetch, lucern, desmodium, leucaena, clover, etc.)
3. Straw (wheat, rice, soya, bean, etc.)
4. Stover (Maize and sorghum)
5. Other (in general by products from processing of crops like sugar cane tops and tree leaves)

A. Grazing and browsing of grasses and legumes.

The feeding value of grasses is depending for a large part on the growth stage of the grass. During "aging" the CF content increases rapidly and energy content is consequently decreasing. The protein content is decreasing even more quickly during the aging of the grass. Often the soil on which grasses and legumes grows is lacking in nutrients for proper growth. Application of a fertilizer (usually containing nitrogen and phosphorus) will not only increase the quantity, but it will also improve the quality of the grasses and legumes.

Ethiopian highlands are rich in pasture species, particularly indigenous legumes. At lower altitudes native legumes are less abundant and commonly have a climbing or sprawling growth habit which leads to higher grazing losses. The area available for grazing is determined by the intensity of annual cropping. The importance of natural pasture is gradually declining due to the expansion of crop farming into grazing lands, redistribution of common lands to the landless and land degradation.

Figure 7: Naivasha Star grass pasture

Legumes usually contribute a lot to the feeding value of a ration, especially the protein content. They are particularly valuable to grazing cattle in the dry season when the protein content of grass is very low. They are also especially valuable in supplementing high energy/low protein forages like maize and maize silage. During aging legumes in general maintain a good protein level, much better compared to grasses. Also hay made of legumes still has a relatively high protein content and can function as protein supplementation in rations comprising mainly out of grass hay and/or silage. For roughage rations it is generally recommended to feed 75% of the roughage dry matter from grasses and 25% from legumes in order to balance energy and protein content.

B. Crop residues.

Cereal straw from teff, barley and wheat is the largest component of livestock diet in the intermediate and highland areas. Straw is stacked after threshing and fed to animals during the dry season, as are pulse-crop residues (e.g. horse beans, field peas and lentils). At lower altitudes maize, sorghum and millet stovers occur to a greater extent. In general cereal and rice straw have very poor energy

Figure 8: Maize silage

values and hardly contain protein. Straw from legume crops still have a reasonable protein content. Maize stover has a higher energy content compared to cereal straws.

C. Maize and sorghum stovers. Maize and sorghum are rather exceptional roughages because of their high TDN value, even when conserved as silage. They have a low protein content, however, and are best supplemented with legumes or medium high protein concentrates.

D. Cultivated Forages

Fodder crops are commonly grown for feeding dairy cattle; Oats, Desho Grass and Vetch mixtures, Alfalfa, Rhodes grass and fodder beet being the most common. Introduced fodder trees (Leucaena, Sesbania spp., Tree Lucerne) have been used for soil and water conservation programs, animal feed source, wind break, for improving soil fertility and around farmers' homesteads.

Figure 9: Young, dark green (well fertilized) leafy Napier

E. Other

There are many other crop by products used for feeding of livestock like sugar cane tops and leaves, bagasse, tree leaves, etc. Usually these products have a poor feeding value and are only used in times of feed shortages.

Judging the quality of locally produced/ available roughages is a very important skill in feeding management. Giving the above information the following criteria are important in assessing the quality/feeding value of a roughage:

- Origin of the roughage, growth stage, when harvested
- Colour, smell, palatability
- DM content
- Price

6.2 Concentrates.

Concentrates are feedstuffs that are easily digested in the rumen and have high energy and protein values compared with roughages. They usually have a low crude fibre content and comprise of very small particles. Their "structure value" is therefore very low (from 0.0 up to 0.2). Concentrates can be categorized as follows:

Energy rich concentrates.

- Grains (maize, sorghum, wheat, barley, teff, oats, etc.)
- Grain processing by-products (wheat bran, rice bran, maize gluten, etc.)

The various milling by-products obtained through processing wheat are of great interest as livestock feed for state farms, city dairy holders, and to a lesser extent for some dairy co-operatives. Wheat grain is processed in big mills, whereas in the case of teff, barley, maize and sorghum the whole grains are processed and used for food.

- Root crops (cassava, potato, etc.)
- Left over bread, by-products from the baking industry
- Sugar industry by-products (molasses, beet pulp)
- Beer industry by-product (brewer's grain). Brewer's grains are traditionally valued for lactating cows because of their palatability and milk-producing property. In addition to commercial beer production small-scale home brewing is also practiced.
- Apples, carrots, onions, fodder beet, pumpkin, banana, citrus pulp, other fruit by-products, etc.

Protein rich concentrates.

- Industrial by-products (mainly oilseed meals, cotton seed cake, etc.) Oil cakes are an excellent concentrate feed for ruminant livestock and have a high level of by-pass protein. The processing of oil seed is widely practiced on a family basis or in small village mills.
- Products of animal origin (blood meal, etc.)
- Mixed compound feeds

For more details see also annex 1 (List of common feedstuffs and their nutritive value for dairy cattle).

Concentrate mixtures in combination with suitable roughages are balanced in composition to meet the requirements of the type of animal they are designed for. They are often sold as a meal. Such a meal should not contain more than 13% of water or otherwise they can not be stored for a long period. The concentrate mix which is best for dairy cattle provides the nutrients lacking in the roughage part of the ration so that production is as high as economically possible. If the roughage is high in TDN content but low in protein content (e.g. maize silage), a concentrate may be used which has a medium TDN content and a high protein content. If the roughage has only a medium TDN value but is high in protein (e.g. young grass/legume pasture), then a high TDN/low protein concentrate may be used.

Concentrates may be bought from milling companies or made on the farm from mainly farm grown ingredients. On farm mixing is often cheaper, but it may not be advisable if the farmer does not have all the ingredients required or knowledge how to mix them.

In practice three kinds of concentrates are used for dairy cattle:

- Low protein content mixtures 100 – 150 g CP/kg DM
- Medium protein content mixtures 150 – 180 g CP/kg DM
- High protein content mixtures 180 – 250 g CP/kg DM

6.3 Comparing the quality of roughages and concentrates on dry matter basis.

The nutritive value of a feedstuff can be expressed per kg product or per kg DM. In practice both will be used. Since the DM content of feedstuffs varies a lot comparison of the nutritive value can only be done if one takes the feeding value per kg DM.

Maize silage with 40% DM has a feeding value of 280 gTDN. The feeding value per kg DM is:

100/40 x 280 = 2.5 x 280 = 700 gTDN

Wet brewer's grain with 23% dry matter has a feeding value of 736 gTDN. In the dry matter one kg product contains:

100/23 x 736 = 4.35 x 736 = 3200 gTDN per kg product.

7. Feed requirements for various categories of dairy animals.

7.1 Energy and protein requirement for maintenance and lactation.

Feed requirements of dairy cattle vary according to their production stage and age categories. Cows produce approximately half of their total milk yield during the first 100 days of lactation. For this reason it is essential to feed cows properly during the early days of lactation. Feed intake is poor at the beginning of lactation but improves as lactation increases. As feed intake is not proportional with milk production requirements the cow possesses the unique ability to utilize her body reserves for milk production.

The lactating cow usually losses weight at the beginning of lactation as a result of withdrawal of her body reserves until a point when she reaches her peak. Cows can even under good feeding conditions lose as much as 66 kg in body mass during the first three months of lactation. From 120 days after calving the body mass gradually increases until calving. Adult cow, which is not producing still, needs nutrients to survive. These nutrients are required for vital body functions, like respiration, blood circulation, maintaining the body temperature, etc. and also for movement. The nutrients needed for this purpose are called the maintenance requirement of the cow. If a cow receives less than its maintenance requirement, it reduces its reserves of body fat and it starts to lose weight. The following table shows the maintenance requirements of adult cows of different body weight.

Table 1: Maintenance requirements of adult cows per day.

BODY WEIGHT	PROTEIN G CP	TDN (G)	ME MJ
200	233	1900	34.5
250	256	2200	38.7
300	276	2500	42.9
350	299	2800	47.2
400	321	3100	51.4
450	344	3400	55.7
500	366	3700	60.0
550	389	4000	64.2
600	411	4300	68.4
650	434	4600	72.7
700	456	4900	76.9
750	479	5200	81.2
800	501	5500	85.4

Source NRC

When a cow is producing (giving milk), extra nutrients are needed above the maintenance level. These extra nutrients needed for production make up the production requirements of the cow. In the next table the amount of CP and TDN is shown which a cow needs to produce one (1) kg of milk. The production requirements are related to the fat content of the milk.

Table 2: Production requirements per kg of milk

% FAT IN THE MILK	PROTEIN (G CP)	TDN (G)	ME MJ
2.5	72	255	4.19
3.0	78	280	4.53
3.5	84	305	4.87
4.0	90	320	5.21
4.5	96	340	5.55
5.0	102	365	5.89
5.5	108	390	6.23
6.0	114	415	6.57
6.5	120	440	6.91
7.0	126	465	7.25
7.5	132	490	7.59
8.0	128	510	7.93

Source : NRC

Example :

A cow weighs 500 kg and produces 10 kg milk/day. The milk contains 4 % fat. What are the total TDN and CP requirements of this cow ?

For maintenance the cow needs:	366 g CP 3700 g TDN
For production the cow needs:	10 x 90 = 900 g CP 10 x 320 = 3200 g TDN
The cow's requirements are:	366 + 900 = 1266 g CP 3700 + 3200 = 6900 g TDN

7.2 Feeding of dry and pregnant animals.

The aim of feeding the pregnant cow is to:

- Get the cow into good condition at calving
- Produce a good calf and
- Have reserves to produce milk during early lactation.

If pregnant animals are underfed, they will be in poor body condition when they give birth and begin lactating. Milk production will be significantly reduced. They will also be

slow to start cycling again. Underfed animals may also give birth to light weight and/or weak offspring. Overfeeding pregnant animals can also cause undesirable outcomes:

- Dams may have fat deposits and poor muscle condition that interfere with giving birth.
- Over conditioning also puts animals at risk of pregnancy ketosis and/or fatty liver syndrome.
- Fat young stock may have reduced milk production due to the deposition of fat in the udder.

The dry, pregnant cow should be fed with good quality roughage such as good pasture, grass, and good hay or Napier grass. During the eighth month of pregnancy, the cow should be fed as if she was producing 5 kg of milk and towards the time of calving, as if she was producing 10 kg of milk. During the eighth month, the cow can be maintained on good pasture or good Napier grass. On poor pasture/Napier grass, 1-2 kg concentrate (e.g. 50% noug cake+50% wheat bran) is necessary. During the last month of pregnancy the cow should get 1-2 kg concentrate with good quality roughage and 3-4 kg concentrate with poor quality roughage. Remember that salt and other minerals are needed. The feeds fed during the dry period should be the same as those fed during early lactation. A poor nutritional program during the pregnancy/transition period decreases reproductive efficiency and increases incidences of metabolic disorders.

Dry matter intake of the dry pregnant cow varies according to age, pregnancy status and time relative to calving. A substantial decline in intake occurs within the last 2–3 weeks of gestation for all age and pregnancy status groups supporting the need for a two-diet dry cow program. Concentrates fed to a drying cow should be stopped followed by stopping milking. It should not require any concentrates until she is "steamed up" two weeks before calving. Observation is the key though. If the animal is not in good condition it should receive improved fodder, concentrates, and minerals during her dry period to enable her to give birth to a strong healthy calf, withstand post-calving problems and have reserves to enable her to produce higher milk yield. Preferably the cow should already have the right body condition (a body condition score of around 3 to 3.5) when she is dried of. The dry cow should not gain excessive body weight. Cows that become too fat are more likely to have problems at calving time and over-feeding dry cows is wasteful and does not make economic sense.

Transition cows should not have to walk long distances to obtain water. Water is the most important nutrient. Watering devices must be kept clean. A dry period of approximately 60 days between lactations is essential for fair milk production. In short, the dry period is the time from the end of lactation until the cow calves again. Many farmers have a tendency to neglect their cows during the dry period. The cow should be dried off about two months before the expected calving date.

The reasons for drying off are:

- The nutrient requirement of the fetus are high during the last months of gestation
- To replenish body with nutrients depleted during lactation and good body condition at calving.

- To repair and regenerate the alveolar system, the milk secretor cell.
- To gain new stimulation for following lactation as a result of parturition
- To produce colostrum, this is indispensable for the calf during the first days after calving.

If the cow does not have optimum dry period between lactations its subsequent milk yield will be reduced. The dry period allows the udder to rest and the cow to become strong again, to build up a body reserve ready for the next lactation. During the dry period the cow udder gets the opportunity to recover after the lactation period. If the cow is not allowed this rest period the next lactation could result in a loss of at least 30% in milk production. It is estimated that the calf (foetus) gains 60% of its birth weight during the last six (6) weeks before calving. For an overview of energy and protein requirements of dry pregnant cows see the table below.

Table 3: Maintenance and pregnancy requirements per day (last 2 months of gestation)

BODY WEIGHT	PROTEIN (G CP)	TDN (G)	ME MJ
250	611	3020	57.2
300	700	3440	61.4
350	786	3850	65.7
400	875	4270	69.9
450	963	4690	74.2
500	1052	5100	78.4
550	1126	5520	82.7
600	1223	5910	86.9
650	1298	6290	91.2
700	1372	6680	95.4
750	1447	7070	99.65
800	1521	7450	103.9

Source : NRC

7.3 Feeding of milking cows in different stages of lactation.

Several changes occur in cows as they progress through different stages of lactation. As well as variations in milk production, there are changes in feed intake and body condition, and stage of pregnancy.

7.3.1 Feeding of a cow during early lactation

Immediately after calving, the cow needs many nutrients to recondition the body as well as to support milk production. During the first and second month after calving, the cow produces a high amount of milk per day. Adjusting the cow to the milking ration after calving is therefore an important management issue during early lactation. Feed intake will not keep pace with nutrient needs for milk production, especially for energy, and body fat will be mobilized to meet energy requirements. Cows at early lactation should be provided with all the necessary nutrients like energy and protein in order to help the cow to produce milk and allowing her to achieve peak production. Feeding

protein according to the requirements helps to stimulate feed intake and permits efficient use of mobilized body fat for milk production.

Feeding of good quality roughage and a high rate of supplementation with concentrates (noug cake and wheat bran for example) is needed to achieve a high milk production. Increasing concentrate supplementation in a gradual way after calving will increase nutrient intake and make sure the cow will continue to eat enough roughages. With high quality roughage 8-10 litres of milk per day can be obtained while it is only 2-3 litres per day on poor quality hay and straw.

Poor feeding in the early lactation results in:

- Low lactation yield,
- Poor condition
- Delayed heat or no heat signs at all (leads to poor fertility) and
- Low fat test and ketosis

Therefore, improve the feeding system of the cow at early lactation through providing good quality roughages.

7.3.2 Feeding of a cow during mid and late lactation.

After the cow has reached peak production, the milk yield will drop gradually. As a result, the energy requirement is less demanding during this stage. Sharp increase in feeding in mid lactation will result in an increase in body mass (fattening) rather than in an increase in production especially in poor productive cows. If a cow is not fed well during early lactation, maximum production will not be obtained.

Milk production requires a lot of energy. If not enough energy is provided to milking cows it will:

- Loose body condition, become thin and weak.
- Milk yield will drop.
- Pregnant cows may become ill after calving
- The calf is likely to be small

If too much energy in the diet of milking cows the animal will become fat which lead to increased incidence of:

- Difficult birth
- Retained placenta
- Displaced abomasum
- Milk fever and ketosis

Cows cannot store much protein in their bodies and so it must be supplied in the daily ration in order to maintain high milk production.

Too little protein in the ration/imbalanced rations can lead to:

- A rapid drop in milk production if the amount of protein in the ration is suddenly reduced.
- Rations providing far too little protein will also cause excessive weight loss in milking cows, in case of sufficient energy levels and low protein levels cows might also fatten

- Rations for dry and pregnant cows having too low protein levels will result in small calves being born.

Protein-rich feeds are expensive. Feeding too much protein to dairy cows is wasteful because the surplus is broken down by microorganisms in the rumen and then excreted from the body. It even takes energy from the cow to get rid of the excess also having a negative impact on milk production.

7.4 Mineral and vitamin requirements.

7.4.1 Which minerals are needed?

Two categories of minerals are needed, Micro/trace minerals and Macro minerals. There are seven macro minerals that need to be analyzed and balanced within a cow's diet. These are calcium (Ca), phosphorus (P), magnesium (Mg), sulfur (S), sodium (Na), chlorine (Cl) and potassium (K). Some of these minerals work together, while others work independently. Macro minerals are supplemented as grams per cow per day and expressed as a percentage of the ration dry matter in the NRC feeding value tables 2001

Trace or micro minerals include cobalt, copper, iodine, iron, manganese, selenium and zinc. These minerals are added as milligrams per day and expressed as parts per million (PPM) in the ration dry matter. Trace minerals or microminerals are needed for blood synthesis, hormone structure, normal reproduction, vitamin synthesis, enzyme formation, and immune system integrity. A major challenge for nutritionists and dairy managers is deficiencies do not immediately impact milk yield or growth. Reduced reproductive performance or impaired health can take several months before a deficiency appears.

Table 4: Function and deficiency signs of macro and micro elements.

a. Macro minerals	Function	Deficiency signs
Calcium (Ca)	Bone & teeth formation, blood clotting, smooth muscle contraction	Rickets, slow growth, bone fractures, lower milk yield, milk fever (hypocalcaemia)
Phosphorus (P)	Bone & teeth formation, energy metabolism, part of DNA	Rickets, poor growth, impaired reproduction, depraved appetite
Sodium (Na)	Acid-base balance, muscle contraction, nerve transmission, osmotic pressure, blood pH	Abnormal eating behavior (pica), urine licking, poor appetite, lower milk production
Chlorine (Cl)	Regulate osmotic pressure and acid-base balance, manufacture of hydrochloric acid	Loss of appetite, weakness, craving for salt, blood alkalosis
Potassium (K)	Osmotic pressure, acid-base balance, nerve transmission	Loss of hair glossiness, decreased feed intake
Magnesium (Mg)	Enzyme activator, bone and muscle, muscle contraction	Muscle hyper-irritability, salivation, convulsions, grass tetany
Sulfur (S)	Sulfur-containing amino acids, B-vitamins, cellulose digestion, acid-base balance	Reduce microbial growth, poor appetite

b. Micro minerals	Function	Deficiency signs
Cobalt (Co)	Synthesis of vitamin B12 by the rumen microbes	Poor appetite, anemia, rough hair coat
Copper (Cu)	Enzyme activation, blood synthesis, nervous system	Rough hair coat, change in hair color (grey or reddish), diarrhea, immune system impairment, mastitis
Iodine (I)	Synthesis of thyroxine (hormone)	Goiter, big neck in calves, reduced metabolic rate, poor reproductive performance
Iron (Fe)	Part of blood hemoglobin, enzyme systems, immune system function	Anemia
Manganese (Mn)	Growth, bone formation, enzyme activation	Impaired growth, poor reproduction, skeletal abnormalities
Selenium (Se)	Enzyme formation (glutathione peroxidase), protect cell membranes, immune function	Reproductive disorders, mastitis, immune system dysfunction, white muscle disease, retained placenta
Zinc (Zn)	Enzyme activation, repair of damaged tissue, immune system, teat keratin formation	Parakeratosis of the skin, elevation in somatic cell count, mastitis, hoof disfunction, stiff joints

Source : Hoard's Dairyman Feeding guide/M. Hutjens

7.4.2 Mineral requirements of dairy cattle.

Although precise figures for mineral requirements of the different categories of dairy cattle in the tropical regions of the world are still not known there are enough research data available from which some general conclusions may be drawn as to dietary recommendations (NRC 2001). These requirements should be used only as rough guides since individual animal needs may differ from averages.

It is recognized that most of the requirements were not established in the case of zebu cattle or cattle living under tropical conditions. It is also recognized that with the introduction of exotic breeds of dairy cattle and cross-breeding production levels have increased, with a consequent increase in mineral requirements. In spite of these shortcomings, most researchers agree that the NRC mineral requirement standards is the best information currently available and that these requirements should be used until more precise data are formulated.

Table 5: Mineral requirements of dairy cattle.

Category	Cows						Heifers (age in months)			
	Dry (far off)	Dry (close up)	Fresh	Early	Mid	Late	6	12	18	24 (close up)
Macro elements required in % of DM										
Calcium (%)	0.44	0.48	0.79	0.60	0.61	0.62	0.47	0.41	0.44	0.40
Phosphorus(%)	0.22	0.26	0.42	0.38	0.35	0.32	0.25	0.23	0.18	0.23
Magnesium(%)	0.11	0.20	0.29	0.21	0.19	0.18	0.11	0.11	0.08	0.14
Chlorine (%)	0.13	0.20	0.20	0.29	0.26	0.24	0.11	0.12	0.10	0.16
Sodium (%)	1.10	0.14	0.34	0.22	0.23	0.22	0.08	0.07	0.12	0.10
Potassium (%)	0.51	0.62	1.24	1.07	1.04	1.07	0.47	0.48	0.46	0.55
Sulfur (%)	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Micro elements in mg per kg DM										
Iron	13-30									
Cobalt	0.11									
Copper	10-16									
Manganese	14-24									
Zinc	22-70									
Iodine	0.3-0.4									
Selenium	0.30									
Fluorine	Maximum concentration 30 mg/kg dry matter !									
Molybdenum	Maximum concentration 6 mg/kg dry matter !									
Vitamins in IU per day										
Vit. A (IU)	58000	60600	75000	75000	75000	75000	16000	24000	36000	60100
Vit. D (IU)	11700	12100	21000	21000	21000	21000	6000	9000	13500	10000
Vit. E (IU)	1168	1211	545	545	545	545	160	240	360	1202

Source: NRC 2001.

7.4.3 General remarks regarding mineral supplementation.

Economic return of mineral supplementation has been at least two to one in various studies done around the world. In Ethiopia commercial mineral mixtures are available which have been developed based on local conditions. For most commercial small holder dairy farms these will be good enough. Dairy cows should have permanent access to a box with a mineral block or mix.

7.4.4 Vitamins.

Dairy cattle require the same vitamins as non-ruminants. However, because of synthesis in the rumen and tissues, most vitamins are not needed in the diet of dairy cattle which have a functioning rumen. Rumen microbes synthesize enough B vitamins and vitamin K to meet the usual needs except for young calves. Vitamin C is synthesized in the tissues of cattle and, thus, is not needed in the diet. Dairy cattle of all ages must have a source of vitamins A and E in the diet. Likewise, vitamin D must be in the diet or synthesized in the skin under the influence of ultraviolet irradiation in sunlight.

7.5 Water requirements.

Water is essential for all categories of livestock. Whereas an animal deprived of food can survive for a considerable time, without water it will die in a few days. Preferably livestock should always be able to drink water when they want to. Unfortunately this situation is not always there and the farmer has to supply water to the animals. Under those conditions cows should be supplied with water at least 2 times per day.

Other factors which will influence the water intake are climatic conditions (hot and dry versus cold and wet) and the DM content of the supplied feedstuffs (hay versus fresh grass). Also the physiological status of the cow (lactating, pregnant or dry) & mineral content of the ration influences the intake.

In general the water requirement, including the water in the feedstuffs, of dairy cattle is as follows:

• Calves	5 – 15	litres per day
• Young stock (1 – 2 years of age)	15 – 35	litres per day
• Dry cows	30 – 60	litres per day
• Lactating cows		
*up to 10 kg milk	30 – 60	litres per day
*up to 20 kg milk	70 – 100	litres per day
*up to 30 kg milk	90 – 150	litres per day

Water intake depends to a large extend on the ambient temperature and the body weight. Under hot conditions the intake will be higher.

7.6. Feeding guidelines for dairy crossbred cows.

- **After 7 months of lactation. Aim : bring cows in proper condition for drying off.**

Extra ration demands:

- Feed for body condition score 3.0 – 3.5
- Ideal dry period is 40 – 60 days (cows shorter, heifers at least 60 days)
- 2 weeks before drying off aim for a milk production of max 10 kg milk by reducing concentrate supplementation to 0 and/or by feeding low energy forage and reducing protein level in the ration (14% CP). BCS should not go down though! Enough water!
- **Dry cows (60 – 14 days before calving). Aim : train rumen muscles and maintain rumen papillae as much as possible.**

Extra ration demands:

- Voluminous and structure rich, 9 – 11 kg DM, feeding value of 575 gTDN/ kg DM
- Supply small amount of starch (e.g. 1 kg Barley)
- Supply enough protein in the ration (+ 12 % CP)
- K, Na and Ca poor to reduce incidence of milk fever
- Enough Mg

- **Dry cows (14 – 0 days before calving). Aim : smooth transfer from "dry" to "high milk production".**

Extra ration demands:

- DM intake drops dramatically
- Energy and protein requirements go up very quickly (calf + colostrum production)
- Rumen flora must adjust to the feeds provided after calving : provide gradually the same basic ration as other high producing cows (650 gTDN/ kg DM)
- Provide roughages ad lib (10% left over), every day cleaning of feeding trough
- Last week provide 2-3 kg concentrates in at least 2 portions (mixing concentrates and roughages by hand avoids fermentation problems), heifers 1-2 kg
- Total ration : CP level 14 %
- More starch
- Provide enough Mg, Se and Cu
- Water should not be too cold
- **Early lactation cows (0 – 20 days after calving). Aim : Careful start of the lactation, making sure that cows have a healthy start.**

Extra ration demands:

- Around calving no ration changes
- Top quality roughage (minimum of 10 – 15% of the ration dry matter should comprise of highly digestible forage like young grass and/or legume)
- Enough effective fibre to ensure optimum rumen fermentation
- Slowly increase concentrate supplementation (increase with 200 grams per day). Make sure animals eat plenty of roughage ! Cows that show healthy rumen function and good dry matter intake can have a faster increase in concentrate supplementation.
- CP level in ration 14%, this makes sure that cows slowly increase milk production (they are not "pushed" too much)
- Provide minerals/ vitamins according requirements

- **High production cows, 30 – 120/150 days in lactation. Aim : feed cows for maximum milk production and reproduction.**

Extra ration demands:

- Record milk production daily; for every 1.5 kg milk produced more provide 1 kg concentrate more
- Top quality roughage (minimum of 10 – 15% of the ration dry matter should comprise of highly digestible forage like young grass and/or legume)
- Never give more than 45% of total ration dry matter in the form of concentrates; generally 8 kg dry concentrates is maximum for crossbred cows weighing 500 kg.
- Provide a source of bypass protein (oil seed meal, fish meal, cereal bran, lignin containing legume) at a level of 10% of the dry matter intake
- Provide concentrate in portions of max. 2-3 kg
- CP level ration 16 %.

- **Low Production cows, > 150 days in lactation. Aim : produce cheap milk based on as much roughage as possible.**

Extra ration demands :

- Good quality roughage if available; DM intake from roughage can be high during this lactation stage.
- Limited concentrates
- Supplementation of concentrates above basic ration level : 1 kg concentrates/2 kg milk more.
- Later in lactation adjust concentrates in accordance to body condition
- CP level of ration around 15%
- End of lactation : body condition score of 3 – 3.5

8. Feed Improvement and feed storage.

There are different types of feed improvement methods to improve the nutrition content of feed such as urea straw treatment and multi-nutrient block. However, under smallholder condition, urea straw treatment and multi-nutrient block making are very common practices.

8.1 Urea-molasses straw treatment

Urea treatment is important for improving nutritive value of cereal straws and stovers. In addition to improving the nutrient content, urea - molasses treatment prevents loss of crop residue and consequently save the bulk which leads to improved utilization of feed resources.

Table 6: Requirements for preparing urea treatment of straw

Straw	Water (Liter)	Molasses (kg)	Urea (kg)
25	15	2.5	1
50	30	5	2
100	60	10	4

Procedure:

1. Make sure the bag is clean and has no holes
2. Chop the straw (3-5 cm)
3. Weigh urea and dissolve in water (stir solution until urea is completely dissolved)
4. Add molasses to urea and water solution and stir until completely mixed
5. Sprinkle (urea + molasses + water) solution on the straw and mix thoroughly. Good distribution is important.
6. Pack treated straw well after each addition in the bag by hand or foot
7. Tie open end of the bag tightly
8. Store in place where the bag is protected from possible damage

Note :

- Animal should feed other basal diet before feeding urea treated straw. Cows weighing 200-300 kg can feed 4-6 kg of urea treated straw in the morning and night
- Do not feed to mono gastric animals, i.e. horses, donkeys, or pigs and young ruminants less than six months of age (calves, kids and lambs).

8.2 Multi-nutrient block preparation

Multi-nutrient blocks (MNB) are a commonly used feed supplement for ruminants. MNB is made from different ingredients where each has its own contribution in the mixture. It is usually made up of molasses, urea, cement, wheat bran, protein rich by-products, salt and water which are mixed and processed to form a block. It provides fermentable

energy (usually from molasses), non-protein nitrogen (usually from urea), essential minerals and occasionally vitamins. Supplementation with Multi-Nutrient Blocks (MNB) can increase digestibility of fibrous feeds by up to 20%, increases nutrients the animal receives and can increase feed intake by 25 to 30%.

Table 7: Materials required for multi-nutrient block preparation

Ingredients	**Alternative Ingredients Formulae**						
	A	B	C	D	E	F	G
Wheat bran	25	25	23	25	35	22	35
Molasses	37	37	40	48	39	50	20
Urea	10	10	10	10	10	9	7.5
Salt	3	3	4	5	5	5	7.5
Cement		5	3	5	6	5	5
Limestone	10	5	10	5	5	9	5
Oil seed cake	15	15	10	2			
Clay							20
Total	100	100	100	100	100	100	100

Source: Holeta Research centre:

Procedure:

1. Weigh out correct amount of each ingredient
2. Pour molasses into a large bowel
3. Spread urea, salt and cement evenly across surface of molasses. Mix them thoroughly.
4. Add concentrate and ground oil seed cake to molasses mixture and mix well.
5. Pack the mixture into a mold. Apply enough pressure by hand to form solid mass and eliminate air pockets.
6. Remove the block from the mold and place in a well-ventilated area to cure (dry and harden). Curing can take a few days to a few weeks.
7. Once cured, the blocks are ready to be fed

Characteristics of a good Urea Molasses Multi-nutrient Block

A block is considered to be good when it fulfills the following characteristics:

- Ingredients are well distributed throughout the block
- It does not have lumps of urea
- It is hard enough not to be squashed between our fingers and should be resistant enough not to break when a person steps on it
- Our hands should feel the sticky molasses when we hold the block.

Precautions while supplementing Urea Molasses Multi-nutrient Block

It is essential to note the following while supplementing Urea Molasses Multi-nutrient Blocks:

- Feed to ruminants only (sheep, goats and cattle).
- Do not feed to mono gastric animal i.e., horses, donkeys, or pigs.
- Do not feed to young ruminants less than six months of age (calves, kids, lambs)
- Blocks should be used as a supplement and not as the basic ration
- A minimum of coarse forage in the rumen is essential
- Never give blocks to an emaciated animal with an empty stomach. There is the risk of urea poisoning due to excessive consumption
- The amount of blocks fed to sheep and goats should be limited to 100 grams/day while for cattle it should be limited to 700 grams/day;
- The blocks should never be supplied in ground form or dissolved in water as this can result in over consumption
- Supply sufficient amount of water *ad lib*

Figure 10: Examples of multi-nutrient blocks

8.3 Feed storage.

8.3.1 Causes of feed spoilage and losses

All types of ingredients, as well as completed compound feeds, require special care during storage to prevent deterioration in quality and loss. Good storage is essential because the value of the feed that you present to your animals depends on it. Feed spoils during storage. Whether it deteriorates quickly or slowly depends partly on its quality when you receive it but very largely on how it is stored on the farm.

Losses and deteriorative changes which occur during feed storage.

Environmental factors, such as moisture (feed moisture content and relative humidity), temperature, light, and oxygen influence deteriorative changes and losses in feedstuffs. These affect the feedstuff either directly or by influencing the rate of development of insects and fungi which consume the feed during storage.

The following are the major factors which affect the quality and weight of feedstuffs during storage:

Physical loss

Significant loss can occur as an accumulative effect of individually small, but regular theft. Less obvious are the losses caused by scavenging animals, particularly rats and mice. Feed stores are notorious breeding grounds for such animals. Temperature in stored feeds can sometimes increase sufficiently to cause fire. Fire can occur in stacked feeds. Feed stores are flammable, particularly if they are constantly full of fine atmospheric dust from grinding processes within the store or adjacent areas.

Water and heat damage

High levels of moisture content and relative humidity cause direct losses by making it difficult to use the material in its original form. More serious is the effect that high levels of product moisture and relative humidity have on insect infestation and the growth of fungi. High temperatures also affect the rate of loss and damage in feeds. High temperature in feeds may occur not only because of environment and the way in which they are stored but because of the heat generated by the growth of fungi and insects. Increases in temperature within large stacks of feed have been known to cause spontaneous combustion followed by fire losses. Increase in temperature may reduce availability of the amino acids in feeds.

Insect damage

Feeds are attractive places for insects including various species of moths, weevils and beetles, which consume the feed. Insects thrive better on ground materials.

Fungal damage

Higher temperatures and moisture levels favor increased fungal growth. Fungal growth itself encourages local rises in temperature and moisture content. Fungal growth causes weight loss, increases in temperature and moisture, staleness (off-flavor), discoloration and perhaps worst of all, some common species produce mycotoxins. Mycotoxins, the best known of which are called aflatoxins, are known to be toxic. Aflatoxins are toxic metabolites of Aspergillus fungi that can contaminate various food and feed products. When ingested, AFB1 is converted to aflatoxin M1 (AFM1) and is secreted in the milk of lactating mammals. In children, exposure to aflatoxins can cause stunting. In livestock, consumption of aflatoxin contaminated feed reduces productivity, which can result in serious economic losses.

Sorghum, maize and its by-products, groundnut, cottonseed, cassava, coconut and

sunflower are ingredients especially prone to contamination with mycotoxins. Many fungi are killed during the processing of ingredients but their spores are resistant and remain present to re-infect the material later if the environmental conditions become favorable for their development.

8.3.2 Proper feed handling and storage

Ingredients should be stored for as short a period as possible and compounded feeds used quickly, especially in tropical conditions. Vitamins should not be mixed with minerals before storage. Mixed feeds, which have undergone a heat treatment during production, such as steam pelleting, store better than other mixtures because many of the damaging factors will have been destroyed. Provide a building for storage which is secure and can be adequately locked. Ensure that its roof will protect the feed from rain and that surface water cannot enter the store. Provide it with ventilation points. Plan your ingredients purchases carefully so that you do not need to keep too large quantities in stock. If possible, raise sacks off the ground by stacking them on wooden pallets. Don't allow sacks to rest against the outer walls of the store – leave a space between the stacks and the wall.

9. Ration calculation.

9.1 Dry matter intake.

The dry matter intake depends on a number of factors:

a. The cow.

- **Level of milk yield**. A high-yielding cow takes in more kg DM than a low-yielding cow.
- **Weight**. A heavy cow has a higher DM intake than a light cow.
- **Age**. The DM intake of a heifer is around 2 kg less compared to an adult cow. As age increased dry matter (feed) intake decrease and milk yield decreased
- **Lactation stage**. On the last period Lactation stage dry matter intake decrease and milk yield decreased
- **Breed**. Dry matter intake is proportional to body weight of dairy cow; exotic breed DM intake is high than local breed.
- **Individual differences**

b. The feed.

- **Quality of the feed**. The better the quality of the roughage, the higher the intake will be.
- **Taste and smell**. Moulds, butyric acid, ammonia, etc. in roughage will reduce the intake. Also in pastures where manure has been applied will have a negative effect.
- **Digestibility**. Feedstuffs which digest slowly will remain longer in the rumen.
- **Quantity of concentrates fed**. Concentrates will reduce the roughage intake to some extent, but it will increase the total DM intake.

c. Feed supply.

- Grazing system: unlimited, limited or zero grazing.
- Rationed or "unlimited" feeding.
- Variation in the ration.
- Transition, e.g. from a summer to a winter ration, has to be implemented gradually.
- Frequency of feeding

d. Environment.

- Temperature. Particularly too high temperatures will reduce feed intake.
- Weather. In wet weather grass is less palatable, especially in the autumn season.
- The possibility for cows to rest and eat quietly, without disturbances. An overcrowded shed will lead to more fighting among cows which will affect the DM intake.
- Thumb rules for estimating the DM-intake from roughages are (*):
    - Poor quality roughages 1.5% of live weight
    - Average quality roughages 2.0% of live weight
    - Good quality roughages 2.5% of live weight

* Thumb rules are only valid if the animals are given unlimited roughages (roughage leftovers should be at least 5 -10%) ! When the roughage ration is supplemented with concentrates the total DM- intake will go up. The maximum dry matter intake from roughages and concentrates is around 3.5 % of her body weight.

The minimum amount of DM an average cow should have daily to meet maintenance and some production requirements is 2% of her live weight !

Figure 11: Three bags of napier (60 kg) is enough to feed 1 crossbread cow for 1 day

9.2 Steps to be taken in calculating and balancing a ration.

A ration should be calculated step by step. The first step is:

a. Estimate the average roughage quality available for the animals.

b. With this estimated average roughage quality the average DM-intake can be calculated with the "thumb rules". If an animal does not get unlimited roughage then calculate with the actual quantities given. In this situation always check whether the quantities fed are meeting the minimum DM requirements of the animal. **In general, in case enough roughage is there, calculate with a dry matter intake of 2% of live weight out of roughage.**

c. Calculate the kg TDN and g CP available in the roughage. If an animal is also getting a certain amount of concentrates, then add this feeding value as well (the roughages and concentrates which are "always" fed are also called the "basic ration").

d. Calculate the maintenance and production (milk, growth or calf) requirement of the animal.

e. Calculate whether the ration is in balance as far as energy is concerned. In general there will be an energy shortage. If so, then calculate how many kgs of concentrates are required. One can then use the **thumb rule of 1 kg concentrate for 2 kgs of milk**.

f. Then check whether the protein in the total ration and the protein requirement are in balance. If not adjust the composition of the supplemented concentrate (or change, if possible, part of the roughages).

In case rations have to be calculated for high productive cows also check whether the maximum feed intake capacity has been reached/exceeded. Sometimes such cows can not be fed according to their requirement because the maximum feed intake has been reached. These cows usually produce extra milk out of their body reserves (a weight loss of 25 – 30 kgs during the first 2 - 3 months of lactation is quite common with the HF breed).

a. Roughage is of poor quality.

b. The cow will eat 1.5 % of her body weight of the straw, which is 6 kg DM.

c. 6 kg DM straw provides the following amount of energy and protein :

6 x 0.44 = 2.64 kg TDN

6 x 36 = 216 g CP

d. Maintenance requirement is:

3.1 kg TDN and 321 g CP

Production requirement for 4 kg milk, 4% fat is:

4 x 0.32 = 1.28 kg TDN

4 x 90 = 360 g CP

Total requirement of the cow is:

3.1 kg TDN (maint.) + 1.28 kg TDN (product.) = 4.38 kg TDN

321 g CP (maint.) + 360 g CP (product.) = 681 g CP

e. Total requirement minus what is available in the straw is:

4.38 kg TDN - 2.64 kg TDN = 1.74 kg TDN shortage

681 g CP - 216 g CP = 465 g CP shortage

Necessary concentrates (kg) to fulfill the requirements is:

1.74 kg TDN shortage./0.7 kg TDN (energy value 1 kg concentrates) = 2.5

To fulfill the energy requirement 2.5 kg concentrates are necessary.

The protein content per kg concentrate should be 465/2.5 = 186.

The protein content of the concentrate is 180 which is roughly adequate.

9.3 Supplementation and substitution.

After calculating the TDN and g CP content of the basic ration it will become clear whether the ration needs supplementation. Sometimes farmers think that the supplementation is merely providing the animals with more roughage. However, "full is full". A cow (and other categories of cattle) can only digest a certain amount of roughage. If one provides more roughage of another kind the intake of the basic ration will be reduced with roughly the same quantity (depending on the quality). This effect is called "substitution". By substitution we understand the phenomenon that a feedstuff reduces the dry matter intake of another feedstuff because the rumen has already totally or partially been filled with feed.

Roughages more strongly prevent the intake of other products than concentrates. Concentrates digest more easily in the rumen, making space available for roughage. Substitution also depends on the quantity provided. In general, in case of concentrates, the first 2 – 3 kgs of concentrates will hardly have an effect on the intake of the roughage from the basic ration. More kgs will have an effect and this should be taken into account while calculating a ration. In the excel file for ration calculation this substitution effect is taken into account.

Figure 12: Concentrate supplementation during milking, maximum 2-3 kg.

9.4 Formulation of concentrate mixtures on the farm.

Example No. 1.

Suppose that a concentrate feed is required with a medium protein content of 180 g CP and at least 700 g TDN/ kg. The ingredients available are:

	Feeding value per kg product	
	kg TDN	g CP
Wheat bran	0.650	152
Sunflower heads	0.733	114
Cottonseed cake With hulls	0.755	242

First the difference between the desired CP content and the content of each ingredient is calculated:

Wheat bran	152 – 180	= - 28
Sunflower heads	114 – 180	= - 66
Cottonseed cake With hulls	242 – 180	= + 62

These differences must be combined in such a way that they add up to about zero. Then the overall mixture will have the desired CP content :

Wheat bran	- 28	x 2	- 56
Sunflower heads	- 66	x 1	- 66
Cottonseed cake With hulls	+ 62	x 2	+ 124
		5	+2

The desired concentrate comprises of 2/5 wheat bran, 1/5 sunflower heads and 2/5 cottonseed cake with hulls. For checking whether the above answer is correct 5 kg mixture can be prepared:

	kg TDN	g CP
Wheat bran contributes	2 x 0.650 = 1.300	2 x 152 = 304
Sunflower heads contributes	1 x 0.733 = 0.733	1 x 114 = 114
Cottonseed contributes	2 x 0.755 = 1.510	2 x 242 = 484
Total :	3.543	902

Per kg mixture there is 3.543/5 = 709 kg TDN and 902/5 = 181 g CP. This meets the requirement.

If a 100 kg of the mixture is required then:

Wheat bran contributes	2/5 x 100=	40 kg product
Sunflower heads contribute	1/5 x 100=	20 kg product
Whole cotton seed contributes	2/5 x 100 =	40 kg product
		100 kg mixture

The same calculation can be made with the feeding values on DM basis. In that case the quantities given should be converted from DM to "product", i.e. the water content of the feeds should be taken into account. However most dry ingredients of concentrate feeds have about the same DM content of 90%. The proportions of ingredients calculated on a DM basis will therefore remain the same as for the "product" basis.

Note that the above mixture has a high proportion of whole cottonseed, which has a high fat content. Cows should therefore not be fed more than 6 -7 kgs of this mixture. Higher intakes could upset the working of the rumen. The fibre content of this mixture is rather high, but the cost will probably be low.

Example No. 2.

The Pearson square method with 2 ingredients is also used to determine the proportion of 2 ingredients to achieve a specific nutrient content in the mixture

Example: Determine the right combination of lentil straw (7.7% CP) and tella atela (20.2% CP) to create a mixture containing 13% CP.

Steps in using the Pearson Square Method:

Step 1

- Draw a square with lines connecting the opposite corners.
- Write the desired percent of crude protein (13) in the center of the square.

Step 2

- Write the feeds to be used and their crude protein percent at the left hand corners of the square.

Step 3

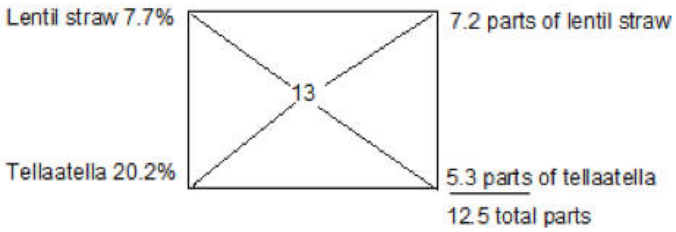
- Subtract the smaller number from the larger, along the diagonal lines. Write the differences at the opposite end of the diagonals.
- The difference between the percent protein in the lentil straw and the percent protein in the ration are the parts of tella atela needed.
- The difference between the percent protein in the tella atela and the percent protein in the ration are the parts of lentil straw needed.
- The sum of the numbers on the right equals the difference in the numbers on the left. This fact is used as a check to see if the square is set up correctly.

Divide the parts of each feed by the total parts to find the percent of each feed in the ration. Hence, the percentage of lentil straw and Tella atella to be mixed will be as follows.

Lentil straw = (7.2/12.5) x 100 = 57.6%

Tella atella = (5.3/12.5) x 100 = 42.4%.

The technique is applicable when the nutrient content of one of the two feeds is lower and that of the other is higher than the target nutrient level shown in the center of the square.



Example No. 3.

Because the cost of protein in a concentrate mixture can be quite high and the farmer might not have enough of the protein source (e.g. oilseeds) on the farm, it may be interesting to replace some of the vegetable protein with NPN in the form of urea. Urea has a very high CP value. Already a small amount of urea can therefore make quite a big difference to the CP content of a mixture. However, urea is poisonous to cattle when eaten in too great a quantity. And it can only be used by ruminants, so it should not be included in the ration for calves as their rumen is not yet developed.

As a general rule 1.5% urea in the dry matter of the concentrate/50 g per cow per day should be the maximum. Cows eating more than 3 kgs of concentrates should only have 1% urea added. Fertiliser grade urea should be finely ground using a mortar and pestle (or similar) and mixed thoroughly with the other ingredients of the mixture. If this is not done, a cow may consume large enough to kill it. There should always be enough easily-digested carbohydrate (e.g. maize) in a ration containing urea. Urea should first be mixed with a few kgs of maize bran for example before it is mixed thoroughly with the other ingredients.

Example No. 4.

Molasses is a useful supplement for dairy cattle. Its energy content is quite high (72% TDN) and it is usually quite cheap. With the inclusion of 2% urea it has a CP value of approximately 5%. Normally cows will only consume 2-3 kgs per day when given free choice. Higher intakes cause digestive problems, so molasses has only a limited role in rations for high productive cows. It is however valuable for low to medium producers which are meeting most of their protein requirements from other sources.

Other possibilities.

There are several other possible ingredients which can be used in concentrate rations for dairy cows. Poultry manure, if available, is useful for low producing cows but not for high producers due to its high NPN content. Poultry manure has a variable composition depending on the diet of the chickens, whether litter is used, and what kind of litter. Manure from battery layers has a CP value of around 18% while a common value for broiler manure is around 15%. The energy content of battery manure is only about

40%, but if maize bran is used as a litter, the energy content will be much higher.

It is also possible to use the pods of various indigenous fodder trees in concentrate rations. They have a CP value of around 15%.

10. Planning for dry season feeding.

An important feeding management objective is to have at all times enough quantity and preferably also quality roughages available to feed your animals all the year round. This requires careful planning which often is neglected. To make sure enough roughage is available in the dry season roughage has to be conserved during the growing season in the form of hay or silage besides dried crop residues. The following steps should be followed in this planning process:

a. Determine the average herd composition during the dry season.

b. Estimate the average roughage quality which will be available during the dry season.

c. Estimate the average dry matter intake of each animal category depending on the average roughage quality.

d. Based on the numbers calculate how much dry matter is required. Include minimum 5% wastage.

e. Determine how much dry matter will be available from crop residues and communal grazing.

f. Total amount from "d" – "e" = the amount of roughage to be conserved during the growing season or purchased.

g. Estimate the dry matter yield per acre of the forage crop you want to use for hay or silage making. The amount of dry matter calculated under "f" divided by this dry matter yield determines the acreage to be grown.

11.Monitoring Dairy Cattle Nutrition Management.

For regular monitoring of dairy cattle nutrition management the following criteria and their benchmarks can be used. Benchmarks are based on a commercial small holder dairy farm with F1 crossbred cows producing around 3000 kg milk per lactation/10 kg milk per day.

Table 8: Criteria dairy cattle nutrition management

Criteria dairy cattle nutrition management	Score (1= bad, 5 = good)	Remarks
1. Herd clearly categorized into groups		Only in case of herds > 10 cows
2. Rations worked out for various ration groups		
3. Trained feeding supervisor		
4. Feed weighed in measurable units		
5. Selective feeding/ other feed/ feeding signals		
6. Rumen fill various feeding groups		
7. BCS various lactation stages		

Criteria dairy cattle nutrition management	Score (1= bad, 5 = good)	Remarks
8. Rumen function: . Cud chewing, more than 70% of animals during resting periods . 7 to 10 hrs/ day . >50 – 70 times chewing per regurgitated cud . Rumen movements (2 per minute) . Manure consistency . Checking manure for digestion		
9. Ration today is balanced ?		
10. Dry matter intake . Daily, intake drop max.5%		
11. Water and trough cleanliness		
12. Feeding frequency, push up and cleaning		
13. Sufficient feeding (feed leftover minimum 5 %/feeding trough never empty)		
14. Feed storage . Concentrates . Hay . Silage . Other		
15. . kg dry conc/cow/yr and day (production level of 3000 kg milk/yr: max. 1200 kg/yr and 4 kg/day) . kg dry conc/100 kg milk (max 40 kg/ 100 l milk) . Conc cost B/kg (max. ….. Birr) . Roughage costs/cow/yr (depending on land area available per cow)		
16. Milk production: . Per cow per day according to expectation . Per cow per lactation according to expectation		
17. Metabolic problems incidence rate: . Milk fever, < 5% . Ketosis, < 5% . Rumen acidosis, 0% . Laminitis, < 10%		
18. Monitors used in commercial farms in Europe: . Feed efficiency (kg DM feed/kg milk) . Milk fat content . Milk protein content . Milk urea content		
19. . Enough space for cows to feed at same time . Enough space for drinking water . Floor feed manger/ trough 5 – 10 cm above standing place cows . Enough space for animals to escape from dominant cows . Comfortable resting place/cubicles . Animals stress free		
20. Planning done for dry season feeding		

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Annex 1: List of common feedstuffs in the (sub) tropics and their nutritive value for cattle

Feedstuffs	In 1 kg product DM g	TDN g	CP g	In 1 kg DM TDN g	CP g	Source
1 Cereals and other energy concentrates						
Maize grain-white	900	868	95	964	106	Tr. Feeds
Maize grain-yellow	880	868	109	964	121	Tr. Feeds
Maize grain	900	765	90	850	100	NRC
Sorghum grain	900	740	98	822	109	Tr. Feeds
Wheat grain	875	805	122	894	135	Tr. Feeds
Barley grain	900	765	117	850	130	NRC
Barley grain	900	765	93	850	103	Tr. Feeds
Tef grain	880	752	116	855	132	Feedipedia
Maize bran	900	695	52	770	58	E/C Africa
Wheat bran	900	650	152	722	169	Tr. Feeds
Wheat bran	900	630	157	700	174	NRC
Rice bran	900	680	130	756	144	NRC
Brewer's grain (sorghum)	320	230	77	720	240	E/C Africa
Brewer's grain, wet	225	166	63	736		Tr. Feeds
Brewer's grain, dry	900	603	250	278		NRC
Cassava meal (tapioca)	900	740	20	670	278	NRC
Potatoes	250	200	26	822	22	NRC
Blackstrap molasses	740	541	31	730	42	Tr. Feeds
Beet molasses	800	589	118	736	147	Tr. Feeds
Cane molasses	750	540	30	720	40	NRC
Citrus pulp	900	760	62	844	69	NRC
Sugar beet pulp	100	76	10	758	99	NRC
Maize gluten feed	900	654	239	727	266	Tr. Feeds
Bakery waste	910	820	110	901	121	NRC
Dried banana powder	830	614	45	740	54	NRC
Fat, animal/ vegetable blend	990	1752	0	1770	0	NRC
2 Legume seeds and oil seeds						
Cowpea seed	900	531	175	590	194	NRC
Cotton seed (whole)	900	880	203	978	226	NRC
Soya bean seed (whole)	900	822	372	913	413	NRC
Soya bean seed with hulls	910	844	240	928	264	Tr. Feeds
Sunflower seed with hulls	940	1118	116	1189	123	Tr. Feeds
Sunflower heads (whole)	900	733	114	814	127	Tr. Feeds
Velvet beans	900	848	233	942	259	Tr. Feeds
Velvet beans, in pods	890	720	132	810	148	E/C Africa
Whole groundnuts	930	997	202	1072	217	Tr. Feeds

Feedstuffs	In 1 kg product DM g	TDN g	CP g	In 1 kg DM TDN g	CP g	Source
3 Oil seed cakes and meals						
Cotton seed cake (with hulls)						
Groundnut oil cake, without hulls, Extr.	900	755	242	839	269	Tr. Feeds
Soya bean oil cake, with hulls	920	831	455	903	495	Tr. Feeds
Sunflower cake (without hulls)	900	760	396	844	440	Tr. feeds
Noug Cake	900	713	384	792	427	Tr. Feeds
4 Animal protein feeds	900	702	282	780	313	Feedipedia
Blood meal						
Fish meal						
Fish meal (herring)	910	603	800	670	880	Tr. Feeds
Meat and bone meal	940	725	606	770	645	E/C Africa
Feathers, poultry, hydrolyzed	900	707	697	785	774	NRC
Poultry manure	960	625	453	650	472	E/C Africa
5 Dry roughages/ crop residues (not pas-	920	630	850	685	924	NRC
ture)	890	480	249	540	280	NRC
Sweet potato vines, hay						
Cotton seed hulls						
Cowpea hay (with seeds)						
Cowpea straw (no seeds)	865	512	142	592	164	Tr. Feeds
Dolichos lablab hay (with seeds)	900	370	3	410	3	E/C Africa
Groundnut hay, mature	910	500	131	550	144	E/C Africa
Berseem hay, good quality	910	380	20	420	22	E/C Africa
	900	555	149	617	166	Tr. Feeds
Lucerne hay, late vegetative	920	470	118	510	128	E/C Africa
Lucerne hay, early bloom	900	500	135	550	150	Pakistan
Lucerne hay, midbloom						
Lucerne hay, full bloom	900	570	180	630	200	NRC
Lucerne hay, early bloom	900	540	162	600	180	NRC
	900	520	153	580	170	NRC
Maize cobs	900	500	135	550	150	NRC
Maize husk (cob sheath)	900	510	115	565	125	Tr. Feeds
Maize stover						
Sorghum stover	900	685	19	761	21	Tr. Feeds
	950	435	4	460	4	E/C Africa
Soyabean hay (mature)	850	425	50	500	59	NRC
Soyabean pod husks	900	450	36	500	40	Tr. Feeds
Soyabean straw						
	920	525	50	570	54	E/C Africa
Velvet bean hay, mature	870	350	10	400	11	E/C Africa
Wheat straw	870	330	15	380	17	E/C Africa
Rice straw						
Tef straw	900	480	104	530	115	E/C Africa
	900	400	32	440	36	NRC
Sugarcane bagasse	900	400	41	440	45	NRC
Sugarcane tops, fresh, post ripe	920	497	38	540	41	Feedipedia
Dry sugarcane leaves						
	910	255	19	280	21	NRC
	400	223	18	558	45	Tr. Feeds
	850	425	22	500	26	Tr. Feeds

Feedstuffs	In 1 kg product DM g	TDN g	CP	In 1 kg DM TDN g	CP g	Source
6 Dry roughages (pasture)						
Rhodes grass hay (early cut)	910	490	34	540	37	E/C Africa
Rhodes grass hay (first cutting)	870	425	32	490	37	Tr. Feeds
Rhodes grass hay (late cut)	910	430	0	470	0	E/C Africa
Starr grass hay	890	445	47	500	53	E/C Africa
Guinea grass (full seed)	910	410	15	450	16	E/C Africa
Napier grass hay, mature	900	365	68	405	75	Tr. Feeds
Natural pasture hay	930	455	4	490	5	E/C Africa
range grass hay	900	410	36	450	40	Pakistan
Rhodes grass/ Siratro hay	880	440	88	500	100	E/C Africa
Stylo hay (2 months regrowth)	760	440	112	580	147	E/C Africa
Berseem hay (good quality)	900	555	135	615	150	Tr. Feeds
Berseem hay, stemmy, few leaves	900	450	45	500	50	Pakistan
Lucerne hay, late vegetative	900	570	180	630	200	NRC
Lucerne hay, early bloom	900	540	162	600	180	NRC
Lucerne hay, mid bloom	900	520	153	580	170	NRC
Lucern hay, full bloom	900	500	135	550	150	NRC
Italian ryegrass hay, early vegetative	900	612	137	680	152	NRC
Italian ryegrass hay, early bloom	900	486	58	540	65	NRC
Perennial ryegrass hay, early bloom	900	522	54	580	60	NRC
Desho grass hay	900	435	36	483	40	Feedipedia
Vetch hay	900	576	180	640	200	Feedipedia
Pigeon Pea hay	900	576	131	600	145	Feedipedia
Desmodium Greenleaf hay	850	451	109	530	128	Feedipedia
7 Fresh pasture and roughages						
Sweet potato vines, fresh	150	100	20	665	135	E/C Africa
Sweet potato vines, fresh	85	60	15	705	175	Tr. Feeds
Maize, fresh, 8 weeks	160	100	16	625	100	Tr. Feeds
Green maize, milky stage	200	120	16	600	80	Pakistan
Sorghum, fresh, mature	230	115	10	500	45	Tr. Feeds
Sorghum, fresh, before flowering	200	115	16	575	80	E/C Africa
Sorghum-sudan grass (over 60 cm High to avoid prussic acid poisoning)	300	180	22	600	75	NRC
Napier grass, fresh, veg., 40 cm	200	128	20	640	98	Tr. Feeds
Napier grass, fresh, 80 cm	200	107	18	533	90	Tr. Feeds
Napier grass, fresh, early bloom, 240 cm	250	124	18	497	72	Tr. Feeds
Desho grass, young vegetative stage	263	147	17	558	65	Feedipedia
Rhodes grass, 1 month regrowth	200	128	18	640	90	E/C Africa
Rhodes grass, 2 months regrowth	230	135	11	590	50	E/C Africa
Rhodes grass, 3 months regrowth	260	115	5	440	20	E/C Africa
Leucaena (ipil ipil) leaves	250	168	72	670	290	NRC
Leucaena pods	240	208	63	867	261	Feedipedia
Maize without cob	350	175	23	500	65	Pakistan
Green oats (boot to milk stage)	200	120	34	602	169	NRC
Green wheat (boot to milk stage)	200	126	33	631	164	NRC

Feedstuffs	In 1 kg product DM g	TDN g	CP g	In 1 kg DM TDN g	CP g	Source
Naivasha starr grass, late veg., 25 cm	200	134	38	670	191	Tr. Feeds
Naivasha starr grass, early bl., 40 cm	280	162	31	578	110	Tr. Feeds
Naivasha starr grass, early bl., 60 cm	300	164	33	547	110	Tr. Feeds
Naivasha starr grass, standing hay	910	379	47	417	52	Tr. Feeds
Perennial rye grass, fresh, early veg.	150	105	27	700	180	Netherlands
Berseem, 1st cutting, early veg.	110	75	24	683	220	Tr. Feeds
Lucerne, early vegetative	110	75	27	686	245	Tr. Feeds
Lucerne, early bloom	200	131	41	655	203	Tr. Feeds
Lucerne, mid bloom	250	140	40	558	160	Tr. Feeds
Lucerne, fully flowering	300	144	36	480	120	Pakistan
soya bean, mid-bloom, fertilized	160	103	27	642	166	Tr. Feeds
Natural grass:						
Early growing season	300	190	25	630	82	E/C Africa
Mid-growing season	300	145	12	490	39	E/C Africa
Mid-dry season	550	135	0	250	0	E/C Africa
Tree lucern young leaves	200	160	50	800	250	Tropical For.
Vetch	200	140	46	700	230	Feedipedia
Pigeon Pea	300	195	57	650	190	Feedipedia
Desmodium Greenleaf	240	140	37	581	155	Feedipedia
8 Silages						
Rhodes grass silage	240	122	11	508	45	Tr. Feeds
Rhodes grass silage, early flowering	230	135	14	580	63	E/C Africa
Rhodes grass silage, full bloom	250	135	12	550	49	E/C Africa
Rhodes grass silage, mature	300	140	5	460	16	E/C Africa
maize silage, good	400	280	25	700	63	E/C Africa
maize silage, average	330	210	17	640	56	E/C Africa
maize silage, poor	270	150	9	550	35	E/C Africa
maize silage, milk stage	220	120	13	545	60	E/C Africa
grass silage, early bloom (Dutch quality)	450	300	70	667	156	Netherlands
sorghum silage	260	145	14	560	53	E/C Africa
sunflower silage	270	156	30	578	111	NRC
Napier (elephant) grass silage, 2 m high	240	115	5	480	21	E/C Africa
Dwarf elephant (Mott) grass silage	290	171	31	590	107	NRC

Resources

Remarks:

-Most of the data comes from research stations in East and Central Africa (indicated by E/C Africa), from the NRC and from the FAO publication Tropical Feeds and FAO Website "Feedipedia". Various other sources have been used as well.

-The list is not at all exhaustive. Our advice to the users of this manual and these feeding value tables is to also consult local research stations or other local sources of information and try to collect feeding value data for all products that are locally available.

-Feeding value data should not be taken too rigidly. Products known under one and the same name are seldom quite comparable and analysing techniques and standards may not be exactly the same in different parts of the world. This is to some extend reflected in our list. Our advice is to rely on the data which local research stations use.

-Grazing cows generally choose the most nutritious vegetation (i.e. selective grazing) when plant growth is relatively abundant. Feeding value data apply to the average product quality. Therefore cows may actually eat a product that is better than assumed. Also keep in mind that the TDN system is a "rough" system which has been designed for assessing fodder quality in temperate climates. It might overestimate the feeding values of tropical roughages. Nevertheless it is not recommended to feed dairy cows (and other livestock) more or less "blindly", i.e. without having an idea of the qualities of the product(s) that are included in feeding rations.

-The data refer to the "pure" product and not to mixtures including a large portion of weeds.

-Presumably the data refer to products grown on well fertilised soils.

Dairy Cattle Feeding and Nutrition management Training Guideline for Dairy Extension Workers

II. Dairy Cattle Feeding and Nutrition management Training Guideline

A. Module Book

Introduction

The Module Dairy Cattle Feeding and nutrition management is part of the Working Packages introduced By SNV Ethiopia as part of the EDGET Project. One of the EDGET project objectives is to make small holders dairy farms more aware about "commercial farming". The Module Dairy Cattle Feeding and nutrition management will help the dairy extension workers to acquire the knowledge and skills to feed dairy cows for optimal milk production.

Feeding management is one of the most important aspects in a commercial dairy farm. It is not only determining milk production levels, but it also has a major impact on the health and fertility levels on the dairy farm. Proper feeding management also influences economic results of the dairy farm to a very large extend. Higher levels of milk production also ensure an efficient use of feed resources reducing the amount of greenhouse gas emissions per litre of milk.

Professional situation

As an extension worker, you have to advise smallholder farms on how to manage their crops and livestock in the most optimal way particularly the dairy enterprise. A smallholder dairy farmer in Ethiopia has to manage his/her dairy farm unit/ enterprise in the most optimal way given his/her specific circumstances. This also means that the farmer has to determine the objectives of his/her dairy enterprise, has to develop action plans for achieving these objectives, has to develop tools for monitoring and evaluation, in short applying the so-called "management cycle" also concerning dairy cattle feeding and nutrition management.

As an extension worker, you have the knowledge, skills and innovations to manage the feeding of all categories of dairy cows in the most optimal way and you have the motivation and "drive" to convince smallholder dairy farmers to improve on their knowledge and skills in order to improve the milk production level of their dairy enterprise. Feeding and nutrition management is the backbone of every dairy farm and is very important to make your dairy farm successful. Not only for the income on the short term but also to sustain the farm on the longer term. The Smallholder Farm Manager has to deal with feeding management issues like:

- Is there enough roughage in stock for the dry or winter period,
- How will I distribute the different feed resources to the different groups of animals,
- Which quality is needed for my breed of dairy cattle, young stock, dry cows, and milk producing animals and maybe also beef cattle,
- How to optimize the rations for a better animal health and (re)production,
- What will happen when rations are not well balanced, will it result in metabolic diseases, etc.

- What is the best feeding system/bunk management given my situation
- improve and conserve feed to increase feed intake and palatability

Not only calculations are important but also observing the animals, what signals are they giving to you as a farmer, how can we recognize and interpret them and what kind of information does it give you. And the most important: what are you going to do, so acting.

In this module, it is your task to develop your knowledge and skills in such a way that you are able to act properly yourself, and that you can guide your farmers, and assist them to optimize the total farm results. On dairy farms, worldwide farmers are looking for the ideal ration for their cows in their circumstances with their roughages and concentrate types. A higher milk production per cow not only requires better quality of roughages, but also a better cow management.

There is also a direct link between the supply of good quality and sufficient roughages, high milk production, greenhouse gas emissions, health and good fertility levels. All the knowledge and skills need to be present on the farm regarding nutritional issues. If only 1% is missing, it might influence your total (financial) result with more than 50%. In all of the above tasks you will consider the "gender" situation of the farm (who takes the decisions with regard to feeding of the livestock, who does the actual feeding on the farm, who decides on which concentrates, minerals and other feeding inputs to buy) in order to address the right target group for farmer training.

Required entry qualification

To take part in this module on Dairy Cattle Feeding and Nutrition Management you should comply with the following entry requirements:

- Competent in the English language
- Have completed other EDGET Program training modules successfully
- Competent in basic calculation skills
- Have basic insight/experience in managing small holder dairy farms

Specific objectives and related topics

a. At the end of the course, participants can judge whether the situation on a farm is conducive for cows feeling comfortable with regard to feeding.

Related topics are:

- Cow behavior and impact on feeding management
- Feed bunk management aspects including water

b. At the end of the course, participants are able to assess the rumen function of dairy cows and their link with metabolic problems.

Related topics are:

- How the rumen functions
- Checking the rumen function using various "cow signals"

c. At the end of the course participants are able to make an inventory of available feedstuffs on a dairy farm, assess their feeding value (dry matter content, energy level, protein level) using physical inspection and the use of a feeding value table and judge the quality of roughages using different criteria.

Related topics are:

- Composition of feedstuffs and their feeding value
- Criteria for judging the quality of roughages

d. At the end of the course, participants are able to calculate dry matter intake of dairy cows, their feed requirements (energy, protein) and compose/ calculate rations to meet these requirements.

Related topics are:

- Calculation of dry matter intake and feed requirements
- Selection of feedstuffs for rations for different categories of dairy cows
- Ration calculation by hand and the use of an excel program
- Explanation of feed improvement and conservation
- General guidelines for feeding dairy cows in different stages of lactation
- Assessing whether a dairy farmer has enough roughages in stock to feed his animals during the dry season

e. At the end of the Course, participants are able to assess dairy cattle nutrition management on dairy farms using a number of criteria and benchmark them.

Related topics are:

- "Monitors" and key performance indicators for proper dairy cattle nutrition management and their reference levels/ benchmarks

Assessment

During the course, one assessment will be conducted to measure the competence level of the participants to advise a smallholder farm on his/ her dairy cattle feeding and nutrition management performance. The assessment will be a group assignment. The group (maximum 4 persons) will have to visit an assigned smallholder dairy farm and implement the following tasks:

a. Making a checklist for monitoring the feeding management.

b. Visit of the assigned smallholder dairy farm, monitor the herd and the dairy unit and fill out this checklist.

c. Develop at least two advices for improving the feeding management on the assigned farm.

d. Assess the quantities of roughages available on the farm and calculate for how many days roughage supply is available.

e. Based on the roughage supply assessment you prepare a feeding plan for this farm.

f. Calculation by hand and the use of the excel sheet of amount of concentrate supplementation of to the ration of all cows present on the farm.

g. Improve feed and conserve feed for dairy cattle and advice which animals should feed the improved feed

h. Presentation of results

Activities

Below an overview of all activities related to this module are presented:

Day	Time	Subject
Day 1	1st	-Introduction Module/ participants/ trainer/ brainstorm on the gender situation on small holder farms with regard to feeding management and introduction into dairy cattle feeding and nutrition management
	2nd	-Feed resource availability -Feed bunk management aspects including water -Rumen function and assessment criteria
	3rdand 4th	Visit of small holder farm and implement following practical lessons: -Judging the quality of available roughages -Making an inventory of available feedstuffs and their quality/ feeding value -Assess "feed bunk" management on the farm -Assess the rumen function of cows on the farm -Homework (study relevant chapters of the manual)
Day2	1st	-Calculation of dry matter intake and feed requirements -Selection of feedstuffs for rations for different categories of dairy cows -Ration calculation by hand and the use of an excel program
	2nd	-Ration calculation continued
	3rdand 4th	Visit of small holder dairy farm -Assessment of roughage supplies on the farm and for how many days supplies are sufficient to feed the animals -Feeding of the dairy cows present on the farm (weighing right quantities, chopping, cleaning manger, feeding, calculation of concentrate supplementation and feeding during milking -Conserve and improve dairy feed for supplementation -Homework
Day 3	1st	-General guidelines for feeding dairy cows in different stages of lactation -Assessing whether a dairy farmer has enough roughages in stock to feed his animals during the dry season
	2nd	-Monitors and key performance indicators for assessing dairy cattle nutrition management on a small holder dairy farm -Explanation of assignment/ assessment
	3rd	-Visit of assigned small holder dairy farm and implement assignment

Day	Time	Subject
	4th	-Assignment/ assessment continued
Day 4	1st	Prepare for presentation
	2nd	Presentation in presence of farmers
	3rd	Brainstorm on farmer training in dairy cattle nutrition management taking into consideration the "gender situation" on small holder farms
	4th	Course Evaluation and closing

Notes:

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B. Lesson matrix

Lesson Matrix	
Topic / Serial #	
Practical Lesson	Lesson 1 Dairy Cattle Feed and nutrition Management
Date	
Venue	
Duration	1 day/ Day 1 of the Course
Type of students	Dairy Extension Workers
Suggested number of students	16
Starting situation	Students have very little or no experience with Dairy Cattle Feeding and Nutrition Management
Learning Objectives:	The student is able to:
Skills	-Assess feeding environment and management aspects on farms -Assess quality of feedstuffs on farms, especially roughage quality -Calculate how many kg fresh/dry matter a cow will eat per day and quantity of roughage required to overcome the dry season -Assess rumen function and link with metabolic problems -Assess feed conservation
Knowledge	-Explain main animal feed resources available in the area -Explain how the rumen functions and the linkage with some metabolic diseases -Explain what impact good feeding management has on other management areas on dairy farms like health and fertility -Explain differences in feeding values of feedstuffs and how to assess the quality of roughages
Attitude	Convince farmers that dairy cattle feeding and nutrition management is a crucial part in dairy farm management influencing not only milk production but also the health and fertility levels on the farm and especially the income a farmer can earn

Time in minutes	Brief Content	Role trainer / didactical methods	Teaching aids	Role/activities Participants
15	-Opening of the course, getting acquainted with each other, explanation Module Book and Course Objectives	-Explaining/ guiding/ making trainees feel at ease	-Module Book	-Listening, introduction of themselves, asking questions, answering questions
30	-Sharing experiences with dairy cattle feeding and nutrition management -Gender situation on farms, who is doing the feeding, who is buying concentrates, etc. -Distribution Dairy Cattle Feeding and Nutrition Management Manual	-Asking for experiences to get an idea about student level and the gender situation in their working area -Introduction to dairy cattle feeding and nutrition management	-Dairy Cattle feeding and Nutrition Management Manual	-Sharing experiences -Check contents of Manual
75	-Feed resource assessment in relation to dairy requirement	-Sharing experiences/ lecturing/ PPT/ assignment	-Manual -PPT/ video -Questions	-Sharing experiences/ listening/ asking + answering questions
30	Break			
120	-Rumen function and assessment criteria, link with some metabolic problems	-Sharing experiences/ lecturing/ PPT/ assignment	-Manual -PPT/ video -Questions/ exercise 1	-Sharing experiences/ listening/ asking + answering questions
60	Lunch			
180	Visit of small holder farm and implement following practical lessons: -Judging the quality of available roughages -Making an inventory of available feedstuffs and their quality/ feeding value -Assess "feed bunk" management on the farm -Assess the rumen function of cows on the farm	-Travel to farm -Explaining assignments and worksheets: *Roughage quality assessment *Inventory feedstuffs *Assessment rumen function	-Small holder farm	-Visit small holder farm/ assess quality of roughages/ make inventory of feedstuffs/ assess rumen function/ ask clarity questions
30	-Summary/ reflection/ homework	-Summary theory/ testing knowledge -Common made mistakes -Study chapter 1/2/3/4/5 -Finish assignment rumen function	-PPT -Manual -Assignments -Homework study Manual	Answering and asking questions

Lesson Matrix	
Topic / Serial #	
Practical Lesson	Day 2 Dairy Cattle Feed and Feeding Management
Date	
Venue	
Duration	1 day/day 2 of the Course
Type of students	Dairy Extension Workers
Suggested number of students	16
Starting situation	Students have very little or no experience with Dairy Cattle Feed and feeding Management
Outcomes	The student is able to:
Skills	-Calculate how many kg fresh/ dry matter a cow will eat per day and quantity of roughage required to overcome the dry season -Calculate energy and protein requirement of dairy cows -Calculate rations for dairy cows/ cow groups manually and with the use of an excel file -Feed a cow/ group of cows in line with requirements
Knowledge	-Explain energy and protein requirements of dairy cows -Explain mineral/vitamin and water requirements of dairy cows -Explain how much a cow can eat in dry matter and fresh matter -Explain how to calculate a ration
Attitude	Convince farmers that dairy cattle feed and feeding management is a crucial part in dairy farm management influencing not only milk production but also the health and fertility levels on the farm and especially the income a farmer can earn

Time in minutes	Brief Content	Role trainer / didactical methods	Teaching aids	Role/activities Participants
120	-Discussion Homework and chapter 1 – 5 -Calculation of dry matter intake and feed requirements -Selection of feedstuffs for rations for different categories of dairy cows -Ration calculation by hand and the use of an excel program	-Discussion results assignment -Answering questions chapter 1 – 5 -Explaining ration calculation -Give assignment ration calculation by hand -Students present -Explanation excel file -Students exercise	-Manual -Answer sheet assignment -PPT ration calculation -Assignment ration calculation by hand -White board for students to present answers -Excel ration calculation file	-Answering/ asking -Listening -Making assignments -Exercising excel file
30	Break			
120	Ration calculation continued	Ration calculation continued	Ration calculation continued	Ration calculation continued
60	Lunch			
180	Visit of small holder dairy farm -Assessment of roughage supplies on the farm and for how many days supplies are sufficient to feed the animals -Feeding of the dairy cows present on the farm (weighing right quantities, chopping, cleaning manger, feeding, calculation of concentrate supplementation and feeding during milking)	-Guidance and coaching	Excursion farms	-Collection of information, measuring supplies, weighing feed, chopping, feeding cows
30	-Summary/ reflection/ homework	-Summary theory/ testing knowledge -Common made mistakes -Study chapter 6/7 -Finish assignment ration calculation	-PPT -Manual -Assignments -Homework study Manual	Answering and asking questions

Lesson Matrix	
Topic / Serial #	
Practical Lesson	Day 3 Dairy Cattle Feed and nutrition Management
Date	
Venue	
Duration	1 day/ Day 3 of the Course
Type of students	Dairy Extension Workers
Suggested number of students	16
Starting situation	Students have very little or no experience with Dairy Cattle feed and feeding Management
Outcomes	The student is able to:
Skills	-Assess feeding environment and "bunk" management aspects on farms -Assess quality of feedstuffs on farms, especially roughage quality -Assess rumen function and link with metabolic problems -Monitor and evaluate quality of feeding management on farms and advise on improvements -Assess water supply/ mineral supply -Assess feed improvement -Assess feed conservation -Write report on findings and recommendations -Present findings and recommendations to farmers
Knowledge	-Explain preparation of urea mineral multi-nutrient block -Explain urea straw treatment -Explain hay and silage making -Give general guidelines for feeding dairy cows in different stages of lactation
Attitude	Convince farmers that dairy cattle feeding and nutrition management is a crucial part in dairy farm management influencing not only milk production but also the health and fertility levels on the farm and especially the income a farmer can earn

Time in minutes	Brief Content	Role trainer / didactical methods	Teaching aids	Role/activities Participants
?	-feed improvement and conservation methods -Preparation of urea molasses multi nutrient block straw treatment, hay and silage making	-Sharing experiences/ lecturing/ PPT/ assignment	-Manual -PPT/ video -Questions/ exercise 1	-Sharing experiences/ listening/ asking + answering questions
?	Visit of small holder farm and implement following practical lessons: -Judging the quality of available hay and silage -Assess feed improvement system and making inventory of available improved feed and their quality/ feeding value -Assess "feed bunk" management on the farm -Assess feed conservation methods	-Travel to farm -Explaining assignments and worksheets: *urea treated straw quality assessment *quality assessment molasses multi nutritional block *Assessment hay and silage making *assess EM technology	-Small holder farm	-Visit small holder farm/ assess quality of MMNB urea straw treated and prepared hay and silage
120	-Discussion homework -General guidelines for feeding dairy cows in different stages of lactation -Assessing whether a dairy farmer has enough roughages in stock to feed his animals during the dry season + assignment	-Discussing/ asking -Explaining and discussion -Explaining and discussion + explaining assignment	-Manual -PPT -Assignment	-Asking/ discussing/ listening/ making assignment and presentation
60	Break			
120	-Monitors and key performance indicators for assessing dairy cattle feeding and nutrition management on a small holder dairy farm, making assignment -Explanation of assignment/ assessment	Explaining/ discussion/ give assignment (included in the PPT) Explaining assignment/ assessment/ making of groups	-Manual -PPT -Assignment	-Listening/ asking/ making assignment/ discussing -Working on assignment
60	Lunch			
180	-Visit of assigned small holder dairy farm and implement assignment	Guiding/ coaching	-Assignment	-Students collecting and processing information
30	-Summary/ reflection/ advises for assignment	-Summary theory/ testing knowledge -Common made mistakes -Study chapter 8/9/10 -Finish assignment	-PPT -Manual -Assignment -Homework study Manual	Answering and asking questions

Lesson Matrix	
Topic / Serial #	
Practical Lesson	Day 4 Dairy Cattle Feed and nutrition Management
Date	
Venue	
Duration	1 day/ Day 4 of the Course
Type of students	Dairy Extension Workers
Suggested number of students	16
Starting situation	Students have very little or no experience with Dairy Cattle feed and feeding Management
Outcomes	The student is able to:
Skills	-Write report on findings and recommendations -Present findings and recommendations to farmers
Knowledge	-Give general guidelines for feeding dairy cows in different stages of lactation -Explain how feeding management can be monitored and evaluated
Attitude	Convince farmers that dairy cattle feed and feeding management is a crucial part in dairy farm management influencing not only milk production but also the health and fertility levels on the farm and especially the income a farmer can earn

Time in minutes	Brief Content	Role trainer / didactical methods	Teaching aids	Role/activities Participants
120	Students prepare for presentation	-Guidance and coaching	-target farms	-Preparing presentation
60	Break and arrival of farmers			
120	Presentation assignment results	-Assessing performance	-Projector/ white board/ flip overs	-Group presentations
60	Lunch (students and farmers)			
60	-Assessment result per group	-Reflection on assignment results and assessment score	-Discussion per group	-Reflection and discussing assessment result
60	-Brainstorm on farmer training -Special focus on gender, whether the male or female members are involved in feeding dairy cattle and take decisions with regard to feeding management of the farm, etc.	-Lead discussion and gives ideas how to train farmers in the topic; -Who are the target group for the training, only men or only women or both -What lesson material to use and at what level to train	-Experiences during the Course -Experiences with the small holder farms in the working area	-Active participation in the brain storm session
30	-Evaluation of course	-Explaining evaluation form	-Evaluation form	-Filling evaluation form
30	Closing	-Final Remarks -Awarding certificates	-Certificates	-Listening and receiving their certificate

C. Checklist for monitoring feeding management

Feed

		Good	Sufficient	Poor
Hay	Quality	0	0	0
	Palatability	0	0	0
	Heating up/fungi	0	0	0

Remarks: _____

_____

_____

		Good	Sufficient	Poor
Other products	Quality	0	0	0
	Palatability	0	0	0
	Heating up/ fungi	0	0	0

Remarks: _____

_____

_____

Cows

		Too thin	Good	Too fat
Body condition	High productive	0	0	0
	Middle productive	0	0	0
	Low productive	0	0	0
	Dry	0	0	0
	Fresh, < 60 days	0	0	0

Remarks: _____

_____

		Good	Sufficient	Poor
General	Hair coat	0	0	0
	Rumen fill	0	0	0
	Rumen function	0	0	0
	Hooves	0	0	0
	Other: …… …..	0	0	0

Remarks: _____

_____

_____

		Good	Sufficient	Poor
Manure	Consistency	0	0	0
	Colour	0	0	0
	Digestion	0	0	0

Remarks: _____

_____

_____

Ration

		Good	Sufficient	Poor
Feeding hygiene	Cleanliness trough	0	0	0
Drinking water	Hygiene/ quality	0	0	0
Composition on	Ration calculation	0	0	0
Paper	Minerals	0	0	0

Remarks: _____

_____

D. Judgement results last milk production registration

	Good	Sufficient	Poor
Standard cow production (SCP)	0	0	0
SCP results over the year	0	0	0
SCP level various production groups	0	0	0
Milk fat %	0	0	0
Milk fat % level of the various			
Production groups	0	0	0
Protein %	0	0	0
Protein % level of the various			
Production groups	0	0	0
Urea level milk	0	0	0

Remarks: _____

_____

E. ANALYSIS OF POSSIBLE METABOLIC DISORDERS

Calculate the various percentages and compare with desired levels with the help of the last milk production registration.

Month	Number of cows 0 – 60 days in lactation	% of cows with lower than expected milk yield	Fat minus Protein > 1,25 (%)	Fat minus protein < 1 (%)	Protein < 3 (%)
January					
February					
March					
April					
May					
June					
July					
August					
September					
October					
November					
December					
Levels which indicate a problem might be there		> 10 % Cows start lactation poorly	> 45 % Negative energy balance	> 38 % Rumen acidosis	> 18 % Negative energy balance/ too low feed intake

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