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Introduction

Livestock production in all its ventures is a major source of incomes all over Kenya, from the most productive to nearly desert areas, And for all livestock owners livestock feeding and nutrition is a major concern. Inadequate nutrition is a major cause of low live-weight gains, infertility and low milk yields in dairy cattle. Also pig, chicken, dairygoat and many other livestock producers have expressed challenges in feeding their animals optimally. The following will explain the principles of animal nutrition and some examples of how to make home feed rations based on the types of feed available in major agroecological zone

The feed nutrients

Animal feed needs to contain various groups of nutrients, and the composition depends on which type of animal is being fed and the stage of production. Generally,

- **protein is the one element most necessary for body building and maintenance as well as milk production. Without protein there would be no body weight gain nor milk production**
- **carbohydrates provide energy and body fat,**
- **fats provide energy and the excess is converted to fat and stored in the body**
- **Minerals help in body building as well as in biological regulation of growth and reproduction. They are also a major source of nutrients in milk**
- **vitamins help regulate the biological processes in the body and become a source of nutrients in milk**
- **water helps all over in body building, heat regulation, biological processes as well as a large constituent of milk production as well as eggs.**

When calculating feed needs of different animals a system called Metabolisable Energy as a basis for formulating rations on the farm is used. Metabolisable energy basically means that part of the feed which the animal is able to utilize.

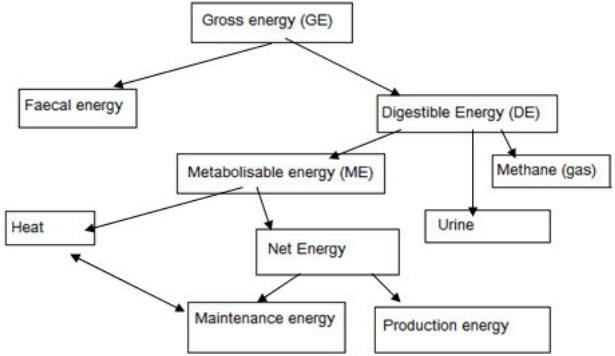
The unit of energy in the ME system is the Joule (J) of which one million units (1000 000 J) is referred as Megajoule (MJ). All foods contain energy, but not all of it is available to the animal. Parts of all feed is lost in the faeces, this part is described as indigestible. Other losses of energy occur in the production of methane, the urine of the animal and the loss of body heat. The energy remaining after all this is called the Metabolisable Energy or ME.

Basically, feed organic nutrients are required by the animals for three things: These are:
(i) use as materials for the construction of body tissues (growth and maintenance)
(ii) synthesis of products such as milk and eggs
(iii) use as sources of energy for work done. The work done include both metabolic (heat increment and maintenance) and physical e.g. walking and feeding.

Use of feed energy within the animal

Gross energy (GE)

The feed is comprised of chemical ingredients which are broadly classified as carbohydrates, proteins, lipids and vitamins. Heat is released when organic material such feed is burnt. For this reason, methods have been developed to measure the quantity of chemical energy present in a feed by determining the amount of heat generated from complete burning a known quantity. This is referred to as gross energy . Most of the common feeds have energy content of about 18.5 MJ/kg DM.



Digestible energy (DE)

Not all the gross energy in consumed feed is available and useful to the animal. Some energy is lost from the animal though excretions and heat. The digestible energy is calculated by subtraction of feaces energy from gross energy. The DE represent the energy content of the digested nutrients

Metabolizable energy (ME)

The animal further loses energy containing-substances through excretion of urine and production of gases during metabolic processes. Metabolizable energy is what remains after subtraction of energy lost from urine and combustible gases resulting from the consumption of a feed. Loss of energy through methane (a combustible global warming gas) can be substantial, particularly for ruminants, hence can be of serious nutritive and environmental consequence.

Heat increment (HI)

The ingestion of feed by an animal is also followed by losses of energy not only as the chemical energy excreta and gases produced but also as heat. Animals are continuously producing heat and losing it to their surroundings, either directly through radiation, conduction and convection or indirectly through water evaporation from the body. The heat is generated through processes of digestion and metabolism of nutrients derived from the feed. For instance, the act of eating, which includes chewing, swallowing and secretion of saliva, requires muscular activity and this generates heat. Unless the animal is in a particularly cold environment, this heat energy is of no value to it, and must be considered, like the energy of the excreta, as a tax on the energy of the feed. Energy lost in this manner is referred to as Heat increment.

Net energy (NE)

The deduction of the HI of a food from its ME gives the Net energy, which is the energy available to the animal for useful purposes such as body maintenance and various forms of production.

Protein requirements

Protein is the basic material for building body tissues, blood cells, hair and skin. Even bones are over ½ part protein, and protein is a major nutritional part of milk and eggs etc. Therefore it is necessary for an animal to eat enough protein to be able to grow well and to be productive whether in terms of milk meat or egg production. No other nutrient can replace protein in the diet.Cows can make protein from non-protein nitrogen containing materials such as Urea and poultry litter. Animals can not store much protein in their bodies and so it must be supplied in the daily ration every day in order to maintain high milk/egg/meat production.

If the amount of protein in ration is suddenly reduced, milk and egg production will drop rapidly and the animals will lose weight, growth rate of calves and heifers will be reduced also. Feeding too much protein to dairy cows is wasteful because the excess is broken down by micro-organisms in the rumen and excreted from the body. This should be prevented through careful and strategic feeding since protein is very expensive.

Proteins are built from what scientists call amino acids. Some amino acids can be generated by the cows in the rumen others cannot and have to be provided in the feed.

The amino acids that animals cannot produce themselves are called essential amino acids - meaning that it is essential for the animal to eat food containing these amino acids in order to be productive. When feed is analysed in the laboratory essential amino acids can be registered in the analysis. Generally it is advisable to feed a mixture of different protein feeds in order to have a good chance of supplying all the essential amino acids.

Essential amino acids	Non essential amino acids
Arginine	Alanine

Histidine	**Aspartic acid**
Isoleucine	**Citrulline**
Leucine	**Cystine**
Lysine	**Glutamic acid**
Methionine*	**Glycine**
Phenylalanine**	**Hydroxyproline**
Threonine	**Proline**
Tryptophan	**Serine**
Valine	**Tyrosine**

***May be replaced in part by cystine**
**** May be replaced in part by tyrosine**

If one of the essential amino acids is lacking in the feed all the other feed cannot make up for this and the animal will be unthrifty and unproductive.

Biological value of protein

The biological value of protein in the feed is the percentage of the digestible protein of a feed or feed mixture which is usable as a protein by the animal. A protein which has a desirable balance of essential amino acids will have a high biological value and is said to be a protein of good quality. A protein which is extremely deficient in one or more essential amino acids will be called a low quality protein.
Digestible Crude Protein (DCP) is that part of the protein the animals can utilize in their nutrition.

Ruminants such as cows and sheep can produce some of the essential amino acids above, but research is not conclusive on this point.
If animals are fed too much protein, the part that is not used in the building of the body and production can be converted into energy, but as proteins are generally expensive to buy and produce this scenario would not be

common in Kenya.

High protein feeds

- **From animal origin such as fish meal, bone meal etc. Have high content of Vitamin B12, but are not essential in cattle feeding. Small quantities can be added to chicken and pig feeds**
- **From plant origin. These can be found in**
  - **Oil seed byproducts such as maize germ cake, cotton seed cake, sunflower seed cake, sesame seed cake, soy bean cake just to mention the more common ones. They vary in composition depending on how the oil was extracted and how much hull and/or seed coat was included (see Feeding section for details). Such protein feeds need to be bought by the farmer as it is not easy to produce on individual farms.**
  - **Green or preserved legume fodder. This includes all fresh cowpea, bean, desmodium, clover, and all the other legume leaves and stems - also the tree fodders promoted by agro-forestry people are good protein providers. Such protein can be grown on the farm quite cheaply and at the same time help improve soil fertility as the same legumes usually fix nitrogen from the atmosphere and use this for producing feed as well as soil nutrients to be used by the following crops (More details in the general fodder production section).**
- **Protein from non-protein source: Ruminants are able to produce protein from non protein nitrogen. The most commonly used non-protein nitrogen used in ruminant feeding is urea. Urea is also a by-product of protein metabolism in the body, so in small quantities is not poisonous to the animals. However if large quantities are fed the urea gets converted to ammonia which is quite toxic and can kill an anim al very quickly. If urea is to be used effectively for ruminant feeding without toxic results, it must be fed together with an adequate amount of readily fermentable carbohydrates such as maize, grain sorghum etc mixed with some type of molasses in order to keep pH of the rumen below 6.**
  Non-ruminants do not benefit from urea feeding.

Tables 1 and 2 give Kenya values nutritional content of some important feeds (Jack Ouda, KARI NARL 2009)

Table 1 Roughages fed to dairy cattle and their quality

Forage/Fodder	Dry matter (g/kg)	ME Energy (MJ/kg DM)	Crude Protein (g/kg DM)	Calcium (g/kg DM)	Phosphorus (g/kg DM)
Napier grass	180	8.5	88	5.0	3.0
Rhodes grass	280	8.5	90	- -	- -
Napier silage	280	9.0	75	- -	- -
Maize cobs	900	7.5	30	1.2	0.4
Fodder sorghum dry	890	8.9	75	4.0	2.1
Maize silage	320	10.5	80	4.0	2.7
Kikuyu grass	200	9.5	120	- -	- -
Rhodes hay	850	9.2	80	- -	- -
Lucerne hay	865	8.5	170	14.0	2.4
Sesbania leaves	260	8.5	260	22.1	2.8
Calliandra leaves	260	8.5	240	11.1	1.4
Leucaena leaves	280	8.4	230	15.5	2.1
Sweet potato vines	100	8.0	160	17.9	2.4
Green maize stalks	300	9	80	5.0	2.5
Maize stover	850	7.5	45	3.5	1.9

Table 3 Concentrates and minerals supplemented to dairy cattle and their quality

Concentrate/Mineral	Dry matter (g/kg)	ME Energy (MJ/kg DM)	Crude protein (g/kg DM)	Calcium (g/kg DM)	Phosphorus (g/kg DM)

High yielder dairy meal	920	12.0	180	- -	- -
Dairy meal	950	12.0	165	6.0	4.0
Calf pellets	920	12.0	180	- -	- -
Cotton seed cake	920	13.5	350	1.9	2.0
Maize germ	900	15.5	106	1.0	0.5
Maize bran	900	11.5	115	1.0	2.0
Wheat pollard	900	15.1	160	1.3	9.0
Fish meal (Omena)	880	15.0	470	60.0	32.0
Fish meal (Buta)	900	13.4	400	60.0	20.0
Poultry litter	880	10.6	160	- -	- -
Urea	950	0.0	2600	- -	- -
Brewers Yeast	930	12.6	340	1.0	14.0
Brewers grains	210	10.5	254	3.3	5.5
Magic protein	900	11.9	480	- -	- -
Wheat bran	890	11.2	140	1.4	13.8
Maize meal	860	13.8	102	- -	- -
Cassava tuber meal	840	15.7	30	3.0	3.5
Lupins	860	14.2	342	- -	- -
Pymarc					
Sunflower seed cake	940	12.5	360	3.0	9.0
Soya bean meal	900	12.4	470	- -	- -
Molasses	750	12.2	35	9.0	1.0

Maclick super	**980**	**-**	**-**	**185.1**	**110.0**
Limestone	**100**	**-**	**-**	**340.0**	**0.2**
Dicalcium phosphate	**970**	**-**	**-**	**220**	**193**

Energy Feeds

Energy is the fuel that keeps all body functions working. Milk production requires a lot of energy. If energy in the ration is not enough, the animal will lose body condition and for milking cows, milk yield will drop, pregnant cows become ill after calving and the calf will usually be small in size. If there is excess energy in the ration, the animals becomes too fat. Cows that are too fat at calving usually have difficult births, often have problems with retained placenta, displaced abomasums and may suffer from milk fever and ketosis.

Sources of energy are roughages and concentrate supplements fed to your animals Minerals are required in small amounts than the other nutrients but are important components of the ration. They are essential for cows to remain healthy and for the body to function properly, for the development and maintenance of strong bones and for successful reproduction and production of milk and eggs. Roughages form the main bulk of the dairy cow ration. Roughages are bulky feeds that have a low weight per unit volume. Generally feedstuffs with more than 18% crude fibre and low digestibility are considered as roughages.

A high yielding cow may not have enough capacity to consume the amount of roughage required to supply sufficient energy required due to limitation of stomach size.For this reason, supplementing roughage diets with feeds high in readily available energy is often recommended. Examples of energy sources (Forages and fodders, agricultural by-products, and concentrates) are shown in Tables 2 and 3.

The currently recognized energy feed nutrients include:

- **Carbohydrates such as Glucose, Fructose, Galactose, Sucrose, Maltose and Lactose, all different types of sugar**
- **Polysaccarides such as**

- **Starch, found in roots and tubers as well as in grain,**
- **Hemicellulose (somewhere between sugar and cellulose chemically speaking),**
- **Cellulose, the principal constituent of cell walls of plants. Most abundant in more fibrous feeds, generally low in digestibility. Cattle, goats, sheep and horses digest cellulose fairly easily. Pigs and chicken do not digest cellulose very easily.**
- **Lignin which essentially is not digestible to animals. Found in overmature hays, straws and hulls. High lignin content in feed may reduce the digestibility of cellulose and other nutrients.**

- **Fats and oils. Found in seeds, grains, avocadoes etc. Fats contain 2.25 times as much energy per kg compared to carbohydrates, but are usually expensive to produce.**

Minerals

Minerals are chemical elements which form important component of animal feed ingredients. They are essential in ensuring normal and proper functions of the body as well as in maintenance of good health. When an element classified as essential lacks in the diet, the cattle will show deficiency symptoms, which are eradicated or prevented by inclusion of this particular element in the diet. Some elements are required in relatively large amounts compared to others. For this reasons the minerals have been classified as *'macro-minerals'* (required in larger amounts) and *'micro-minerals'* or *'trace-minerals'* (required in minute amounts).

Of the 20 elements that function in animal nutrition, carbon, hydrogen, oxygen and nitrogen are regarded as the non-mineral elements. The other 16 are referred to as the mineral elements which function in animal nutrition. Of these 7 are macro-minerals (required in fairly large amounts) and 9 are micro-minerals (required in very small or trace amounts). Micro-minerals are also sometimes called trace-minerals.
Different livestock types have different mineral requirements, which as far as possible will be described under each livestock type.

The macro-minerals are: Calcium, Phosphorus, Potassium, Sodium, Sulphur, Chlorine, Magnesium.

The micro- or trace minerals are: Iron, Iodine, Copper, Cobalt, Fluorine, Manganese, Zinc, Molybdenum,

Selenium.

Macro-minerals

Dairy cows require more of the macro-minerals (Calcium, Phosphorus, Magnesium, Sodium, Potassium, Chlorine, Sulphur) than the micro-minerals (Iodine, Iron, Cobalt, Copper, Manganese, Molybdenum, Zinc, Selenium).If cows do not consume enough of the macro-minerals, this will cause reduced milk yield, infertility problems, weakness of the bone and increased incidences of non-infectious diseases such as milk fever (Due to insufficient Calcium). Deficiencies in micro-minerals (Trace elements) can cause a variety of diseases and conditions depending on which mineral is deficient. Cattle grazing in areas around Nakuru usually have Cobalt deficiency and may develop a wasting disease called Nakuritis. They become anemic and eventually die. The forages are deficient of mineral Cobalt because the soils naturally contain very low levels of this micro-nutrient. Special mineral supplements are available for cattle in such areas. Too much of the micro-minerals can cause poisoning.

Calcium and Phosphorus are of particular importance when formulating rations. Legumes tend to have more Calcium and Phosphorus than grasses. Grains are low in Calcium. Young dark green forage tends to have more minerals than old, dry and yellow forages. Most tropical forages are low in Phosphorus. Extra Calcium and Phosphorus usually need to be provided in the ration over and above that naturally present in the feed and mineral mix, especially for high yielding animals. Tables 2 and 3 shows examples of sources of mineral salts (Forages and fodders, agricultural by-products, concentrates and minerals).

- **Salt: (Sodium chloride) deficiency develops slow (weeks) but causes unthrifty appearance and low performance. Provision of ad lib salt licks are recommended.Plants tend to be low in both sodium and chlorine. It is therefore an important practice to give common salt to herbivores such as dairy cattle in order to prevent deficiency symptoms. Feeding diets deficient in salt may not show immediate symptoms, but chronic deficiency dairy cattle diets has been shown to lead to low appetite, low milk production and loss of weight. The addition of salt in the diet usually provide immediate cure.**
- **Calcium:**

Calcium is the most abundant mineral in the animal body. It is the most important constituent of the skeleton (bones) and teeth. Calcium also plays important roles in the activities of enzymes and hormones, which catalyze and/or balance the body metabolic processes. Agricultural lime, fish meal, milk, crushed shells, marble dust, some seaweed and green leafy forages, especially legumes, are good sources of calcium. Calcium tend to be low in old, dry and yellowing forages.

In dairy cows, a condition known as 'milk fever (*parturient paresis*) commonly occurs shortly after calving. It is characterized by a lowering of the blood calcium level (hypocalcaemia), muscular spasms, and in extreme cases paralysis and unconsciousness.

Deficiency symptoms: a) rickets in young stock. Joints become enlarged. Bones become soft and deformed. Condition may be corrected in early stages with calcium feeding. b) Osteomalacia or osteoporosis in older animals. Bones become porous and weak. Condition may be corrected by feeding calcium if bones do not break.Examples are known of cows fed too little calcium breaking their backs during mating

- **Phosphorus: is needed for bone and teeth formation, building body tissue (growth of animals), milk and egg production. Signs of phosphorous deficiency include animals eating soil, chewing on non feed objects, slow or poor appetite, slow gain of bodyweight, low milk or egg production.Low dietary intakes of phosphorus have also been associated with poor fertility, apparent dysfunction of the ovaries causing inhibition, depression or irregular oestrus.**

Sources of Phosphorous: Bone meal, Rock phosphate, Superphosphates such as TSP etc. Also many improved salt licks contain phosphorus.Cereal grains are a good source of Phosphorous, but hays and straws have very low phosphorous content.

- **Magnesium: is needed in proper functioning of the nervous system, carbohydrate metabolism and enzyme systems.**

Deficiencies: a) Hypermagnesemia also called grass tetany, grass staggers and wheat poisoning can occur when animals are grazing on young fresh grass or wheat heavily fertilized with nitrogen and with very little content of magnesium.

Symptoms are hyper excitability and frequent death. More common in Europe than in Africa. Prevention: use animal salts containing magnesium especially when animals are grazing on new young grass or grains such

as oats.

- **Sulfur: Sulfur requirements of cattle and sheep are around 0.1-0.2% of ration dry matter. For non-ruminants sulphur should be in the form of sulfur-containing proteins. A deficiency of sulfur will express itself as a protein deficiency, general unthriftiness and poor performance.**

Micro-minerals

- **Iron: Necessary for blood and some enzyme formation. The precise minimum requirements have not been determined for various classes of livestock, but 80mg of iron per kg of diet is more than adequate for most animals. Deficiencies are most often found in young pigs (other animals much less sensitive): Laboured breathing, Flappy wrinkled skin, edema of head and shoulders, pale eyelids, ears and nose. Prevention/cure: A few drops of ferrous sulphate or similar daily during the first 3-4 weeks. Salt licks containing iron.**
- **Iodine: Needed for the production of Thyroxine in the thyroid gland. A level of 0.25 mg/kg air dried diet is considered adequate for most classes of livestock. Dairy cows should be provided with 0.5 mg iodine/kg dry matter feed.**

Deficiency symptoms: Goiter at birth or soon after, Hairlessness at birth, infected navels, dead or weak at birth. Prevention: mix normal iodized salt (table salt) into the salt licks of the livestock.

- **Cobalt: Needed in vitamin synthesis. For cattle and sheep, feed containing from 0.05-0.10 mg of cobalt/kg feed prevents any cobalt deficiency. For pigs cobalt is only needed as part of Vit B12. Several areas in Kenya have cobalt deficient soils, producing feed deficient in cobalt.particularly around Nakuru and Naivasha due to the absence of this element in the soils, leading to the absence in the pastures. A feed analysis will show whether feed in your area is cobalt deficient. Consult your livestock officer.**

Deficiency symptoms are simply those of malnutrition: poor appetite, unthriftiness, weakness, anemia, decreased fertility, slow growth and decreased milk and wool production. There are number of disorders due to cobalt deficiency characterized by emaciation (wasting disease or *Nakuritis*), pining, anaemia and listlessness. Although excess cobalt can be toxic to animals, there is a wide margin of safety level. Thus cobalt toxicity is generally unlikely. Prevention and cure: Where cobalt deficiency is diagnosed, 12.5g of any cobalt salt, such as cobalt chloride, cobalt sulphate or cobalt carbonate can be mixed with 100 kg of normal cattle salt.

- **Copper: needed for blood and hair production as well as in the enzyme system. Where diets are not high in Molybdenum and/or sulphate the following levels of copper per kilo of diet dry matter have been found adequate:**
  - **Dairy cattle: 10 mg/kg**
  - **Beef cattle and sheep: 4-5 mg/kg**
  - **Pigs: 6 mg/kg**
  - **Horses: 5-8 mg/kg**

  High levels of Molybdenum and/or sulphate may increase the copper requirements 2-3 times. Many areas in Kenya have copper deficiency in the soils and produce feed deficient in copper. Deficiency symptoms are not specific and may include any of the following: Bleaching of hair in cattle, abnormal wool growth in sheep, muscular incoordination, weakness at birth, anemia.Prevention and cure: Supplementation of livestock with copper in copper deficient areas is essential. This can be done by using trace mineralized salt containing from 0.25-0.50% copper sulphate. Pigs may be fed up to maximum 250g copper/kg dry feed. More than 100 mg copper per kilo dry matter may be toxic to cattle and over 50mg/kg will be toxic for sheep. It is also possible to repair your grazing areas for especially ruminants by upgrading the soil content of copper according to soil analysis recommendations. Generally grass and fodder deficient in copper have yellow or burnt leaf tips and low rates of production.
- **Fluorine: necessary for healthy teeth, but excess may weaken and stain the teeth. In Kenya fluorine deficiencies are not common, but drinking water especially from boreholes often contain very high levels of fluorine. If the levels of fluorine are too high water can be filtered through a filter containing burnt bones, which will absorb most of the fluorine. This is more practical for human water consumption than for livestock.**

  In Kenya the best advice for water treatment for excessive fluorine can be obtained from the Catholic Diocese in Nakuru.
- **Manganese: influences estrus, ovulation, fetal development, udder development, milk production, growth and skeletal development. Requirements:**
  - **Dairy cattle: 40 mg/kg of dry matter feed**
  - **Beef cattle and sheep: 5-20 mg per kg dry matter feed**

- **Pigs: 10-20 mg/kg dry matter feed.**

Deficiency symptoms noted from areas deficient in soil manganese include: delayed estrus, reduced ovulation, abortions, resorptions, deformed young, "knuckle over" in calves, poor growth. Supplementation is easily done with trace mineralized salts containing 0.25% manganese.

- **Molybdenum: Important in poultry as it stimulates uric acid formation, and in ruminants stimulates action of rumen organisms. Molybdenum deficiencies have only been observed in poultry in special cases. Molybdenum supplementation is normally not recommended in livestock production.**
- **Selenium: works in vitamin E absorption and utilization.**

Requirements: about 0.1 mg or less per kg dry feed. Deficiency symptoms include: Nutritional muscular dystrophy in lambs and calves, retained placenta in cows, heart failure, paralysis, poor growth, low fertility, liver necrosis, pancreatic fibrosis in chicks. Many areas in Kenya are known to have selenium deficieny of the soils. If selenium deficiency is expected, a soil or feed sample can be sent to any of the major laboratories for analysis. Supplementation must be done very carefully as selenium in too large quantities is poisonous. 1 gram Selenium in the form of sodium selenite can be added to 10 kg dry feed in deficient areas (=10g or 2 teaspoons per 100kg feed- really not much).

- **Zinc: promotes growth and thriftiness. Promotes wound healing, related to hair and wool growth.**

Deficiencies mostly found in pigs fed on concrete floors. Deficiency symptoms include: general unthriftiness, poor growth, unhealthy looking hair, skin and wool, slow wound healing. Pigs can be supplemented with 50 mg of zinc per kg of dry feed or as trace mineralized salt.

A well balanced mineral salt mixture adjusted to local conditions is the easiest way to ensure good mineral balance in animal feeds.

Tables 3and 4 give mineral content of the most important feeds in Kenya (Jack Ouda, KARI NARL 2009)

Table 3:
Quality of some commonly available roughages in Kenya

Feed Name	DM %	NEM MJ/kg	CP %	CF %	ADF %	NDF %	Ash %	Ca %	Mg %	Na %	P %	S %	Cobolt ppm	Copper ppm
Pyrethrum marc	90	5.78	13	26	37	59	7							
Napier Grass, medium maturity	20.3	1.97	8	36.1	30.3	56.1	12.4	0.36	0.14	0.05	0.32	0	0.01	1.8
Rhodes Grass, medium maturity	30	2.97	6.8	40	30.3	54.1	10	0.36			0.32			
Kikuyu Grass, medium maturity	25	4,43	12.1	35.2	30	68.2	10.5							
Star grass	19.1		12.2	33.3			9.6							
Maize Stover	80	4,44	4.3	3.8	44	72.9	6.5				0.19	0.14		
Barley Straw	90	4.51	4.3	42		59	1.9	0.3			0.07			
Wheat Straw	90	3.14	3.6	27	50	80	7.8	0.18			0.05			
Lucerne, Fresh	16	6.45	22.9	18	28	39	11.5	1.82	0.33		0.33			
Lucern Hay	85	4.27	16	32	37.4	52.8	8.1	1.4			0.24			
Desmodium	22.3		18.3	30	43.2	71.4	11	1.27						
Leucaena			21.6		36.9	49.8	10.5	2.3			0.16			
Calliandra	21.9		22.4		48	53	12				0.15			
Sesbania	23.6		19.9		23.7	32.1	14.6							
Sweet Pot. Vines	10.3	7.62	17.5	15	28.4	49.7	9.3							
Sorghum Silage	28	5.53	6	28.5	38	38	9.3	0.29	0.27	0.03	0.26	0.14	0.29	27
Columbus/Sudan Silage	45	4.77	10.8	33.1	42	68	9.8	0.46			0.21			
Lucerne Fresh (M)	20	5.53	18	24	32	43	8.6	1.41	0.33	0.14	0.22	0.28	0.16	11
Banana Pseudostem	6	7.16	6.8	20.5	40.5	58.7	11.5	1.16						
Rice Straw	88	3.98	6	34			21.4							

Table 4:

Quality of some commonly available concentrates and agro-industrial by-products in Kenya

Feed name	DM%	NEM MJ/kg	CP%	RUP%	RDP%	CF%	ADF%	NDF%	Ash%	Ca%	Na%	P%	S%	Cobolt ppm	Copper ppm	Selenium ppm
Maize Bran	91	6.82	12			12	17	51	3	0	0	0.2	0.08			
Maize Germ Cake	91	7.12	14			15.2	17	51	7	0.08	0.1	0.5	0.4	0.08	30	1.1
Maize grain	89	8.12	10	5.2	4.8	2.6	3	9	1.6	0.03	0.03	0.29	0.12	0.05	4	14
Maize Germ meal	91	7.49	16			10	17	51	7	0.04	0	0.15				
Sorghum grain, ground	89	8.79	10.5	55		2	6	17	4	0.05		0.3	0.14			
Millet grain	90	8.37			4.3			3.4			0.29					
Brewers grains	21	6.36	25.4	12.4	12.9	14.9	23	42	4.8	0.33	0.23	0.55	0.32	0.1	23	0.76
Barley grain	89	7.99	13.4	3.61	9.78	8	11	23	3.6	0.05	0.02	0.37	0.18	0.1	9.1	0.22
Wheat Pollard	88.6	7.53	16.5			5	13	44	2.8	0.23	0.24	0.9	0.34	0.23	21	2
Wheat bran	1.81	6.15			12.5		18.9		7.7	0.13	0	1.4				
Rice Bran	91	7.12	13			14	18	33	12.8	0.1	0.04	1.7	0.2		15	0.44
Dairy Meal	90.2	7.79	15.6			12.2	12.3	25.2	7	0.6		0.45				
Cotton Seed Cake	91.8	7.95	32	22.2	22.2	23.2	20	20	6.6	0.19	0.05	1	0.4	0.17	20	
Sunflower cake	92.6	8.37	28.2	6.7	22.9	25.2	16.4	16.4	8.4	0.3	0.24	1	0.3		4	
Soya beans whole	88	9.59	40	28		9	11	15	5	0.27		0.64	0.34			
Soya Cake	93.5	8.79	42	6.3	35.7		6.6			0.29	0.03	0.68	0.37	0.2	24	66
Fish meal - [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	16	2				0.14		3.2		0.14	9	2
Fish meal - [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Molasses	67.7	8.79	3.4						8.9							

Vitamins

Vitamins in ruminant feeding

While all the different vitamins are essential for all livestock, under most conditions only vitamin A needs to be given attention in ruminant feeding. Carotene and/or Vit A can be stored in the liver and body tissues during periods of high intake and used during periods of low intake. Vitamin A is found in green plants, carrots and other feed stuff.

Vitamin B is usually synthesized in the rumen of ruminants.For other animals it is beneficial to include small amounts of feed from animal origin to supply vitamin B12, as this vitamin is only found in animal products. Vitamin C will most of the time be enough in the green roughages eaten by ruminants , but non-ruminants will need access to green vegetation or vegetables to cover their vitamin C needs. Vitamin D gets produced when animals are exposed to direct sunlight, for which reason it is always advisable to give livestock a chance to spend time in the sun.

Vitamin A deficiencies in ruminants may include:

- **Reduced feed intake**
- **Slow weight gains**
- **Night blindness**
- **Swollen hocks, knees, and brisket**
- **Total blindness**
- **Diarrhea**
- **Muscular incoordination**
- **Staggering gait**
- **Reduced sexual activity**
- **Low fertility in bulls**
- **Poor conception rates**
- **Abortion in cows**

For this reason it is advisable to supplement ruminant feed with Vitamin A (or carrots if available) during periods where little green fodder is available.

Vitamins in pig nutrition

Pigs need a lot more vitamin supplements than ruminants. As for ruminants Vitamin D can be produced by the pigs themselves if they are given a chance to spend time in direct sunlight. This does not always happen in today's pig production. So recommendations for vitamins to pigs look as follows:

- **Vitamin A: Add 2-3 % good quality Lucerne meal or similar (such as dried crushed comfrey or amaranth leaves) to the normal pig rations. Another alternative can again be carrots if cheap enough and available.**
- **Vitamin D: Try to expose the pigs to sunlight. If this is not possible addition of Vitamin D supplementation is needed.**
- **Riboflavin: This is found in Lucerne meal, green plants, fish meal or milk products. If none of these are used in the pig feed, supplementation with riboflavin is recommended.**
- **Niacin: As most feeds are short of this vitamin, supplementation is recommended. Some good sources of**

Niacin include: rice and wheat bran, sunflower meal, brewers yeast and fish meal.

- **Pantothenic Acid: Supplementation recommended with for example rice or wheat bran, rice polishings, sunflower meal, Lucerne meal, fish- or peanut meal, brewers yeast.**
- **Vitamin B12: This vitamin is only found in animal products such as fish meal, blood meal, or for open range pigs and poultry: insects, grubs, etc. If your pigs are mostly fed on soya meal for their protein, a small addition of fishmeal will be beneficial.**
- **Choline: Is usually sufficient in pig rations.**
- **Vitamin E: Effective vitamin E utilization is dependant on adequate selenium, and selenium is sometimes deficient in feed from some areas. If selenium content of feed is a problem also the production of vitamin E will be a problem. Ask advice on Vitamin E from your livestock nutritionist.**

The values in table 5 for vitamin content of feed stuffs, should only be used as guidelines, as vitamin content depends on weather conditions where the crops are grown. However it can be seen which crops are able to produce the various essential vitamins

Table 5: Vitamin content of some feeds - American values (From Cullison 1987) as Kenya values are not available. It is assumed that similar products in Africa do not differ substancially in Vitamin composition, so the values indicated can be used when choosing which ingredients to balance your feeds from.
Alfalfa = Lucerne, Copra meal = coconut meal, Corn = Maize

Essential amino acids in some important feeds

Feed Name and Description	Carotene mg/kg	Vitamin D_2 IU/kg	Vitamin E mg/kg	Vitamin K mg/kg	Biotin mg/kg	Choline mg/kg	Folic Acid (Folacin) mg/kg	Niacin mg/kg	Pantothenic Acid mg/kg	Riboflavin mg/kg	Thiamine mg/kg	Vitamin B_6 mg/kg	Vitamin B_{12} µg/kg	Xanthophylls mg/kg
Alfalfa hay, sun-cured, ground	135.0	—	66.0	8.6	0.33	1,283.0	4.1	42.0	29.1	13.8	4.2	4.4	—	123.0
Alfalfa leaves, sun-cured	88.0	373.0	—	—	0.31	1,189.0	6.5	53.0	32.4	23.1	5.2	—	—	—
Alfalfa meal, dehy, 17% prot	131.0	—	121.0	9.0	0.36	1,494.0	4.8	40.0	32.4	14.1	3.7	7.7	—	287.0
Bakery product, dried	5.0	—	45.0	—	0.07	1,005.0	0.2	28.0	9.0	1.5	3.2	4.7	—	2.0
Barley grain	2.0	—	25.0	0.2	0.17	1,177.0	0.6	94.0	9.1	1.8	5.0	7.3	—	—
Barley meal	0.0	—	13.0	—	—	1,063.0	—	53.0	5.8	2.9	—	—	—	—
Beet pulp, dried	0.0	637.0	—	—	—	902.0	—	18.0	1.5	0.8	0.4	—	—	—
Blackstrap molasses	—	—	7.0	—	0.92	1,012.0	0.1	49.0	50.3	3.8	1.2	5.7	—	—
Brewers grains, dried	0.0	—	29.0	—	0.68	1,757.0	7.7	47.0	8.9	1.6	0.7	0.8	—	—
Citrus molasses	—	—	—	—	—	—	—	40.0	18.8	9.2	—	—	—	—
Citrus pulp, dried	0.0	—	—	—	—	867.0	—	24.0	15.4	2.5	1.6	—	—	—
Copra meal, solv extd	—	—	—	—	—	1,189.0	0.3	28.0	6.9	3.7	0.7	4.8	—	—
Corn distillers grains, dried	3.0	—	—	—	0.52	1,262.0	0.9	40.0	12.5	5.6	1.8	4.7	—	2.0
Corn distillers grains with solubles, dried	3.0	600.0	43.0	—	0.85	2,803.0	1.0	79.0	15.3	10.0	3.1	5.4	—	10.0
Corn distillers solubles, dried	1.0	—	49.0	—	1.79	5,151.0	1.4	134.0	25.2	22.7	7.3	9.5	3.0	2.0

Feed Name and Description	Carotene mg/kg	Vitamin D_2 IU/kg	Vitamin E mg/kg	Vitamin K mg/kg	Biotin mg/kg	Choline mg/kg	Folic Acid (Folacin) mg/kg	Niacin mg/kg	Panto-thenic Acid mg/kg	Ribo-flavin mg/kg	Thiamine mg/kg	Vitamin B_6 mg/kg	Vitamin B_{12} µg/kg	Xantho-phylls mg/kg
Corn germ meal	2.0	—	94.0	—	0.24	1,785.0	0.2	33.0	4.6	4.2	4.9	6.8	—	—
Corn gluten feed	7.0	—	14.0	—	0.36	1,684.0	0.3	79.0	15.1	2.5	2.2	11.0		

Essential amino acids in some important feeds

Feed Name and Description	Carotene mg/kg	Vitamin D_2 IU/kg	Vitamin E mg/kg	Vitamin K mg/kg	Biotin mg/kg	Choline mg/kg	Folic Acid (Folacin) mg/kg	Niacin mg/kg	Panto-thenic Acid mg/kg	Ribo-flavin mg/kg	Thiamine mg/kg	Vitamin B_6 mg/kg	Vitamin B_{12} µg/kg	Xantho-phylls mg/kg
Milk, cow's dried	—	353.0	—	—	0.40	—	—	9.0	23.8	20.6	3.9	4.9	—	—
Milk, skimmed, dried	—	446.0	10.0	—	0.35	1,480.0	0.7	12.0	38.6	20.5	3.9	4.5	54.0	—
Oats, grain	—	—	15.0	—	0.31	1,116.0	0.4	16.0	8.8	1.7	7.1	2.8	—	—
Oat groats	—	—	16.0	—	—	1,264.0	0.6	11.0	15.4	1.3	7.2	1.2	—	—
Peanut meal, solv extd	—	—	—	—	0.36	2,120.0	0.7	188.0	50.7	9.8	6.2	6.9	—	—
Poultry by-product meal	—	—	2.0	—	0.09	6,451.0	0.5	50.0	11.8	11.2	0.2	4.7	322.0	—
Rapeseed meal, solv extd	—	—	—	—	—	7,278.0	—	161.0	8.8	6.4	1.7	8.0	—	—
Rice bran, with germ	—	—	66.0	—	0.47	1,357.0	2.4	330.0	25.2	2.8	24.7	—	—	—
Rye grain	0.0	—	17.0	—	0.06	479.0	0.7	21.0	9.1	1.9	4.2	2.9	—	—
Safflower seed meal, without hulls, solv extd	—	—	1.0	—	1.82	3,543.0	1.7	24.0	42.7	2.6	4.9	12.4	—	—
Sesame seed meal, mech extd	0.0	—	—	—	—	1,655.0	—	20.0	6.4	3.6	3.0	13.4	—	—
Soybean seed, heat processed	—	—	—	—	0.32	—	3.9	24.0	17.4	2.9	—	—	—	—
Soybean meal, solv extd, 44%	0.0	—	3.0	—	0.36	2,915.0	0.7	31.0	18.2	3.2	6.2	6.7	—	0.0
Soybean meal, dehulled, solv extd, 49%	—	—	3.0	—	0.36	3,054.0	0.8	24.0	16.4	3.2	3.4	5.5	—	0.0

Essential amino acids in some important feeds

Feed Name and Description	Carotene mg/kg	Vitamin D_2 IU/kg	Vitamin E mg/kg	Vitamin K mg/kg	Biotin mg/kg	Choline mg/kg	Folic Acid (Folacin) mg/kg	Niacin mg/kg	Panto-thenic Acid mg/kg	Ribo-flavin mg/kg	Thiamine mg/kg	Vitamin B_6 mg/kg	Vitamin B_{12} µg/kg	Xantho-phylls mg/kg
Sunflower seed meal, without hulls, solv extd	—	—	12.0	—	—	4,430.0	—	288.0	43.9	4.2	3.4	14.8	—	—
Tankage, rendered	—	—	—	—	—	2,391.0	1.7	40.0	2.8	2.4	0.4	—	147.0	—
Triticale grain	—	—	—	—	—	514.0	—	—	—	0.5	—	—	—	—
Wheat bran	3.0	—	21.0	—	0.32	1,797.0	1.6	268.0	33.5	4.6	7.9	9.6	—	—
Wheat shorts, flour by-product, less than 7% fiber	—	—	61.0	—	—	2,050.0	1.9	121.0	25.3	4.7	21.7	8.2	—	—
Wheat germs, ground	—	—	160.0	—	0.24	3,468.0	2.4	81.0	22.8	6.8	25.8	12.9	—	—
Wheat grain	0.0	—	17.0	—	0.11	1,085.0	0.5	64.0	11.4	1.6	4.8	5.6	1.0	—
Whey, dried	—	—	0.0	—	0.38	1,921.0	0.9	11.0	49.6	29.4	4.3	3.6	20.0	—
Yeast, brewers, dried	—	—	2.0	—	1.08	4,227.0	10.3	482.0	118.4	38.1	99.2	39.8	1.0	—

Essential amino acids in some important feeds

Fiber requirements and Water

Fiber Requirements

Domestic livestock require varying amounts of dietary fibre. Usually the fast growing animals such as broilers

and piglets are fed a low fibre diet in order to be able to eat enough calories and protein for fast growth. This is however expensive, and it can be argued, results in lower quality meat production. Such low fiber diets also makes the animals susceptible to diseases, which has resulted in many feeds being added antibiotics as a preventative. Addition of antibiotics in animal feed has again led to traces of antibiotics in their meat, and the development of antibiotic resistant human disease bacteria, as humans are the ultimate consumers.

For animals to lead a healthy life, they must consume enough dietary fibre to keep the stomach/ rumen healthy and functioning. Higher fibre diets are healthier, as also humans are starting to realize. However there are limits; too high content of fibre (lignin, dry cellulose) will fill the stomach without bringing enough nutrients along. Various livestock species have different adaptabilities to high fibre diets.

Water

Water is a necessary compound of plants and animals. Growing plants contain 70-80% water and animals contain 70-90% water. Water has several important functions in the animal body such as regulation of body temperature, carrier of nutrients, regulation of tissue structure etc.Water is needed to make saliva for swallowing feed and for chewing the cud, for feed to be digested, to cool the body when it is too hot and to remove waste materials from the body in the urine and faeces. In addition a milking cow needs water for milk production. Lack of water will kill an animal faster then lack of any other nutrient. Lack of sufficient amounts of water or poor quality water will seriously reduce animal performance.

Cattle:

It takes 5 litres of water to produce 1 litre of milk. Ideally, water should be available to dairy cattle at all times. If this in not possible, a rule of thumb is to supply 1litre of water for every 10 kg of live-weight of the cow plus 1.5 litres of water per 1 litre of milk produced.

The amount of water dairy cattle will drink is influenced by the quantity of dry matter ingested, composition of the diet, characteristics of the water, environmental temperatures and physiological state of the animal. Table 6 shows water requirements for dairy cows at different ambient temperatures based on dry matter intake

requirements for production of 20 kg milk per day (NRC, 1988)

Table 6:

Water requirements for dairy cattle

Temperature °C →	5	10	15	20	25	30	35
Dry matter intake (Kg)→	4.4	4.6	4.8	5.0	5.2	5.4	5.6
Live-weight (kg)							
350	59.4	62.1	64.8	67.5	70.2	72.9	75.6
400	63.8	66.7	69.6	72.5	75.4	78.3	81.2
450	68.2	71.3	74.4	77.5	80.6	83.7	86.8
500	70.4	73.6	76.8	80.0	83.2	86.4	89.6
550	74.8	78.2	81.6	85.0	88.4	91.8	95.2
600	77.0	80.5	84.0	87.5	91.0	94.5	98.0

Feed additives

A feed additive is defined as a feed ingredient of non-nutritive nature that stimulates growth or other type of performance or improves the efficiency of feed utilization or that may be beneficial in some manner to the health or metabolism of the animal. Examples of feed additives for dairy cattle are anti-helmintics (Dewormers), anti-bloat agents, rumen buffers (NaHCO3, MgO), flavouring agents (Molasses), rumen microbes for fibre digestion (Yea sac) and growth promoters or hormone-like substances. In Kenya, feed additives are not commonly added to dairy cattle rations

Feed quality

At farm level, dairy cattle are exposed to many feeds, with diets varying in different regions and farming systems. The productivity of a dairy system is highly dependent on the quality of feeds. This is because the feed quality determines the intake and availability of ingested nutrients for utilization by the dairy cattle. Consequently, farmers are not only faced with the problem of knowing the quality of the feeds but also the factors that influence the quality. The objective of this chapter is to provide highlights of information about quality indicators of cattle feeds and backgrounds of some measurements of feed quality often encountered in

dairy industry. The highlights include physical indicators and some scientific feed evaluation methods that can be employed to determine feed quality.

Physical indicators of feed quality

The physical nature of the feeds can pose serious limitations to efficient utilization of a feed or a ration comprised of several feed resources. However, the influence of physical attributes of feeds on quality is often ignored. Some of the physical aspects that can limit the quality and utilization of feeds in dairy production are briefly discussed:

Stage of growth

Vetch (Vicia villosis) harvesting at the right stage of growth

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The nutritive quality of forages varies as they grow towards maturity. Consideration of the stage at which both biomass yield and nutrient content are optimal is therefore important. After attainment of maturity, the forages generally depreciate in nutritive value. This is mostly due to increase fibrous material, particularly lignin. For many forages, the leaves die off systemically after attainment of maturity, and this reduces photosynthetic activities. As a result, there will be reduced accumulation of nutrients. These factors are important to be considered e.g. when harvesting forage for conservation as hay. For instance, when making hay from grass (e.g. Rhodes grass) and legumes (e.g. Lucerne) it is generally advisable that cutting be done at the onset of flowering upto the time of 50% flowering. For a vegetatively propagated forage such napier grass, cutting height is the most important physical consideration for quality. Studies have shown that optimum harvesting height for Napier grass range between 50-60 cm (dry season) and 130-140 (rainy season).

Texture

Grass exhibiting difference in quality due to the impact of texture

Grass exhibiting difference in quality due to the impact of texture

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The physical/textural changes which occur as forages grow can impact on palatability, intake and animal digestive physiology. For instance, high intake of succulent young forages (e.g. Lucerne, vetch and Comelina spp) may cause bloat. At young stage the dry matter (DM) content of some forages can be very low (e.g. sweet-potato vines and napier grass), and this can limit the adequate intake of dry matter to support the desired level of production. The palatability can be compromised as the forages age because of increase in toughness. This can further complicate issues if some species and classes of livestock e.g. young ones are unable to consume old and tough forages or parts of.

Ratio of stem and foliage

It is important to have knowledge of the nutritive attributes of the various morphological components of the individual forages. The leaf is in most cases the most nutritive component, hence the need to consider the utilization of a forage when the biomass yield and leaf:stem ratio are optimal.

Processing

Where the cattle are stall fed, the particle size may play an important role in selection, intake and digestibility. For instance, the chop length of ensiled maize stovers have been shown to influence the selection where leafy parts are consumed more and the overall intake is reduced with increase in chop length. Also, where different

feed resources are to be mixed, the particle size must be considered to enable homogeneity in mixing.

Some ingredients necessary in the diets may not be in appropriate physical/textural form for cattle intake. Generally, cattle do not prefer powdery or finely processed feeds. Also, feed resources like molasses (semi-liquid) need to be mixed appropriately with a carrier feed. Some feed additives or supplements are better provided in pellet or lick block forms e.g. calf pellets and mineral licks.

Appearance and Colour

Generally, feeds have typical appearance, which the farmers are or should be familiar with. The appearance can be an important attraction to both farmers and animals. Deviation from the typical appearance should be taken seriously as this may have implication on quality. The colour of specific feed resources can be good indicators quality. Thus feed users need to know the typical colour of feeds so that when there is deviation from the norm, precaution can be observed. For most forages, green colour is a good indicator of quality. For instance, greenness may depict good growing conditions, hence abundance of nutrients. It may also indicate absence of diseases, pests and parasites. Appropriate colour can be used by farmers to judge the stage of harvesting.

Freshness

Freshness of the feeds can be indicated by e.g. colour, smell and/or presence of mould. Generally, the cattle intake will be negatively affected as the feed deteriorates in freshness. Consumption of stale feed can harm the cattle due to toxicity.

Mould infested maize stovers as a result of poor conservation practice.

Presence of visible undesirable objects is also a good pointer to poor quality. The foreign bodies may include pieces of glass, polythene, nails and metals and wood particles or rodent faeces. Visual inspection of feeds should not be neglegted, because this can lead to harmful or at worse fatal consequences for the animals being fed.

Mould infested maize stovers as a result of poor conservation practice.
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Dairy meal contaminated with foreign objects.

Dairy meal contaminated with foreign objects.

© JO Ouda, Kenya

Acceptability

Cattle, like most animals have natural instinct of preference. It is therefore possible that a good feed may be rejected because it unfamiliar. On other hand, rejection of certain feeds can be a good indicator of hidden

factors which should be identified and eliminated to improve the intake. In this regard, it may be dangerous and unethical to provide such a feed in mixtures where the cattle are forced to consume it. It is therefore necessary to ascertain the factors causing rejection and the benefits of such a feed before its use.

Negative symptoms after feeding

Cattle may consume feeds normally, but there can be negative symptoms shown as result of the consumption of certain feeds. These may include diaorrhea, abnormal water intake, bloat, poor appetite, non-typical or unpleasant smells in products (e.g. milk) and excreta and of discomfort. Appropriate action must be to ascertain the quality aspects of the feed concerned when such negative effects are noted.

Formulation of balanced dairy cattle rations

Dairy cattle production in Kenya is a serious business. However, in most cases dairy farmers are not able to meet family needs because of low profit margins. Inadequate nutrition is a major cause of low live-weight gains, infertility and low milk yields in dairy cattle. About 50-70 % of cost of dairy production is made up of cost of feeds.

Poorly nourished dairy cow and dairy cattle showing good nutrition status.

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Good dairy cattle feeding practices can be implemented with due regard to different nutrient requirements for the various classes of dairy stock in order to avoid either overfeeding or underfeeding of the dairy cattle and hence wastage of scarce feed resources. Balanced dairy cattle rations can be formulated using various methods (Pearson square, simultaneous equations, least cost formulation using computer models). Although use of the methods give more accurate and reliable dairy cattle rations, the methods are a bit complicated and for some farmers may need the assistance of the local livestock Production Officer.

Dairy cattle feed requirements

General nutritional requirement for livestock is listed under chapter Principles of Animal Nutrition.

Tab. 6 Estimation of live-weight of dairy cattle using chest girth measurements

Calves		Heifers		Cows	
Girth size (cm)	Live-weight (kg)	Girth size (cm)	Live-weight (kg)	Girth size (cm)	Live-weight (kg)
45	15	108	112	172	420
47	17	110	118	174	435
49	19	112	124	176	451
51	21	114	130	178	467
53	23	116	137	180	483
55	25	118	143	182	500
57	27	120	150	184	516
59	29	122	158	186	534
61	31	124	166	188	552
63	33	126	174	190	570
65	35	128	182	192	590
67	37	130	190	194	610
69	39	132	198	196	631
71	41	134	206	198	653
73	43	136	214	200	675
75	45	138	222	202	697
77	47	140	230	204	720
79	49	142	240	206	
81	51	144	248	208	
83	55	146	256	210	
85	59	148	264	212	
87	63	150	272	214	
89	67	152	280	216	
91	71	154	290	218	
93	75	156	301	220	
95	79	158	313	222	
97	83	160	325	224	
99	87	162	353	226	
101	92	164	366	228	
103	98	166	378	230	
104	103	168	392	232	
106	106	170	406	234	

Dairy cattle feed requirements depend very much on their size and stage of production. Whereas most farmers do not have access to weighing scales that can weigh animals, a system has been developed whereby the weight can be determined by chest measurements using a simple measuring tape available everywhere.

Live-weight of dairy cattle

Animal nutrition and feed rations

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The amount of feed which will provide adequate nutrients to animals will depend on their body size (live-weight). Table 6 gives data which can be used by farmers to estimate live-weight of their cattle from girth measurements

Maximum dry matter intake

Animal feedstuff can be divided into two major components namely dry matter and water. The dry matter component consists of organic and inorganic matter. The organic matter consists of carbohydrates (source of energy), lipids and fats (source of energy), protein and vitamins. The inorganic matter is the source of macro- and micro-minerals. Since all nutrients are contained in the dry matter the animal must consume this portion in adequate amounts to obtain the required nutrients.

If a feed is high in moisture, the animal may not be able to consume enough of the feed to obtain the required nutrients due to limitation of rumen space. Table 9 shows the maximum dry matter intake by dairy cattle of various live-weights.

Dairy cattle under stall feeding; feed intake must adequately supply desired nutrients.

Table 7 Estimated maximum daily dry matter intake by dairy cows (kg)

	Cow live-weight (kg)					
Milk yield (4% Butter-fat)	350	400	450	500	550	600
10	10.5	11.0	11.5	12.0	12.5	13.0
15	12.0	13.0	13.5	14.0	14.5	15.5
20	13.5	14.5	15.5	16.0	17.0	17.5
25	15.0	16.0	17.0	17.5	18.5	19.5
30	16.5	17.5	19.0	19.5	20.5	21.0
35	19.0	20.0	20.5	21.0	22.0	22.5
40	21.0	22.0	22.5	23.0	24.0	24.5

Maximum dry matter intake may also be estimated from the following equations:
Maximum daily Dry matter intake (kg/cow) = 0.025 (Live-weight in kg) + 0.1 (Kg of daily milk yield) or 3.0 ? - 3.5 % of live-weight of cow (MAFF, 1975).

Nutrient requirements for maintenance

The nutrient requirements for maintenance of animals are influenced by their live-weight, activity (e.g. walking long distance) and environmental temperature (too cold or too hot). Table 6 shows nutrient requirements for maintenance of dairy cattle of various live-weights (NRC, 1988).

Table 8 Daily nutrient requirements for maintenance of a dairy cow

Cow live-weight (kg)	ME Energy (MJ)	Crude protein (g)	Calcium (g)	Phosphorus (g)
350	45.5	294	14	10
400	50.3	318	16	11
450	54.9	341	18	13
500	59.4	364	20	14
550	63.8	386	22	16
600	68.1	406	24	17

Nutrient requirements for growth

The amount of nutrients required by an animal is equal to the nutrients in the tissue gained. Nutrients concentrations in deposited tissue are influenced by the animal rate of weight gain and the stage of growth or live-weight. The nutrients required for growth by dairy cattle of various live-weights are given in Table 11 (NRC,1988).

Table 9

Daily nutrient requirements for growth of dairy cattle

Live-weight (Kg)	Daily gain (g)	ME Energy (MJ)	Crude protein (g)	Calcium (g)	Phosphorus (g)
Calves					
25	200	8.4	84	6	4
30	300	11.3	112	7	4
50	500	27.2	315	10	6
75	600	33.4	387	14	8
Heifers					
100	400	26.5	386	15	8
100	500	29.0	422	16	8
100	600	31.5	458	17	9
150	400	35.1	529	17	10
150	500	38.2	575	18	11
150	600	41.3	622	19	11
200	400	43.5	598	19	13
200	500	47.1	648	20	13
200	600	50.8	718	20	14
250	400	51.7	629	21	15
250	500	56.0	682	21	16
250	600	60.4	753	22	16
300	400	60.2	761	22	16
300	500	65.2	824	23	17
300	600	70.3	888	23	17
350	400	69.1	909	23	17
350	500	74.8	985	23	18
350	600	80.7	1062	24	18
400	400	78.5	1078	24	18
400	500	85.2	1169	24	19
400	600	92.0	1263	25	19
450	400	89.0	1276	27	19
450	500	96.7	1387	28	19
450	600	104.6	1500	28	19
Lactating cows					

Nutrient requirements for milk production

When feeding a dairy cow the aim should be to maximize milk yield by meeting cow?s feed requirements. Requirements for milk production will depend on the amount of milk produced by the cow, energy content of milk which is indicated by fat content (the higher the fat content the higher the energy required).

Table 10 Nutrient requirements for production of 1 kg of milk of various butter fat contents

Milk BF (%)	ME Energy (MJ)	Crude protein (g)	Calcium (g)	Phosphorus (g)
3.0	4.5	78	2.7	1.7
3.5	4.8	84	3.0	1.8
4.0	5.2	90	3.2	2.0
4.5	5.5	96	3.5	2.1
5.0	5.9	101	3.7	2.3
5.5	6.2	107	3.9	2.4

In addition to nutrient requirements for milk production nutrients will also be required to cater for other functions such as reproduction (pregnant cows require more to cater for growth of calf) and growth rate if she is not mature (in case of first calf cows).

Ration formulation guidelines

Dairy farming is a serious business and therefore farmers need to make profit in order to meet family needs. Feed rations fed to dairy cattle either originate from the farm or are purchased. In order to minimize feed wastage and to overcome the problem of low levels of production, dairy rations need to be efficiently utilized by the animal. A cow fed on balanced ration will utilize the feed more efficiently and hence it production will be better than a cow fed on imbalanced rations. Feed rations that are offered to dairy cows are considered balanced if they provide adequate nutrients (Carbohydrates, protein and minerals) to meet the animal requirements for maintenance, reproduction, growth and milk production.

Proportions of basal diet and supplement in a dairy cow ration

The cheapest feed for milk production is good quality roughage. However, quality of roughage fed to dairy cattle is usually low resulting in sub-optimal levels of production. Further increase in production can therefore be achieved by the use of supplements. Among the factors influencing the quantities of roughage and

supplements offered are their quality and level of production of dairy cattle. Table 13 shows simple guidelines on proportions of basal diet and supplements depending on levels of milk production in dairy cattle.

Table 11: Proportion of basal diet and supplements in dairy cattle rations

Milk yield (kg/day)	Basal diet DM (%)	Supplement DM (%)
10-14	70	30
15-19	60	40
20-24	50	50
25-29	40	60
30-34	30	70
35-40	20	80

Total mixed rations (TMR's)

Dairy cattle feeding as practiced by most farmers (roughage feeding followed by concentrate feeding at milking), may not meet all the nutrient requirements of the animal. Fluctuations in rumen fermentation and supply of nutrients to the mammary glands occur when basal diet and concentrates are offered to dairy cattle at different times. This has a negative effect on productivity of the animal because requirements are met mostly for one nutrient and not the other nutrient and thus the ration is not balanced. To overcome this problem, a total mixed ration can be formulated (Tables 11 and 12).

Limitations of Total Mixed Rations

- **Lack of technical skills and knowledge by farmer and extension officers**
- **Narrow feed resource base at farm level**
- **Cost of feed ingredients, processing and mixing equipment may be high for small scale farmers**

Advantages of TMR's

- **Nutritional balanced diet is supplied to the animal 24 hours a day for maximum productivity**
- **Convenience of feeding a single meal per day**
- **Minimise selection and hence wastage of feed by the animal**

Table 12 Simple total mixed ration for a dairy cow (DM basis)

Feedstuff	%
Rhodes hay	66
Dairy meal	33
Maclick super	1
Total	100

Table 13 Total mixed ration made from several feed ingredients (DM basis)

Feedstuff	%
Napier grass	65
Lucerne hay	4
Maize germ	18
Wheat pollard	4
Soya meal	2
Cotton seed cake	6
Maclick super	1
Total	100

Proportions of energy, protein and minerals in concentrates

Concentrates are needed to promote better utilization of low quality roughage and increase dairy production. Since availability and cost of commercial concentrates are limiting factors to small holder dairy production, formulation of inexpensive home-made concentrates is a necessity. Various combinations of feed ingredients can be compounded depending upon the costs of ingredients and costs per unit protein and energy (Table 14).

Table 14 Proportion of energy, protein and minerals in concentrates for dairy cattle

Nutrient	%
Energy feed ingredient	68
Protein feed ingredient	30
Mineral feed ingredient	2
Total	100

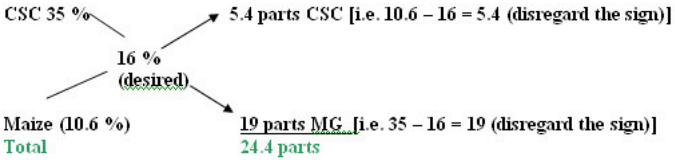
Table 15 Example of how to mix a high yielder home-made concentrate

Nutrient	%
Maize germ	66
Cotton seed cake	20
Poultry litter	8
Fish meal	4
Maclick super	2
Total	100

a) Formulation of rations using a single Pearson square

Assume you want to make a dairy meal with 16% crude protein (CP) using cotton seed cake (CSC) and maize

germ (MG). The CSC provides 35 % CP while MG provides 10.6 % CP. Arrange the information as shown in the square below. In the middle of the square is desired value of the nutrient. On the left are the two ingredients with their nutrient content. Subtract diagonally (lesser from the larger) or disregard the sign.



Mix 5.4 parts of CSC with 19 parts of MG. Expressed as % (100 kg feed) this gives: 5.4/24.4*100 = 22.1 % of CSC 19/25*100 = 77.9 % of MG

Check to confirm the CP value. CSC 22.1*35/100 = 7.74 MG 77.9*10.6/100 = 8.26 Total 16

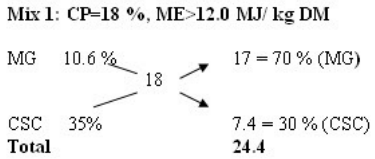
One ingredient must be higher in the nutrient (e.g 35 % CP for CSC) than the desired value (e.g. 16 % CP for dairy meal). The other ingredient must be lower in the nutrient (e.g. 10.6 % CP for MG) than the desired value for dairy meal. No ration can be mixed with a higher value than the highest of the ingredients or vice versa. This method balances only one nutrient from two feedstuffs at a time

b) Formulation of rations using several Pearson square

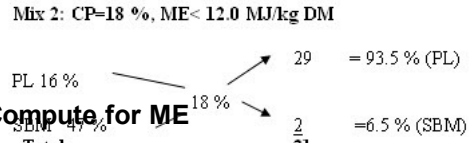
In many instances, more than two feedstuffs and for more than one nutrient need to be balanced. A double Pearson square method may be used with four feedstuffs and two nutrients. This is accomplished using three Pearson squares.

Example: Make a ration for a lactating cow of 18 % CP and ME of 12.0 MJ/ kg DM of ME using MG (10.6 % CP and 15.5 MJ/ kg DM), Poultry litter(PL) (16 % CP and 10.6 MJ/ kg DM), Cotton seed cake (35 % CP and 13.5 MJ/ kg DM) and Soyabean meal (47 % CP and 12.4 MJ/ kg DM).

Normally, two sets of a high energy and a high protein concentrates are chosen. The first two Pearson squares are used to balance for the first nutrient in both sets. The densities of the second nutrient in either mixture are calculated. Then the two mixtures are balanced in the third set for the second nutrient.



Note: for ME to be >12.0 MJ/kg DM, MG must be used. For CP = 18 %, either CSC or soybean (SBM) can be used. Compute for ME in mix 1. MG (70*15.5/100) + CSC (30*13.5/100) =14.9 MJ/ kg DM



Compute for ME

PL (93.5*10.6/100) + SBM (6.5 *12.4/100) = 10.7 MJ/ kg DM

Mix 3: CP=18 %, ME=12.0 MJ/ kg DM Mix 1 = 14.9 1.3 = 31.0 % (Mix 1) 12.0 Mix 2 = 10.7 2.9 = 69.0 (Mix 2) Total 4.2

Calculate ingredient composition

To avoid mixing three times, calculate the ingredient composition of the final mix.

Table 16 Final mix of raw materials when two nutrients are balanced

Ingredient	Mix 1	Mix 2	Amount of Mix 1 in Mix 3	Amount of Mix 2 in Mix 3	Final composition of ration
Maize germ	70	0	31.0	0	70*31.0/100 =21.7
Poultry litter	0	93.5	0	69.0	93.5*69.0/100=64.5
Cotton seed cake	30	0	31.0	0	30*31.0/100 =9.3
Soy bean meal	0	6.5	0	69.0	6.5*69.0/100 =4.5

Table 17 Check for ME and CP

Ingredient	% In Ration	CP %	ME, MJ/kg DM	CP contribution	ME contribution
Maize germ	21.7	10.6	15.5	2.3	3.4
Poultry litter	64.5	16.0	10.6	10.3	6.8

Cotton seed cake.	9.3	35.0	13.5	3.3	1.3
Soybean meal	4.5	47.0	12.4	2.1	0.6
Total				18.0	12.1

c) Formulation of rations using an alternative procedure

If the following information is provided: A cow weighing 450 kg and producing 20 kg/day of milk (4 % butter fat) is fed on a basal diet of Napier grass supplemented with dairy meal and Maclick super. How much of the Napier, dairy meal and minerals will meet the cows requirements.

STEP 1

From table 7 estimate maximum dry matter intake for a 450 kg cow producing 20 kg of milk (4 % butter fat) = 15.5 kg

STEP 2

From table 11 estimate proportions of Napier and dairy meal for a cow producing 20 kg/ day of milk Napier grass = 15.5*50/100 = 7.75 kg Dairy meal = 15.5*50/100 = 7.75 kg

STEP 3

From tables 3 and 4 estimate nutrients supplied by the feedstuffs and from tables 5 and 6 estimate nutrient requirements by a 450 kg cow producing 20 kg/ day of milk (4 % butter fat)

Table 18 Nutrients supplied by feeds and requirements to produce 20 kg/day of milk

	DMI	ME	CP	Ca	P
	(Kg/day)	(MJ/kg)	(g/day)	(g/day)	(g/day)
Feedstuffs	15.6	155.8	1938	102.1	64.2

~~Requirements~~	~~15.6~~	~~158.9~~	~~2141~~	~~82.0~~	~~53.0~~
Difference	0.0	-3.1	-203	+20.1	+11.2

STEP 4

Estimate amount of feed to be fed to the cow per day Napier = 7.75*1000/180 = 43.1 kg fresh Napier With 5 % wastage allowance = 43.1 + (43.1*5/100) = 45 kg of fresh Napier Dairy meal = 7.75 = 8.0 kg Maclick = 100 g

d) Formulation of rations using computer software

Feeding standards are considered as minimum; hence the final mix should have at least the stated amounts. The Pearson square and the alternative method cannot give a least cost formulation.
Where more than two feed ingredients are available and more than two nutrients must be balanced and costs must be considered then linear programming (LP) must be used. The technique allows for simultaneous consideration of economical and nutritional parameters. The formulator must have a good understanding of the specifications and the techniques of formulation so as to enable interpretation of results.
Most of the performance drill of linear programming is a black box but it is good to know the basic concept to enable verification, interpretation and reformulation of formulas when necessary. A host of LP programs are available. In LP the fewer the constraints the more accurate are the results. But because of nutritional considerations these are necessary. However, with each additional constraint, cost of feeds increases.

Advantages of least cost formulation

- **Avail cheap supply of nutrients**
- **Avoid unnecessary costs when one ingredient's price increases**
- **Determines critical price ranges before reworking the problems**

Dairy cattle under stall feeding; feed intake must adequately supply desired nutrients.

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Record keeping

Record keeping
Status: under construction

Introduction

What Is Record?

Record is information that has been systematically and carefully collected and appropriately stored for intended use. To be able to run any economic enterprise successfully, carefully thought out, properly collected and kept records are a must. For the purpose of keeping track and decision making in any economic enterprise, comprehensive and well kept records must be kept.

The records will:

- **Be used in determining profitability of various techniques of production or systems**
- **Be used to compare the efficiency of use of inputs, such as land, labour and capital, with that of alternative production activities**
- **Help the investor in improving the efficiency of farm's operations**
- **Be used to preserve institutional memory of the enterprise for future reference**

Records should be used for decision making on a farm/ranch and should be interpreted in the right way, otherwise there will be a waste of time, money and energy. Too often, records are only kept for the purpose of official reporting, e.g. to the Ministry headquarters for the parasitical and not used as a tool on the farm/ranch for making the decision in time. A good memory can be very useful but it is never entirely reliable. Good facts tend to be remembered and the others forgotten.

Adequate and correct record keeping is also a valuable tool for assessing the performance of your herd or flock and making good management decisions.

- **The records should be simple, easy and quick to interpret.**
- **In all records, there should be a 'Remarks' column/entry explaining the reasons behind any unusual observation. This is very essential in interpreting the implications of the records, particularly for a third party who may have not been directly involved in taking the records, but needs to make informed/accurate decisions.**

Record keeping for Cattle production

Excellent records are the cornerstone of building a financially successful beef/Dairy enterprise and they will be of great help in the development of the Beef/dairy husbandry and beef/dairy industry of any country.
In summary, the importance of good record keeping include:

- **Aids in efficient management of the herd**
- **Improves bargaining power on products**
- **Evaluation of livestock for selection**
- **Adding value to livestock**
- **Control of inbreeding and aid in breeding planning**
- **Aid in culling low performers**
- **To assess profitability/losses**
- **Aid in gross margin analysis**
- **Credit/loan access**
- **To rationalize labour**
- **Aids in disease management**
- **Aids in feed planning and management**

Types of Records

The major types of records are:

- **Physical (identification)**
- **Breeding**
- **Production (Performance)**
- **Feeding**
- **Health**
- **Financial records**

Identification Records

The needs are for an identification method that is cheap, not damaging to the animal and reliable at a distance of at least 2-3 metres and by preference permanent.
Identification of animals is usually through use of numbering, by marking of the animal and by description of certain characteristics of the animal. Methods of identification can be subdivided into 2 categories: permanent and non-permanent.

Permanent Identification
1. Tattooing (ear or under)
2. Description (diagrams, sketches and photographs)
3. Ear-notching/Punching
4. Brands (Hot iron, freeze and chemicals)

Non-Permanent identification
1. Tags (Ear-tags, Flank-tags, tail-tags and Brisket-tags)
2. Collars or neck straps (chains)

3. **Paint and dyes**
4. **Hair Braiding**
5. **Naming**

Breeding Records

The importance of breeding is to measure the productive efficiency of the herd and to enable culling and selection exercise to be carried out for breeding and genetic improvement. A good farmer would like a cow which gives a calf yearly. Therefore, an accurate breeding record of each individual cow which is up-to-date is needed and also a breeding record for the total herd. An indicator for that is e. g the number of inseminations needed to get a cow in calf. In addition to this, the data for the breeding record provides information about when certain cows have to be dried off and when certain cows are due to calve while others need to be insemination for proper herd management. The important data in breeding records include:

- **Pedigree/parentage (Dam name, grand dam, sire name, grand sire)**
- **Growth (Date of birth, birth weight, date of weaning, weaning weight, sale weight, sale date)**
- **Fertility (Age at first service, age at first calving, date of calving, number of services per conception)**

Production (Performance) Records

These records are useful in measuring the performance of the herd/flock and for the economic appraisal of the enterprise. Production and breeding records will give the farmer direct profit but also indirect profit by using progeny tested bulls from Artificial Insemination (AI) stations. Progeny testing is only possible if production and breeding figures of daughters are available. At the moment many farmers in Africa are importing semen of purebred and progeny tested bulls from Western Europe, North America, New Zealand, and Australia to improve the genetic ability of their cattle. This would have been impossible if those countries did not have a highly developed recording system. Breeding recording system would be a great help in selecting the bulls for the National AI services and would make imports of often very expensive semen superfluous.

Records however, are worth the most when they are used the most. For dairy industry, the important records

are:

- **Daily milk yield**
- **Milk content (Butter fat content, protein, Solid Non Fat)**
- **Lactation length**
- **Milk fed to calves**
- **Milk consumed at home**
- **Milk sold**
- **Milk spoilt**

Feeding Records

These should indicate the amount of feeding given as well as the type of feed. Feeding records should be used the most for day-to-day management, evaluating pasture management practices and for planning of activities in the future. The day to day management decisions which are to be made are for instance, which cows need concentrates and how much, cows to be culled and why etc. Thus the important records are:

- **Available fodder on farm**
- **Quantity fed**
- **Concentrate supplemented**
- **Minerals**
- **Left-over (per head and per feed, if possible)**
- **Spoilage (per batch)**

Health records

Health records are needed to do the required vaccinations at the right time and to prevent disasters like foot and moth epidemic. They also provide information about the health status of each individual animal and the whole heard. Only with the breeding and health records can a good and wise decision be made.

- **Vaccination**
- **Dipping/spraying**
- **Treatment**
- **De-worming**
- **Postmortem**

Financial Records

The records of the expenditure and revenue should be kept for cash analysis and enterprise appraisal. Economic records are of paramount interest in providing the farmer with information concerning the profitability of his farm. Moreover they are of great help in decision making at the right time.
For example, is it profitable to feed concentrates, is it advisable to apply for a loan or credit to invest in a machinery or technology, is it more economic to raise the calves with whole or skimmed milk? Answering these questions is only possible if adequate records are available. Moreover, for tax purposes and for the purpose of getting loans or credit, economic records are required.

Record keeping for Pig production

The prime objective of a pig farmer is to manage his farm in such a way that it is a continuing source of income. In order to achieve this he needs to implement a set of good management measures and technical skills through good record keeping and administration. This makes it possible to control and monitor production and reproduction activities and to identify the results both technical and financial.

Identification Systems

A means of animal identification is an essential part of any record-keeping system. The most common identification systems are ear notching, tattooing and ear tagging. Other identification systems include, naming, colour differences, ear shapes, however this is only applicable for small number of sows.
Being able to identify the pigs is essential if records are to be kept and for managing the pigs accordingly. As

long as you do not have large numbers of pigs there is no problem recognising them and no need to worry about marking them. However, when you have more pigs it is needful to introduce an identification system. All the animals should be marked when they are young.

Notching

Notching involves cutting small pieces of skin out of the edges of the ears. This is a very cheap method of marking using only a very sharp knife. The wounds made by the cutting should be disinfected with iodine. By having different patterns of the cuts, these can be used for the identification of pigs.

Notching step-by-step:

- **Catch the pig and secure it well.**
- **Clean the ears with methylated spirit.**
- **Clean the knife or pliers to be used for cutting with methylated spirit.**
- **Cut off the edge of the ear flap on the parts of the ear that correspond to the number you want to give the pig**
- **Apply some disinfectant like iodine, healing oil or wound spray to the cuts in the ear flap.**

The picture on the left shows the right ear of an adult pig with notches, which were made when the pig was very young.

Example of notching on the ears of a pig

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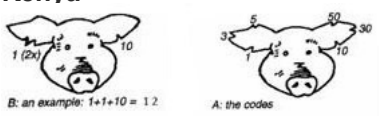

The disadvantages of the method are that it takes time 'to read' the patterns (or codes), and that problems can arise if the ears are damaged.

Example of ear notching codes

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What does record keeping involve?

Good record keeping means noting down all important details and events, in a simple and clear manner. It can also be used to provide and record information for future activities. To keep records, use a notebook or exercise book. Dedicate a few pages for each pig, and a few pages for what you buy and what you sell. Other information should also be marked on a calendar (sow calendar), so that any necessary preparation can start well in advance (for example preparing the farrowing pen for the sow).

Records will help when comparing the production or growth of different animals. Records will indeed make it easier for you to carry out day to day activities on and for the pigs. When pigs are sick, you may note down the symptoms, the treatment, and whether the pig recovered or not. This will improve your knowledge on how to treat your animals successfully. It will also help you to keep track of expenses and incomes from sales. This information will tell you whether you are running a profitable business or not.

Records

- **Litter records**

-Birth weight (1.5.kg is good)

-Weaning weight (18kg is good)

- **Dams record**

- Number of piglets weaned per year (18 is good)

- **Marketing**

- Age and weight

- **Conversion rate**

- Pigs that gain more weight from a given amount of food.

- A satisfactory conversion ratio should be 1 kg live weight gain for 3 to 5 kg of feed.

NB: Simple and necessary record should be kept for all piglets e.g. date of birth, dam and sire record, and weaning weight, feed type and feed consumption, decrease etc.

A good record keeping system will permit constant surveillance and monitoring of animal health and performance. It will assist the farmer in maintaining a steady flow of pigs through his enterprise and in identification of problem areas in the production programme.

Considerations to be made while designing a record keeping system

- **The records should be as simple as possible**
- **Records should be kept in a place where they are readily accessible**
- **Transferring of information from one record sheet to another should be minimized**
- **The information that should be included in the records varies with the type of operation being run. A swine operation that is engaged in an expensive breeding stock improvement programme will require more detailed records and more individual pig records than will a commercial operation**
- **Individual records are of value in culling non-productive breeding stock and in selecting replacement animals**

Individual records

- **Sow identification**
- **Reproduction Records**

Date of first Oestrus/heat, Breeding dates, Farrowing dates, Number of pigs born alive and number born dead, Average birth weight (comments on evenness of litter should be included) ,Abnormalities

- **Weaning Records**

Weaning date, weaning weight

- **Litter management records**

Dates of routine management practices e.g. Iron treatment, castration

- **Health Records**

A record sheet summarizing important aspects of herd production on weekly or monthly basis should be kept. The farmer can compare these records which are a good measure of production efficiency with previous figures as well as with production goals he has set for his production.

Herd records should include:

- **Reproduction Records**
  - **Females services (categorise as to the first and repeat breeders).**
  - **Litters farrowed**
  - **Pigs born alive and number born dead**
- **Feed Consumed**
  - **Either herd total or by ration i.e dry sow, starter finisher etc**
  - **Pigs marketed (sows, boars, market or breeding stock)**
  - **Pigs added (breeding stock from outside the herd)**
- **Market Information**
  - **Age at marketing of at least a sample number of pigs and their weight**
  - **Carcass indices of pigs marketed.**

The data above can used to compute the following parameters:

- **Average litter size born and weight**

- **Average litter size weaned and weight**
- **Percentage of pigs born dead**
- **Percentage death loss in any category**
- **Repeat breeding as a percentage of the total breeding**
- **Feed conversion ratio (fcr), - Average daily gain (adg)**
- **Average market index**

NB:

- **The above indicators tell how well the production programme is managed.**
- **The secret to the success of any record keeping system is not the particular design of the system but rather regular manner in which the records are kept.**

Record keeping for Fish Farming/ aquaculture

The main drawback on the economic operation of aquaculture investment in Kenya is lack of deliberately kept economic records of production operations. Investors who operate without records are likely to make wrong decisions. The best sources of information needed to advice on proper running of aquaculture investments are farm records.

Good records will, for example;

- **Be useful in projection of expected production**
- **Be useful in determining the amount of inputs requirements for specific ponds at various stages of production**
- **Be useful determine the expected harvesting time**
- **Determine the financial health of the enterprise**

Important record parameters in aquaculture include:

- **Total area under culture**
- **Individual pond identity**

Record parameters in aquaculture

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- **Individual pond treatments**
- **Stocking densities and time of stocking**
- **Species stocked**
- **Kinds, quantities and cost of inputs used**
- **Pond productions in amounts and values**
- **Other productions and values**
- **Daily occurrences**

Aquaculture records can be classified into:

- **Daily records kept for input usage like feeds, fertilisers, labour and daily occurrence**
- **Occasional record which are kept for events that do not happen on daily basis. Such records would include:**
  - **Specific pond production (Quantity and values) by species**
  - **Costs of acquisition of inputs**
  - **Cost incurred in new constructions or repairs**
  - **Salaries (both in cash and in kind)**

How much and how comprehensive kept records are, is dependent on:

- **Level of investment; Complex investments require complex records**
- **Motivation of investor; Serious investors will have more comprehensive records**
- **Level of aquaculture management: Intensive operations will have more complex records as compared to semi intensive operations**
- **Skills of the investor (or manager); Well trained managers will keep better records**

As the management levels rises, culture systems become more complex and so is the record keeping. This is

the reason the farmer must think very carefully of what he needs to record.

Examples of aquaculture records

- **Fish farming biological management records**
- **Financial management records**
  - **Purchase of inputs**
  - **Salary records**
  - **Inventory of equipment**
  - **Records on payment of rents and hire of equipment, machinery, services etc**
- **Occurrence book**

It is very important for individual farmers to clearly know what they need record and the intended use of this. This will assist them in preparing the most effective way of capturing the needed information.

Examples of aquaculture records would include (but not limited to) the following:

Pond management records

Pond identity	.	.	.	.	.	.
Date	**Type of input**	**Rage of usage**	**Total usage**	**Unit cost**	**Total cost**	**Remarks**
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.

Stocking records

Date	Pond identity	Size (m2)	Species	Source	Stocking rate	Average Weight	Total number /weight	Unit cost	Total cost
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
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Harvesting records

Pond No.	Date	.	.	Amount sold			Amount consumed on farm		Amount given away		Payment in kind		Total value produ
		Species harvested	Quantity harvested Kg	Quantity Kg	Unit Price Ksh/Kg	Total value Kshs	Quantity Kg	Value Kshs	Quantity Kg	Value Kshs	Quantity Kg	Value Kshs	
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Cash flow records

Cash inflow				**Cash outflow**			
Date	**Source**	**Amount**	**Comments**	**Date**	**Source**	**Amount**	**Comments**
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.

Other records could include

- **Salary records**
- **Inventory of equipment**
- **Records on payment of rents and hire of equipment, machinery, services etc**
- **Pond sampling records**

Record keeping for Chicken production

Management of poultry requires detailed records on a daily or weekly basis. It is important to spend some time each day observing your flock carefully. In this way early signs of disease, malnutrition, or other problems may be detected and the necessary action taken.

Table: Record keeping for small-scale chicken production

Month _____
No. Cocks _____
No. of hens_____

Date	Age(wks)	No. birds	Mortality	Feed	consumed Eggs	Sales	Remarks
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.

Materials and feed

Records should be kept on all poultry noting their approximate age or time of hatching. Most hens under good management will start laying at 22-32 weeks of age. Keep records such as age at first egg and production over time. If egg production is delayed or drops suddenly check for housing condition, access to feed, water etc. However, when egg production drops gradually, it may be a sign of old age. Sell the older hens in the flock and replace them with young hens. If your costs for feed exceed the income from selling cocks and/or eggs, you may also consider selling birds, or reducing the amount of feed given.

All expenditures for feed or feed ingredients should be recorded carefully, noting quantities, price and date of purchase. If purchasing commercial feeds note the name of the seller/manufacturer and the time of purchase to keep track of poor quality feeds. Keep records of disease control activities such as type, price and date of vaccines and medication purchases.

Supplementary feed consumed on a daily or weekly basis should be noted for each flock housed separately. Sudden changes in feed intake may be the first indicators of poor health. Income from sale of eggs, cockerels or chickens should also be recorded. Gifts and consumption of eggs and birds by house hold members and others should also be noted.

Record keeping for Camel production

Why keep records

- **By keeping records, a camel keeper can monitor the camel herd in terms of trends which are occurring. This is important for planning.**
- **Records provide information which can be used to make decisions on future management of the herd in terms of when to breed, which camels to keep and which ones to sell, when to market and the quantities of products and income which may be expected, among other information**
- **Records help the camel keeper in doing economic analysis in order to assess the profitability of the camel rearing enterprise.**

Some worth keeping records, suggested recording interval and importance of the records

Type of records	Recording Interval	Why keep these particular records	Useful tools for record keeping
Herd size	At the end of every calving season	To know whether the herd is growing or not	
Live weight estimation	Every two	• To know the growth	Cloth tape

	months	**performance of calves and decide on feeding regimes including milk allowance, know when the camel is likely to be ready for breeding etc** • **To estimate the sale value**	**measure (in metres)**
Milk yield of individual camels	**Every two weeks**	**For selection and breeding, deciding on which camels to keep and which to cull**	**Milk measuring jug (plastic)**
Reproductive performance of individual camels (bull and females) including: number of females served, number conceived, cases of heat repeat, cases of abortion, incidences of difficult birth, cases of deformities	**During breeding seasons**	**For selection and breeding, deciding on which camels to keep and which to cull**	**Record sheets Writing materials**
Mortality rates, main causes and the seasonality	**As they occur**	**Plan the health management in terms of drugs that may be required and when**	
Economic data including cost of labor (hired or family), drugs, mineral supplements, water fees, money value of camels which may die, equipments, materials, value of products consumed at home, income from milk sales, live camels, meat & hides	**Monthly**	**Assess profitability of the enterprise**	

Samples of data collection sheets

Milk production data

	Milk yield (cups of known volume/litres)												
Camel name/brand number	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13
1		X	X	X	X	X	X	X	X	X	X	X	X
2		X	X	X	X	X	X	X	X	X	X	X	X
3		X	X	X	X	X	X	X	X	X	X	X	X
4		X	X	X	X	X	X	X	X	X	X	X	X
5		X	X	X	X	X	X	X	X	X	X	X	X
6		X	X	X	X	X	X	X	X	X	X	X	X
7		X	X	X	X	X	X	X	X	X	X	X	X
8		X	X	X	X	X	X	X	X	X	X	X	X
9		X	X	X	X	X	X	X	X	X	X	X	X
10		X	X	X	X	X	X	X	X	X	X	X	X
11		X	X	X	X	X	X	X	X	X	X	X	X
12		X	X	X	X	X	X	X	X	X	X	X	X
13		X	X	X	X	X	X	X	X	X	X	X	X

Live weight data

	Live							

	weight (kg)							
Camel name/brand number	Period 1	Period 1	Period 1	Period 1	Period 2	Period 2	Period 2	Period 2
	Heart girth (m)	Abdominal girth (m)	Shoulder height (m)	Heart girth** Abdominal girth**Shoulder height***50 is a constant factor****	Heart girth* (m)	Abdominal girth** (m)	Shoulder height*** (m)	Heart girth*Abdominal girth**Shoulder height***50 is a constant factor****
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								

Reproductive performance data

	Reproductive parameters							
Months	**Number of dams ready for service**	**Number of dams served**	**Number of dams conceived**	**Number of females that do not conceive**	**Number of abortions**	**Number of calves born alive**	**Cases of difficult birth**	**Calves born with deformities**
January								
February								
March								
April								
May								
June								
July								
August								
September								
October								
November								
December								

Economic data

	Cost											

Cost items (KES)	Months 1	Months 2	Months 3	Months 4	Months 5	Months 6	Months 7	Months 8	Months 9	Months 10	Months 11	Month 12
Family labor												
Hired labor												
Drugs												
Mineral supplements												
Water fees												
Equipment & material												
Money value of dead camels												
Value of products consumed at home												
TOTAL												
	Income Items (KES)											
Income from milk sales												

Live camel & or meat sales												
Hides sales												
TOTAL												

Record keeping for disease management

Some important records for planned disease control include the following:

1. Calf management and disease control records sheet

Calf identification Number			.	**Sire Number**		.
Date of birth				**Dam Number**		
sex						
	Kg	**Date**		**Remarks**	**date**	
Birth weight				**1st insemination**		
Weaning weight				**2nd insemination**		
Age and breeding weight				**Date due to calf**		
Average pre weaning growth rate (grams)				**Bull used**		
Average post weaning growth rate (grams)						
Body condition score				**Vaccinations**		

2. Cow cards for planned fertility management

Cow No.				
Last calving	**Date of vet**	**Examination remarks e.g. pregnancy**	**Service**	**Expected calving**

date	examination	diagnosis	date	date
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3. Disease occurrence and treatment record sheet

Date	Animal no.	Kind of disease	treatment	Remarks
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4. Mastitis management and treatment record sheet

Farm				1st		2nd		3rd		4th		

code				treatment		Treatment		treatment		treatment		
Cow no.	Quarter	Sample	Remarks	date		date		date		date		Sample results
				am	pm	am	pm	am	pm	am	pm	
.	.	.	.	.	.	.	.	.	.			
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5. Vaccination records for planned disease control

Date	Vaccination done	Type of vaccine and quantity	Remarks
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6. Deworming records for planned disease control

Date	Deworming done	Type of drug and quantity	Remarks
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Information of www.infonet-biovision.org

Information of www.infonet-biovision.org

Poultry: Geese

Poultry: Geese
Status: under construction

Introduction

Geese are part of the duck family but are much bigger than ducks and, unlike ducks, they feed entirely on grass and other herbage and spend very little time in water. When they do swim, they do not dive.

The flesh of a goose is delicious but is a dark meat and contains a high % of fat, making it very rich. A goose can live in excess of 20 years, so if looked after and managed properly, it is an easy domestic animal to keep and can be a cheap and productive asset. They have a reputation for being very good askaris, and some farmers keep them penned with livestock at night as they make a lot of noise if they are disturbed and can be intimidating if they attack as a flock.

Origins

Geese were one of the first animals to be domesticated, probably in Egypt about 3000 years ago (Buckland and Guy, 2002). They are found in most parts of the world, and can adapt to both hot and cold climates- as long as adequate shelter, especially shade, is provided. However, commercial production of geese is currently important in only a few countries in Europe and Asia.
Geese belong to the family Anatidae, and were one of the first domesticated animals. The name "Goose" itself has its origins as one of the oldest words of the Indo-European languages - the proto-Indo-European root, ghans, from which the Sanskrit, Latin, Greek, Germanic, Norse, English, Irish and Russian names for the goose are derived.

A majority of wild geese of Europe, Asia and North America are migratory. There are two main types of domestic geese, derived from the wild Greylag goose (*Anser anser)* in Europe, and from the wild Swan goose (*Anser cygnoides*) in Asia. The FAO's Animal Genetic Resources database (AnGR) identifies 204 different breeds or varieties of geese. Many of these are thought to to have little economic importance because of their relatively low production or performance levels, or a limited geographic distribution.

Domestic geese come in a wide range of colours, sizes and shapes. In general, domestic breeds are much larger than their wild ancestors although they have in many cases retained their ability to fly. There are two main types of domestic geese. The first are thought to have their origins in Europe, descendants of the wild Greylag goose (*Anser anser*) and the second are thought to have their origins in Asia, descendants of the wild Swan goose (*Anser cygnoides*). Crosses between the domestic breeds which have originated from these two species of wild geese are fertile and in fact have resulted in a number of recognized breeds.

Breeds of geese

There are two main types of domestic geese, derived from the wild Greylag goose (Anser anser) in Europe, and from the wild Swan goose (Anser cygnoides) in Asia. The FAO's Animal Genetic Resources database (AnGR) identifies 204 different breeds or varieties of geese. Many of these are thought to to have little economic importance because of their relatively low production or performance levels, or a limited geographic distribution.

CZECHOSLOVAKIAN WHITE (*Anser anser)*

This goose is a white goose with orange shanks and an orange beak. It is also known as the Bohemian goose. It has a relatively small body size, with the males weighing 5.0 kg and the females 4.0 kg but its egg production, averaging 45 eggs with an egg weight of 140 g, is fairly good for Anser anser type geese. This means it can be useful as a female line in the production of a crossbred commercial goose.

EMBDEN (*Anser anser*)

The Embden is a white goose with relatively tight feathering, an erect stand, orange shanks and an orange beak. Most strains of Embden can be sexed on the down colour of the goslings, as males are a lighter grey than females. This difference is evident until the goslings are two to three weeks of age. The breed has been relatively popular for many years in both Europe and North America. It is one of the larger breeds with males weighing up to 10.0 kg and females up to 9.0 kg. It has a moderate egg production producing 40 eggs per year with an egg size of 170 g. The Embden is suitable for heavy type meat production but is probably of more value when used as a male line in the production of a crossbred commercial goose.

KUBAN (*Anser cygnoides*)

This breed was developed at the Kuban Agricultural Institute (southern Russia) by crossing Gorki and Chinese geese. The feather colour is brown which results in relatively dark pin-feathers and thus an unattractive carcass. These birds have orange shanks while their beaks and knobs are black to dark green. The adult body weight for the male is 5.2 kg and 4.8 kg for the female. The advantage of this breed is that they have a relatively high egg production of between 50-60 eggs with an average egg weight of 150 g. This makes the Kuban suitable for use as a female line in a crossbreeding programme provided it is used in such a way that the resulting commercial crossbreeds are essentially white and that the poor body conformation associated with the Kuban can be overcome.

LANDES (*Anser anser*)

Both the males and females of this breed are grey and their shanks and beaks are orange to yellow. This breed originated in France but has been widely used in a number of other countries, notably Hungary, for the production of fatty livers (Foie Gras). Today there are a number of lines of the Landes that have been selected for their ability to produce fatty livers. They originate from the grey Toulouse geese, but today their feather phenotype is similar to the wild Greylag goose although they are much larger in body size. The adult body weight of the male is 6.0 kg while that of the female is 5.0 kg. The annual egg production is 40 eggs per female per year with an egg weight of 170 g.

POMERANIAN (*Anser anser*)

Pomeranian geese originated from the north-western part of Poland but they are also present in northeastern Germany and the south of Sweden. They come in three colours: white, grey or white and grey. In all cases, they have orange shanks and beaks. The Pomeranian as been described as a solidly built goose with the adult body weight of the male being 6.0 kg and that of the female being 5.0 kg. The average egg production is 40 eggs per female with an average weight of 170 g.

WHITE ITALIAN (*Anser anser*)

The White Italian is a very popular breed in Europe and one often finds reference to it in the formation of local stocks. It is also a breed that has been well researched. The White Italians reported on in this publication are those kept at the Koluda Wielka Experimental Station in Poland where they have been under genetic selection since the 1960s and where separate male and female lines have been developed.
Goslings of both lines can be sexed during the first ten days of life on down colour, as males are lighter in colour than females. As the name indicates, the adult plumage is white while the shanks and beaks are orange. In the male line, the average body weight of males is 7.0 kg and of females is 6.5 kg, while in the female line the average is 6.5 kg for the males and 6.2 kg for the females. Annual egg production for the male line is 55-65 eggs while for the female line it is 60-70 eggs and egg weight for both is 160-180 g. The White Italian, at least for these strains, has the highest egg production of any of the Anser anser type breeds. Thus these lines can be used directly as male and female lines respectively to produce two-way commercial crosses or the female line can be used to produce a crossbred female parent line. The White Italian and, particularly, these lines are therefore one of the breeds of choice for anyone wanting to produce geese for meat production.

For more information on goose production see the publication by Buckland and Guy, which includes sections on reproduction, breeding, flock management, housing, meat produciton, killing and processing. This publication also includes papers on goose production in South America, Indonesia, and Poland and Eastern Europe. References and Further Reading Buckland, R. and Guy, G. (2002). Goose Production. FAO Animal Production and Health Paper 154. FAO, Rome. FAO's DAD-IS: Information system for the Global Strategy

Goose diseases

In this chapter the most common goose diseases are listed, described, and the appropriate treatments/prevention proposed. A well-managed production system which includes cleanliness, know-how, and disease prophylactic practices can greatly reduce the incidence of many diseases.

Recomendations for the control and prevention of disease

- **Examine the geese before buying them. Buy geese only from a reliable breeder**
- **Before the arrival of new geese, make sure that there is adequate good quality feed and water**
- **Keep feed troughs and drinkers clean**
- **Provide a stress-free environment for the geese (away from noise and other disturbing elements)**
- **Do not add birds from an outside source to your own flock; if you must have additional geese, it is better to establish a second flock**
- **Keep breeders away from growing geese**
- **The younger the geese, the more susceptible they are to diseases so never mix geese of different ages**
- **Give timely vaccines and medications. Always use the correct vaccine or medication at the recommended dose**
- **When inspecting the geese, always go from the youngest to the oldest**
- **Isolate any sick geese immediately. Removing sick geese from a flock reduces the number of infectious organisms available to pen mates**
- **Safely destroy dead geese immediately by either incinerating or burying them. Get an early diagnostic report by sending sample carcasses to a veterinary laboratory for a diagnosis of the cause of death**
- **When selling geese, do not allow a buyer to bring unclean crates and/or boxes onto the farm for transporting the geese**
- **Thoroughly clean and disinfect the building and equipment between flocks of geese. This may not render the building sterile but it can reduce the number of infectious organisms to such a low level that they cannot initiate a flock infection**
- **As much as possible, keep wild birds out of your pens**
- **Maintain complete records at all times**

In the following pages a list of goose diseases classified alphabetically is provided. An alternative classification could be according to infectious agent i.e. bacteria, fungi, protozoa or viruses.

ASPERGILLOSIS

Aspergillosis is a condition caused by a member of the fungal genus Aspergillus. In the goose, as in most other classes of poultry, the organs most affected are the lungs, hence the term Pulmonary Aspergillosis. The disease can be quite severe in young goslings as they may become infected during hatching and even embryos may become infected. The source of infection can be either dirty incubator equipment and/or dirty eggs. Dirty eggs can contaminate both the setter and hatcher. In addition, it is possible for Aspergillus to penetrate the egg which is how embryos can become infected. Young growing goslings are also susceptible to Aspergillosis but usually not as severely although they can be infected from contaminated litter.
Symptoms.
The symptoms are difficult and accelerated breathing (gasping) with rattling or gurgling noises. The birds might be very depressed and mortality can be high. Nervous symptoms may appear in a small percentage of the birds and can be accompanied by increased thirst and diarrhoea.
Prevention/Treatment.
The first step is to clean the hatching facilities, organize a good sanitation programme and ensure that all hatching eggs are cleaned and fumigated as soon as possible after laying. Mouldy feed and litter must be removed and destroyed and the building cleaned and disinfected with 1:2000 copper sulphate. The treatment of Aspergillosis is not always effective. Nystatin and Amphoteciricine-B have proven to be the most effective medications for geese. If these are not available, a recommended low cost treatment consists of 5 percent potassium iodine in the drinking water for three days, followed by two days of no treatment and then a second treatment for three days.

CHLAMYDIOSIS

Chlamydiosis is a general term which refers to infections caused by a bacterium of the genus Chlamydophila. In birds, the disease is caused by Chlamydophila psittaci and, although reported in geese, is very rare. It is however a disease of public health significance in that it is transmissible to other animals as well as to humans.

Symptoms.

The disease has been reported to affect a wide range of organs with symptoms including mild respiratory difficulties, conjunctivitis, inflammation of the sinuses, rhinitis, diarrhoea and atrophy of the breast muscle.

Prevention/Treatment.

The antibiotics of choice to treat this disease are the tetracyclines. In some cases salmonellosis may be a complicating factor and it may be necessary to use a combination of antibiotics.

COCCIDIOSIS

Geese can get two distinct types of coccidiosis. The most prevalent form is renal coccidiosis caused by *Eimeria truncata*. While intestinal coccidiosis is less prevalent, it is caused primarily by *Eimeria anseris*. At least five additional species of Eimeria have been isolated from the intestine of the goose. The level of infection and degree of economic loss associated with coccidiosis in the goose is generally low and it is not regarded as a major problem.

Symptoms.

Renal coccidiosis can affect geese from 3-12 weeks of age, although the younger birds are much more susceptible. In an exceptional acute form, renal coccidiosis can result in mortality as high as 80 percent. Other indicators of the disease include depression, weakness, diarrhoea, whiteish faeces, anorexia, dull, sunken eyes and drooped wings. Diagnosis of renal coccidiosis can be confirmed by locating the distinctive oocysts in the kidneys and in the cloaca near the urethras. Birds quickly develop immunity to re-infection by *Eimeria truncata*. Intestinal coccidiosis also mostly affects young birds but does not always result in mortality. Rather, the infection produces anorexia, a tottering gait, debility, diarrhoea and morbidity. The small intestine becomes enlarged and filled with reddish brown fluid. Lesions are primarily in the middle and lower portion of the small intestine.

Prevention/Treatment.

Various sulphonamide drugs and coccidiostats have been used in the treatment of renal and intestinal coccidiosis of geese. If the geese are to be fed rations which were formulated for other types of poultry, it should be noted that in spite of popular belief to the contrary, waterfowl can be fed rations containing most of the coccidiostats used for chickens.

CRYPTOSPORIDIOSIS

This is a protozoan disease caused by parasites of the genus Cryptosporidium which infects both the lungs and intestine of geese. It is found worldwide wherever commercial poultry are raised and, as poultry health specialists develop appropriate tools to identify it, it is expected that more cases will be reported. This probably explains why reports from the goose industry are that its incidence seems to be on the increase.

Symptoms.

One form of Cryptosporidiosis infects the respiratory tract and the symptoms include depression, sneezing and respiratory distress with moderate mortality. The other form infects the digestive tract and the symptoms include diarrhoea and, if the geese are young, can result in a relatively high mortality rate. Because a number of diseases can produce the same symptoms, fluids obtained from respiratory tract and the faeces should be examined for cysts.

Prevention/Treatment.

There are no effective drugs for the prevention or treatment of Cryptosporidium. There is evidence that once infected birds recover, they are immune, but to date no vaccine has been developed. Good sanitation is recommended as a preventative measure, together with steam cleaning of infected premises. The oocysts of Cryptosporidium are extremely hardy.

DERZY'S DISEASE

Derzy's disease is a viral disease also known as Parvovirus disease because of the causative agent. Other names include Goose Plague, Goose Hepatitis, Goose Enteritis, Goose Influenza, Infectious Myocarditis and

Ascetic Hepatonephritis. It is a highly contagious disease that affects young geese. The disease has been reported to exist in any part of the world where geese or Muscovy ducks are raised since they are also susceptible to it and can transmit the disease to geese. In its acute form, the disease can result in up to 100 percent mortality rate or it can occur in a more chronic form. If birds are infected during the first week of age, very high losses can occur but if the goslings are 4-5 weeks old or older the mortality rate will be negligible.
Symptoms.
For goslings under one week of age the clinical signs are morbidity (anorexia and prostration) and mortality, with deaths occurring in 2-5 days. Older birds, depending on their level of maternal immunity, will exhibit anorexia, polydipsia, weakness with a reluctance to move, nasal and ocular discharge, swollen and red uropygial glands and eyelids and a profuse white diarrhoea.
Prevention/Treatment.
There is no treatment for Derzy's infection. Adult breeding geese that have been naturally infected with the parvovirus become immune and transfer this passive immunity to their progeny. This passive immunity will persist in the newly hatched goslings for 2-3 weeks. It is the phenomena of passive immunity being transmitted to the offspring that has led to the development of a recommended vaccination programme. In its simplest form, all goslings should be vaccinated at about two weeks of age. This assumes that the goslings' parent flock had been vaccinated which would mean that the goslings? natural passive immunity would protect them until 2-3 weeks of age.
For birds not designated to be breeders, this single vaccination is sufficient. Birds designated to be breeders should be vaccinated again three weeks before the beginning of lay and three weeks before the beginning of each subsequent lay. In addition, some practitioners recommend a booster vaccination at peak egg production. If the parent flock had not been vaccinated which would mean that no passive immunity was passed on to the goslings, the recommendation would be to give serum to the goslings on day one and on day ten to give them passive immunity and to then vaccinate them on day 21.

DUCK VIRUS ENTERITIS

Duck Virus Enteritis (DVE) is an acute, contagious disease caused by a herpes virus that can infect ducks,

geese and swans although the incidence of the disease in geese is very low. DVE can be transmitted directly, by contact between infected and susceptible birds, or indirectly, by contact with a contaminated environment. Birds that have recovered from DVE are immune to re-infection by the DVE herpes virus. It should be noted that in Australia a herpes virus has been isolated from a flock of infected geese (with a mortality rate of 97 percent) which was anti-genically distinct from the duck viral enteritis herpes virus.

Symptoms.

The symptoms depend on the age and sex of the geese, the stage of infection and the virulence and intensity of the virus exposure. Lesions of DVE are associated with vascular damage (tissue haemorrhages and free blood in the body cavities), vascular eruptions at various locations on the mucosa surface of the gastrointestinal tract, as well as lesions of lymphoid and other tissues.

Prevention/Treatment.

There is no treatment for DVE but vaccines that are effective have been developed.

ERYSIPELAS

Erysipelas is generally an acute, sudden infection of individual geese within the flock. In both young and adult birds it is caused by the bacterium *Erysipelothrix rhusiopathiae*. Outbreaks of this disease which are economically significant are uncommon in avian species, with the exception of turkeys, but some cases have been reported for geese.

***Erysipelothrix rhusiopathiae* is somewhat unique in that it can infect over 50 animal species and can also infect humans. In the latter case, the infection usually enters through scratches or uncture wounds and is considered a safety issue for people working with infected animals. Human infections can be treated with antibiotics.**

Symptoms.

Infected geese will appear depressed, have diarrhoea and die suddenly. Lesions are suggestive of generalised septicaemia.

Treatment.

The antibiotics of choice are rapid-acting forms of penicillin that can be administrated together with an erysipelas bacterin. Since the presence of the disease in geese is sporadic, routine immunisation is not

generally recommended. However, in areas where the disease is prevalent, and particularly for breeder flocks, vaccination is recommended. Birds that have recovered from acute infections have a high degree of resistance to re-infection.

FLUKES

Flukes (trematodes) are flat, leaf-like parasitic organisms. Over 500 species belonging to 125 genera and 27 families are known to occur in birds. Generally, flukes are not a problem for geese, however, geese with access to natural lake or pond water may become infected. This is because most flukes have an aquatic snail (genus Limnaea) as an intermediate host. The dragon fly (genus Odonata) is the second intermediate host in many cases.

Symptoms.

Flukes may invade almost every cavity and all tissue of birds and can show up unexpectedly at a post-mortem. One species of fluke known as the oviduct fluke (*Prosthogonimus ovatus*), can infect the oviduct which results in flukes appearing in the geese's eggs.

Prevention/Treatment.

The only practical solution is to remove the birds from the source of infection. This can be done if the intermediate host(s) is/are known.

A sample life cycle of flukes (Source: Guy, 1996)

(1) Infected geese excrete fluke eggs in their dropping.
(2) When the conditions are favourable, the eggs hatch, producing a primary larvae.
(3) The larvae mature in an intermediate host (a snail of genus Limnaea).
(4) The intermediate host lays the mature larvae on grass.
(5) After ingesting the larvae by grassing, the geese become re-infected.

FOWL CHOLERA

Fowl Cholera, also known as Pasteurellosis, is a contagious disease affecting all domestic and wild birds.

Pasteurella multocida is the causative agent, to which geese are highly susceptible and mortality can be high.
Symptoms.
Fowl Cholera usually appears as a septicaemic disease, associated with high morbidity and ortality. Perhaps the most characteristic aspect of the acute form is the sudden death of birds with the symptoms appearing only a few hours before death. The chronic form, which can follow the acute form, normally shows as localised infections. The lesions associated with this disease can take several forms, but in most cases the heart, pericardium and air sacs are damaged.
Prevention/Treatment.
Fowl Cholera is not a disease of the hatchery nor is it one transmitted through the egg. Rather, infection occurs when the geese are on the farm. The first step in the control of Fowl Cholera is therefore good sanitary management practices and keeping the geese separate from other birds. In areas where Fowl Cholera is present either in geese or other species of birds, vaccination of all birds is recommended. In the case of an outbreak, it is possible to treat the birds to stop the spread of the disease, but this must be done quickly.

LEUCOCYTOZOONOSIS

This is a parasitic disease of birds which affects the blood cells (especially the white blood cells) and the tissues of various internal organs (parasite multiplication occurs in the macrophages of brain, liver, heart, lungs, and spleen). It is a very uncommon disease in geese but outbreaks of economic significance have been reported. Leucocytozoon simondi is the causative agent in waterfowl and has been reported in 27 species of ducks and geese in North America, Europe and Vietnam.
Symptoms.
Leucocytozoon infections are diagnosed by direct microscopic observation and by identification of either the gametocytes (sexual stage of the parasite) in stained blood samples or of the schizonts (stage of massive multiplication) in tissue sections.
Prevention/Treatment
Treatment of leucocytozoonosis with drugs has, in general, limited success and no effective treatment has been found for Leucocytozoon simondi. Control methods require the elimination of the insect carriers that

include various species of diptera (simuliid flies and culicoid midges) that live near streams.

LISTERIOSIS

Listeriosis is not a common disease of geese but some instances have been reported in temperate areas of the world. This is probably due to the fact that, in temperate climates, Listeria monocytogenus (the causative agent) is found in both faeces and soil. Also, it is in these areas that many geese are kept on pasture and therefore are exposed to the organism.

Symptoms.

The symptoms are septicaemia with necrotic areas in the liver and heart. Encephalitis has been reported in young geese. Infected birds appear emaciated with diarrhoea.

Prevention/Treatment.

Prevention depends on eliminating the source of infection. As the organism is resistant to most commonly used antibiotics, high levels of tetracyclines are usually recommended for treatment.

MYCOPLASMA INFECTIONS

Mycoplasma infections, also know as Pleuro-Pneumonia. Like Organisms or PPLO, can cause relatively serious problems in geese. These organisms have an intermediary structure between that of bacteria and viruses. At least three species of Mycoplasma (Mycoplasma anseris, Mycoplasma claucale and Strain 1220) have been isolated in geese. In recent years the prevalence of Mycoplasma infections in geese in a number of areas appears to have increased. This is most notable when birds are managed under intensive conditions.

Symptoms.

The main problem of Mycoplasma infections is that in breeder flocks it results in reduced egg production and lower fertility. There is necrosis of the phallus (Venereal Disease) which can cause a severe drop in fertility. In young goslings Mycoplasma infection results in reduced growth, and respiratory and air sac infections. For young geese the common source of Mycoplasma infection is from the hatching egg.

Prevention/Treatment.

The most important aspect of a Mycoplasma control programme is to ensure that the grandparent and parent stocks are Mycoplasma-free so that goslings from these flocks are not infected. Treatment of eggs from an

infected flock is achieved by dipping the eggs in a tylosin solution before the eggs are incubated. Infected goslings can be treated by adding either tetracycline or tylosin to their drinking water.

MYCOSIS OF THE DIGESTIVE TRACT

Mycosis of the digestive tract, caused by Candida albicans, can occur frequently in some classes of poultry but not in geese. An exception is force-fed birds, where inflammation of the oesophagus may be caused by the insertion of the corn dispenser. This inflammation can then provide a port of entry for *Candida albicans*.
Symptoms.
The symptoms are not particularly characteristic but infected birds show unsatisfactory growth, are stunted, listless and have ruffled feathers. Lesions occur most frequently in the crop and are characterised by a whitish deposit.
Prevention/Treatment.
Since unhygienic and overcrowded conditions are conducive to Candida albicans infections, the first step is to eliminate these. The addition of copper sulphate to the drinking water has had variable results in treating chickens and geese. Sodium bicarbonate in the drinking water increases the pH in the crop and creates an unfavourable condition for the organism as it likes an acid environment. Addition of either Nystatin or Amphotericin to the feed has been reported to be effective.

MYCOTOXICOSES

Mycotoxicoses is a disease caused by exposure to mycotoxins, and the most prevalent source of mycotoxin contamination for geese is mouldy feedstuffs. Diagnosis of Mycotoxicoses can be very complex since hundreds of mycotoxins have been identified. However, knowing what the geese are being fed, the source, the symptoms the geese are exhibiting and whether or not other livestock or poultry being fed the same feedstuffs are showing similar symptoms, will allow diagnosis of the problem and identification of the source(s) of the mycotoxin. In tropical countries where aflatoxins are very common, their origin is connected with the development of genus *Aspergillus flavus* and *Aspergillus parasiticus* growing mainly on peanuts but

also on soybeans, copra, rice bran and corn. According to the literature, alflatoxins may cause slow growth, a drop in egg production and feather loss for all species of waterfowl, although geese are among the less sensitive. The genus Fusarium produces numerous toxins injurious to geese, and these have been found in corn, sorghum, barley, sunflower seed, oats, mixed feed and brewers' grains. Fusarium mycotoxin production thrives in conditions of high humidity and a temperature of 6-24°C. In temperate climates it is therefore essential that grains be harvested early before the cool-humid conditions of fall arrive as these are conducive to mycotoxin production.

Symptoms.

T-2 toxin is one of the most common Fusarium toxins and, depending on the level of contamination, will cause feed refusal, reduced activity, increased water consumption, reduced egg production and reduced hatch. There are reports that exposure of young geese to T-2 toxin has resulted in the geese dying within two days. Another Fusarium toxin to which geese are very sensitive is zearalenone which can not only result in an immediate drop in fertility but can also permanently damage the testes of the gander.

Prevention/Treatment.

Treatment is to remove the contaminated feedstuff immediately and provide the geese with fresh, uncontaminated feed. The best prevention is to ensure that all purchased feedstuffs are mycotoxinfree.

NECROTIC ENTERITIS

Necrotic enteritis is caused by Clostridium perfringens and has been reported to occur in geese although the incidence of the disease does not appear to be high. *Clostridium perfringens* can be found in soil, faeces, dust, litter and contaminated feed.

Symptoms.

The clinical signs of Necrotic enteritis are severe depression, decreased appetite, reluctance to move, diarrhoea and ruffled feathers. Sick birds may die quickly due to enterotoxemia and necrosis of the small intestine.

Prevention/Treatment.

Prevention is the rule. Many birds have natural populations of Clostridium perfringens in their caeca, but

rarely in the small intestine. Stress or any irritant to the digestive tract can provide the stimulus for this genus to appear and multiply in the small intestine and should be avoided. If the disease appears, a number of antibiotics have been found to be effective which include lincomycin, bacitracin, oxytetracycline, penicillin, tylosin, virginiamycin, avoparcin and nitrovin.

NEPHRITIC HEMORRHAGIC ENTERITIS

Nephritic hemorrhagic enteritis is a disease that is currently quite prevalent in the south western region of France and is often referred to simply as NEHO. It can infect geese from 4-20 weeks of age and causes mortality rates from 30-100 percent. The causes of this disease are not well understood but it seems to be primarily poor management. An excess of protein in the feed or any sudden change in the diet of the birds can also bring it on, as can poor quality drinking water and parasite infections.

Symptoms.

When suffering from this disease, geese are often unsteady on their feet, have difficulty getting up and have erratic movements. These symptoms are accompanied by diarrhoea and trembling and death usually follows shortly afterwards. The characteristic lesions are urates and haemorrhaging in the kidneys, an exaggerated sub-cutaneous swelling and the presence of intestinal parasites.

Prevention/Treatment.

The first measures to take are good management prevention practices such as controlling parasites and ensuring that the geese have a balanced ration. For outbreaks of the disease, good results can be obtained by injecting homologous serum. Also available are renal tonics and liver detoxicants, both of which can help relieve the symptoms. Due to a lack of knowledge of the disease, no vaccine has yet been developed.

NEWCASTLE DISEASE

The Newcastle Disease Virus is of the genus Paramyxoviruses which has been isolated from geese. Clinical signs are the exception rather than the rule, but when present, consist of greenish diarrhoea and, occasionally, disorders of the central nervous system. In many cases, geese may be infected without showing

any clinical symptoms, yet they can be carriers for a prolonged period. Usually geese are not vaccinated since Newcastle disease is not generally a problem for them.

PARATYPHOID

Paratyphoid, or salmonellosis, is an important disease in geese with young birds, generally under six weeks of age, being the most susceptible. In addition, the concern regarding salmonella infection in humans and the demand for salmonella-free poultry products has increased the awareness of this disease and resulted in various monitoring programmes being undertaken in many countries. Over 2 000 types of salmonella organisms have been isolated from various species of fowl worldwide. Generally, the salmonella serotypes isolated from poultry are more characteristic of the region than the species of poultry. Paratyphoid is easily spread through contact with either infected birds, their faeces or through infected equipment, particularly that used for hatching and brooding. It now appears that salmonella is spread by salmonella entering the egg both in vivo before it is laid and by penetrating the egg after it is laid. In both cases it can multiply in the egg. For this reason, the importance of collecting eggs frequently before they get dirty, and cleaning and fumigating them as soon as possible, cannot be over emphasised.

Symptoms.

Geese with Paratyphoid will usually be less than six weeks of age, tend to stand in one position, with their heads lowered, eyes closed, wings dropping and feathers ruffled. Sick birds will also exhibit marked anorexia, increased water consumption, watery diarrhoea, pasty vent and a tendency to huddle close to the heat.

Prevention/Treatment.

The first step in the control of Paratyphoid is to remove all the possible sources of salmonella. This requires excellent management and sanitation of the breeders, the hatching process and the rearing of the goslings. The cleanliness of the hatching eggs is perhaps the most important single aspect in the control of Paratyphoid, especially the fumigation of eggs immediately after laying. Rodent control is also very important. A number of sulphonamides, antibiotics and nitrofurans have been recommended in the treatment of paratyphoid. In addition, furazolidone and injectable gentamicin and spectinomycin can be used. The final diagnosis of Paratyphoid depends on isolation and identification of the causative organism. This will help

determine which drugs are best suited to treat a particular outbreak.

RIEMERELLA ANATIPESTIFER INFECTION

Riemerella anatipestifer infection is a contagious disease affecting domestic geese, ducks and various other birds which means that infections in geese can originate from other species.

Symptoms.

The common symptoms are ocular and nasal discharges, mild coughing and sneezing, greenish diarrhoea, uncoordinated movement, tremor of the neck and head and coma. Geese that recover from the disease are resistant to subsequent infection.

Prevention /Treatment.

The sulphonamides and antibiotics as listed under Fowl Cholera for the control of *Pasteurella multocida* are usually effective against *Riemerella anatipestifer*. Vaccines have been developed but they have been used primarily with ducks although they can be expected to prevent the disease in geese as well.

PSEUDOTUBERCULOSIS

Pseudotuberculosis caused by Yersinia pseudotuberculosis has been reported in a large number of avian species, including geese. It is not, however, a common disease in geese.

Symptoms.

The disease is characterised by an acute septicaemia and infected birds have difficulty breathing and are weak, with dull and ruffled feathers and diarrhoea. A definite diagnosis requires isolation and identification of the causative agent.

Prevention/Treatment.

Due to the low incidence of the disease, there is very little information available but chloramphenicol, streptomycin and tetracycline have been effectively used in some species.

RETICULOENDOTHELIOSIS

Reticuloendotheliosis refers to a group of syndromes caused by the retroviruses of the REV group. The disease occurs in a wide variety of domestic poultry but is rare in geese. It is sometime called the Runting Disease because it is characterised by poor growth and abnormal feathering. In geese, viruses have been isolated from tumours of the spleen, liver, pancreas and intestines. No vaccine has been developed for this disease because the incidence and economic importance of the disease is very low.

SPIROCHETOSIS

Spirochetosis in avian species is caused by Borrelia anserina and is tick-borne. Spirochetosis was first described in 1891 as a severe septicaemic disease of geese in Russia but it is now found worldwide, especially in the tropical and subtropical areas where fowl ticks (genus Argas) are common. However, even in these areas the incidence of the disease is low.

Symptoms

. Morbidity and mortality are highly variable, ranging from 1-2 percent up to 100 percent. Lowest rates occur when the birds have previously been exposed to Borrelia anserina and have developed immunity. Larval ticks or puncture haemorrhages from tick bites on the birds, or ticks in the birds' environment are indicative of the disease.

Prevention/Treatment.

In areas where Spirochetosis is prevalent, vaccination is the control method of choice. Female geese that have acquired immunity, either through natural exposure or through vaccination, are capable of passing on passive immunity to their offspring which will protect them for 5-6 weeks post hatching. When an outbreak occurs, the treatment of choice is usually antibiotics. Borrelia anserina is sensitive to most antibiotics including penicillin, chloramphenicol, kanamycin, streptomycin, tylosin and tetracyclines.

STAPHYLOCOCCOSIS

All avian species are susceptible to staphylococcal infections though geese do not appear to be affected to any great degree. If and when they are infected, it is generally as a secondary infection but even this is rare. Staphylococcus aureus is the most common infection in birds. One of the major concerns is that staphylococcus infections can be transmitted from birds to humans. This has been observed among both slaughterhouse workers and people performing autopsies.

The most frequent sites of infection in poultry are bones, tendon sheaths and leg joints but infections may occur elsewhere.

Prevention/Treatment.

Staphylococcus infections can be treated with antibiotics. Penicillin, streptomycin, tetracycline, erythromycin, novobiocin, sulphonamides, linomycin and spectinomycin have been used successfully.

STREPTOCOCCOSIS

There are a number of species of streptococcus that infect birds. However, to date, streptococcus infections in geese are very rare although Streptococcus mutans, a common bacterium of the human oral cavity, has been identified as a cause of septicaemia and mortality in geese.

Symptoms.

In its acute form, the clinical signs of Streptococcosis are related to septicaemia, depression, lethargy, diarrhoea and head tremors, although often the birds are just found dead. In the chronic form, depression, loss of weight, lameness and head tremors may be observed.

Prevention/Treatment.

Prevention and control require reducing stress and following proper sanitation practices. Treatment includes the use of either antibiotics such as penicillin, erythromycin, tetracycline or nitrofurans.

NEMATODES (worms)

The main problem with geese in EA is that they are susceptible to gizzard worms which kill them if left untreated. Gizzard worms are a very common parasite and geese should be wormed at least twice a year with

1ml Levamisole 7.5% (consult your pharmacist who will advise you of similar products available. Never use more than the recommended dose as it is easy to overdose and this may prove fatal. This treatment is not suitable for goslings 10 weeks and younger.

Alternatively, use Flubenvet which is a multipurpose wormer and covers gizzard worm. It is a powder which sticks readily to feed. The correct dose (on the pack) should be administered for 7 days. It is suitable for goslings and it is adviseable to treat a hen when she starts sitting, as well as the gander.

It has been said that nematodes, or roundworms as they are commonly called, constitute the most important group of helminth parasites of poultry.With geese, Ascaridia are generally not a problem but various species of Capillaria and Heterakis can cause problems. The most common nematode in geese is *Amidostomum anseris*.

Symptoms.

The usual symptom of worm infection in geese is lethargy. The presence of eggs or worms in either the faeces or in any organ, as revealed upon autopsy, will confirm a worm infection. Amidostomum anseris infects the horny lining of the gizzard and sometimes the proventriculus. It causes dark discoloration of the gizzard and a sloughing off of the lining.

Prevention/Treatment.

The first principle in controlling nematode infections is to practice good management. For geese on range, it is essential to rotate pastures 3-4 times a year and to change the pastures every year so as to break the cycle of nematode re-infection. For geese in confinement, the litter should be changed regularly and the uilding washed and disinfected with insecticide after each flock of geese. It is important not to mix young and old geese together, nor to follow old geese with young geese who are much more susceptible to nematode infections. A number of anthelmintic drugs are available to treat nematode infections. For the control of Amidostomum anseris in geese cambendazole, pyrantel, mebendazole and fenbendazole have each been shown to be effective.

The following nematodes have been isolated from the small intestine of the goose: Echinura uncinata, Epomidiostomum uncinatum, Ascaridia galli, Capillaria anatis, Capillaria bursata, Capillaria annulata, Capillaria anseris, Capillaria caundinflata, Capillaria obsignata, Heterakis dispar, Heterakis gallinarum, Strongyloides avium and Trichostronglus tenuis. The nematode Syngamus trachea has been isolated from the respiratory tract of the goose.

TAPEWORMS

Over 1 400 species of cestodes or tapeworms have been noted in wild and domestic birds and for many an intermediate host has been identified. Control of the intermediate host has proven to be the best way of controlling the tapeworm. Even though geese have been reported infected with numerous species of tapeworms introduced by wild waterfowl, tapeworms are generally not a problem in goose production. This is particularly so if geese are denied access to natural waterways where they can ingest an intermediate host (most of the time a fresh water crustacean). At least four tapeworms have, however, been isolated from the intestinal lumen of geese: Fimbriara fasciolaris, Hymenolepis megalops, Hymenolepis compressa, Hymenolepis lanceolata.

Symptoms.

Normally geese infested with tapeworms will not perform well, but isolation and identification of the worm is required for an accurate diagnosis.

Prevention/Treatment.

As with many other poultry species, it is not easy for geese to contract a tapeworm infection because of the trend towards confinement poultry production systems. This trend has resulted in a marked decline in tapeworm infections simply because poultry species are now more separated from the intermediate host. For this reason the first step to control tapeworm infestations in geese is to separate the geese from the intermediate host by confining them or by developing an effective pasture rotation system. The geese must also be isolated from natural waterways. Using only drugs to expel the worm will have a very short-term effect if the intermediate host is not controlled. Drugs that have been effective in controlling tapeworms in chickens are butynorate, either on its own or in conjunction with piperazine and phenothiazine under the trade name Wormal. Experimentally, hexachlorophene and niclosamine have also been shown to be effective.

TRICHOMONIASIS

This is a protozoan disease that infects mostly mature geese in breeder flocks. The causative agent in geese

is Trichomonas anseris while for other classes of poultry it is Trichomonas gallinae. These organisms are transmitted from bird to bird through the water and, to a lesser degree, through the feed.

Symptoms.

The infection in geese is mainly in the lower digestive tract and the first symptoms are reduced reproductive performance and weight loss. The droppings can be monitored for the protozoan although an autopsy (with heavy infections mortality can be high) will generally not yield the protozoa as they disappear quickly.

Prevention/Treatment.

If the disease has not spread throughout the flock, any sick birds that can be identified should be isolated. Nitrofurazon, metronidazole and dimetridazole are effective in treating the disease.

VENEREAL DISEASES

Bacteria, especially Neisseria, Mycoplasma, and Candida albicans have been associated with a venereal disease in ganders although it now seems that Mycoplasma are the primary infective agents.

Symptoms.

Initially, the base of the phallus becomes swollen and inflamed with the infection extending to the cloaca. Later, there is necrosis, ulceration and eventually considerable scarring, making reproduction impossible. The disease spreads throughout the flock very rapidly.

Prevention/Treatment.

The onset of the disease has, in some cases, been associated with a high density of ganders that has led to fighting, resulting in the phallus of some ganders being injured and becoming infected. The infection then spreads through the flock via the females. When infected, the females exhibit symptoms such as airsaculitis, peritonitis, and salpingitis. The first control measure to take is good management of the breeder flock. Because of the principle involvement of Mycoplasma, some veterinarians view the disease as a component of Mycoplasma infections rather than as a separate disease. Treatment is therefore with antibiotics effective against mycoplasma such as tylosin, tetracycline, chlortetracycline, linomycin, oxytetracycline, spectinomycin, spinomycin and tiamulin. Sensitivity tests should be conducted to select the appropriate antibiotic.

Information Source Links

- **Buckland, R. and Guy, G. (2002). Goose Production. FAO Animal Production and Health Paper 154. FAO, Rome. ftp.fao.org/docrep/fao/005/Y4359E/Y4359E00.pdf**

Information of www.infonet-biovision.org

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Cattle Breeds and Breeding

Cattle Breeds and Breeding

Introduction

A breed is a race or variety related by descent and similarity in certain distinguishable characteristics. More than 250 breeds of cattle are recognized throughout the World.

In Africa there are two main races of Cattle: Bos indicus (cattle with humps) including the Boran, Sahiwal and Zebu cows (indigenous) and the Bos taurus (exotic or imported breeds). The two races can cross breed, and the crosses can be very productive both in terms of growth rates for beef, improved milk production as well as disease resistance.

Kenya is a home to a wide range of cattle genotypes. Within the East and Central Africa region, Kenya has the highest number of exotic dairy cattle. As for indigenous breeds, Kenya also ranks high with Ethiopia and Sudan topping the list of African countries with the highest population of indigenous cattle breeds.

Crossbreeding

Some agroecological zones (AEZ's) are not suitable for pure breed high yielding milk cows, but can benefit

from crossbreeding the local breeds of cattle with exotic breeds. However, this will only be useful if management practices such as improved feeding, plenty of fresh water available, and a reliable source of veterinary drugs are available. Without these conditions the survival rate of cross breeds is likely to be low.

The Friesian breed

A Friesian cow from Gicheha Farm

© J.O. Ouda, KARI, Kenya

The exact origins of the breed are difficult to determine but it is known that in the 18th century, herds of small black-and-white cattle were brought into northern Holland and Friesland from northern Jutland to replace animals that had fallen victim to disease and flooding. These animals were crossed with the existing Dutch cattle and formed the basis of the Friesian.
Before the establishment of the Netherlands herd book in 1873 and the Friesland herd book in 1879, both black-pied and red-pied animals were maintained separately. The preference for black-pied cattle, particularly in the United States, led to the further segregation of red-pied animals and presently this colour variation only exists in small number in the Netherlands.

Production levels of this breed declined during the 1950's when excessive emphasis was placed on correct colour pattern. During the 1970's Holsteins were imported from the United States and used to improve the milk production. This resulted in larger animals with a more pronounced dairy characteristics. The mixing of these two breeds is such that now many Friesians are 25% to 75% Holstein.

The modern Friesian is pre-eminently a grazing animal, well able to sustain itself over much lactation, on both low lying and upland grassland, being developed by selective breeding over the last 100 years. Some outstanding examples of the breed have 12 to 15 lactations to their credit, emphasizing their inherent natural fecundity. In response to demand, protein percentages have been raised across the breed and herd protein levels of 3.4% to 3.5% are not uncommon.

Typical characteristics include:

Purpose: Milk production
Potential yield: 40-50 Litres milk/day
Average body size: Large (500-550kg)
Description: Black and white short haired coat, short horns

Friesian cow with calf

Advantages:

- **High milk production potential with low butter fat content of about 3.2%**

Note: Milk production will depend on level of feeding and other management

- **Suitable for zero grazing and high level management**
- **Frequent calving in their lifetime**
- **Need less replacements**
- **Provide valuable male calves**
- **Have lower cell counts**
- **Have higher fat and protein percent**
- **They are known for their versatility: they provide high quality milk and high quality lean meat**

Disadvantages:

- **Heavy feeder**
- **Susceptible to diseases, susceptible to milk fever**
- **Susceptible to high temperatures**
- **Feed requirements high (90-110Kg fresh forage/day i.e. 3 gunny bags)**

- **Adequate clean water (min 60 Lts/day, more for heavy yielders)**

Friesians and their crossbreeds are predominant in Kenya particularly in Central Kenya and Central Rift Valley. The farms where they can be found include:

1. Manera (Delamere Estates), Naivasha
2. KARI Naivasha, PO Box 25 Naivasha
3. KAR Lanet, PO Box 1275, Nakuru
4. Agricultural Development Corporation (ADC) Katuke Complex, PO Box 1392-30200 Kitale
5. Makongi Farm, PO Box 1320-30100 Eldoret
6. Kisima Farm, PO Box 19- 20107 Njoro
7. Gogar Farm PO Box 6-201080 Rongai
8. University of Nairobi Farm PO Box 29053-10202 Kabete
9. Sanctuary Farm PO Box 244-20177 Naivasha
10. Marimba Farm PO Box 32 Meru
11. ADC Olngatongo PO Box 680-30200 Kitale
12. Gicheha Farm, PO Box 236 Ruiru

The Ayrshire breed

The Ayrshire breed originated from in the county of Ayr in Scotland, prior to 1800. The breed was introduced to Kenya in 1908 from South Africa. It has been developed over the last century through inputs of bloodlines from Britain, South Africa, Sweden, New-Zealand, Canada and USA.

Kenya Aryshire cattle breeders emphasize on medium cow balanced for type, production, longer life and fertility. Ayrshire population in Kenya is estimated to be over 1.2 million of which nearly 30'000 are registered (see the list of breeding farms below).

Typical characteristics include:


Airshire cow

Purpose: Milk production. Ayrshire milk is referred as "he ideal drinking milk"; it is not excessively rich, not lacking adequate fat, and it possesses desirable quantities of proteins.
Potential yield: 30 Litres/day
Average body size: Large (average live-weight 450kg)
Description:

- **Body colour: Brown and white patches in almost equal amounts with some cows tending to dark mahogany colour**
- **Prominent strongly attached and balanced udders**
- **Strong loins, long stooping from hip to pin bones**
- **Good spring of ribs and deep body capacity**

Advantages:

- **High milk production potential (30 Litre/day). The average milk yield from this breed in Kenya is roughly 3'000 Litres in 305 days with butter fat of 4.7%.**
- **The cow's milk has moderate butter fat content 4.0%**
- **Fairly hardy and adaptable to varied agro-ecological zones (AEZs)**
- **They are easy calving**
- **They are relatively resistant to diseases and free of genetic diseases**
- **Better suited to range management than the Fresian breed**

Disadvantages:

- **Feed requirements high (90-110 kg fresh forage/day i.e. 3 gunny bags)**
- **Need plenty of clean water (60 Litres/day)**

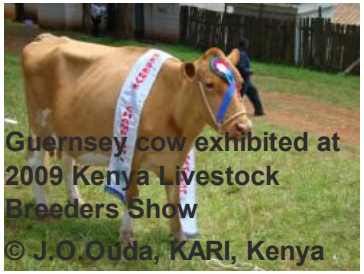
Farms keeping Ayrshire in Kenya (officially registered):

1. **Agricultural Development Corporation (ADC) Katuke Complex, PO Box 1392-30200 Kitale**
2. **Makongi Farm, PO Box 1320-30100 Eldoret**
3. **Kisima Farm, PO Box 19- 20107 Njoro**
4. **Gogar Farm PO Box 6-201080 Rongai**
5. **ADC Lanet Farm PO B0x 1124-20100 Nakuru**
6. **University of Nairobi Farm PO Box 29053-10202 Kabete**
7. **Moi University Farm PO Box 30900-30100 Eldoret**
8. **Loruk Farm PO Box 104-10400 Nanyuki**
9. **Waunyomu Ngeke Ranch PO Box 236-00232 Ruiru**
10. **Sanctury Farm PO Box 244-20177 Naivasha**
11. **Marimba Farm PO Box 32 Meru**
12. **KARI Ol Joro Orok Private Bag 20302 Ol Joro Orok**
13. **ADC Olngatongo PO Box 680-30200 Kitale**
14. **Sunset Farm PO Box 13366-20100 Nakuru**
15. **Limuru Agricultural Youth Centre PO Box 30496 Nairobi**
16. **Chemusian Farm PO Box 86-20107 Menengai**

The Guernsey breed

The Guernsey originated on the small Isle of Guernsey, situated in the English Channel just off the coast of France. There is no concrete evidence as to the development of the Guernsey before the 19th Century but there may be some truth in the theory that the Isigny cattle of Normandy and the Froment du Léon breed from Brittany were ancestral relatives of the modern Guernsey.

Purpose: Milk production. Heifers generally come into milk at about two years of age.
Average body size: Medium (average live-weight 400kg).
The cow weighs 450 to 500 kg slightly more than the average weight of the Jersey cow which is around 450 kg (1000 pounds). The bull weighs 600 to 700 kg. The average weaning weight of heifers and bull calves is 75 kg.



Guernsey cow exhibited at 2009 Kenya Livestock Breeders Show
© J.O.Ouda, KARI, Kenya

Description:
1. The colour of the Guernsey varies from yellow to reddish-brown with white patches.
2. They have a finely tuned temperament, not nervous or irritable.
3. Physically the breed has good dairy conformation and presents the visual impression of a plain animal bred for utility rather than good looks.
4. They have an attractive carriage with a graceful walk, a strong back, broad loin, wide rump and deep barrel, strong, attached udder extending well forward, with the quarters evenly balanced and symmetrical.
5. The Guernsey bull has an attractive individuality, revealing ample vigour and masculinity. It has smooth-blending shoulders showing good refinement, strength and even contour.

Guernsey cow
© J.O.Ouda, KARI, Kenya

Advantages: 1. High milk production potential (25 Lt/day).
2. Milk has moderate butter fat content 4.3%.
3. Feed requirements: Moderate (65-85Kg fresh forage/day i.e. 2 gunny bags)
4. Guernsey are efficient converters of feed to product, being of intermediate size, Guernsey produce their high quality milk while consuming 20 to 30 percent less feed per pound of milk produced than larger dairy breeds.
5. Guernsey reach reproductive maturity at an early age and can calve at 22 months of age. This provides an early return on investment.
6. Guernsey produce calves big at birth, which are easy to rear.
7. Guernsey are well known for having the minimum of calving complications.
8. Guernsey are adaptable to all climates and management systems and lack any known undesirable genetic recessives.
9. Her fawn and white coat enhances her heat tolerance and reduces heat stress, which adds to her ability to maintain production levels anywhere.
10. They are docile and have an ideal Dairy Temperament.

Disadvantages:
1. Need plenty of clean water (40 Lts/day)

Farms keeping Guernsey in Kenya (options):

1. Egerton University, PO Box 356, Njoro
2. ADC Lanet Farm PO B0x 1124-20100 Nakuru
3. ADC Olngatongo PO Box 680-30200 Kitale
4. Gicheha Farm, PO Box 236 Ruiru

The Jersey breed

Despite considerable research, nothing definite is known as to the actual origin of the cattle first brought to Jersey Island. Most research agrees that the Jersey probably originated from the adjacent coast of France, where in Normandy and Brittany cattle resembling Jerseys are found.

Purpose: Milk production.
Average yield: 22 litres/day and 6.3% butter fat.
Average body size: Small - medium (350 Kg)

Jersey cow

Description:
1. Jerseys in Kenya are typically light brown in colour, though this can range from being almost grey to dull black. They can also have white patches which may cover much of the animal. A true Jersey will however always have a black nose bordered by an almost white muzzle.
2. They have protruding eyes.
3. This breed is well known for milk with high quality - it is particularly richer in protein, minerals and trace elements than those from the larger dairy breeds. The milk is also rich in colour which is naturally produced from carotene.

4. Milk production potential is moderate (20 Lt/day), depending on feeding and management regime.

5. The highest milk production record of 12,138 litres in 305 days from this breed has been reported Canada with 6.4% butter fat (782 kg) and 3.5% protein (428 kg).

Advantages:

1. Feed requirements is relatively low (65-85 Kg fresh forage/day i.e. 2 gunny bags).
2. Milk has high butter fat content 5.2%.
3. It is hardy and adaptable to varied AEZs.
4. The Jersey's hard black feet are much less prone to lameness.
5. They perform well under a wide range of systems and are well-known for their high feed conversion efficiency.
6. Jerseys generally produce milk components at a lower cost compared to the other major breeds.
7. They stay in the herd longer than any other dairy breed. Her milk has greater nutritional value, plus the highest yield and greater efficiency when processed into cheese and other value-added products.
8. The breed has little or no calving problems, greater fertility, a shorter calving interval, and earlier maturity.
9. Also suitable for cross breeding/ improving local breeds.

Disadvantages:

1. Susceptible to milk fever and tick borne diseases

A few contacts/farms where Jersey can be found in Kenya are:

1. **OlEndeti (Grammaticas) Nairobi, Tel-2067686**
2. **Ololua Farm (Carol Rees) PO Box 21007 Nairobi, Tel-891015**
3. **Ontulele (Biddy Davis) Nairobi Tel-891518)**
4. **Ol Donyo (Tara Llewelyn) PO Box 111 Nanyuki**
5. **Rawhide (Janet Mills) Nakuru 051-343005**
6. **ADC Sabwani Complex, PO Box 680 Kitale**

The Boran breed

By careful selection and application of the strict standards of excellence of the Boran Cattle breeders Society, the Boran breed has been developed into an ideal beef animal suitable for the arid range areas to be found in many parts of the world.

The original strains of the breed came from Ethiopia and were adopted early in the 20th Century by commercial cattlemen in Laikipia, Machakos and the Rift Valley Districts of Kenya. The Boran society was formed in 1951 and its panel of inspectors continues to ensure that the breed progresses and keeps up to date with the demands of modern beef production. The society promotes exports of embryos world wide and semen is exported throughout the East African region.

Purpose: Meat and milk production
Average body size: Medium (Average live-weight is 350-400 kg)

Description:
The Boran is typically white in colour with dark points and pigmented generally black skin. Steel-grey with black points is not uncommon. Fawn and red also occur, but black is rare and is not considered a true Boran colour. The Breed standard permits all colours except brindle.

The head is carried well, of medium length and slightly convex. Ears are small in comparison with the Indian breeds and not pendulous. Horns are generally

Boran cow dehorned

© AIC Documentation Unit, Kenya

short, round in cross- section and upright, but there is some variation in size and length. They can be 46 cm in circumference at the base and up to 84cm or more in length, measured on the outside curve, but this is exceptional. Polled animals are not uncommon and some animals have been selected for this condition.

The hump is well defined and thoracic; it is larger in the male than in the female. The Boran shows a surprisingly straight top line for a Zebu animal. The well developed hindquarters have frequently been remarked upon. The rump is long., wide and muscular in the male and the buttocks are well fleshed. Among Zebu breeds the Boran is outstanding in this character.

Skin is generally thin, with loose folds and pliable. Both the dewlap and umbilical folds are well developed.

The Boran is generally vigorous and alert. Being accustomed to desert condition, it covers vast distances in search of grazing and water and in some areas is only watered on alternate days or on the third day.

Fertility

In the view of the cattlemen, the first job of a cow is to produce a calf a year. Boran can meet this objective. It is acknowledged that the greatest attribute of the Boran is its fertility. Even under harsh conditions the Boran cow will continue to breed and rear calves and do this without punishing herself. One explanation for this high fertility is that the cow has relatively low body weight loss over the suckling period, thereby maintaining a good condition, thus able to conceive again.

Longevity

Boran cattle live a long time. It is quite normal for 15 years old breeding cows to be sound mouthed and it is also on record that a 16 year old Boran bull is still producing high quality semen for artificial insemination.

Temperament

Boran cattle are recognized as being generally quite, docile and easy to handle. This trait has developed over many generations of cattle living close to man.

The Boran cattle Breeders society makes docility a strait selection criterion and this feature has been recognised by Australian cattlemen who import Borans.

Beef production and Carcass Quality

Average weight gains per day on grass & feedlot: Grass = 0.7 - 1.0 kg per day depending on grass quality. Feedlot = 1.3 kg per day depending on type of cross used (this was found at a recent trial at Marania Farm - Timau where using Boran cross Angus steers & heifers) . Trials in Nebraska, USA, show that the Boran and its crosses score consistently better than other Zebu breeds for meat tenderness, carcass marbling and rib eye area. Butchers in Kenya prefer Borans and their crosses for this reason.

Disease resistance

True resistance to disease is a complicated matter. Recent studies of immunity to diseases in Zebu breeds are now becoming more widely known. For practical purpose the Boran has a useful degree of host resistance to ticks and from Australia it is reported that the breed is 'completely resistant to buffalo fly'. Borans are generally less affected by foot and mouth diseases than exotics and recover faster. It is also clear that the morbidity and mortality rates of East Cost Fever are lower in Boran than in *Boss taurus* breeds; the Boran being naturally more resistant.

Survival Characteristics

Being an animals which in obliged to walk long distances, selection for perfect feet and leg conformation is necessary for registered cattle. Inspectors will not compromise on this point. Dark pigmentation and black points have become more sought after to satisfy pedigree criteria and export demands.

The herd instinct of the Boran makes it very easy to manage in bush country. They are noted for being able to 'graze on the trot' and they will always stay together. The Boran male and female share breed points, the sexes, however, show marked dimorphism - the female being notably small, whilst the male grows to a large size.

The cow has a well-carried udder with strong attachments and neat, small teats, in contrast to some Asian Zebu breeds. Boran heifers reach puberty at an average age of 385 days. She is an excellent mother, not only will she feed her calf so well that high weaning weights are attainable, but she guards against predators, and will never allow her calf to get lost in the bush. Calving problems hardly exist. Calves at birth weigh an average

of 28 kg for males and females, 25 kg.

Boran cattle have developed adaptive traits of crucial importance for their survival. Some of these characters are - the ability to withstand periodic shortage of water and feed, ability to walk long distances in search of water and feed and ability to digest low quality feeds. The herd instinct of the Boran makes it easy to manage and survive in bush country. They will always stay together and can 'graze on the trot'.

The well-developed beef conformation shows up in carcase appraisals. The depth of eye muscle, marbling, even fat cover and ratio of hind to forequarter make the Boran difficult to beat, hence the preference of Kenya butchers for young, well-finished Boran steers.

Advantages:
1. Docile
2. Milk has high butter-fat of 4.8%
3. Good breeds for marginal areas

Disadvantages:
1. Milk production potential is low (10 Kg/day)
2. Difficult breeders, most mating at night

The Sahiwal breed

Sahiwal bull

This Zebu breed originates from India and Pakistan. National study was established in 1963 in Naivasha with the purpose of improving the breed for milk and beef i.e. as dual purpose breed. For a long time the breed was confined to government farms where the focus was conservation, characterization, improvement and utilization in smallholder systems. This breed is adapted to utilization of of poor quality pasture and rough terrain.

Purpose: Meat and milk production

© AIC Documentation Unit, Kenya

The milk yield is highly variable because of variation of management regimes.
Yields may range from 5-10 litres/day
Average body size: Large (average live-weight 350-400 kg)

Description: Body colour is solid brown

Advantages:
1. Docile.
2. Good breeds for marginal areas.
3. Milk has high butter-fat of 4.8%

Disadvantages:
1. Milk production potential is low (10 Kg/day)
2. Difficult breeders, most mating at night

Farms where they can be found include:
The largest herds in Kenya are kept by KARI, Naivasha and El-Karama Nanyuki.

The East African Zebu

East African Zebu

© Anne Bruntse, BioVision

Purpose: Milk and meat production
Average body size: small (average live-weight 250-300 kg)

Description: Body colour is variable, the breed has a prominent hump

Advantages:
1. Very hardy and disease resistant animal

Disadvantages:

1. Milk production potential is low (5 Lt/day)

2. Late maturing (3 years)

- **Mainly in southern rangelands**

Other breeds: Hereford, Simmental, Charolais

HEREFORD

Purpose: Meat production
Average body size: Large (average live-weight 550 kg)
Description: Body color reddish brown body with white head and feet

Advantages:
1. Good beef conformation for the discerning consumer.

Disadvantages:
1. High forage requirement
2. As all exotic breeds Hereford is susceptible to tick borne diseases.
3. Only suitable for cool areas with year round quality fodder availability.

SIMMENTAL

Purpose: Meat and milk production
Average body size: Large (average live-weight 750 kg)
Description: Body color brown

Advantages:
1. High production potential with good management and good feeding

Disadvantages:

1. **Susceptible to tick borne diseases.**
2. **Only suitable for cool areas with year round quality fodder availability.**
3. **Potential milk yield: low to moderate (10-15 Liters/day)**
4. **High forage requirement**

CHAROLAIS

Purpose: Meat production
Average body size: Large (average live-weight 800 kg)
Description: Body color white

Advantages:

1. **High production potential with good management and good feeding.**
2. **Good beef conformation for the discerning consumer.**

Disadvantages:

1. **Susceptible to tick borne diseases.**
2. **Only suitable for cool areas with year round quality fodder availability.**

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Introduction to Animal Husbandry

Images

Integrating animals into the farm

Animals integrated into the farm, showing the flow of fodder, dung

and products

Ifoam Training Manual for Organic Farming in the Tropics

Sheep

Sheep on Biofarm, Ethiopia

F.Wertli / BioVision

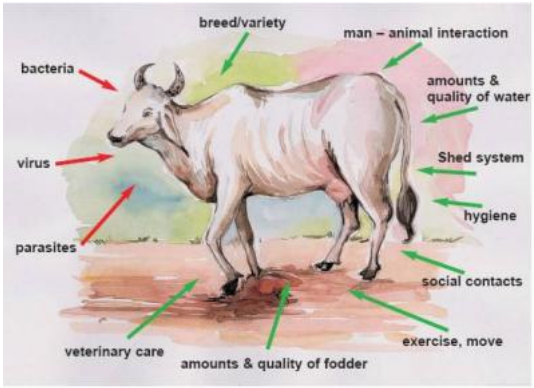
Pig

Pig on Biofarm, Ethiopia

F.Wertli / BioVision

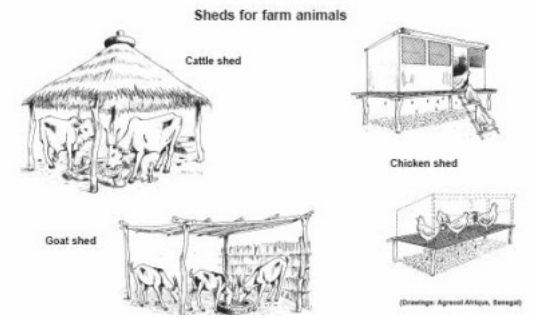
Factors influencing animal health

Bacteria, viruses and parasites attacking the farm animal which fights back with its immune system. The farmer can influence both sides of this balance



Ifoam Training Manual for Organic Farming in the Tropics

Sheds for farm animals



Traditional simple sheds in Senegal: cattle shed, goat shed, chicken shed

Ifoam Training Manual for Organic Farming in the Tropics

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Cattle

Images

Friesian cow with calf

AIC Documentation Unit, Kenya

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Goats

Images

Saanen goat

Wikipedia

Goats

S. Fontana, BioVision

Goat housing

S. Fontana, BioVision

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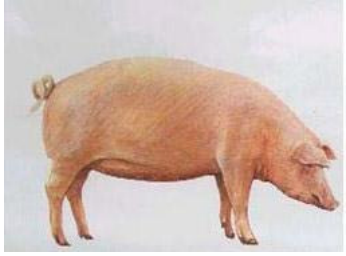
Pigs

Images



Landrace sow

S. Gikonyo, Kenya

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Camels

Images

Camels

Anne Bruntse, Biovision

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Donkeys

Images

Donkey

S. Fontana, BioVision

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Poultry: Chicken

Images

A hen with Fowl Pox pimples on the comb.

Henry Ondwasy, KARI

Poultry

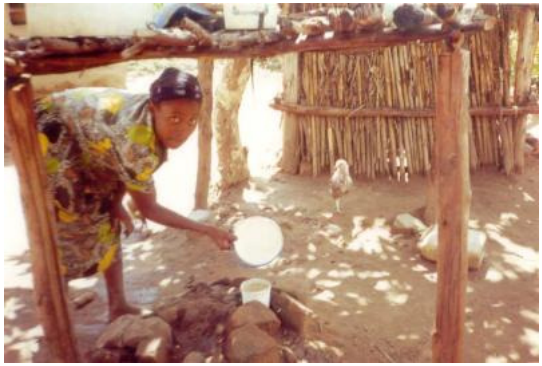
S. Fontana, BioVision

Indigenous chicken

Henry Ondwasy, KARI

top left: Protective housing shields chicks from predators and harsh weather; top right: Simple houses built with sticks, mud and polythene paper are easy and cheaper to construct.

Henry Ondwasy, KARI



Henry Ondwasy, KARI

Give clean and fresh waer in a specific place

Synchronised ducks sitting on eggs

Henry Ondwasy, KARI

A foster hen with chicks of different ages

Henry Ondwasy, KARI

Multiple infestations by 4 species of worms

Henry Ondwasy, KARI

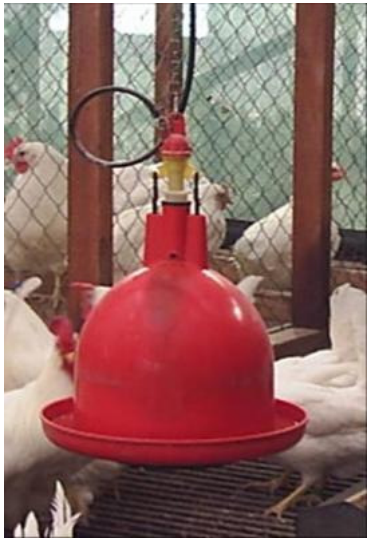
This hen did not show signs of sickness when it was put in the basket with chicks but died of acute Newcastle disease 4 h later.

Henry Ondwasy, KARI

Death caused by Infectious bursa disease.

Henry Ondwasy, KARI

Automatic drinker



A. Wachira, KARI, Kenya

Green grams for protein

A. Wachira, KARI, Kenya

Mange

**A. Wachira,
KARI, Kenya**

Laying nest on a slatted poultry house

A. Wachira, KARI, Kenya

Chick drinker

A. Wachira, KARI, Kenya

Broilers on cemented deep litter floor

A. Wachira, KARI, Kenya

Brooding hen

A. Wachira, KARI, Kenya

Chicken Indigenous

A. Wachira, KARI, Kenya

Dwarf hen

A. Wachira, KARI, Kenya

Feathered shank hen

A. Wachira, KARI, Kenya

free range cockerels

A. Wachira, KARI, Kenya

Frizzled feathered chicken

A. Wachira, KARI, Kenya

Kuchi game bird

A. Wachira, KARI, Kenya

Naked neck cock

A. Wachira, KARI, Kenya

Naked neck hen

A. Wachira, KARI, Kenya

Hybrid layers

A. Wachira, KARI, Kenya

Hybrid Cockerels

A. Wachira, KARI, Kenya

Normal feathered indigneous chicken

A. Wachira, KARI, Kenya

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Rabbits

Images

Rabbit

Valerie Corr, Naivasha, Kenya

Rabbits

A. Bruntse, Biovision

Rabbits housing

A. Bruntse, Biovision

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Beekeeping

Images

Bees

A. Bruntse, Biovision

Ugandan basket hive

The lid is removed to harvest honey. Care in harvesting yields top quality honey.

Thomas Carroll, Kenya (2006)

The pot hive

The pot hive has a super or honey chamber on top.

Thomas Carroll, Kenya (2006)

Traditional log hive

A traditional log hive located in Koibatek District.

Thomas Carroll, Kenya (2006)

Examples of Kenyan Top Bar Hives (left) and Langstroth hive (right)

Thomas Carroll, Kenya (2006)

Hives in Turkana District. Beginners should go for the simpler and cheaper KTBH.

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Fish farming

Images

Nile tilapia (Oreochromis niloticus); max length: 60 cm

Mbugua Mwangi, Kenya

A Paddle wheel aerator in a fish farm in Israel.

Mbugua Mwangi

A simple feed mill in a fish farm in Kenya

Mbugua Mwangi

Trout circular tanks in Kenya

Mbugua Mwangi

Hatchery sedimentation systems

Mbugua Mwangi

Fish Culture - Raceways

Mbugua Mwangi

Trout raceways at a trout farm in Kenya.

Mbugua Mwangi

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Animal nutrition and feed rations

Images

Dairy cow feeding on banana stems

A. Seif, icipe

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Record keeping

Images

Record keeping

V. Albertin, BioVision

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Poultry: Geese

Images

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Cattle Breeds and Breeding

Images

Sahiwal bull

AIC Documentation Unit, Kenya

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Animal husbandry and beekeeping

Introduction to Animal Husbandry

Animal nutrition and feed rations

Record keeping

Cattle

Cattle Breeds and Breeding

Beekeeping

Camels

Donkeys

Fish farming

Goats




Pigs **Poultry: Chicken** **Poultry: Geese** **Rabbits**

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