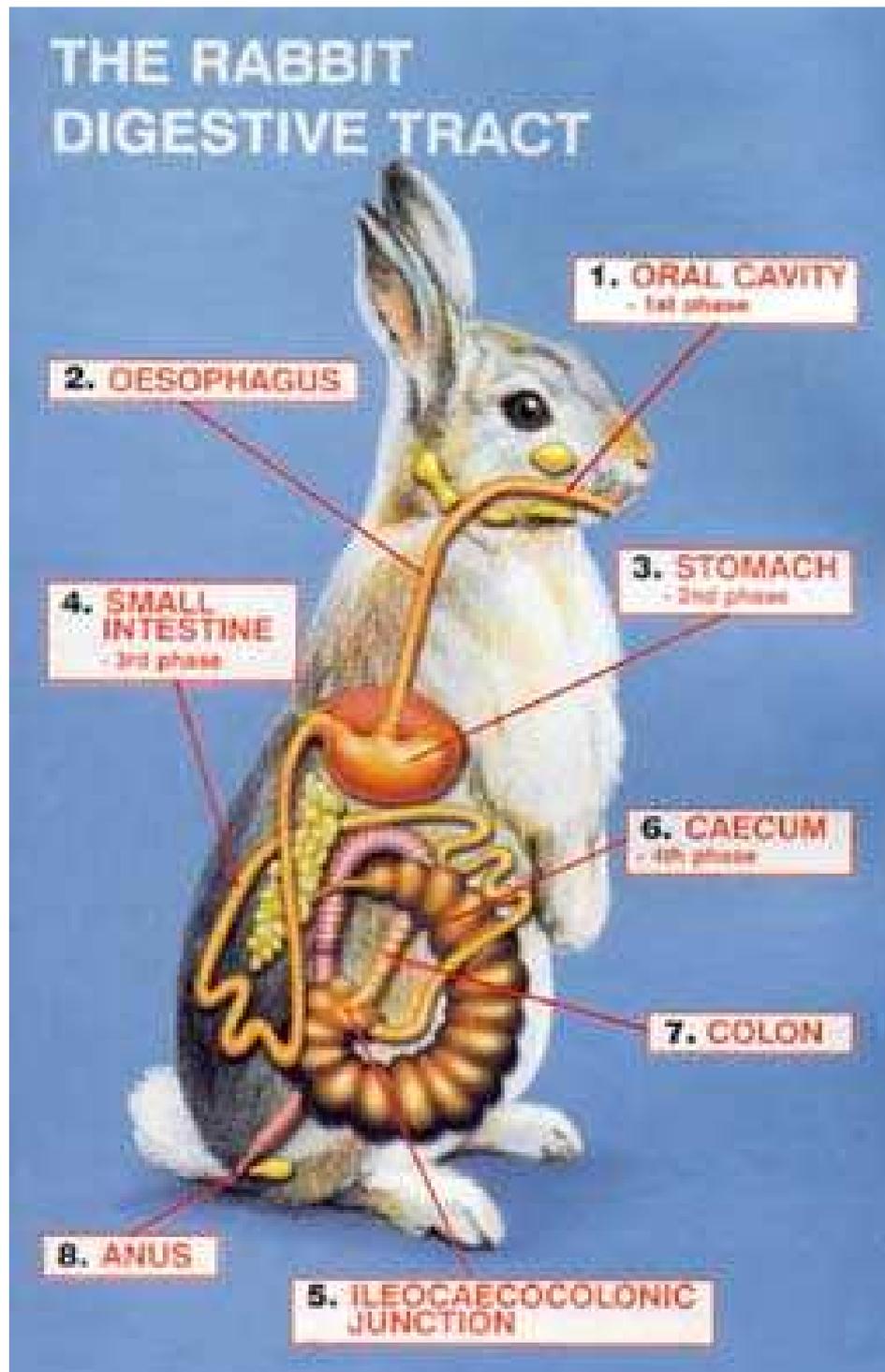


ANN 508: Rabbit Nutrition & Feeding



By **Dr. Idowu, O.M..O.**

RABBITS FEEDING AND NUTRITION

I. INTRODUCTION.

- A. Rabbits are monogastric (single stomach), herbivorous (eat plant material) animals.
- B. They need nutrients (such as proteins, carbohydrates, lipids or fats, minerals and vitamins) in specific amounts to grow and perform at their best.
 - 1. Feed is very important when raising rabbits, because it accounts for about 75 percent of your production costs.
 - 2. In the wild, rabbits eat a variety of grains, greens, roots, and roughages.
 - 3. Most domestic rabbits eat a pelleted feed made to meet their nutritional needs.
 - a. Rabbit pellets consist mostly of ingredients from plants (primarily alfalfa meal and wheat middlings).
 - b. Pelleted rabbit feeds are available from many companies and are easy to feed and store.
- C. Some rabbit raisers prefer to formulate (mix) their own rabbit diet.
 - 1. Rabbit feeds can be prepared from many readily available ingredients.
 - 2. The following feedstuffs are commonly used in diets for rabbits.
 - a. Green feeds -- growing plants such as grasses, weeds and leafy vegetables.
 - b. Root crops -- carrots, sweet potatoes, turnips and beets.
 - c. Cereal grains -- oats, wheat, barley,, grain sorghums, corn and rye.
 - d. Milled feed -- bran, middlings and shorts.
 - e. Hays -- alfalfa, clover, lespedeza and timothy.
 - f. Protein supplements -- soybean meal, peanut meal and dried milk products.
 - g. Salt.

II. FEEDING.

- A. Feeding has a strong influence on breeding, fertility, conception, kindling, nursing, growth, and resistance to disease.
 - 1. Young rabbits begin to consume feed when they are approximately three weeks of age.
 - 2. A well balance, palatable ration should be available to them at all times in amounts which will adequately supply their nutritional needs.
 - 3. Special "milk supplements" are not needed.
 - 4. The following table shows the amounts of feed which should be fed daily for young rabbits and other rabbits in various stages of the life cycle.

<u>Age or Condition</u>	<u>Amount to Feed Daily</u>
Growing rabbits (After weaning)	3 to 4 ounces
Resting Does	2 to 5 ounces
Does in Gestation	4 to 8 ounces
Nursing Does (until litter is 3 weeks of age)	6 to 8 ounces
Does with litter of 7 or 8 (3 to 8 weeks)	1 to 2 pounds

- B. Feed requirements for rabbits will vary with individual animals.
1. Proper amounts should be fed to keep the animal in good physical condition without allowing it to become overly fat.
 2. Fat rabbits should have feed reduced; thin rabbits should have feed increased.
 - a. The most important thing is to feed only fresh, high quality pellets.
 - (1) The way a pelleted feed is put together is important.
 - (2) The pellets should be firm and not broken into small particles (fines).
 - (3) Rabbits tend to only eat the solid pellets and will not consume the fines.
 - (4) Look at the end of the pellet.
 - (5) The firm pellets will have squarer ends.
 - (a) If the ends of the pellet are extremely ragged, this may indicate a softer pellet which will produce a greater amount of waste due to fines.
 - b. Feed every animal over 3 weeks of age one small handful of legume hay every day.
 - c. Pellets or hay should never be fed if moldy.
 3. **Some special feeding of nursing does is sometimes required.**
 - a. The doe's ration is normally reduced to one-half the usual amount on the day she kindles.
 - b. From the second to the seventh day, the amount of feed is gradually increased daily.
 - c. After the first week, feed should be kept before the nursing doe and her litter at all times.
 - d. When hay, greens, or root crops are fed, the amount of grain can be reduced.
 - e. When feeding greens, introduce small amounts at a time to rabbits, increasing total amount fed gradually to prevent diarrhea.
 - f. Salt can be provided either by mixing into the feed at one percent or in the form of commercial salt cakes.
 - g. Vitamins.
 - (1) Vitamin A is available from root crops and hay.
 - (2) Vitamin B is found in greens and crude roughage.

- (3) It is also synthesized in the rabbit's cecum and is obtained by the rabbit's re-ingesting its droppings.

III. COPROPHAGY (ka-prof-a-gee).

- A. Rabbits are unique in that they produce two types of fecal material, a hard, dry fecal pellet and a soft of "night" feces.
 1. The soft feces are produced in the cecum (a pouch located between the small and large intestines) and are consumed by the rabbit directly from its anus as they are excreted.
 2. This practice is called coprophagy or cecotrophy and usually takes place when the animal is alone.
- B. Some feces contain a mucus coating and are excreted in a cluster rather than as single pellets as with hard feces.
 1. Coprophagy is a natural process which provides the rabbit with B-vitamins which are synthesized (produced) by bacteria in the cecum and excreted in the soft feces.
 2. Night or soft feces are much higher in protein and water and lower in fiber than hard feces.

IV. KEEP THESE POINTS IN MIND WHEN DETERMINING FEED AMOUNTS:

- A. Breeding does and bucks should be kept in good condition. Many breeding failures are caused by does being overweight. In general, it is best to have a doe a little lean rather than a little fat.
- B. Pregnant does and lactating does require more feed. Consult an experienced breeder and/or a rabbit feed salesperson to help determine the amount of increase needed.
- C. Reduce the amount of feed given to a doe 24 to 48 hours before she kindles to help prevent caked mammary glands. After kindling gradually increase to full feed in 7 days.
- D. Growing young rabbits should have as much feed as they can eat; however, DO NOT let stale or moldy feed accumulate in the feeder.
- E. Provide only as much feed as your rabbits will eat between feedings; any excess left in the feeder is usually wasted.

V. TIPS TO REMEMBER WHEN FEEDING RABBITS.

- A. Use a good quality, commercially prepared, pelleted rabbit feed.
- B. Use a suitably sized container to measure your feed. (A 6-ounce tuna fish can holds about 5 ounces of pellets if shaken off level).
- C. To lower feed costs, feed a small amount of good, clean hay every day.
- D. DO NOT feed young rabbits cabbage, lettuce, or green grass.

RABBIT NUTRITION

They are not rodents, but are included in a family called Lagomorphs. They are strict herbivores and have continually growing incisors and molars that are designed to tear and macerate very tough leafy foods. The teeth rub against each other and are worn down by the action of eating. Rabbits require a large percentage of fiber in their diet to maintain normal gastrointestinal motility. Rabbits are monogastric animals with enlarged caeca. They are medium sized hopping mammals with long legs, long ears and short tails. Rabbits are mainly reared for their meat and fur. Rabbit meat is normally regarded as a white meat. Rabbits kept as a source of meat and/or a source of income. The nutrition of rabbit is an important aspect of production. Rabbit is also a small non-ruminant herbivore with an enlarged hind gut. It is a monogastric or single stomachs animal.

The digestive system consist of :

- Mouth & teeth.
- stomach & small intestine
- Caeca & large intestine

The Mouth and rabbit's teeth.

Digestion begins in the mouth, where food is mashed up by the teeth and mixed with saliva. Enzymes in the saliva begin the process of breaking down food into pieces small enough to move into the blood. When food is broken up and moist, the rabbit swallows and the food enters the stomach.

Dental formula 1 :2/1 C 0/0 pm 3/2 m 3/3
 Incisors canine premolar molars.

Total number of teeth is 28.

The mouth part of rabbit is adapted for cutting and chewing.

The incisors are for cutting. The front surface of the incisors has a thick layer of enamel which forms a sharp edge at the cutting point of the teeth.

The incisors are open rooted, meaning that they continue to grow thru out the rabbit's life as they worn down by chewing. Premolars of mortars are for grinding.

Stomach AND Small intestine.

The stomach of rabbit weights about 20g and the contents weight about 90 – 100g. The pH is between 1.5 and 2.0. The food in the stomach is exposed to acidity and some enzyme digestion begins. The weak muscular contractions in the stomach push the ingested feed into the first loop of the small intestine. The small intestine is about 310 – 350 cm long and has a weight of about 60+ 3 g. The contents of small intestine ranges between 18-42 g depend of on diet density and bulkiness. The pH of small intestine is 7.2 or slight alkaline. The first loop of the small intestine is called duodenum, Here the ingesta is bath in bile which is released into the GIT via bile duct. The bile is produced in the liver and is stored in the gall bladder. Next to the duodenum is the pancreatic loop which produces pancreas via the pancreatic duct. In the stomach the food is mixed with stomach acid and

different enzymes continue the process of digestion. Once food has been broken into even smaller pieces by the stomach, it moves into the small intestine. Small water-soluble nutrients such as sugars, amino and nucleic acids, and non water soluble fats are absorbed in this region. Larger indigestible molecules such as fiber are passed into the large intestine. Once in the large intestine the material is sorted by size. Smaller fragments are moved backwards into the cecum for use by the cecal bacteria. Larger fiber fragments are passed to the large intestine and then excreted as fecal pellets.

Caecum and large intestine

Rabbits are referred to as hind – gut fermenter that is feed is broken down by bacteria at the end of the digestive system. The major site of breakdown is the caecum. The caecum is between small and large intestines and is about 45cm long, 25-30g in weight while the content vary between 120-140g. The pH is 6.0. The caecum has absorbing and secretory cell. Its end there is a small closed sac called appendix. A rabbit's cecum maintains a delicate mix of protozoa, yeast and *good bacteria*, which is crucial to keeping your rabbit healthy. If something upsets the delicate bacterial balance (such as stress; some oral antibiotics such as penicillin & related drugs; a high fat, low fiber diet; too many carbohydrates, etc.), *bad bacteria* will begin to grow. These bad bacteria produce toxins that can be harmful or fatal to your rabbit. On the other hand, the products of *good* cecal fermentation are crucial to healthy gut flora, because they break down, or "ferment" the fiber the rabbit cannot digest. Through coprophagy, the oral re-ingestion of the cecal pellets produced by this fermentation process, the rabbit can absorb by normal digestion the special nutrients and vitamins contained in the cecal pellets.

The bacteria use the energy generated during fermentation to grow. By products of fermentation include VFA like acetic acid of monophonic butyric acid, bacteria, B. vitamins, gas like methane, bacteria protein and essential amino acids, all of which can be used by the rabbit. Volatile fatty acids are absorbed directly into the bloodstream through the lining of the cecum and provide approximately 30% of the energy required by the animal. Nutrients that cannot be absorbed directly into the bloodstream pass through the large intestine and are excreted as "cecal pellets" Cecal pellets are different from the round rabbit droppings that are left in the litterbox, they are soft, grapelike clusters that have a distinctive smell

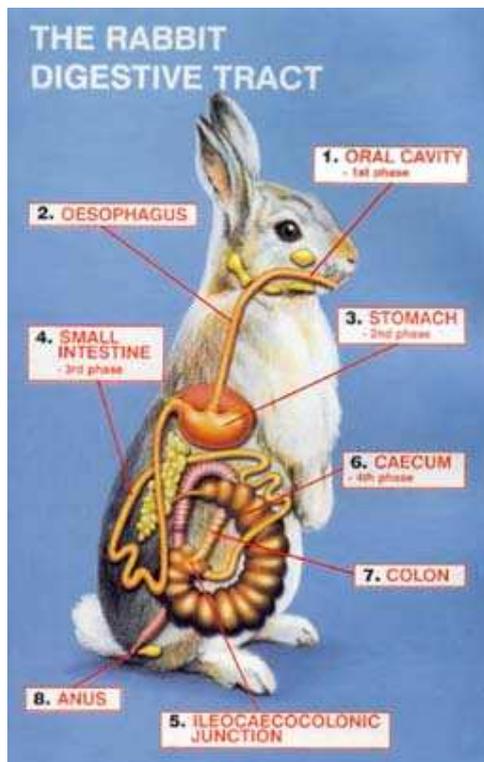
The content of the caecum are digested, VFA like acetic acid of monophonic butyric acid, bacteria, B. vitamins, gas like methane. Bacteria in the caecum cause fermentation are digested to produce B-vits, e.g. thiamine bacteria protein and gases.

Note: That when a rabbit is treated with anti biotic for a bacterial diseases, the cecal bacteria may also be killed. This often lead to disturbances in the digestive system. Water is reabsorbed throughout the caecum of large intestine. This result in relatively hard, dry fecal pellets.

Digestive tract and caecotrophy

Feed eaten by the rabbit quickly reaches the stomach. There it finds an acid environment. It remains in the stomach for a few hours (three to six), undergoing little chemical change. The contents of the stomach are gradually "injected" into the small intestine in short bursts, by strong stomach contractions. As the contents enter the small intestine they are diluted by the flow of bile, the first intestinal secretions and finally the pancreatic juice.

After enzymatic action from these last two secretions the elements that can easily be broken down are freed and pass through the intestinal wall to be carried by the blood to the cells. The particles that are not broken down after a total stay of about one and a half hours in the small intestine enter the caecum. There they have to stay for a certain time, from two to 12 hours, while they are attacked by bacterial enzymes. Elements which can be broken down by this new attack (mainly volatile fatty acids) are freed and in turn pass through the wall of the digestive tract and into the bloodstream.



The digestive system of the rabbit

The contents of the caecum are then evacuated into the colon. Approximately half consists of both large and small food particles not already broken down, while the other half consists of bacteria that have developed in the caecum, fed on matter from the small intestine.

So far, the functioning of the rabbit's digestive tract is virtually the same as that of other monogastric animals. Its uniqueness lies in the dual function of the proximal colon. If the caecum contents enter the colon in the early part of the morning they undergo few biochemical changes. The colon wall secretes a mucus which gradually envelops the pellets formed by the wall contractions. These pellets gather in elongated clusters and are called soft or night pellets (more scientifically, caecotrophes). If the

caecal contents enter the colon at another time of day the reaction of the proximal colon is entirely different.

Successive waves of contractions in alternating directions begin to act; the first to evacuate the contents normally and the second to push them back into the caecum. Under the varying pressure and rhythm of these contractions the contents are squeezed like a sponge. Most of the liquid part, containing soluble products and small particles of less than 0.1 mm, is forced back into the caecum. The solid part, containing mainly large particles over 0.3 mm long, forms hard pellets which are then expelled. In fact, as a result of this dual action, the colon produces two types of excrement: hard and soft. Table 14 shows the chemical composition of these pellets.

The hard pellets are expelled, but the soft pellets are recovered by the rabbit directly upon being expelled from the anus. To do this the rabbit twists itself round, sucks in the soft faeces as they emerge from the anus, then swallows without chewing them. The rabbit can retrieve the soft pellets easily, even from a mesh floor. By the end of the morning there are large numbers of these pellets inside the stomach, where they may comprise three quarters of the total contents.

From then on the soft pellets follow the same digestive process as normal feed. Considering the fact that some parts of the intake may be recycled once, twice and even three or four times, and depending on the type of feed, the rabbit's digestive process lasts from 18 to 30 hours in all, averaging 20 hours.

The soft pellets consist half of imperfectly broken-down food residues and what is left of the gastric secretions and half of bacteria. The latter contain an appreciable amount of high-value proteins and water-soluble vitamins. The practice of caecotrophy therefore has a certain nutritional value.

The composition of the soft pellets and the quantity expelled daily are relatively independent of the type of feed ingested, since the bacteria remain constant. In particular, the amount of dry matter recycled daily through caecotrophy is independent of the fibre content of the feed (Table 7-15). The higher the crude content of the feed and/or the coarser the particles, the sooner it passes through the digestive tract.

On the other hand, this particular function requires roughage. If the feed contains few large particles and/or it is highly digestible, most of the caecal contents are pushed back to the caecum and lose elements which nourish the "normal" bacteria living in the caecum. This would appear to increase the risk of undesirable bacteria developing in this impoverished environment, some of which might be harmful.

It is thus advisable to include a minimum of roughage in the feed, enabling the rabbit's digestive process to be completed fairly rapidly. In theory, roughage is provided by the crude-fibre content of the feed, as this is normally rather hard to digest. However, certain fibre sources (beetroot pulp, fruit pulp in general) are highly digestible (digestibility of crude fibre varies from 60 to 80 percent). Recommendations now made on quantities of indigestible crude fibre to be fed are therefore given below. Table 16 gives the chemical composition of various raw materials which can be fed to rabbits.

Caecotrophy regulation depends on the integrity of the digestive flora and is governed by intake rate. Experiments have shown that caecotrophy starts eight to 12 hours after

the feeding of rationed animals, or after the intake peak of animals fed ad lib. In the latter case, the intake rate and hence the function of caecotrophy are governed by the light regime to which the animals are subjected.

Caecotrophy also depends on internal regulatory processes as yet not understood. In particular, the removal of the adrenals halts caecotrophy. Cortisone injections of animals without adrenals causes the resumption of normal behaviour. The digestive process of the rabbit appears to be highly dependent on adrenalin secretions. Hypersecretion associated with stress slows down digestive activity and entails a high risk of digestive ailments.

Composition of hard and soft faeces: averages and range for ten different feeds

Components	Hard pellets		Soft pellets	
	Average	Range	Average	Range
	<i>(Percentage)</i>			
Moisture	41.7	34-52	72.9	63-82
Dry matter	58.3	48-66	27.1	18-37
	<i>(Percentage of dry matter)</i>			
Proteins	13.1	9-25	29.5	21-37
Crude fibre	37.8	22-54	22.0	14-33
Fats	2.6	1.3-5.3	2.4	1.0-4.6
Minerals	8.9	3.1-14.4	10.8	6.4-10.8
Nitrogen-free extract	37.7	28-49	35.1	29-43

Source: Proto, 1980.

Intake and excretion of dry matter by growing rabbits eating isonitrogenous feeds containing two levels of straw in place of maize starch

	Experimental feeds	
	Low fibre content	High fibre content
Straw content (%)	5	20
Crude-fibre content (%)	10.8	16.8
Daily dry-matter intake (g)	60±28	67±28
Dry matter excreted each day in:		
hard pellets (g)	20±5	33±8
soft pellets (g)	10±4	10±5

Source: C. Dehalle, personal communication, 1979.

Caecotrophy first starts to function in young rabbits (domesticated or wild) at the age of about three weeks, when they start eating solid feed in addition to mother's milk.

Feeding behaviour

Feeding behaviour studies have basically involved rabbits receiving balanced concentrates or fed ad lib on dry feed (cereals, straw, dry forage).

The feeding pattern of newborn rabbits is imposed by the dam. A doe feeds her young only once every 24 hours (although some does will nurse their young twice). Suckling lasts only two or three minutes. If there is not enough milk the young try to feed every time the doe enters the nestbox, but she will hold back her milk. This behaviour signals insufficient milk production in the doe.

From the third week of life the young rabbits begin to move about, taking a few grams of mother's milk and a little drinking water if available. In a few days the intake of solid feed and water will exceed the milk intake. During this period the changes in feeding behaviour are remarkable: the young rabbit goes from a single milk feed a day to a large number of alternating solid and liquid feeds distributed irregularly throughout the day: 25 to 30 solid or liquid meals every 24 hours.

The number of feeds during light periods drops and the morning "feeding rest" tends to lengthen. The feeding habits of wild rabbits are even more nocturnal than those of domesticated rabbits.

The Importance of Fiber in rabbit nutrition

Many different types of microorganisms (bacteria and protozoa) normally live in the rabbit intestine and cecum and aid tremendously in fermentation and digestion of foods. Fiber is required for these microorganisms to function properly and stay in balance. Fiber also stimulates motility of the gastrointestinal tract and helps keep food moving properly so that normal digestion and absorption of nutrients can take place. Without fiber, gut motility slows down, the normal bacterial population is disrupted, and changes in gut pH and fermentation occur. This dangerous cascade of events can lead to indigestion or gut stasis, and can make a rabbit very ill. Rabbits experiencing this type of illness, called ileus, may show a decreased appetite, decreased fecal production, decreased size of fecal balls, softer feces, weight loss, increased gas production, and possibly diarrhea or other life-threatening disease. Ileus is frequently misdiagnosed as a "hairball" stomach obstruction.

High fiber is also necessary to keep the teeth in normal wear. A rabbit's teeth grow continuously throughout its lifetime. In the absence of a high fiber diet, the teeth tend to overgrow, and complications can result including incisor or molar malocclusion, molar points, or tooth root and facial abscesses. When your rabbit is fed an improper diet that is, one that does not contain an adequate amount of [indigestible] fiber or one that is too high in carbohydrates the Gastro-Intestinal (GI) tract cannot function properly and it begins to shut down, causing various degrees of what is called GI stasis.

what is GI stasis ?

When the speed with which material moves through the GIT is altered it can affect how quickly the stomach and cecum empty. When this happens we often see a

dramatic decrease in the rabbit's appetite for both food and water, which only furthers the problem: The body still needs water to function so it takes it from the stomach and cecum, causing the contents of the entire GI tract (food, hair from grooming, etc.) to become further dehydrated and impacted. The bunny is then unable to pass the mass of food/hair in the stomach, feels full, uncomfortable and often gassy (due to the build-up of the bad bacteria in the cecum), which only adds to his "I don't want to eat" mentality! A rabbit in GI stasis will often stop eating, become anorexic and die. When a rabbit dies from GI stasis and its related problems it is most often due to hepatic *lipidosis* or Fatty Liver Disease, which is caused by the toxins produced by the bad bacteria in the cecum.

In most cases, especially those caught early-on by observant owners, GI stasis can be reversed with time, *patience* and good advice from your rabbit vet. But our goal is to prevent it from happening at all.

What Causes GI Stasis?

A rabbit's intestine can become static for a variety of reasons, including

(1) stress (2) dehydration (3) pain from another underlying disorder or illness (such as gas, dental problems, infections, or urinary tract disorders)

(4) an intestinal blockage or (5) insufficient dietary crude fiber. Left untreated, the slowdown or complete cessation of normal intestinal movement (peristalsis) can result in a painful death, in a relatively short period of time.

An intestinal slowdown can cause ingested hair and food to lodge anywhere along the GI tract, creating a potential blockage. Also, because the cecum is not emptying quickly enough, harmful bacteria such as *Clostridium* species (related to the ones that cause botulism and tetanus) can proliferate, their numbers overwhelming those of the normal, beneficial bacteria and fungi in the cecum. Once this overgrowth occurs, gas emitted by the bacteria can cause extreme pain. Some *Clostridium* species also produce potentially deadly toxins. It is the liver's job to detoxify these poisons, at a high cost to that all-important organ. Damage to the liver can be a serious--even life-threatening--side effect of GI stasis.

Rabbits can be fed on four major types of feed

- | | |
|-----------------|---------------------------------|
| 1) Grass | 2) Weeds |
| 3) Leaves | 4) Agro- industrial by products |
| 5) Concentrates | |

GRASSES

- | | |
|------------------------|----------------|
| 1) Elephant grass | 2) Spear grass |
| 3) Guinea grass | |

WEEDS

- | | | |
|----------------------------|------------------------------|------------------------------|
| - <i>Tridax procumbens</i> | - <i>Asphilia africana</i> | - <i>Syndrella nodiflora</i> |
| - <i>Milk weed</i> | - <i>Talinum triangulare</i> | |

LEAVES

- | | | | |
|----------------------|----------------|----------------|------------------|
| 1) Sweet patoto leaf | 2) Pawpaw leaf | 3) Cowpea leaf | 4) Plantain leaf |
|----------------------|----------------|----------------|------------------|

AGRO-INDUSTRIAL BY PRODUCT

- Maize milling waste
- Maize chaff
- Ground nut haulms
- Rice milling waste

TYPICAL RABBIT CONCENTRATE

Ingredients	%composition
Maize	45.00
Soya bean meal	10.00
Ground nut cake	10.00
Palm kernel cake	10.00
Wheat offal	19.50
Bone meal	2.00
Oyster Shell	1.50
Premix	0.25
Salt	<u>0.25</u>
	<u>100.00</u>

M.E=2.55 KCAL/G

CP= 18%

CF = 15%

CONCENTRATE FEEDING IS THE MANAGEMENT OF CHOICE

Because -Concentrate feed is in form of mash

- It is easy to serve.
- Left over does not stink
- It supplied the necessary nutrients
- It encourage and maintain sanitation and cleanliness in farm

A recommended level of 50-100g concentrates daily depending on age and physiological status Concentrates are supplied in concrete feeders of varying height

-Clean water is supplied in drinkers daily

-Wash feeders every other day to prevent mouldiness

Adaptation of Rabbits to forage based- diets

The caecum is the major site of microbial growth and fermentation. So small herbivores like rabbit have evolved a unique digestive strategy that allows them to utilize a forage- based diets. The followings are noted in rabbit:

- (i) The digestive system involves selective separation of fibre particles from non-fibre components (stomach) for fermentation in the caecum.
- (ii) The selective separation and excretion of fibre is accomplished by muscular activities of the portioned colon. Fibre particles are less dense than other components of a forage, so they tend to segregate out in solution. The separated fibre particles are moved rapidly by peristaltic action to the colon, forming the faecal pellet (hard feces)
- (iii) Reverse peristalsis moves the non- fibre components (starch, granules, proteins, hides) from the proximal colon to the caecum where they undergo microbial fermentation. Colon is emptied completely every 24hrs of hard faeces and the soft faeces or chemotropism are excreted. In this process, the caecum contracts to move the caecal content into the proximal colon. Mucus is separated

by goblets cells into the lining of proximal colon, covered or coated the cecotropes, which resembles grapes in appearance. These are moved true the colon by peristaltic action and are consumed directly from the anus by the animal.

PELLETS

The recommendations for feeding pellets to rabbits have changed dramatically over the past 5-10 years. Pelleted rabbit feed used to be recommended as a complete diet for rabbits with little other supplementation necessary. However, pelleted diets were originally formulated for the rapid growth of the meat, fur production, or laboratory rabbit. Most of these rabbits were not meant to live out their full life span. The breeding rabbit, with an average life span of 5 to 10 years, needs a balanced, low-energy, consistent diet with plenty of fiber primarily in the form of hay. Pelleted diets are typically made up of chopped, compressed hay, various grains, molasses, and other added nutrients. Grains can be quite high in calories (starches and fats) and lower in fiber than hay, and disrupt the microbial balance when eaten in significant quantities. The hay in pellets is chopped, compressed, and heated, and thereby loses a lot of its fiber quality. A high-quality pellet should be chosen that contains over 20% fiber and less than 16% protein. Avoid pellet mixes that contain too much seeds or grains such as corn .

Feeding a high quality diet comprised of hay, fresh vegetables, and limited quantities of pellets is key to optimal rabbit health and good preventative medicine. Many common diseases of rabbits are related to improper nutrition and can be prevented by learning about their nutritional requirements, consistency in the diet, and maintenance on a well-balanced high-fiber ration.

Nutrient Requirement of Rabbits

Carbohydrates

Carbohydrates provide energy for the rabbit.

Types

- Simple sugars (a.k.a. monosaccharides):
glucose, fructose (fruit sugar), corn syrup, high fructose corn syrup, dextrose
- Complex sugars (a.k.a. polysaccharides):
starch

Source

- Grains - Concentrated Starch
- Pellets - Concentrated Starch

- Fruit - Fructose

Needs

Carbohydrates are the primary energy source in the rabbit's diet. Therefore, the rabbit's need for carbohydrate is dictated by their energy level. Rabbits with higher energy demands, such as nursing mothers, growing bunnies, rabbits with some types of cancer, and those on certain drugs, may require more carbohydrates in the diet. Spaying and neutering decreases the need for energy and intake should be modified accordingly.

Dangers

Too much starch or sugar can contribute to obesity because the rabbit will convert the excess energy to fat. Enterotoxemia can be caused by too much carbohydrate in the diet. This is because the excess carbohydrate travels to the cecum where the extra energy can cause the wrong populations of bacteria to grow and produce toxins.

Fiber

Function

- Drives digesting food through the digestive tract (breaks digested food/feces into smaller masses)
- Is the best source of energy for bacteria living in the cecum (eg. fiber is converted into volatile fatty acids)
- Protects against diet induced enterotoxemia (maintains the cecal bacteria balance)
- Protects against GI stasis and helps prevent blockages due to hair
- Adds water and bacterial bulk to the feces (makes defecation easier)
- Helps retain water in the digestive tract.

Protein

Function

Protein is essential to make a bunny.

- Proteins help make bone and muscle and fur, they also are responsible for turning food into energy.
- Proteins are important for the proper functioning of the cecal bacteria

Fats

Function

- Provide energy
- Facilitate absorption of fat soluble vitamins

Source

- Grains

- Nuts
- Pellets
- Oils (flax seed oils and vegetable oils)

Needs

- Rabbits require approximately 1-1.5% of the total caloric intake to be fats.
- There is also a requirement for essential fatty acids, linoleic and linolenic acids.
- Eicosanoid hormones are essential for blood pressure control, blood clotting, muscle contractions and memory. Precursors for these hormones (omega 3 and omega 6 fatty acids) are essential and must be supplied by the diet.

Vitamins

Function

- Are important to help release energy from food and energy stores
- Act as hormones to regulate metabolism
- Act as antioxidants to prevent cellular damage

Source

- The water soluble vitamins and vitamin K are synthesized by the cecal bacteria and obtained by coprophagy.
- Carotenes (plant pigments) are converted to Vitamin A in animal tissues.
- Pre-vitamin D is found in sun-dried hay and can be synthesized by the skin after exposure to UV light.
- Vitamin E is found in vegetable oils and cereal grains.

Needs

- Rabbits do have an absolute requirement for all the vitamins except C.
- However, the vitamin K and the B-vitamins are provided by the cecal bacteria and therefore may not need further supplementation until the cecum is disturbed or the cecal pellets are not consumed.
- Rabbits receiving pellets as part of the diet should be receiving sufficient amounts of vitamins D, A, and E. For rabbits receiving no pellets, it is possible that D and E would become deficient after a long time (many years). Carrots, of course, are rich in vitamin A.
- Extreme excesses of Vitamin C can cause kidney damage.
- Excess vitamin D can cause calcium deposits in tissues (joint, kidneys, etc.).
- Excess vitamin A causes neurological and skin damage.

Minerals

Function

- Are important for bone structure (calcium, phosphorus, magnesium).
- Bind oxygen and carry it through the blood stream (iron).
- Act as antioxidants to prevent cellular damage (selenium).
- Help to release energy from foods and stores (iodine, cobalt, chromium).
- Participate in blood pressure control (sodium, potassium)

Source

- Many plants concentrate minerals therefore there is not a big risk that rabbits fed a varied diet including lots of vegetables would develop deficiencies.
- Pellets are a good source for minerals.

Excess minerals can be toxic, however, this should not be a concern with most minerals. The one exception is calcium. Rabbits metabolize calcium very differently from other animals. Rabbits absorb calcium from the intestine very efficiently (60-80% of ingested calcium is absorbed into the blood stream), and the major way for them to get rid of this calcium is through the urine.