

ST. FRANCIS COLLEGE
OF EDUCATION

NON-TRADITIONAL ANIMAL FARMING.
EBS 305

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OVERVIEW OF NON-TRADITIONAL LIVESTOCK PRODUCTION

Globally, wildlife has great potentials for meat production and serves as an important source of the highly desired animal protein to the people of Africa, both in urban areas and rural communities. The preference for bush meat or the meat of commercially available game animals is widely accepted. However, with ever increasing human population and obvious protein inadequacy in Africa, there is the need for an exploration of other means to provide readily acceptable meat on short term basis. Wildlife domestication has been recognized as a way of achieving this objective.

Until recently, non-traditional livestock species were hunted from the wild, but there are several challenges associated with this practise, hence, the need to rear them at home. These include:

Uncertainty of catch – hunting from the wild is not a sure way of assuring consumers who need meat supplied to them for various functions. This is because hunters may return on some days without a catch, while on other days, they may get more than expected. This inconsistency in meat supply may inconvenience some consumers, hence the need to keep them at home.

Inadequate supply of products – Keeping animals at home enables the farmer to intensify productivity, so adequate quantities could be obtained when needed, unlike hunting from the wild.

Species not available when needed – When one goes to hunt, they may return with livestock species which were not planned for. For instance, a hunter may set out to go and hunt for grasscutters, but may return with an antelope.

Environmental degradation – Some crude hunting methods may cause environmental degradation such as wild fires which may pollute the air and also burn down people's properties.

Wildlife extinction – Some crude hunting methods such as the use of poisonous substances and bushfires may kill entire generation of some livestock species, causing possible extinction.

The Grasscutter

Grasscutter (*Thryonomys swinderianus*) is a wild rodent widely distributed in the African sub-region and exploited in most areas as a source of animal protein. Being the most preferred and most expensive meat in West Africa including Nigeria, Togo, Benin, Ghana and Cote d'voire, it contributes to both local and export earning of most West African Countries and is therefore hunted aggressively. Unfortunately, its collection from the wild is attended by destruction of the environment through the setting of bush fires by hunters. To alleviate this problem, attempts are being made in the sub-region to domesticate the grasscutter and make it more readily available, gain economic benefit and also reduce the environmental destruction that accompanies its collection from the wild.

Rabbit (*Oryctolagus cuniculus*) rearing

Rabbit rearing has been in existence for centuries, but were purposely raised as laboratory animals for experimental purposes. The hair of rabbit (fur), and the skin (pelt) later became of economic importance as they are used for decorative and for protective clothing. Through breeding, meat producing rabbits were bred, and now play very essential roles in supplementing the protein requirements of consumers. Rabbit meat is now a delicacy, which is widely acceptable to consumers, hence the need to rear these on commercial basis.

Bee Keeping

Bees have been in existence since creation. They play several roles in human life by providing products such as honey, propolis, bee wax and bee venom for health and financial benefits. In addition, bees contribute to pollination of agricultural crops to improve crop yield and ensure biodiversity. Despite the significant roles played by bees, their existence is threatened by uncontrolled use of insecticides in crop production, which directly has adverse effects on their lives. There must be a way of protecting these species to avoid their extinction. Bees produce

products such as honey for use as food and medicinal purposes. They also produce propolis, which is used mainly for medicinal purposes. Propolis is a mixture of various amounts of beeswax and resins collected by the honeybee from plants, particularly from flowers and leaf buds. Bees have been observed scraping the protective resins of flower and leaf buds with their mandibles and then carrying them to the hive like pollen pellets on their hind legs. It can be assumed that in the process of collecting and modelling the resins, they are mixed with some saliva and other secretions of the bees as well as with wax.

The African Giant Snail

Snail meat, is often called “Congo meat” in some parts of West Africa, is consumed in many countries in the world, with some, considering it as a delicacy for the rich. Snail farming and research are particularly being conducted in countries like Ghana, Nigeria, Benin, and Cameroon.

Despite high demand for snails internationally, the supply from Africa is solely dependent on handpicking from nature.

More snails are available for collection during the rainy season than in the dry season, but activities like snail hunting, bush burning, deforestation and the use of agricultural pesticides are causing a decline in snail numbers. Snails can however, be reared under extensive, semi-intensive and intensive systems, depending on the location, and are best reared in the rainy season.

UNIT ONE (1)

GRASSCUTTER PRODUCTION

HOW TO START AND SUCCEED

ORIGIN OF LIVESTOCK REARING

- Domestication of livestock started over 11,000 yrs. ago (Lawrie and Ledward, 2006).
- It was necessitated by the depleting wild animal numbers, environmental degradation associated with hunting of animals, uncertainty of catch etc.
- Some animals were therefore, brought home where feeding, housing and medications are provided to boost productivity.
- Some livestock species are however, in a transitional stage of domestication. These include:
 - Grasscutters (cane rat)
 - Rabbits
 - Snails
 - Ostriches etc.
- For the purpose of this meeting we shall consider Grasscutter production in details

GRASSCUTTER, WHAT IS IT?

- Grasscutter is a wild rodent which is widely distributed in the African sub-region and exploited as a source of animal protein.
- As the name suggests, it feeds mainly on forage materials (especially grass), but subsists on household remnants, farm wastes and on agro-industrial by-products.
- It is a quick runner and a skilled swimmer as well.
- Its visual powers are relatively poor, making communication to be based on hearing and their strong sense of smell.

WHY GRASSCUTTER?

- Grasscutter meat sells higher than most conventional meats (beef, mutton, chevon chicken etc)
- It is widely hunted for using crude methods that can harm humans and the environment.
- The meat is tender and is rich in high quality proteins but low fat contents.
- It is a good business for landless and poor individuals, as they require minimal space and resources for adequate production.
- It is a hardy animal that requires minimal health attention.
- Unlike other meat types, grasscutter meat is not imported into the country; thus less competition to producers.
- They grow and reproduce well even in the absence of good quality feed.
- It is a good source of employment as it requires minimum capital investment
- They generate relatively minimal waste, hence the farmer will have minimal problems with waste disposal and with neighbours.
- With a capital of about 1000GH, one could obtain a hutch, breeding stock of 4 (3F, 1M).
- Reproductive capacity is good (about 8 animals /F/year).
- Ready for sale or for slaughter in a year (52 weeks).
- Young ones are born developed, so no extra care is required.

PHYSICAL CHARACTERISTICS OF GRASSCUTTERS

- The head of mature grasscutter is slightly elongated in the female and more rounded in the male.
- The nostrils of both male and females are pink and hairless.
- The eyes are black in normal animals but red in albinos.
- The neck is short and thick.
- Their fur is shiny and slippery, to enable escape when in trouble.

PICTURES OF GRASSCUTTERS



PHYSICAL CHARACTERISTICS OF GRASSCUTTERS

- The limbs of grasscutters are short, and the digits have tough powerful claws.
- The hind limbs are well developed, robust and enable powerful leaps.
- When frightened, grasscutters have been known to jump distances of 2m and heights of up to 4m.
- They are harmless, and their response to danger is generally to flee.

BEHAVIORAL CHARACTERISTICS OF GRASSCUTTER

- Grasscutters are more active during the night and at dawn, compared to day time.
- They are excellent swimmers, have a delicate ear and a nose to detect scents.
- They live in small groups of family colonies, comprising a buck, one or more does and their offspring. Adult males however live solitarily.

HOUSING GRASSCUTTERS

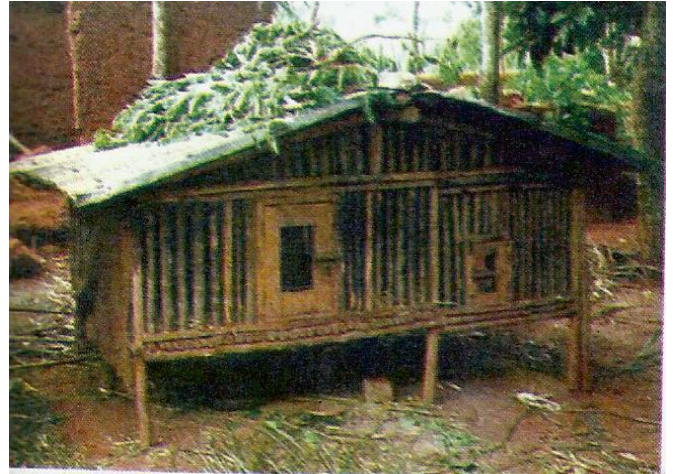
- Housing is meant to protect the animals from extremes of temperature, wind, sunlight and from rains.
- Housing also protects the animals from predators, thieves and also prevents the animals from escape.
- Housing enables easy examination and treatment of the animals by the attendants.
- It also facilitates effective and efficient breeding operations.

CONDITIONS FOR HOUSING THE ANIMALS

- It is advisable to use locally available materials to minimize costs of construction.
- The housing must be situated at areas devoid of strong scents
- Grasscutters are easily scared by noise, and can injure themselves or even die as a result, so it should be situated far from noisy areas.
- The housing should facilitate easy cleaning and disinfection.
- The building must be roofed to avoid escape of the animals, as grasscutters can jump as high as 4m.
- Sides facing the direction of the wind should be closed up to prevent direct winds in the cages, as these can cause pneumonia.

- The floor of the house should be kept dry always, as wet and muddy floors predispose animals to diseases.
- Preferably, the floor should be made of wire netting to enable droppings and wastes to drop.

A CAGE SHOWING METAL REINFORCEMENT WITHIN





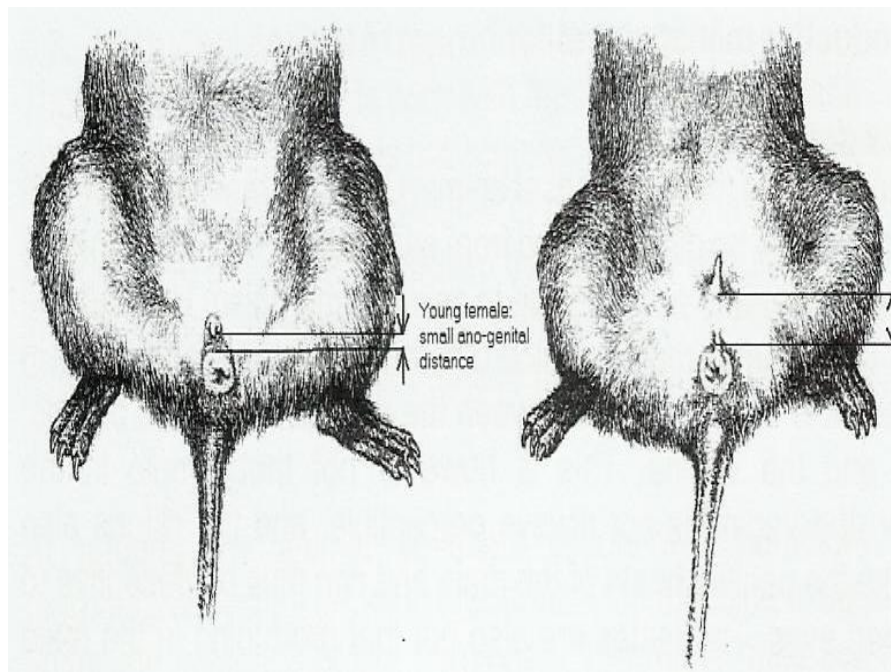
- The animal for breeding must be healthy, i.e.
- It must be active when allowed to move about
- Its face and anal region must be clean and dry
- The skin-covering must be clean, smooth and shiny
- The female must have well developed teat
- It must not have open sores, as these could serve as routes for infections.

SOURCES OF BREEDING STOCK

- Since grasscutter farming is an emerging business, there are currently no breeding stations in the country.
- However, there are farmers in certain parts of the country that can supply reliable breeding stock.
 - Animal Research Institute, Accra.
 - Kumah farms, Kumasi
 - Several other farmers mostly in the Brong Ahafo and Ashanti regions.

SEX IDENTIFICATION

- Males have bigger heads than females
- The ano-genital distance of the males is longer than for the females
- The males have shorter snouts than the females
- The testes of the male can be felt after 4 weeks of age.



FEEDING THE GRASSCUTTER

- The growth rate, reproductive performance and the health of an animal largely depends on what it eats.
- The nutrients required for the physiological functions of animals are
 - Proteins
 - Carbohydrate
 - Fats
 - Minerals
 - Vitamins
 - Proteins are required for tissue construction, and are a major component of muscles.
 - Carbohydrates are needed to provide energy for the animals.
 - Fats serve as a secondary source of energy for the animals.
 - Minerals are needed for bone and blood formation.
 - These nutrients are available in various plants and plant parts.
- The grasscutter is a herbivorous animal with wide nutritional intake. •

SOME FEED INGREDIENTS FOR GRASSCUTTERS

LEAFY MATERIALS

- Sugarcane
- Cassava leaves and stems
- Plantain pseudostem
- Spear grass
- Guinea grass
- Sweet potato vines
- Oil palm seedlings
- Sandpaper tree
- Fresh groundnut tops

• TUBERS AND UNDERGROUND STEMS

- **Spear grass**
- **Cassava tubers**
- **Yam**
- **Sweet potato**

FRUITS AND GRAINS

- Mango (unripe)
- Oil palm fruits
- Pineapple
- Maize (both fresh and dried)
- Cowpea (beans)
- Wheat bran
- Bread
- Kitchen leftovers
- Salted corn cobs etc

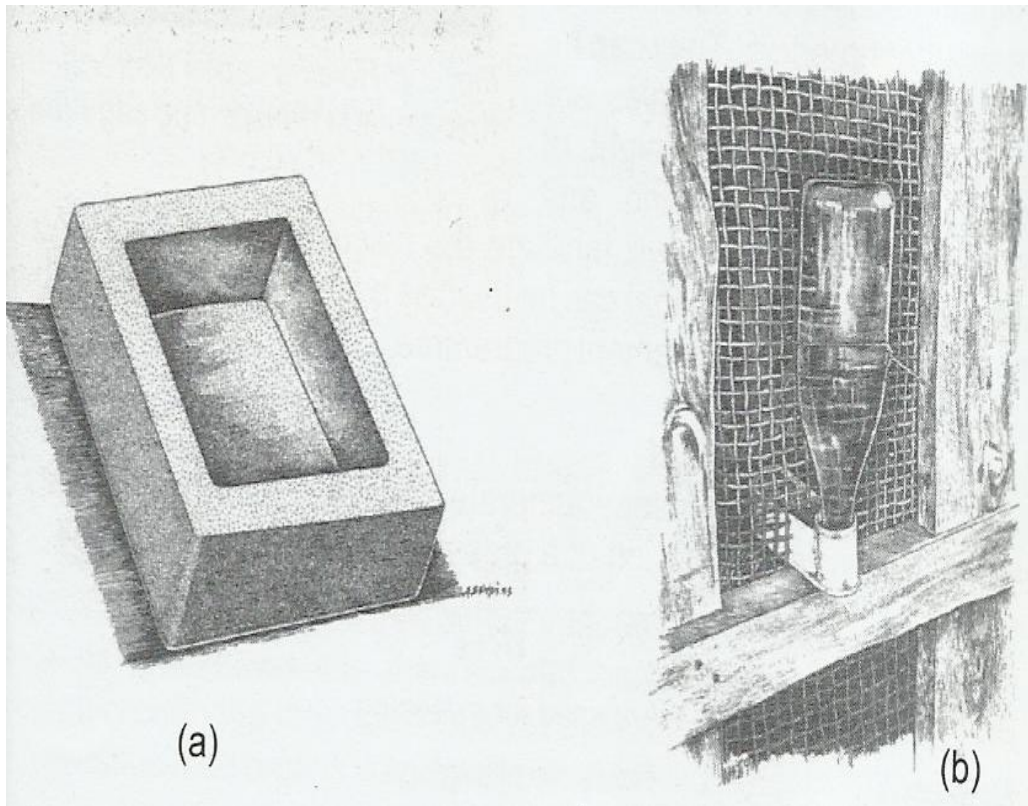
FEEDING SYSTEMS

- Intensive
 - This is where the animal is fed on concentrate as a sole diet. This is cost intensive, and animals tend to lay down more fat. Productivity is however high under this system.
 - Extensive
- This is where animals are fed on forage or kitchen leftovers. This system is cheap, but does not ensure optimum productivity.
- Semi-intensive system
- This is a combination of the first two systems. Animal are given forage, kitchen leftovers, and are supplemented with concentrates.
- Productivity under this system is high, and is currently the commonest.
- It is less expensive and carcass characteristics are better than those raised under the intensive system.

IMPORTANT FACTS ABOUT GRASSCUTTER NUTRITION

- Green grass forms the bulk of grasscutter diet.
- The animal eats mostly the stems of grasses and legumes, and little of the leaves
- Agro-industrial by-products such as corn chaff, cassava peels, yam peels, maize stocks, groundnut tops can be fed as supplements
- Care should be taken when feeding fresh cassava, because high cyanide contents can kill the animals
- Always dry cassava before feeding to the animals
- Feed sugar cane in smaller quantities, because too much sugarcane can lead to inflammation of the gum (gingivitis).

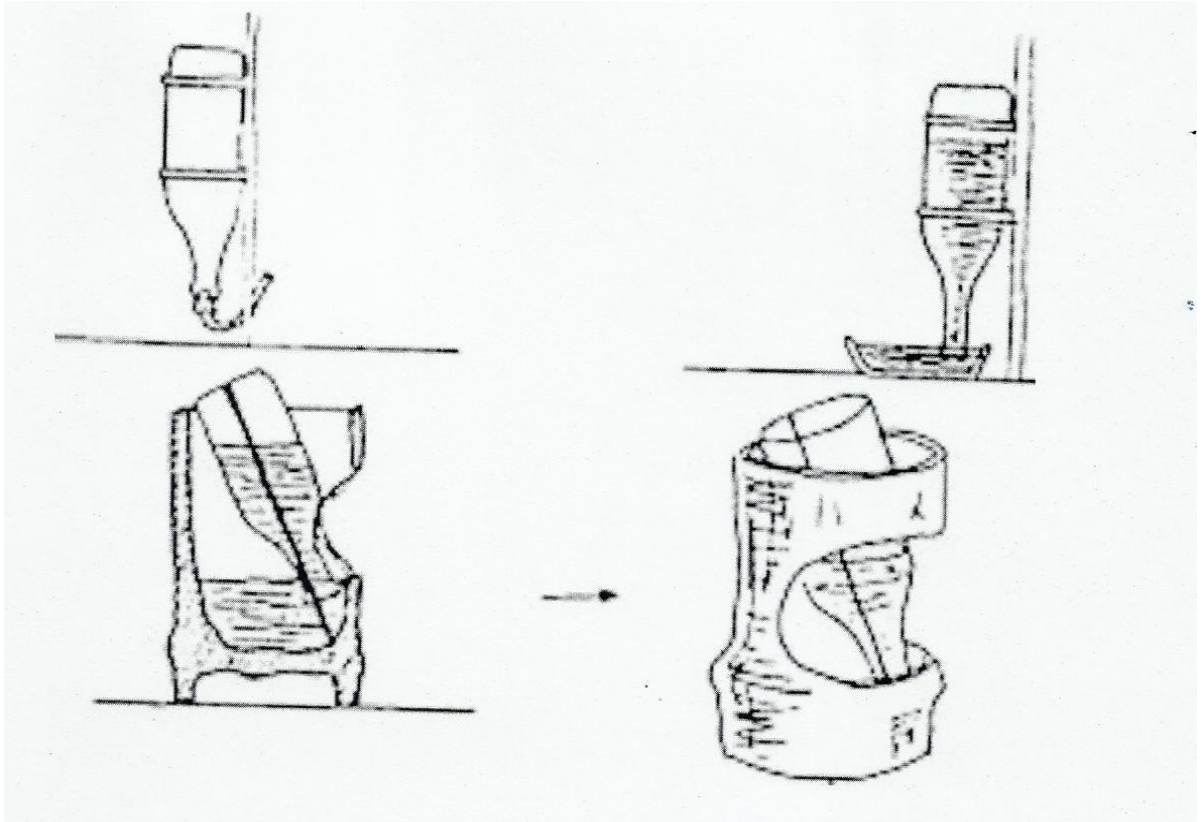
- The incisors of the grasscutter can overgrow and pierce the upper gum. This causes the animal to refuse to eat.
- In the wild, they chew hard bones to sharpen the teeth. In the home, they can be provided with hard bones such as thigh bones of cattle to help wear down the teeth.
- Feed should be wilted before feeding, as very wet grass often causes diarrhoea. Freshly cut grass can be kept for a day or two before feeding.
- Grains, such as maize and millet can be fed as supplements, but too much of these can cause bloat in the animals.
- Grasscutters are nocturnal organisms, so feed little in the afternoon, but much in the night and at dawn, so provide much feed at these times of the day.



WATER

- Water is needed by the grasscutter for feed digestion, cooling the body when the weather is warm, rehydration of cells and tissues, etc.

- Although the animal obtains water from the feed it eats, it is important to provide cool, clean and fresh water ALL THE TIME to the animals.
- They can survive shortly without feed, but not without water.



- Absence of water to the grasscutter can result in:
- Abortions
- Still births
- Lower birth weights
- Incidences of digestive disorder,
- Some diseases

BREEDING OF GRASSCUTTERS

- Grasscutters breed all year round with a peak incidence of pregnancy in June.
- The males must be housed singly when they reach 4 months old (attain sexual maturity), because they can fight to death.
- The vaginal opening of the female is normally blocked with a thin membrane (the vaginal closure membrane).
- During oestrus and at birth however, there is perforation of this membrane.
- Grasscutters are induced ovulators, and breed all year round; therefore no consideration is given to the time of mating.

- During mating the female should always be taken to the male, not vice versa.
- Male and female live together until mating takes place.
- The signs include – perforation of vaginal membrane, presence of copulatory plug in the vagina and on the floor of the cage and scratches on the trunk of the female.
- Separate the female from the male immediately you observe signs of mating.
- Successful mating is manifested by vulval congestion, vulval oedema and protrusion of the vaginal wall.
- The gestation period for grasscutter is 152 ± 3 days (5 months).
- Litter size ranges between 4 and 8 depending on the breed (Sex ratio is approximately 1:1).
- Small breeds (4), whilst larger breeds (6-8)
- Litters per year is 2
- Unlike rabbits, the young grasscutters are born with opened eyes, skin covered and developed teeth.
- The young therefore follow the mother and can eat immediately they are born.
- This makes their management quite easier than with rabbits.

WEANING OF YOUNG ONES

- Young ones are weaned (separated from mother) when they are between 4-6 weeks old.
- To minimize stress among the young ones, the mother should rather be taken from the young ones.
- Grasscutters defend their territories, so when mixing weanlings from different mothers, the many should rather be moved to the few.

FACTS ABOUT GRASSCUTTER REPRODUCTION

- Females attain sexual maturity at age 6-8months (1.5 kg weight).
- Males are ready for mating when they are 7-8months old (2.5kg weight)
- When females are ready for mating - they lash their tails at the male, and attempt to reach the male.
- Females can be mated in a group. One male can service up to 6 females.
- Females are taken to the male for about a month before separating them.
- Pregnancy is visible after 2 months of mating – becomes sluggish, abdomen enlarges, teat become very prominent
- Females should not be allowed to litter in the presence of the male, as it can kill all the young males, to avoid future competition.

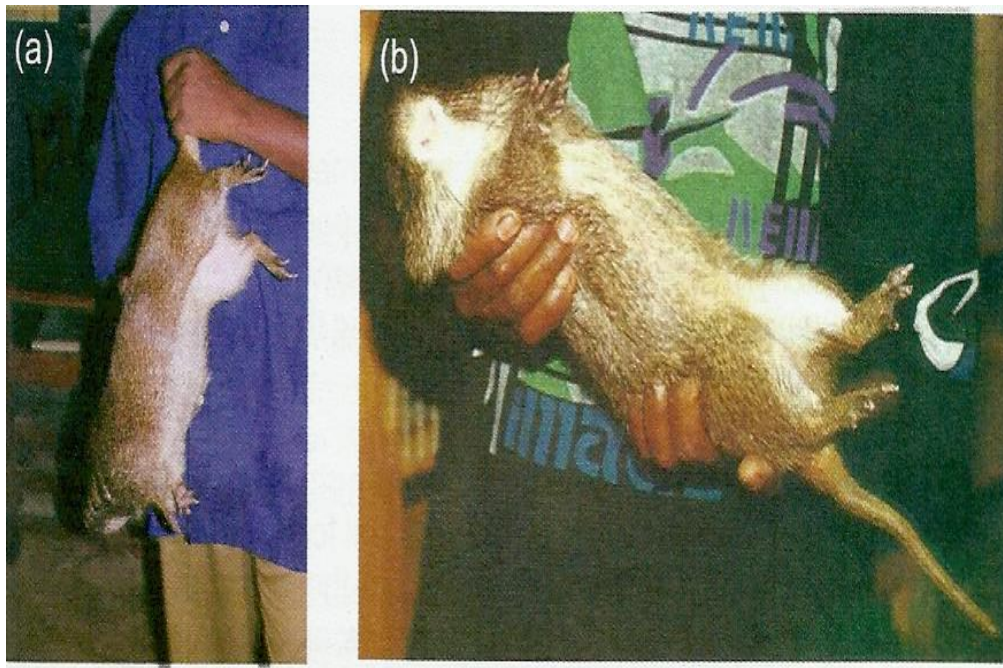
- A group of mothers (up to 3) and their litters can live at peace in the same cage. The young could suckle from any of the mothers without harm.
- Female weanlings can be grouped in cages according to size, but males should live singly when they are about 4 months old.
- Mothers can be mated after 1-2 weeks of weaning to enable some rest resulting from the stress of lactation.
- Females will normally refuse mating by males that are too big or too small for them.
- Females should be replaced when they litter about 5 or six times
- Replacement should be done with females that are not related to the male to avoid in-breeding

HANDLING GRASSCUTTERS

- Grasscutters have very sharp and dangerous incisor teeth. One must be cautious when handling them.
- Holding the limbs is dangerous, as it can result in fracture.
- You can restrain by the tail
- By the shoulder and the rump
- Or by the rump only

APPROPRIATE WAYS OF HANDLING GRASSCUTTERS

9



DEVICES FOR RESTRAINING AND TRANSPORTING GRASSCUTTERS



- Grasscutters are hardy animals and with good management practices (strict hygienic conditions), there should be little or no veterinary care.
- Major causes of ill-health are:
 - poor feeding of animals,
 - insanitary conditions
 - Injuries due to struggles
 - Poisoning of animals
 - General stressors

STRESS-RELATED DISEASES

- Grasscutters become nervous when caged. They then feel threatened and panic when such situations occur.
- This may lead to:
 - Body injuries
 - Fractures
 - Internal bleeding
 - Abscesses (when wounds get infected)
- ☐ Treat external injuries with antibiotic sprays and healing oils

PREVENTING STRESS-RELATED DISEASES

- Avoid situations that may lead to struggling

- Adopt proper handling and approach courteously
- Remove sharp edges and points such as those of wire nettings from the cage.
- Limit the number of visitors to your farm
- Adopt proper cage design

PATHOGENIC DISEASES

- Pneumonia and upper respiratory tract infections

Predisposing factors include chilling, dampness and cold windy weather conditions.

This can be controlled by preventing animals from coming into contact with cold and strong winds

ECTO-PARASITES

- Ticks
- Mites
- Fleas
- Control by keeping away stray animals, especially dogs.
- Disinfect cages regularly
- Clear all bush in the area
- Dust the animals with recommended powdered insecticides.

ENDO-PARASITES

- These are found in the gut of the animals. They feed on the food taken by the animal, and on its blood.
- Very common in young animals
- Endo-parasites infestation result in certain diseases such as Coccidiosis.
 - The symptoms of this disease include pasty faeces, weakness, prostration and emaciation.
 - Control: Use Amprolium at 3g/kg body weight.
 - Precautions – good general hygiene, keep rabbits away.

BLOAT

- Results from feeding food with too much high soluble sugars e.g. Maize, sugar cane, wet grass.
- Symptoms include – discomfort, extended abdomen, pain, gas within the abdomen.
- Precautions:

- Give grains only as supplement.
- Wilt grass before feeding
- Do not feed too much sugarcane.

OVERGROWN TEETH

- Results from feeding too much non-fibrous feed.
- Signs include injured gums, salivation.
- Prevention:
- Give hard bones to the animals to sharpen teeth
- Feed more fibrous feed to the animals

DYSTOCIA

- Inability of the animal to deliver
- Results from mating immature females, feeding too much concentrate to pregnant animals resulting in foetal oversize.
- Precaution – handle pregnant animals well

GENERAL DISEASE PREVENTION

- Provide clean feed regularly
- Provide clean, fresh water all the time
- Waste and dead animals must be disposed off properly to avoid pollution
- New stock must not be mixed with the old ones.
- Sick animals must be separated from the lot.
- Consult the nearest veterinary office when in any doubt.

SALE OF ANIMALS

- Animals are ready for sale when they are 52 weeks old (1 year).
- There is no grasscutter meat importation to the country, hence has high market potential.
- Sales could be done to
 - Ghana export promotion council
 - Individuals about to start grasscutter farming
 - For home consumption
 - Hotels, Restaurants/chop bars etc.
 - Slaughter, package and sell the meat.

UNIT TWO (2)

RABBIT (*Oryctolagus cuniculus*) PRODUCTION

- The meat is tasty, good quality and similar to chicken (white meat).
- There are few religious or taboos on rabbit meat consumption (except ujhytamong vegetarians). Islam for example, does not prohibit eating rabbit meat.
- Initial capital outlay is minimal. With some scrap wood or bamboo, a hutch can be constructed.
- When a small amount of money is needed, it is easier to sell a small animal than for example the hind leg of a goat.
- The quantity of meat provided by a rabbit is big enough for a family dish. Rabbit meat is small enough to eat at once without the need for refrigeration or other conservation methods.
- Rabbits are very prolific, hence returns on investment is quicker.
- Rabbits can be tended by women and children. Unlike bigger animals they need no force to be restrained.
- A rabbit is a nice present for a child on a birthday, for a neighbor who will marry or for a servant who wants to go home to his village.

CHALLENGES ASSOCIATED WITH RABBIT KEEPING

- Diseases are common and unlike chickens, specific rabbit medicines are not easily available. Moreover, veterinarians do not usually have much experience in the diagnosis and treatment of rabbit diseases.
- In areas where one is the first to start rabbit farming, often people are reluctant to accept something new (the meat).

BREEDS OF RABBITS

- Just as there are many different breeds of cattle, it is not surprising to know that there are many breeds of rabbits too. Some breeds include New Zealand white, Californian, Chinchilla, Flemish giants, etc.
- As with other animals, very often crosses occur between one race and another (crossbreeds).

- We will consider the breeds in two groups (Fancy/fur breeds and Meat breeds) for practical purposes.

FANCY AND FUR BREEDS

- They have nice skin coverings, nice colours and funny physical features.
- The hair can become very long and provides a very valuable fibre for spinning and weaving.
- The hair seems to grow better in colder climates, thus their value might reduce in the tropics.
- One typical example of these breeds is the **Angora rabbit**.
- They however have poor carcass characteristics, do not have large litter size, are less resistant to pests and diseases.

FANCY/FUR BREEDS



FLEMISH GIANT RABBIT



FLEMISH GIANT RABBIT



CALIFORNIA



CHINCHILLA



MEAT BREEDS

- These are most suitable for meat production.
- They are further classified in terms of weight into:

Light breeds – up to 2-3 kg adult weight

Medium Breeds – 3-5 kg

Heavy breeds - more than 5 kg

More often local crosses seem to be of the lighter breeds. They may have the genetic potential to grow large, but due to poor feeding, disease, mating too early and too often and suboptimal care, they do not get the chance to do so.

- Big animals look nice and are impressive, but it is not always advantageous to have large animals.
- They mature later than small ones, so start to produce offspring at about 9 months old, whereas the lighter breeds do so at 6 months.
- An example of large breeds is the **Flemish giant**. It is a very good show animal and does well for public relations (up to 9 kg live weight). Its fertility is not very good; litter size is low, quite susceptible to disease problems. It has a lot of bone and intestine compared with medium breeds like the **New-Zealand** (white) and the **Californian**.

SELECTION OF BREEDING STOCK

- The best place to purchase breeding animals is research farms and/or reputable farms.
- However, when you cannot buy animals from a reliable source and you have to buy from an unknown person or market, there are some things to keep in mind.
- **HEALTH** – the animals must be healthy. Signs of health are similar for grasscutters
- **SEX** – the male breeding animal must have two well-developed testicles. **Cryptochids** should not be selected even if they are fertile. This is because it is a hereditary defect.
- **MARKET BUYING** – buying from a market place is risky. A market is gathering and meeting place for diseases and in general, farmers are unlikely to take their best animals to the market to sell there.

A salesman often does not keep rabbits himself so he is also a poor adviser, moreover he will not know the history of the rabbit, or he will only pretend to know.

REPRODUCTION IN RABBITS

- The proper age for first mating depends on the breed and individual animal's development.
- For small breeds it is 4-5 months, but for large breeds it is 9-12 months.
- One male can easily handle up to 10 or more does, but this depends on mating intensity, heat, stress, age of the male, nutrition etc.
- There should always be a male on stand-by for use under emergency conditions
- Unlike males, female rabbits require more care and attention
- Females (does) could be mated when they reach 75-80 % of mature body weight, i.e. 4-5 months for the lighter breeds, and 7-9 months for heavy breeds.
- Rabbits have no clear reproductive cycle. Nevertheless they do exhibit periods of greater willingness.
- Signs of greater willingness are restlessness, noisiness (scratches the hutch), rubbing her chin on the feeding tray or drinking dish, the genital area will have a redder colour than usual.

MATING THE BUCK AND DOE

- Rabbits ovulate at any time, and especially when it is mated.
- Mating should be carried out during the cooler times of the day (early morning or late afternoon)
- Always bring the doe to the buck and not the other way round.
- Bringing the doe to the buck will not result in a fight. The doe may do some initial running around but will eventually accept the buck.

HANDLING RABBITS



KINDLING AND MOTHER CARE

- Few days after mating, a conceived doe becomes quieter, seems to eat less, and sits with her abdomen resting.
- The doe normally starts pulling out her hair to make a nest at about 2-3 days to litter.
- Sometimes she fails to litter after preparing the nest. If this happens at 2 weeks after mating, it is called pseudo-pregnancy, thus must be re-mated.
- At about Four (4) weeks after mating, a litter box should be placed at a corner in the cage.
- The doe will take some time to familiarize itself with the box before nesting.
- Bedding materials in the form of old clothing or straws should be kept in the box to provide warmth to the litter.
- Kindling takes place mostly in the night or at dawn
- Unlike grasscutters, rabbits are born hairless, blind and cannot walk. It should therefore be ensured that they suckle, are provided with some warmth and not trampled upon.

- The doe should be allowed to eat and rest. Disturbed doe tend to eat their young ones. Cannibalism could also occur due to lack of water, minerals and unrest.

GENERAL HUSBANDRY

- The doe suckles the young about 2-3 times a day.
- The kittens start coming out of the box after 2 weeks, depending on the size of the box, temperature and general conditions in the box.
- Weaning usually takes place between 4-6 weeks old.
- After weaning, allow the doe some period of rest before it is mated again, otherwise, the litters will be smaller, lighter and with a higher mortality rate.
- It is always advisable to mate 2 or more does at a time.
- Like all animals, rabbits require proper care if they are to (re)produce well. Before going to sleep at night one should check them, and during the day an eye should be kept on them.
- All activities of the animals should be predictable and regularly monitored.
- Animals have no holiday, and therefore need to be attended to irrespective of a holiday.
- Animals to be used for further breeding should be isolated and given identification numbers
- Separate young males from females before they reach sexual maturity.

FEEDS AND FEEDING

- Newly born rabbits feed on the mother's milk until they are about 3 weeks old.
- Adult rabbits however feed on similar materials as grasscutters. Some common rabbit feed materials include:
- Guinea grass (*Panicum maximum*), *Euphorbia heterophylla*, *Tridax procumbens*, *Talinum triangulare*, *Amaranthus spp*, Groundnut leaves and pods, cabbage, carrots, roots and tubers.
- Concentrates could be compounded from cereals, oil cakes, and possibly fish meal.

FEEDING STRATEGIES

- Do not change feed suddenly. It should rather be done gradually to avoid digestive disorders.
- Greens fed should not be too wet, because it will upset the stomach and cause bloat, diarrhoea and possibly death.
- Remove and discard properly all left-over and soiled feed from the cages.

- Clean concentrate could be provided as supplements for rabbits to improve their growth rates and minimize disease incidence.

PREVENTION OF DISEASES IN THE RABBITRY

- Avoid buying breeding stock from market centres where diseases and pests could be acquired. Stock should always be obtained from reputable farms and breeding stations only.
- Never mix new stock with old ones without a period of quarantining.
- Make routine checks on the health of the animals by observing abnormalities, presence of pests and diseases.
- Check for smell in the hutch. Diarrhoea/enteritis often cause bad smell.
- Make a hutch design and use materials which permit easy cleaning. When bedding materials are used, it should be ensured that it is dry, and dirty ones changed regularly
- Keep animals away from their manure; slatted floors and no (deep) litter are preferred.
- Separate all sick animals from the herd to avoid infecting healthy ones.
- Clean fresh air in the hutch is essential. Strong manure smell is not good, your own nose is your best measuring guide. If you cannot stand it, the rabbits probably cannot either.

DISEASES OF RABBITS, CAUSES AND CONTROL

Diseases and Symptoms	Cause	Treatment and Control
<p>Ear mange or Canker: Shaking of head, scratching of ears, brown scaly crusts at base of inner ear</p>	<p>Ear mites: <i>Psoroptes cuniculi</i> (rabbit and goat ear mite) and <i>Notoedress cati</i> (cat ear mite)</p>	<p>Into each ear, pour 1 oz. of a 5 % limesulphur solution (prepared by mixing commercial 30% limesulphur concentrate: 1 part with 5 parts of water)</p>
<p>Skin mange: Reddened scaly skin, intense itching and scratching, some loss of fur</p>	<p>Mites: <i>Cheyletiella parasitivorax</i> (rabbit fur mite) and <i>sarcoptes scabiei</i> (scabies or itch mite)</p>	<p>Dip entire animal in a 1.75% limesulphur bath (prepared by mixing commercial 30% limesulphur concentrate, 8oz. laundry detergent: 1 tablespoonful per gallon tepid water). Repeat in 2 weeks if necessary.</p>
<p>Favus or ringworm: Circular patches of scaly skin with red elevated crusts. Usually starts on head. Fur may break off or fall out.</p>	<p>Fungus: Trichophyton and Microsporum</p>	<p>Griseofulvin given orally at the rate of 20 milligrams per Kg body weight for 14 days. Combine this treatment with dusting nest boxes with industrial fungicidal sulphur. Can also be treated with a brand of hexetidine. Apply to infected area for 7-14 days.</p>

RABBIT DISEASES CONTINUED

<p>Conjunctivitis or weepy eye: Inflammation of the eyelids. Discharge may be thin and watery or thick and purulent. Fur around the eye may become wet and matted</p>	<p>Bacterial infection of the eyelids. Also may be due to irritation from smoke, dust, sprays or fumes.</p>	<p>Early cases may be cleared up with eye ointment, argyrols, yellow oxide of mercury or antibiotics. A combination of 40,000 units of penicillin and 0.5 grams of streptomycin to each 2 ml. For eye infections drop directly into eye. Protect animals from airborne irritants.</p>
<p>Heat prostration: Rapid respiration, prostration, blood tinged fluid from nose and mouth. Does that are due to kindle are most susceptible.</p>	<p>Extreme outside temperature. Degree varies with location and humidity.</p>	<p>Reduce temperature with water sprays, foggers. Place wet burlap in hutch or wet the animal to help reduce bodytemperature</p>
<p>Coccidiosis, intestinal: Mild cases, no symptoms; moderate cases, diarrhea and no weight gain. Severe cases have pot belly, diarrhea with mucus and pneumonia is often secondary.</p>	<p>Parasitic infection of the intestinal tract caused by coccidia (<i>Eimeria perforans</i>, <i>E. magna</i>, <i>E. media</i>, <i>E. irrisidua</i>).</p>	<p>Keep floor clean and dry, remove droppings frequently. Prevent fecal contamination of feed and water. Add feed grade sulfaquinoxaline so that level will be 0.025%, feed 3-4 weeks. Water soluble sulfaquinoxaline can be added at level of 0.025% and fed 2-3 weeks. These treatments combined with sanitation will greatly reduce numbers of parasites and animals infected.</p>

RABBIT DISEASES CONTINUED....

<p>Enteritis, bloat or scours: Loss of appetite, little activity, eyes dull and squinted, fur rough and animals may appear bloated. Diarrhea or mucus droppings, animals may grind teeth. Stomach content fluid, gaseous or filled with mucus.</p>	<p>Unknown. Never has been shown to be infectious or transmitted to other animals</p>	<p>Add 0.5 gr. Furazolidine per ton of feed to give final concentration of 0.0055%. Feed intermittently or continuously. Water soluble chlortetracycline at a level of 1 pound to 100-150 gal. of water may be used for treating individual cases, too costly for herd control.</p>
<p>Caked breasts: Breasts become firm and congested, later hard knots form at sides of nipples. Knots may break open, showing dried milk.</p>	<p>Milk not drawn from glands as fast as formed, because too few young or young not nursing sufficiently. Usually a management problem with high milk-producing does.</p>	<p>Do not wean young abruptly. If litter is lost rebreed doe and protect doe from disturbance so young can nurse properly. Correct faulty nest boxes that injure breasts.</p>

RABBIT DISEASES CONTINUED...

<p>Fur block: Animals reduce feed intake or stop eating completely. Fur becomes rough and weight is lost. Stomach filled with undigested fur blocking passage to intestinal tract. Pneumonia may become secondary.</p>	<p>Lack of sufficient fiber, bulk or roughage in the diet. Junior does or developing does are most susceptible.</p>	<p>Increase fiber or roughage in the ration.</p>
<p>Mastitis or blue breasts: Breasts become feverish and pink, nipples red and dark. Temperature above normal, appetite poor, breasts turn black and purplish.</p>	<p>Bacterial infection of the breasts: Staphylococcus or Streptococcus.</p>	<p>Inject 100,000 units of penicillin intramuscularly twice a day for 3-5 days. Disinfect hutch and reduce feed concentrates. If severe case, destroy. NEVER transfer young from infected doe to another doe.</p>
<p>Snuffles or cold: Sneezing, rubbing nose; nasal discharge may be thick or thin. Mats fur on inside of front feet. May develop into pneumonia. Usually chronic type of infection.</p>	<p>Bacterial infection of nasal sinuses: <i>Pasteurella multocida</i> or <i>Bordetella bronchiseptica</i>.</p>	<p>Individual animals may be treated with a combination of 400,000 units of penicillin and 0.5 gr. Streptomycin to each 2 ml. Give intramuscularly 1 ml. for fryer size, 2 ml. for mature. Repeat on third day.</p>

RABBIT DISEASES

CONTINUED...

<p>Pneumonia: Labored breathing with nose held high, bluish color of eyes and ears. Lungs show congestion, red, mottled, moist, may be filled with pus. Often secondary to enteritis.</p>	<p>Bacterial infection of the lungs. Organisms involved may be <i>Pasteurella multocida</i>, <i>Bordetello bronchiseptica</i>, Staphylococcus and Streptococcus.</p>	<p>If the above treatment is started early, it is effective. For control in herds add feed grade sulfaquinoxaline so that level will be 0.025%, feed 3-4 weeks. Water soluble sulfaquinoxaline can be added at a level of 0.025% and fed 2-3 weeks.</p>
<p>Tapeworm larvae: White streaks in liver or small white cysts attached to membrane on stomach or intestines. Usually cannot detect in live animals.</p>	<p>Larval stage of the dog tapeworms (<i>Taenia pisiformis</i>) or of the cat tapeworm (<i>T. taeniaeformis</i>)</p>	<p>No treatment. Keep dogs and cats away from feed, water and nest box material. Eggs of tapeworm occur in droppings of dogs and cats.</p>

RABBIT DISEASES CONTINUED...

<p>Pasteurellosis: May be an acute or chronic infection. Nasal discharge, watery eyes, weight loss or mortality without symptoms. Inflammation of lungs, inflammation of bronchi and nasal sinuses.</p>	<p>Bacterial infection: <i>Pasteurella multocida</i>.</p>	<p>Individual animals may be treated with a combination of 400,000 units of penicillin and 0.5 gr. Streptomycin to each 2 ml. Give intramuscularly 1 ml. for fryer size, 2 ml. for mature. Repeat on third day. For herd control, add feed grade sulfaquinoxaline at level of 0.025%, feed 3-4 weeks. Save replacement stock from clean animals and cull out chronically infected animals. Use good sanitary measures to reduce transmission to new animals.</p>
<p>Wry neck: Head twisted to one side. Animals roll over, cannot maintain equilibrium.</p>	<p>Infection of the organs of balance in the inner ear. May be parasitic or bacterial.</p>	<p>None. Eliminate ear canker from herd. Some cases result from nest box injuries.</p>

UNIT THREE (3)

Bee Keeping Importance of bee keeping

- **Products** - Bees produce several products including honey, beeswax, pollen, propolis, royal jelly and venom, which have various applications. The demand for bee products is increasing at the national and international level.
- **Pollination of agricultural crops** - Bees play an important role in the pollination of many flowering plants and crops. They improve yields and quality of both field and horticultural crops. They are of special importance in coffee, cocoa, mango and avocado production.
- **Conservation of biological diversity** - Pollination of wild plants increases their seed production.

CHALLENGES RELATED TO BEEKEEPING IN AFRICA

- **Low returns** – Many farmers have left beekeeping because of lack of profits and low yields and due to the amount of work and the investments that are required for hives and equipment.
- **Poor apiary husbandry** – Bees are left to look for their own forage, water and to provide their own security from invaders. During times of scarcity, like dry seasons, hives swarm and abscond and hence the farmer loses potential yield from such hives.
- **Pests and diseases** – The varroa mite as well as other pests and diseases are threatening beekeeping in Africa, and farmers lack knowledge on their proper management.
- **Poor harvesting methods** – Rudimentary harvesting methods, for example, using too much smoke or burning the hives leads to destruction of the bee colonies as well as to contamination of the honey harvest.
- **Quality control challenges** – Due to limited availability and improper use of harvesting equipment, honey becomes susceptible to contamination and adulteration. The resulting low quality honey cannot enter the formal market chain, but ends up in the informal markets being used as an ingredient for making local brews or herbal products.

Types of Bees

- There are many different species of bees.
- Most of them are solitary, but few others are social bees.
- Social bees live together in colonies, with a division of labor among the individuals.
- All bees gather nectar and pollen from flowers, but only a few of the social bees store the nectar as honey.

Stingless bees

- These do not sting, hence they defend their colony by biting the intruder. Some secrete irritating substances along with the bite.
- The brood comb of stingless bees is one cell thick and is usually horizontal.
- These bees store honey in thimble-sized wax honey pots placed around the brood area of the nest.
- Their honey yield is very low, but marketing it is worthwhile only on a local level.
- Such honey is often highly prized purposely for medicinal use.

STINGLESS BEES



APIS - THE TRUE HONEY BEE

- There are **four species** in the bee genus **Apis** -
- All of these are similar in appearance, though there are size and color differences.
- They all build vertical combs that are two cells thick.
- The giant or rock honey bee (*Apis dorsata*) and the little honey bee (*Apis florea*) are found in Asia. Both of these bees build a single-comb, exposed nest.

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- These bees can be kept in hives, and methods have been devised to allow for a more rational utilization of their potential.
- The western hive bee (*Apis mellifera*) is native to western Asia, Europe, and Africa.
- There is tremendous variation in this bee across its range, and at least twenty different sub-species are recognized.
- Several races of this bee are considered more desirable for beekeeping.

Traits desirable for selecting bees for keeping

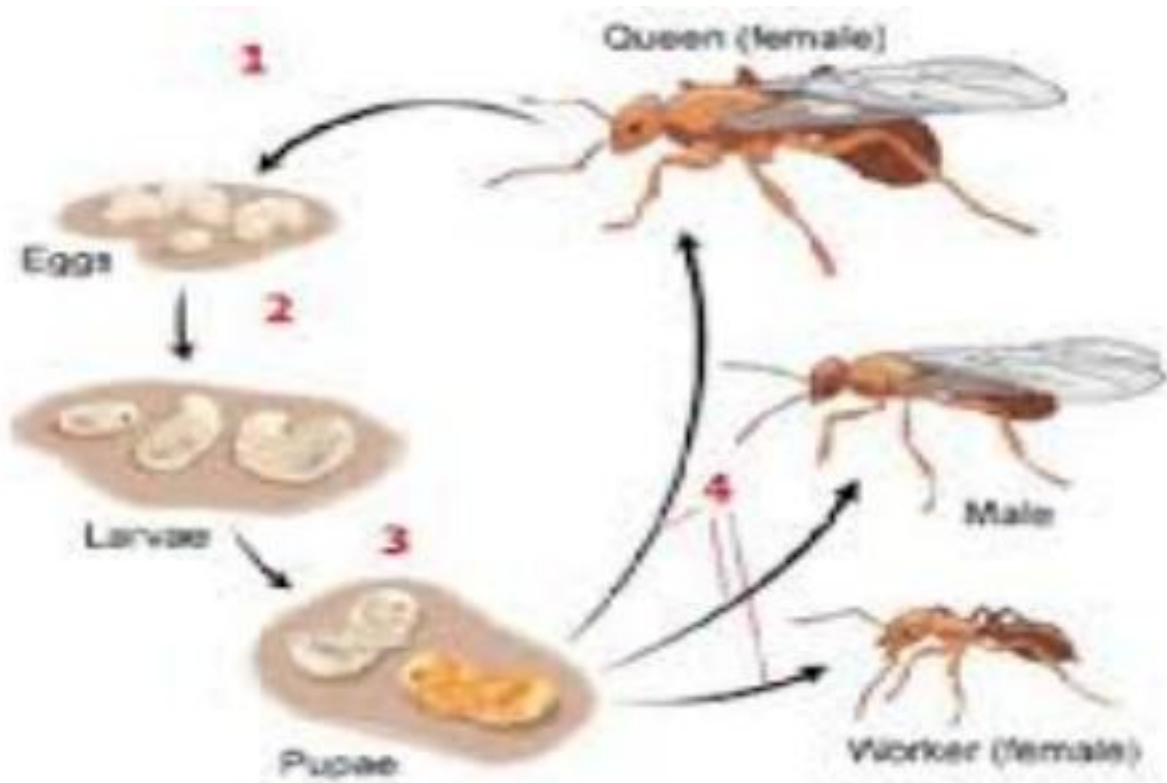
- High honey production
- Gentleness
- Low tendency to swarm
- Low tendency to abscond

- Calm on comb when colony is being worked
- Disease resistance
- Little use of propolis
- Little brood rearing during dearth periods to conserve stores

LIFE CYCLE OF THE HONEY BEE

- The honey bee is an insect with complete metamorphosis, thus there are four distinct stages in the life cycle - egg, larva, pupa and adult.
- The first three stages develop in cells in the comb, and are collectively referred to as the brood.
- Eggs and larvae are in open cells and are cared for by adult workers. These stages are called the open or unsealed brood.

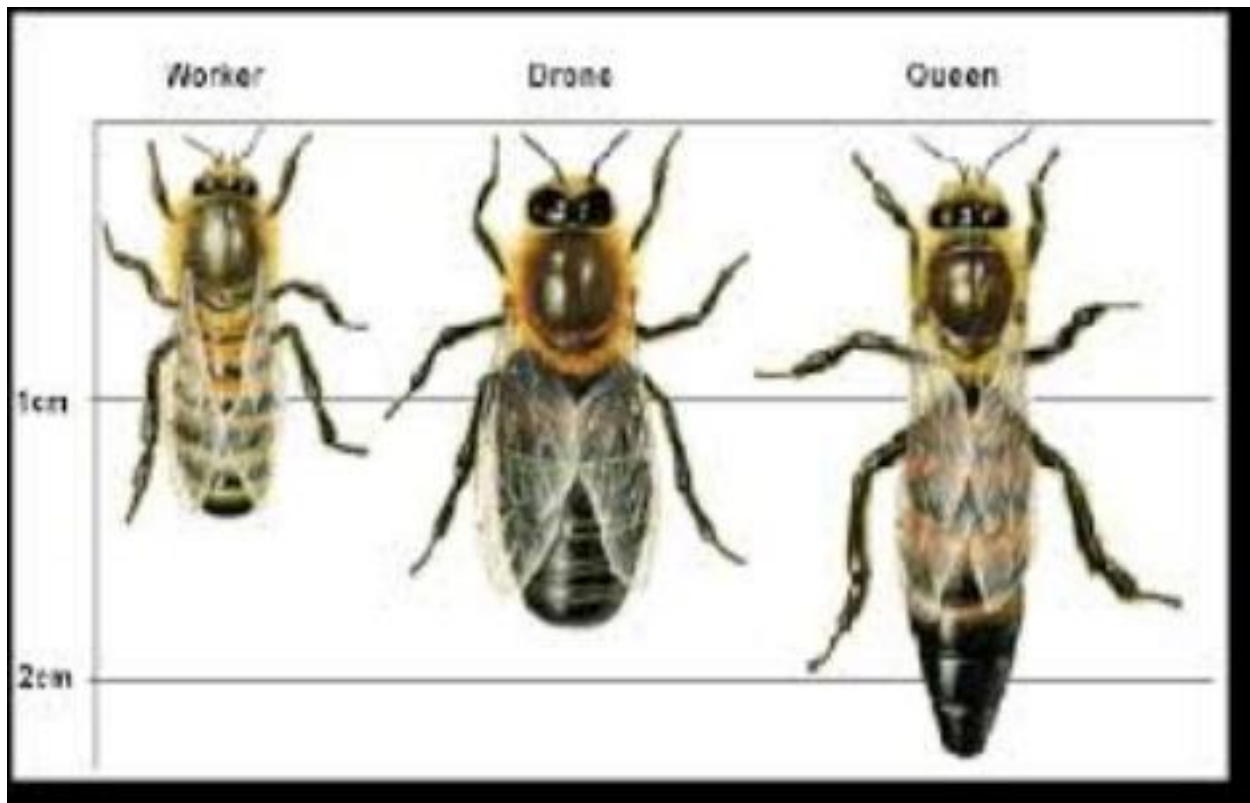
LIFE CYCLE OF BEES



THE LIFE CYCLE OF A BEE



- The developing queen larva is always surrounded by royal jelly, a special, highly-nutritious food produced by head glands of the workers.
- This feeding scheme, called **massive provisioning**, is unique to the queen and continues throughout her entire developmental period.
- All young larvae of less than two days are fed with royal jelly.
- After the second day, worker larvae are gradually switched to a progressive feeding scheme where they are fed with a mixture of royal jelly, honey and pollen.
- With progressive feeding, the larvae are fed periodically, thus food is not always available to them.
- The different feeding schemes determine the caste of the adult bee - thus any female egg or larva less than two days old has the potential to become either a queen or a worker.
- Workers are reared in the same type of cell that is used to store honey and pollen. This type of cell makes up the majority of the comb in the colony.
- The adult worker emerges from the cell 21 days after the egg is laid.
- The developmental period of drones is 23 days. Drones are reared in cells of the same shape as worker cells but larger.



The queen

- Is the only female that is completely developed sexually. This is a result of a total diet of royal jelly during a developmental period.
- She is distinguished by her long, slender appearance, due to the full development of the ovaries in her abdomen.
- She has a sting without barbs. In the colony, she is found in the area of the brood nest.
- Approximately five days after emerging from her cell, the virgin queen begins to take a series of mating flights.
- She takes a number of such flights over a period of two to three days, and may mate with ten or more different drones.
- The sperm is stored in a special organ, the **spermatheca**, and the queen never mates again after this period.
- About five days after taking her mating flights, the queen begins to lay. During favorable periods a good queen can lay more than 1500 eggs per day.
- Factors which affect egg laying are the weather, the nectar and pollen flows, the size of the queen, and the condition of the colony.
- The number of eggs laid varies with the annual cycle as available resources of nectar and pollen vary. Large amounts of incoming resources stimulate workers to give the queen more food, which in turn stimulates her to lay more eggs.
- Several of the queen's glands produce a complex of compounds called the queen substance, which is distributed throughout the colony by workers that care for the queen.
- The queen substance is a combination of pheromones, chemical compounds which serve to control the behavior of other individuals of the same species.
- Pheromones produced by the queen and by the other individuals of the colony serve to harmonize colony behavior.
- The queen can live for up to four years, but in the tropics, where the yearly laying period is longer, the queen does not live as long.
- Older queens do not have the laying capacity of younger queens, therefore young, vigorous queens are preferred by beekeepers.

Drones

- They are the males of the colony, and are produced from unfertilized eggs. (The queen can control whether or not the egg is fertilized as she lays it).
- The body of the drone is larger than that of the worker or queen.
- The eyes are large and cover practically the whole head.
- The end of the abdomen is blunt and is covered with a tuft of small hairs.

- Drones cannot sting. Sting is a modified structure of the female genitalia, thus drones do not have stings.
- They also do not have any of the structures necessary to collect nectar and pollen.
- A strong colony can have about 300 drones. But during periods of resource scarcity, the workers run the drones out of the colony.
- They die as they cannot fend for themselves. The sole function of the drones is to fertilize the queen.
- When the weather is good, mature drones leave the colony during the afternoon and congregate in certain areas where they wait for virgin queens to fly by.
- Drones sometimes return to colonies that have a virgin queen. Such colonies will accept drones from other colonies and will tolerate a large drone population while the queen is a virgin.
- However, after a queen mates, the workers run many of the drones out of the colony

Workers are females which are not fully developed sexually.

- They do the work of the colony and maintain it in good condition.
- Workers have special structures and organs which are associated with the duties they perform.
- The life span of worker adults varies greatly with the time of year.
- During periods of scarcity, workers may live three months or more, but when the colony is active, few workers live for as long as six weeks.
- The life span of workers of tropical races of the western hive bee and the eastern hive *Apis cerana* bee is shorter.

<i>Structure of organ</i>	<i>Location</i>	<i>Function</i>
head glands	front of the head	produce brood food and royal jelly
wax glands	under the abdomen	produce wax
odor glands	near upper tip of the abdomen	produce scent to orientate bees when the colony is disturbed
sting and associated glands	tip of the abdomen	defend the colony
long tongue	Head	gathers nectar
honey stomach	enlarged area of esophagus	carries nectar and water
pollen comb, press and basket	hind legs	comb pollen from the body, press it into pellets, and carry it to hive. Also used to carry propolis

- Foraging workers fly up to 3 kilometers from the colony to collect the resources needed by the colony.
- Bees will fly further than three kilometers, but this is often energy inefficient.
- There are four main substances collected by foragers for the colony – Nectar, Pollen, Propolis and Water.

Nectar is a sugary secretion of plants.

- Nectar is 70% to 80% water. Higher percentages of water are found during rainy periods.
- The remainder is sugar and trace amounts of other organic compounds.
- Nectar is the carbohydrate or energy component in the diet of the bee.
- Foragers take the nectar from the nectaries and carry it back to the hive in their honey stomachs.
- When they return to the colony, they pass the nectar to younger workers who ripen it into honey and store it in cells.



oni

Pollen is a powdery substance produced by the male organs of flowers.

- It contains the sperm cell of the plants.
- When foragers visit flowers, pollen sticks to the fine, plumose hairs which cover the body.
- Periodically, the worker remove the pollen from the hairs using the pollen comb, a structure on the hind legs.
- Pollen is used to feed older brood and is also eaten in large quantities by nurse bees who are producing royal jelly from the head glands.
- It is the protein, vitamin and mineral component in the bee diet. A complex of yeasts in the pollen acts to preserve it.

BEE CARRYING POLLEN



POLLEN USED AS FOOD SUPPLEMENT



Propolis is a resinous substance collected from plants. It is found around wounds on plants and sometimes around buds.

- Bees use it to seal small cracks and holes in the colony, for reinforcing and repairing old comb, and for covering dead animals in the colony which are too big to be removed.
- Propolis contains chemicals called turpines which act to limit bacterial and fungal growth.
- Therefore, it serves to help control bacteria and fungi in the colony environment.

BEE PROPOLIS



AFTER SWARM

- The first queen that emerges in the old colony usually searches out other queen cells and destroys them.
- If two or more queens emerge at the same time, they fight until one kills the other.
- Sometimes, if a colony has a large population, a recently emerged queen leaves the colony with a number of workers, instead of destroying the other queen cells. This is called an [after swarm](#).
- After swarm is similar to the original swarm, except that it is smaller, and the queen is a virgin.

SUPERSEDURE

- **Supersedure** is a queen replacement without colony division.
- If the old queen begins to fail, workers construct queen cells to rear a replacement.
- These supersedure cells are usually located on the face areas of the comb.
- The old queen does not leave the colony in supersedure.
- The new queen mates, returns to the colony, and begins to lay, together with the old queen.
- However, the old queen dies shortly after.

ABSCONDING

Absconding is the abandonment of a nest site by a colony.

- It is usually due to excessive disturbance of the colony by predators or beekeepers.
- Due to diminishing resources in an area. Absconding is more common in tropical species and races of the honey bee.

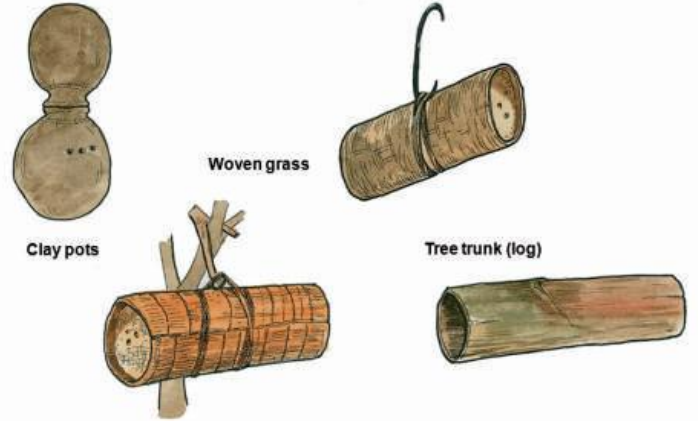
BEE-KEEPING EQUIPMENT



EQUIPMENT FOR BEE KEEPING



Examples of traditional bee hives



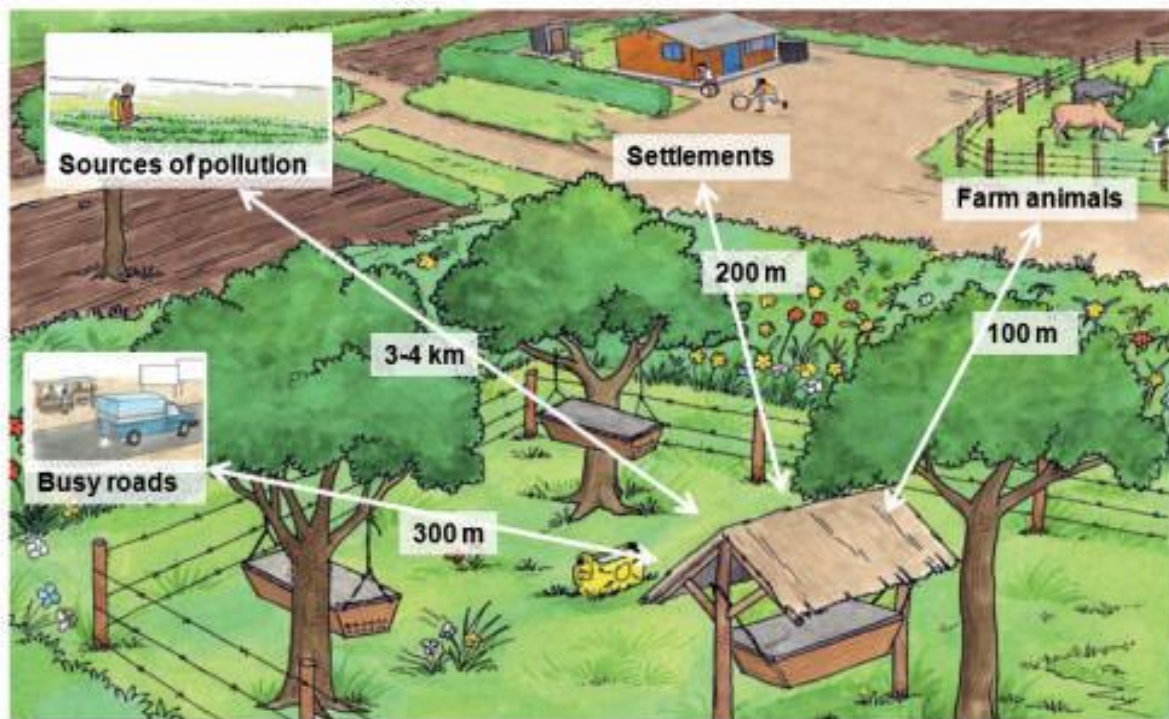
Removable comb hives with top-bars



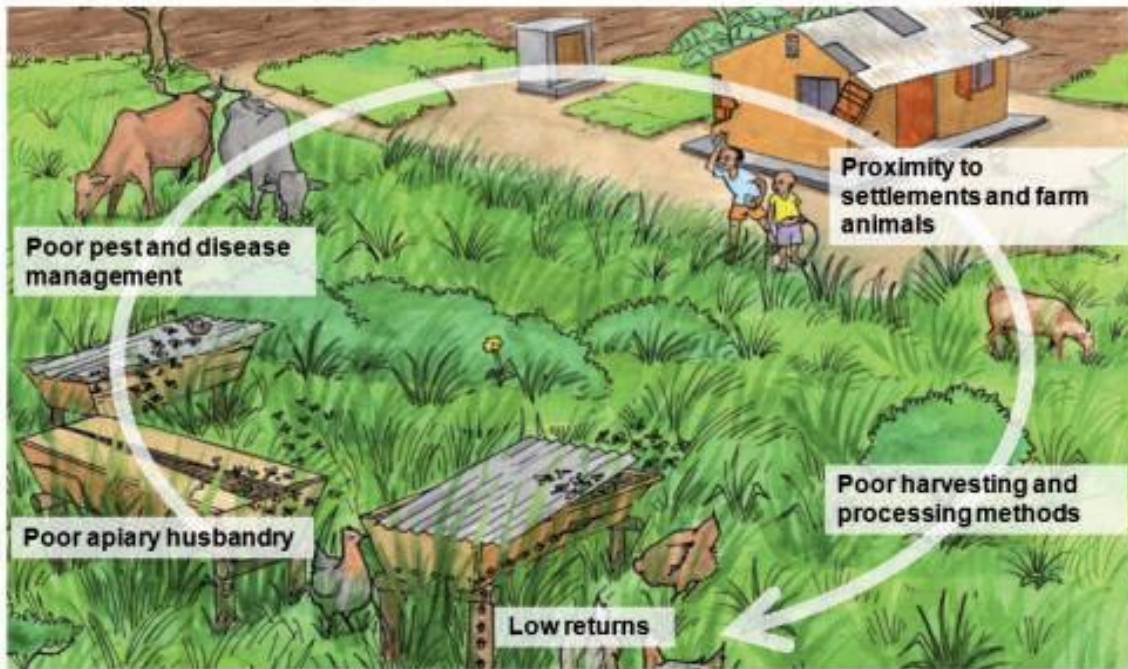
ESTABLISHING A NEW APIARY - SELECTING A SUITABLE SITE FOR BEEKEEPING

- The environment for beekeeping should consist of diverse vegetation that provides plenty of pollen and nectar.
- There should be a source of good water in the immediate area since bees need as much water as pollen and nectar, and a colony may drink up to several liters of water a day.
- In case there is no natural source of water the beekeeper must frequently provide fresh water for the bees by filling a shallow tub with fresh water and placing some straw or twigs inside so that bees have something and can access the water without drown
- With a source of water near the apiary, the bees do not waste much energy searching for water, but instead save it for sourcing more nectar and pollen.

Recommended distances of the apiary



Typical honey production situation



- The area should also be free from flooding and protected from extreme hot or cold weather conditions.
- The site should be far enough from human settlements, livestock and agricultural activities, especially because African bees have strong protection instincts and easily attack when disturbed.
- Precaution must be taken especially in areas with intensive application of chemical pesticides. The bees can be poisoned and the resulting honey contaminated.

HARVESTING AND PROCESSING OF HONEY



HONEY EXTRACTION BY CENTRIFUGATION



EXTRACTION UNDER GRAVITY



PROCESSING BY PRESSING



HONEY READY FOR THE MARKET



and
seed
: flesh.

UNIT FOUR

INTRODUCTION TO SNAIL PRODUCTION AND PROCESSING

- The Giant African Snail (*Achatina achatina*), in the genus *Achatina*, also known as the Agate Snail or Ghana Tiger Snail. It is a native of West Africa. The shells of these snails often grow to a length of 18 centimetres (7.1 in) with a diameter of 9 centimetres (3.5 in), making them the largest land snail on earth.
- The Giant East African Snail (*Achatina fulica*), is also edible, but in some places, it is considered as a serious agricultural pest. It is a native of East Africa, and can be traced back to Kenya and Tanzania, but a significant number of them can be found in West and Central Africa. The adult snails have a height of about 7 centimetres (2.8 in), and their length can reach 20 centimetres (7.9 in).
- Archachatina:
 - The Giant West African Snail (*Archachatina marginata*) is an edible snail, and a native of West Africa. They can grow up to 20cm long, and live up to 10 years.

ACHATINA ACHATINA (TIGER SNAIL, GHANA SNAIL)



ACHATINA ACHATINA



ACHATINA ACHATINA ON SALE



ARCHACHATINA MARGINATA



ARCHACHATINA MARGINATA



**ARCHACHATINA MARGINATA
(NORMAL VRS ALBINO)**



ACHATINA FULICA
(EAST AFRICAN LAND SNAIL)



ACHATINA FULICA



A SNAIL WITH ITS EGGS



We shall focus on the cultivation of the *Achatina achatina* (African Giant snail).

- Snails are mainly collected from the wild during the rainy season.
- Dry season, use of slash and burn method of land preparation, uncertainty of catch from the wild necessitate their domestication.

Geographical distribution of *A. achatina*

- Several countries in West Africa – from Guinea, though Ghana to Nigeria.
- In Ghana, they are found mainly in the south and forested areas of the Eastern, Western, Ashanti etc

Importance of snail farming

- Treatment with snail blood is reported to reduce the severity of strokes and accelerate the movement of foetuses.
- Snail saliva contains the enzyme B-glucosinodase which is used in treatment of cardiovascular diseases.

- In Ghana, Cote d'ivoire and Nigeria, snail meat is particularly popular, forming about 10% of the trade in wildlife of 'bushmeat'.
- The price of snail meat is higher than that of beef, chevon and mutton, due to higher demand and limited supply especially during the dry season.
- The shells of the snail are decorated and sold for ornamental purposes. The shell is also included in livestock feed as a rich source of calcium.
- Snail meat is high in protein (12-16%) and iron (45-50mg/kg) but low in fat (0.05-0.08%). The meat is tasty and of good texture, provided the snails are harvested at the correct age.
- The meat is believed to have aphrodisiac properties.
- In the past, snail meat was recommended as a means of combating ulcers and asthmas.
- There are claims of its use for the treatment of hypertension.
- In Ghana, the bluish liquid obtained from the shell, after the meat has been removed, is believed to be good for infant development

Biology of snails

- Snails are cold blooded, and therefore sensitive to changes in atmospheric humidity and ambient temperature (poikilothermic). Snails thrive well in areas which have moderate temperatures and high humidity.
- *Achatina achatina* is nocturnal, feeding at night. The soil forms a major part of the snail's habitat. The shell is made up mainly of calcium, most of which, together with the snail's water requirement, is derived from the soil.
- When humidity falls below 75%, as is the case during the dry season (October to mid March), *Achatina achatina* becomes inactive, retreats into its shell and secretes a papery covering (epiphragm) over the opening, covers itself with a white calcareous layer to prevent water loss and then aestivates. The length of aestivation depends on the conditions; in Savannah regions it may be up to 5 months, whereas in wetter forested areas, it may be only a few days or weeks. When the rains arrive, the epiphragm is broken and the snail becomes active again.



Choice of site and soil structure

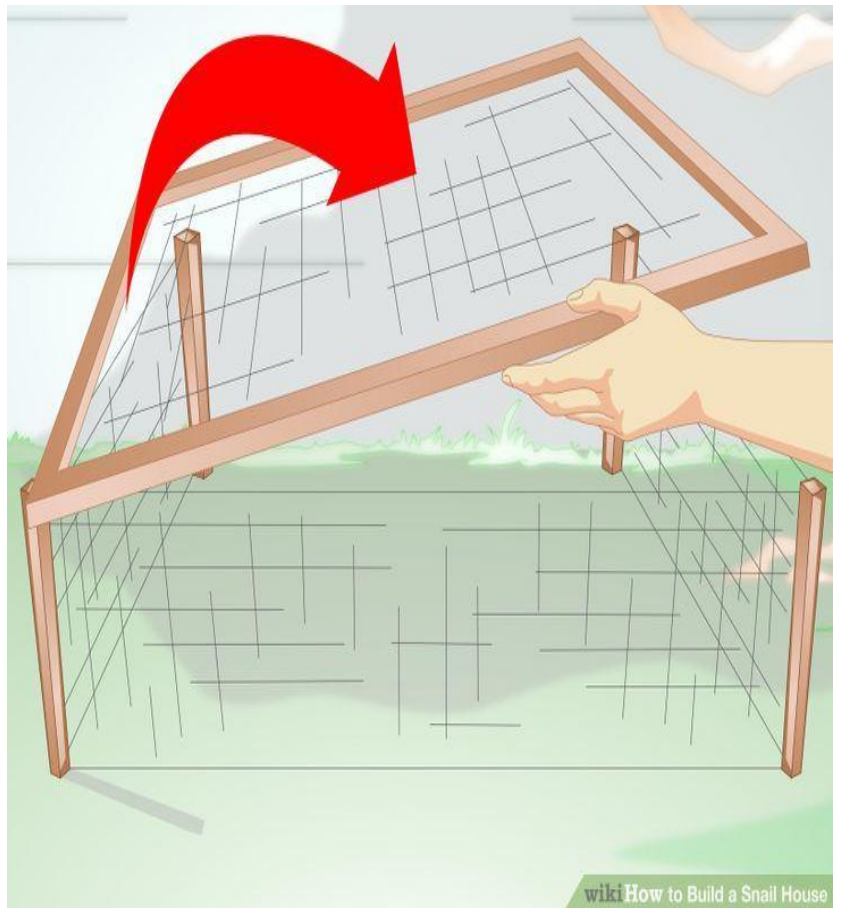
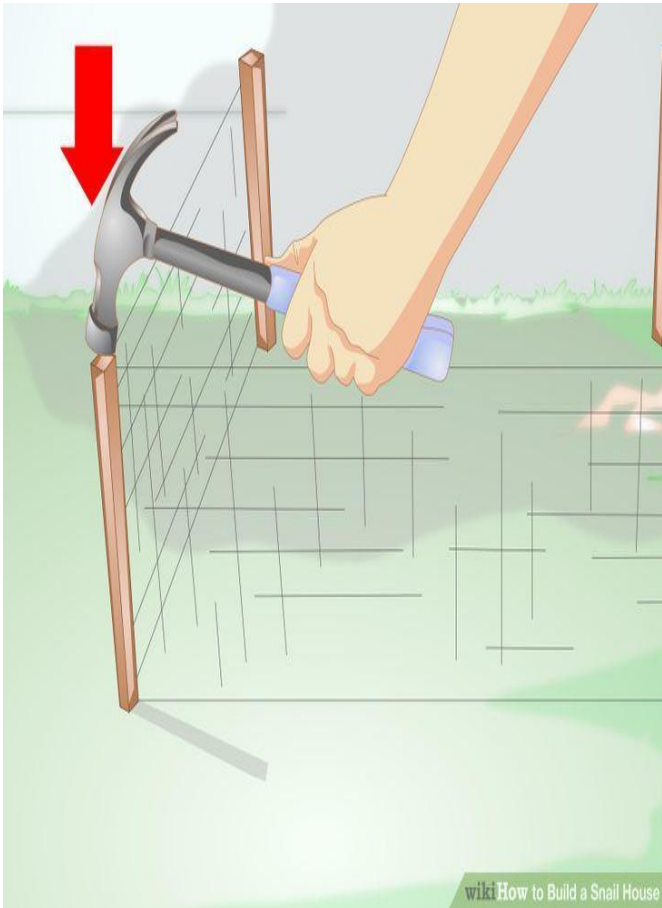
- The site should be free from strong winds
- The soil should be disinfected, and must be good for growing green leafy vegetables.
- The structure of the soil should be medium to light, and friable with pH 5.8 to 7.5. Acidic and clay soils are not suitable.
- The soil should have a high amount of calcium to aid in shell formation.
- The site must be free of large trees, as these can attract predatory birds, give too much shade for crop development and prevent dew fall.

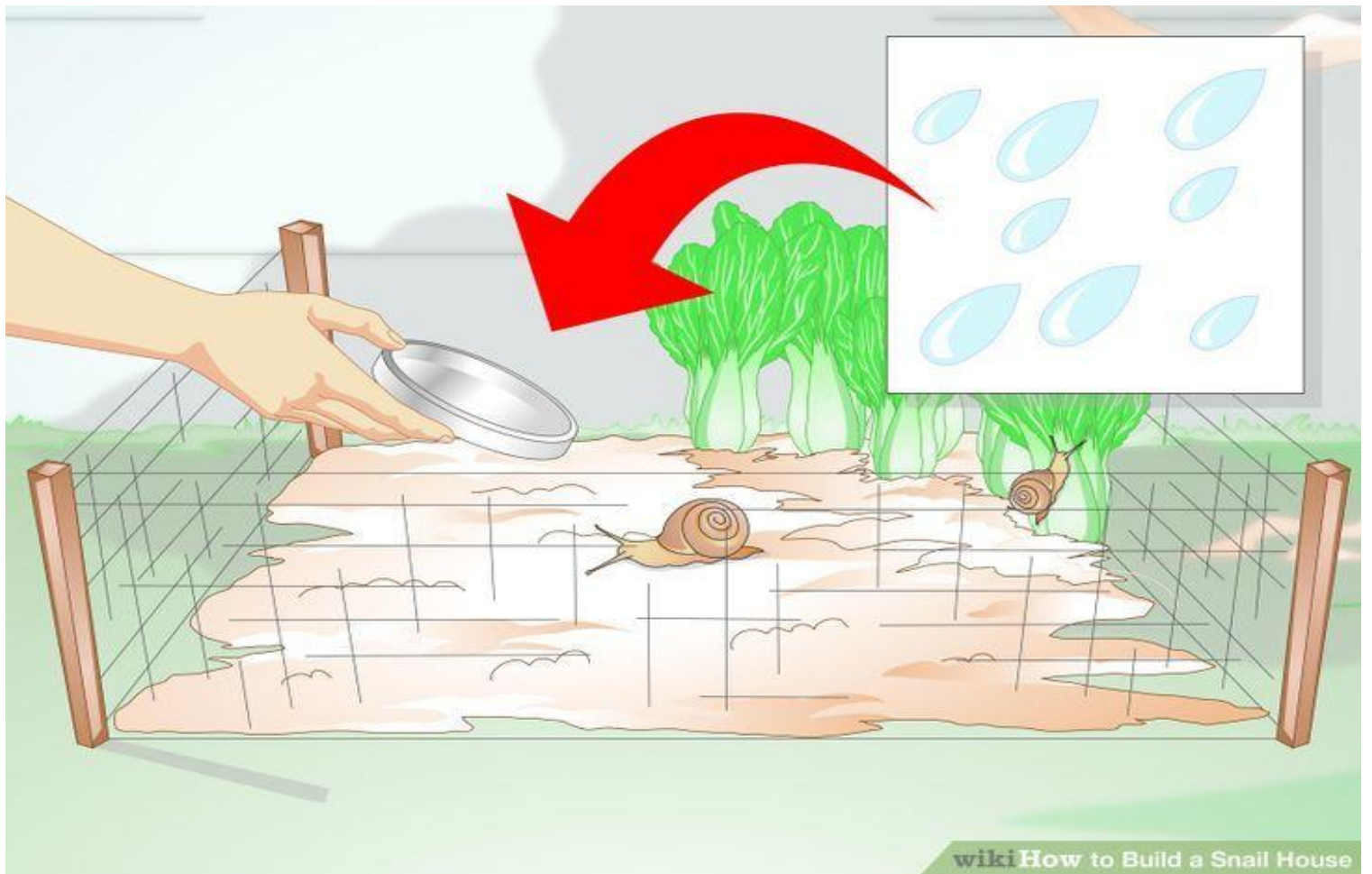
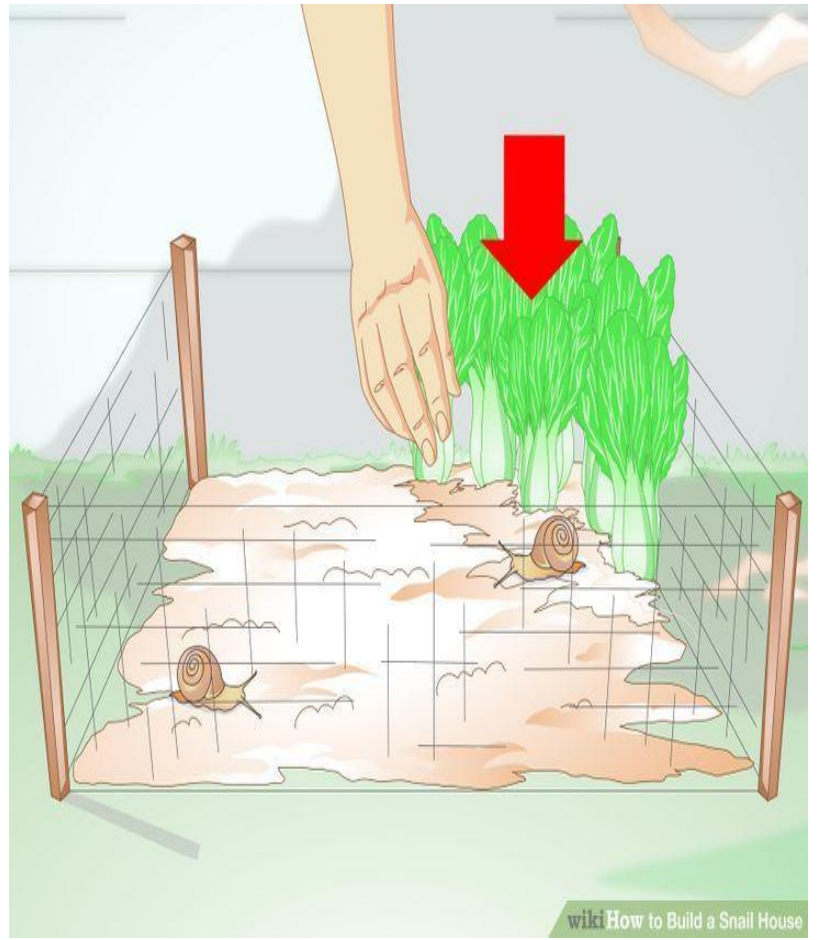
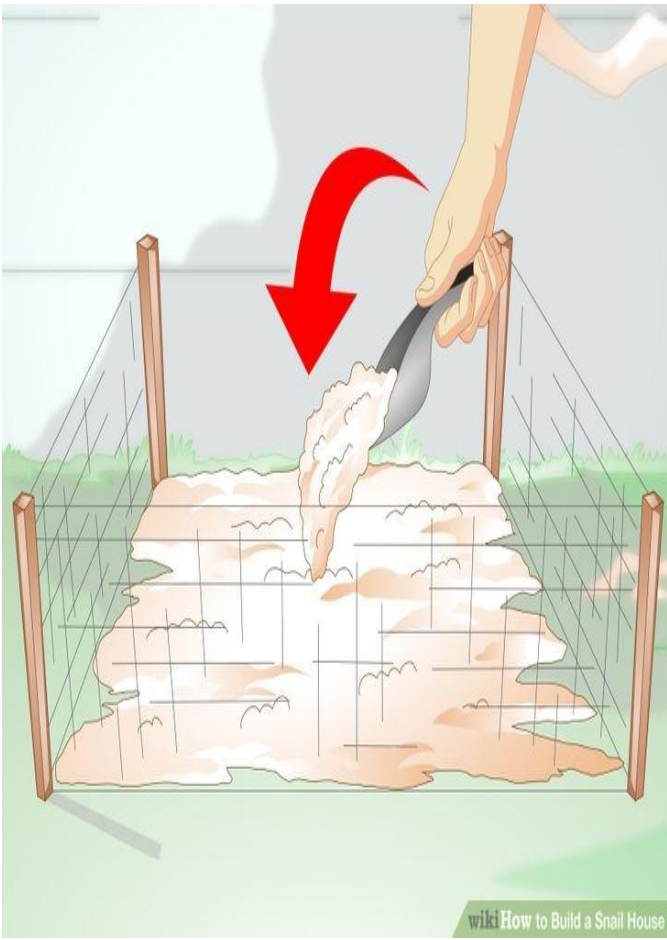
HOUSING

- The giant African Snail prefers high humidity and cool areas.
- It is sensitive to light, so snail houses (snaileries) should provide dim light conditions.
- The bottom of the snailery should be covered with moist sandy-loam soil, kept loose to allow the snails to prepare holes for egg laying. There should be an opening at the top for feeding, and all openings should be sealed with wire netting to prevent escape.
- There are different types of snailery that can be constructed, depending on the scale and stage of production.
- Whatever the type, it is important that it prevents snails from escaping and keeps out predators. Materials used can include decay and termite resistant timber, landcrete blocks, mosquito nets or 5mm wire mesh.

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Use of baskets

- These are ideal for small scale fattening of snails. A basket (60cm diameter, 45cm depth) can contain 30-50 medium sized snails. Plastic baskets with holes in the sides can also be used. When using baskets, special care is needed to
- Clean the snails and the baskets frequently, under a tap or using a hose pipe to prevent the accumulation of faeces, mucus and rotten feed.
- Remove uneaten feed and replace with fresh ones every day.
- Carefully remove eggs for hatching, else could be destroyed



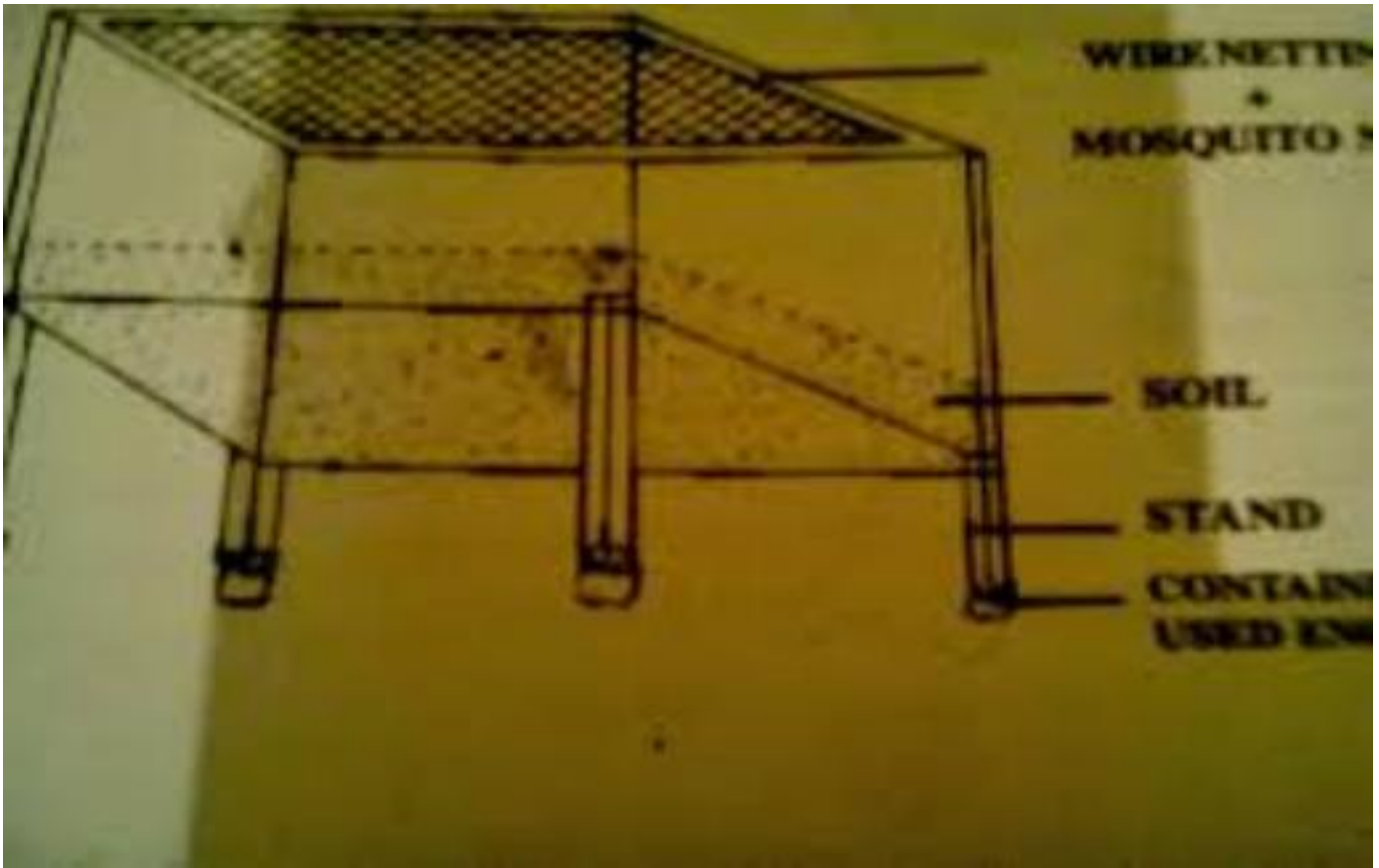
A SNAIL WITH TRACES OF MUCUS



Use of cages/boxes

- Cages/boxes are square or rectangular boxes with lids, containing one or more chambers. The boxes are placed above ground on wooden stilts in a shaded area. The floor of the box must have several drainage holes, and covered with sieved black soil to a depth of 18-25 cm.
- The soil must be changed occasionally (every three months), as an accumulation of droppings will increase the chance of disease development.
- A cage of dimensions 1.2m x 1.5m x 60cm height can house 200 medium sized snails. Cages are ideal as hatchery and nursery pens, as the eggs and young can easily be monitored.
- Mature snails raised under any system at all, should be transferred to cages or boxes to lay their eggs.

SKETCH OF A MOBILE CAGE FOR SNAILS



MOBILE CAGE



Pit and trench pens

- Pit and trench pens can also be used as hatchery and nursery pens, but are more suitable for growing/fattening snails. The use of these is however more difficult than the use of boxes, as one has to bend or stoop to tend the snails.
- Constructing a trench involves digging a square or rectangular hole in the ground, about 50cm deep. The sides are normally of concrete blocks and the bottom covered with loose soil. The pens are covered with nylon mosquito mesh or with 5mm wire mesh.



A CARETAKER TENDING SNAILS IN A TRENCH PEN



CAGE FOR FREE RANGE REARING OF SNAILS





Pit and trench pens have the following advantages.

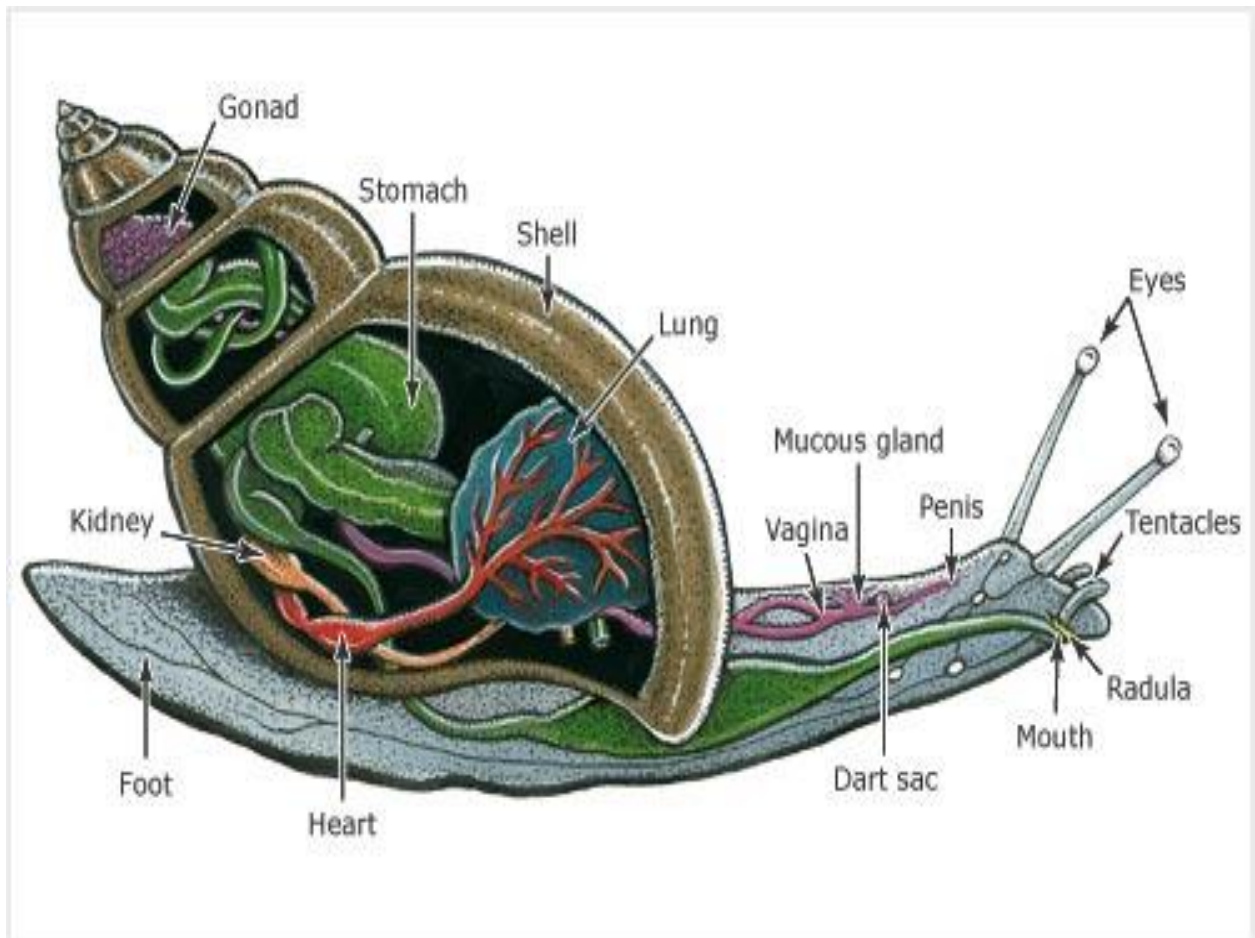
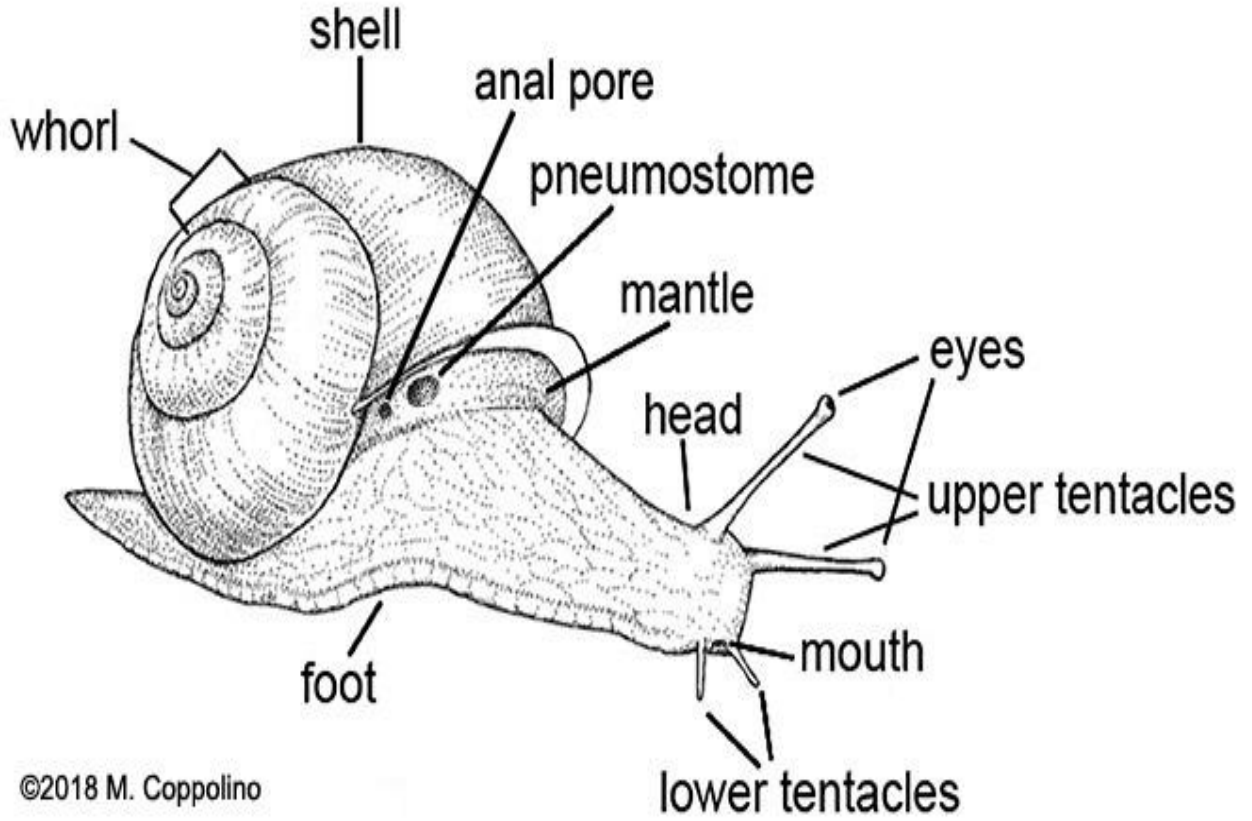
- Snails are able to lay their eggs directly into the soil, where they hatch easily
- Snails eat the soil to obtain their mineral requirements
- Snail faeces do not accumulate because earthworms and other organisms convert the waste into organic matter for inclusion in soil.

Other pens for rearing snails include mini-paddock pens, movable pens, free range pens etc.

Feeds and feeding of snails

- Snails have well developed alimentary canal comprising a buccal cavity, pharynx, crop, stomach, intestine and anus.
- The mouth has a set of teeth called **radulae**, which help it to feed on vegetable matter. The snail has a well developed sense of smell and can detect feed from a distance of about 60cm.
- Snails are predominantly vegetarian, and will eat the soft tender leaves and stems of most broad-leafed plants, vegetables and fruits. They do not eat grass.
- Older snails show preference for decaying matter, including garbage and faeces.

ANATOMY OF THE LAND SNAIL



FEED FOR SNAILS



- Snails also ingest soil, especially alkaline soils with a high content of calcium.
- Feeding occurs mostly at night or on cloudy days when there is a light rain.
- Snails locate feed with their shorter pair of tentacles, and feed on the green leaves of cocoyam, lettuce, cabbage, spinach, fruits and palm fruits. Gari with palm oil is also known to be a good fattening ration for snails.
- It is advisable to offer snails a range of feeds so that they can select.

GENITALIA OF A SNAIL



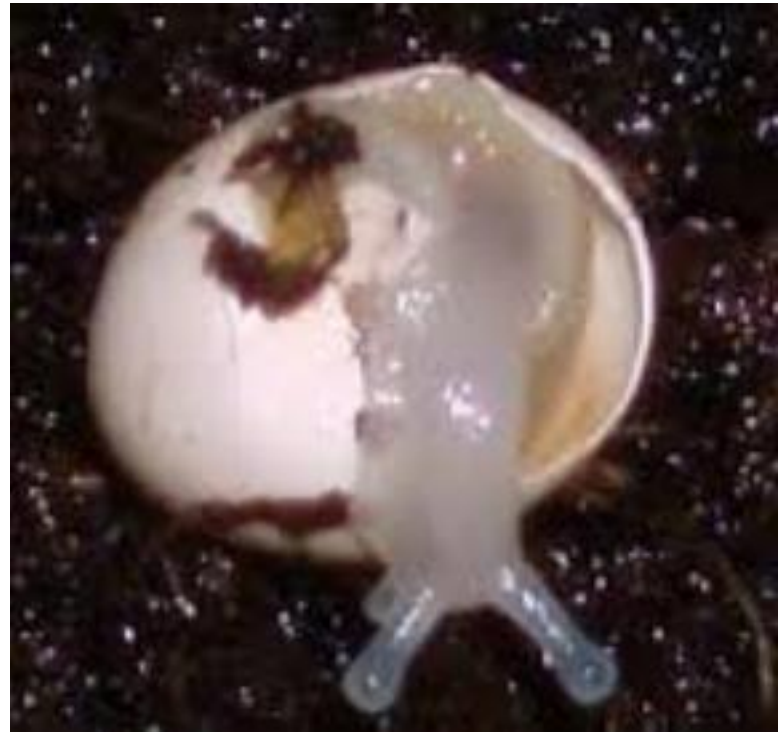
SNAILS IN A MATING POSITION



LAYING IN SNAILS



HATCHING OF SNAILS



Pests and diseases of snails

- There are many predators of snails. These include field mice, rats and shrews, frogs and toads, crows and domesticated birds such as ducks and turkeys, lizards and snakes, beetles, millipedes and centipedes. Frogs tend to take only the young snails, while reptiles eat both the eggs and the snails.
- Little is known about the diseases attacking the *A. Achatina* in West Africa. Some common diseases of snails include *Pseudomonas* – which leads to intestinal infection, and the fungus *Fusarium* - which attacks the eggs of snails.

MILLIPEDES AND CENTIPEDES



A HAWK PREYING ON A SNAIL



Harvesting and purging of snails

- When the 'lip edge' of the snail becomes hard, then it has reached maturity and will not grow anymore.
- They are then picked on weekly bases or when one pleases, and transferred to purging cages for about a week to rid their digestive system of soil or grit.
- Purging involves the removal of snails from their normal pen, and kept in new pens devoid of soil or dirt.

MATURE SNAIL (HARDENED LIP-EDGE)



- Cotton wool is usually used to line the bottom of the pen, and these are changed when soiled.
- During purging, the snails are not fed, but are provided with adequate water to minimize excessive weight loss.
- Purging rids the intestinal tract of soil particles, feces and undigested feed.
- Purging causes a loss of about 20% weight, but snails could be alive for about 2 months if kept under cool condition and provided with cool fresh water at all times.

SNAIL-PURGING CAGE



PURGING CAGE



- If purging has been effective, the snail's GIT will be emptied, and this eases processing and also ensures that the meat is more presentable / hygienic to consumers.
- Processing of snail meat starts with parboiling the whole snail with the shell at about 60 - 70°C for some few minutes (about 5 minutes).
- Parboiling kills the snail as well as make the flesh firm to ease processing (similar to chilling of conventional meat before sectioning).
- The meat is then pulled out of the shell after cooling.
- The flesh is slippery, so when not parboiled, makes its removal and the removal of the slime quite difficult.
- Breaking of the shell of the snail to remove the flesh is not advisable because particles of the cracked shells could be trapped in the flesh.
- The edible muscular foot is detached from the visceral contents and washed in warm water several times to remove the slime.
- Alternatively, the slime can be removed by washing the meat in lime juice.
- It is then cut into suitable sizes for further processing.
- To minimize microbial numbers and reproduction, the flesh washed with salt, lime and vinegar, and allowed to stay in the solution for about an hour to become foamy.
- They are then washed thoroughly in clean water and put in perforated baskets to drip.
- The meat can then be canned in brine or oil, and the cans sterilized before sealing.
- The snails can be dehydrated by smoking at a temperature of 250-300°C for about 5 minutes. The rest of the drying is done in the sun or in a solar drier for about 2-3 days, so that the flesh losses about 30-90% of its weight.
- Where facilities are available, the snail can be packaged in polythene bags and frozen at a temperature of about -18°C until it is needed.