Moving forward in the Implementation of Non-Legally Binding Instrument (NLBI) on All Types of Forests in Liberia, Nicaragua and the Philippines: A contribution to Reducing Deforestation and forest degradation

FOREST INSTRUMENT LIBERIA

FARMER LEVEL TECH - NOTE

IMPROVED SNAIL FARMING

With support of
The views expressed in this information product are those of the author(s) and do not necessarily reflect the views of BMELV, FAO, FDA, NFP Facility.

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Preface

In May 2007, the National Forum on Forests (UNFF) adopted the Non-Legally Binding Instrument on All Types of Forest (NLBI), which is commonly called the “Forest Instrument”. This significant international consensus was reached to boost the implementation of sustainable forest management (SFM), and thus to maintain and enhance the economic and environmental values of all types of forests, for the benefit of present and future generation. Most specifically, the Forest Instrument is to: (i) Strengthen political commitment and actions at all levels to effectively implement SFM, (ii) Enhance the contribution of forests to the achievement of the international agreed development goals including the MDG, and (iii) Provide a framework for national action and international cooperation.

The overall objective of the project is “to support Liberia, Nicaragua and the Philippines, on a demonstration basis, to move forward in the implementation of the Non-Legally Binding Instrument on all types of forest”.

Towards this end, an agro forestry component under the Project is providing intensive training to rural communities in three Counties, including Nimba, Grand Gedeh, and River Gee respectively in the areas of beekeeping and snail farming and total of 60 farmers were trained.

There isn’t any real history on were snails eating started from or when people started eating snail. In Liberia, edible snails can be found in the forest, in the swamp and on garbage sites. People gather snails, eat them and sell the remaining as a way to make money. This Farmers level Tech-Note aims to provide inspiration to farmers who would like to produce snails on a small scale for eating or selling. It is not for farmers who want sell or export snails in large-scale. The tech-note is focused on the three types of edible snails that are common in Liberia, the forest snail or giant African snail (Achatina achatina), the swamp snail (Archachatina marginata), the city girl (Achatina fulica).

Through this publication, FAO and FDA, Forest Development authority of Liberia (FDA) want to contribute to the income generation and food security of the Liberian farmers.

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1 Introduction

We do not have any real history where snails eating started from or when people started eating snail. In Liberia, edible snails can be found in the forest, in the swamp and on garbage sites. People gather snails, eat them and sell the remaining as a way to make money. This Farmers level Tech-Note aims to provide ideas to farmers who would like to produce snails on a small scale for eating or selling. It is not for farmers who want to sell or export snails in large-scale.

The tech-note is focused on the three types of edible snails that are common in Liberia:

- The forest snail/Giant African snail (Achatina achatina)
- The swamp snail (Archachatina marginata)
- The city girl (Achatina fulica)
2. Advantages and disadvantages of snails farming

2.1 Advantages of snails farming

Environment
Snails are environment-friendly, because, unlike poultry or pigs, neither the snail nor its droppings smell offensively. Snails can also be reared in the backyard. Also, snails manure improve the organic content of the soil.

Input
Capital, technical, labor and financial inputs in simple snail farming are relatively low compared to those in other types of livestock farming (poultry, pigs, goats, sheep, cattle).

Snail meat
Snail meat is a good source of protein. It is rich in iron and calcium, but low in fat and cholesterol compared to other protein sources like poultry and pigs.

2.2 Disadvantages of snails farming

Climate
Without expensive artificial means of climate control, snail farming is restricted to the humid tropical forest zone, which offers a constant temperature, high relative humidity, preferably no dry season, and a fairly constant day/night rhythm throughout the year.

Cultural limits
Snail meat is considered a delicacy by some, whereas others will not even touch it for religious or cultural reasons.

Growth
Snails are relatively slow-growing animals. Furthermore the consumable meat makes up only 40% (maximum) of the snail's total live weight. Consequently snail farming is not a way to make money quickly!

Snails as a pest
Snails that have escaped from a farm, or been dumped by a farmer, may quickly develop into a serious pest in agriculture.

For these reasons it must be emphasized that snail farming should be seen as only one component in a diversified farming venture. But there are many examples of cases in which giant African land snails (GALS) were introduced to other parts of the world for farming, but were eventually dumped (or allowed to escape) into the wild for lack of a market. Once the snails have been introduced, dumped or allowed to escape, they develop into agricultural pests. Without any natural elements, they end up destroying a wide range of agricultural crop and causing considerable economic damage. Achatina fulica (city girl in local language) has a particularly poor reputation in this respect. The giant African snails/forest snails are considered a delicacy by people accustomed to
consuming them, whereas other people, even within the same country, will not even touch, let alone eat them. For that reason, don’t start farming snails unless you are absolutely sure someone will buy or eat them.

3. **Suitable tropical snail species for farming**

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Local names/Liberia</th>
<th>Other names used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achatina achatina</td>
<td>Forest snail</td>
<td>Giant African snail, Tiger snail</td>
</tr>
<tr>
<td>Archachatina marginata</td>
<td>Swamp snail</td>
<td>Big black snail, Giant African land snail</td>
</tr>
<tr>
<td>Achatina fulica</td>
<td>City girl</td>
<td>Garden snail, Foolish snail</td>
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</tbody>
</table>
4. Choosing a site

Snails are good at escaping from enclosures. A priority in setting up a productive snail farming venture, therefore, is to construct escape proof housing. There are several types of snail housing (snaileries) to choose from, depending on the size of the venture. The first step, however, is to select an appropriate site. The main factors to consider in site selection are the following:

- (Micro)climate
- Wind speed and direction
- Soil characteristics
- Safety (protecting the snails from diseases, predators and poachers)

5. Soil characteristics

Soil is a major part of a snail's habitat. Soil composition, water content and texture are important factors to consider in site selection.

The snail's shell is made up mainly of calcium derived from the soil and from feed.

Snails derive most of their water requirements from the soil. Snails dig in the soil to lay their eggs and to rest during the dry season.

Soils with high organic matter support the growth and development of snails. In general, if a soil supports good growth of cocoyam, tomatoes and leafy vegetables, it is suitable for snail farming. Before introducing snails to the site, the soil should be loosened by tilling. Snails need damp, not wet, environments. Although snails need moisture, you must drain wet or waterlogged soil.

Calcium and magnesium stimulate growth best. Calcium may also be set out in a feeding dish or trough so the snails can eat it at will.

Snails dig in soil and ingest it. Good soil favors snail growth and provides some of their nutrition.

Lack of access to good soil may result in fragile shells even if the snails have well-balanced feed; the snails' growth may lag far behind the growth of other snails on good soil. Snails often eat feed, then eat dirt. Sometimes, they eat only one or the other. Eventually the soil in the snail pens will become fouled with mucus and droppings. Chemical changes may also occur. The soil must, therefore, be changed once every three months.
6. Constructing a snailery

The type and dimensions of your snailery or snaileries depend, obviously, on the snail growing system you choose, and on the quantity of snails you intend to produce. As far as housing is concerned, your snail farm could be extensive, semi-intensive, or intensive, in increasing order of complexity, management and financial inputs.

Three options might be considered:

1. **Extensive system**: outdoor, free-range snail pens.
2. **Mixed, or semi-intensive system**: egg laying and hatching occur in a controlled environment; the young snails are then removed after 6-8 weeks to outside pens for growing or fattening or both.
3. **Intensive system**: closed systems, for example plastic tunnel houses, greenhouses and buildings with controlled climate. (Note: the same options of extensive, semi-intensive, or intensive apply to feed and feeding).

Regardless of the size and type of your snail farm, the housing system must meet the following conditions.

It must be:

1. **escape-proof**: snails are master-escapists and unless prevented from doing so they will quickly wander all over your (or your neighbors’) garden or house;
2. **spacious, in accordance with the growing stage of the snails** (hatchlings, juveniles, breeding snails, or mature snails fattened for consumption). Snails suffer from overcrowding, which impedes their development and increases the risk of diseases. Suitable rearing densities range from 100/m² for hatchlings to 7-10/m² for breeding snails;
3. **easily accessible** and easy to work in or with, for handling the snails, placing feed, cleaning and other tasks;
4. **well-protected from insects, predators and poachers**. Different materials can be used for building snaileries, depending on price and availability.

The materials you will need are:

1. Decay- and termite-resistant timber, cement blocks, or mud bricks.
2. Galvanized sheets or polythene sheets.
3. Chicken wire, for protection.
4. Mosquito nets or nylon mesh, for covering the pens as protection against insects.
5. Second-hand materials, like car tires, oil drums and old water tanks.
7. Choosing a system: the options

In addition to car tires, oil drums and such materials, the following types of pens might be considered for simple snaileries:

- Hutch boxes/cages
- Trench pens
- Mini-paddock pens
- Free-range pens

**Car tires, oil drums**

Discarded tires or oil drums may serve as relatively cheap snail pens. Three or four tires are placed on top of each other, with chicken wire and mosquito mesh between the topmost tire and the second one from the top.

Oil drums should have some holes in the bottom for drainage, be filled with good soil to a depth of 7-10 cm, and be fitted with wire plus mosquito mesh on top. Such pens are suitable for keeping a few snails (up to about four mature snails in each container) close to the house, for private use.

**Hutch boxes**

**Description**

Hutch boxes are square or rectangular, single or multi-chamber wooden boxes with lids, placed on wooden stilts above the ground at a suitable height for easy handling. The stilts should be fitted with plastic or metal conical protectors or aprons, to prevent vermin from crawling or climbing up the stilts to attack the snails in the boxes. The protectors could be made from old tins or plastic bottles. In the middle of the lid is an opening covered with wire netting and nylon mesh. The lid should be fitted with a padlock to discourage pilfering. In the floor of the box are a few holes through which excess water can drain out. The boxes are filled with sieved black soil to a depth of 18-25 cm. The box(es) should obviously be well protected from scorching sun or torrential rain.

![Drawing 1: Hutch box with single (left) and double (right) chamber](image)

Hutch boxes are useful in a semi-intensive snail breeding system. They are very suitable as hatchery and nursery pens because eggs and young snails can be easily located and observed.
**Trench pens**

**Description**

Trench pens are adjoining snail pens of 0.6 × 0.6 m to 1 × 1 m, either dug into the ground (which must be very well-drained), or raised 40-50 cm above the ground. Outside walls and inner partitions consist of sandcrete blocks or mud bricks in either case. The pens are filled with suitable soil to a depth of 10-15 cm. They are covered with wooden or steel frame lids with chicken wire plus nylon mesh, and fitted with padlocks to discourage poachers. Obviously the pens must be protected against the fierce heat of the sun or heavy rain. Shredded semi-dry banana leaves may be spread in the pens to provide shelter for the snails.

![Drawing 2: Two types of trench pens. A: dug in trench pen, B: raised trench pen](image)

Trench pens are suitable in semi-intensive to intensive snail growing ventures. They can be used as hatchery, nursery or fattening pens, with the number of stock being adapted to the size of the snails in each case. The snails can be moved from one pen to another according to the growing cycle.

**Advantages and disadvantages**

The main advantage of a trench pen system, whether sunken or raised above the ground, is its flexibility. Snails can be moved around easily, in accordance with their size and phase in the growing cycle. The snails are always easy to locate, for feeding, handling, and selection for final sale and consumption.
Mini-paddock pens

Description

Mini-paddock pens are small square or rectangular pens, usually within a larger fenced area. They are built of bamboo and nylon mesh, or of timber, chicken wire and nylon mesh.

The walls should be some 50 cm high and be dug at least 20 cm into the ground. Wooden frames are attached to the top of the walls (extended inwards) and covered with the mesh, to prevent snails from escaping as shown in drawing 3.

Plants providing shelter and/or food are planted in the pens before snails are released into them. Suitable plants include cocoyam, sweet potato, fluted pumpkin, and leafy vegetables. Rectangular pens allow the farmer easier access to the whole area without having to enter the pens. Mini-paddock pens may also be constructed higher above ground, with a completely enclosed frame, and may even be roofed. Application and use mini-paddock pens, like free-range pens are suitable as fattening pens, where snails that are no longer needed for breeding are allowed to put on weight before being collected for consumption or sale. Additional snail food may be placed in the pen, but uneaten food must be removed regularly. Food and shelter plants must be replanted from time to time.

Advantages and disadvantages

The advantage of mini-paddock pens is that snails grow in an environment resembling their natural habitat without much additional effort from the farmer. The limited dimensions of the pen still permits close supervision. The main disadvantage would seem to be that the snails are not protected against predators, unless the pen is entirely closed and roofed, which makes it more expensive.
**Free-range pens**

**Description**

Essentially, free-range pens are large mini-paddock pens: a fenced area of up to \(10 \times 20\) m, planted with plants, shrubs and trees that provide food and shelter from wind, sun and rain. Just like in a mini-paddock pen, the vertical fence must be extended inwards, to prevent snails from escaping. If the fence is constructed of fine chicken wire mesh, the overhang is not obligatory because snails dislike crawling on wire mesh.

The fence must be dug at least 20 cm into the ground. The free-range pen might even be completely enclosed and roofed.

![Drawing 4: Open free-range snail pen with vegetation providing shelter for the snails.](image)

**Application and use**

Free-range pens may serve as the sole snail enclosure in cycle of the snail develops within the open pen an extensive snail farming system, or as growing and fattening pens in a semi intensive one. In the extensive snail farm the entire life cycle of the snail develops within the open pen: mating, egg laying, hatching, hatchling development, and growth of the snails to maturity. Snails feed on the plants provided in the pen. In a semi-intensive snail farm the free-range pen serves as a growing and fattening pen for adult snails, which were raised through the egg hatching- juvenile stages in hutch boxes or trench pens.

**Advantages and Disadvantages**

In an extensive system using a free-range pen the snails develop in a near-normal habitat. They will take shelter in the vegetation or the soil during the day, coming out at night to feed. A simple fenced free-range pen is relatively simple and cheap to construct. Management is restricted to occasional replanting of food and shelter plants. If the vegetation within the pen is kept in shape, additional feeding of the snails is not necessary. A fully enclosed and roofed pen is quite costly to build, obviously, especially if provided with a concrete apron and drain.
Both types require the availability of land with a secure title, considering the investment involved, specifically for the fully enclosed and roofed variety.

The free-range pen has several disadvantages. It requires more land than other types of snail farming. It is difficult to locate and protect eggs and small snails. This may lead to poor disease management and higher mortality compared to other snail production systems. It is difficult to keep track of snail performance and, for that reason, to keep useful records of inputs and output. In the open type of free-range pen it is more difficult to keep out predators and poachers. Besides the natural shelter provided in mini-paddock and free-range pens, it is advisable to also provide other forms of shelter to ensure that the snails are not exposed to too much heat. For example, concave tiles or split bamboo can be placed on stones on the ground, with the concave side facing downwards. On very hot days, the soil can be cooled by sprinkling water on it.
8. Types of snail food

**What snails eat**
Snails are vegetarian and will accept many types of food. All snails will avoid plants that have hairy leaves or produce toxic chemicals, like physic nut (Jathropa curcas). Young snails prefer tender leaves and shoots; they consume about twice as much feed as mature snails. As they get older, mature snails increasingly feed on detritus: fallen leaves, rotten fruit and humus should be introduced gradually.

**What snails need**
Snails need carbohydrates for energy, and protein for growth. In addition they require calcium (Ca) for their shells, as well as other minerals and vitamins. Snail meat is low in crude fiber and fat; for that reason, these components are of minor importance in snail feed.

**Recommended food items**
- **Leaves**: cocoyam, kola, paw paw, cassava, okra, eggplant, loofa, centrosema, cabbage and lettuce. Paw paw leaves (as well as its fruit and fruit peels) stand out in many trials as good snail food.
- **Fruits**: paw paw, mango, banana, eggplant, pear, oil palm, fig, tomato and cucumber. Fruits are usually rich in minerals and vitamins, but low in protein.
- **Tubers**: cocoyam, cassava, yam, sweet potato and plantain. Tubers are a good source of carbohydrates, though low in protein.
- **Household waste**: peels of fruit and tuber, like banana, plantain, pineapple, yam especially paw paw, and leftovers like cooked rice, beans, fufu and eko. Caution: household waste must not contain salt!

**Recommendations on natural feed**
- **Market waste**: because snails are vegetarians, the cheapest way to feed them is by collecting rejected food from marketplaces. At the end of any market day, some perishable vegetables and fruits still useful for snail consumption can be collected from the dumping areas. This would reduce the cost and labour of buying or cultivating vegetables and fruits only to feed snails. Caution: you should not collect vegetables and fruits that are decaying.

Snails can feed on a large range of food items but feed containing waxy or hairy leaves should be avoided. Providing the forest snail with a mixture of foods, rather than only one or two items, will enhance its growth. Food attractiveness is important in the nutrition of this species. If the food is appetizing (e.g. paw paw) the snails will eat a lot and grow quickly. If food is unattractive, however nutritious it may be, the snails will not eat much of it.

Paw paw leaves, fruit and peels are a good source of crude protein. For strong growth and good shell development, powdered calcium sources from egg shells, limestone, wood-ash, oyster shells (crushed), or bone meal, should be added to the feed at a level of about 15 to 20% of diet dry matter. Crushed oyster shell calcium is best.

Snails need water! Most is supplied by the food they consume, but additional water must be supplied in the growing pens: a water soaked sponge or a dot of cotton wool for
hatchlings and juveniles, in shallow dishes (otherwise the snails may drown) for mature and breeding snails.

**Supplementary vitamins.** Other food plants known to contain moderate amounts of vitamins D, E and K should be added. Examples are sunflower and copra cake (vitamin D), wheat germ, lettuce and other vegetables (vitamin E), cabbage and African spinach (vitamin K).

**Supplementary calcium.** If the soil is not high in calcium, supplementary calcium will be needed. This can be provided by sprinkling powdered oyster or snail shells or ground limestone onto leafy vegetables.

**Supplementary minerals.** Other minerals can be provided by placing licking stones containing the mineral in the pen.
9. Breeding and management

Although snails are hermaphrodites (i.e. they have male and female parts), in most species the individuals mate with each other before laying eggs.

In extensive snail farming in free-range pens, the snails follow their natural life cycle. Interference from the snail farmer is restricted to the daily removal of any dead snails, refilling watering troughs, keeping the soil moist in the dry season, and occasionally harvesting mature snails for sale or for the cooking pot.

In semi-intensive or intensive snail farming the farmer will actively manage the snails during the successive stages of their life cycle: egg laying, hatching, growing and maturity. Management activities proceed in tune with the snails' life cycle, which in turn follows the seasons with their periods of snail activity and of dormancy (aestivation during the dry seasons). (Note: Domesticated snails continue to lay eggs in the rainy and dry seasons).

9.1 Selecting breeding stock

It is recommended to use sexually mature snails, weighing at least 100-125 g, as initial breeding stock. Farming should preferably start at the onset of the wet season, because that is the time snails normally start to breed. Until snail farms become self-sustaining, farmers may have to collect snails from the wild or buy them cheaply in the peak season and fatten them in captivity in the off season. In relatively undisturbed forest areas, snails can be collected on days following rains. Snails are active at night and on cloudy or foggy mornings. During the day they tend to keep well hidden, so it is best to collect them at night or early in the morning, when the sun is low and the humidity high. Farmers purchasing breeding stock from snail gatherers or from the market should expect a fairly high level of mortality as a result of poor handling and the adjustment to different foods. The most reliable way of obtaining parental stock is from known breeders, or from agricultural institutes. Such parent snails might be more expensive than snails from other sources, but they are better and safer because they have been properly fed and managed from hatching, and have not been damaged during collection and subsequent handling. Once the snail farm is established, farmers should select breeding stock from their own snails. Breeding stock must be selected in the wet season preceding aestivation, based on the following attributes:

- Fecundity (expected number of eggs, based on numbers laid in previous seasons)
- Hatchability (percentage of eggs likely to hatch out of the total number laid)
- Establishment rate (percentage of snails likely to survive after hatching)
- Growth rate
- Shell strength

Simple records kept by snail farmers can provide the necessary information. As a general rule, the fastest growers with the strongest shells should be selected as breeding stock. The stronger its shell, the better the snail is protected against predators.
9.2 Nursery

Snails selected as breeding stock are placed in hutch boxes or trench pens, which must contain feed and water troughs. Some farmers let snails lay eggs in the grower pens, and then transfer the eggs to the nursery boxes or pens, but this is not recommended. It may be difficult to locate the eggs, and the eggs may be physically damaged during the transfer. A breeding snail may lay one to three egg masses (clutches) per season. The number of breeding snails placed in a hutch box/snail cage depends on the fertility of the group and on the number of young snails required. The latter depends on the pen space available. After egg laying, the parent snails should be returned to their grower pens. In forest snails, large differences have been observed in egg production within and between populations. Generally, snails lay between 100 and 400 eggs. The eggs are broadly oval and measure about 5 mm long. They are usually laid in round-shaped holes dug 2-5 cm deep in the soil. Occasionally they are laid on the soil surface or at the base of plants. Snail eggs require a certain amount of warmth to induce hatching.

They usually hatch 12-20 days after laying.

In forest snails, the baby snails have light-brown shells with black stripes. They should be kept in the boxes and fed on vegetable or fruit leaves (like cocoyam and paw paw leaves), fruits (preferably paw paw), powdered oyster shells and water until they are big enough to move to grower pens. Young snails do best if they are kept with snails of the same size.

The eggs of the city girl are small (4 mm) and are laid in clutches of 10 to 400; usually a parent snail lays several clutches in a year. Hatchlings remain 5-15 days underground before emerging.

The eggs of swamp snail are quite large (17 × 12 mm) and egg clutches are small (4-18 eggs). A parent snail may produce several clutches a year. The incubation period is around 4 weeks. Hatchlings remain underground for 2-5 days after hatching.
9.3 Rearing density

Density affects the growth and breeding capacity of snails. High density populations tend to grow slowly, develop into smaller adults, and lay fewer clutches of eggs and fewer eggs per clutch. If the snails are very densely packed, they may not breed at all. The accumulating slime suppresses reproduction. Other disadvantages of high density are the high rates of parasitism and ease of transmission of diseases. In terms of snail weight, the recommended density is 1-1.5 kg per m² (for the forest snail, this would be about 15 to 25 snails per square meter).

It is best to start a snail farm with as low a density as possible. As the farmer becomes more familiar with snail habits and with managing the enterprise, the numbers could be increased.

9.4 Seasonal and daily management

As in any livestock farming operation, good management practices are the key to success. Seasonal activities, as described below, follow the march of the seasons of West Africa, with breeding and egg laying in March through July. Note that domesticated snails may continue laying during the dry season as well.

The successive stages of the life cycle of snails are: egg laying, hatching, growing and maturity. In semi-intensive or intensive snail farming, farmers keep and care for hatchlings, growers and breeding snails in separate hutch boxes or pens.

Hatchlings

Hatchlings require more humid conditions than adult snails. They should be fed tender leaves, such as paw paw and/or cocoyam, and a calcium supplement for good shell development. The soil in their pens should be kept moist and enough water should be provided. The pens should be fitted with small gauze wire mesh or nylon mesh; otherwise the small snails will escape. Hatchlings and juveniles may be kept at a density of around 100/m².

Growers

Growers should be transferred to separate pens at around 3 months of age, at a stocking density of 30-40 snails/m². Breeders start to lay eggs at sexual maturity, at the age of 10 to 12 months.

 Breeders

Breeders start to lay eggs at sexual maturity, at the age of 10 to 12 months. They should be transferred to boxes or pens at a density of 10-15 snails/m². The soil should be loosened to facilitate egg laying. The breeders' food must be rich in crude protein and calcium. Any eggs found on the surface must be buried promptly to a depth of 1 to 2 cm. Before hatching, the soil on top of the clutches might be loosened or the breeders must be removed to their growing pens soon after the hatchlings emerge. Adults no longer required for breeding and are kept in fattening pens until ready for sale or consumption.

Note: stocking densities mentioned are indications. The general stocking density guideline of 1-1.5 kg snail/m² should always be kept in mind!
Daily management involves several activities:

**Feeding**

Snails should be fed after sunset. The feed must not be stale or moldy. Leftovers should be removed the following morning. Water should be replenished.

**Housing**

Check whether wire mesh and mosquito netting are intact; repair where necessary. Clean the pens. Keep doors or covers of the snail pens closed and locked.

**Soil**

Keep the soil moist by mulching and watering if necessary in the dry season. Never add fresh poultry droppings to the soil. The soil in the cage should be changed every three months.

**Hygiene**

Check pens for any dead snails; remove them immediately. Do not use insecticides or herbicides in your snailery. Handle your snails carefully and wash them with fresh water from time to time.

To wash snail, lay the mouth in your hand and carefully wash the back (shell).

**Recording**

Record inputs and output of your snail farm daily. Include your own labor or that of family members, and inputs, like food or repairs to the pens.

### 9.5 Snail farming tools and equipment

Besides the customary gardening tools (shovel, hoe, rake, cutlass, broom), the following equipment and tools are needed in successful snail farming:

- small weighing scale, for weighing snails;
- feed measuring tape, for measuring pens;
- snails hand trowel, for digging in and cleaning out the pens;
- water container and watering can, for keeping the soil moist and refilling water and feeding troughs or dishes; and
- most important: a notebook, for carefully recording inputs (e.g. labour, materials and feed) and output of the snail farming venture.
10. Predators, parasites and diseases

Snail farmers must be aware of several predators, parasites and diseases if mortality rates are to be kept to a minimum. Snails have many natural predators, including members of all major vertebrate vertebrate groups, carnivorous snails, ground beetles, leeches and even predatory caterpillars. Humans also pose great dangers to snails in the wild. Pollution and destruction of habitats have caused the extinction of some snail species in recent years. Human poachers pose a great danger to farm grown snails as well!

**Predators**

The major predators a snail farmer may have to deal with are field mice, rats and shrews, frogs and toads, thrushes, crows and domesticated birds such as ducks and turkeys, lizards and snakes, drilled and carabid beetles, and millipedes and centipedes. The frogs tend to take only the young snails, while the reptiles eat both eggs and snails of all ages.

In areas with high bird predation, it is necessary to place cover nets over the pens. Keeping some of the other predators out may require building fences around the pens. The fences should be between 15 and 30 cm high and dug well into the ground. It is also advisable to set bait or traps outside the snail farm area.
Leftover food should be removed daily from pens because some predators, particularly rats and field mice, are attracted by the uneaten food. These predators can decimate a farm in a few days.

However, the main predators are humans looking for a nutritious meal at the snail farmer's expense. Snail farmers must introduce any legal measures they consider necessary to protect the farm against poachers.

**Parasites**

Major parasite on snails was found to be a fly that belongs to the same family as the housefly and the adult resembles the adult housefly. This fly lays 20-40 eggs in the snail shell or on the snail. The eggs hatch in about one week and then start feeding on or in the body tissue. They feed until the body is reduced to a putrefying mass, and then pupate within the shell. After a 10-day incubation period, the adults emerge. The best protection against these flies is to cover the pens with nylon mesh.

**Diseases**

Basic hygiene is the best way to prevent the spread of diseases. Therefore pens should be cleaned out regularly to remove excreta and uneaten food, as well as any other decaying matter that may serve as substrate for pathogenic organisms.

It is also advisable to sterilize the soil in hutch boxes by steaming or heating every time they are being prepared for a new batch of egg clutches (i.e. when the breeders are transferred to the boxes for egg laying).
11. Processing and consumption of snail meat

11.1 Processing of snail meat

Harvesting and storage

The age and size at which snails should be collected from the snailery obviously depends on the farming objective: whether the snails are grown for personal use or for the market. Snails grown for personal use can be harvested according to the farmer's needs; whereas customer preferences dictate the optimum size and consequently age of snails harvested for the market.

Snails usually need to grow for at least one year to reach their proper size and weight. It is recommended to harvest snails by the time they reach two years, because after this age their rate of growth slows down. Snails are picked by hand, at nightfall, when they become active and are easier to find and collect. They need to be put carefully into a basket, box, crate or sack, to avoid damaging the shell, which would lower their market value. Never put more than 10 kg snails together in whatever storage receptacle you use, to avoid cracking or crushing the shells in the lower layers. Snails, whether for household consumption or for the market, can be stored safely for up to 6-8 weeks in a box or crate, if you do not want to collect them daily.

To store them, first put a 5 cm layer of sawdust or finely cut corncob leaves on the bottom of the box; place over this a layer of snails, then another 3 cm layer of sawdust, and so on, ending with a covering layer. The box should be kept in a cool, shaded place, well protected from predators and poachers. Snails can be transported to the market in baskets, boxes or sacks, but always take care not to damage them by putting too many together or on top of each other (max. 10 kg).

Processing

Freshly gathered snails have just eaten (except if collected when aestivating or hibernating). They can be used directly, but all feces and dirt must be removed in the kitchen.

It is easier and more hygienic to have defecate before use. Store them in a basket or sack in a cool, shaded place without food for four days, to enable them to discharge all aliment in their intestinal tract. They are now ready for washing, boiling and dressing.

Washing

Put snails in a bucket with water, adding some salt and a dash of vinegar. Lemon or lime juice can be used instead of vinegar. Soon, the snails will start to discharge their slime: a milky, whitish liquid. Throw away the water and repeat the washing procedure until the water remains clear.

Boiling

After washing, put snails into boiling water, again adding some salt and vinegar, or lime or lemon juice, and boil thoroughly for at least 5 minutes. Improperly cooked snail meat may act as a major source of human infection in places where it is commonly eaten by people. Thorough boiling is essential!
Dressing

Extract the snail from its shell, draining off the body fluid (unless local recipes call for its use), remove the viscera (heart, stomach, kidney, liver, intestines) and cut off the head. The meat is now ready for boiling, stewing, frying or whatever cooking technique your local snail recipe book calls for.

11.2 Consumption of snail meat

Composition and nutritive value

Meat compares well with traditional sources of protein like chicken meat, pork or beef. It contains good levels of iron, magnesium, calcium, potassium and sodium. Snail meat complements the minor and trace elements required for proper growth and development in humans, so it is recommended for regular consumption.

Palatability

In Liberia Achatina achatina (forest snail) is considered the most prized species for consumption, followed by Archachatina marginata (swamp snail) and Achatina fulica (city girl), in order of preference.
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