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Front cover photo: A picture of Snailery Farming. (Photo credit: APDC)
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INTRODUCTION

Snail meat has been consumed by humans worldwide since prehistoric times. It is high in protein (12-16%) and iron (45-50 mg/kg). Low in fat and contains almost all the amino acids needed by humans. A recent study has also shown that the glandular substances in edible snail meat cause agglutination of certain bacteria, which could be of value in fighting a variety of ailments, including whooping cough.

Edible snails also play an important role in folk medicine. In Ghana, the bluish liquid obtained from the shell when the meat has been removed is believed to be good for infant development. The high iron content of the meat is considered important in treating anaemia. In the past, it was recommended for combating ulcers and asthma. At the imperial court in Rome, snail meat was thought to certain aphrodisiac properties and was often to visiting dignitaries in the late evening.

In West Africa snail meat has traditionally been a major ingredient in the diet of people living in the high forest belt

(the forested area other than the savannah forest). In Cotedvoire, for example, an estimated 7.9 million kg are eaten annually. In Ghana it is clear that demand currently outstrips supply.

Advantages of snail 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.

Inputs

Capital, technical, labour 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 livestock sources like poultry and pigs.

PLANNING A SNAIL FARMING VENTURE

A sequence of five steps is suggested:

1. Plan (market, production, organisation)
2. Pilot production and sales
3. Go or no-go decision
4. Investment in facilities and know-how (cages/pens, finance knowledge)
5. Upscaling (logistics, quality, financial control

SUITABLE SPECIES

2.1 Biology of snails

Snails belong to a group of invertebrate animals known as molluscs.

Most molluscs carry a shell. Other members of this group include slugs, mussels, squid and cuttlefish.

This snail training manual concentrates on the farming potential of the giant African land snails (GALS), more specifically the species Achatina achatina, Achatina fulica and Archachatina marginata. These belong to the family Achatinidae, a diverse group of large pulmonate land snails, originally from western, eastern and southern Africa, with long slender shells.

Their size ranges from 3cm to 25cm. the 14 genera are: Achatina, Archachatina, Atopochochlis, Bequeartina, Burtoa, Columna, Callistpepla, Lignus, Limicollaria, Limicolariopsis, Lissachatina, Metachatina, Periderriopsis and Pseudachati.

They mostly live in jungles in tropical countries, but some may live in grassland. They primarily feed on fruits and leaves. They are easy to find and not difficult to rear. They lay several batches of eggs each year. Generally, they are quite easy to care for, being able to put up with a range of conditions.

Essentially, a snail consists of two parts, the body and the shell. The body is divided into three parts, - the head, the foot and the visceral mass. The head is not well demarcated and carries two pairs of retractable tentacles. One pair of tentacles is far longer than the other and contains the eyes in the knobbed end. The long, muscular foot occupies almost the entire ventral surface and, like the head, is not clearly demarcated from the rest of the body. A shallow longitudinal groove runs along the centre of the foot. The hump-shaped visceral mass is housed in the shell above the foot. It contains the digestive, reproductive and respiratory organs.

The skin over the visceral hump secretes a large calcareous shell (98% of the shell is made up of calcium carbonate). In most species the shell accounts for about a third of the body weight. It is the snail's protective casing. Whenever danger threatens, the snail withdraws its body into the shell.

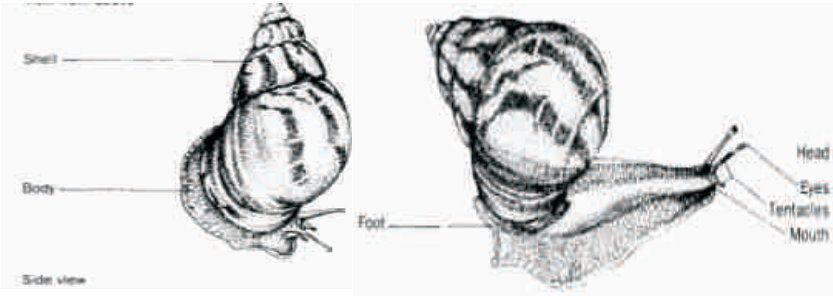


Figure 1: The main anatomical features of a typical snail

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

2.2 **Achatina Achatina**

Achatina Achatina (giant snail, tiger snail), a widely distributed species in West Africa (particularly in Benin, Cotedvoire, Ghana, Liberia, Nigeria, Sierra Leone and Togo), can be considered a good candidate for snail farming in most areas of West Africa , although it requires higher humidity than the other two species and needs a longer growing time to reach maturity.

Description

Achatina achatina snails are reputedly the largest land snails in the world. They can grow up to 30 cm in body length and 25 cm in shell height. Average adult shell length is 18 cm with an average diameter of 9 cm. The conically shaped, pointed shell is brownish with a characteristic stripe pattern (hence the name tiger snail).

Distribution

Achatina achatina originates from the West African rainforest belt, from Guinea through Nigeria. Because A. achatina is the most prized specie for consumption in West Africa and it is becoming increasingly rare in the wild. Several ecotypes (locally adopted populations of A.achatina) can be found, with differences in growth rate, size, aestivation (dormancy) patterns, colour and even flavour. The differences in size may be explained partly by differences in the length of the aestivation period; the shorter the aestivation period, the longer the feeding period and the larger, therefore the ecotype.

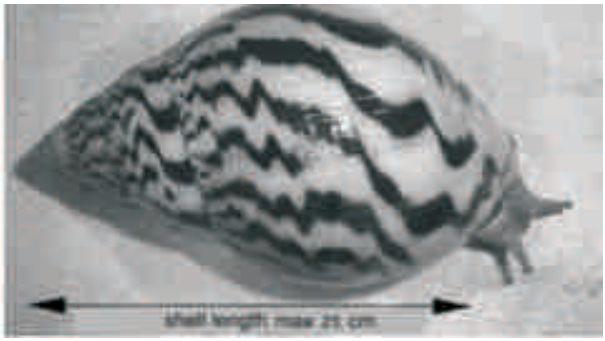


Figure 3: Achatina Achatina

Growing Conditions

The species prefers warm conditions, 25-30 degree Celsius and a relative humidity of 80-90%. A.achatina is said not to be the easiest specie to farm because of the very steady conditions it is used to in the wild: a practically constant 12/12 photoperiod, only extending to 13/11 for about 3 months, and a temperature difference between night and day of only 2-4 degree Celsius. Even in the most humid areas of West Africa the snail, in its natural habitat, buries itself for aestivation during the drier months.

Life history

Reproduction; Achatina achatina reproduces by self-fertilization. Unlike in many other species, reproduction is not preceded by coupling, although it is not unusual to find two snails in proximity.

Laying: laying usually takes place in the late evening and night. Eggs are laid in clutches of 30 -300 eggs. They are broadly oval, dirty yellowish, 8-9 mm long and 6-7 mm wide. Eggs are deposited in dug-out holes about 4cm deep.

When small clutches of eggs are laid, a second laying is indicated, and sometime a third.

Hatching: usually, the eggs hatch 2-3 weeks after laying, with a range of 10-31 days, depending on temperature. A. achatina has a high hatching rate of 90+%; even 100% hatchability is not uncommon.

Hatchlings: the baby snail has a thin shell membrane which calcifies progressively. Although this period is characterised by rapid growth, the snails are able to survive the first few days (5-10 days) after hatching without food.

Juveniles: the juvenile phase covers the period from 1 or 2 months to the stage of sexual maturity (14-20 months). During this period, the snail accepts a much wider range of food. At the ends of the period, the shell is well formed.

Adults: the adult phase starts when the snail reaches sexual maturity. Not all adult snails lay eggs each season. An average life expectancy is 5-6 years, although there are reports of snails surviving up to 9 or 10 years.

2.3 Achatina fulica

Description

Achatina fulica (garden snail, foolish snail) is a large snail, reaching 20 cm in length or occasionally more, with a shell length up to 20 cm and a maximum diameter of 12 cm. the conical, spiralled shell is predominantly brown with weak, darker banded markings across the spiral. Colouration is highly variable, depending on diet.

Figure 4: Achatina Fulica

Distribution

The species originated in the coastal regions of East Africa (Kenya, Tanzania), and spread by the 19th century into Southern Ethiopia, Southern Somalia, and Northern Mozambique. During the 19th century, it was introduced into India and Indian Ocean islands. During the 20th century, it was introduced, sometimes intentionally, into South East Asia, East Asia (Taiwan, Korea and Japan), the USA (now eradicated in various states), the Caribbean, Central America and South America (Brazil).

Growing Conditions

The species is highly adaptable to a wide range of environments, modifying its life cycle to suit local conditions.

Life history

Reproduction: Without delays because of aestivation or hibernation, snails will reach sexual maturity in less than a year (even as early as 5 months under laboratory conditions). Reciprocal copulation (6-8 hours) must occur to produce viable eggs.

Laying: The small (4mm in diameter) yellowish-white eggs are laid in clutches of 10-400 eggs within 8-20 days of copulation, usually in nests excavated in the soil. Repeated layings may result from one copulation, as sperm is stored in each snail.

Egg laying frequency depends on climate, particularly on frequency and duration of the rainy seasons:

Hatching, Hatchlings: Upon hatching, the hatchlings consume their eggshells (and unhatched siblings), remaining underground for 5-15 days and feeding on organic detritus. Eventually they feed primarily on plants at night, returning to roost before dawn.

Juveniles: Animals with shell lengths of 5-30 mm apparently cause the most damage to plants.

Adults: The snail may reach sexual maturity in less than a year. Larger snails continue to feed on plant materials but feed increasingly on detritus as they age. Normally, they live for 3-5 years.

Significance as a pest

The species causes considerable economic damage to a wide variety of commercial crops. In most parts of the world, the amount of damage is greatest when the species is first established; during this period, snails are usually very large, and their population can become immense. This is followed by a stable population phase, and then finally a period of decline.

Parisitology

Achatina fulica is reported to be an intermediate vector of the rat lungworm Angiostrongylus cantonensis, which can cause eosinophilic meningoencephalitis in humans; as well as of a gram-negative bacterium, Aeromonas hydrophila, which can cause a wide variety of symptoms, especially in persons with compromised immune systems.

2.4 Archachatina Marginata

Description

Archachatina marginata (big black snail, giant African land snail) is a large snail, generally growing to about 20cm and a live weight of 500g. The shell is much pointed than the Achatina species, the roundness being especially obvious in young animals. Striation on the shell may give the appearance of a "woven" texture. The head of the snail is dark-grey; its foot is a lighter shade.

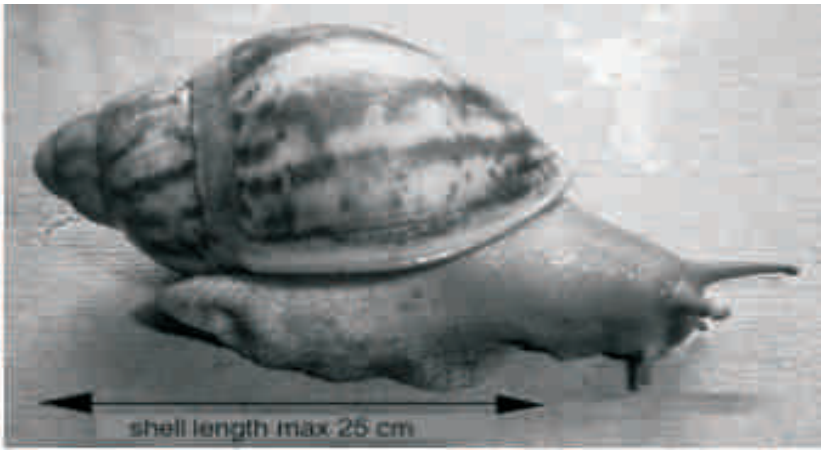


Figure 5: Archachatina Marginata

Distribution

Archachatina marginata is native to the humid African rainforest belt, from Southern Nigeria to Congo, but is now found in other parts of the rainforest zone.

Growing conditions

In the Nigerian experiments, juvenile growth was found to be inversely proportional to temperature, falling sharply at temperatures > 30 degree Celsius, and directly proportional to rainfall humidity. Body weight gain slows down significantly during the dry season (December to March in Southern Nigeria, where the breeding trials took place).

Life history

Reproduction: the species reaches sexual maturity at an age of around one year, when the individuals reach a live weight of 100-125 g. Reciprocal copulation must occur to produce viable eggs.

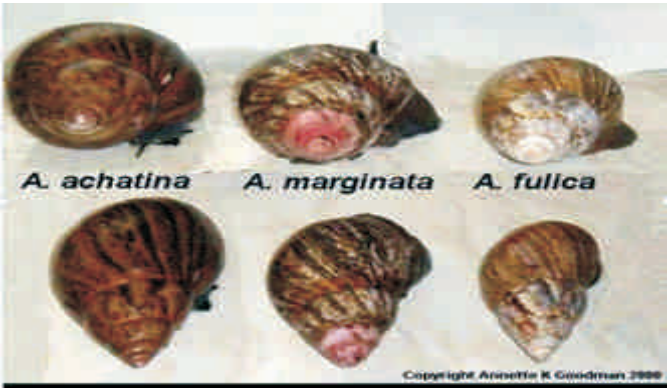
Laying, eggs: the eggs are comparatively large at 17 x 12 mm, with an average weight of 4.8 g in a Nigerian stocking trial. For that reason, the number of eggs per clutch is low, 4-8 eggs. Eggs are laid in the soil at a depth of about 10 cm.

Hatching, Hatchlings: the incubation period, from egg to hatchling, is around 4 weeks. Hatchlings have a thin, transparent shell; they generally remain in the soil for 5 to 7 days before emerging, but sometimes wait even longer. Because of the relatively high weight of the eggs the numbers of hatchlings repeatedly burrow into the soil.

Juveniles: in laboratory trials, shell length of the juvenile snails increased by an average of 0.33 mm/day for the first 8 months slowing down to 0.22 mm/day at 15 months. Shell length hardly increases after that time.

Adults: the snails reach sexual maturity at around 10 -12 months (plummer, 1975).

picture showing the three types of GALS



2.5 Climatic and environmental requirements and restrictions for raising snails

From the descriptions of the three GALS species of snails, as cold-blooded animals, are sensitive to changes in atmospheric humidity and temperature. GALS, especially Achatina fulica, can put up with a range of conditions, but when temperature and/or humidity are not to their liking, they go into **dormancy**. The snail retracts its entire body inside its shells, sealing off the opening with a white, calcareous layer to prevent water loss from the body. This reaction is typical of all snail species.

Figure 6: Aestivating snail sealed into its shell by a calcareous layer

Snails aestivate if the *temperature* is too high, > c. 30 °C, or if *air humidity* is too low, < c. 70-75% relative humidity.
Snails hibernate if the *temperature* drops below c. 5 °C.

For the snail farmer the result is the same: his (or her) snails become inactive and stop growing, losing valuable growing time, while expenses for housing, tending and protection continue.

Consequently, it is in the snail farmers interest to prevent, or at least reduce, dormancy

- By selecting the most favourable site for the snail farm
- By providing good housing for the snails
- By providing good feed and ensuring good snail management.

Obviously, it is possible to farm snails in a completely controlled environment, but this would require considerable investment costs, without artificial climate control, successful commercial snail farming is restricted to areas with the following characteristics:

- **Temperature**: a steady year-round temperature of 25-30 degree Celsius and a low fluctuation between daytime and night-time temperatures.
- **Day-length**: a constant 12/12-hour photoperiod throughout the year.
- **Air humidity**: a year-round relative air humidity of 75-95%.

These conditions correspond to the tropical rainforest climate zones and they work best when there is no pronounced dry season or strong fluctuations.

CHOOSING A SITE

3.1 General considerations

Snails are adept 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

Optimal site selection helps to prevent, or at least reduce, dormancy. Factors such as temperature and humidity and soil characteristics that influence snail survival and growth are discussed below.

Figure 7: General view of an open free-range snail pen, with multi-storey tree cover acting as a windbreak and reducing loss of water from the soil.

CONSTRUCTING A SNAILEREY

4.1 Choosing a system: The options

The type and dimensions of your snailerey 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 concerned, your snail farm could be intensive, semi intensive, or intensive, in increasing order of complexity, management and financial inputs. Three options might be considered:

- Extensive system: outdoor, free-range snail pens.
- 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 fattening or both.
- Intensive: closed systems, for example plastic tunnel houses, green houses and buildings with controlled climate.

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

- **Escape-proof;** snails are master-escapists and unless prevented from doing so they will quickly wander away.
- **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/m^2 for hatchlings to 7-10/m^2 for breeding snails

- **Easily accessible and easy to work in or with** for handling the snails, placing feed, cleaning and other tasks.
- **Well-**protected from insects, predators and poachers.

Different materials can be used for building snaileries, depending on price and availability.

- **Decay-and termite-resistant timber:** in West Africa favourable tree species are iroko, opepe. In South East Asia poles can be made of specie like teak, which is widely planted in other continents as well.
- Sand Crete blocks, or mudbricks.
- Galvanised sheets, polythene sheets
- Wire gauze, for protection.
- Mosquito nets or nylon mesh, for covering the pens as protection against insects.
- Second-hand materials, like car tyres, oil drums and old water tanks.

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

- Hutch box
- Trench pens
- Mini-padlock pens
- Free-range pens
- Car tyres/oil drums

Car tyres, oil drums

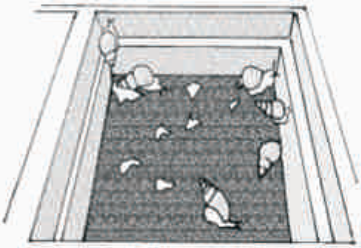


Figure 8: Snails in one of the chambers of a hutch box

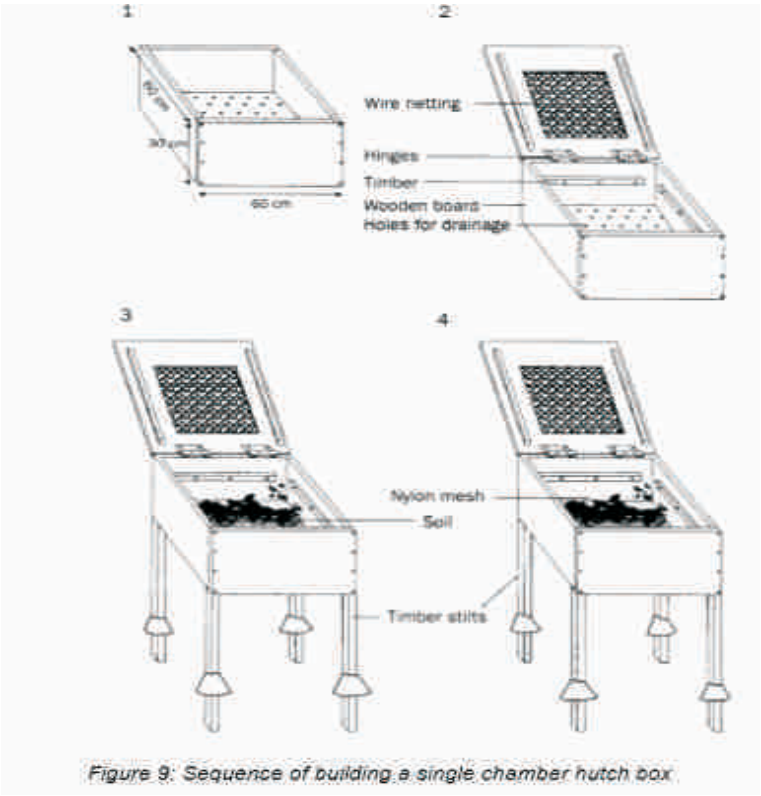


Figure 9: Sequence of building a single chamber hutch box

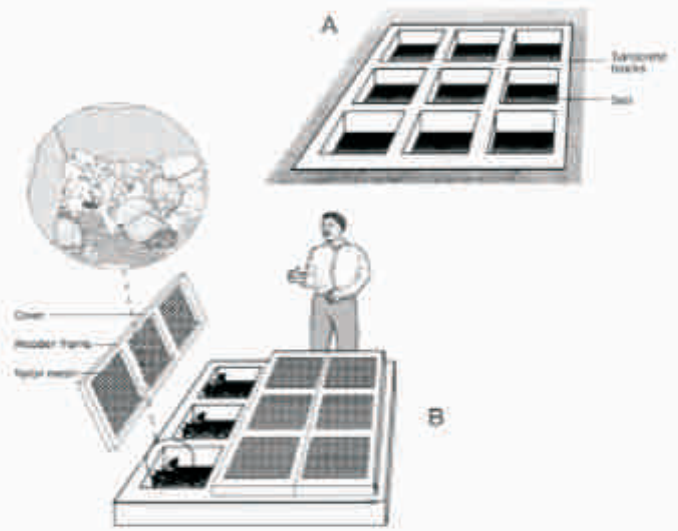


Figure 10: Two types of trench pens: A: dug in, B: raised. The inset shows Archachatina marginata snail crawling around in shredded banana leaves (for dimensions see Appendix 2)

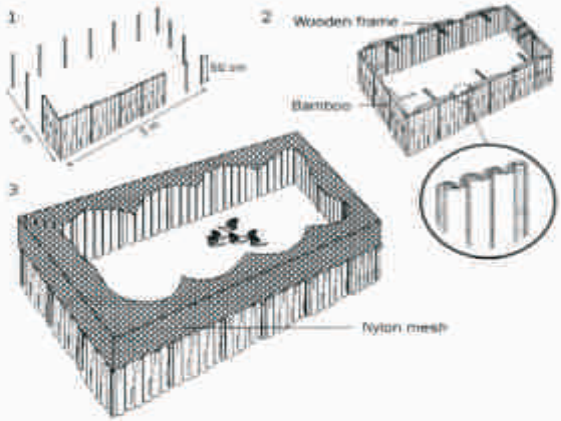


Figure 11. Sequence of building a mini-paddock pen using bamboo and nylon mesh

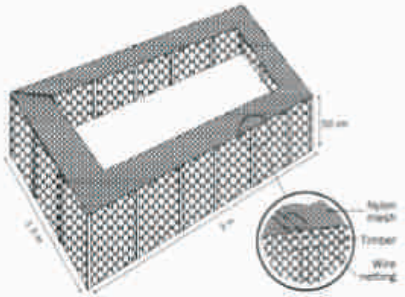


Figure 12: A mini-paddock pen built of timber, wire netting and nylon mesh

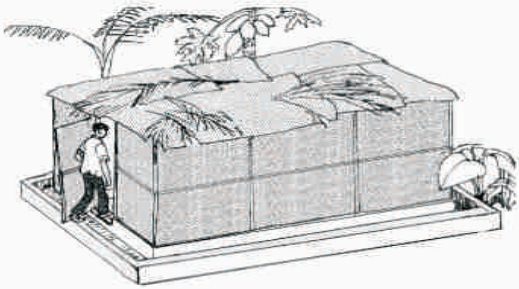


Figure 13: Completely enclosed free-range pen on concrete slab with drains. Note shade trees and palms around, and palm fronds on top to provide shade.

Figure 14: Small-sized free-range snail pen in a city courtyard

FOOD AND FEEDING

1.1 Introduction

The distinction between extensive, semi-intensive and intensive snail farming systems applies not only to **housing** but also to **feeding.**

In an extensive system snail feed only on vegetation planted in their pens specifically for that purpose, as in mini-paddock and free-range pens.

In a semi-intensive snail farm, external feed is provided to hatchlings, juveniles and possibly to breeding snails housed in hutch boxes or trench pens.

In very intensive farms, the snails are fed a formulated snail feed mix containing all the proteins, carbohydrates, minerals and vitamins required for optimal growth. Snails are housed in boxes or trench pens.

5.2 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. 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. Older snails should be fed the same items as immature snails. If a change in the diet must be made, the new food items should be introduced gradually.

Recommended food items

Leaves: cocoyam, kola, pawpaw, cassava, okra, eggplant, cabbage and lettuce. Pawpaw leaves as well (as well as its fruit and fruit peels) stand out in many trials as good snail food.

Fruits: pawpaw, mango, banana, eggplant, pear, oil palm, fig, tomato watermelon and cucumber. Fruits are usually rich in minerals and vitamins, but low in protein.

Figure 15: Snail food: flowers and fruit

Tubers: cocoyam, cassava. Yam, sweet potato and plantain. Tubers are a good source of carbohydrates, though low in protein. (Cassava should be the low cyanide type).

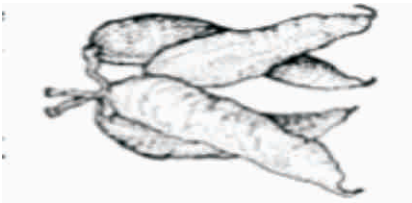


Figure 16: Snail food: tubers

Household waste: peels of fruit and tuber, like banana, plantain, pineapple, yam and especially pawpaw and leftovers like cooked rice, beans, fufu. Caution: household waste must not contain salt!

5.3 Recommendations on natural feed

Market waste

Because snails are vegetarians, the cheapest way to feed them is by collecting rejected but recommended 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.

Table showing a self-mix snail feed formula

Ingredients	Kg
Maize	5
Groundnut cake	15
Soybean meal	10
Groundnut cake	7
Wheat meal	3
Palm kernel cake	5
Limestone	30
Bone meal	10
Fruits (pawpaw, watermelon, pineapple)	15

5.3 FEEDING AND GROWTH
FEEDING MANAGEMENT

- Growth is highly dependent on ambient temperature and humidity. At high temperature (> 30 degree) and relatively low air humidity (<c. 70%) growth slows down or stops, because snails go into dormancy. This should be avoided as much as possible, by good snail housing and management.
- Optimum stocking density obviously depends on age and size of the snails. For hatchlings and juveniles stocking rates of $100/M^2$. Or more applied; for mature breeding snails stocking should not exceed 10-15 snails/M^2. Overcrowding results in reduced growth and increased mortality.
- How and when to feed snails. In their natural habitat snails are nocturnal animals, hiding during the day and coming out at night to feed. Their main feeding time starts from around two hours after sunset. For best results the snail farmer should not put snail feed in pens before night fall. Uneaten snail food should be removed from the pens daily; otherwise, it will attract vermin and or diseases. To facilitate cleaning, the snail food might be placed on a flat dish, placed within the pen.

SNAIL GRWOTH

It takes about 15 months for Achatina achatina to reach full maturity; so, they are not fast-growing animals for the quantity of food they eat and the amount of consumable meat they produce. The other GAL species discussed in this manual grow relatively slowly as well. Studies on diet and growth indicate growth rates from 5 to 20 g live weight per month, corresponding to about 2 to 8 g edible snail meat per month when the average dressing percentage of around 40% is considered (the remaining 60% of the snails weight is made up mostly of its shell, body fluid and intestines).

BREEDING AND MANAGEMENT

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 ay dead snails, refilling watering troughs, keeping the soil moist in the dry season, and occasionally harvesting mature snails for sale or for consumption.

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 snail's 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: Omole et al., 2007).

In either case, farmers must obtain breeding stock to start their snail farms. Snails might be obtained directly from the bush, from snail farmers or from research institutes.

6.1 SELECTING BREEDING STOCK

It is recommended to use sexually mature snails, weighing at least 100g, 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 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 the 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 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.

6.2 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, and the eggs may be physically damaged during the transfer.

A breeding snail may lay one to three masses (clutches) per season. The number of breeding snails placed in a hutch box 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.

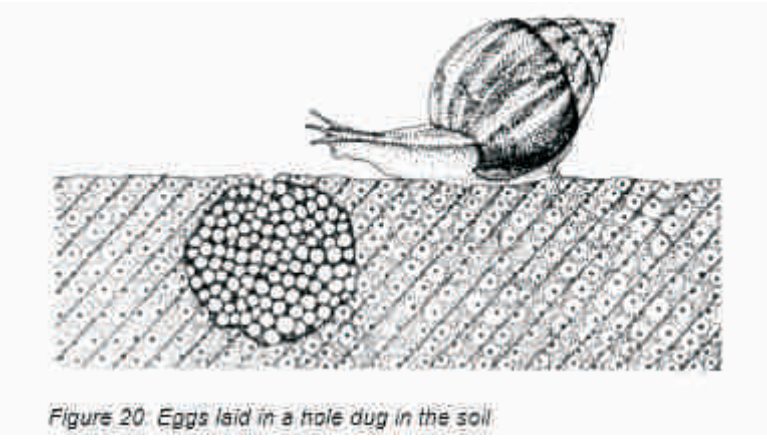


Figure 20. Eggs laid in a hole dug in the soil

6.1 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/ M^2(for A.achatina, this would be about 15 to 25 snails per square metre). It is best to start a snail farm with as low a density as possible. As the farmer becomes more familiar with snail habits with managing the enterprise, the numbers could be increased.

6.2 Seasonal Daily Management

As in any livestock farming operation, good management practices are keys to success.

In semi-intensive or intensive snail farming, farmers keep and care for the 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 pawpaw 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/m^2

Growers

Growers should be transferred to separate pens at around 3 months of age, at a stocking density of 30-40 snails / m^2. For fast growth, they might be given compound feed, rich in crude protein, calcium and phosphorus, besides their normal diet.

Breeders

Breeders start to lay eggs at sexual maturity, at age 10 to 12 months. They should be transferred to boxes or pens at a density of 10-15 snails/m^2. (Note: stocking densities mentioned are indications. The general stocking density guideline of 1-1.5 kg snail/m^2 should always be kept in mind) soil should be loosened to facilitate egg laying. The breeders ration 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 removed to facilitate uniform emergence. To avoid cannibalism, the breeders must be removed to their growing pens soon after the hatchlings emerge. Adults no longer required for breeding are kept in fattening pen until ready for sale or consumption.

Daily management involves several activities:

Feeding

Snails should be fed after sunset. The feed must not be stale or mouldy. 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 checked.

Soil
Keep the soil moist by mulching and watering if necessary, in the dry season. Change soil in the cages 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 clean water weekly.

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

6.3 Snail farming tools and equipment

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

- Small weighing scale, for weighing snails and formulated feed.
- Measuring tape, for measuring pens and snails
- Hand trowel, for digging in and cleaning out the pens

- Cooking drum for treating soil
- Ash for pen treatment
- Calcium carbonate
- Neem leave, moringa leave, bitterleave
- Water container and watering can for keeping the soil moist and refilling water troughs
- Water and feeding troughs or dishes
- Most important: a notebook, for carefully recording inputs (eg, labour, materials and feed) and output of the snail farming venture.

6.5 Factors aiding proper incubation and good hatching

1. **Good soil: (**Most loamy or slightly loamy sandy soil).
2. Incubator should be kept in a cool dry place (Direct sun or rain should not touch it).
3. Do not water it more than once every five days at most; except you discover the soil to be dry during routine inspection. (do not add water, sprinkle water on the leaves on the surface).
4. Monitor the soil to ensure it is neither too dry nor too wet. (the soil should be moist)
5. Do not expose egg on the surface of the soil; completely bury the eggs
6. Endeavour to have mulching materials on the topsoil
7. Incubator should have a cover or light net material as covering. (Perforate the lid with little nail to allow air into your incubator).

PREDATORS

The major predators a snail farmer may have to deal with are field mice, rats and shrews, frogs and toads, thrushes, cows and domesticated birds such as ducks and turkeys, lizards and snakes, 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 baits 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.

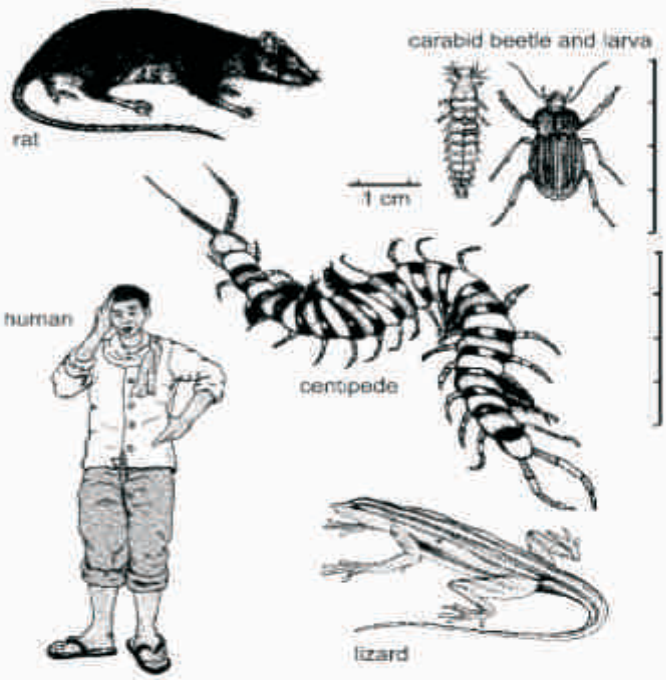


Figure 21: Some natural enemies of snails

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

7.2 Parasites

The major parasite on snails was found to be a fly, Alluaudihella flavicornis. This species belongs to the same family as the housefly and the adult resembles the adult housefly.

A.flavicornis lays 20-40 eggs in the snail shell or on the snail. The eggs hatch in about one week and the small, cream-coloured worms 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.

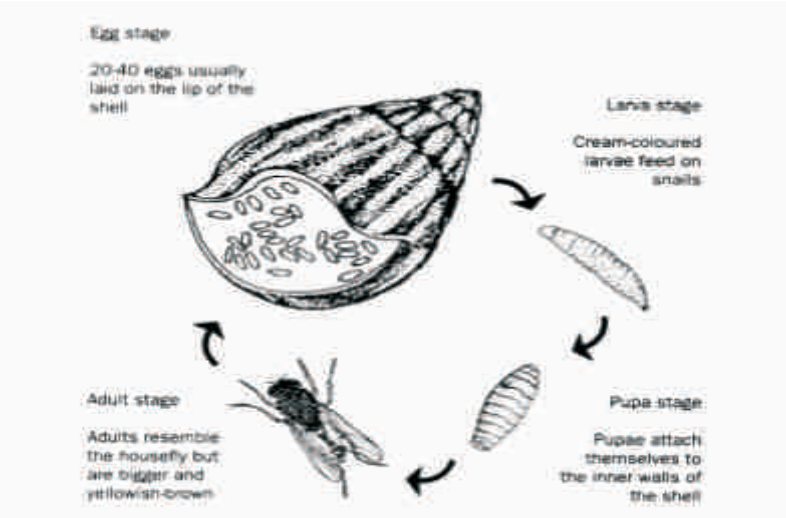


Figure 22: The entire life cycle of Alluaudihella flavicornis, a parasite of Achatina achatina, takes 25-40 days.

Ectoparasitic mites are sometimes found on the snails in hutch boxes. They seem to be secondary parasites, usually occurring on inactive snails.

Some nematodes are known to attack European species of edible snails. However, there are no known reports of nematodes parasitizing A.achatina.

7.3 Diseases

Little is known of the diseases which attack A.achatina in West Africa. As snail farming increases in popularity, more research will probably focus on this area. The main disease that has been reported to date is fungal disease, spread through physical contact by the snails licking slime from each other's bodies.

The two major diseases affecting European species may also affect African species, because the organisms that cause these diseases do occur in the natural range of A.achatina. the first is a bacterial disease, caused by Pseudomonas, it leads to intestinal infections that may spread rapidly amongst dense snail populations. The second disease is caused by the fungus Fusarium, which parasites the eggs of Helix aspersa. The affected eggs turn reddish-brown and development stops. This disease is commonly referred to as 'rosy eggs disease'.

Basic hygiene prevents the spread of diseases. 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 sterilise 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).

Soil and Snail treatment

Snail business is lucrative however, it could be challenging when mortality strikes.

There are few biological means of preventing diseases in snailery as well as treating sick snails. They are

- **Soil treatment**: this entails hitting of the soil to extreme temperature either by exposing it to direct sunlight or by hitting it up on fire.

This helps in getting rid of the disease-causing microbes hidden on the soil.

Picture showing soil treatment by hitting with fire

Another means of soil treatment is by mixing the soil with wood ash and or calcium carbonate, this is aimed at increasing the calcium content of the soil, as well as getting rid of the fungi carrying organisms present in the soil.

picture below showing soil treatment by mixing with wood ash and calcium carbonate

Treatment of snails

Snails can be treated using moringa or neem leave.

The moringa leave and or neem leave is either boiled with water or pounded and the juice mixed in a water solution and used to bath the snails.

Picture showing Snail treatment, using neem leave solution

PROCESSING AND CONSUMPTION OF SNAIL MEAT

8.1 Processing

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. 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 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 faeces and dirt must be removed in the kitchen. It is easier and more hygienic to have them 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 ailments in their intestinal tract. They are now ready for washing, boiling and dressing.

Locally made device from oil drum, processing snails through drying

Washing

Put snails in a bucket with water, adding some salt, or alum. Lemon or lime juice can be used as an alternative. 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.

Picture below showing a washed snail

Boiling

After washing, put snails into boiling water, again adding either of salt, alum, or lime or lemon juice, and boil thoroughly for at least 5 minutes. Achatina fulica (but possibly the other GALS specie as well) is reported to be an intermediate vector of the Rat Lungworm and other diseases potentially lethal to humans. Improperly cooked Achatina fulica meat may act as a major source of human infection in places where it is commonly eaten by people without proper washing, thus proper washing is essential.

Dressing

Extract the snail from its shell, draining off the body fluid or haemolymph (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.

Picture below showing a dressed and frozen processed snail

8.1 Consumption

Composition and nutritive value

The data provided below originate from Nigerian studies of the GALS species Archachatina marginata. It can only be assumed that the composition and nutritive value of the two GALS species discussed in this manual are more or less the same.

Table 2: Approximate dressing percentage of Archachatina marginata

Total live weight of snail	100%	
Meat	40%	The edible foot of the snail
Shell	30%	
Viscera	17%	
Body fluid	13%	(haemolymph)

Table 3: Approximate carcass composition (including moisture)

Crude protein	60->80%	Depending on diet of the snails
Fat	1.3-1.7%	
Ash	1.3-1.4%	

As far as protein is concerned, snail meat compares well with traditional sources of protein like chicken meat, pork or beef.

A Nigerian study on mineral composition of snail flesh showed that values of iron, magnesium, calcium, potassium and sodium were co-pollution- were not detected. 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 Nigeria, Achatina achatina is considered the most prized specie for consumption, followed by Archachatina marginata and Achatina fulica, in order of preference.

Several sources mention Achatina fulica as being slightly inferior to the edible European snails because it is 'rubbery' and often 'swampy tasting'. However, when highly flavoured with garlic, chopped and stuffed into shells of the genuine escargot, most people eating the Achatina fulica snails are easily effectively deceived.

MARKETS

8.1 Local markets

In the high-altitude forest areas of West Africa, particularly in Ghana, Nigeria and Cotedvoire, snail meat forms a substantial part of the meat in the diet of the local people. Snails are gathered in the wild, packed into bags, wooden crates or baskets and transported to selling points along main roads or urban centres.

In urban areas, the gatherers may sell the snails directly to consumers or to wholesale traders or retailers. Snails can be smoked and stored for sale during the off season (November to March) when prices are highest.

Snails may take up two years to reach the size that meets local consumer preferences. The marketable size required for export is slightly smaller.

In some areas of West Africa, snail meat has never been part of the local diet in the predominantly Muslim northern areas of West Africa, snail meat is not consumed, for religious and cultural reasons.

Snail products

Crushed snail shells may be applied in chicken feed or in liming to improve the quality of acidic (fishpond) soils. However, do not forget that your snail feed must contain enough calcium to enable the snails to develop sturdy shells.
Processed snail meat

Fresh snail meat can be processed, for storage or marketing, in several ways;

- At farm level, it can be smoke-dried for sale in the off season when prices are traditionally higher.
- Snail meat can be frozen or canned, for sale to domestic or export markets. This type of processing requires investments on a scale that is (probably) beyond the means of the individual snail farmer, though it might be undertaken by strong prosperous farmers cooperatives.
- On-farm processing of snail meat into locally well-received, tasty dishes, for sale at your own roadside shop or to nearby restaurants, may be another way of adding value to snail farm products. Obviously, you should abide by local sanitary regulations when starting and running a snail meat kitchen.

8.2 Export markets

France plays a central role in the growing international trade in snails. Some of the snails imported into France are processed and exported to other European countries or to North America, especially to the USA, which imports hundreds of millions of US dollars' worth of snail meat annually. Other important markets are Germany, Belgium, Netherlands, Canada, Switzerland, Japan, Sweden, Austria, Denmark and South Africa.

Among the major suppliers to these markets are Greece, Turkey, Romania, Algeria, Tunisia, as well as Taiwan, Thailand and China. Most countries supply the European snail species Helix aspersa, H. pomatia and H. lucorum, while the Asian countries supply Achatina fulica. The snails are supplied fresh, frozen or canned. The African species fetch about one third of the price of the European species. This is mainly because, compared to the European species, the meat of the African species is rather rubbery and the shell less suitable for presenting the final product. European consumers generally prefer snails served in the shell.

However, studies by the Ministry of Agriculture, Fisheries and food in the United Kingdom have shown that juvenile A.achatina snails are meatier and more tender than the more favoured European species. It is hoped that this finding will increase demand for the African species. For West African producers, this might mean not only a bigger market for their product but also reduced cost of production because of the shorter growing period required (for the snails to reach the size preferred by consumers). However, it will take some time before the long-standing prejudices in continental Europe against the African Snail species are overcome.

Export markets clearly offer opportunities, though the small-scale snail producer should not underestimate the difficulties, including import regulations, hygienic and health requirements. The small, local snail farmer might participate in export opportunities best through farmers cooperatives, or by contract farming for large, local snail processing and export ventures.

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