



Australian Government

**Rural Industries Research and
Development Corporation**

Free-range Snail Farming in Australia

A report for the Rural Industries Research and Development Corporation

by Sonya Begg

August 2006

RIRDC Publication No 06/104
RIRDC Project No SFI-1A

© 2006 Rural Industries Research and Development Corporation.
All rights reserved.

ISBN1 74151 367 7
ISSN 1440-6845

Free-range Snail Farming in Australia
Publication No. 06/104
Project No. SFI-1A

The information contained in this publication is intended for general use to assist public knowledge and discussion and to help improve the development of sustainable industries. The information should not be relied upon for the purpose of a particular matter. Specialist and/or appropriate legal advice should be obtained before any action or decision is taken on the basis of any material in this document. The Commonwealth of Australia, Rural Industries Research and Development Corporation, the authors or contributors do not assume liability of any kind whatsoever resulting from any person's use or reliance upon the content of this document.

This publication is copyright. However, RIRDC encourages wide dissemination of its research, providing the Corporation is clearly acknowledged. For any other enquiries concerning reproduction, contact the Publications Manager on phone 02 6272 3186.

Researcher Contact Details

Mrs Sonya Begg
2 Sunrise Way
ORANGE NSW 2800

Phone: (02) 6361 8104
Fax:
Email: snails@netwit.net.au

In submitting this report, the researcher has agreed to RIRDC publishing this material in its edited form.

RIRDC Contact Details

Rural Industries Research and Development Corporation
Level 2, 15 National Circuit
BARTON ACT 2600
PO Box 4776
KINGSTON ACT 2604

Phone: 02 6272 4819
Fax: 02 6272 5877
Email: rirdc@rirdc.gov.au.
Web : <http://www.rirdc.gov.au>

Published in August 2006
Printed on environmentally friendly paper by Union Offset

Foreword

The production of edible snails in Australia has been conducted by a small number of people operating ‘cottage industry’ businesses since 1985.

In most cases the snails were collected and grown in small enclosures or greenhouses, a labour-intensive process that was unsustainable. Few people carried out a snail breeding program and the operations often failed. This was due to either lack of livestock numbers and/or not maintaining continuity of production.

This report provides detailed information and self-explanatory graphics on the subject of mass producing snails utilising the Italian method of farming snails in pasture production or free range production. It explains the process of farming snails in large numbers, necessary for a sustainable, viable, commercial operation.

Potential snail farmers in Australia will gain valuable insight into successful breeding of the edible snail, *Helix aspersa*. The report highlights the importance of the full biological cycle of breeding snails as a requirement for a successful, sustainable commercial operation.

Included in this report is important information about the purging process and research results regarding nutritional analysis and product shelf life information.

This project was funded from RIRDC core funds which are provided by the Australian Government.

This report is an addition to RIRDC’s diverse range of over 1500 research publications. It forms part of our New Animal Products R&D sub-program which aims to accelerate the development of viable new animal industries.

Most of our publications are available for viewing, downloading or purchasing online through our website:

- downloads at www.rirdc.gov.au/fullreports/index.html
- purchases at www.rirdc.gov.au/eshop

Peter O’Brien

Managing Director

Rural Industries Research and Development Corporation

Acknowledgements

Without the encouragement and support of many people, the possibility of creating Australia's first 'model' commercial, free-range snail farm would not have been possible. I greatly appreciate the following people who have contributed their time and physical assistance, allowing me the opportunity to make it happen.

Thank you to Dr Peter McInnes for his continuing support and encouragement for my proposals. His subtle guidance and calm suggestions have played an important part in the success of this project.

I wish to acknowledge Joanne Bobbitt and Jemma Isaac from Primary Industries Research, Attwood Victoria, for their keen interest and work carried out on the microbiological analysis of the snails.

Thank you also, to Peter and Terri Robson of Ross Hill Vineyard who agreed to supply, without charge, the land and water for the project and to Bob Lewis for his great 'builder's ideas' and his work in the initial establishment of the farm.

I wish to pay tribute to my husband Col. His unfailing energy and his enthusiasm to work long hard days are greatly appreciated. Without his 'strive for excellence' attitude and physical assistance, a lot of the work could not have been done.

Finally, without the financial support of the Rural Industries Research and Development Corporation the project would not have got off the ground. I appreciate the single, most significant resource it provided to assist the emerging snail farming industry in Australia.

About the author



The principal researcher Sonya Begg, is Australia's pioneer commercial snail farmer and has been committed and dedicated to snail farming activities since she became a Charter Member of the Snail Club of America in 1986.

Her early enthusiasm for raising and farming snails peaked in 1987 when she launched Australia's first successful, commercial snail farm in Gunnedah NSW.

She is a recognised Helicicultural Consultant and has written three manuals on farming snails in Australia, two research reports and has refereed an international scientific paper on the subject. The Rural Industries Research and Development Corporation (RIRDC) funded her first research project in 1988.

In Cherasco, Italy in 2003, Sonya was made a Meritorious Associate of Associazione Nazionale Elicicoltori and was presented with the coveted 'Silver Snail' award at the annual Conference of International Snail Farmers for her contributions to the industry over many years.

Sonya has continued to research snail production methods, conduct feasibility studies and has offered practical assistance to numerous people who are interested in learning about snail farming in their own region or country.

Contents

Foreword	iii
Executive Summary	vii
Introduction	1
Objectives.....	1
Method.....	2
'Model' pasture production or free range snail farming trial	2
<i>Helix aspersa</i> Müller (1774).....	3
Reproduction	3
The site	4
Soil.....	5
External fencing.....	5
Fencing the pasture production fields	7
Pathways	9
Snail predators	9
Crop predators.....	10
Good bug bed.....	10
Irrigation.....	11
Preparation of seed bed	11
Crops	12
Supplementary feeding.....	14
Planting times	14
Maintenance	15
First Production Year – 2004/2005	16
Production Schedule (First year — 2004/2005)	16
Selecting breeding snails.....	17
Introduction of snails to reproduction field.....	17
Growing fields.....	17
Winter hibernation	18
Springtime.....	18
Second Production Year – 2005/2006	19
Production Schedule (Second year — 2005/2006)	19
Activities for 2005/06	20
Mortality	21
Harvesting snails for transfer or purging	21
Tips for harvesting or transferring snails	21
Purging	21
Marketing	25
Discussion	26
Implications	30
Appendices.....	32
Appendix A: Statistics of snail imports to Australia	32
Appendix B: Microbiological and chemical analysis of snail products	33
Appendix C: Proposed Australian Snail Breeders' Association	38
Appendix D: Health safety	39
References.....	40
Resources.....	40

List of Tables and Figures

Table 1: Method.....	28
Table 2: Labour requirements	28
Table 3: Establishment and production cost estimates for two-year establishment phase	29
Table 4: Comparison of production systems	29
Table 5: Financial year 2003-2004.....	32
Table 6: Financial year 2004-2005.....	32
Table 7: Tests performed	33
Table 8: Certificate of Analysis.....	37
Table 9: Comparison of cholesterol between snails other molluscs and crustacean.....	37

List of Figures

Figure 1: Microbiological examination of chilled snails	34
Figure 2: Microbiological examination of shelf stable snails	35
Figure 3: Shelf life of snails, total viable count	36

Executive Summary

The report – its reason and purpose

The existence of technical and practical information about farming edible snails on a large scale is limited, especially for Australian environmental conditions.

This report provides information on the viability of an alternative method of producing edible snails by mass production.

The report gives details about the suitability of raising snails in pastures rather than the more labour-intensive growing methods in small enclosures and greenhouses.

The information is important because it offers an alternative to create sustainable, viable snail production for import replacement and for an expanding domestic market.

No research has been conducted in Australia before on the widely accepted Italian pasture production system that has proved less labour intensive and more cost efficient in Italy and other European countries.

It provides detailed information about management principles, reproduction and yield of a sustainable, commercial snail farming enterprise.

Target

The report is targeted at people seeking ways to diversify farming operations away from traditional livestock, cropping and horticultural enterprises or to specialise in a niche market.

Background

The Australian snail industry was pioneered in 1986 but did not progress past ‘cottage industry’ status. It continued to struggle to gain acknowledgement as an accepted agricultural activity as most snail producers were unable to maintain continuity of production.

During the last few years however, interest in snail farming has escalated. This may be due to the growth of multicultural restaurants in Australia and the culinary tastes of people becoming more adventurous. And, chefs are now creating interesting recipes that differ from the traditional European methods of serving snails.

It was timely to investigate an alternative method of snail cultivation and management in Australia. The Italian method of the full biological cycle of breeding snails and pasture production was chosen to gauge the suitability of raising large numbers of snails in Australia.

The aims of the research project

The primary aim of the research project was to assess the viability of an alternative method of mass producing edible snails for domestic trade and international trade.

Research was conducted on the practical and technical aspects of pasture production and to create a ‘model’ as a trial of the pasture production system for containment and cultivation of edible snails.

A secondary aim of the project was to support the results with a PowerPoint presentation as a resource for potential snail producers and users and consider the feasibility and value of the formation of an Australian Snail Breeders’ Association.

Method

The research project was implemented for three years and practical and technical research was studied in detail at the International Snail Farming Institute and Conference of International Snail Farmers in northern Italy in 2003.

Results of the fact finding trip were published by Rural Industries Research and Development Corporation (RIRDC) in a report titled *Farming Edible Snails – lessons from Italy*.

A site was chosen in Orange, in central western NSW for the physical trial and in October 2004, the Italian method of pasture production was commenced.

The initial breeding stock (1,087 adult snails) was introduced to the first reproduction field in early November 2004. It is estimated that approximately 25,000 snails were hatched by the end of February 2005.

Approximately one third of the snails that were hatched in early January 2005, reached an acceptable marketable size (average 32mm) by the end of April 2005. The remainder continued to grow and then hibernated during the winter months of June, July and August 2005. They finished their growing in the following spring (October/November 2005) and the biological cycle commenced again with new season breeders selected from these snails.

During 2005/06 10 fields (total area of 535.5 sq m) were completed as part of the rotational system for cropping and snail production. Some of these fields were sown with crops suitable for grazing and habitat for the snails and some were fallow at any one time during the season.

One field was used for reproduction and a total of seven were used for growing during January to April.

Another field was utilised in early spring for adult snails that were harvested after the clearing of the 2004/05 production fields.

An additional field was utilised as a ‘good bug bed’ and was planted with a mix of herbs and flowers to attract predatory insects to assist in the biological control of unwanted crop pests.

Because of the high through-put of snails, it was necessary to have an efficient and effective purging facility as the final stage of production

As an extension of the research project, existing building facilities were modernised and the purging capacity was expanded. An atmosphere-controlled environment was deemed necessary to keep the temperature below 23°C, to assist in the efficient purging of commercial quantities of snails and reduce snail deaths.

One thousand five hundred snails were prepared as four separate products and sent to Primary Industries Research Victoria (PIRV) for microbiological testing to determine shelf life and nutritional analysis — an important extension of the project. Results attached at Appendix B.

Results

The objectives of the research project were met. It was found that it was possible to successfully breed and grow large numbers of snails in a pasture production system in Australia.

A very positive outcome of the research project was the successful breeding program.

Estimates showed the pasture production method was more cost effective to establish and produce snails than the current method of farming snails in Australia today.

The majority of the snails that were bred were consistent in size and there was a very low mortality rate due to acclimatisation to the environment that existed in the pasture production fields.

The benefits of the full biological cycle of breeding snails in natural conditions in open pastures far outweigh current methods of indoors or greenhouse production.

Approximately one third of the newly bred snails reached marketable size before they were 12 months old in the first year of production. This number increased to approximately half the number of newly bred snails in the second year of production.

This offers serious producers a significant marketing advantage over snails that are collected and grown out in enclosures or greenhouses. Collected snails are often aged and therefore are not as palatable as younger snails.

The snails were bred and grown in natural environmental conditions and it was observed that the snails responded sensitively to environmental factors. While the snails remained reasonably active during unusually hot weather, they became lethargic and lost some body weight, in spite of multiple water misting applications. As soon as the weather cooled and rain was received, the snails resumed their normal growing activity.

It was determined that snail farming in the pasture production system in Australia is a seasonal occupation. Snails must have winter hibernation as part of the full biological cycle in order to breed successfully in spring.

The results of the microbiological testing showed that fresh snail meat contained in spring water has a shelf life of nine days when refrigerated at 4°C. Two other products were tested along with the nutritional analysis and the results are shown at Appendix B.

A key finding of the research project was the results of the microbiological shelf life and nutritional analysis. These analyses have not been conducted before in Australia, so it was an important factor to investigate as an addition to the physical aspects of the main project.

Relevance to stakeholder groups

Industry

Now that the research project has been completed, Australia's fledgling snail production industry has reliable, practical data to inject into business plans of a new entrant to Australian new animal product industries — edible snails.

Interest in the research project has been extensive and numerous requests for information have been received by the principal researcher.

Communities

Communities will benefit from the completion of the project as there now exists potential for a reduction in exposure to garden pesticides with the commencement of demand for live ‘foundation’ stock from the domestic garden.

The details of this report are aimed at providing all stakeholders with information to produce snails in large numbers that will help establish a sustainable, lower labour method of commercially viable, Australian fresh snail production for the gourmet food industry and restaurant trade.

Policy makers

With some vision and subtle lobbying it may be possible to encourage policy makers to apply disincentives to importers of processed snail meat from various overseas areas, as a means of assisting a domestic snail industry to replace imported product.

Others

The completion of the RIRDC funded research project provides hard data to further underpin 20 years of practical experience in Australian snail production, processing and marketing by the principal researcher.

Australia now has a local intellectual resource that is backed up with scientific data and research results, conducted in Australian conditions, that is equivalent to that offered by some traditional European snail production and marketing organizations.

Recommendations

This report and its associated PowerPoint presentation be promoted to the following target groups:

- agri-politicians
- potential Australian snail producers
- regional and city-based media
- local government authorities
- rural research and extension specialists
- commercial farm consultants
- farmer organizations.

Introduction

Snails are a healthy food, high in protein with almost no fat. While they contain a small amount of cholesterol they are low in kilojoules and also contain amino acids, vitamins and minerals.

Background

During the last 20 years, culinary tastes of people living in Australia have changed significantly.

Australia is now home to a large number of ethnic groups which has contributed to an increase in the growth of multicultural restaurants. Consequently, today's chefs are creating exciting and different types of cuisine with a unique blend of innovation and tradition. And, they are now willing to create their own 'Australian' snail recipes.

The production of snails in Australia is limited to the species *Helix aspersa* Müller — a snail imported to Australia around 1888. Other species have not been established due to strict quarantine restrictions that totally prohibit importation of live snails into Australia from other countries.

In Italy, farming large numbers of snails (including *Helix aspersa*) in open pastures has been carried out for many years. It appears this method of farming snails is less labour intensive than the conventional and current method of producing snails in Australia.

The Italian pasture production method was studied by the principal researcher on a study trip to Cherasco in northern Italy in 2003.

A report titled *Farming Edible Snails – lessons from Italy* describing the techniques, was published by RIRDC in December 2003. The report is available from RIRDC's website at <http://www.rirdc.gov.au/reports/NAP/03-137sum.html>

In the financial years 2003/2004 and 2004/2005, figures from the Australian Bureau of Statistics (International Merchandise Trade – Imports of Snails) based on information provided to the Australian Customs Service show that 9,797 kilograms of snail meat was imported to Australia with a value of \$79,179.00. (See Appendix A).

There is limited exposure of fresh Australian snails to restaurants. With the advent of mass production of snails on a commercial basis in Australia, there may now be an opportunity for import replacement, domestic and international trade in fresh Australian snails.



Outcomes and information about the three-year research project and an outline of the 'model' pasture production or free-range system is described in the section 'Method'.

Objectives

This research project was conducted to assess the viability of an alternative method of mass producing edible snails for domestic and international trade. Up until now, snail farming in Australia has been conducted on a 'cottage industry' basis using an intensive and high labour process of farming.

A physical 'model' of the Italian snail farming method of pasture production was established to determine if this system is suitable as a sustainable viable operation for mass producing snails for the gourmet food industry.

Method

'Model' pasture production or free range snail farming trial

The following sections describe the technical and practical aspects of the model pasture production trial and the full biological cycle of breeding snails.

Pasture production is the Italian method of breeding and growing snails in fields of fresh vegetables and forage crops.

In Australia this method of growing snails will be known as free-range snail farming.



***Helix aspersa* Müller (1774)**

The edible snail *Helix aspersa* Müller (1774) — is the scientific name for the European brown snail or the common brown garden snail. It was first described in Italy by Müller in 1774.

It was introduced to many countries by man, either for use as food or by being accidentally transported on plants. Records that date back to 1888 indicate *Helix aspersa* Müller was introduced during the colonisation of New South Wales in Australia.



Helix aspersa Müller belongs to the great animal group phylum Mollusca (or molluscs). It is one of around 80,000 known species of snails.

It is a member of the family Helicidae and belongs to the order Pulmonata encompassing terrestrial, air-breathing molluscs.

In general conversation, it is mostly referred to as simply '*Helix aspersa*'.

Reproduction

Helix aspersa is an hermaphrodite and each individual snail possesses both male and female reproductive organs. During mating, mutual fertilisation takes place and one or both snails will usually lay eggs.

Before mating begins, the snails have a gentle courtship where they circle and touch each other.



Eventually they discharge a calcium 'love dart' that sometimes protrudes for a while before becoming lodged in the partner. Mating usually begins during the night but can take from four to fourteen hours before it is complete.

Mating usually begins in spring but can continue through to autumn if the environmental conditions are correct.

Around six to ten days after mating, the snail makes a hole in the soil where it lays its eggs in batches of 30 to 100 eggs at a time.

It then covers the hole with a mixture of soil and mucus before leaving to rest.



The eggs are round and measure approximately 3mm in diameter. They are pearly white in colour and have a rubbery texture. The eggs hatch within three weeks of being laid and the newly hatched baby snails are exact replicas of the adult snails.

The site

An area of around one hectare was selected as the potential site for the pasture production trial. The site was chosen at a north-facing position at an elevation of 700m in Orange, central western NSW.

Because of its north to south layout, it was an ideal position for growing crops as food and shelter for the snails.

It was situated on a slight slope and protected from the prevailing westerly winds by a large hill.

The ground cover consisted of native and introduced grasses and weeds.



The one hectare area was cleared and a fence line that ran down the middle of the block was removed.

The ground was worked up with a scarifier several times over a six-month period from January to June 2004.

An area of 850 square metres was fenced with galvanized iron as the perimeter fence for the production area. A compromise on space was made due to large trees growing at the end of the site that may have contributed to loss of nutrients to the crops.

Prior to the erection of the external fence the ground was prepared with a rotary hoe. Any germinating seeds were sprayed with a contact herbicide such as glyphosate.

Soil

A soil sample corer or tube was used to extract soil samples for testing acidity and for nutrient analysis.

A total of 15 soil cores at a sampling depth of 10cm were collected across the site. The nutrient analysis was conducted by Pivotest Laboratory in Werribee, Victoria.

The soil consisted of red clay loam and was a little low in sulphur necessary to grow forage crops. The addition of organic mulch helped make the soil more friable. The pH values were considered acceptable for snail production.

Soil testing took place every third year to monitor the chemical properties of the soil.

To avoid chemical residues in the soil or snails, disinfection or fumigation of the soil was not carried out so there was no detrimental compromise to the concept of a biodynamic growing system.



Pasture Soil: Analysis Report

ELDERS LTD (ORANGE)
PO BOX 89
ORANGE 2800

Phone No: 06 63613000
Fax No: 06 63618249
Email:

Customer No: 66890
Sample No: 20149862
Sample Taken: 14/12/2004
Reported: 22/12/2004
Order No: EGG

Paddock Name	SHAIL PEN	Size 0 ha	Paddock dGPS Ref
Sample Name		Depth 0 to 10	Northing
Paddock Location	ORANGE		Easting

TEST	RESULT	VERY LOW	MARGINAL	OPTIMAL	VERY HIGH	EXCESS	OPTIMAL RANGE
Phosphorus - Colwell (P)	25 mg/kg			***			
Available Potassium (K)	129 mg/kg			***			
Available Sulphur - KCl (S)	7.8 mg/kg			***			
Zinc (Zn)	3.70 mg/kg			***			
Copper (Cu)	1.80 mg/kg			***			
Iron (Fe)	83.00 mg/kg			***			
Manganese (Mn)	25.00 mg/kg			***			
Boron (B)	0.28 mg/kg			***			
Chloride (Cl)	< 10.00 mg/kg			***			
Electrical Conductivity (EC)	0.12 dS/m			***			
EC of saturated extract (ECe)	1.20 dS/m			***			
Organic Carbon (OC)	2.10 %			***			
pH water	7.30			***			
pH CaCl2	6.70			***			
Nitrate Nitrogen (NO3)	24.0 mg/kg						
P Buffer Index (PBI)	100	Low					
Soil Texture	Loam						
Soil Colour	Brown						
Total Cation Exchange Capacity	~15.04 meq/100gm						
Calcium (Ca)	11.00			***			
Magnesium (Mg)	3.67			***			
Sodium (Na)	0.05			***			
Potassium (K)	0.33			***			
Calcium to Magnesium Ratio	3.00			***			
Potassium to Magnesium Ratio	0.09						

Insitec Pivot Limited
ABN 42 004 080 264
Analysis performed by
Pivotest Laboratory
Wilson Avenue
Warrabee Victoria

Enterprise
Expected stocking rate/yield 10.0 dse/ha
Average annual rainfall
Irrigation No
Paddock use this year Summer fodder
Legume % in pasture
Method of sowing

Paddock History
Lime applied n/a
Gypsum applied n/a

External fencing

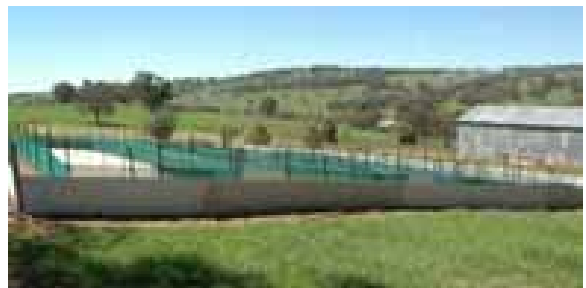
Materials required for fencing external fence

- sheets of galvanized iron (second-hand)
- pop rivets and bolts
- iron posts (second-hand)



A trenching contractor was hired to dig channels for the preparation of the external boundary fence.

The fence was constructed from galvanized iron sheeting and supported by iron posts. The sheets were pop-riveted together and bolted to the posts.



Fencing the pasture production fields

Materials and tools required for fencing internal fences

- iron posts
- open-weave, windbreak material, sewn as described above
- fencing wire
- mattock and shovel

Once the external fence was in place, the first of the internal mesh fences was constructed for the pasture production fields.



Nine pasture production fields measuring 17 metres by 3.5 metres and one measuring 15 metres by 3 metres were erected as the trial breeding and growing areas.

Paths in between the fields measured around 80cm.

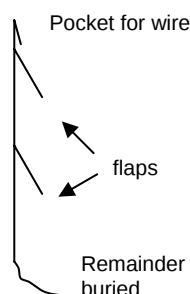
An open-weave, windbreak mesh was sourced as suitable for the internal fencing material as it provided good ventilation.

Two downward facing flaps were integrated into the design to help prevent snails from climbing up the sides of the fencing.

A pocket was sewn at the top of the mesh and threaded with fencing wire so it could be easily attached to the iron posts.

Iron posts were placed in the ground 2 metres apart to support the mesh.

Trenching was dug around the perimeter of each field to allow the remainder of the mesh to be buried in the ground. At the completion of the fences, they stood 70cm high.



The material was purchased in rolls measuring 1.8m x 50m. Each flap measured 20cm. Because the flaps were sewn as pleats, it was necessary to allow 40cm of material for each pleat. 30cm was buried into the ground. The completed fence stood 70cm high above the ground.

Pathways

At least 80cm of space was allocated for the paths between the internal fences. One metre of space was allowed between the internal fences and the external galvanized iron fence.

The paths were kept clear of weeds and vegetation.

There were times when some snails climbed over the nets, especially after it had rained.

Helix aspersa is territorial and because the snails were born in their field, they usually made their way back before the day became too warm

If there were any large clumps of weeds or vegetation in the pathways, the snails were inclined to go only as far as the weeds, rather than go back to the nets.

Clear spaces on either side of the external fence were also essential so that any sign of predators — (eg: mouse and frog holes) could easily be seen.



Snail predators

The main predators of snails are rodents such as rats and mice and reptiles such as lizards and frogs.

Other predators include birds such as currawongs, crows, ducks, butcherbirds, chicken hawks and owls.

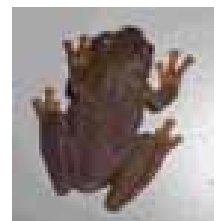


Some beetles and centipedes can also be a threat to snails (especially carnivorous beetles such as carabids, and staphylinids), that attack and kill small snails. The beetles live in the soil and enjoy the same moist environment as the snails.

Snail species such as *Strangesta capillacea* are cannibalistic and care should be taken to make sure that when introducing initial breeding stock, they are identified as *Helix aspersa*.

The research project did not experience any significant problems with snail predators.

Because the habitat of the snails was dense any movement by snails went undetected by birds. While currawongs were seen in the area, they did not attempt to rummage in the snail fields.



Some centipedes and slugs and small frogs were seen in the fields and a few frog and mouse holes were found (eight mice were trapped). No further mice (or holes) have been detected and a decrease in snail numbers was not identified.

As soon as any type of predator 'threat' was noticed, this was removed by hand. Once the fields were cleared out and left fallow, nature appeared to take its course and further threats disappeared.

Crop predators

The main crops grown were silverbeet, forage brassicas, chickory and clover.

In the first year of production the brassicas in the initial reproduction area were attacked by aphids and white cabbage moths.

This was a major problem as no chemicals could be used and the brassicas were the main food source for the breeder snails.

Hosing with a strong jet of water managed to dislodge a lot of the aphids and most of the white cabbage moth caterpillars were removed by hand.



After about three weeks nature once again took its course and the aphids were significantly reduced in number by ladybirds and small wasps attacked and killed the caterpillars.

The desiccated plants were trimmed back and watered and new leaves grew well enough to sustain the snails for another two months.

Good bug bed



Due to the infestation of aphids, it was realized that a strategy was required to enhance and encourage the natural biological agents and controls already present in the garden ecosystem to allow biodynamic principles to be followed.

To improve the natural balance and reduce harmful insect pest outbreaks, particular flowers and herbs known as insectary plants were introduced. These plants provided a nectar source for beneficial insects and acted as an attractant for natural biological control of pest insects.

The mix included annual and perennial flowers such as red clover, alyssum, cosmos, marigolds, Queen Anne's lace, buckwheat, lucerne, dill, caraway, coriander and gypsophila. These plants provided nectar, pollen and habitat for beneficial insects such as predatory mites, micro wasps, ladybirds, lacewings, hoverflies and predatory beetles.

The insects helped to control aphids, scale, red spider mite, caterpillar and other pests without the use of chemicals.

The 'good bug bed' was planted in early spring and its biological control has been successful in controlling many of the pests in the crops grown for snails.



Irrigation



An abundant supply of water is necessary for irrigating crops and misting snails to encourage night-time activity.

A polythene pipe irrigation system was integrated into each field and connected to water tanks filled with dam water.

Irrigation outlets were placed every two metres and consisted of a riser standing 90cm with a full circle sprayer on the top.

Water misting was carried out each evening for 20-30 minutes.

The watering time was adjusted according to the weather.

Extra water was required during January and February when the weather was hot and dry.

During periods of extreme weather conditions such as strong, drying winds, around 10,000 litres of water was used for crop watering and misting in the purging pod each week.



Preparation of seed bed

Ten kilograms of agricultural lime and 20kg of organic blood and bone was spread in each field and incorporated into the soil with a rotary hoe.



A commercial hand-pushed seeder was trialed but it was found unsuitable for sowing small seeds at high rates.

As an alternative, seed rills were made at 30cm row spacing and the seed was trickled by hand into the furrows. A light covering of soil was raked over the seeds and water applied to the rows to germinate the seed.

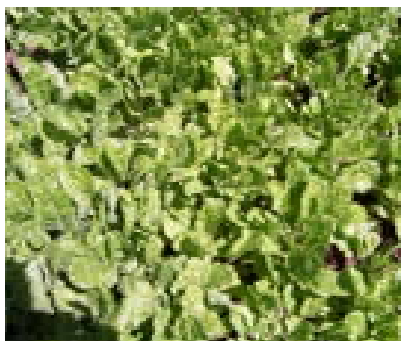
Crops

A horticulturist and agronomist from NSW Agriculture were consulted regarding the most appropriate cool season varieties of crops to plant, suitable for the climate of Orange NSW.

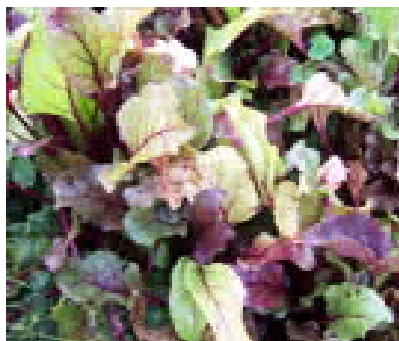
The following crops were trialed and grown as a food source for the snails as well as providing shelter from the sun.

- White clover (*Trifolium repens*)
- Strawberry clover (*Trifolium fragiferum*)
- Forage rape (*Brassica napus*)
- Forage brassica hybrids (*Brassica campestris* spp.)
- Plantain (*Plantago lanceolata*)
- Silverbeet (*Beta vulgaris*)
- Beetroot (*Beta vulgaris*)
- Chickory (*Cichorium intybus*)
- Endive (*Cichorium endiva*)
- Sunflower (*Helianthus annuus*)
- Lettuce (*Lactuca sativa*)
- Radicchio (Red chickory) (*Cichorium intybus*)
- Dandelion (*Taraxacum officinale*)
- English or common spinach (*Spinacia oleracea*)
- Radish (*Raphanus sativus*)

Interestingly, some of the plants well liked by snails in Italy were not as well tolerated in Australian conditions.



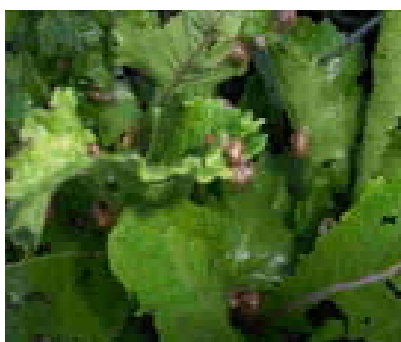
silverbeet



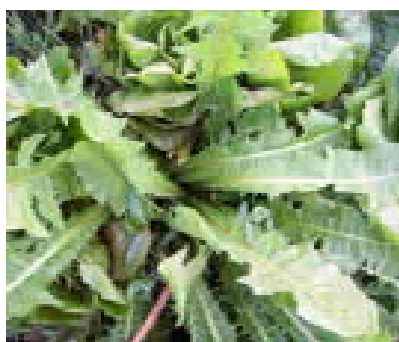
beetroot



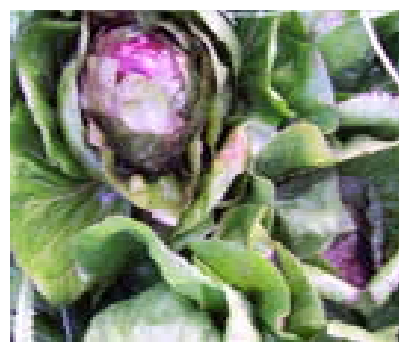
forage rape



leafy turnip



dandelion



radicchio

- Sunflowers — grown in the first year but were not liked by the snails
- chickory — useful only as shelter and was not eaten by the snails
- radicchio and dandelion — unpopular as food but also provided shelter.

Forage brassicas, leafy turnips, silverbeet, plantain, English spinach and clover were the most successful and most liked food and shelter source for the snails.

Forage brassicas

The brassicas proved to be suitable for the cool region of the NSW central tablelands and were planted in spring and autumn. They provided high quality feed and withstood low temperatures, frost and snow during winter. The leaves provided high levels of protein and that resulted in high weight gain and fast snail growth rates.

The brassica crops grew quickly and were dense enough to smother most germinating weeds.

The forage brassicas were not resistant to attack by aphids and white cabbage moths and the first crops planted were infested badly. However, ladybirds and wasps appeared and quickly reduced the offending insects.

After a few weeks, the crops regenerated and grew new fleshy leaves.

Leafy turnip

Leafy turnips are a hybrid cross between various species of the brassica family and are less resistant to attack from insects such as aphids. They are a smaller plant and are well-liked as snail food but have a reduced growing period.

The plants need trimming to maintain new growth and they need to be planted densely as the snails quickly strip the fleshy leaves.

Silverbeet

Silverbeet produces prodigious volumes of leaves and has proved to be an ideal crop for shelter and a minor food source. The leaves retain moisture from evening irrigation and dew and provide a cool microclimate and shelter for the snails.

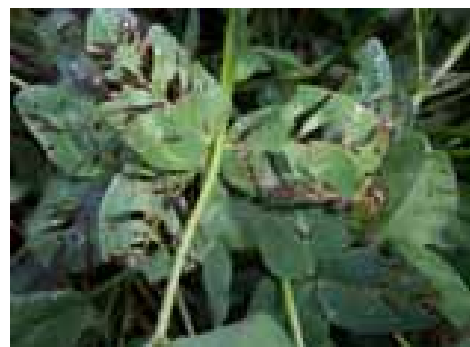
With consistent trimming of the old leaves, fresh and tender leaves appear quickly. The vigorous growing variety 'Fordhook' survived winter temperatures and new shoots grew again the following spring. It is planted in spring and autumn.

Clover

Both white and red clover proved to be a useful and easily grown plant and was well liked by newly hatched snails. Clover is a perennial legume and has a high nutritive value.

After the snails were hatched, they reduced the leaves to a lacy effect before moving on to the brassicas

Clovers also provide shelter and it was observed that eggs were often laid in the areas planted with clover. The condition of the soil is also improved with the use of clovers as a 'green manure' crop. Clover can be planted in spring or autumn.



Lacy effect of clover leaves

English or common spinach

English spinach is an ideal plant if sown in autumn. It grows best during cooler months and is a useful source of vitamins A, B and C and calcium. The leaves are smaller and softer than silverbeet. English spinach provides some calcium for growing snails to assist with shell development.

Plantain

Plantain is mineral rich and also contains calcium. It has a strong cool season growth and is useful as a rotation crop with brassicas. It appears to be well liked by snails.

Supplementary feeding



The Italian snail farming method of feeding snails recommends that supplementary crops be grown as an additional food supply when the crops have been eaten out or are at the end of their life.

The recommended crops include sunflowers, brassicas and kale.

In the Australian trial, supplementary crops were not grown as a supply of green waste leaves from local fruit and vegetable suppliers was readily available.

The leaves consisted of fresh lettuce and cabbage. Second-grade carrots were purchased in 20kg bags as an additional supplement.

In times of low feed or high density of juvenile snails, conventional feeders containing custom snail mix were also used as supplementary food. The custom snail mix consisted of extruded grains such as maize and soybean, whey powder, limestone and vitamins and minerals.

Planting times

In line with biodynamic principles, planting time of seeds was planned to coincide with the fertile phases of the moon.

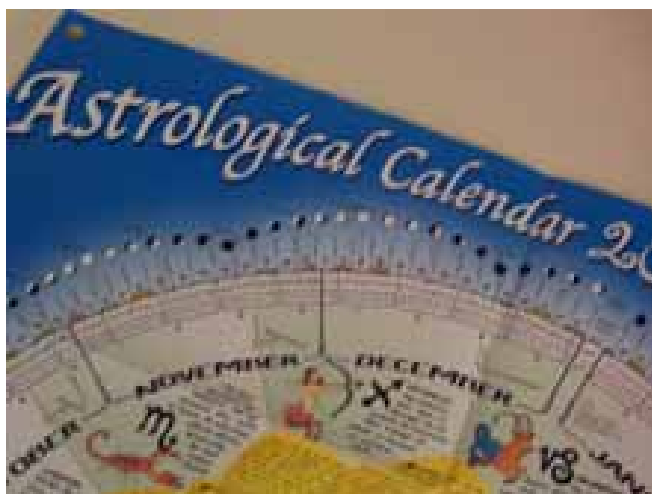
Plans for planting were formulated by using lunar phases for sowing seeds so the connection between the solar system and natural biological cycles was maximized.

Leafy vegetables were planted when the moon was waxing and root vegetables were planted when the moon was waning.

Harvesting was carried out when the moon was in its waning phase

Because the lunar phase is said to control the moisture in the soil, it was noticed that the seeds germinated quickly and the plants grew strong and healthy in a relatively short time.

An astrological calendar was used as a guide to plant crops.



Maintenance

One of the biggest jobs in the pasture production system was maintenance.

As well as keeping the pathways clean, the crops were trimmed at least three times during the growing season. This was done to encourage new growth of fresh, clean leaves for the growing snails.



The use of a line trimmer was effective for this task but a pair of good hedge shears was also useful for crop trimming.

The removal of old or decaying leaves helped to avoid the attraction of unwanted insects.



As the crops were grown without the use of chemicals, weeds were a problem and were removed by hand and destroyed.

The importance of good preparation of the seed bed, to make sure the soil is well worked to prevent weeds from growing is essential.



Internal fences were checked regularly for holes and weeds growing at the base.

The base of the external fence was monitored for the intrusion of predators such as rats and frogs.

A daily check was carried out for any snails that had been transferred to the growing fields that may climb up to the top of the nets for the first day or two.

These snails were placed back in their field so they did not dehydrate in the sun. The snails settled down and

remained in their field after a few days as their new territory was recognized.

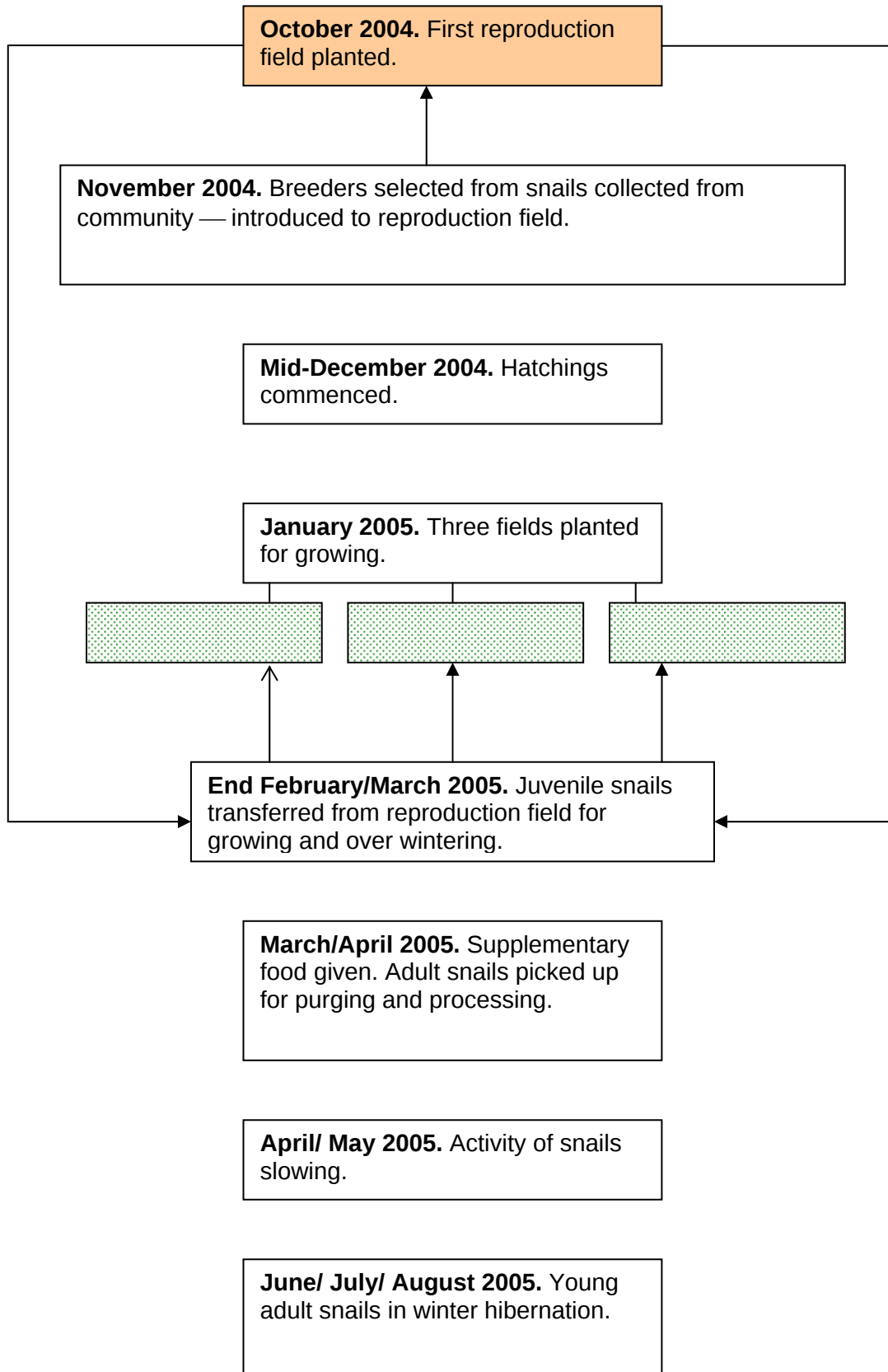
The water holding tanks (providing 30m head of pressure) were monitored regularly to make sure they were filled with water for the evening irrigation.

The irrigation filter was frequently flushed to prevent a build-up of foreign material. Spray nozzles were regularly checked and replaced when necessary.



First Production Year – 2004/2005

Production Schedule (First year — 2004/2005)



Selecting breeding snails

The initial breeding stock was carefully selected from a large collection of snails sourced from the community of Orange.

Members of the local garden club supported the research project by collecting and donating their snails.

Gardeners who choose not to use chemicals or poison baits in their garden were keen to pick up their unwanted snails.

Large snails measuring 30-32mm were selected as the first year's reproduction livestock



Introduction of snails to reproduction field

When the forage brassica crops were around 20cms in height, it was considered that it was time to introduce the snails for reproduction.



The collected snails were sorted and culled and 1,087 of the largest of the snails were chosen as the initial breeding stock.

These snails were placed in the reproduction field in early November 2004.

They continued to mate and breed and the first hatchlings were noticed in mid December 2004.

It was estimated that 25,000 snails were hatched from mid December 2004 to end February 2005.

Growing fields

Three growing fields were planted in January 2005 in readiness for the transfer of the juvenile snails for growing.

As a trial, one field was planted densely with chickory, silverbeet and white clover and the other two with forage brassicas and white clover. The forage brassica has an extended growing period during the central tablelands winter climate and it tolerated frost and snow.

The juvenile snails were transferred between February and March 2005 and supplementary food was added to the fields for extra sustenance in preparation for winter hibernation.

The stocking density of the growing fields was around 140 snails to the square metre.

Adult snails and others that had reached suitable size for harvesting were picked up from the reproduction field for purging and processing in March and April 2005.

The remaining juvenile snails were left in the growing fields for winter hibernation and to complete their biological cycle.

Winter hibernation

The activity of snails decreased dramatically when the temperature dropped below 6°C.



As the weather progressively became colder, the snails completely closed off the opening of their shells with a hard, calcareous cover called an epiphragm.

During the first year of production, the snails' activity started to slow in late April and hibernation period began in May. Full hibernation occurred in June, July and August.



A special environmental cloth was placed over the crops and snails during winter. This cloth allowed sun and water to penetrate but kept the temperature of the soil around 7°C higher than it would be without the covering.

Springtime

The juvenile snails that over-wintered in the growing fields emerged from their winter hibernation after the first shower of rain at the beginning of September 2005.

As soon as they emerged from hibernation they were fed with lettuce leaves, carrots and custom snail mix. Small hills of around 500 grams of calcium carbonate were placed in the fields as a supplement for strong shell development.



The snails grew quickly and by mid October, they had reached adult size (32mm). By early November the shells had developed a hard lip and the snails were considered ready to be purged and processed.

The construction of all the fields necessary for next year's production was completed during winter.

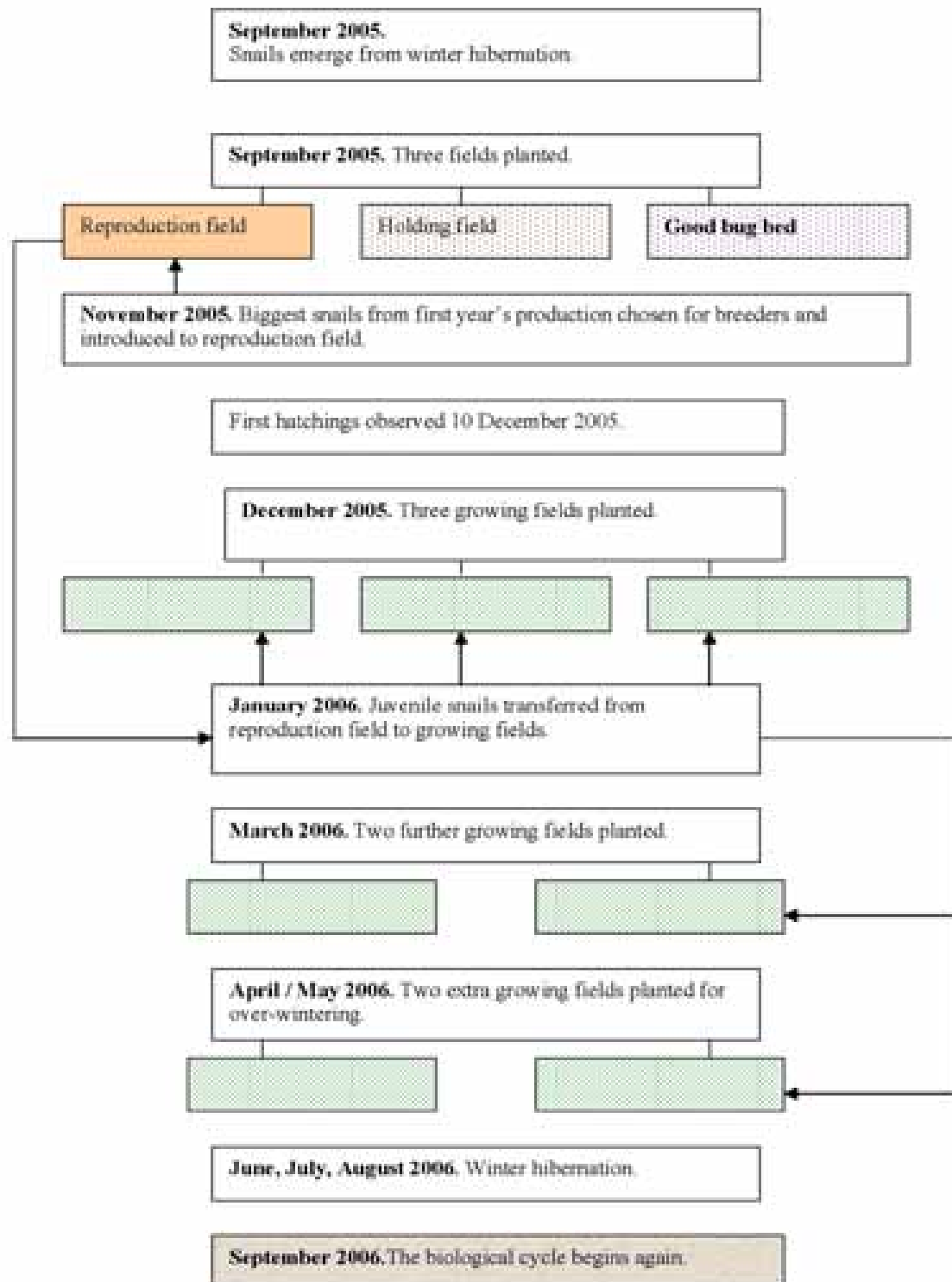
The old reproduction field was cleared and left fallow as part of the rotational system for cropping and snail production in the following season.

Once a field was cleared of snails and depleted crops, it was left fallow until needed.



Second Production Year – 2005/2006

Production Schedule (Second year — 2005/2006)



Activities for 2005/06

Three fields were planted in September 2005.

One was used as the reproduction field and was planted with hybrid turnip, silverbeet and clover. The second field was used as a holding area for the adult snails from the previous year's production and the third field was utilised as the 'good bug bed'.

A total of 850 of the biggest snails for reproduction were chosen from the 10-12 month-old snails that were produced in the first season. They were introduced to the reproduction pen in early November 2005.

Because the new breeding snails were acclimatised, a reduced number of snails for reproduction was acceptable.

To accommodate the anticipated volumes of baby snails, another three growing fields were planted in December 2005, mainly with silverbeet, hybrid turnip and clover.

Some small trial patches were also sown with radish and beetroot but these were found to be mostly unpalatable to the juvenile snails.

The first batch of juvenile snails was transferred in mid January 2006 and most of these snails grew to a marketable size by the end of March 2006.



Stocking density in the growing fields was 90 snails to the square metre.

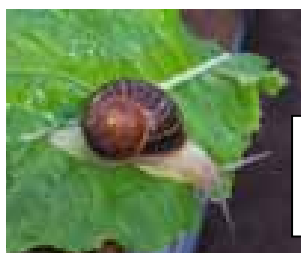
Another four fields were established — two in March 2006 followed by two more in April 2006.

These were planted with plantain and silverbeet in rotation with the previous crop of brassicas.

The juvenile snails will be left in these fields for overwintering.



Hibernation will take place during June, July and August 2006.



In September 2006, the biological cycle will begin again.

Mortality

Deaths of snails were mostly adult snails and usually occurred at the end of the mating season or during hot dry conditions, especially in the first year.

Others were culled during the growing season if a hard lip had formed on the shell edge and they were found to be undersized.

Some snails died in the purging bins, once again in the first year of production because of the unusually hot, dry conditions.



Overall, the mortality rate was not as significant as occurs in other types of production. In the second year snail deaths were greatly reduced as the 'locally' bred snails were suitably acclimatised.

Harvesting snails for transfer or purging

Harvesting for purging was carried out as soon as the juvenile snails reached maturity. This was determined by the accepted mature size of 32cm and the hardness of the lip of the shell. The measurement is taken across the underside of the shell. The shell lip is the outer edge of the shell.



If the outer edge of the shell (or lip) is soft and pliable, it means that the snail has not finished growing. To determine maturity, the shell lip should be hard and resistant to touch.

Sometimes undersize snails developed a hard shell lip so those snails were discarded. They are not suitable for reproduction or processing and if left will eat valuable food.

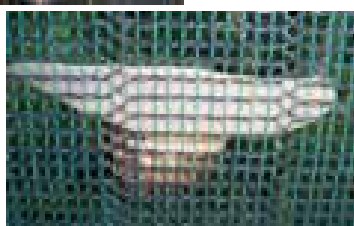
It was found that harvesting was a time consuming task as the snails have to be selected and picked up by hand. The best time for harvesting is at dawn and dusk, especially after rain or water misting.

Tips for harvesting or transferring snails



Feeders containing custom snail mix were put out to attract snails. Once the snails gathered on the feeders they were easily picked up and transferred to other fields or to the purging bins.

After rain and watering, the snails climbed up the sides of the netting fences. This allowed the snails to be easily picked off the nets early in the morning.



Cost of set-up of production fields, during two-year establishment phase \$17,974.

Purging

Purging is the process of the passing of any soil and grit from the digestive systems of the snails. This is to ensure they are palatable, safe and clean for human consumption. It is not necessary to trim any part of the snail so proper purging is an important final activity before snails are cooked and sold.

Snails are purged to make sure they are perfectly clean and safe for human consumption.

The snails were given a purging formula for three days before leaving to dry. When the colour of the faeces changed, it was considered that the snails were properly purged of soil and grit.

Purging pod

Due to warm to hot climatic conditions during the summer months it was necessary to construct a separate, environmentally controlled enclosure, or pod, to ensure the initial activity of the snails during the purging process.

The purging pod was constructed inside an existing shed from insulating material used for cool rooms and electricity and water were connected.

A skylight was added for daytime light and neon lighting for use at night. A window and stable door were also incorporated into the pod.



Large deciduous trees were planted on the western side of the existing shed to provide shade and natural thermal comfort. In line with the researcher's commitment to environmental sustainability, the trees will help reduce the daytime temperature, thus the pod will become more energy efficient.

A portable evaporative cooling system was installed and modified. A float valve was added to its tank to ensure a continuous supply of water to the unit.



A specially designed digital temperature controller was added. It was set to cool when the temperature rose above 16° C and it turned the cooler off when the temperature dropped below 16°C.



It was observed that there was a significant improvement in the activity of the snails that resulted in more effective purging and a lower mortality rate.

Construction of purging pod

A timber frame was constructed and food quality plastic bins were mounted in two tiers on each side of the purging pod.

Household guttering was used along the rear to support the bottom edge of the bins and allow the waste water to drain. The waste water was drained to the exterior of the shed and utilised on the newly planted trees.



An automatic misting system was installed on the timber frame. Misters were directed to the inside of the bins through the wire mesh on the bins lid.

Purging containers

Forty 25 litre white plastic bins accommodated the snails during purging operations. These bins were selected for ease of cleaning and more efficient management of snails. The bins were modified for drainage and air circulation.

A portion was cut from the lid of the bins to leave a square hole. This was covered with wire mesh (about 10mm) and secured by heavy duty staples on the inside of the lids.



Several holes were drilled in the bottom edge of the bins for water and waste drainage.

A flexible security cord was attached to the side of the rim of the bins to keep the lid in place. (When large numbers of snails congregate together on the lid, it can easily come off).

Method of purging



Day 1

- harvested snails sorted by size and placed into the bins — 30 snails to a 25 litre bin.
- snails left overnight for the initial flush of soil and grit from their digestive systems

Day 2

- automatic misting system activated for one minute
- snails removed from the bins while the waste material hosed out by hand
- snails returned to the bins
- purging formula given

Day 3

- automatic misting system activated for one minute
- faeces and uneaten food hosed out
- purging formula given

Day 4

- automatic misting system activated for one minute
- faeces and uneaten food hosed out
- purging formula given

Day 5

- faeces hosed out
- no purging formula given

Day 6

- snails left dry (no misting or purging formula given)

Day 7

- dry snails ready for processing were transferred from purging bins to netting bags early morning and hung in a well ventilated, cool area for 24 hours in preparation for the cooking process.

The bins and lids were thoroughly cleaned with a portable cold water high pressure cleaner after snails were removed for processing. Each bin and its lid took 2.5 minutes to clean thoroughly.

Purging formula



A mixture of 50% organic unprocessed wheat bran and 50% organic oat bran was used as a high-fibre purging formula.

The mix was sprinkled lightly on the floor of the bins after the final hosing in the evening.



Any dead or dying snails were removed from the purging bins to avoid attracting flies.

When purging was complete, the snails were removed to netting bags and hung in a well ventilated area for 24 hours prior to processing.

Cost of purging pod and associated expenses, \$9,780.

Marketing

With the ability to mass produce large numbers of snails, consistent and regular supply of snails is now a possibility.

It is suggested that market research and good marketing principles be conducted before undertaking commercial snail production.

Experience gained by the principal researcher from many years involvement with snails and snail farming suggests that as long as a snail farmer provides a consistent high-quality product and helps educate and promote the product, chefs are willing to try fresh snails and to have them on the menu.



At the time of writing this report, pre-cooked snails were selling for \$9.50 per dozen.

Discussion

The purpose of this research project was to assess the viability of an alternative method of mass producing edible snails and to reduce the high-labour content of the current method of cultivating snails in Australia.

Current method – Gal-ring enclosures

The conventional and current method of producing snails outdoors in Australia is where snails are contained in smaller enclosures (galvanized iron rings) and hand fed custom snail mix in covered feeders.

The snails are also provided with roofing tiles as daytime retreats.



As stock numbers increase, the number of enclosures is increased to provide breeding and growing space.

It is an ideal way for beginners entering the snail farming industry or for people wishing to grow snails for home consumption and can be managed by one person. This method gives an inexperienced farmer the opportunity to learn about snail behaviour and associated problems that may occur and to gain some practical experience — an important factor that should be considered before undertaking a large commercial operation.

The labour component becomes higher as the operation grows. The food must be renewed each day, and any leftover vegetable leaves removed to avoid attracting insects and flies. The feeders need to be washed regularly and the soil in the containers refreshed periodically. Juvenile snails need to be culled and transferred to growing rings throughout the season.

This type of snail production has proved to be an excellent method for beginners and for people who wish to farm snails as a hobby or cottage industry. The rings can be maintained without difficulty and the snails can easily be monitored — it's a good starting point.

Pasture production — or free range



With careful management, free-range snail farming is significantly more time productive.

Importantly snails grow in a shorter time with noticeably more consistent growth in the pasture production system.

There are certain prerequisites that are essential before pasture production or free-range snail production is commenced.

- abundance of water
- good soil with adequate drainage
- suitable environmental conditions — cool to temperate climate
- access to snails in the community
- space to establish and expand
- sunshine for good crop development
- time, patience, energy and good health.

Free-range snail farming has many benefits for raising high-quality snails but nevertheless it involves a high degree of labour content.

As well as the practicalities of farming the snails, there are other matters to be considered such as processing and marketing that may make the project too large for one person to manage efficiently.

After establishment of the fields, on-going maintenance necessitates a lot of physical work and time to ensure the correct environment and conditions for effective snail production.



- preparation of soil
- sowing the seeds
- rotating crops
- weeding
- trimming the crops
- maintaining clean paths
- transferring and harvesting snails.

After initial establishment (over two years), production costs decrease and become stable. Financial overheads may only include:

- repairs and maintenance
- supplementary food
- seeds
- contractors if required.

The results of the research project showed that substantial profit returns are realised during the third year of production.

Statistical analysis

Table 1: Method

PRODUCTION YEAR	2004/05	2005/06	COMMENT
Reproduction analysis			
Total area for site of pasture production (sq m)	850	850	Area within external fence
Total area utilised for snail production (sq m)	238	535.5	Area designated for reproduction and growing fields
Total number of reproduction fields planted	1	1	Each measuring 17 x 3.5m (59.5 sq m)
Total number of growing fields planted	3	7	Each measuring 17 x 3.5m (59.5 sq m)
Other fields planted	0	2	Holding and 'good bug bed' fields
Number of breeding snails	1,087	850	Second year's breeders acclimatised, so reduced number acceptable
Number of hatchings (est)	25,000	37,000	Increased reproduction due to second year's acclimatised 'farm bred' snails
Density of breeder snails (to each sq m)	18	15	Second year's adults acclimatised
Density of juveniles in growing fields (to each sq m)	140	90	Lower density produced better snails in shorter time
Mortality/culling rate	45%	15%	Fewer deaths in second year's production
Mortality rate in purging bins	3%	1%	The addition of environmentally controlled purging pod in the second year reduced deaths in purging bins
Final results of reproduction	13,300	31,100	Dramatic increase in reproduction and decrease in mortality in second year

Table 2: Labour requirements

PRODUCTION YEAR	2004/05	2005/06	COMMENT
Farming activity (person hours per week)			
Number of hours for harvesting	6	10	Picking up or transferring snails
Number of hours for crop and weeding maintenance	8	12	Trimming crops, weeding, monitoring fencing and predators
Number of hours in purging pod	3	8	Cleaning bins and feeding purging formula
Total	17	30	
Other associated tasks (person hours per week)			
Number of hours processing	9	15	Pre-cooking snails, shelling and cleaning
Number of hours packaging/labelling	2	4	Packing snails into insulated boxes for transport and associated labelling and invoicing
Marketing	6	6	Communication with existing and potential customers
Miscellaneous	3	9	Phone calls, email enquiries, correspondence etc
Total	20	34	
Total person hours for all labour per week	37	64	

Table 3: Establishment and production cost estimates for two-year establishment phase

Description	Amount
Compost mulch/fertilizers	2,043
Fencing materials	4,669
Irrigation costs	3,429
Equipment	4,759
Plumbing	471
Contractors	817
Seed	684
Freight	282
Supplementary food/purging formula	820
Construction of purging shed and associated equipment	9,780
Total establishment costs	\$27,754

The estimates (calculated to rounded figures) were associated with the complete setting up and production of the ‘model’ open pasture production site and its associated expenses over the two-year period of establishment.

Labour costs were not calculated in the establishment costs, except for the hire of contractors for heavy equipment operation and maintenance of fields when required.

Table 4: Comparison of production systems

Establishment and production over two years		
	Establishment and production cost estimates	Output — snail yield (hatchlings)
Gal-ring enclosures ¹	\$12,500	12,000
Open pasture or free-range	\$27,754	37,000

¹*Snail Farming in Australia – a practical guide for beginners*

Implications

The outcomes of this research project demonstrate that the trial of pasture production or free-range snail production is unquestionably viable as a means of producing large numbers of high-quality Australian snails.

Estimates indicate the pasture production or free-range method is more cost effective to establish and produce snails than the current method of farming snails in Australia today.



The biological cycle of breeding snails in open pastures allow snails to grow and develop in a natural biodynamic environment — they can breed and grow as nature intended.

It produces clean, healthy, well developed, consistent-sized snails rapidly. After the first year of production the mortality rate is very low compared with indoor and green house farming systems.

During the first two years of establishment, the 'model' pasture production method demonstrated a 75c/snail cost of production, compared to \$1.04 for the gal-ring system for the same period.

See Table 4

Recommendations

The outcomes of the research project were successful and its objectives were met. Pasture production or free-range snail farming appears to be an ideal system for breeding and growing large numbers of snails.

From this trial, it was observed that some streamlining with management of crop planting and rotation is needed to help reduce the work load, especially when the operation is expanded in the future.

In the third year of production some minor changes will be made to planting times to coincide better with the growing of juvenile snails.

Because the second year of reproduction generated acclimatised snails, it resulted in a higher number of snails hatched in the second season.

Therefore the area for growing fields will be increased to at least four times larger than the area allowed for reproduction. This will assist in accommodating the large numbers of new snails

The trial also verified that spring time is the optimum time when snails are at their highest quality. They grow quickly and evenly and there are thousands ready for harvesting in November and December. Snail tasting trials proved that young, plump snails are better presented to the consumer and are more palatable.

This could mean that the 'snail season' may be reduced to spring and autumn to guarantee quality assurance standards are met consistently unless refinement to the processing and packaging procedures is made.

To maximize the flush of spring snails, the management of processing and packaging needs to be reviewed so shelf life can be extended.

Snail farming in Australia is in its infancy so there is no infrastructure for commercial processing in place. It is up to the snail farmer to provide purging and processing facilities which add to the high labour requirement.

Considerable thought should go into the area allocated for growing as an extensive area of fresh crops is required for the hungry juveniles. Overcrowding causes problems with the development of the young snails and excess slime in the growing fields can also be detrimental to the effective growth and development of young snails.

It is suggested that the area for a commercial-sized snail farm should be chosen and developed gradually in size from approximately half to one hectare for the first year and expanding to greater than one hectare in the second year. After this time, the possibility to expand further is feasible.

This recommendation of slow expansion will allow the inexperienced farmer to obtain a good understanding of the complexity of the biological cycle of snails, the farming principles and progression to the processing and marketing phase.

Conclusion

The 'model' pasture production or free-range trial demonstrated that snail farming on a large-scale basis requires a considerable investment in time, equipment, and financial resources.

To be successful the potential snail producer should carefully consider the environment in which they intend to farm snails, the timing, growing and rotation of suitable crops.

As this is the first time in Australia that a trial has been conducted in close replication of the Italian snail farming system, the positive outcomes will help pave the way for a sustainable, commercially viable snail farming industry in Australia.

The demand for fresh snails on the domestic market is very positive but is not unlimited. However, many enquiries from overseas countries imply there is a good future for international trade.

With the advent of the prospective Australian Snail Breeders' Association (see Appendix C), standards for production, processing and supply will set precedents for the supply of high-quality snails and improve the image and quality of snails produced in the future, in Australia.

Appendices

Appendix A: Statistics of snail imports to Australia

International trade statistics published by the Commonwealth Government's Australia Bureau of Statistics are based on information provided to the Australian Customs Service (ACS) by importers, exporters or their agents.

The source of the data was provided by the Australian Bureau of Statistics (ABS) on 30 September 2005 for the reference period FIN YR 2003-2004 and 2004-2005. Tariff code for the data is 0307 6000 23 and the information provides country of origin, Australian state of destination, quantity and customs value.

Harmonized tariff item statistical classification: Snails (excl. sea snails), live, fresh, chilled, frozen, dried, salted or in brine.

Note

The quoted value figures for Country of Origin, Hong Kong (SAR of China), financial year 2003-2004 appeared to the researcher to be very high compared to other figures quoted so the value may distort the average.

This figure was queried with ABS and the researcher was referred by its consultant to its booklet '*International Trade, Insuring Data Quality*' that states: "While the ABS receives many queries on detailed data from clients, it isn't cost effective to investigate or practicable to investigate all of them". Further information about data checks can be obtained from the booklet available from the ABS website.

Table 5: Financial year 2003-2004

Country of Origin	State of final destination	Quantity (Kilograms)	Customs Value (\$'000)
China	New South Wales	136	1,201
Hong Kong (SAR of China)	New South Wales	826	45,395
Indonesia	New South Wales	960	2,787
Indonesia	Western Australia	2,040	11,440
Vietnam	Victoria	420	1,700
Total		4,382	62,523

Table 6: Financial year 2004-2005

Country of Origin	State of final destination	Quantity (Kilograms)	Customs Value (\$'000)
China	Victoria	327	2,698
Hong Kong (SAR of China)	New South Wales	345	2,394
Indonesia	New South Wales	1,914	6,567
Vietnam	New South Wales	1,720	1,911
Vietnam	Victoria	600	1,340
Vietnam	Queensland	509	1,746
Total		5,415	16,656

The figures provided show total imports over two years 9,797 kilograms at a value of \$79,179.

Appendix B: Microbiological and chemical analysis of snail products

No investigation of storage, shelf life and nutritional analysis had been conducted in Australia prior to commencement of this project. Due to the potential viability of mass rearing snails and the future development of a commercial snail farming industry in Australia, there was a strong need to investigate these important areas.

Microbiological testing was conducted to determine shelf life and was implemented by Primary Industries Research Victoria (Attwood). The nutritional analysis was carried out at Primary Industries Research Victoria (Werribee).



A total of 63 samples each consisting of 70 grams of snail meat were required for the three products for shelf life testing. One 70 gram sample of Product 1 and 2 was required for the nutritional analysis.

All samples were prepared in accordance with the *Australia New Zealand Food Standards Code* prior to sending them to the laboratory for testing.

Table 7: Tests performed

Test performed on all samples	Description of test
<i>Escherichia coli</i> and Coliforms	Coliforms are a group of organisms of similar characteristics that inhabit the human or animal intestine and some can inhabit foods and the environment. <i>E.coli</i> is a member of the coliform group and is an indicator of faecal contamination.
Total Plate Counts 25°C	This test gives an indication of overall hygiene of the product and gives count of all bacteria present on the sample
<i>Pseudomonas</i>	Spoilage organism under aerobic conditions
<i>Listeria monocytogenes</i>	Food borne pathogen and is of ubiquitous origin
<i>Salmonella spp.</i>	Food borne pathogen of faecal origin
<i>Staphylococcus aureus</i>	Potential food borne pathogen and is associated with food handlers
<i>Aeromonas spp.</i>	Potential pathogenic species in this genus also cause spoilage organism which has been isolated from cold blooded animals

Explanation of results

Product No 1:

Pre-cooked whole snails (out of shell) in spring water in a plastic container (chilled snails).

Chilled snails stored at 4°C and tested periodically over a nine-day storage period. Results are summarised in Figure 1.

The Total Viable Count (TVC) of all bacteria, increased over the storage period as expected, but was still of good microbiological quality.

Salmonella and *Listeria monocytogenes* were not detected from any of the samples tested.

All other tests were below the limit of detection for the test period.

Suggested shelf life – nine days at 4°C

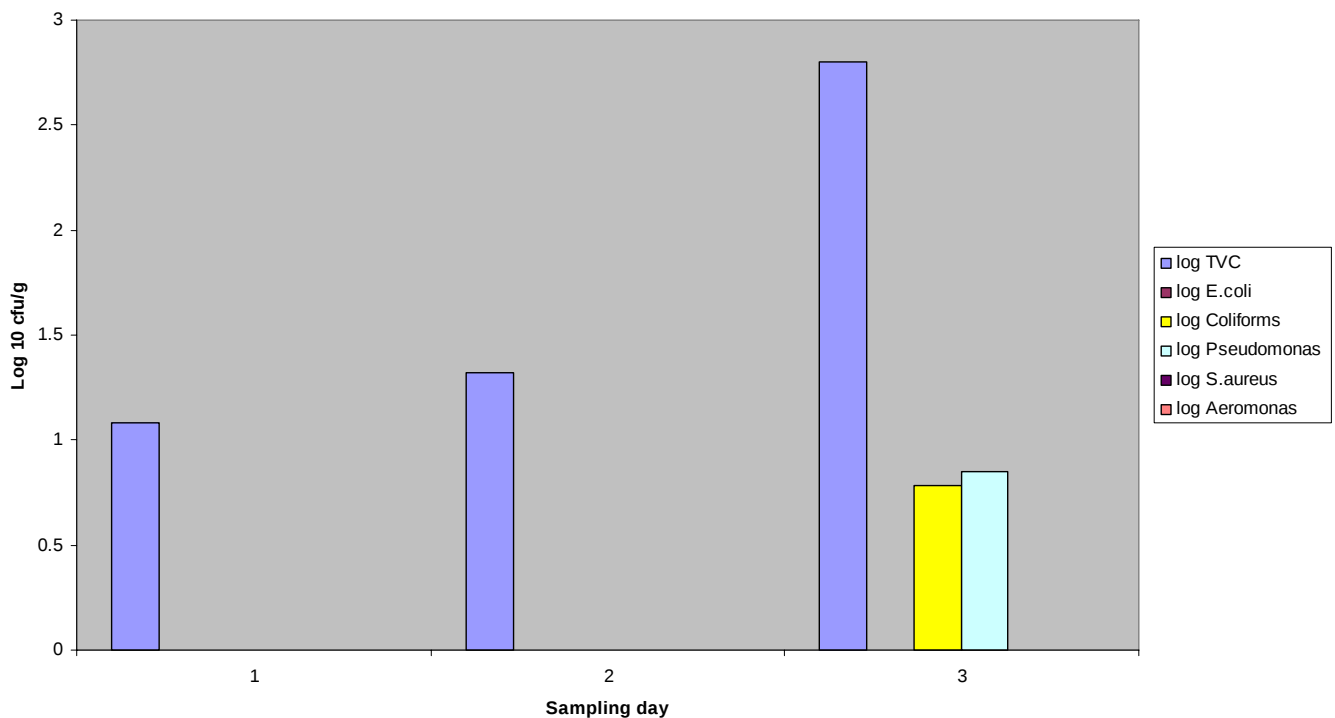


Figure 1: Microbiological examination of chilled snails

Product No 2

Pre-cooked whole snails (out of shell) in ratio ¼ extra virgin olive oil to ¾ white wine contained in a glass jar and sealed with a twist top lid.

Shelf stable snails stored at room temperature and tested microbiologically on day of arrival and then on a monthly basis for a period of 4 months.

Results are summarised in Figure 2.

The TVC increased to high levels by month two and displayed off odours, and by month three had developed a slimy texture. This product was organoleptically considered unacceptable at two months storage.

Salmonella and *Listeria monocytogenes* were not detected from any of the samples tested.

All other tests were below the limit of detection for the test period, except for coliforms which were detected at low levels upon arrival in the laboratory and again at 2 months storage.

Suggested shelf life – eight weeks

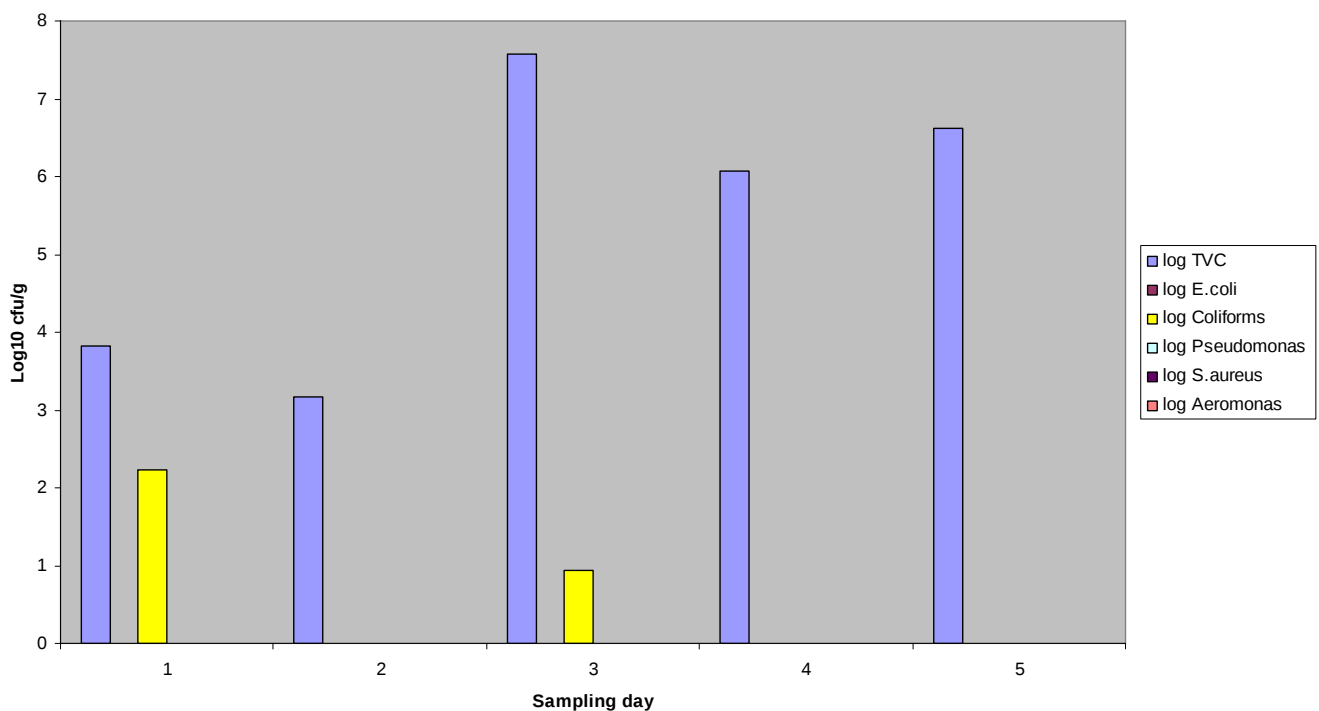


Figure 2: Microbiological examination of shelf stable snails

Product No 3

Pre-cooked whole snails (out of shell) with the addition of half quantities of white wine and cider vinegar with pickling spices (cinnamon, allspice, mustard seed, coriander, bay leaves, ginger, chillies, cloves, black pepper, mace, and cardamom) contained in a glass jar with twist top lid (shelf stable).

Shelf stable snails stored at ambient temperature tested on day of arrival and then at monthly intervals for a period of 5 months. Results are summarised in Figure 3.

The TVC remained low throughout the test period and suggests good hygiene practices that had occurred during the production of the snails.

Salmonella and *Listeria monocytogenes* were not detected from any of the samples tested. All other tests were below the limit of detection for the test period.

Suggested shelf life – five months.

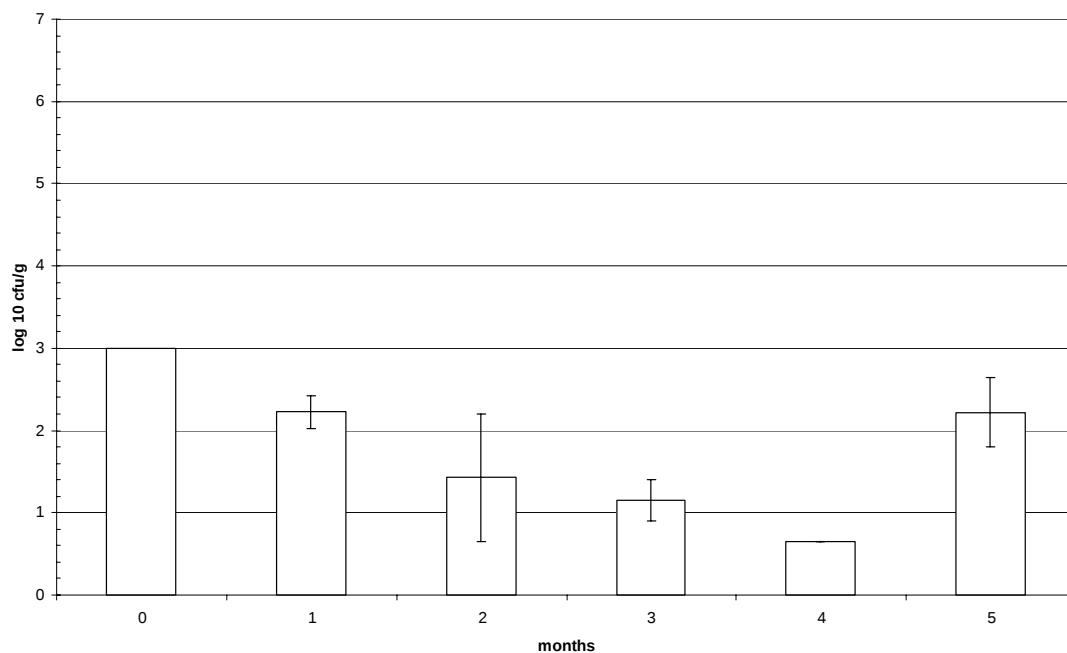


Figure 3: Shelf life of snails, total viable count

Nutritional analysis

The Certificate of Analysis provided the following information regarding the ‘results by test’.

Sample 01- A

Pre-cooked snails with the addition of white wine and olive oil contained in a glass jar and sealed with a twist top lid.

Sample 02-A

Pre-cooked snails in spring water in a plastic container.

Table 8: Certificate of Analysis

Work order: 04-04-029	CERTIFICATE OF ANALYSIS		Reported: 8-Jun-04
Test	UNITS	SAMPLE #01-A	SAMPLE #02-A
Method			
Cholesterol FTP02043	mg/100g	140	120
Energy Value FSC:Std R2	kJ/100g	430	350
Protein 20146	g/100g	14.9	13.0
Total Fat (Acid Hydrolysis) 20116	g/100g	1.6	1.3
Total carbohydrate (calc) FSC:Std A1	g/100g	7	5
ICP elements 138			
Sodium	mg/100g	18	22
Test results apply only to the sample(s) submitted for analysis. Ash and Moisture analyses were required to calculate Total Carbohydrate. Energy value was calculated using the protein, fat and carbohydrate contents of the sample. Protein calculated from nitrogen times 6.25.			

Table 9: Comparison of cholesterol between snails (*Helix aspersa*) other molluscs and crustacean

Mollusc	Cholesterol mg/100
Snails (in natural spring water)	120
Scallops	40
Mussels	90
Crustacea	
Lobster	150
Prawns	190
* Data show molluscs and crustacean have a similar fat, protein and energy count	

Appendix C: Proposed Australian Snail Breeders' Association

Now that it has been proved that snails can be bred successfully in large numbers in Australian climatic conditions, and judging by the interest shown to the principal researcher, more people will become involved in snail farming.

Clear standards regarding the production of the full biological cycle of breeding snails, processing, marketing, promotion and safety and health will be set in place by the Incorporated Association. This will guarantee consumers are assured of a high-quality, safe to eat, fresh Australian snail product. Certain criteria regarding the breeding and production will apply regarding successful nomination of membership of the Association.

A logo will be designed for use by members as an important indicator of quality assurance to consumers.

A number of potential and new snail farmers have indicated their interest in nominating for membership of the Association and have been placed into a database for future consultation.

Snail Farming Information Service is currently cataloging snail farmers in Australia who are interested in becoming members of the Association by submitting an 'expression of interest' form that can be found on website <http://www.snailfarming.net>

Appendix D: Health safety

Advice is extended to people with a weakened immune system or who have a history of respiratory or lung diseases considering working with soil and snails.

The use of potting mix and compost mulches has been associated with legionnaire's disease, a respiratory infection which, in susceptible individuals such as the elderly and those with particular respiratory conditions can prove dangerous to humans.

Soil and certain contaminants that may emanate from animal protein (snails) can cause fungal infections such as Aspergillosis and serious bacterial infections such as Nocardia.

People on chronic steroid therapy, those with cancer, organ or bone marrow transplants, or HIV/AIDS are at risk of contracting these infections.

Refer to [Department of Employment and Workplace Relations](#) for information regarding Occupational Health and Safety in the workplace.

References

Australian Bureau of Statistics (2005) International Merchandise Trade – Imports of Snails. Code 307600023 ABS, Canberra. 'International Trade, Insuring Data Quality'
<http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/5498.0.55.0012001?OpenDocument>

Basinger, A.J. (1931) *University of California College of Agriculture Agricultural Experiment Station, Berkeley. The European Brown Snail in California. Bulletin 515:1-23*

Begg, S. (2005) <http://www.snailfarming.net/booknow/booknow.html>
Snail Farming Information Service

Resources

Agronomists
NSW Department of Primary Industries
161 Kite Street
ORANGE NSW 2800
Ph: (02) 6391 3100

Australian Bureau of Statistics
National Information and Referral Service
ABS House
45 Benjamin Way
BELCONNEN ACT 2617
Ph: 1300 135 070

Department of Employment and Workplace Relations
Standards and OHS Legal Obligations
<http://www.nohsc.gov.au>

Astrological Calendar and Moon Planting Guide (2004, 2005, 2006)
Organics Australia On-line
<http://www.organicsaustraliaonline.com.au/prod3498.htm>

Custom Snail Mix
Prydes Pty Ltd
Animal Feed Specialists
Quia Rd
GUNNEDAH NSW 2380
Ph: (02) 6742 3966

Good Bug Bed Mix
Green Harvest Organic Gardening Supplies
Ph: 1800 681014
<http://www.greenharvest.com.au/index.htm>

Soil testing laboratory
Incitec Pivot Limited
Pivotest Laboratory
Wilson Avenue
WERRIBEE VIC