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Are Crickets commercially viable to utilise as an alternative protein within Australia

Paula-Lee Pownall, 2020 Scholar
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Scholar contact details

Paula-Lee Pownall

Grubs Up Australia

952 Old Bunbury Rd, West Coolup, WA 6214

0419 378 496

Paula@grubsup.com.au

In submitting this report, the Scholar has agreed to Nuffield Australia publishing this material in its edited form.

NUFFIELD AUSTRALIA Contact Details

Nuffield Australia

Telephone: 0402 453 299

Email: enquiries@nuffield.com.au

Address: PO Box 495, Kyogle, NSW 2474

Are Crickets commercially viable to utilise as an alternative protein within Australia?

Executive Summary

In 2013 the World Health Organisation released the publication “Edible Insects, Future prospects for Food and Feed”. The 200-page document was a catalyst for anyone interested in alternative proteins and sustainable food opportunities.

Eastern and Indigenous Cultures have farmed insects for consumption (and medicine) for thousands of years. However, Western society has only recently developed an interest in insects as a potential source of nutrition. This has resulted in substantial growth in research and insect production facilities around the world. These facilities have been developed with the intention of utilising insects for human food and animal feed.

Australia has many opportunities to take advantage of the global insect industry through production, products, research, and technology. The question is, “**Is it commercially viable to produce insects for human food in Australia?**”

Well, it depends.

Production systems for common commercially farmed species like black soldier fly larvae and mealworms are attracting investment and showing signs of commercial viability, particularly as a substitute for soy and fish meal in pet and livestock feed. Their ability to be part of the circular economy, utilising waste products and turning them into high protein, high fat, feed formulations also enhance their business function.

This report serves to discuss the many aspects of cricket protein, from production through to marketing, regulation, and future opportunities.

A common theme from many businesses interviewed was that cricket production systems need to increase automation and technology, reduce costs, increase supply and consistency, and develop consistent markets to ensure success.

When shopping, consumers are bombarded with product information - nutrition profile, sustainability credentials, provenance, ‘value’, ingredients and more. It is into this landscape that cricket protein is trying to get noticed and gain credibility. It’s a challenge.

Through interviews and site visits it is clear cricket production facilities need to be systematic, clinical, and controlled, with the ability to scale whilst growing markets.

Furthermore, within the cricket protein space, markets are constantly changing from a range of factors including food trends, COVID-19, import and export costs, and regulations.

Whilst there are opportunities for cricket protein as a sustainable source of nutrition, the industry needs to work closely with government and key stakeholders to not only identify markets, but also develop and build markets for crickets as an alternative protein source to become economically viable.

Keywords: cricket protein, circular economy, sustainability, nutrition, human health, food, food systems, agriculture, alternative protein

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Are Crickets commercially viable to utilise as an alternative protein within Australia?

Foreword

I founded Grubs Up in 2016; a vertically integrated, 30 square metre space in a shed in West Coolup, Western Australia, Australia.

But how did I come to set up Western Australia's first edible insect farm?

After attending Agricultural boarding school, I attended Marcus Oldham College, and went on to complete a Bachelor of Agribusiness at Curtin University in 2011.

My first job post university was to manage a mosquito management program within the Peel -Harvey Estuary (134 square kms). One day I investigated the alternative uses of mosquito larvae and to my surprise found that many fish species eat them for their nutritional qualities.

I also stumbled across the World Health Organisation's document "*Edible Insects, Future prospects for Food and Feed*", published in 2013 (van Huis, 2013). The document explained the many benefits of insects as an alternative protein source. That's when I quite naively thought, "Why are we feeding quality protein such as lupins to our livestock, and could crickets supplement traditional protein sources for livestock"?

That's when Grubs Up was born.

Within the first 12 months of business, it was clear that there was a demand for cricket protein, however surprisingly, it came from the human food market. Grubs Up developed the insects for human food policy in collaboration with the Department of Health, Western Australia. The next three years, Grubs Up tried intensive cricket production. We farmed, processed and sold crickets wholesale into the restaurant market, online, and shared insights and experiences at schools and universities.

We had a trial production system capable of producing four kilograms of mature crickets each week at the completion of a seven-week life cycle. Although we could successfully produce and breed crickets, there were many operational challenges. These include the high cost of labour, high energy costs, minimal end product volumes and supply chain issues.

Typically, wholesale commercial food and feed manufacturers made enquiries regarding the procurement of up to eight tonnes of cricket protein per year. Clearly there was a strong demand for cricket protein and a lack of supply. Achieving price competitiveness with other sources of protein e.g. whey or soy, is also a significant challenge for insect producers, especially start-ups producing small volumes. Simultaneously, potential investors were enquiring about investment opportunities with Grubs Up, however when there are so many unknown unknowns, there was too much perceived risk for investors, and the business.

As founder of Grubs Up, I wanted to better understand the global cricket landscape and how it compared to the domestic context. I wanted to identify the key criteria for business success and any other contributing internal and external factors e.g. government policy, availability of investment and available markets.

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Acknowledgments

I would like to acknowledge the Western Australian Nuffield Alumni for sponsoring my 2020 Nuffield Scholarship. It is truly a privilege to be supported by so many like-minded individuals, of whom took a chance on a topic completely foreign to any previous industries.

I will always be grateful to Nuffield Australia for the opportunity to grow, learn and engage with people around the world.

My scholarship was also supported by a Regional Economic Development Grant, through the Peel Development Commission (PDC). I would like to sincerely thank the board and staff at PDC for their ongoing support and patience.

I would also like to acknowledge all the businesses and professionals that I have interviewed around the world since 2020. Many people have supported my scholarship sharing information and insights across different time zones and at times conveying in different languages.

To my Global Focus Program group, thank you! There were many challenging discussions that at times were not easy, however my scholarship is better for it.

They say it takes a community, and I will always be grateful for the local Coolup community for the encouragement and support.

I would like to extend my deepest gratitude to my husband, Rohan, for his unwavering support and dedication throughout my Nuffield journey. His willingness to take on all the family responsibilities allowed me to fully concentrate on my Scholarship. Thank you for being my rock and my inspiration.

To my Mum and my children Belle and Clancy, thank you for your love, endless support, strength, and patience.

Last but not least, thank you to Jeannine Malcolm, of Mobius Farms for the support with editing my report.

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Abbreviations

ASRS	Automated Storage Retrieval Systems
CSIRO	Commonwealth Science and Industrial Research Organization
FAO	Food and Agriculture Organisation, United Nations
FAP	Food Additive Petition
FMCG	Fast Moving Consumer Goods
FSA	Food Standards Agency
FSANZ	Food Standards Australia and New Zealand
GMP	Good Manufacturing Practices
GRAS	Generally Recognized as Safe
IP	Intellectual Property
IPAA	Insect Protein Association of Australia
IBC	Intermediate Bulk Containers
IPIFF	International Platform of Insects for Food and Feed
R&D	Research & Development
UN	United Nations
WHO	World Health Organisation

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Objectives

The objective of this study was to better understand the contributing factors to success in the production of insects for human consumption. Specifically, the research activities were designed and implemented to examine the global edible insect industry and reflect this back onto the potential domestic barriers and opportunities.

In summary, the key objectives of this Nuffield Research Project were:

- Identify the key drivers for the growth in interest in edible insects.
- Identify the core considerations for the establishment of a viable insect farming business (e.g. operational, environmental etc.).
- Identify and assess the impacts of contributing factors such as regulatory framework, maturing of the industry, customer perceptions etc. to the success of edible insect businesses.
- Reflect on the considerations being made by key stakeholders including government, industry associations, investors etc. to support the edible insect industry.
- Identify the strengths, weakness, opportunities and threats to the Australian edible insect industry; and
- Provide recommendations on how to improve the viability and long-term sustainability of the Australian edible insect sector.

To achieve these objectives, a range of activities were undertaken. These include, but are not limited to:

- Primary Resources - interviews (in-person and virtual)
- Site Visits
- Stakeholder surveys /interviews
- Literature Review

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Introduction

By 2030, the global population is forecast to reach 8.6 billion, and by 2050, 9.8 billion, with roughly 83 million people being added to the world's population every year (United Nations (UN) 2015). The UN's Food and Agriculture Organisation (FAO) also reported that "feeding a world population of 9.1 billion people in 2050 would require raising overall food production by some 70 percent between 2005/07 and 2050. Production in developing countries would need to almost double.

Everyone needs a source of protein to survive. It is a foundational building block to human health and nutrition. The question remains: where will this protein come from, and what form will it take? Will future generations prefer traditional protein sources e.g. chicken, fish and beef? What will be the readiness to include alternative proteins, including insects, in their everyday diets?

In Australia we are blessed to live in a free democratic country, rich in our lifestyle choices, including the food we eat, mainly traditional animal-based proteins.

So why would, or *should* we, consider insects as an alternative?

The global edible insect industry is growing fast, with the worldwide market expected to reach \$1.4 billion AUD in value by 2023. More than 2,100 insect species are currently eaten by two billion people from 130 countries, including 60 native insect species traditionally consumed by Indigenous Australians (Ponce-Reyes, 2021).

In 2013, the FAO of the UN published a report "Edible insects, Future Prospects for Food and Feed" (van Huis, 2013). The report helped catalyse interest and growth in this sector globally. The report brought widespread attention to the potential of edible insects, including crickets.

Following the report, there was a significant increase in edible insect startups, investment and funding, and regulation and research. This report is based on my travels to research commercial viability of the *Acheta domesticus* (Domestic house cricket) for both human food and animal feed.

Countries I visited included Singapore, India, Qatar, Germany, Netherlands, United States, Canada, and Australia. Indications suggest that despite strong consumer demand for cricket protein, cricket production systems in Australia are currently not viable for the human food market. This may be due to the high cost of labour, lack of automation, alternative preferable protein choices, product education and the insect "ick" factor.

COVID-19 has significantly impacted the global insect sector, causing many businesses to shut down or reassess and adapt to market changes. However, the pandemic has also underscored the strengths and opportunities in alternative proteins.

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Why Insects

Insects have survived for millions of years due to their ability to adapt to change, often producing many offspring and having a short life cycle, in comparison to domestic animals (Van Huis, 2013).

Insect production globally can be categorised mainly into two areas: human food and animal feed; a third significant category involves using insects in food waste bioconversion. Most insects contain high concentrations of protein, fat and other essential minerals and vitamins, depending on the species. This makes insects suitable as a reasonably balanced food source. The practice of eating insects is known as 'entomophagy'.



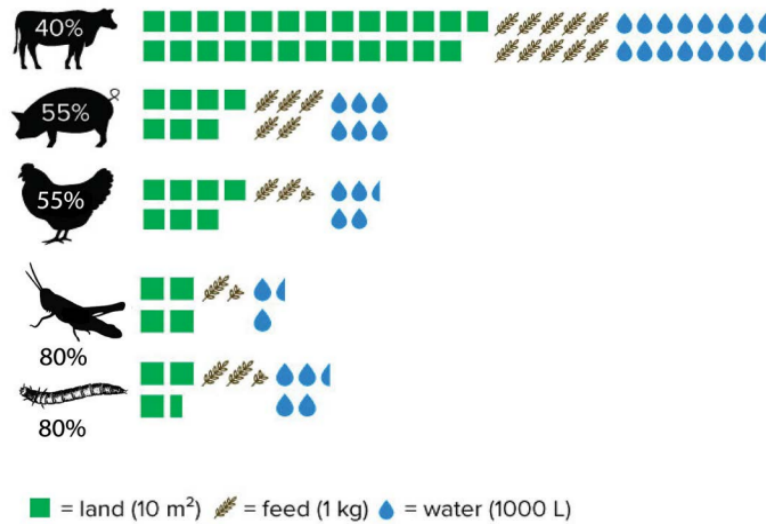
Figure 1 Abundance of Edible Grasshoppers, Mexico (Source: Gonzalez, 2024)

In many Eastern, and some African cultures, insects are wild foraged and consumed as part of a staple diet. There are examples of small-scale farming operations often integrated within food production systems e.g. feed for poultry or fish.

Insects have only recently been introduced into western culture with the interest stimulated by a desire for sustainable sources of protein. Commercial insect production for human food is typically focused on crickets, mealworms, grasshoppers, worms, and ants.

Insect protein requires less land, water and other resources to produce per equivalent kilo of traditional meat proteins.

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Amount of land, feed and water needed to produce 1 kg of live animal weight and percentage of the animal that is edible.1 Source: Food and Agriculture Organization of the United Nations. Reproduced with permission[1]. Top line format adjusted for clarity in this configuration.

Figure 2 Land, feed and water resources needed to produce 1 kg of live animal weight (and percentage that is edible) (Source: van Huis, 2013).

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Why Crickets

Since the World Health Organization (WHO) released the report "Edible Insects, Future Prospects for Food and Feed" in 2013, there has been a rapid increase in advancements related to the commercial production, technology, research, and regulation of using crickets as an alternative protein source to support the expanding global population.

Crickets, along with many other insects, can reproduce quickly, require minimal water, and exhibit an efficient feed-to-weight gain ratio. They can be farmed vertically and produce fewer carbon emissions compared to traditional livestock.

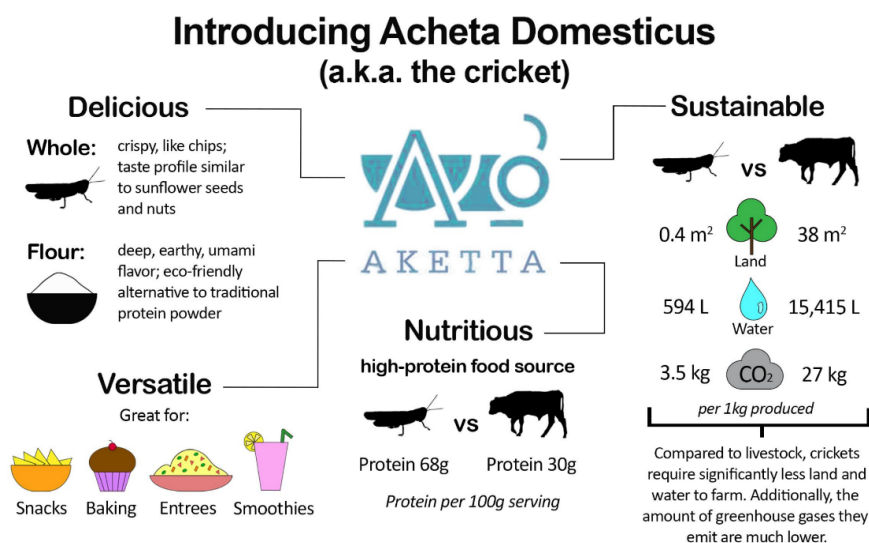


Figure 3 The benefits of crickets - (Source: Aspire Food Group, 2024)

Crickets contain up to 68% protein per 100gms, have 200% of your recommended Vitamin B12 daily intake, and contain all 9 essential amino acids (van Huis & Tomberlin 2017). Within an intensive, high-value farming system, the life cycle of a cricket can range from 4 to 8 weeks, from the time it hatches until it is harvested.

Each female cricket can lay up to 1,000 eggs, with an incubation period of 5 to 7 days. When harvested, up to 100% of the cricket can be utilised in a range of consumable products. It's important to note that the nutritional content can be influenced by factors such as the crickets' diet and how they are processed. For example, crickets fed a diet high in certain nutrients will have a different nutritional profile than those fed a different diet (van Huis, 2013).

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Commercial Viability

Commercial viability is defined as the ability of a product, service, or business venture to succeed in the marketplace by generating sufficient profit to sustain operations and achieve growth. It involves several key factors, including market demand, competitive advantage, financial feasibility, scalability, operational feasibility, profitability, and risk management (Von Eichborn, 1962).

So, are crickets for human food commercially viable? Well, it depends.

When establishing an emerging alternative protein, it is crucial to plan and consider the production system, automation and technology, and market supply and demand for the short, medium, and long term. Understanding the limiting factors at each step is essential to ensure success.

Insect production systems incorporate vertical farming, automation, controlled environment agriculture, precision farming, sustainable feeding practices, species-specific management, biosecurity measures, scalability, and continuous research & development integration. These elements collectively ensure efficient, sustainable, and high-quality insect production (Rowe, 2020 and Pells, 2023).

Crickets can be raised either in a "free-range" environment or within an "intensive" farming system. Their growth requirements such as temperature, ventilation, and humidity, vary based on their developmental stage and population density. Insect businesses often start small, developing their systems and expanding as product demand increases. Initially, small-scale operations are typically labour-intensive. However, as the business grows, there is a need to automate processes to reduce costs and increase efficiency.

Through interviews with Schubugs in South Australia, Future Green Solutions in Western Australia, and Small by Small in Germany, it has been found that in the early stages of insect production, most companies initially had to create their own production systems and automation, then adapt the systems as the business grows.

Later, companies chose to either collaborate with others, such as universities, or purchase pre-designed systems off the shelf and modify them to meet their specific needs. Successful insect production systems are often safeguarded through Intellectual Property (IP) or patents. Companies are often reluctant to share their IP, and before Covid-19, there were few off-the-shelf insect production systems available for purchase.

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Case Studies: Commercial Cricket Farming

EntoCube® - Finland

EntoCube® is an example of a company that started out as cricket producers then patented their production system. They developed a suite of offerings including a modular cricket farming system, farm data management systems, training, feed formulations, and specialised equipment. EntoCube® began a process of collaboration with community groups and local governments to utilise 'vacant' urban spaces including inside a disused mine. The modular nature of this cricket farming system met a demand for small-scale insect production.



Figure 4 Images of the Entocube modular cricket farming system (Source: Entocube)

Entomo Farms - Canada

Entomo Farms, a Canadian cricket producer, was founded in 2014 by three environmentally conscious brothers: Jarrod, Darren, and Ryan Goldin. Located in Norwood, the facility spans 5,600 square metres of repurposed poultry barns and produces approximately 72,000 kilograms of crickets annually.

Entomo Farms have an alternative approach to housing crickets in comparison to traditional intensive farming methods. Entomo crickets are "free range"; crickets live within "cricket condos" with minimal manual handling until they are ready to harvest. The crickets have access to fresh food and water and remain in the same condo for the 6-week life cycle, until they are ready to harvest.



Figure 5 Left to Right: Lauren Park 2022 Nuffield Canada Scholar, Kelly Hagon CEO Entomo Farms, Ryan Goldin Cofounder Entomo Farms, Paula Pownall 2020 Nuffield Australia Scholar, Cricket Condos free range system and Entomo's dried cricket products. (Source: Entomo Farms)

Being pioneers of the cricket industry meant that the team at Entomo were largely self-reliant on the "how-to" of running an ethical and sustainable cricket farm, but also for the development of products that would be desirable to the consumer. Where necessary,

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Entomo engaged consultants, external researchers and advisors to help guide their farm management practices.

To reduce the upfront capital expenditure required, Entomo farms chose to lease their farm property and instead invest their available capital into the core cricket farming operations. This decision allows the company to focus and continue to improve food, hygiene, and manufacturing standards, whilst ensuring the quality of the product is of the highest standard.

Schubugs - Australia

Schubugs, founded in 2018, is a small-scale cricket business, owned and operated by Zac Schubert and family. Their mission is to provide high quality cricket-based products while prioritising ethical and environmentally friendly farming practices. Founder, Zac was inspired to farm crickets as a sustainable source of protein due to his studies in sports nutrition and his activities as a professional athlete.

Schubugs demonstrates a resourcefulness and resilience found in many of the other cricket start-ups. Utilising their rural farm's existing infrastructure, Schubugs built a cricket farm to meet Good Manufacturing Practices (GMPs) with respect to insect welfare and hygiene.

Crickets are farmed in vertical container systems constructed from IBCs (Intermediate Bulk Containers). They utilise solar energy to off-set the energy of controlling the temperature and humidity within the cricket farm. The crickets are fed using locally sourced agricultural 'waste' e.g. out of specification carrots, that would otherwise go to landfill or stock feed.

Some of the challenges experienced by Schubugs is the lack of regulation with respect to the inclusion of insects in human food products. Consequently, during their start-up phase, they have sold their product to the reptile live-food market - selling live crickets across Australia. This has its own set of problems including reliability of logistics and shipping services, especially across vast distances.

In the future, the business has a long-term goal of entering the human food market and has experimented with cricket pasta and protein powder through their business venture Grub Protein.



Figure 6 Timothy and Zachary Schubert, IBC cricket housing, and the Schubugs Sea Containers
(Source: Schubugs)

Cricket One - Vietnam

Across Southeast Asia, the farming of insects for human food and animal feed is more widely accepted. The climatic conditions are favourable for producing many common

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edible insect species and hence do not require the operating costs of environmental conditioning incurred by previously stated businesses.

Despite the perception of many visitors to South East Asia that edible insects are a novelty only served on sticks to wary tourists, the edible insect industry is also becoming more professional. The low cost of labour, the access to large consumer markets, the favourable support from government and investors mean that South East Asian companies are well positioned to scale edible insect farming.



Figure 7 Cricket One (Vietnam) - whole roasted crickets, live crickets, cricket farm. (Source: Cricket One)

Automation and technology

Automation and technology will significantly enhance commercial cricket production by improving efficiency, scalability, reducing costs and increasing sustainability. The cricket industry is limited by lack of automation throughout production systems, systems that are available are expensive, or limited in the ability to manage the entire production process.

Many producers purchase 'ready-made' systems available from other industries and adapt them to cricket farming. For example: using a temperature and humidity control system from the horticultural industry or sifting and drying equipment from the food industry.

Aspire Food Group is leading the way when it comes to automation.

Aspire Food Group - Canada

Aspire Food Group opened a world class, fully automated cricket production facility in 2022, based in Canada. Aspire's innovative farming systems utilise vertical farming, automation and data-driven management to efficiently produce high-quality cricket protein.

Aspire have designed a production system that can rapidly scale through leveraging robotics, using automated storage retrieval systems (ASRS), data analytics and continuous improvement through machine learning. To date, over \$US 40m investment has been secured by Aspire to build and operate their high-tech cricket farms in the United States, Canada and Africa.

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Figure 8 Aspire food - high tech, automated, vertical cricket farming operation (Source: Aspire Food Group)

Markets

The initial premise of the value of cricket protein was as a sustainable, nutritious ingredient suitable for a range of consumer products. The global insect food market is forecast to be \$3,751 Million USD by 2032. This figure includes insects for both food and feed and reflects a market growth of 1304% within the 10 years from 2022. Crickets fall into the 'Orthoptera' insect family.

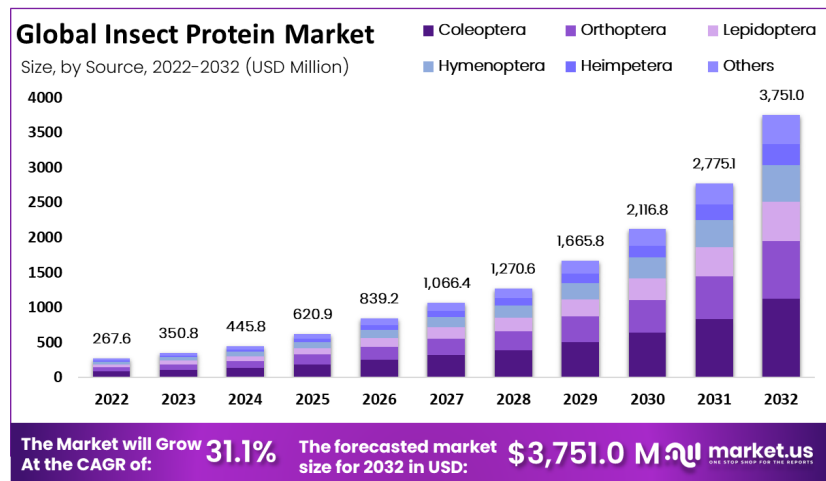


Figure 9 Global Insect Protein Market 2022 - 2032, \$USD m (Source: Market U.S.)

The early traction of insect protein was typically in the health food segment e.g. protein bars, balls and protein powders. Companies could vertically integrate product development into their company operations or supply of bulk protein powder to existing Fast Moving Consumer Goods (FMCG) manufacturers.

As with many novel ingredients like acai, chia seeds, matcha, the onus for developing customer awareness and demand for their product, lies with the business itself. It is important for ingredient producers to understand the customer market, their wants and needs and how to best position their product in a crowded market.

Whilst the nutritional and sustainability claims behind cricket protein were well documented, in my experience, the biggest challenge was the market readiness to accept insects as an alternative protein source. This is especially difficult in Western societies that do not have a cultural history of entomophagy.

2014 Nuffield Scholarship Alumni, Dan Richards (Humpty Doo Barramundi) sums up the modern consumer landscape as follows:

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“I think a fundamental challenge to the development of any new protein source in the first world is that we have never had more choice, food has never been more affordable relative to our incomes. So, selling on nutritional value alone is difficult when we don't need more protein or calories. We also have individual identities that are tied up with what we eat, "I'm a vegan, Carnivore, pescatarian, etc.” That have more to do with identity, philosophy than anything else. The consumer is selfish so they will eat it if it is tasty, much cheaper, enables them to virtue signal or perhaps just be novel”.

This quote exemplifies the challenges of introducing and gaining traction within such competitive consumer brand and identity segments. How does a small-scale start-up cut through the noise of health claims and big company branding? It's extremely difficult.



Figure 10 Site visit: Humpty Doo Barramundi, Dan Richards 2014 Nuffield Australia Scholar with author, Paula Pownall - Grubs Up (Source: Author)

As part of my Nuffield Scholarship, I was able to interview Singapore based investor, Paul Teng about his views on the potential market opportunities for insect protein companies. Paul suggested that to attract further investment, and subsequently achieve market penetration, the industry needed to consider the following:

- Traceability: *How clearly are you able to communicate the provenance of your product to the consumer i.e. “paddock to plate”*
- Sustainability: *How will you support your “clean, green and sustainable” claims?*
- Security of Supply: *Can you produce your product consistently at volume, all year round?*
- Branding *What is your point of difference? Why should I buy your*

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product?

- Integrity *Tell us about why your business is great. Do you have an R&D strategy? What about your quality systems? Your staff? Your environmental policy?*
- Value proposition *What should investors expect in return for their investment? Why should they invest in your company over others?*

An alternative business development strategy is to identify commercial opportunities for niche or high value products i.e. in cosmetics or nutraceutical applications. An example may be the extraction and refinement of chitin, the compound found naturally in the exoskeletons of crickets that has multiple uses in cosmetics and industrial applications. Paul Teng also saw this as a potential way forward for the insect industry to survive and thrive.



Figure 11. Potential Applications of Insect Chitin (Source: Insect Academy)

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Market supply and demand

Demand for crickets is driven by both the nutritional benefits and the need for the food industry to find sustainable ingredients for food products based on consumer demand and the growing global population.

Market supply and demand continuously evolve, and my research has identified three significant changes in the cricket protein market:

1. Prior to 2013: Limited awareness and niche market
2. 2013 to 2020: Growing interest and initial expansion
3. 2020 – Present: Technological advances and mainstream acceptance

Prior to 2013: Limited awareness and niche market

Prior to 2013, Cricket farming was primarily small-scale, often operated by niche enthusiasts and smaller enterprises focused on animal feed and exotic pet markets (van Huis, 2013).

2013 to 2020: growing interest and initial expansion

The report, "*Edible insects, Future Prospects for Food and Feed*" (van Huis, 2013) helped catalyse interest and growth in this sector globally and brought widespread attention to the potential of edible insects, including crickets.

Start-ups emerged and attracted investment, funding and development of regulation and research. Awareness of cricket protein as a sustainable and nutritious alternative grew.

Early adopters, including health enthusiasts, athletes, and environmentally conscious consumers began to drive demand. Cricket-based products like protein bars, powders, and snacks started appearing in specialty stores and online markets.

Present: Covid-19, technological advances, and mainstream acceptance

The COVID-19 pandemic significantly impacted the supply and demand in the cricket protein industry. Before the pandemic, companies like Entomo Farms (Canada) had enough demand for cricket protein powder to export to over nine countries. Post pandemic, demand declined across the globe impacting sales and viability.

The factors driving this change included:

- Increased import/ export costs due to government regulations.
- Higher production costs.
- Increased costs imposed by importing countries.
- A shift of perception of cricket protein as a human food.
- Value-adding companies could no longer afford to produce value-added insect products, such as protein bars, due to rising ingredient costs.
- Decreased consumer demand as a human food ingredient.

Paradoxically, this period saw an increase in automation systems and advancements in technology, leading to an increase in supply of cricket protein.

Regulatory approvals in various regions also matured with the COVID-19 pandemic underscoring the need for resilient and sustainable food systems.

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Case Study: United Kingdom lifts ban on edible insects

In July 2022, the United Kingdom government lifted the ban on crickets as a novel food. The Food Standards Agency (FSA) recognized the need for transitional measures to allow edible insects to remain on the market while formal approvals were processed. This regulatory change was necessary after the Brexit transition period initially led to the ban on these products. By October 2022, legislation was in place to provide temporary relief for the industry until the end of December 2023, allowing companies to continue trading edible insects while awaiting final approval (Horizon Edible Insects, 2021).

Mainstream acceptance can potentially be quite misleading. While media and insect protein companies often highlight a high demand for insect protein and related products, my personal experience with my own business suggests otherwise. Online sales tend to be one-time purchases with few repeat customers. Additionally, demand from wholesale clients such as protein bar manufacturers, is limited. When inquiries are made, the price point for insect protein is significantly higher compared to alternative protein sources.

Companies like Entomo Foods and Aspire Food Group, both of which produce substantial quantities of crickets, are shifting their focus to the animal feed market to address potential challenges of market oversupply.

Marketing

Edible insects need to be marketed in a way that highlights their nutritional benefits, sustainability advantages, and reduces fear of the unfamiliar.

Overall, to improve the perception and acceptance of edible insects, efforts should focus on education, effective marketing, and gradual integration into common food products.

Insect companies have made a conscious effort to move away from the images of whole crickets that dominated the media in the early days of the commercialization of insect-based foods. It was also necessary to challenge the perceptions that eating crickets was something 'dangerous' or to be feared as was promoted on shows like 'Survivor'.



Figure 12 Common images used in early media reporting crickets as food (Source L to R: Foodgressing, 2017, Exoprotein, Goncalves, A, 2020).

Below are some examples of more positive representations of insect-based consumer food products. Early adopters focused heavily on the health food market. Later, attempts were made to integrate cricket protein into 'everyday' items like bread, chips and pasta to 'normalise' cricket protein to a broader range of consumers.

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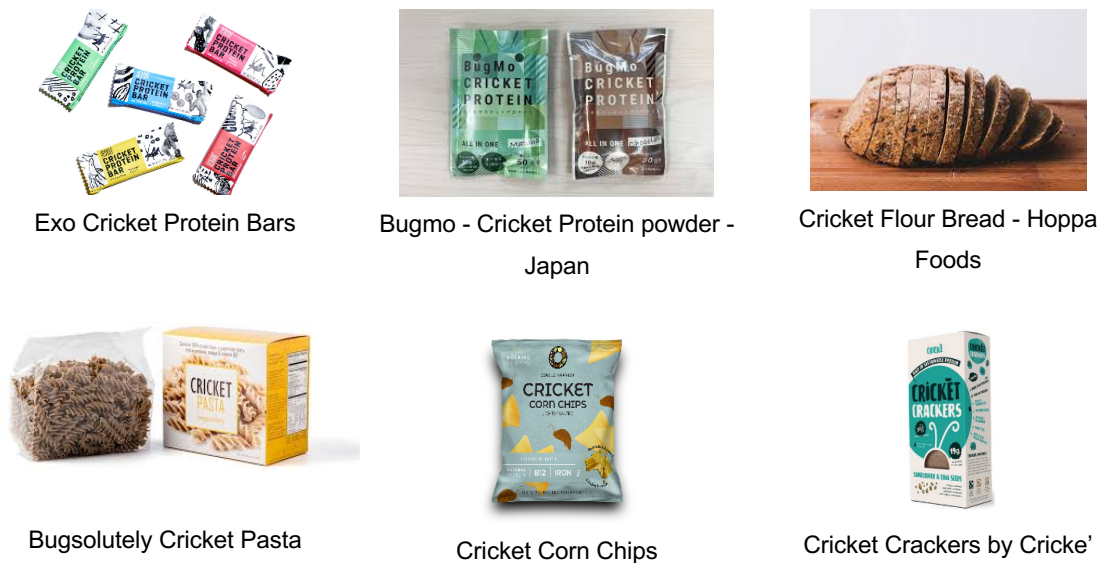


Figure 13 Commercial cricket protein-based foods (Source: L-R: Top Row: Exoprotein, Nutraingredients, Hoppa Foods, Bottom row: Busolutely, Circle Harvest, Food Market)

Whilst branding and messaging are important in gaining the attention of consumers, there are many other considerations for start-up businesses when trying to develop a product and a market.

“You can promote a product before you have much of it, this can create hype and potentially low volume, high value sales, although you risk creating frustration if the expectation you have created can't be delivered upon. If you have technical or biological production and scaling issues people will think you are all hype. You can't develop significant actual sales markets until you have reliable supplies of consistently available, consistently safe products that you can produce at below the market value - i.e. make a profitable and sustainable business”.

Dan Richards, CEO - Humpty Doo Barramundi /Nuffield Australia Scholarship Alumni

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Education and awareness

Education to consumers is crucial for any business, especially those in alternative or emerging markets. In Western countries, the main barriers to acceptance include feelings of disgust, association with disease or spoiled food, and neophobia (fear of the new) (foodnavigator.com, 2020).

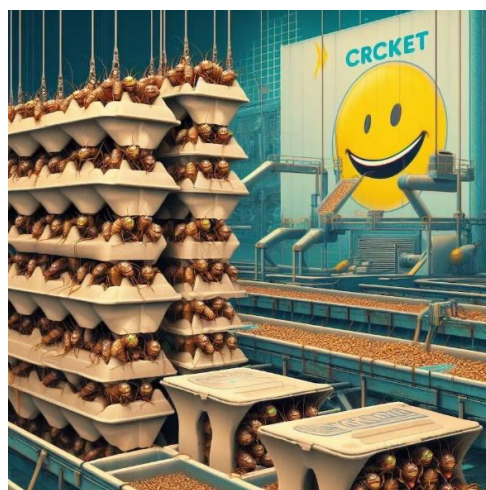


Figure 14. Fear Mongering around industrialisation of insect farming (AI generated image- Corporate Knights) (Source: foodnavigator.com)

Education is paramount to the success of edible insects, and the role of education is often the responsibility of stakeholders like insect producers.

Small-scale insect startups often invest countless hours in educating the public through interviews, events, and seminars, often with little or no immediate financial return. They undertake these efforts to raise awareness and increase understanding of the benefits of insect products.

Schubugs (Australia) emphasises transparency in their cricket farming business. They actively share their farming processes through blogs, YouTube videos and social media. This has allowed them to build a following as well as educate the public and challenge myths about cricket protein. They also make their business policy manual available for download on their website, detailing how they conduct their operations.

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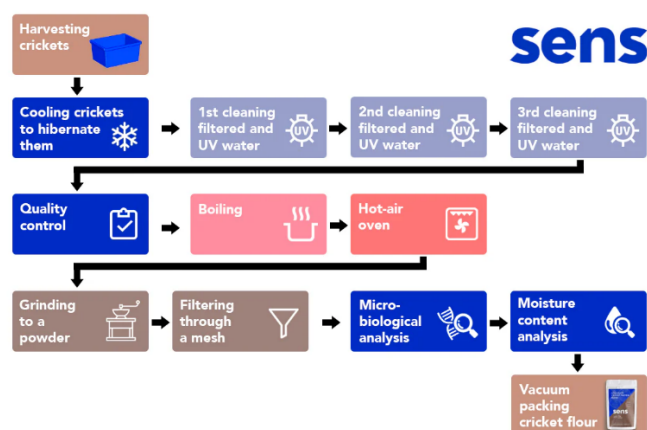


Figure 15 Process flow diagram - Cricket harvest & processing - SENS Cricket Farms (Source: Sens)

Another example is that of SENS, a German cricket protein producer who have communicated their post-harvest processing methods clearly on their website. This approach effectively builds consumer trust and demonstrates a strong example of how to market a brand that is growing and targeting its long-term market goals.

Another perspective on the acceptance of novel foods is to look for contemporary examples e.g. sushi. Sushi's journey to mainstream popularity in Western society is a fascinating example of cultural adaptation and acceptance.

Case Study: Acceptance of Sushi

Below is a timeline of the long-term acceptance of Sushi:

1948	Sushi was introduced to the United States and other Western countries primarily by Japanese immigrants and returning American servicemen who had been stationed in Japan after World War II. The recipes were adapted to suit Western tastes, with innovations like the California Roll, which substitutes raw fish for avocado.
1980s	The rise of health-conscious eating in the 1980s significantly benefited sushi, as it was perceived as a healthy, low-fat option. This decade also saw an increase in international travel, exposing more people to Japanese culture and traditions. Media representation in movies, TV shows, and cooking demonstrations further popularised sushi
2000's	During the 2000s, there was significant investment in establishing Japanese restaurants offering unique dining experiences, such as sushi trains, which provided a novel way to enjoy the cuisine. Restaurants also made efforts to educate consumers about the cultural significance and preparation of sushi, enhancing its acceptance and popularity.

Education needs to be a collective effort from private industry, government, and research institutions. Domestic examples of this include the '*Australian Insect Industry RD&E plans*' (Nolet, S and Lever, B), 2023) published by AgriFutures Australia in consultation with insect industry stakeholders, and the '*Edible Insects Roadmap*' (Ponce-Reyes, R and Lessard, B,

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2021) produced by CSIRO. These documents provide authenticity and legitimacy to the insect industry and offer a strategy for future collaboration opportunities to grow the industry.



Figure 16 Australian Insect Industry Reports (Source: L to R: Agrifutures Australia, Agrifutures Australia, CSIRO)

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Regulations and market approvals

Food manufacturing and marketing guidelines and standards are well documented for most commercial products. However, when introducing a novel ingredient such as cricket protein, producers can run into barriers with existing, or non-existent regulations. For example, food regulations often report how to exterminate or minimise the inclusion of insects in your products.

The highest barrier to entering the commercial cricket market for human food is regulatory approval. Navigating the complex and varying food safety regulations across different countries can be a significant challenge for new entrants in the market. This involves ensuring that cricket-based products meet stringent health and safety standards, obtaining necessary certifications, and complying with labelling requirements (Van Huis & Tomberlin, 2017).

Regulation needs to be considered in two parts:

1. Regulation relating to production and biosecurity, and
2. Regulation about the safe consumption of edible insects.

Individual insect businesses need to work closely with the government to ensure effective, and appropriate regulation is implemented.

Europe

Europe has the strictest regulatory framework for edible insects largely due to its past experiences with food-related diseases, such as mad cow disease. This rigorous approach aims to ensure food safety and prevent similar outbreaks in the future.

Insects are regulated as a novel food and the European Food and Safety Authority regulates this. The International Platform of Insects for Food and Feed (IPIFF) work closely to co-produce these regulations.

United States of America

The US Food and Drug Administration considers insects food under the Food, Drug, and Cosmetic Act. As food for humans, insect rearing must be conducted under Good Manufacturing Practices (GMPs) addressing the food to be clean (i.e. no filth, pathogens, or toxins), and properly produced, packaged, stored, transported and labelled. Insects produced for animal feed cannot be consumed by humans. If an insect-derived food is used as an ingredient, it is considered as a 'food additive' and requires authorization. An exemption is granted if the producer can demonstrate that it has previously been recognised as "food-safe" i.e. Generally Recognized as Safe (GRAS) compliant or a Food Additive Petition, FAP has been completed (Lähteenmäki-Uutela, Marimuthu and Meijer, 2021).

Australia and New Zealand

Food Standards Australia and New Zealand (FSANZ) regulate the use of insects as food. Insects are not considered a novel food, however insects produced for human food are considered a medium food risk business and need to comply with individual state Health Department guidelines. The Insect Protein Association of Australia (IPAA) has guidelines available only to its members concerning best practices in insect farming.

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Thailand

As the largest producer of crickets for consumption in the world, Thailand has standards that dictate the feed, water, animal health, and environmental requirements for cricket farming, as well as the necessary components and record-keeping required. These can be found in the Good Agricultural Practices for Cricket Farm, Thai Agricultural Standard 8202-2017. These regulations came about to increase cricket food exports, particularly to the European market (Lähteenmäki-Uutela, Marimuthu and Meijer, 2021).

International collaboration

Discussions with producers in Canada, the United States, Germany, and the United Kingdom revealed that effective regulation needs to be well-informed and supportive of the industry. For the edible insect industry to become commercially viable, there must be a clear, collaborative, and consistent exchange of information between producers, policymakers, and across countries.

Pest species

Pest species are an important factor when considering producing insects with each country and state having different regulations insects are permitted to be produced.

In Australia for example, producers are not permitted to produce the Australian Plague Locust, as it is considered a pest species and threat to Australian Agriculture.

Indigenous foods

Indigenous foods are bound by approvals and regulation not only from government, but also through the indigenous community/ organisation within the area of where the native food is grown. Native foods are culturally significant for their medicinal qualities, traditional knowledge, storytelling, and connection to the land and people.

The CSIRO report '*Edible insects: A roadmap for the strategic growth of an emerging Australian industry*' identified 60 native insect species traditionally consumed by First Nations Peoples of Australia (Ponce-Reyes, R and Lessard, B, 2021).

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Investment, Incentives, and support

The commercial insect farming industry has attracted substantial venture capital in recent years with several insect farming startups having raised significant funding to support their operations and scale up efforts (Nolet and Lever, 2023).

Insect farming's ability to attract venture capital investment is unique relative to many other emerging agricultural industries. While attracting venture capital presents opportunities for innovation and growth within the industry, it also introduces competitive dynamics that are not typically observed in traditional farming sectors. Rather, this makes the industry more like industrial manufacturing. For example, in addition to competing for capital itself, producers are incentivised to protect intellectual property, creating barriers to collaborative research efforts. Moreover, the competitive dynamics arising from venture capital investment can create barriers to entry for new entrants to the industry. As certain insect farming companies succeed in securing substantial funding and scaling their operations, they establish a competitive advantage over potential newcomers that lack the relative resources and scale to enter the market and compete effectively (Nolet and Lever, 2023).

Investment

Despite the hype and attention, the investment received by alternative protein companies is still significantly less than other food-related innovation businesses (Admassu et al., 2020).

In 2021, I had the opportunity to interview Gerald Chia from New Protein Capital, who has been facilitating investments in the global insect industry since 2013. During our discussion about the state of investment in the insect sector, Gerald shared several key insights.

- **Preference for waste management systems:** Investors show a preference for insect bioconversion technologies i.e. black soldier fly larvae.
- **Understanding the industry:** Investors need to be educated on the insect industry including risks, rewards, research and governance.
- **Cautious investment approach:** Lack of clear policy and regulation for both human food and animal feed creates caution amongst investors.
- **Drivers of investment:** Technology advancements and protein development are primary drivers for investment in this sector.
- **Rising interest from Superannuation Companies:** Superannuation companies are investing in alternative agriculture sectors.
- **Shift to plant-based proteins:** The early-stage, high-valuation investment phase for insect-based businesses has passed, with early-stage investors now shifting their focus to plant-based proteins.
- **High cost of infrastructure:** Engineering and automation infrastructure for insect farming require large amounts of capital to scale.
- **Government support:** Successful cricket farms often receive government support through ag-tech initiatives, tax incentives and labour incentives.

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- **Collaboration for success:** Successful companies collaborate closely with research organisations, industry groups, and government entities.

These insights underscore the importance of understanding industry dynamics, regulatory landscapes, and the critical role of technology and government support in the growth and success of the insect farming industry.

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Incentives and support

In an emerging industry such as insect farming, government support is critical to establish the credibility of the sector and support long term growth and sustainability.

This can come in a range of forms:

- development of regulatory guidelines and policy documents.
- investing in research and development.
- grant funding; and
- tax incentives.

Almost all successful commercial insect farms have utilised government incentives to increase production and development.

The most popular and effective funding from the government is via co-funding, or “matched” funding with businesses. These grant programs are typically highly competitive, and applicants are required to align with government objectives, such as innovation, research and development, or sustainability.

Canada

The Canadian government offers incentives for innovative and sustainable agricultural practices including co-funding and tax incentives.

Aspire Food Group chose Canada for its new facility due to the supportive regulatory environment, strong agricultural sector, government incentives, research & development (R&D) capabilities, skilled workforce, market potential, sustainability initiatives, and logistical advantages. These factors collectively created an ideal setting for Aspire to innovate, grow, and succeed in the edible insect industry.

United Kingdom

The United Kingdom (UK) government supports the edible insect industry through a combination of regulatory guidance, funding and grants, research and development support, sustainability initiatives, market development efforts, industry networking, and digital infrastructure investment. These measures aim to foster innovation, ensure safety, and promote the growth of the edible insect sector, aligning with broader goals of sustainability and food security.

Two examples of such government support are the Innovate UK and the Agri-Tech Catalyst programs.

- **Innovate UK** is an agency that provides funding for projects that drive innovation in the food and agricultural sectors. Grants and competitions support research, development, and commercialization of new insect-based products.
- **Agri- Tech Catalyst** offers grants for collaborative research and development projects between business and research organisations to bring new agricultural technologies, including insect farming to market.

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Thailand

Most notable government support comes from international collaboration and networking. The government supports tradeshows and events to promote its edible insect industry. This helps Thai businesses connect with global partners, explore new markets, and stay updated on international trends and standards.

Australia

The R&D tax incentive is the most effective support to insect businesses. This allows the business to scale, whilst allowing a tax offset for any research and development carried out by the business.

Case Study: R&D Tax Incentive

Luke Wheat from Future Green Solutions (rebranded as Arvela in 2023), was interviewed in December 2020. Future Green Solutions farm black soldier fly larvae on agricultural waste streams, producing insect protein for pet and animal feed as well as frass as fertiliser.

Key Takeaways from this interview include:

- Building and equipment infrastructure was 'off-the-shelf'.
- The company chose not to invest in developing their own insect farming technology IP.
- Working with universities to research the health benefits of larvae oil
- Raised private investment in 2019 to establish a commercial premise.
- Heavily relied on the Australian Taxation Research and development funding.
- Employs university students/interns.
- All infrastructure and production currently based within a university research facility.

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Challenges

There are many challenges when it comes to producing insects at scale for the human food markets.

- **Regulatory Compliance**

- The maturity of the regulatory framework for insects as feed is a contributing factor to the rate of growth and adoption in the broader consumer markets. Across Australia and the world, regulations can vary from states and territories.
- e.g. many cricket farm start-ups in Singapore cite that they were forced to close their operations due to the tardiness with which the Singapore government was able to develop regulatory guidelines allowing the use of crickets for human food (Tan, C, 2024).

Frustrations mounting among
companies selling insects as food as
SFA delays approval



Crickets being harvested for R&D in a pilot farm by Future Protein Solutions. PHOTO FUTURE PROTEIN SOLUTIONS

Figure 17 Straits Times (Singapore) article on cricket startups (Source: Tan, C).

- **Consumer Acceptance**

- It is imperative to understand the current public perception of insects as food and what actions might need to be taken to overcome these (if negative).
- It is critical to know 'who' your customer is and what drives their purchasing decisions. Are you going to sell directly to customers (B2C) or to other businesses (B2B)? Both options require a well-articulated value proposition.
- Crickets must be identified as a potential food allergen as they contain chitin, a chemical compound found in the exoskeleton of insects and shellfish. This must be considered carefully when developing and marketing new products to market.

- **Operational and Technical Considerations (inc. skills & capabilities)**

- There is currently no training pathway in Australia to become an insect farmer. This means that to start, you need to be highly motivated and self-directed to learn the skills required to breed, grow and manage the

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farming processes. Similarly, developing a skills pipeline to support a growing business is an important consideration.

- Similarly, there are few industry experts to support insect farming and production. Poor advice may lead to costly trial and error.
- How scalable is your business? If you received an order for a large volume, would you be able to fulfil it - in full and on time? If not, why not?

- **Environmental**

- Whilst the environmental sustainability credentials of cricket farming have been well documented, there are other environmental considerations that pose challenges to farmers. These include biosecurity risks: pests and diseases can decimate cricket colonies very quickly, risk of escape of live insects into surrounds etc.

- **Financial Risk**

- Any new business must be fiscally responsible with regards to loans/debt management and cash flow expenditure. Standard best business practice applies and needs to be carefully considered across all aspects of the insect farming activities.
- The retail price for cricket protein is \$90 per kg compared to dairy derived whey protein at approximately \$50 per Kg. Cricket protein needs to retail at a lower price, and or be marketed differently to become competitive. Cricket production systems need to decrease production costs through increasing efficiencies including automation, to bring the retail price down.

Case Study: Business closures

Leap Protein (Victoria) and Grilo Protein (NSW) both relied on imported cricket powder to produce value-added cricket products such as protein bars and protein powder. Despite achieving some retail success, both businesses closed in 2020.

Grilo Protein had significant media exposure including a feature on ABC Tv's "Landline" program, so why did they close?

Grilo Protein's primary distribution channels were fresh food markets and health food shops, both of which were heavily impacted by COVID-19. Combined with increasing cost of organic ingredients and production, the company could not remain viable.

Leap Protein had a limited product range sold to a limited customer base. As an emerging small company, once external factors such as Covid-19 emerged, the business was no longer economically viable.

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Opportunities

National Vision

The aforementioned Insect Industry reports published by AgriFutures Australia and CSIRO forecast that by 2030, the insect market in Australia will be worth over \$100 million for animal feed alone. AgriFutures Australia identified the insect industry as 'emerging' and supported its Australian Insect Industry RD&E framework with \$2m of funding over 5 years.

The CSIRO Edible Insects Roadmap was the result of a 2-day seminar in late 2019 where over 50 participants, government agency representatives made up most attendees. Some participants viewed the roadmap as lacking industry connections and production pathways for future growth.

The "Protein Market: Size of the Prize" publication, Food Innovation Australia Ltd report (FIAL, 2020), stated that although insects as alternative proteins are the fastest growing protein market, by 2025 insects will still make up less than 1% (A\$1.3 billion) of the total value of the global protein market.

Retailer acceptance

Major supermarkets have shown interest in stocking insect-based products demonstrating a basic understanding of the nutritional benefits of insects.



Figure 18 Retail cricket-based products (Source L to R: Circle Harvest, Grilo Protein, MasterChef Australia)

In the 2021 Australian MasterChef series, contestants were offered roasted crickets as an ingredient for one of their cooking invention rounds. This high-profile event demonstrated the adaptability of cricket protein to include desserts.

Despite there being few cricket based human food products available in the Australian market in 2024, there are still commercial opportunities in pet food. Below are some examples from TBH Pet Foods and Good Country Hemp.

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Figure 19 Cricket based pet food products – Australia (Source L to R: Habitat Pet Supplies, Good Country Hemp)

Education

Education organisations have an increased focus on sustainable agriculture and alternative food sources during the pandemic. In 2021 National Science week focus was “Food by Design”. Grubs Up had enquiries from all over Australia to provide information sessions on insect production and agriculture, which in turn provided over 30% of our annual revenue that financial year.



Figure 20: Education packs (Source: Circle Harvest)

Although speaking engagements are not part of the core of our business, it has highlighted an opportunity for agricultural education and awareness along with the need to share the story of alternative protein products. Circle Harvest has also achieved traction through their education programs (Circle Harvest, 2024). More research is needed on the return on investment into the education space.

Potential future opportunities

Alternative Market Segments

When establishing Grubs Up there were many potential opportunities to enter the animal feed market. We soon learnt that we did not have enough product to supply the animal

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feed market and chose to remain focused on the human food markets. We assumed the Body Building market would be our largest market, however to date, Cricket protein remains limited within this market, due to the price point, taste and texture. We learnt very early on how important it is to listen to not only existing customers, but also to be open to other potential market opportunities.

Contract farming

Many farmers are interested in an alternative enterprise business model to complement and diversify existing farming businesses. Cricket farming lends itself to being an activity that could supplement an existing farm or offer a small-scale operation as a source of income. There are several co-operative, distributed type cricket farming models overseas that demonstrate the value of aggregating small volumes to secure better prices and larger contracts.

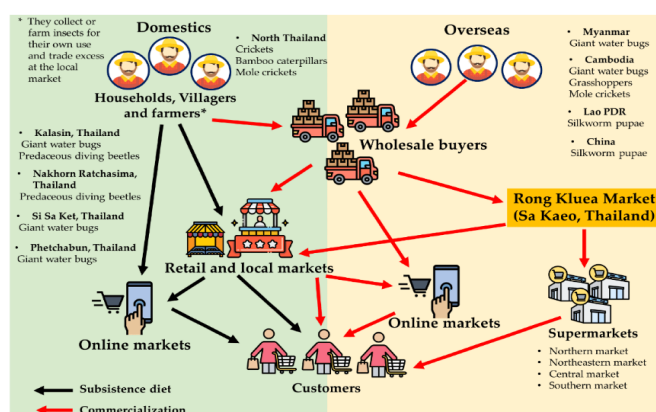


Figure 21. Diagram of cricket farming co-operative in Thailand (Source: Krongdang)

Closer to home, Southampton homestead pasture raised poultry, based in Southwest Western Australia approached us with a request to design an insect growing system that is synergistic to day old chickens hatching, to provide them with specific nutrition. The systems would complement each enterprise, and the outcome being healthier chickens and a market for the crickets.

These systems could be designed to be modular and replicated based on small insect farming systems overseas. The price point for the end product would need to be significantly lower than \$2 dollars a kilo to be a cost competitive substitute for traditional protein sources e.g. soy.

Growth through acquisition

There is also the potential to recover the brand value and intellectual property via acquisition of early-mover companies who were unable to remain viable. This may include buying product recipes, customer databases and supply chains that can be reactivated when the consumer market for cricket-based products matures.

Nutraceutical Products

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Crickets contain biological products that can be isolated and marketed to alternative industries including cosmetics and nutraceuticals. This includes specific proteins, chitin and VitB12.

Conclusions

Insects are a sustainable alternative protein that can be utilised for not only food and feed, but also food waste bioconversion. It is an attractive solution to the increasing demand for food and resources given the forecast population increase of 9 billion people by 2050 (van Huis, 2013).

There are multiple growth opportunities within the emerging insect industry, however there are a range of factors that should be considered before embarking on a new venture.

Selling cricket protein on its nutritional value alone is not enough; the product needs to tell a story, provide value for money and meet the perceived 'needs' of the consumer.

Though there is considerable consumer demand for cricket protein, cost of production, supply volumes and regulatory standards are impediments to growth. Automation and skills development may help lower future costs of production.

Governments and industry need to continue to research and develop policy, regulations, and incentives to support the industry. This includes working collaboratively to ensure cricket production systems operate in accordance with regulatory guidelines and consumer expectations. Similarly, support via grant programs and tax-incentives are critical to the success of early-stage insect start-ups.

Globally, successful insect businesses have demonstrated a strong understanding of market drivers, culture, customer relations, leadership, productivity and innovation.

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Recommendations

The edible insect industry both at a national and international level needs to develop and build markets whilst ensuring key stakeholders along the supply chain are proactive, collaborative, transparent and supported by the government.

Finance and Marketing:

Individual businesses need to understand short- and long-term financial obligations when participating in the edible insect supply chain. This includes understanding which markets will be most receptive to their products, the value proposition of your product and the margins needed to make and market a product successfully.

Businesses need to demonstrate transparency and good governance. Consumers don't buy a product; they buy the story and the brand. Edible insect products need to solve a problem. Education of financial institutions, including investors is also a key factor for the future growth and success of the edible insect industry.

Research & Development:

Desktop research and research that does not directly support industry, is insufficient to ensure success. Markets need to be actively developed in collaboration with industry and research organisations to effectively identify and supply current and future markets.

Government Support:

Government incentives such as matched funding for production, food safety and policy development is critically needed. Incentives such as the R&D Tax incentive are vital to support the emerging players within the industry.

Collaboration:

Key stakeholders including IPAA, Food Standards Australia, and AgriFutures Australia need to continue to work together, in order for insects to be commercially viable into the future. Collaboration between producers, ensures the industry scales.

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