



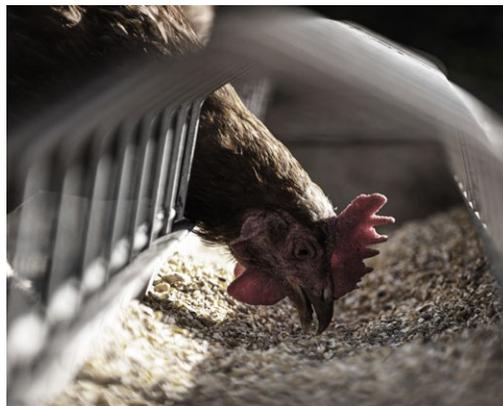
NATURAL PRODUCTS CANADA



GAME CHANGERS



Canadian movers and shakers in the burgeoning industry of insects as food and feed.





ABOUT THE AUTHOR

Natural Products Canada

Natural Products Canada (NPC) is the not for profit corporation behind Canada's Natural Product Innovation Cluster—a strategic and diverse community focused on the development and commercialization of naturally-derived products and technologies in health and life sciences, natural resources, agriculture and agri-food, and sustainable bioproducts.

NPC has identified insect protein as a potential area of growth for Canada, and has initiated several events, reports and other initiatives to address the needs and challenges of Canada's emerging insect industry. It has directly supported several Canadian insect companies through its Commercialization Programs (Oberland, Aspire, Entomo, and Entosystem) and many more through its advisory and other services.

Research Methods

Information for this report was obtained through publicly available data including company websites and media coverage, as well as in-depth interviews with various academic and industry experts in the Canadian insect industry (as listed in the acknowledgement section). While every effort was made to capture relevant data from across the country, the nascent nature of the companies, organizations, and the industry itself mean that some stakeholders may have been inadvertently omitted. As one of the aims of this report is to document the status of Canada's insect industry, we welcome any additions or clarifications that can improve the accuracy of the data.

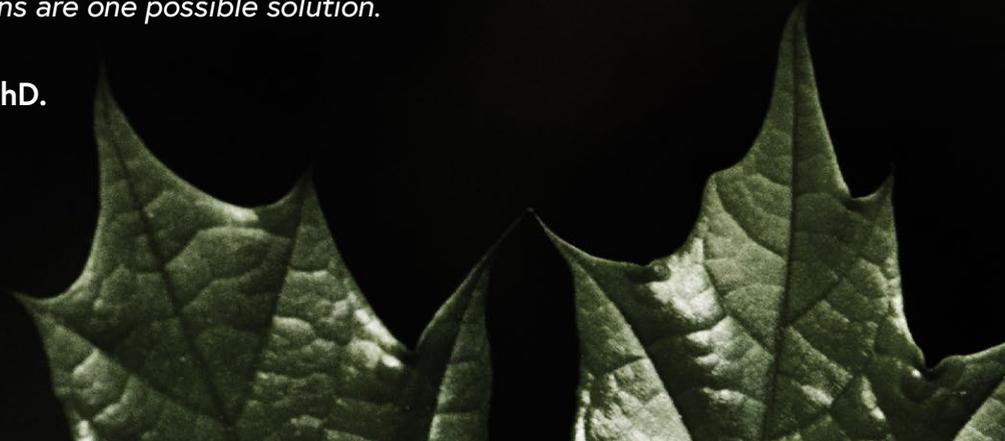
INTRO

The idea of introducing insects into the human and animal food chain is increasing in popularity. Insect production is gaining credible traction in discussions around the need for sustainable protein to meet the growing demands of the planet. Critical food production issues—food security, food waste, human nutrition, risks to traditional food production, the environmental impact (water, energy, etc.) of current food systems—are all cited as potential reasons to incorporate insects as food and feed.

While the custom of consuming insects is more traditional in regions such as Asia, South America, and Africa, there is growing interest in the potential of insects to sustainably address the growing 'protein crisis' in other parts of the world. Europe, for instance, has some of the largest and most well-funded insect companies such as Ÿnsect, Protix and Entocycle, as well as a strong industry association dedicated to obtaining regulatory and public support. On June 1, 2021, the EU took the unprecedented step of approving insects as a novel food, and industry analysts are predicting a significant uptick in people-focused insect products on shelves over the next year or so. And later in 2021, insect frass was added to the EU category of approved agricultural fertilizer with the same criteria as animal manure.

There's a considerable challenge to meet the food production demands for 9 billion people, the FAO's global population projection for 2050. It is imperative to find alternative and sustainable sources of protein, both for direct human consumption and for animal feed. Insect-derived proteins are one possible solution.

Grant Vandenberg PhD.
University of Laval



The recent uptick in interest and investment—both in Canada and around the world—indicate the substantial opportunity that lies ahead of this young industry. As with any emerging opportunity, the insect industry will significantly benefit from increased technology adoption, clear and swift regulatory frameworks, market acceptance, supply chain efficiencies, and research.



In Canada, insect-based companies and products have been making significant moves. For instance, Loblaw's—the largest grocer in the country—put their own brand of insect protein powder on shelves in 2018, and the Canadian Food Inspection Agency made various announcements permitting the use of insects in poultry, hog and aquaculture feeds.

Pioneers in Canada's insect industry like Enterra and Entomo Farms are seeing more and more new entries join them in this field. Now more than two dozen insect companies—both insect producers and those creating insect-based products—exist across the country. And investment is following suit. While still lagging behind Europe, in the last couple of years Canadian companies like Enterra, Entomo Farms, Entosystem, and Aspire have attracted multi-million-dollar investments from government and private investors, many of which are outlined in the Newsmakers section of this report.

The recent uptick in interest and investment—both in Canada and around the world—indicate the substantial opportunity that lies ahead of this young industry. As with any emerging opportunity, the insect industry will significantly benefit from increased technology adoption, clear and swift regulatory frameworks, market acceptance, supply chain efficiencies, and research.

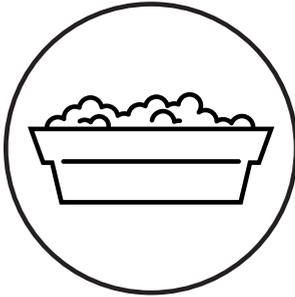
This snapshot provides a look at this emerging opportunity, and the key Canadian players who are poised to bring it to fruition.

THE OPPORTUNITY

The driving force behind much of the interest in insects is environmental sustainability and food security. Insects are touted for the efficiency with which they can produce valuable nutrition—namely protein but also healthy fats, fibre and other nutrients. Compared to beef, poultry, hogs or fish, sustainably-raised insects have a better feed conversion ratio; require less water, land and feed; create fewer green house gases (GHG) with a minimal physical footprint. Insects are part of the growing interest in a circular economy as many may convert pre-consumer byproducts from food and agricultural production into a valuable source of feed for poultry, fish, pets and humans.

As with other indoor controlled growing environments, insect production also helps to address food security concerns as it can produce a steady supply of protein for both humans and animals despite weather-related phenomenon. Thriving on a range of feed sources including pre-consumer byproducts from food and agricultural production, sustainably reared insects do not compete for feedstocks such as corn or soy. More broadly, as a regionally-produced alternate source of protein, they reduce the risk on the entire food supply chain in the event of an unexpected interruption such as the closure of meat processing plants during COVID or the delay in delivery of supplies around the blocked Suez Canal earlier in 2021.

The opportunity for the insect industry across both the human and animal food chains can be divided broadly into the following categories:



Production Animal Feed

A variety of fish and animals consume insects as part of their natural diet so it's not surprising that many species of insects provide a highly digestible source of nutrients, including protein. Poultry and hogs are primary markets. In Canada, Black Soldier Fly meal (defatted protein meal mechanically extracted from the whole larvae) has shown positive dietary benefits, and is approved for inclusion in feed products.^{i,ii} Cargill, a global leader in agriculture and feed, has announced significant interest in insects as feed and recently inked a deal with InnoVaFeed for the use of insect oil in piglet feed.ⁱⁱⁱ

But the most prominent segment of the feed market may be the growing aquaculture industry. Globally, the practice of raising fish and seafood for human consumption is a \$264 billion industry.^{vi} In Canada alone, it's valued at \$1.2 billion.^v Feed makes up a high percentage (50-70%)^{vi} of both the expense and environmental footprint of aquaculture, so sustainable and cost-competitive options are a priority. Insects can be a good replacement for fishmeal and oil, which have seen rapid fluctuations in price in the last several years due to a range of factors, including inconsistent anchovy harvests. Feed companies like Skretting^{vii} (fish feed division of Nutreco)

and Cargill have been actively pursuing insect-based alternatives.

The challenge for insect producers to meet the needs of the aquaculture and other feed industries is scale and cost. Globally, the annual market for aquafeed is roughly 41 million tonnes.^{viii} Large, fish-feed mills require a steady, reliable production of 3,000 to 4,000 tonnes of insect product per year. Media reports have indicated that even some of the largest producers in Canada can barely produce enough to supply a single fish-feed mill, let alone the entire aquaculture industry, indicating significant room for growth. As a simple protein ingredient replacement, insects are currently difficult to produce at a competitive price. However proponents of the industry cite the added health and nutrition benefits that insects deliver should be factored into overall comparisons. Improved growth rates, improved feed conversion (feed reduction) and improved immune response are just some of the benefits that could create tangible cost-saving advantages. Research on both production improvements and efficiencies, as well as nutritional impacts will be required to address these scale and cost issues.





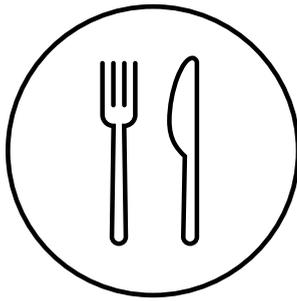
Pet Food and Treats

The pet food industry is worth over \$84.5B globally, and over \$1.7B in Canada alone.^{ix} The environmental impact of pet ownership is a growing concern and one of the key factors behind the interest in insect-based food and treats. Many pet owners are applying the same values they have for their own food (natural, healthy, sustainable, local, etc) to the products they give their pets. The pet food industry has followed suit with a range of products and ingredients, including insects, which are regularly consumed by many pets (dogs, cats, birds, reptiles, etc) in nature.

As with many novel products, insects were primarily introduced to pet food by smaller companies and start-ups. In Canada, Wilder Harrier, Dockside and First Mate, are examples of small companies who were some of the first to incorporate insects into their pet treats and food products. Now, larger companies like Purina, Hagen, and Mars Petcare have introduced full lines of insect-based products.

For insect producers, the pet food industry has a few advantages, the first of which is price. Unlike animal feed, which is commoditized, the pet industry can demand a higher price for its premium products. Sustainably-reared insects are seen as a natural ingredient with significant amounts of bioavailable nutrients such as calcium and fibre (chitin) in pet treats. In addition, unlike production animal feed the inclusion levels and species of insects used in pet treats in North America are less highly regulated and are governed by North American industry standards set by the Association of American Feed Control Officials (AAFCO).





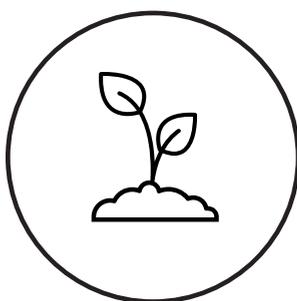
Human Nutrition

Insects also present a viable source of nutrition for humans. Those seeking sustainable 'clean' protein and avoiding traditional animal sources of protein find insects a viable option. Crickets are currently the species of choice as they are a good source of protein, vitamin B12, fibre and iron.^x The clear issue here is consumer acceptance. Overcoming the cultural aversion to eating bugs is not something that will happen quickly, no matter how solid the case for sustainable nutrition may be. However, according to a 2018 survey, Canadians' willingness to consider insects as a replacement for meat is surprisingly high at 10 percent.^{xi}

Although some insect enthusiasts eat whole dry roasted crickets, many consumers will be more amenable to consuming insects when they are an

invisible ingredient. Producers have leveraged this approach by selling insect protein powder that can be added to other foods such as smoothies or baking. Ready-made products containing insect powder include crackers, energy balls and bars, cookies, pancakes and pasta. Small Canadian companies like Naak, Landish, and Earthproof are creating bars and smoothie add-ins with cricket powder sourced from producers such as Entomo Farms. Entomo has also launched its own brand of functional snacks, Actually Foods, a cricket & fava fortified cheese puff.

There is also some interest in other functional attributes of insects such as pre- and probiotic properties, which are under investigation and may at some point reveal new product development opportunities.^{xii}



Soil Health

One of the interesting revenue streams for insect producers is a by-product known as frass (insect excrement and exoskeleton), which shows positive results as a natural soil additive. Insect producers are able to sell the products as a specialty fertilizer in Canada. There are early indications of positive impacts on both plant growth, disease immunity as

well as pest management^{xiii} with the use of frass. At the current time, the limited production capacity makes it an option for small-scale fertilizer needs such as home gardens or greenhouses, but is not yet viable at large commercial scale. However, with increased production capacity from insect producers, greater market penetration of insect frass into agriculture use is predicted.



CANADA'S INSECT INDUSTRY

Currently, Canada has over 30 companies involved in insect production or insect-containing products.



Insect Producers

There are over a dozen insect producers (often called insect farmers) active in Canada, varying in size, insect species and market focus. The companies listed below represent those producing insects for the human, animal feed or petfood markets, which represent the majority of production by tonnage in Canada. There are many other companies producing insects for live feed usually at a much smaller scale.

Insect producers in Canada include:

- Alimentomo^{xiv} (Quebec)
- Aspire Food^{xv} (Ontario facility to open in 2022)
- Enterra^{xvi} (BC and Alberta)
- Entologik^{xvii} (Quebec)
- Entomo Farms^{xviii} (Ontario)
- Entosystems^{xix} (Quebec)
- Grevio Inc.^{xx} (Quebec)
- Intrinsic^{xxi} (Quebec)
- Larvatria^{xxii} (Quebec)
- LesGrillonettes^{xxiii} (Quebec)
- Midgard^{xxiv} (Nova Scotia)
- Neoxis^{xxv} (Quebec)
- Nutrento Inc. (New Brunswick)
- Nutrivore^{xxvi} (Quebec)
- Oberland Agriscience^{xxvii} (Nova Scotia)
- Tarzan Nutrition (Quebec)
- TriCycle^{xxviii} (Quebec)
- YesCrickets^{xxix} (Ontario)

Insect-Containing Products

Most insect producers also develop and market the end products in these areas, whether it be products intended for human, pet or production animals. However, there are several companies that develop products for human or animal consumption—everything from insect protein powder to add to smoothies, to pet food—that rely on insect producers for insect-based ingredients.

These players include, but are not limited to the following:

- 4EverFood
- Actually Foods^{xxx}
- BiteSnacks^{xxxi}
- Catit^{xxxii}
- EarthProof^{xxxiii}
- Entomo Protéine^{xxxiv}
- FirstMate^{xxxv}
- FitCricket^{xxxvi}
- Globe Protein (Grillon le Pain)^{xxxvii}
- HOPE^{xxxviii}
- Landish^{xxxix}
- Latentation Bala^{xl}
- La Mexicoise^{xli}
- Melio^{xlii}
- Naak^{xliii}
- President's Choice^{xliv} (the popular Loblaw's brand cricket-based energy bars and cricket powder)
- Wilder Harrier^{xlv}

¹ Note: This report does not include the many insect producers whose primary product is for bait and/or live feeds for reptiles/rodents.

There's a bit of a chicken and egg issue here for many insect producers. You can't attract a large customer until you can supply insects at low cost. But to do that, you need to produce at large scale in a large facility, and that requires a large customer.

Gabe Mott
COO, Aspire Foods

ORGANIZING BODIES AND SUPPORTS

There are a variety of regional organizing bodies developed to advance insects as food and feed. The North American Coalition for Insect Agriculture^{xlvi} (NACIA) has a mission to encourage positive use of insects in North America. Canadian companies are well served by this organization and represent a significant portion of its membership.

In addition, Quebec has a provincial organizing body, the Association of Quebec Insect Breeders and Transformer^{xlvii} (AETIQ). The Province has recognized insect production as a "new animal production sector" that is included in the provincial agriculture department's tables of agricultural interest.^{xlviii}

In Europe, the International Platform of Insects for Food and Feed^{xlix} (IPIFF) is a very active non-profit organization that represents the interests of the insect production sector towards EU policy makers, European stakeholders and citizens.





Several of the Canadian companies listed earlier have made significant moves in the last couple of years, greatly expanding their capacity to address the demand for insects for human, pet, and feed markets.

NEWS MAKERS



Aspire Food Group is one of the most recent additions to the Canadian insect industry. Its Canadian founders started the business in 2013, and built a thriving cricket-based business in Texas. In 2020, Aspire announced its plans to expand into Canada with a new 150,000 sq ft facility in London, Ontario for which it received \$10 million from Sustainable Development Technologies Canada.ⁱ The company then received \$16.8M from the Government of Canada through the NGEN Superclusterⁱⁱ to work with partners to develop the high tech automation of the cricket processing plant. The facility will open in 2022 and is projected to produce 20,000 metric tonnes of products annually, which will include insect powder for the human and pet markets as well as frass.



Enterra is one of the largest and most established insect producers in the world, originating in British Columbia in 2007. They completed initial R&D from 2007-2012, operated a pilot facility from 2013 to 2014 and a small commercial facility from 2014-2019. During that time Enterra obtained Canadian Food Inspection Agency approvals for swine, poultry, salmonids and tilapia.ⁱⁱⁱ In 2018 they completed funding for the construction of a world class, 180,000 sq ft facility near Calgary, Alberta, which allowed them to increase production capacity of insect based feed ingredients and frass.

Enterra continues to operate the commercial scale SQF-certified facility near Calgary and an R&D facility in British Columbia. In January 2021, the Government of Canada invested \$6M in the project through its AgriInnovate Program.ⁱⁱⁱ



Another Canadian pioneer in the insect industry, Entomo Farms was founded by three brothers in 2014.^{lv} The cricket producers are backed by investors, including Canadian meat giant, Maple Leaf Foods, and their product was used in Loblaw's President's Choice cricket powder, which made headlines in 2018. Their \$3.7M capital raise in January, 2021 helped them expand production in their 60,000 sq ft facility in Norwood, Ontario.^{lv}

Insects were originally thought to provide primarily a sustainability benefit over traditional protein sources, but as we learn about the overall nutritional profile, it's clear that there is a dual benefit – environmental sustainability and great health benefits – Crickets for example have loads of B12, prebiotic fibre, protein and healthy fats – making them nutritionally more complete than both plant based and animal based sources.

Jarrold Goldin

Co-founder, Entomo Farms



Entosystem is a Quebec-based black soldier fly producer focused on the poultry feed market. In February, 2021, they received \$1.6M from Sustainable Development Canada towards the construction of their new 150,000 sq ft facility.^{lv}



Oberland Agriscience was founded in 2017 in Halifax, Nova Scotia by a former NASA scientist. The company raises black soldier fly larvae that are fed with pre-consumer by-products from breweries and other local food manufacturers, and are focused on sustainable production and closing their local food loop. The company received funding from Natural Products Canada in 2019 to conduct a demonstration trial to move from R&D to a commercial facility. With the pilot plant in full production, Oberland is now expanding to a 100,000 sq ft facility, breaking ground in 2022.

GLOBAL

NEWSMAKERS

Outside of Canada, some notable deals and initiatives indicate a growing confidence in the potential of the industry:

-  ADM and InnovaFeed announced plans for what they claim to be the "world's largest insect protein plant" which is set to produce 60,000 tonnes of animal feed protein per year.^{lvii}
-  BetaHatch, a US-based producer, raised \$9M.^{lviii}
-  Next Protein, a significant producer in Tunisia, raised \$11.2M.^{lix}
-  Protix, another large producer raised \$19M.^{lx}
-  The International Platform of Insects for Food and Feed (IPIFF) welcomed the adoption of EU regulations regarding the use of insect frass for agricultural fertilizer, completing the circularity of insect farming.

-  The EU granted approval for yellow mealworm for human consumption^{lxi} paving the way for increased development of insect-containing products for human consumption.^{lxii} Adjacent to this move, Agronutris became the first company allowed to market insects to humans in Europe.^{lxiii}
-  The EU then approved locusts as safe for human consumption, following an application from Protix.^{lxiv}
-  The UK government's Industrial Strategy Challenge Fund (ISCF) earmarked \$12.9 million to help build the country's first large-scale industrial insect farm.^{lxv}
-  Ÿnsect, one of the largest insect producers in the world, closed a Series C investment round in 2020 of \$372M USD.^{lxvi}



You look at another protein industry such as poultry where they've been doing research for over 50 years on every aspect of the process – diet, nutrition, disease, breeding – and they're still doing research. In comparison, the insect industry is just getting started with its research efforts. There is a lot more research to be done to help us reach the level of production efficiencies that we need to make this industry a viable contributor to the global protein supply chain.

Gabe Mott
COO, Aspire Foods

RESEARCH

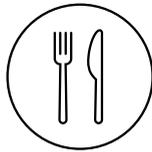
With any new industry, there are growing pains. Things to learn or improve about the product, production processes, market opportunities, customer behavior, regulation and more. The insect industry is no exception. Understanding the impacts of insect physiology, their nutritional content, the impact of that nutrient content on the target feed subject (fish, dog, human, etc), optimal growing conditions, and disease and other health risks have been just some of the areas of research critical to advancing this industry. In addition, sustainable and cost-effective production practises have been a key area of focus as one of the challenges of gaining interest by the traditional feed industries has been the cost and scale of production of insects.

Fortunately, research around all aspects of the insect industry is happening at a rapid pace. Around the world, research related to insects as food and feed has grown dramatically over the last ten years. Significant insect research capacity exists in global institutions such as Wageningen University and Research (Netherlands), and the Center for Environmental Sustainability Through Insect Farming (USA). In Canada, Laval University (Quebec) is active in a range of areas related to insects as food and feed, and recently introduced a chair of leadership in teaching the production and processing of edible insects (Titulaire de la chaire de leadership en enseignement en production et transformation primaire d'insectes comestibles).

University of Laval hosted the international Insects to Feed the World^{lxvii} conference in 2020, which attracted hundreds of insect researchers and enthusiasts from around the world, and is currently in the process of planning for the next event in 2022.

REGULATORY ENVIRONMENT

In Canada, insects are approved for both human and animal consumption, with some qualifications.



HUMAN FOOD/INGREDIENTS

To date, no specific regulations, standards, or guidelines regarding the sale and the production of edible insects (from farming, processing and storage) have been established in Canada. Edible insects produced for human consumption and available to Canadian consumers must meet the same safety and hygiene standards as other foods available in Canada.^{lxviii} Any species may be used, as long as it is clearly indicated on the label. A report by Health Canada in 2018 following an analysis of 55 different insect products available in the Canadian market revealed that *Salmonella* spp. and generic *E. coli* (>100 Colony Forming Units (CFU)/g) were not found in any of the samples analysed and therefore it appears that the edible insects have been produced under sanitary conditions.^{lxix}



PRODUCTION ANIMAL FEED/INGREDIENTS

Regulations around the use of insects as feed for animals can be more complex. Insects (black soldier fly larvae) are approved in certain quantities in feed/feed ingredients for aquaculture, hogs and poultry in Canada. The regulatory approval is based on positive feed trials under careful supervision. For more information on current Canadian regulatory standards contact NPC for our Insect Regulatory Guide.



PET FOOD/INGREDIENTS

Pet food and feed ingredients come under the guidelines of the Pet Food Association of Canada and the Competition Bureau. There is currently no specific regulation or restriction around the use of insects in pet food or treats. However, as an ingredient, appropriate labeling and adherence to safety consumer safety measures must be met. In addition, pet products made in Canada but intended for export are handled through the Canadian Food Inspection Agency to meet the regulations of the countries to which they are exported.^{lxx} As many Canadian companies are interested in US markets, it's worth noting that the Association of American Feed Control Officials (AAFCO) is the not-profit that works with U.S. regulatory agencies about the inclusion of ingredients in pet food.



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- Jarrod Goldin, Co-founder, Entomo Farms
- Gabe Mott, Chief Operating Officer, Aspire Foods
- Grant Vandenburg, Professeur titulaire, Université Laval

END NOTES

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