



Insects
to feed the world.

Bühler Insect Technology

Bühler AG

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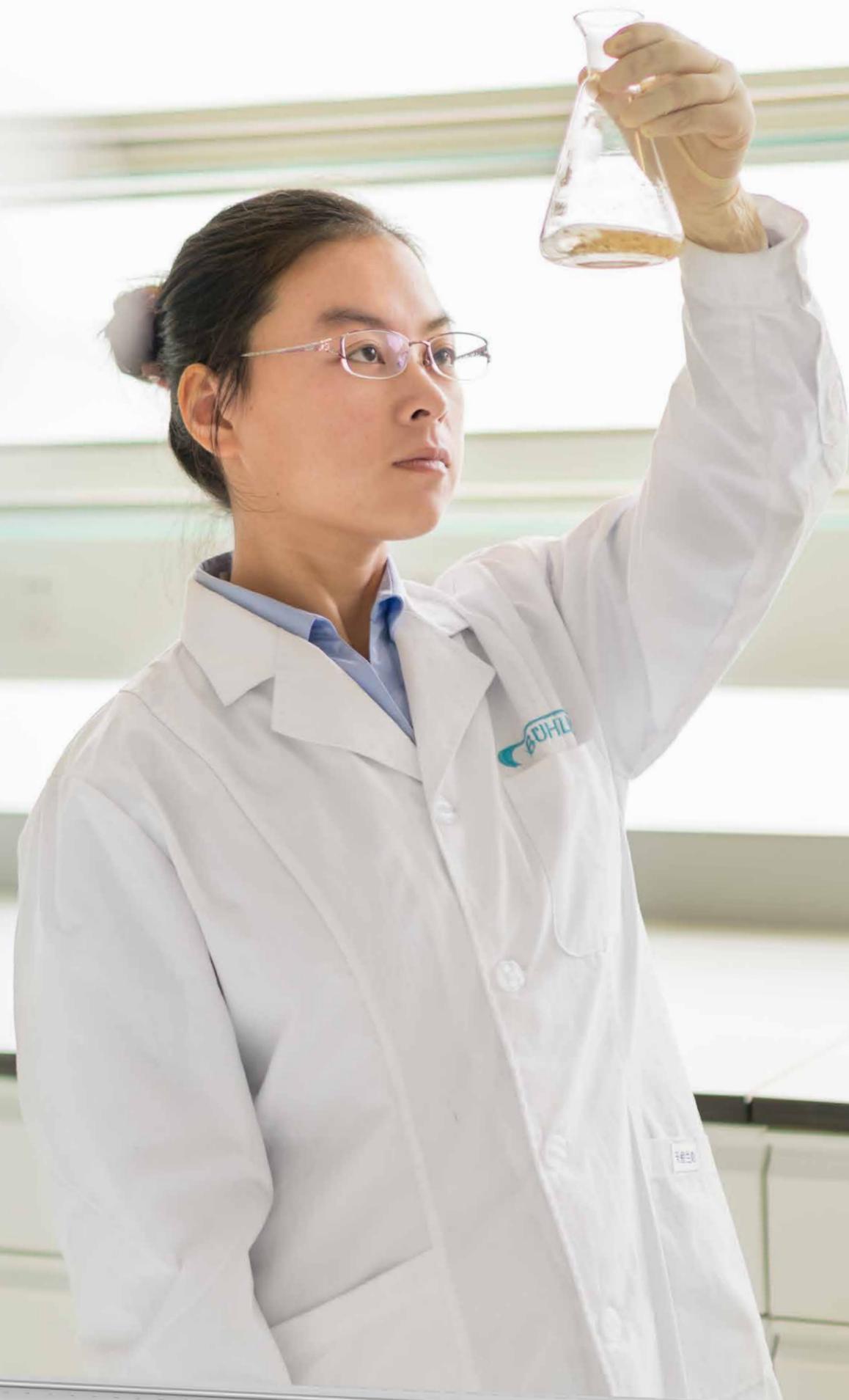
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Innovations for a **better world.**





An industry of the future is **here.**

Ten billion people are expected to live on our planet by 2050. To feed them all, we will need more than 250 million metric tons of additional protein a year – that is an increase of 50% compared to today. Providing this growing global population with protein requires new and innovative approaches as existing sources are overused and expanding them is problematic for the environment.

Added to the population challenge is the fact that we don't use the food we produce very efficiently. Roughly one-third of the food intended for human consumption is lost or wasted every year. This accounts for approximately 1.3 billion metric tons of food that never reaches our tables. This is not only a loss of valuable nutritional resources, but also a challenge in terms of disposal. In many regions, landfill or incineration are the prevalent solutions for dealing with food waste, and they come with their own problems. There is an ongoing quest for new and efficient technologies to better deal with organic waste.

Insects offer a unique opportunity to address both challenges: protein supply and organic waste disposal. Insects close the loop on organic waste as they recycle nutrients that are otherwise lost and bring them back into the food value chain. Today, this sustainable solution is not only feasible – it can be realized on a large scale and in an economical way.

Bühler Insect Technology is your technology partner for industrial insect plants, lines, equipment and related services. With our solutions, we enable you to transform organic residues with the help of insects into quality products such as food ingredients, proteins and lipids for animal feed as well as fertilizer suitable for agricultural and horticultural use. Our automated and modular process technology meets the safety and quality standards required by the industry and will help to sustainably feed the planet.

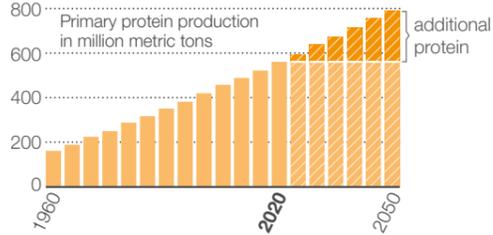
Insects contribute to a circular economy.

Today's challenges

The increasing demand for meat puts pressure on our current animal feed protein source of fertile land means that increased meat production will have considerable impacts on the environment. A huge amount of food doesn't even reach our tables.

The protein gap

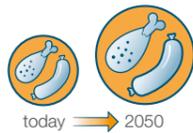
Primary protein production needs to increase by 50% until 2050.



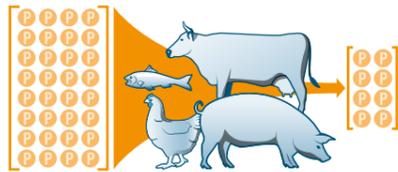
Today, 85% of arable land is already in use.

Meat production and consumption

Meat consumption will increase by 50% until 2050, most of which in Asia, Africa, and Latin America.



Four plant-based proteins are needed on average to make one animal-based protein.



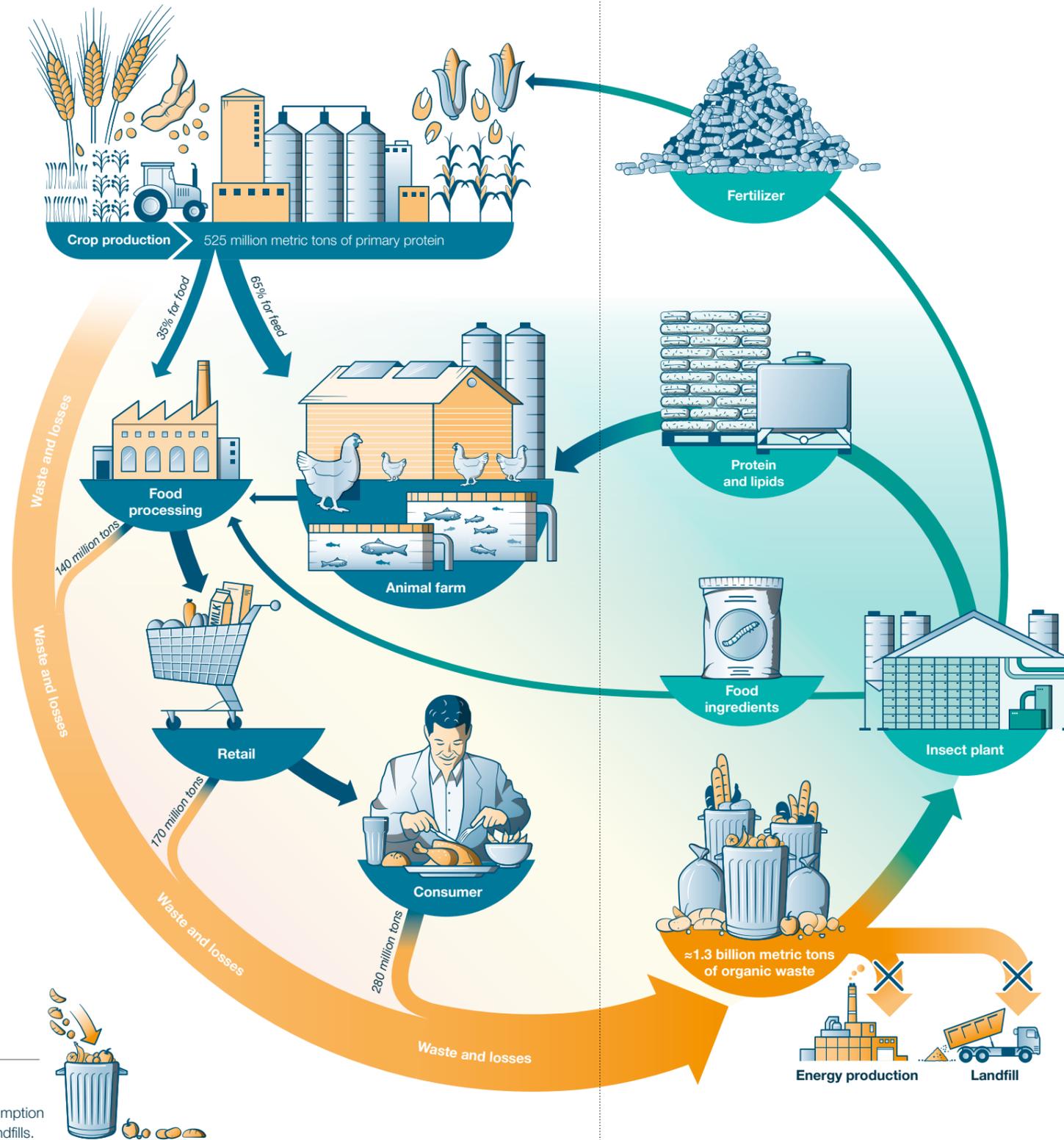
Current feed proteins pose challenges.

The example of soy:

- 80% of production occurs in only three countries
- high price volatility in some regions of the world
- expansion of soy production is contributing to deforestation

Food waste and losses

One-third of the food produced in the world for human consumption is lost or wasted every year. 95% of food waste ends up in landfills.



Today's solutions

Insects are able to recover nutrients from organic residues and bring them back into the food value chain, thereby contributing to a circular economy. Since no fertile land is needed for their production, they are a promising and sustainable new source compared to today's main alternatives. Some species, such as the black soldier fly and mealworms are well-suited for growth on large scale.



Benefits of insects

Insect proteins can be produced locally.



They are the natural diet of many animals.

Insects can be produced with little environmental impact.

	Land use (m ²) per kg of protein	Water use (m ³) per kg of protein
Insects	4	5
Rape-seed	50	16
Soybean meal	73	21
Nuts	79	139
Eggs	57	29
Chicken	71	34
Beef	1836	112

Nutrient content and health benefits of insects

- Are rich in **proteins**, with a balanced amino acid profile
- Contain healthy unsaturated **fatty acids**
- Are a good source of **micronutrients**, such as vitamins and minerals
- Contain **immunostimulants**, such as chitin and antimicrobial peptides

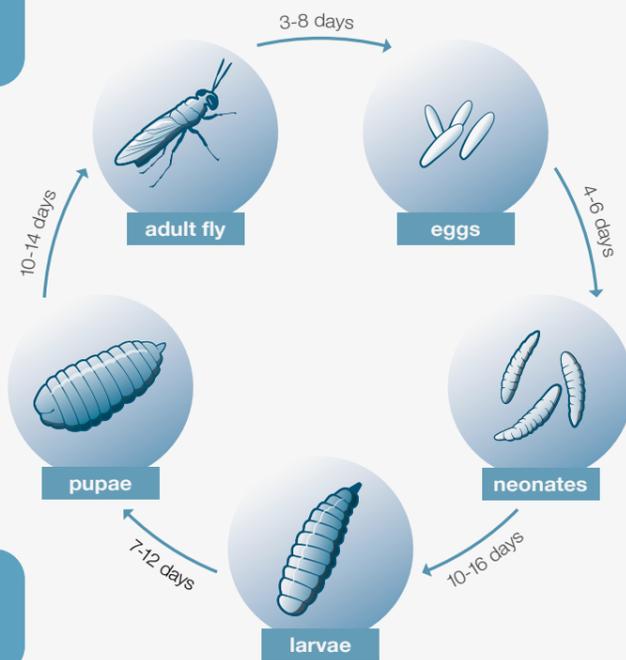
Insect species with industrial relevance.

Selected due to key performance criteria.



Feed

Wide range of diets



Very fast growth cycle

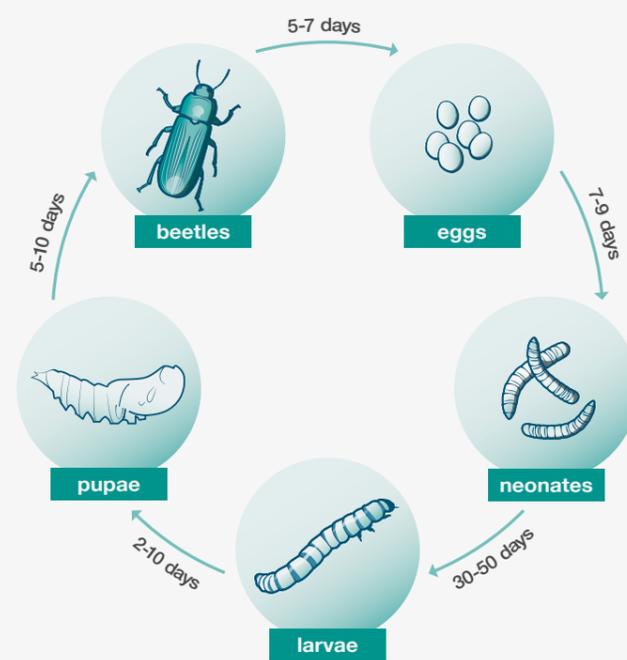
Black soldier fly
(Hermetia illucens)

High nutrient accumulation

Naturally in high densities

Food

Easy to handle



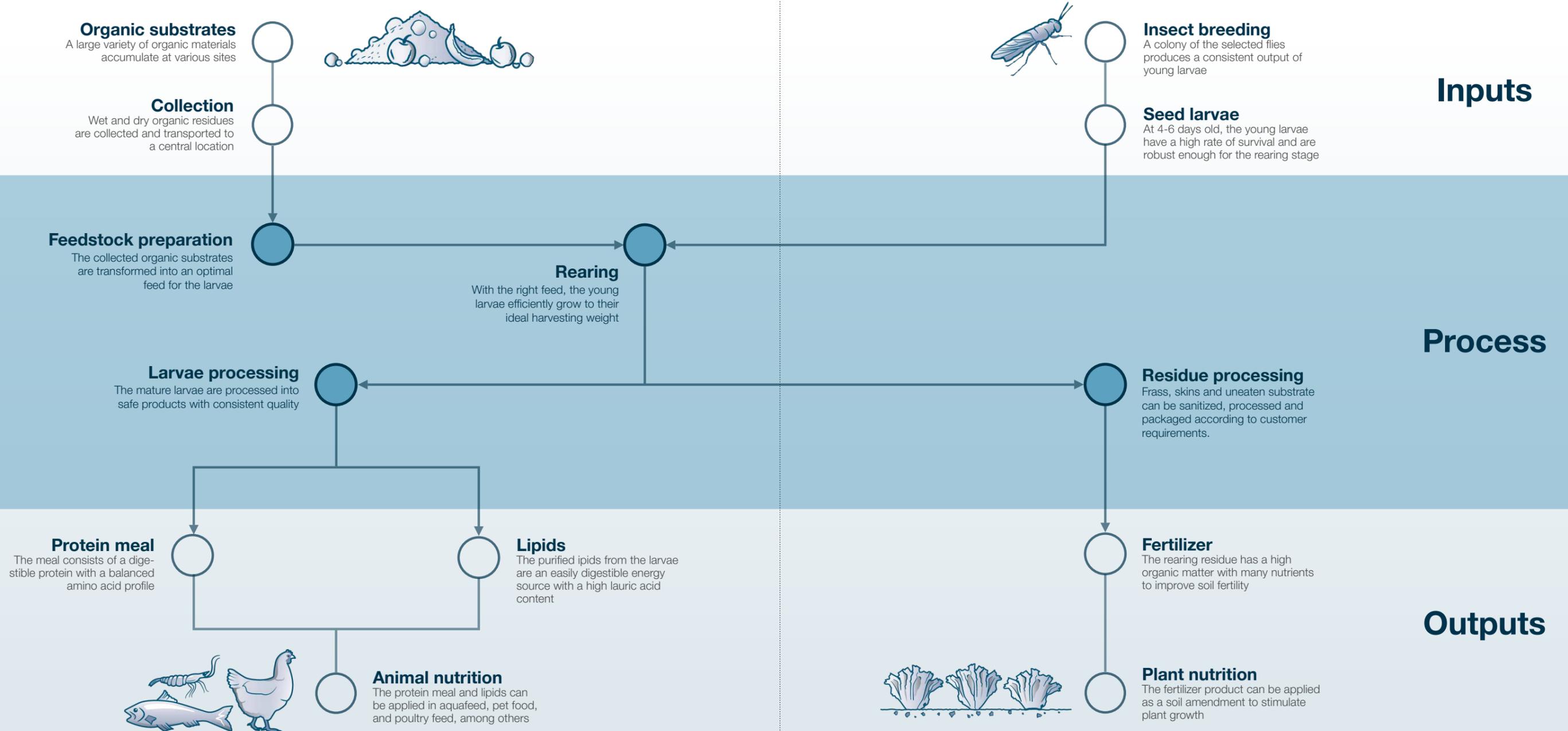
Pleasant, nutty taste

Mealworm
(Tenebrio molitor, Alphitobius diaperinus)



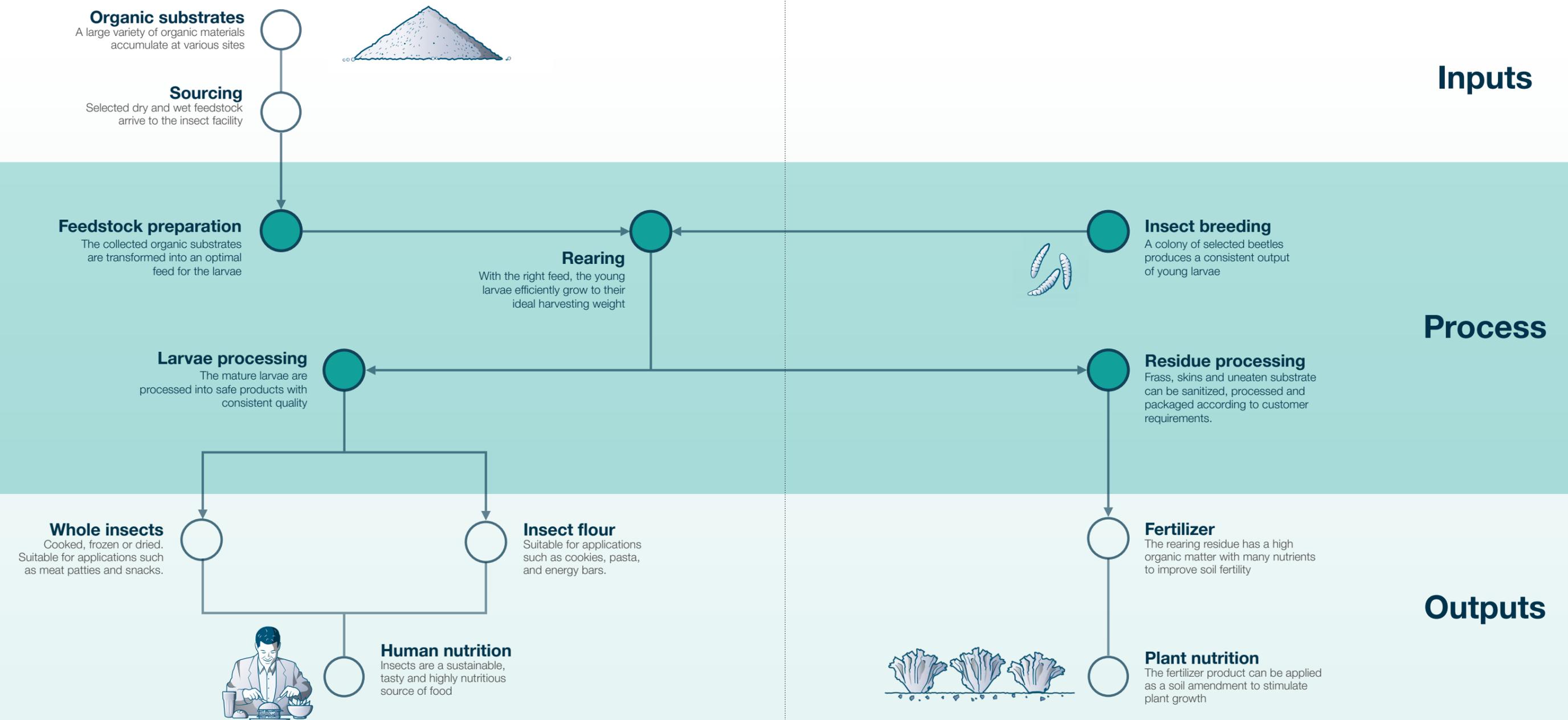
Our black soldier fly solutions. Turn your organic side streams into high-value feed ingredients.

Black soldier flies can valorize a wide variety of organic side streams into high-quality and sustainable ingredients for application in animal feed products. Our reliable process solutions cover feedstock preparation using all kinds of organic residues, rearing of the larvae, their processing into protein meal and lipids, as well as the processing of the rearing residue into fertilizer products. Proven to work on an industrial scale, the high degree of automation allows achieving consistent and superb product quality.



Our mealworm solutions. Create your innovative food ingredients.

Mealworms can be grown on food by-products and processed into tasty and nutritious food ingredients for the booming alternative protein market. Our innovative process solutions cover feedstock preparation, breeding and rearing of the insects, as well as their processing into whole and ground insect products. With our modular design, we can easily scale-up plant capacities over time and transform existing buildings into mealworm plants. Finally, the integration of the mealworm reproduction allows a very flexible and independent operation.



Feedstock preparation. Our solutions are fully customized.

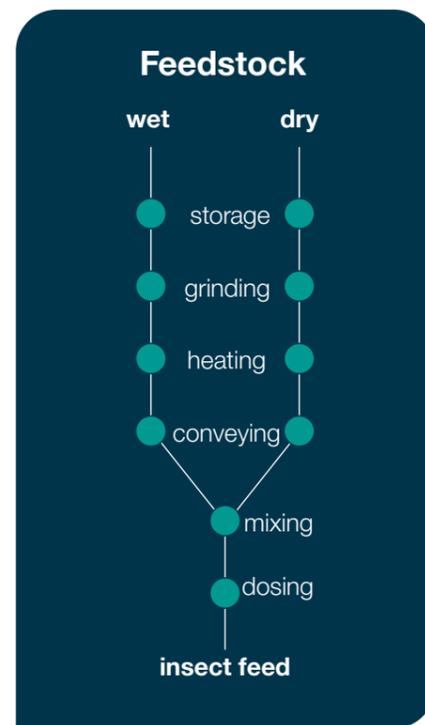


The organic residues are stored in silos before they are mixed into a proper feedstock.

Proper feedstock preparation is the first order of business for any successful insect plant. The objective is to transform the different organic residues in a timely manner into safe, palatable, and nourishing feed for insects.

We offer process technologies that can be easily customized to deal with the wide range of potential feedstock suitable for rearing insects. The technical solution includes the reception and safe storage of wet and dry raw materials as well as their mixing into a homogeneous feed with a suitable composition and texture. If required, additional treatments such as grinding and/or heat treatment can be applied in order to facilitate the ideal access to nutrients within the organic materials.

Taking into account the availability, cost and nutritional composition of different organic side streams, the solution can be tailored to optimize the yield of the selected insect and the economics of the overall plant.

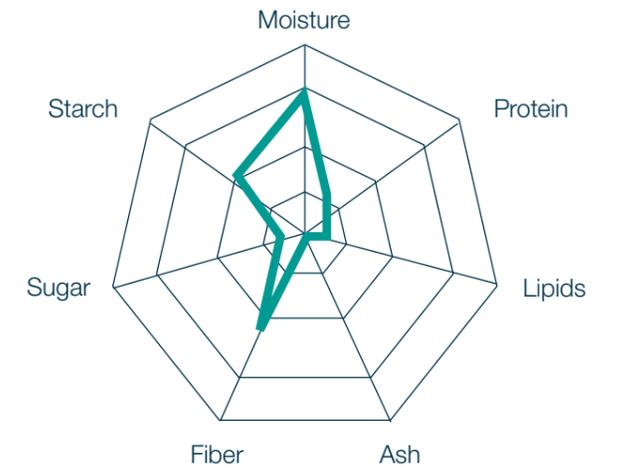


Feed for the best results. Consistent nutrition is key to quality.

Even though insects are very flexible in terms of what they can eat, the feed mix they are given should fulfill the nutritional requirements of the larvae and have the right structure to ensure a good acceptance, a short rearing duration and a satisfactory weight gain of the animals.

The feedstock to be used should not only be available in large quantities but also be a good source of digestible protein and energy. The optimal feed mix consistency is achieved by using fiber-rich residues in order to adjust the free water content. While black soldier fly larvae consume their feed in slurry form, mealworms grow optimally in a more dry substrate.

Whether wet or dry, for a reliable production of larvae it is beneficial that the feed provided is consistent throughout the year. The insect facility should be built as close as possible to the location where the organic residues accumulate to minimize transportation costs. Local regulations should also be taken into account as they can limit feedstock options.

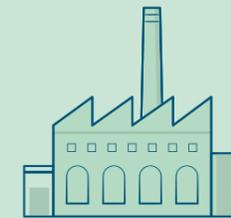


Example of a feed composition for black soldier fly.

Examples of potential feedstock

Industrial byproducts

- Distiller's grains
- Brewer's spent grains and yeast
- Fruit, vegetable, and potato cutoffs
- Fruit juice pulp
- Sugar beet pulp
- Vinasse and molasses
- Dairy residues
- Corn slurry
- Wine remains
- Rice and wheat bran
- Reject grains
- Tofu industry residues
- Oil cakes / pomace



Agricultural residues

- Fruit and vegetable leftovers



Consumer discards

- Old bread
- Supermarket discards
- Kitchen waste



Insect rearing. Our solutions enable fast and uniform insect growth.

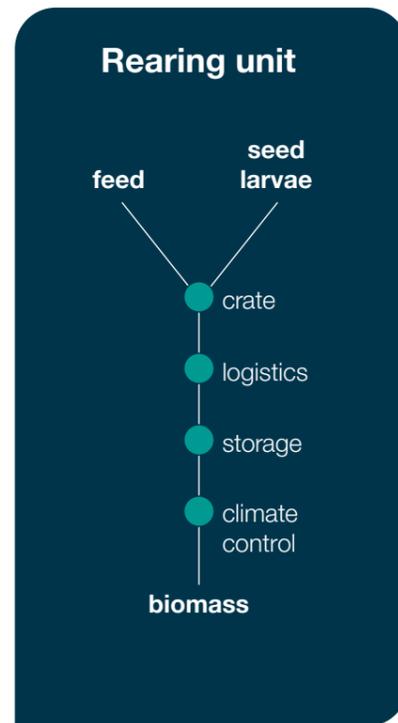


Larvae grow under controlled conditions to ensure an efficient feed conversion rate.

Rearing facilities make up the largest part of an insect plant. The objective is to efficiently grow young larvae to their ideal harvesting weight in the shortest possible time. The state of the art is to grow larvae in crates.

Bühler Insect Technology works with rearing units containing stacked crates that are automatically filled, harvested and cleaned. This makes optimal use of the available space and minimizes manual labor and operator errors. The feedstock is dosed accurately and in a consistent pattern to maximize the availability and delivery of nutrients.

A patented air distribution system ensures uniform climate conditions in each crate even at high rearing densities. Finally, the overall solution is designed to withstand the harsh conditions experienced in mass rearing environments and can be easily cleaned.



Black soldier fly larvae processing into feed ingredients. Our solutions allow high yields and productivity.



The sophisticated lipid separation process fulfills the highest quality standards.

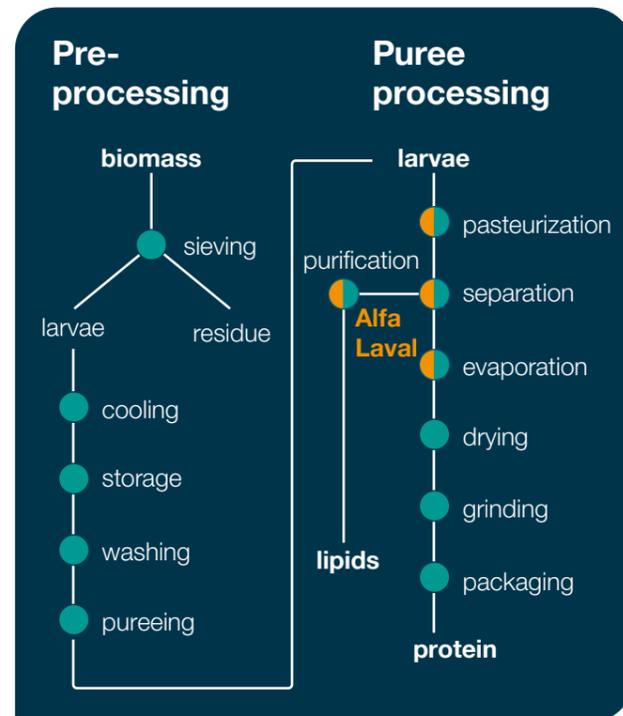
We use a wet processing route to transform the insects into high-value end products. The objective is to gently defat the larvae to achieve protein meals and lipids ready to use in pet food and animal feed applications.

Our processing lines are separated into two key areas: pre-processing for gentle handling of the live animals and puree processing for efficient separation of the larvae into shelf-stable products with consistent quality.

In partnership with Alfa Laval

During pre-processing, the live larvae are carefully sieved from the rearing residue and washed thoroughly before being pureed. Our life larvae storage solutions allow running the processing fully independently from the harvesting schedule.

In puree processing, we use customized equipment developed together with our partner Alfa Laval to pasteurize and defat the puree, purify the separated lipids and concentrate the protein-rich fraction through evaporation. Drying, grinding and packaging finally result in a feed-grade protein meal with an attractive nutritional profile.



High-quality end products. Protein and lipids.



Protein meal.

Benefits

- Balanced amino acid profile.
- Very good digestibility > 85%.
- Highly palatable.
- Adequate techno-functional properties.

Sample applications

- In pet food products, given its nutritional profile and hypoallergenic properties.
- In fish feed for high growth performance, a good feed conversion rate, and a better gut health.
- In shrimp feed as an attractant for better feed intake.
- In broiler and pig feed for better nutrient digestion and satisfactory productive performances.



Lipids.

Benefits

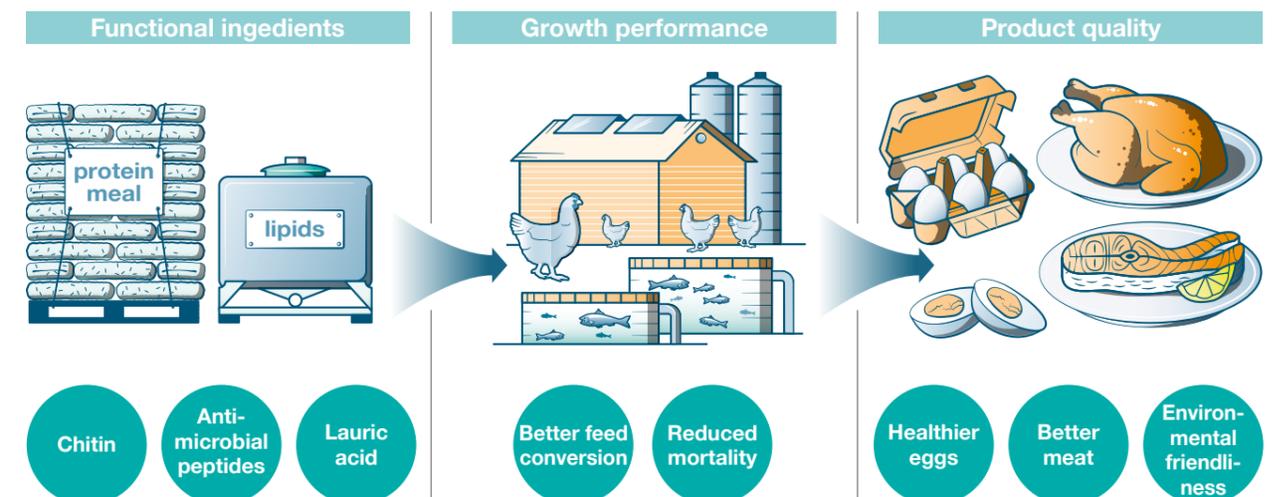
- High in lauric acid that has antibacterial and antiviral properties.
- Easily digestible source of energy.
- Naturally palatable.
- Simple integration into products.

Sample applications

- In piglet feed for improved feed intake and better gut health.
- In broiler feed with satisfactory productive performances and overall meat quality.
- In cosmetics and detergents as an alternative to animal or vegetable fats.

Insect products improve growth performance and product quality.

Several studies indicate beneficial effects of insect products in feed for chicken, pigs and fish.



Mealworm processing into food ingredients. Our solutions are able to make various products.



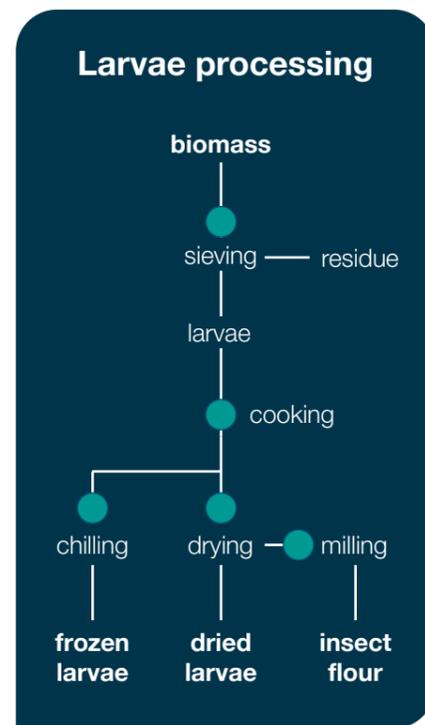
Hygienically designed processes ensure consistent end-product quality as required by the food industry.

Our processing lines result in frozen, dried or ground mealworms that can be readily applied in a wide variety of food products. The objective is to maintain the intrinsic nutritional value of the fresh insects.

We offer a range of different processing technologies, allowing you to obtain the type of mealworm product that best suits your desired food application.

As a first step, live larvae are carefully separated from the rearing residue. A well-defined cooking step ensures safe end products without diminishing the nutritional quality. Finally, the larvae are turned into shelf-stable food ingredients, either still recognizable as whole insects in frozen or dried form or as high-quality insect flour.

The food ingredients can be even further processed into finished products using Bühler technologies like extrusion. Various products are suitable for the application of insect ingredients including pasta, breakfast cereals, meat analogs, cookies, wafers, and biscuits, among many others.



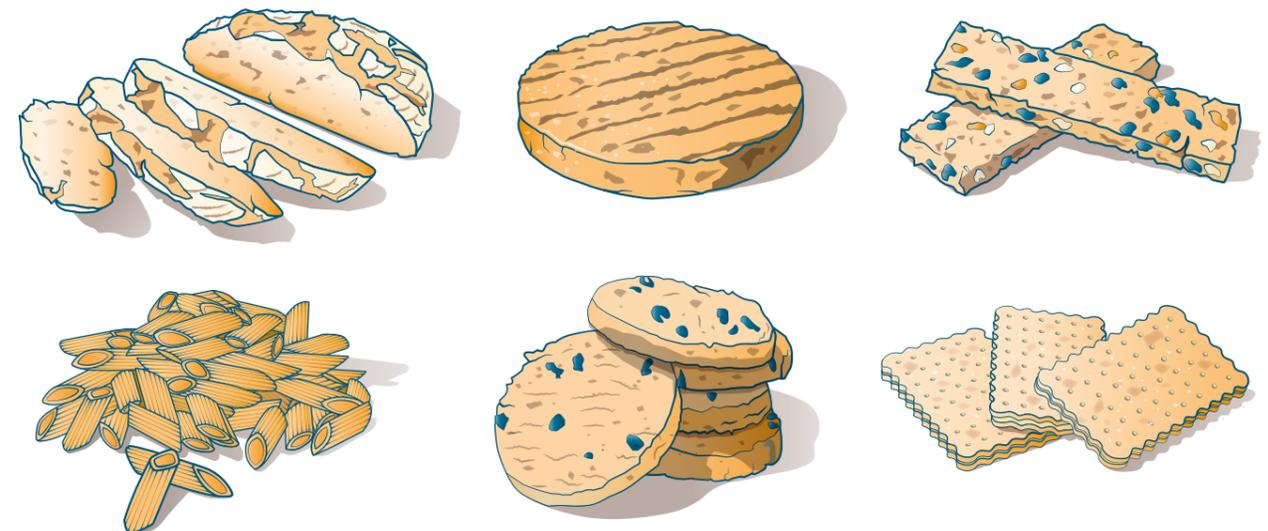
High-quality end products. Whole insects and insect flour.



Benefits

- Contain all the nine essential amino acids and have a high digestibility.
- Rich in micro-nutrients such as iron, calcium, vitamins B2 and B12.
- With a natural nutty flavor, they can be used in both sweet and savoury products.
- Either frozen, dried or ground, they can be incorporated in a wide range of food products.

Examples of product applications.



Residue processing into fertilizer. Our solutions result in zero waste.



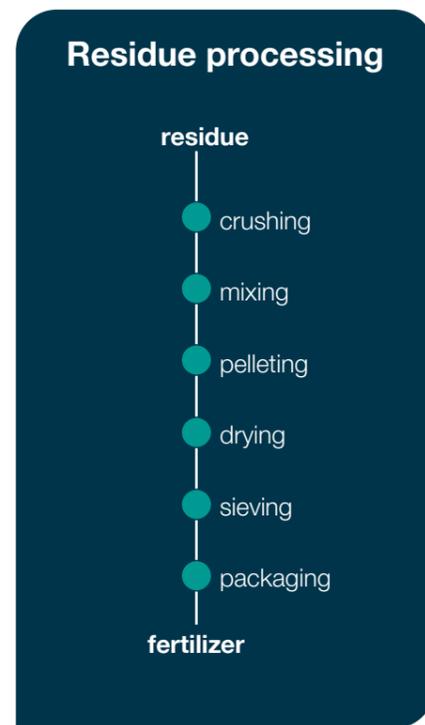
The value of the rearing residue can be increased by a pelletizing and sanitation process.

Our residue processing lines add value to the biggest output of an insect plant. The objective is to transform rearing residue into high-quality soil amendments for application in agriculture and horticulture.

Based on our circular economy philosophy, we see the rearing residue as an important revenue source for the insect plant. By applying the correct processes, valuable fertilizers or soil amendments with interesting functions can be achieved.

We offer two different solutions with regard to residue treatment. If you aim for an integrated value chain all the way down to fertilizer production, we can offer a complete line to produce sanitized and dried fertilizer pellets. If you consider selling the wet residue directly to nearby farmers, fertilizer production companies or biogas plants, a simple crushing process to inactivate potential live larvae is needed before packaging it for off-take.

Besides the high organic matter and the interesting macronutrient profile, the chitin from the insect skins acts stimulates plant development and acts against pests and pathogens.



High-quality end products. Fertilizer.



Fertilizer.

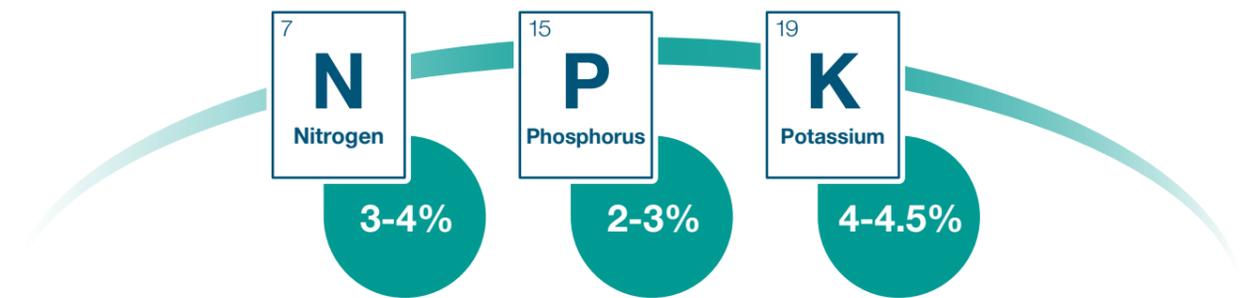
Benefits

- High organic matter (>85%) with nitrogen and minerals.
- Contains chitin that improves the defense mechanisms of plants.
- Slow and constant nutrient release over time.
- Safe and ready to be applied on field.

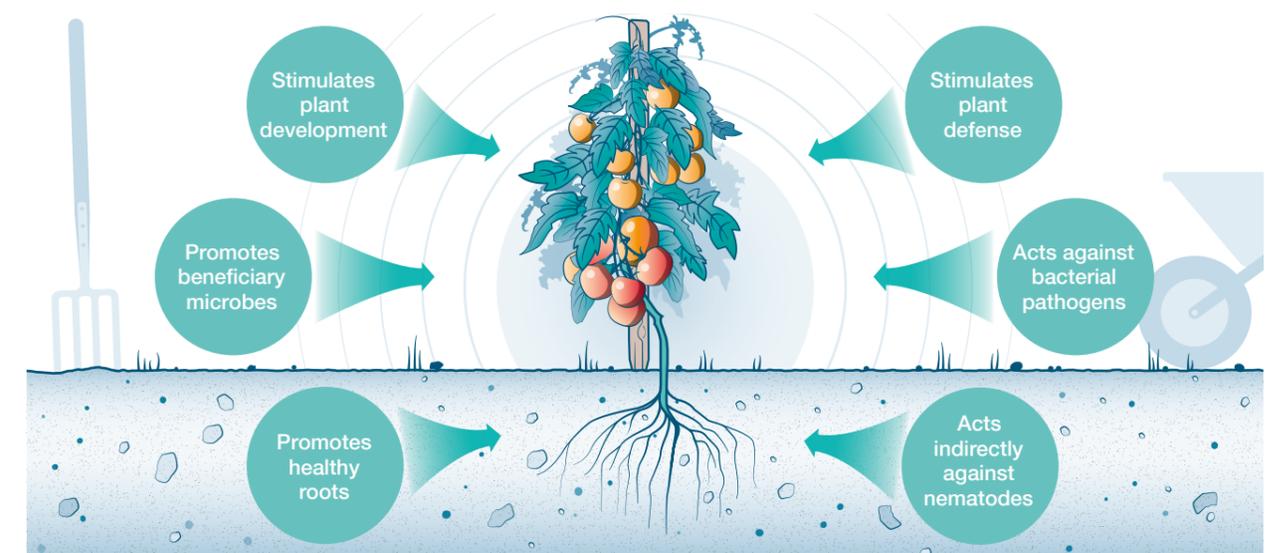
Sample applications

- In soil amendments for farms, gardens, horticulture, and greenhouse.
- In low fertile soil (acid and sandy soil) with satisfactory results.
- In crop production for higher yields.

Nutritional value for plants.



Chitin acts as a biostimulator and natural pest control.



A plant overview. Our proven solution.

We have solved the challenge to produce insects at industrial scale with our fully integrated, complete and reliable solutions. We are also happy to serve you with only part of the entire solution, be it individual lines or single equipment.

Sustainability



Our plants ensure efficient and economical use of raw materials, land, water, and energy. This facilitates production with low operating costs, giving plant owners a crucial competitive advantage in the marketplace.

Safety and quality



Our plants follow good manufacturing practices (GMP). The hygienic zoning and defined cleaning and disinfection procedures ensure safe and consistent output of end products.

Automation

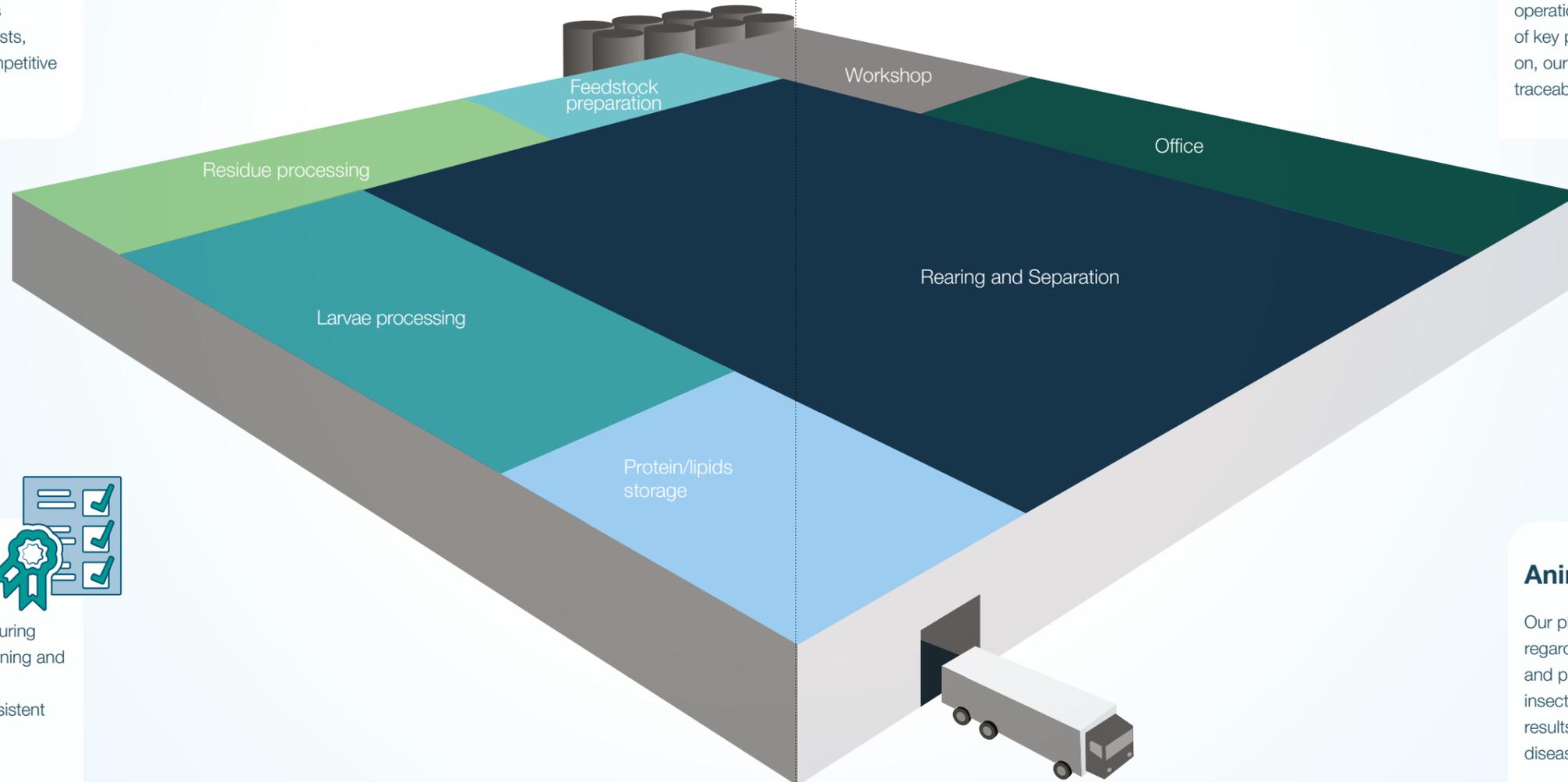


Our automated system with data-driven technology enables the reliable control of operations and continuous improvements of key performance indicators. In addition, our automation software ensures full traceability throughout production.

Animal welfare



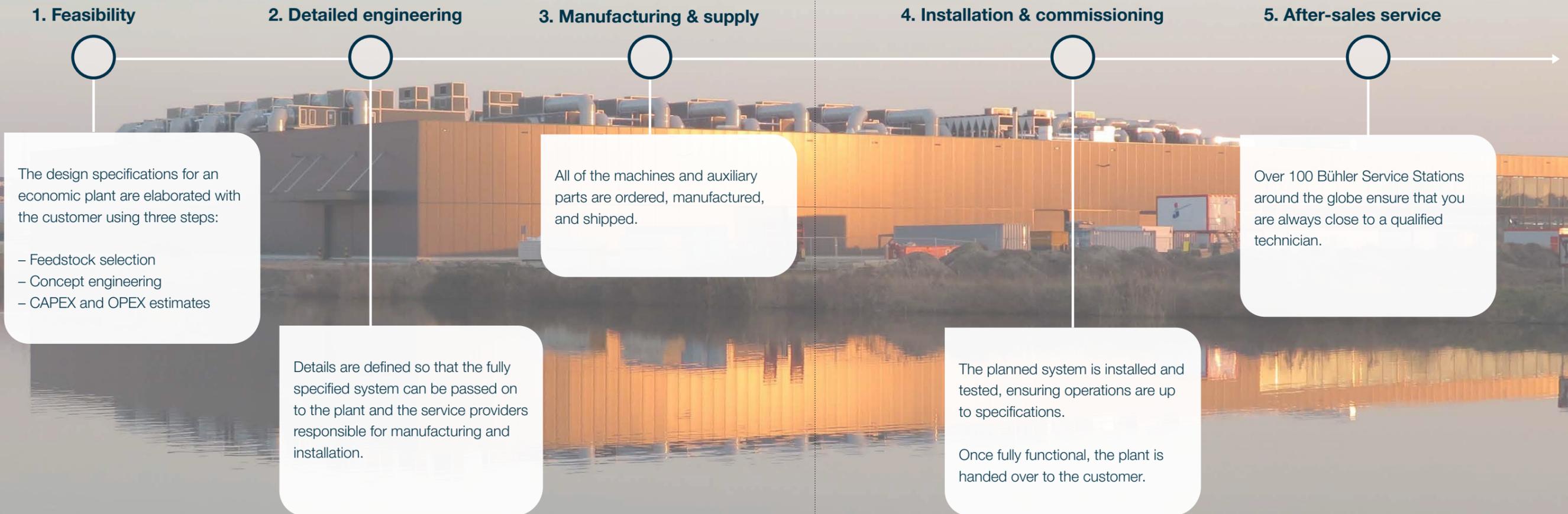
Our plants operate with the highest regard to animal welfare. We set rearing and processing conditions to make insects feel as they do in nature. This results in higher growth rates and better disease control.



Insect	Capacities	Wet feedstock intake	Wet larvae processing
Black Soldier Fly	Pilot	5 – 25 t/d	0.5 – 1 t/h
	Medium	50 – 150 t/d	2 – 3 t/h
	Large	200 – 500 t/d	4 – 7 t/h
Mealworms	Medium	5 – 25 t/d	0.5 – 1 t/h

Phased approach. Step-by-step to a successful plant.

We offer a phased integral solution that goes from the complete plant feasibility analysis to the successful fulfilment of the project. Moreover, we provide after-sales service that ensures efficient plant operation for many years to come.



Project management

We deliver projects in a high-quality and timely manner. This is achieved with state-of-the-art project management in close collaboration with the customer. We have dedicated and talented project managers with detailed knowledge of the local circumstances to deliver our plants all over the world.



Engineering

We engineer customer success. Our technologists and engineers have the in-depth process know-how to design reliable plants and lines that will enable easy and cost-effective operation. We also offer advice and services on how to fully utilize the insect plant over its lifetime.

Bühler Insect Technology. Your technology partner for reliable insect production.



By our fully integrated, and reliable solutions, we have solved the challenges of insect production at industrial scale.

Established in 2017 and based in Switzerland and China, the market segment Insect Technology of Bühler has built up strong technology know-how to be a fully dedicated solution provider for plants, equipment lines, and related services for the insect industry. Thanks to our wide portfolio and proven solutions, we will get your plants operational in short time.



Andreas Baumann
Head of Insect Technology

“We consider every aspect in order to ensure that your project will be successful.”

Bühler Group. Innovations for a better world.



Operating in a truly global network, we are close to our customers and partners.

Billions of people come into contact with Bühler technologies to cover their basic needs for food and mobility every day. Having this global relevance, Bühler is in a unique position to turn today’s global challenges into sustainable and good business. For this, the best process solutions along complete value chains are developed.

Bühler at glance*

 **CHF 2.7 billion**
Turnover

 **12,457**
Employees

 **140**
Countries

 **100%**
Family-owned company

 **100**
Service stations

 **5.2%**
of turnover are invested in R&D

* as of 2020