THE CASE OF INSECTS
IN THE FUTURE OF PROTEIN SOURCES

sens

The best protein for the human body

Protein Diversity

The most beneficial protein? Not one. More of them! Increasing the diversity of protein has overall positive outcomes. Novel sources of protein that may be used in the future, such as insects, lab grown meat, and other synthesised proteins, may have substantial longer-term potential.

Source: Carbon Trust, The Case for Protein Diversity, 2015, link

Protein, fat, fibre

The composition of a single house cricket is around 65% protein, and 20% fat.

Source: Rumpold et al., 2012, Potential and challenges of insects as an innovative source for food and feed production, link

Field crickets provide more than the minimum amino acid profile suggested by the World Health Organization in order to be an adequate source of essential amino acids.

Source: Wang et al., 2004, Nutritional value of the field cricket (Gryllus testaceus Walker), link

Crickets contain around 5 % of healthy fibre made up of chitin and chitosan.

Source: Ibitoye EB et al., 2018, Extraction and physicochemical characterization of chitin and chitosan isolated from house cricket, link

Eating crickets may improve gut health and reduce systemic inflammation due to the content of fibre.

Source: Valerie J. Stull et al., 'Impact of Edible Cricket Consumption on Gut Microbiota in Healthy Adults, a Double-blind, Randomized Crossover Trial', Sci Rep. 2018, link

Minerals and vitamins

Vitamin B12 is found in sufficient amounts in house crickets, at 5.4 µg per 100 g. Recommended dietary amount is 2.4 µg daily.

Source: Arnold van Huis, 2013, Potential of Insects as Food and Feed in Assuring Food Security, link

Insects offer a wide range of micro-nutrients! Mainly calcium, copper, potassium, iron, magnesium, manganese, phosphorous, selenium, and zinc.

Source: Rumpold and Schlüter, 2013, Nutritional composition and safety aspects of edible insects, link

Insects have better bioavailability of minerals such as Calcium, Copper, Magnesium, Manganese, and Zninc than sirloin beef.

Source: Latunde-Dada GO et al., 2016, In Vitro Iron Availability from Insects and Sirloin Beef, link

Insects vs Plant protein

Animal proteins (including insects) are on average better digestible and have a more favourable amino acid profile than plant proteins.

Source: Jay R. Hoffman, 2014,Protein – Which is Best?, link

It's hard and in some cases impossible to cover several micro-nutrient needs with only plant sources of protein. Namely vitamin B12, heme-iron, calcium, and zinc. Insects are great at reliably delivering these nutrients.

Studies show that 68 % of vegetarians and 83 % of vegans are B12 deficient.

Herrmann W. et al., 'Vitamin B-12 status, particularly holotranscobalamin II and methylmalonic acid concentrations, and hyperhomocysteinemia in vegetarians.', Am J Clin Nutr. 2003, link

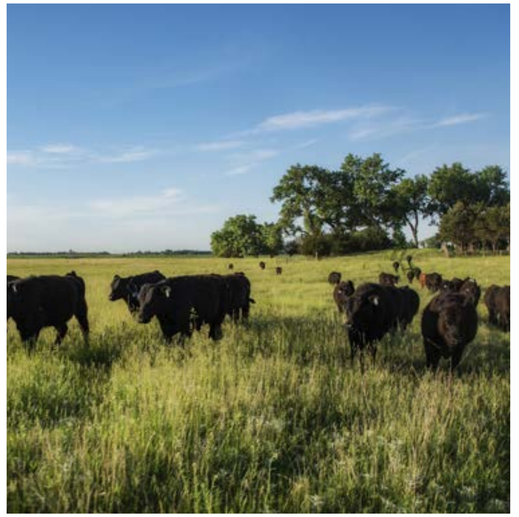
The human body will not extract the full amount of minerals such as calcium and zinc present in plant foods.

Source: Janet R. Hunt, 'Bioavailability of iron, zinc, and other trace minerals from vegetarian diets', The American Journal of Clinical Nutrition, 2003, link

Plants only contain non-heme iron, which our bodies have a lot harder time absorbing.

Source: Waldmann A. et al., 'Dietary iron intake and iron status of German female vegans: results of the German vegan study.', Ann Nutr Metab. 2004, link

Grounded crickets in protein powder



Sustainably raised cattle on pasture

Soybeans

SUSTAINABILITY

Insects make valuable what would normally be wasted

Organic waste + Insects = High Quality Protein

Insects can be reared on low-grade bio-waste and they can turn this bio-waste into high quality proteins - up-cycling nutrients from organic matter.

Cricket poop, a farming byproduct, is a premium fertilizer

The byproduct of insect rearing, frass, consists of excrements and shedded exoskeletons (= fiber chitin). It can be used as an organic fertilizer to enrich soil and hydroponic systems, and it serves as a natural biopesticide.

PS: Isolated chitin and chitosan in insect exoskeletons have a potential for a wide spectrum of uses in medicine, cosmetics, textiles and food industry.

Source: Natural Resources Institute Finland, 'With insects towards circular economy', 2017, link

Crickets can be successfully fed rice bran, a cheap agro-byproduct

Source: M. Orindta et al., ' Growth performance of Common House cricket and Field Cricket fed on agro byproducts', Journal of Entomology and Zoology Studies, 2017, link

Exceptionally low resource consumption & GHG production

Source: Bloomberg, 'Bugs Are Coming Soon to Your Dinner Table', 2018, link

				
Greenhouse gases released per kg of live weight, g	2	N/A	1,130	2,850
Feed required per kg of live weight, kg	1.7	2.5	5	10
Land required per g of protein, m^2	18	51	63	254
Water required per g of protein, li	23	34	57	112

Industrial cricket farming

Relatively large part of "rice" is not eaten

Many organic byproducts of agriculture are not used for human diet

Insects do not feel pain the way we understand it

"No example is known to us of an insect showing protective behavior towards injured parts, such as by limping after leg injury or declining to feed or mate because of general abdominal injuries. On the contrary, our experience has been that insects will continue with normal activities even after severe injury or removal of body parts."

/EXAMPLES/ An insect walking with a crushed tarsus (part of a leg) continues applying it with undiminished force. A locust carries on feeding while being eaten by a mantis. A tsetse fly, although half-dissected, flies in to feed.

Source: C. H. Eisemann, 'Do insects feel pain? — A biological view', Cellular and Molecular Life Sciences, 1984, link

The best animal farming conditions possible

Source: R. L. Patton, 'Growth and Development Parameters for Acheta domesticus", Annals of the Entomological Society of America, 1978, link

	NATURAL FEED	ENOUGH LIVING SPACE	ANTIBIOTIC FREE	HUMANE SLAUGHTER
CRICKETS	✓	✓	✓	✓
CATTLE	✗	✗	✗	✗

Living conditions of farmed animals

Humane slaughter, insects firstly hibernate in cold

Source: Steven C. Hand et al., 'Mechanisms of animal diapause: recent developments from nematodes, crustaceans, insects, and fish', Am J Physiol Regul Integr Comp Physiol, 2016, link

Pain would provide no evolutionary advantages to insects

Robert Elwood, a biological science professor at Queen's University in Belfast, said that pain would provide no evolutionary advantages to insects. The average lifespan of a field cricket is a few weeks – its protection comes from its remarkable reproductive efficiency.

Source: link

Most insects do not have nociceptors, nerves that transmit pain

Source: Adrienne E. Dubin1 and Ardem Patapoutian,'Nociceptors: the sensors of the pain pathway', J Clin Invest., 2010, link

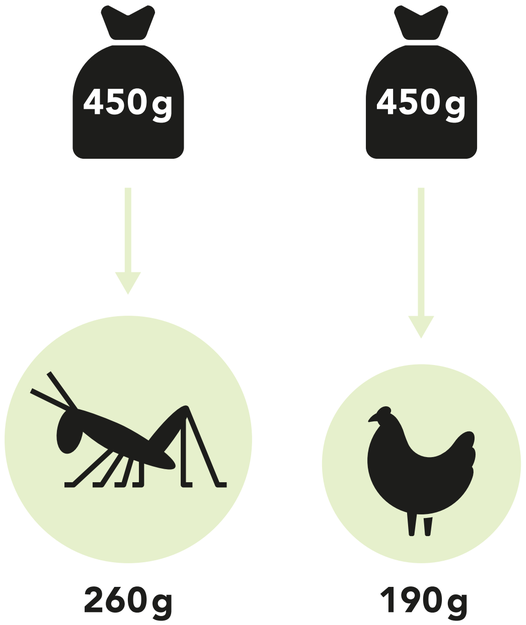
Cold weather causes ants to go into dormancy. They head below the frost line until spring arrives. Other insects hibernate as adults through winter.

COST-EFFICIENCY

Cheapest animal protein, while organic and ethically farmed

Crickets are more efficient at producing protein than chickens

Despite the advantage of 90 years of farming experience over 500 consecutive growing cycles on roughly 20 billion chicken, crickets converted 450g of poultry feed better than chickens. Crickets also require almost no water. The only byproduct is premium frass.



Source: Lundy ME, Parrella MP, 'Crickets are not a free lunch: protein capture from scalable organic side-streams via high-density populations of Acheta domesticus.', PLoS One. 2015, link

Chicken farming, one of the most studied industry

In last 60 years, chickens grow 90% bigger (the 1930s – 1.3kg, to 2010 – 2.58kg), and take less and less time to reach those weights (1935 – 113 days, 2010 – 42 days). These improvements were mostly reached through the selection and feed optimization. Automatization of all processes is so advanced that feed costs are 73% of the costs of chicken.

Source: Smil, V. (2013). Should we eat meat?. Chichester, West Sussex: Wiley-Blackwell

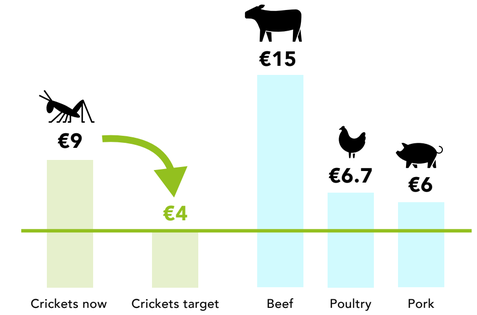
Disruptive vision for improvements in cricket farming

There are not even 1% of the time and resources in cricket farming research compared to chickens. Through specialized feed to all growing stages of crickets, economies of scale and automatization, cricket farming can disrupt the protein market through lower price.

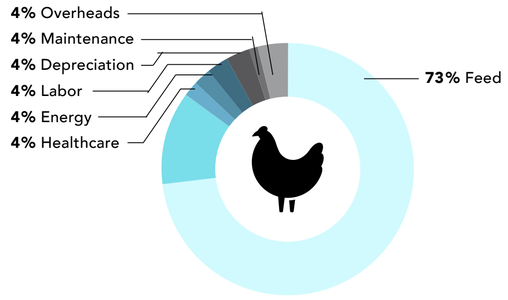
Moreover, crickets are used to live in dense conditions, can be farmed vertically, do not require any antibiotics and are fed organically.

Automatized industrial chicken farming

Price for 1 kg of protein:



Disruption price of €4 per 1kg of protein, the target price of costs for Cricket Lab Ltd.



Distribution of Chicken Production Costs (2012)

ROLE IN THE FUTURE

Once we colonize Mars, there will be a cricket farm

/OPINION/ In conclusion, there will be a whole portfolio of protein sources in the following decades. People will not stop eating meat. Hence, on one side of the portfolio there will be ecologically farmed pasture-raised cattle. On the other side there will be a rich variety of plant protein. Between these two, there will also be industrial cattle farming, which the world will be fighting to mitigate completely. But the most sustainable and ethical animal protein, insects, will be growing in popularity. The yuck factor will be overcame. Slowly, the costs of insect farming and processing will have lowered to the cheapest animal protein on the market. Due to their low price, insects will be added as meat to various common foods. Along with insects, there will be new kinds of protein: mycoproteins, algae proteins and all kinds of plant-based substitutes. Proteins are not a winner takes all market.

The first animal farm ever built outside of Earth will be an insect farm. Plant agriculture is producing many by-products, which would normally be left to rot. But in the outer space, there is no place for wasting resources. Fully automatized insects farms are easily transportable and their production can convert low value organic waste streams to high value protein.

If there is a place for a cricket farm on Mars, there will certainly be a place for many on Earth.

Team of SENS