Selection for larval weight in the Black Soldier Fly – empirical evidence

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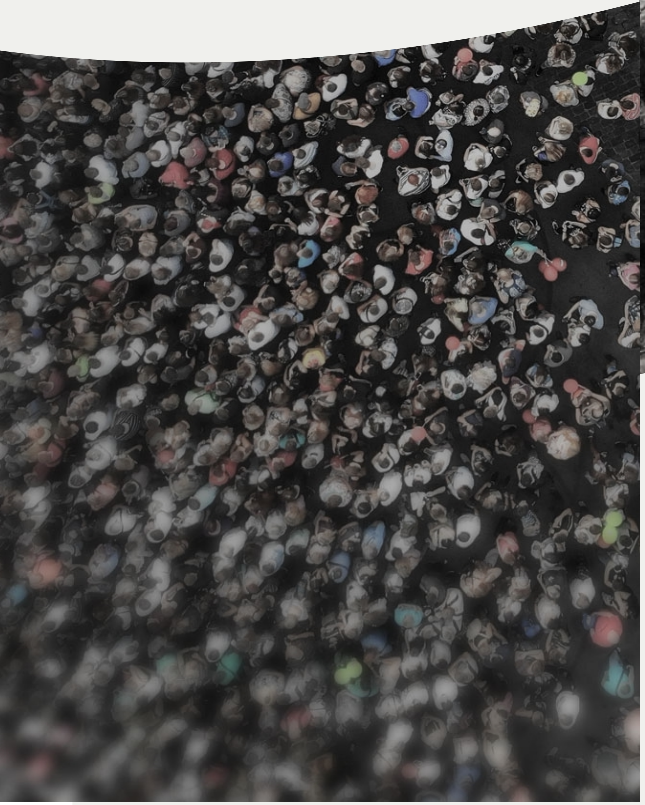
Agenda

Growing population

10 billion people
to be fed in 2050



Deforestation

80% caused by
agriculture

Empty oceans

⅓ of world fish stocks are
subject to overfishing

Food waste

1.3 billion tonnes
per year globally

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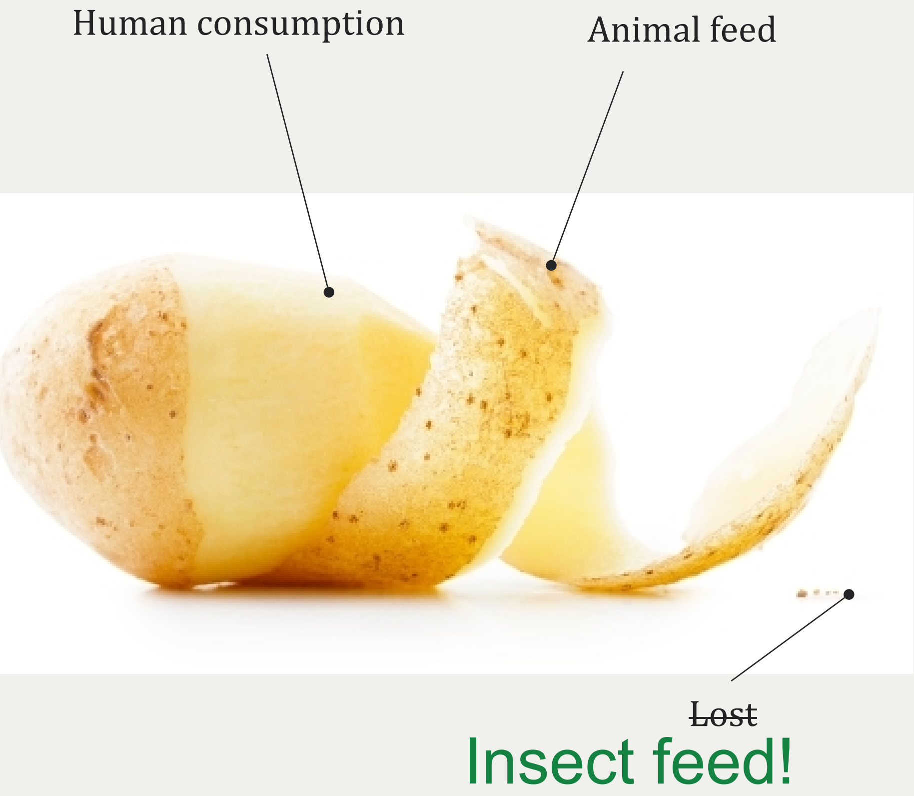
Insects **naturally eat waste** and can solve our food waste problem!

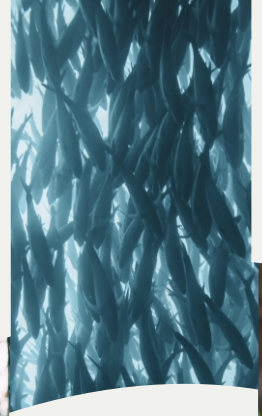


Combining nature with high-tech, we can create **proteins and lipids** very **efficiently** and **sustainably**.

Insects are a natural **food** to many **animals** and also **humans**.

Pet food

- ProteinX
- LipidX
- PureeX



Aquaculture

- ProteinX
- LipidX

Livestock

- ProteinX
- LipidX
- PureeX

Plant care

- Flytilizer

Protix at a glance

Leading insect company in Black soldier fly (*Hermetia illucens*) production and technology

Founded in 2009, The Netherlands

224	patents
175	employees
1	production location
17,5%	R&D investment of revenues
25	nationalities
4	continent exports

* 2020-2022

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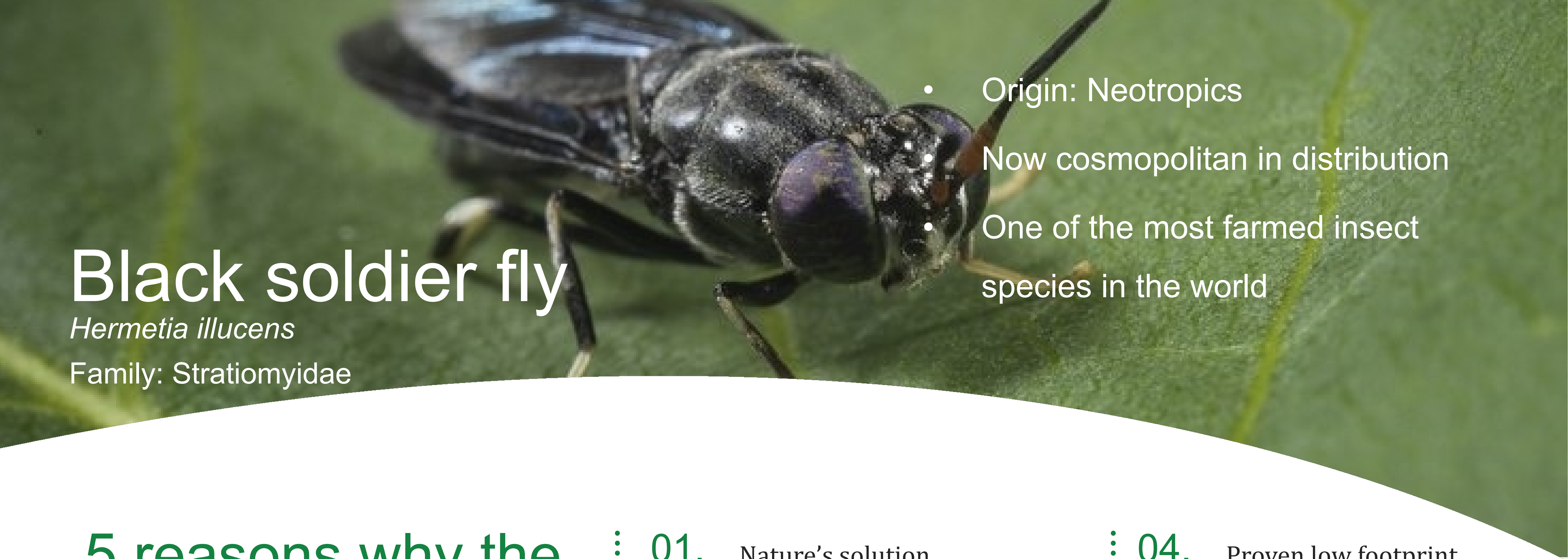

Black soldier fly

Hermetia illucens

Family: Stratiomyidae

- Origin: Neotropics
- Now cosmopolitan in distribution
- One of the most farmed insect species in the world

5 reasons why the black soldier fly is superior

01. Nature's solution

02. Highly nutritious

03. Upcycles low-grade waste

04. Proven low footprint

05. Reliable yield

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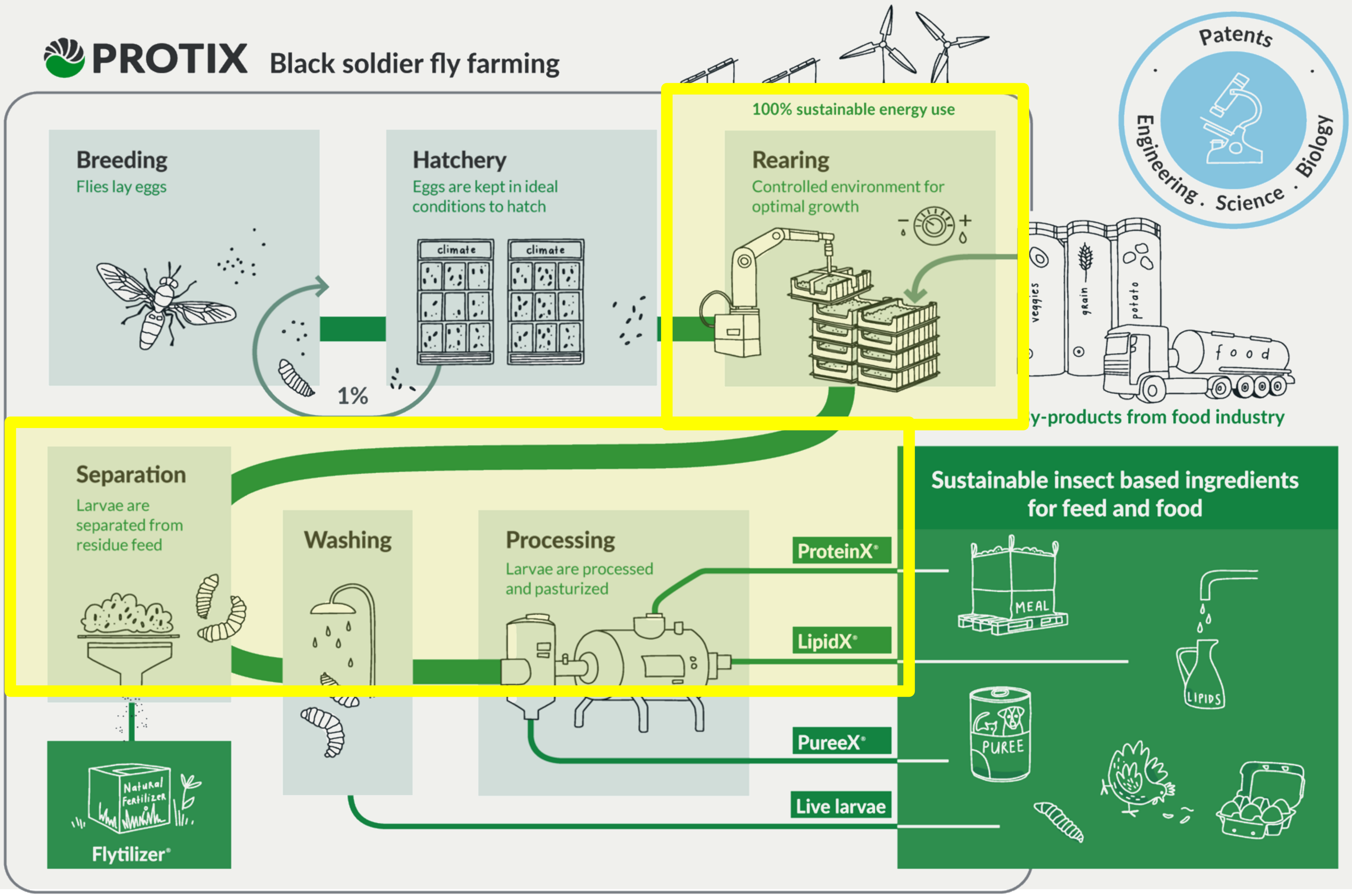
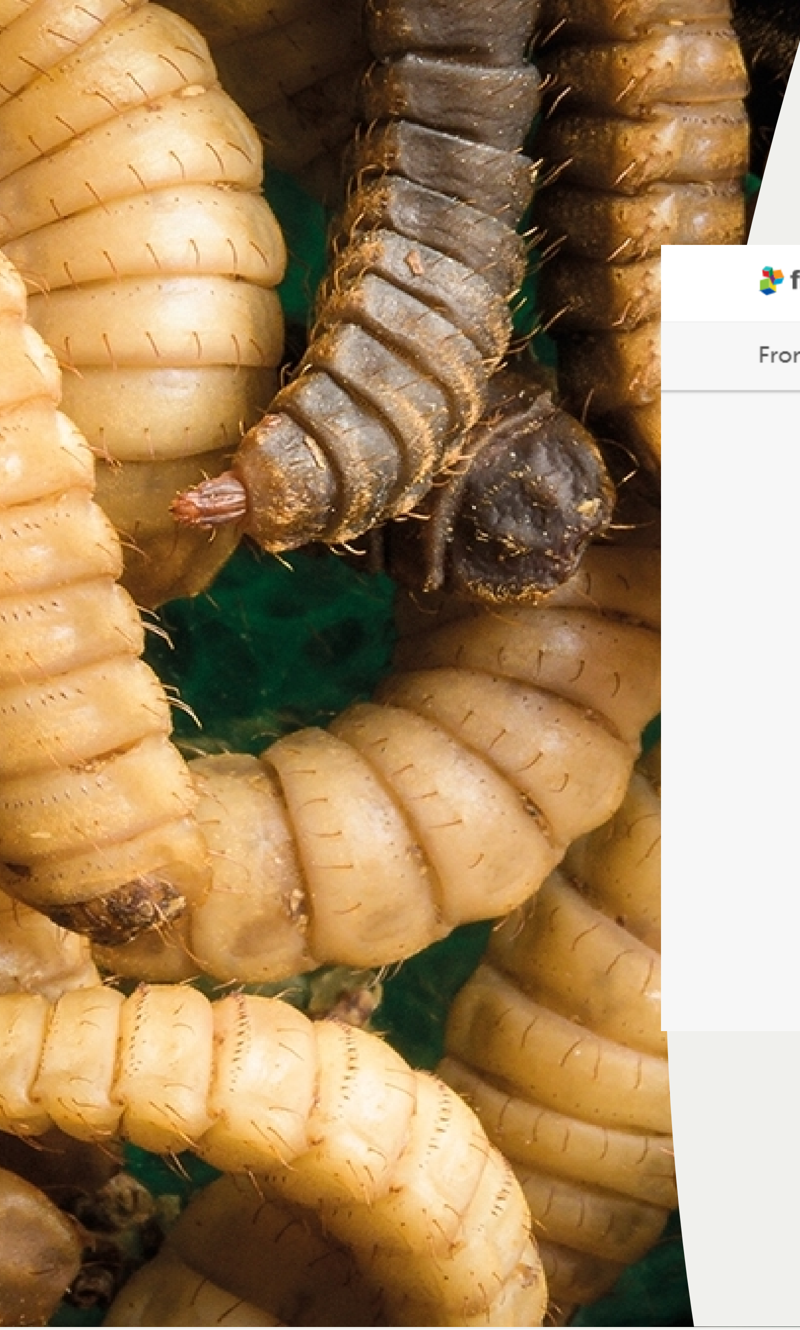
Lifecycle and products

Insect life cycle graph

Industrial cycle and products





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ORIGINAL RESEARCH article
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Long-Term Artificial Selection for Increased Larval Body Weight of *Hermetia illucens* in Industrial Settings

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Black soldier fly (*Hermetia illucens*) farming has exponentially increased in recent years due to the ability of its larvae to efficiently convert low-grade organic materials into high-value food, feed, and technical products.

provement
large scale
n

GOAL OF THIS RESEARCH
Evaluate the performance of Body weight(BW) line compared to the base population (BP) line under Industrial setting.

Methodology

Variables measured on Harvested Larvae:

1. Average larval weight
2. Crate yield (wet and DM)
3. Protein yield
4. Fat yield
5. Feed conversion ratio (FCR)
6. Protein conversion ratio(PCR)

Repeated for 6 rounds , minimum 6 crates/treatment

5 day old larvae of know density

Dosed in Y kilo feed

Reared in semi/Full automated system

Blind refeeding according to need

Harvest clean larvae by mechanical separation

Experimental setup

Table 1 Summary of the experimental setup.

Round	Feed type	Environment	Line	Pattern code	Δ Density	Δ Feed ration
1 May-20	A	1	BW	1-BW-D4	-15%	21%
			BP	1-BP-D4	-15%	4%
2 Sep-20	A	2	BW	2-BW-D1	-55%	135%
			BP	2-BP-D1	-55%	135%
3 Jan-21	B	2	BW	3-BW-D2	-27%	58%
			BP	3-BP-D2	-27%	12%
4 Mar-21	B	2	BW	4-BW-D3	-18%	49%
			BW	4-BW-D5	0%	30%
			BW	4-BW-D6	18%	10%
		3	BP	4-BP-D5*	0%	-2%
5 May-21	B	3	BW	5-BW-D5	0%	30%
			BP	5-BP-D5*	0%	0%
6 Jun-21	B	3	BW	6-BW-D5	0%	22%
			BP	6-BP-D5*	0%	0%

Selected for 10 gen (Round 1)

Selected for 13 gen (Round 2)

Selected for 16 gen (Rounds 3–6)

Blind feeding (Round 1)

Same feeding (Round 2)

Feed as needed (Rounds 3–6)

Note: Density and feed ration (grams of feed per larva) are represented as deviations (Δ) in percentage from a common benchmark set at BP industrial production conditions. Pattern code indicates round-line-density, where density is coded in ascending order from D1 to D6. Asterisks (*) indicate BP comparison groups that were extracted from production batches parallel in time.

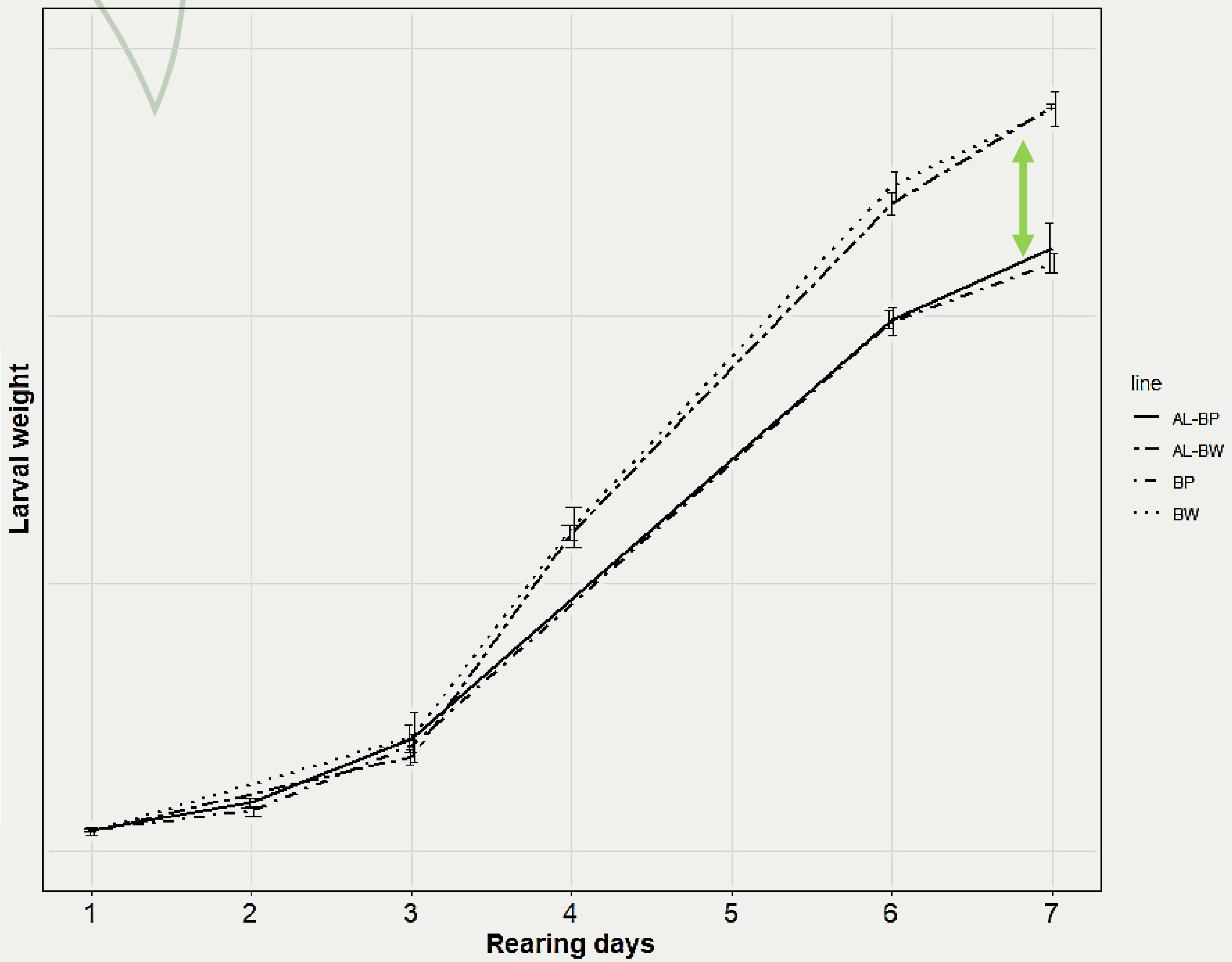
Results: Ad-libitum feed test

✓ Different feeding requirements for BW

Table 2 Average larval weight during rearing period; Larva weights are expressed as deviation (%) from the BP line at standard feed

Line	Feed regime (gr per larva)	Rearing days			
		1	3	6	7
BP	1.67	0	0	0	0
BW	1.82	-7.2%	8.6%	25.7%	26.3%
AL-BP	2.5	-0.7%	7.1%	0.4%	2.6%
AL-BW	2.5	-7.2%	-10.5%	22.3%	26.7%

AL-BP: ad-libitum Base population line; AL-BW: ad-libitum Body weight line; BW: Body weight at standard feed).



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Results

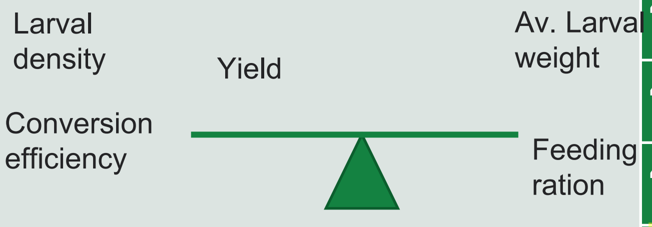
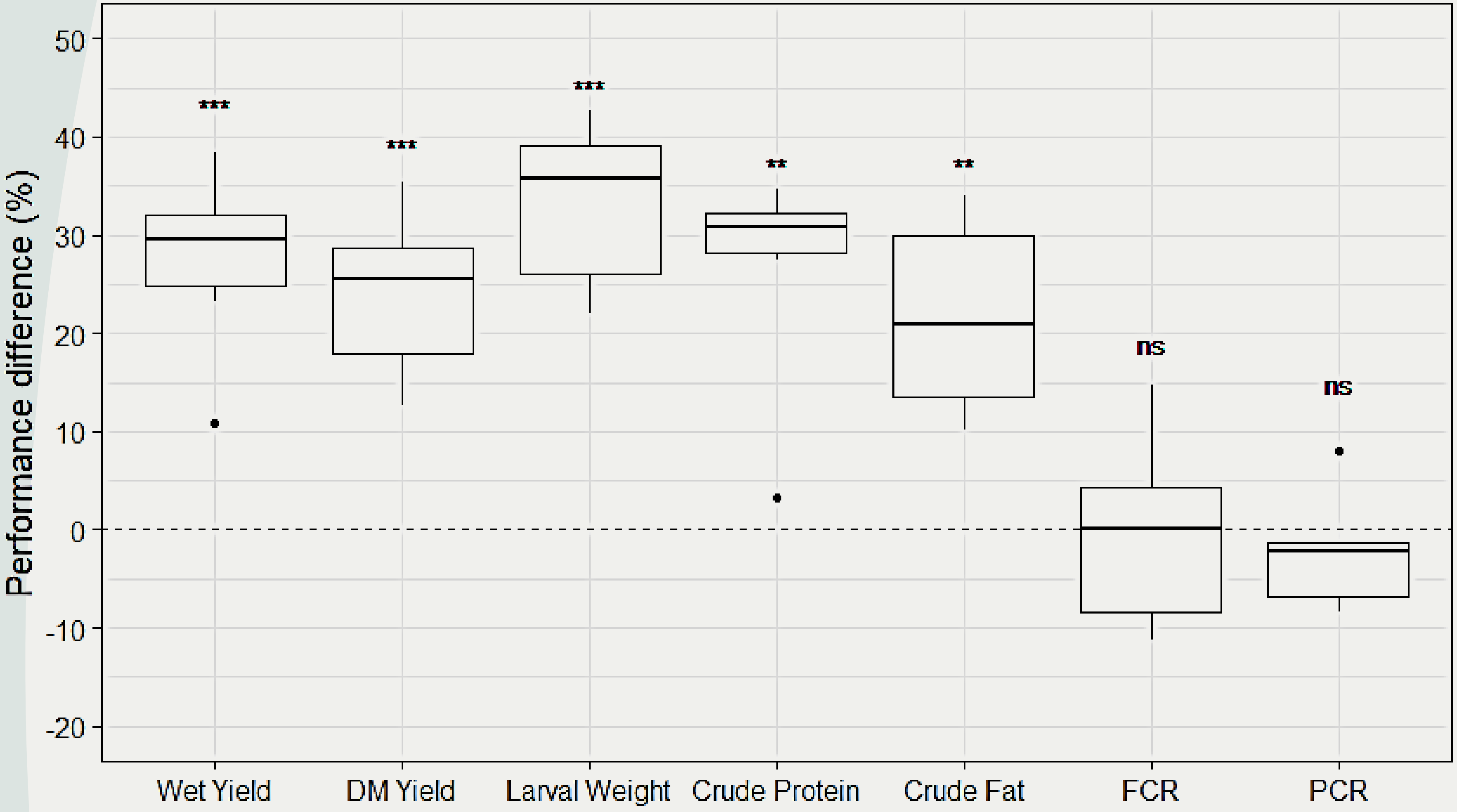


Table 3 Summary of results per round for variables measured

Round	Feed ration	Larval density	Larval weight	Wet Yield	DM Yield	Crude Protein	Crude Fat	FCR	PCR
1	+17%	D4	22%	33%	29%	27%	34%	-10%	-8%
2	0%	D1	23%	11%	13%	3%	10%	-11%	-3%
3	+46%	D2	40%	29%	35%	30%	33%	4%	8%
4	+52%	D3	53%	13%	11%	21%	6%	13%	3%
4	+32%	D5	37%	23%	16%	35%	11%	15%	-1%
4	+12%	D6	18%	24%	14%	26%	8%	17%	5%
5	+30%	D5	43%	30%	24%	31%	20%	4%	-1%
6	+17%	D5	35%	38%	27%	33%	22%	-4%	-8%

Results

- ✓ Significant yield improvements
- ✓ Non-significant conversion ratio



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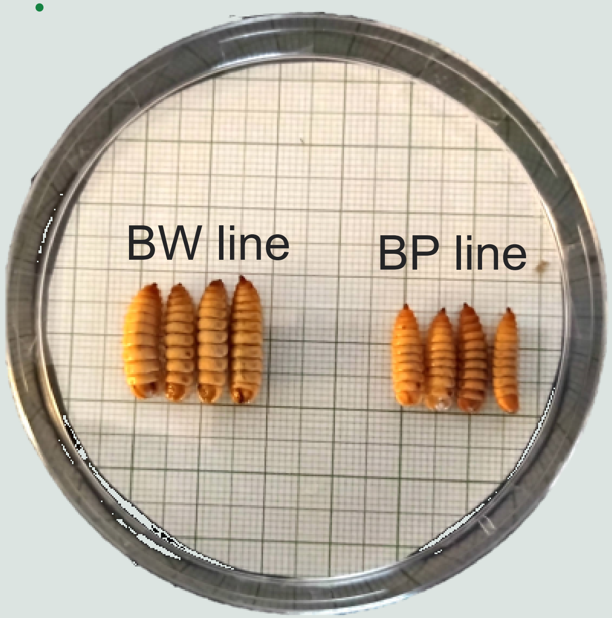
Results: 49% variance explained by Line



Average larval weight data was analysed fitting a linear model:

Yijk= μ + Li + Fk + Rj + εijk

Where

μ = the overall average larval weight,

L = the fixed effect of the line (i = BW, BP),

F = covariate for the adjusted feed ration (feed amount/estimated larvae density),

R = the fixed effect of the round (j = 1, 6),

ε = the random error term.

Variable	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Line	1	127391	127391	1347.21	P<0.001
Adj. Feed ration	1	88661	88661	937.63	P<0.001
Round	5	15777	3155	33.37	P<0.001
Residual	314	29692	95		

Conclusions

- Improvement through selective breeding for body weight in BSF was demonstrated successfully in an industrial setting.
- Annual improvement of 17-20% as opposed to traditional livestock species
- Results provide an indication on potential value of selective breeding in cultivation of BSF.

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Europees Landbouwfonds voor Plattelandsontwikkeling; Europa investeert in zijn platteland

LEADER

Stay tuned for ….

EAAP – Lyon – 30th August 2023 "insect genetics and reproduction"

HENDRIX GENETICS

Effects of artificial selection in the black soldier fly – a Pool-seq approach

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