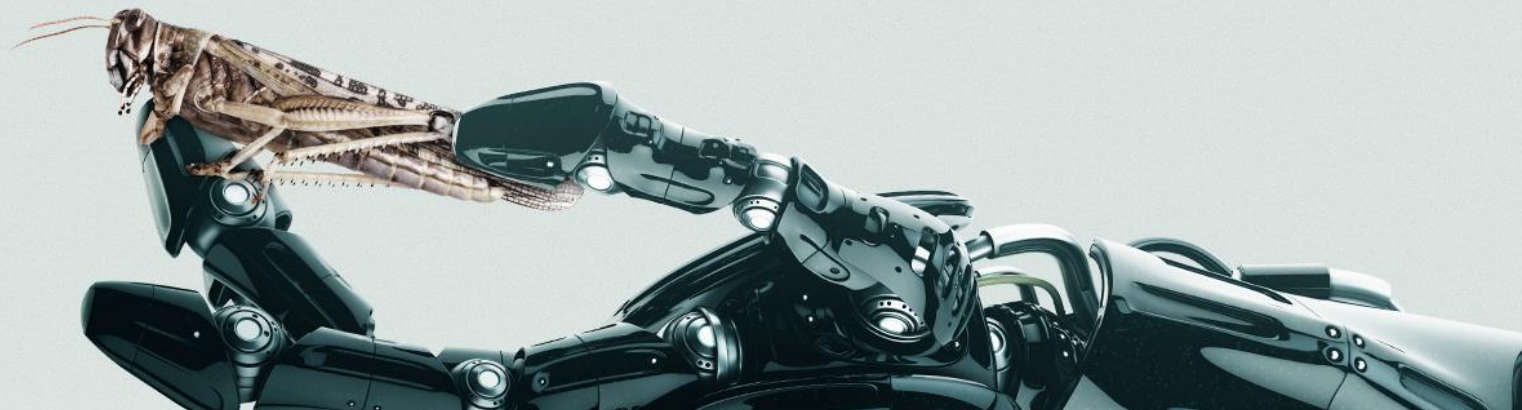




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it's all about innovation





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Insect protein for sustainable feed production

Feed Additives Global 2018
Amsterdam 2018

Anton Gligorescu, Consultant, DTI

Agenda



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- Global protein – current situation
 - Demands
 - Environmental impacts
 - Sustainability
- Alternative protein
 - Insects and insect sector
 - Sustainability aspects
 - Production process
 - Nutritional profile
 - Main challenges
- Questions

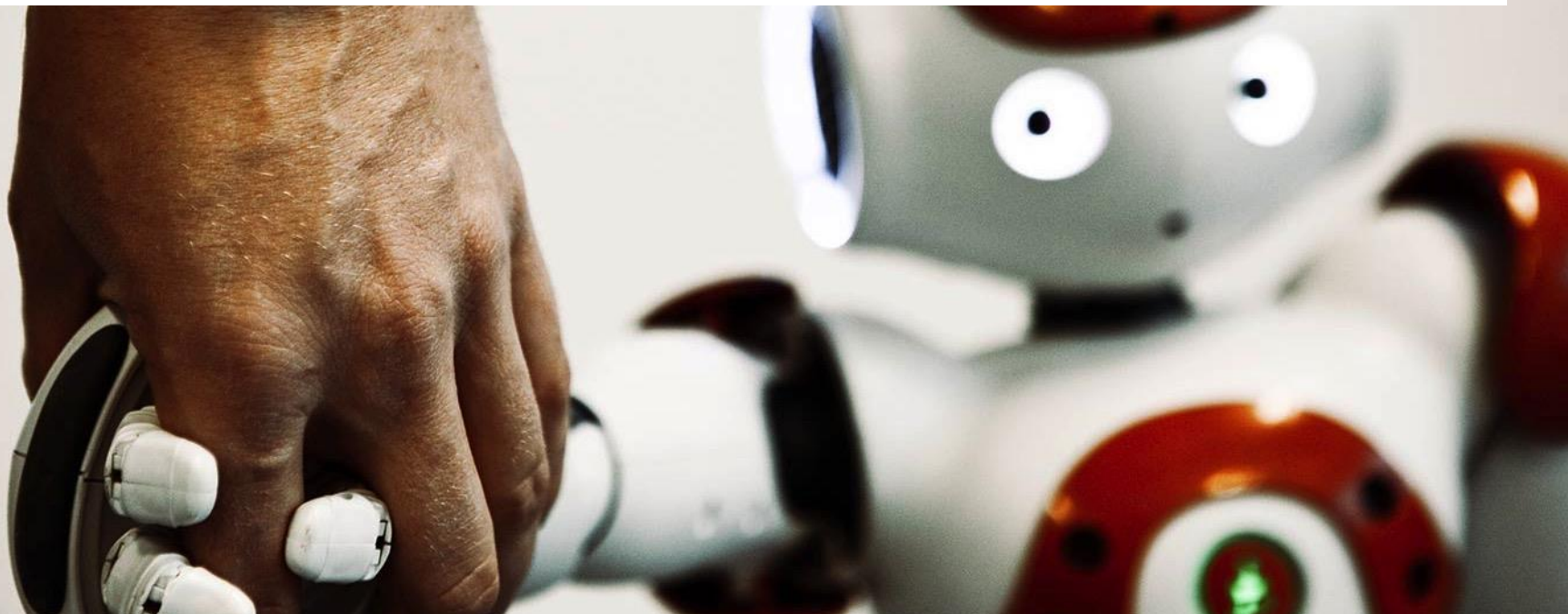


Self-owned and not-for-profit



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More than 1,000 innovative employees, state of the art equipment and facilities as well as a strong global network.

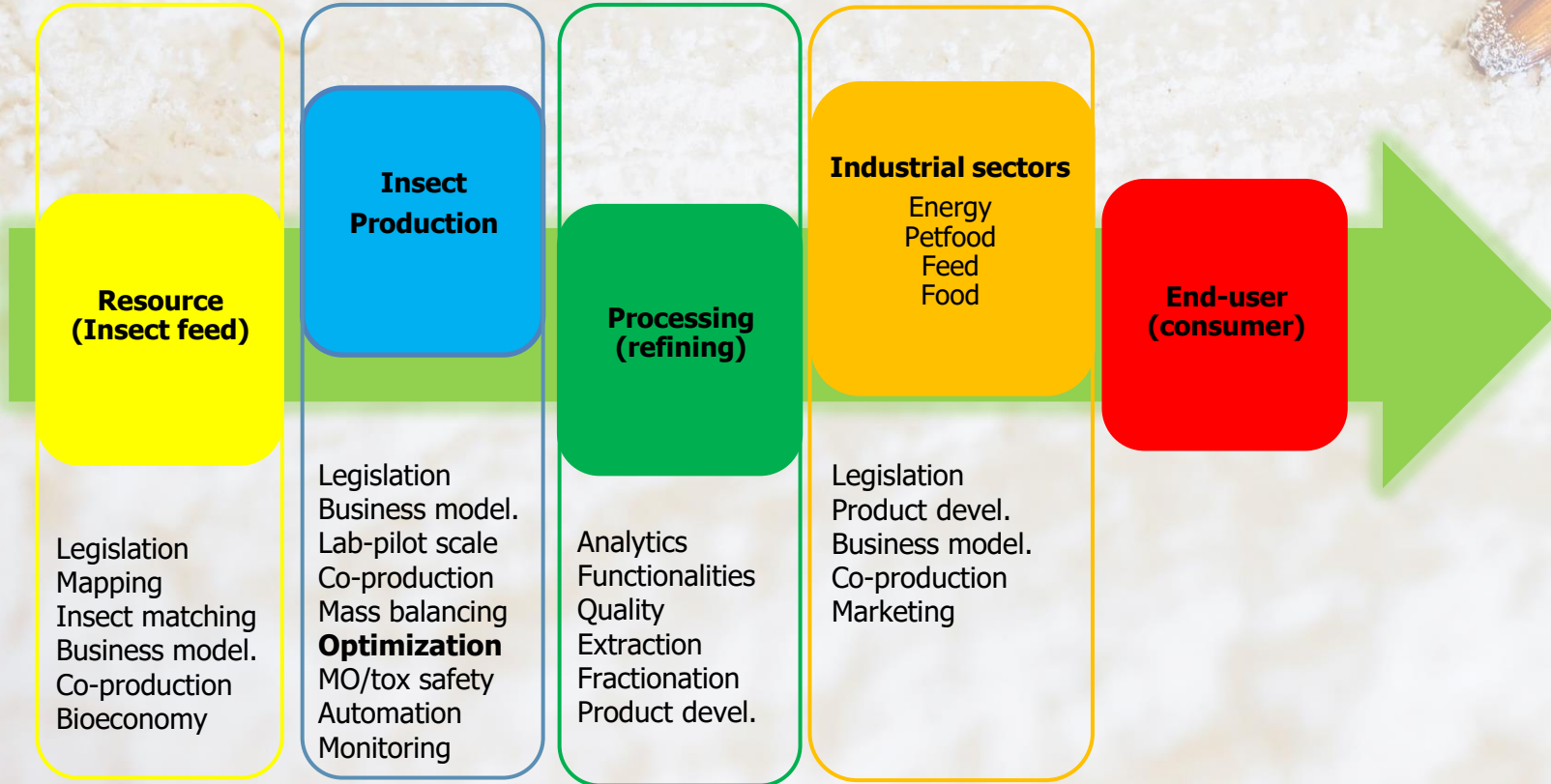


The 'Insect Value Chain' @DTI

Competences and relevant facilities to support R&D and business development



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Global protein: demand and impact



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- **Animal feed**, estimated at a global volume of 1,000M tons in 2014, **represents 60-70% of animal production costs**
- Livestock sector: **75% of all agricultural land**, requires **8% of global human water** use – irrigation and emits **14.5% of all anthropogenic GHG**.
- FAO estimates that **food production has to increase by 70%** to feed the global population in 2050
- Main protein sources: **Soya, Fishmeal, Maize and Grain**

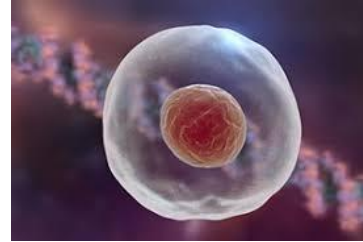


Alternative proteins



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- Requirements:
 - **Moderate-high protein** content
 - Good protein **digestibility** and nutritionally **relevant amino acid** profile
 - Moderate to high content of relevant **minerals and vitamins**
 - Limited content of anti-nutritional factors
 - Health promoting properties (e.g **pre-biotic, feed fibers**)
 - **Sustainable** production
 - Competitive prices (soymeal and fishmeal)
- Candidates:
 - Aquatic biomass – microalgae, macroalgae and seaweeds
 - Industrial residues and formal foodstuffs
 - Single cell protein
 - **Insects**



Insect production - sustainability aspects



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- Low land demand
- Low GHG emissions
- Low water demand
- Short life-cycle
- Bio-conversion of residual streams
- High efficiency
- High yield per unit production
- High protein
- High fat
- Fibers
- Vitamins and Minerals
- Pro-biotic properties



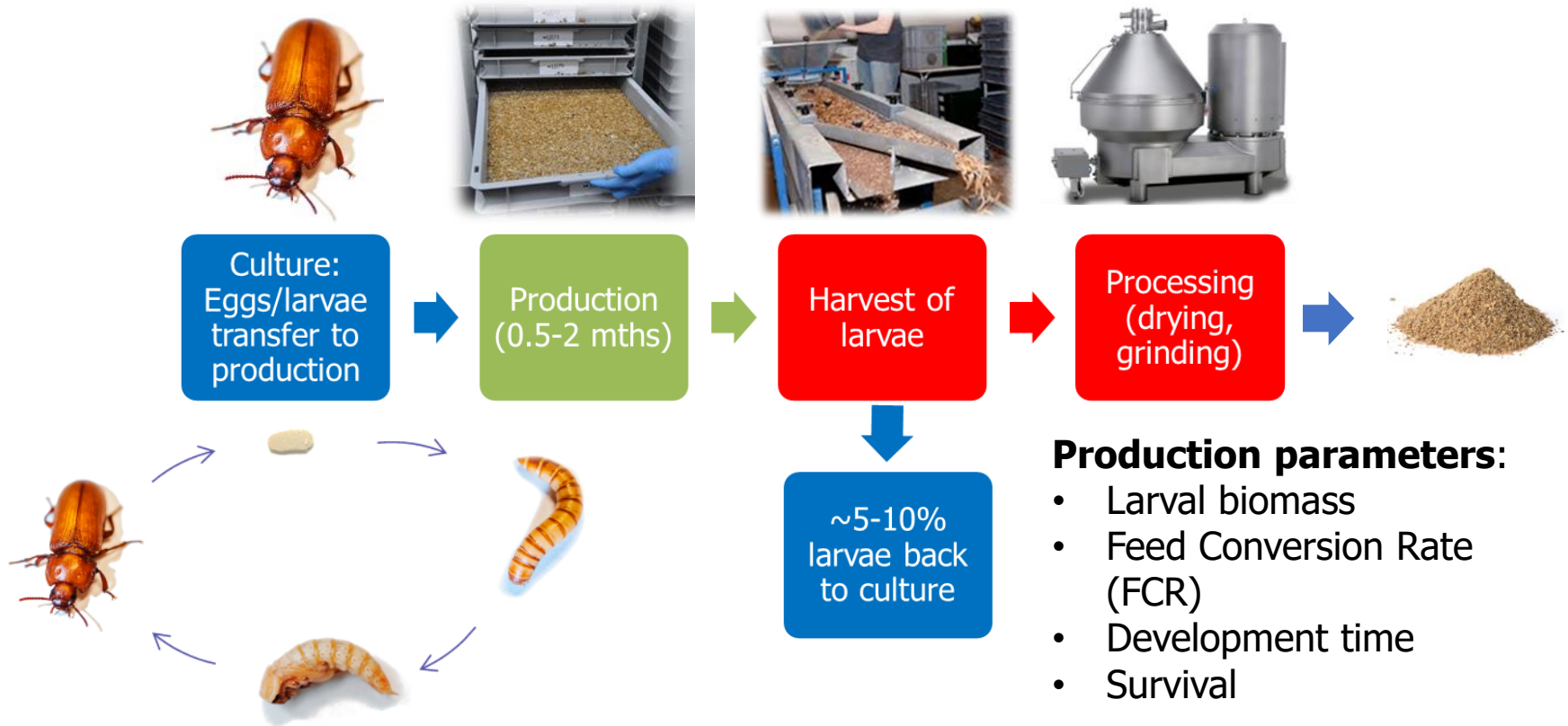
European insect sector



Insect production - generic production process



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Insect production – *Hermetia illucens*



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- Garage dimensions:
5m * 4m * 2m
- Production place:
4m * 3m * 1.75m

Experimental parameters:

- Substrates: Chicken feed
- Duration: 8-10 days
- Survival: 80 – 100%
- ≈ 30 °C; 60% RH
- Substrate DM: 18 -22%
- Larval production per m³: 23 kg

Production in a garage:

- Larval biomass: 17 tones/year (dm)
- Larval protein: 6 tones/year (dm)

Soy production USA

- Soy seeds: 3.2 tones/hectare
- Soy protein: 2.26 tones/hectare

Larval characteristics:

- Ash: 9.5%
- Protein: 46%
- Fat: 18%

Latest FCR (DM): 1.6

Nutrients quality



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Essential amino acids	Mealworm	BSFL	Fishmeal	Soymeal
Histidine	2.7	2.6	2.6	2.6
Arginine	4.5	4.8	5.8	7.4
Threonine	3.6	3.6	4.3	3.9
Valine	5.9	5.6	4.8	4.8
Methionine	1.2	1.4	2.9	1.4
Isoleucine	4	4	4	4.6
Leucine	6.9	6.6	7.4	7.5
Phenylalanine	3.2	3.8	3.6	5
Lysine	4.9	5.6	7.8	6.1
Total	36.9	38	43.2	43.3

Mealworm, BSFL and fishmeal: Józefiak *et al.*, 2016
Soymeal: Fedepedia, Soybean meal



Protein: 50-60%
Fat: 10-30%
DM: 30-40%



Protein: 40-50%
Fat: 25-35%
DM: 30-40%

Fatty acids	Mealworm	BSFL
C12:0	0.2–1.3	21–37
C14:0	1.1–8.2	2.9–8.6
C16:0	11–23	12–20
C16:1	1.6–4.7	3.8–6.3
C18:0	1.0–4.5	1.8–6.5
C18:1n9c	40–61	23–32
C18:2n6c	15–31	2.1–6.8
C18:3n3	0.3–1.3	0.0–0.5

Oonincx *et al.*, 2015

Digestibility in mink and young pigs



Digestibility in mink	BSFL		Fishmeal (322-0)	
	Digestibility %		Digestibility %	
Dry matter	42.8%		92.4 %	
Protein (N*6.25)	20.1%	86	70.5 %	83
Fat	15.5%	90	11.3 %	94
Ash	1.2%	-	12.9 %	

Diets	Nutrients digestibility in young pigs		
	Diet 1 (fishmeal 5%)	Diet 2 (BSFL meal 7%)	Diet 3 bioactive additive: 0.5kg BSFL/t
Dry matter (%)	74.85	80.4	81.28
Protein (%)	79.82	82.45	82.85
Fat (%)	53.71	64.05	55.37
Fibre (%)	29.6	41.39	51.09
Growth rate (g/day)	500	533	571.8

Main challenges of the insect industry

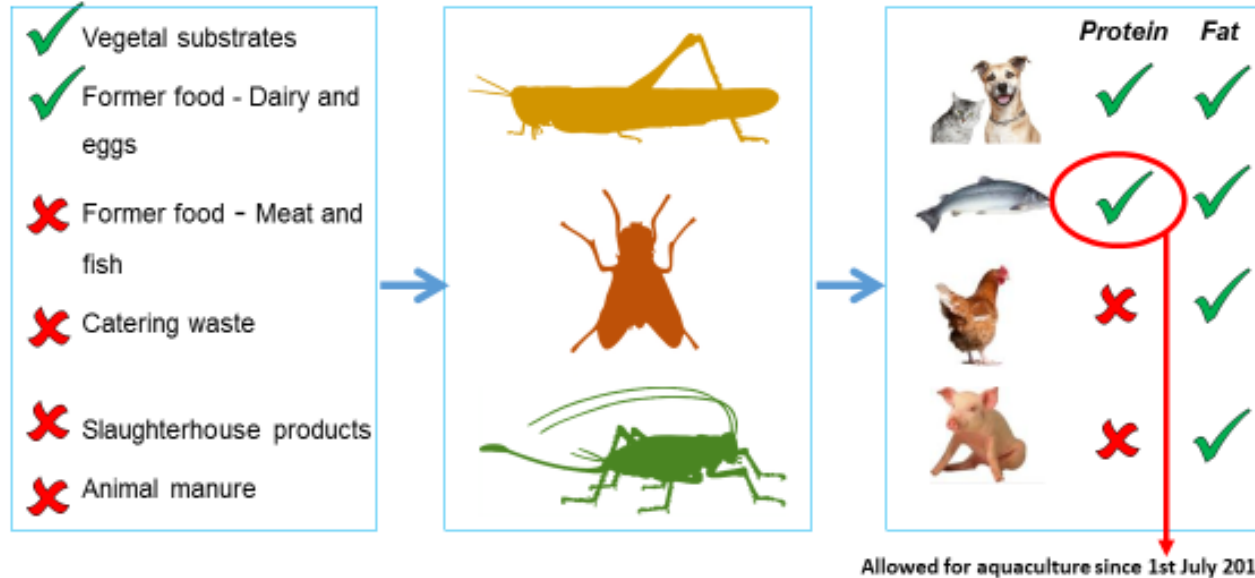


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- **Upscaling (industrial level)**
 - Insect biology in production environment
 - Development of (customized) automation
 - Development of species-specific feed
- **Legal barriers (EU) in feed and food**
 - Increasing the knowledge-level on feed/food safety of insects
 - Political priority to promote the use of insects as feed and food
- **Consumer acceptance (mainly as food)**
 - Information...



Insects: Regulatory overview



References



- Józefiak et al., 2016. Insects-a natural nutrient source for poultry- a review. *Ann. Anim. Sci.*, 16, 2: 297–313.
- Fedepedia, Soybean meal, Nutritional tables. Online source: <https://www.feedipedia.org/node/674>
- Onincx et al., 2015. Feed Conversion, Survival and Development, and Composition of Four Insect Species on Diets Composed of Food By-Products. *Plos one*. Online source: <https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0144601&type=printable>
- Nekrasov et al., 2015. BIOCHEMICAL CHARACTERISTICS OF HERMETIA ILLUCENS: A BASE FOR PROSPECTIVE USE OF LARVAL BIOMASS IN YOUNG PIG FOOD. *Journal of Nature Science and Sustainable Technology* 9, 2.



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