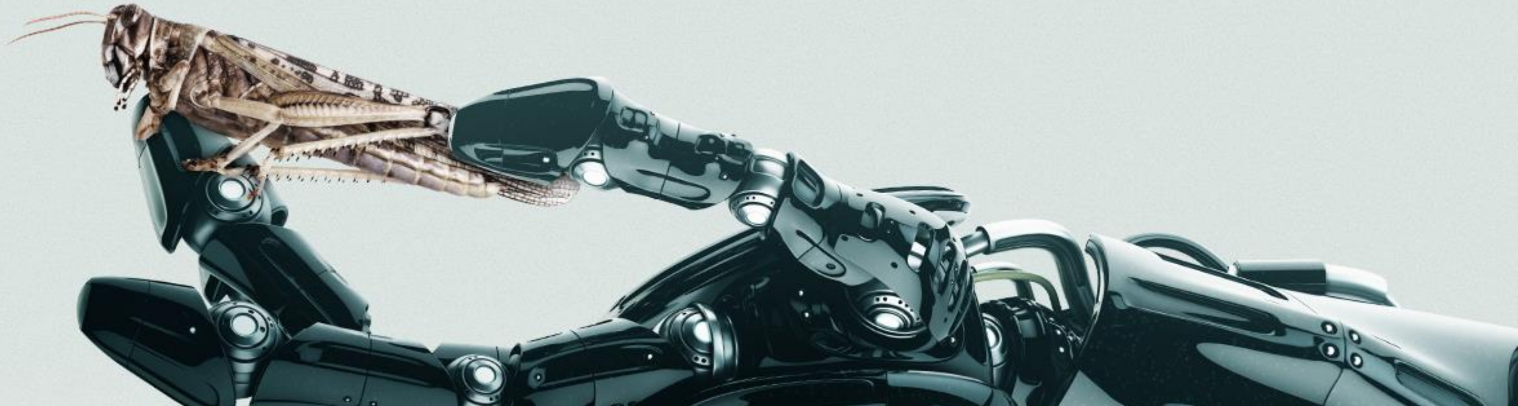
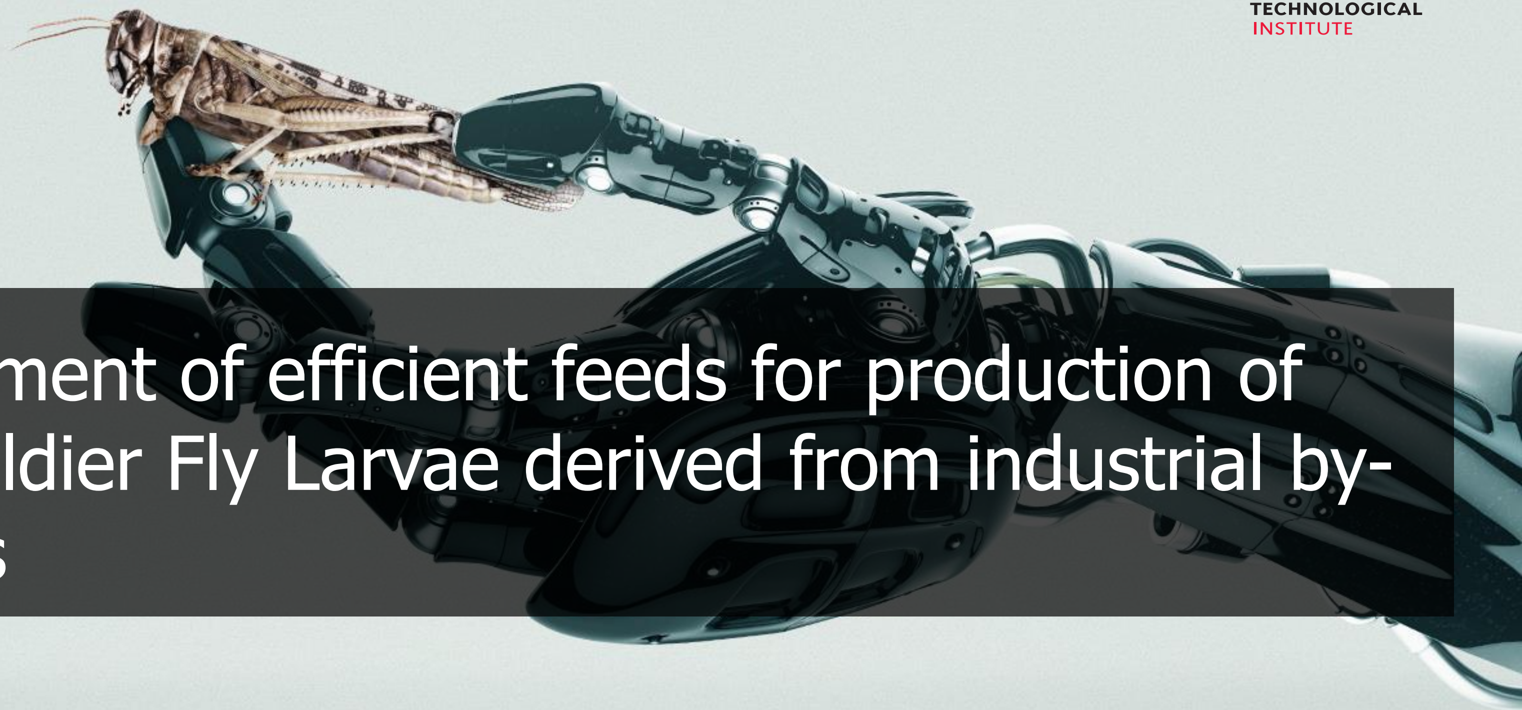
it's all about innovation





Development of efficient feeds for production of Black Soldier Fly Larvae derived from industrial by-products

DANISH TECHNOLOGICAL INSTITUTE

Insecta 2019
Potsdam 2019

Anton Gligorescu, Consultant, DTI

Agenda

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- Global food and feed
  - Demands
  - Protein feed requirements
- Feeding services
  - Diet formulation
  - Dietary experiments
  - Validation – pilot production
  - Nutrient content
  - Ongoing work
- 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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Resource (Insect feed)

- Legislation
- Mapping
- Insect matching
- Business model
- Co-production
- Bioeconomy

Insect Production

- Legislation
- Business model
- Lab-pilot scale
- Co-production
- Mass balancing
- **Optimization**
- MO/tox. safety
- Automation
- Monitoring

Processing (refining)

- Analytics
- Functionalities
- Quality
- Extraction
- Fractionation
- Product development

Industrial sectors

Energy
Petfood
Feed
Food

- Legislation
- Product Development
- Business model
- Co-production
- Marketing

End-user (consumer)

Global feed: 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 feed** sources: **Soya, Fishmeal,** Maize and Grain.

Protein feed requirements

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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. **prebiotics, feed fibers**)
  - **Sustainable** production
  - Competitive prices (soymeal and fishmeal)

Substrate selection and diet formulation

Dry matter (dm), protein, lipid and ash content (%) and availability of different substrates from Guldborgsund Municipality.

Substrates	Dry matter (dm) (%)	Protein (%dm)	Lipid (%dm)	Ash (%dm)	Sesonability
Seagrass	13	7	1	31	all year
spent grain	17	25	11	3	all year
apple pomace	20	5	4	4	autumn
wheat	88	12	3	1	all year
Rapeseed cake	74	35	10	8	all year
sugarbeet tops	14	29	3	24	autumn
malt	75	24	3	7	all year
butter cookies	96	6	22	1	all year

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Percentage of different substrates and water used in the formulation of 4 diets

Substrates	Diet 1 (%)	Diet 2 (%)	Diet 3 (%)	Diet 4 (%)
seagrass	10	5	0	0
spent grain	15	20	19	25
apple pomace	0	10	0	10
wheat	20	10	11	10
rapeseed cake	0	2	0	2
sugarbeet tops	5	0	2	0
malt	5	10	3	10
butter cookies	5	0	3	0
water	40	43	62	43

Experimental parameters

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Total protein, lipid and ash content of different diets used in the dietary experiment

	Diet 1	Diet 2	Diet 3	Diet 4
Protein (% dm)	24	28	19	29
Lipid (% dm)	10	7	9	7
Ash (% dm)	6	7	3	6

- Tray size: 30x20 cm
- Replicates: 3 per diet
- Temperature: 27ºC
- Density: 11 larvae/cm²
- Total feed per replicate: 2 kg
- Dry matter: 19%
- Feeding episodes: 3
- Experimental time: 12 days

Dietary experiments

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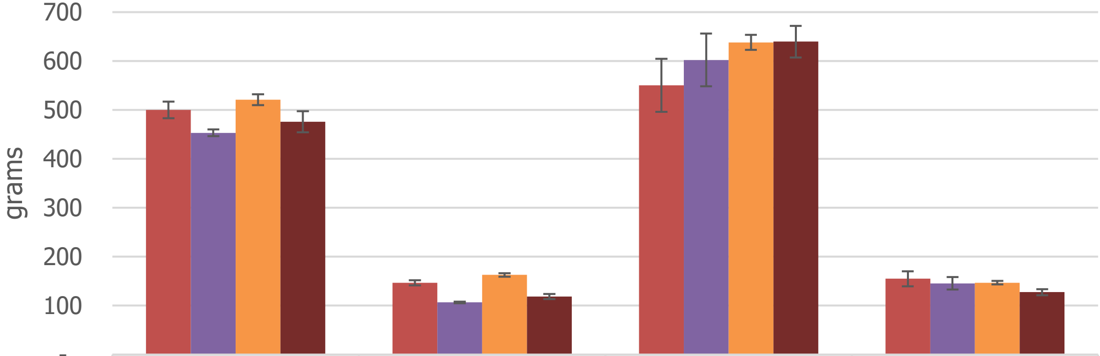
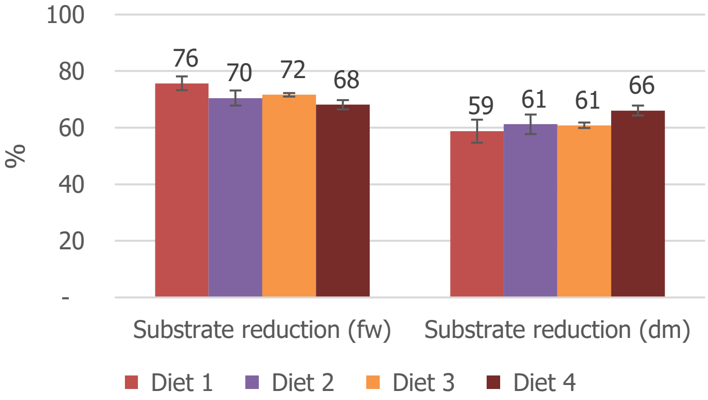
Larval and insect frass production during the dietary experiments (avg±sd)



	Larval production (fw)	Larval production (dm)	Insect Frass (fw)	Insect Frass (dm)
Diet 1	500	147	550	155
Diet 2	453	107	602	146
Diet 3	521	163	638	147
Diet 4	476	119	640	127

Substrate reduction during the dietary experiments (avg±sd)



Dietary experiment

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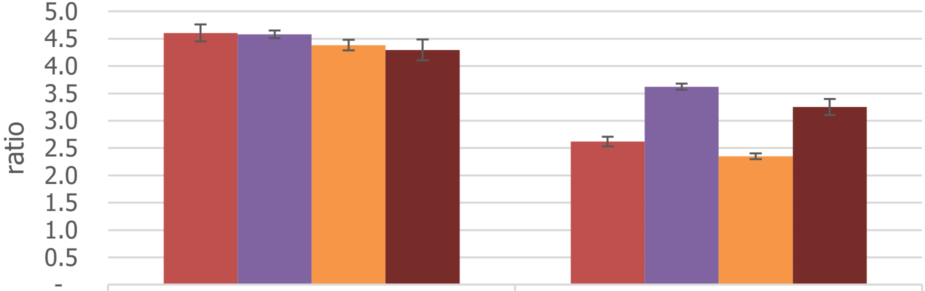
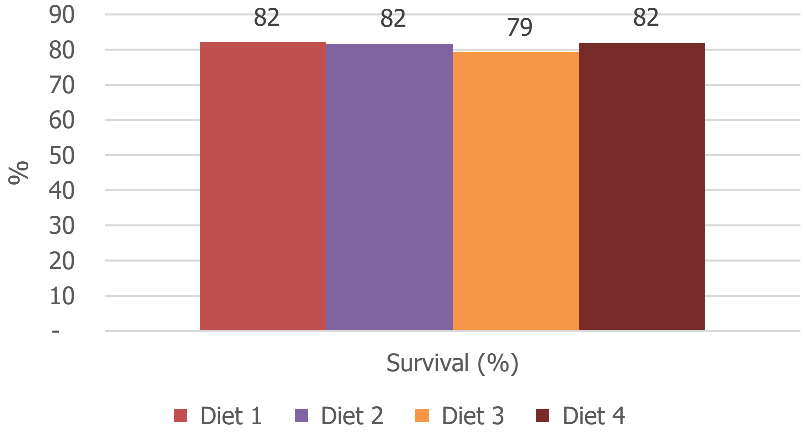
Feed conversion ratio on both fresh and dry weights, from the dietary experiment (avg±sd)



	FCR (fw)	FCR (dm)
Diet 1	4.6	2.6
Diet 2	4.6	3.6
Diet 3	4.4	2.4
Diet 4	4.3	3.3

Survival rate of BSFL during the dietary experiment (avg)



Validation of Diet 3 in pilot production

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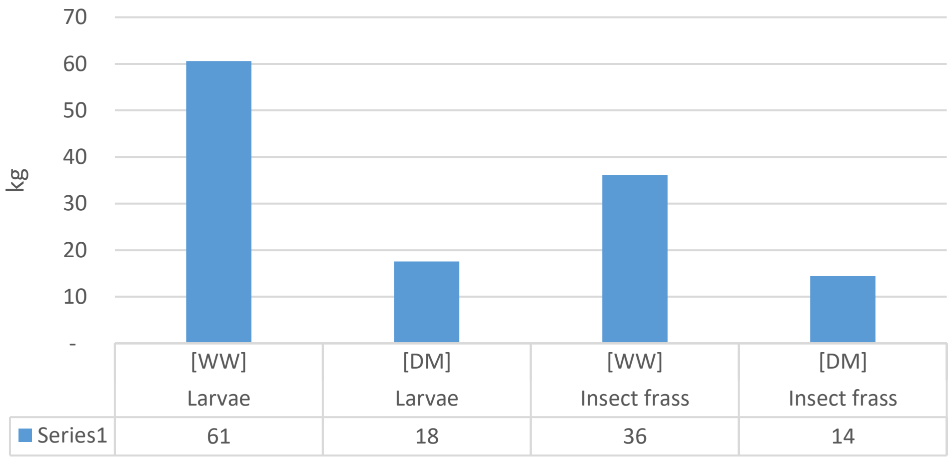
Production parameters:

- Tray size: 60x40
- Temperature: 27ºC
- Density: 10 larvae/cm²
- Feed used: Diet 3
- Total feed per replicate: 8 kg
- Dry matter: 19%
- Feeding episodes: 2
- Experimental time: 10 days

Total larval and insect frass production during validation



Validation of Diet 3 in pilot production

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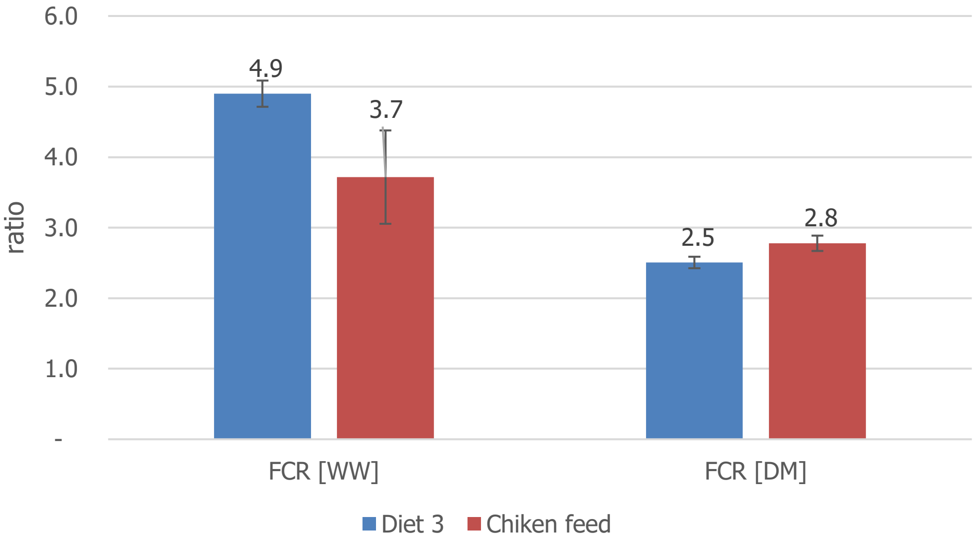
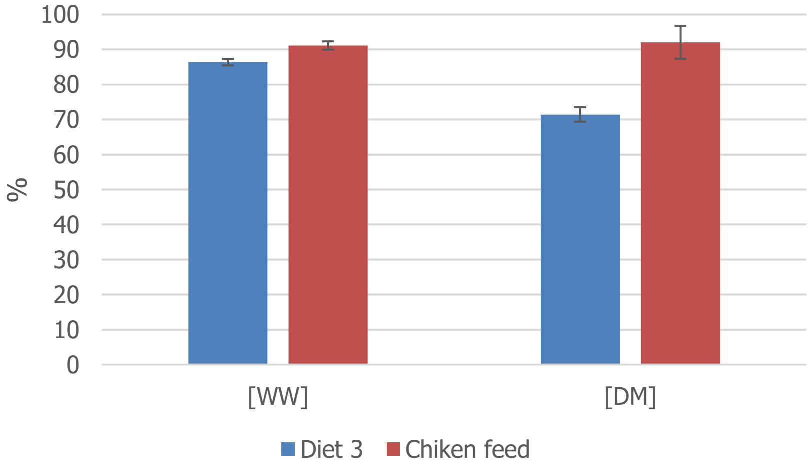
Feed conversion rate from 2 pilot productions using Diet 3 and Chicken feed



Substrate reduction from 2 pilot productions using Diet 3 and Chicken feed

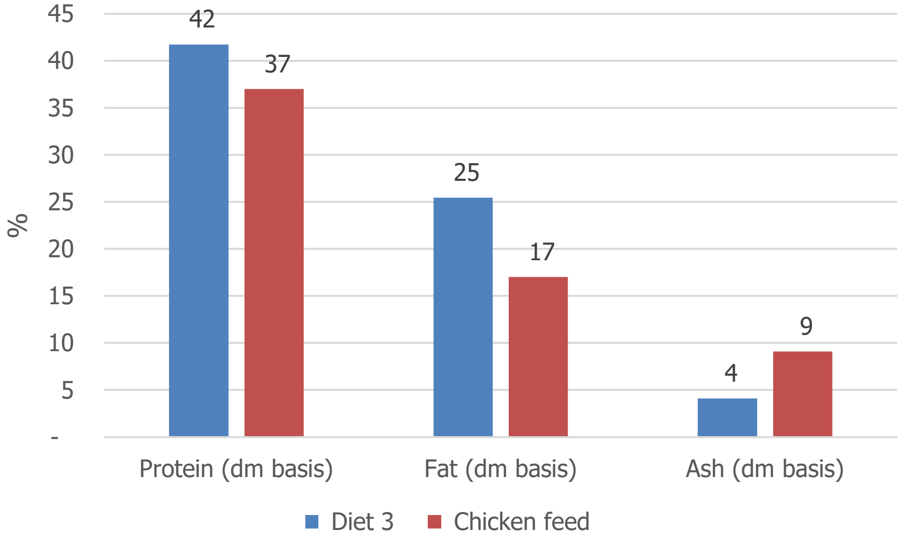


Survival rate

- Diet 3: 84%
- Chicken feed: 91%

Validation of Diet 3 in pilot production

Total protein, lipid and ash content of BSFL reared on Diet 3 and Chicken feed (avg.)



Nitrogen, Phosphorus and Potassium content in insect frass, diet 3.

	Nitrogen (kg/tonne)	Phosphorus (kg/tonne)	Potassium (kg/tonne)
Insect frass	17.2	4.8	7.4

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Conclusions and ongoing activities

Conclusions:

- By-products from Guldborgsund Municipality can be used to produce BSFL meal
- Low FCR indicating high efficiency of the system
- High protein and lipid content.

Ongoing activities:

- Faecal profiling
- Optimization of insect meal processing
- Fish trials

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