Environmental impact of feeds utilized for poultry protein productions: soybean vs insect larvae

Dusan Ristic

Research Associate, DIL
PhD Candidate, BOKU

With support:

W. Heines[1], Carl L. Coudron[2], Achille Schiavone[3], Jonas Claeys[2], Francesco Gai[4], Sergiy Smetana[1]

[1]DIL Deutsche Institut für Lebensmitteltechnik e. V., Germany;
[2] Inagro VZW; Belgium;
[3]Dept. Veterinary Sciences, University of Turin, Italy;
[4]Institute of Sciences of Food Production, National Research Council, Italy

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POULTRYNSECT – PROJECT OVERVIEW

Organic Food Side Streams

Live Hermetia Illucens larvae

Slow growing local chicken breeds

Organic, high quality chicken meat

POULTRYNSECT – PROJECT OVERVIEW

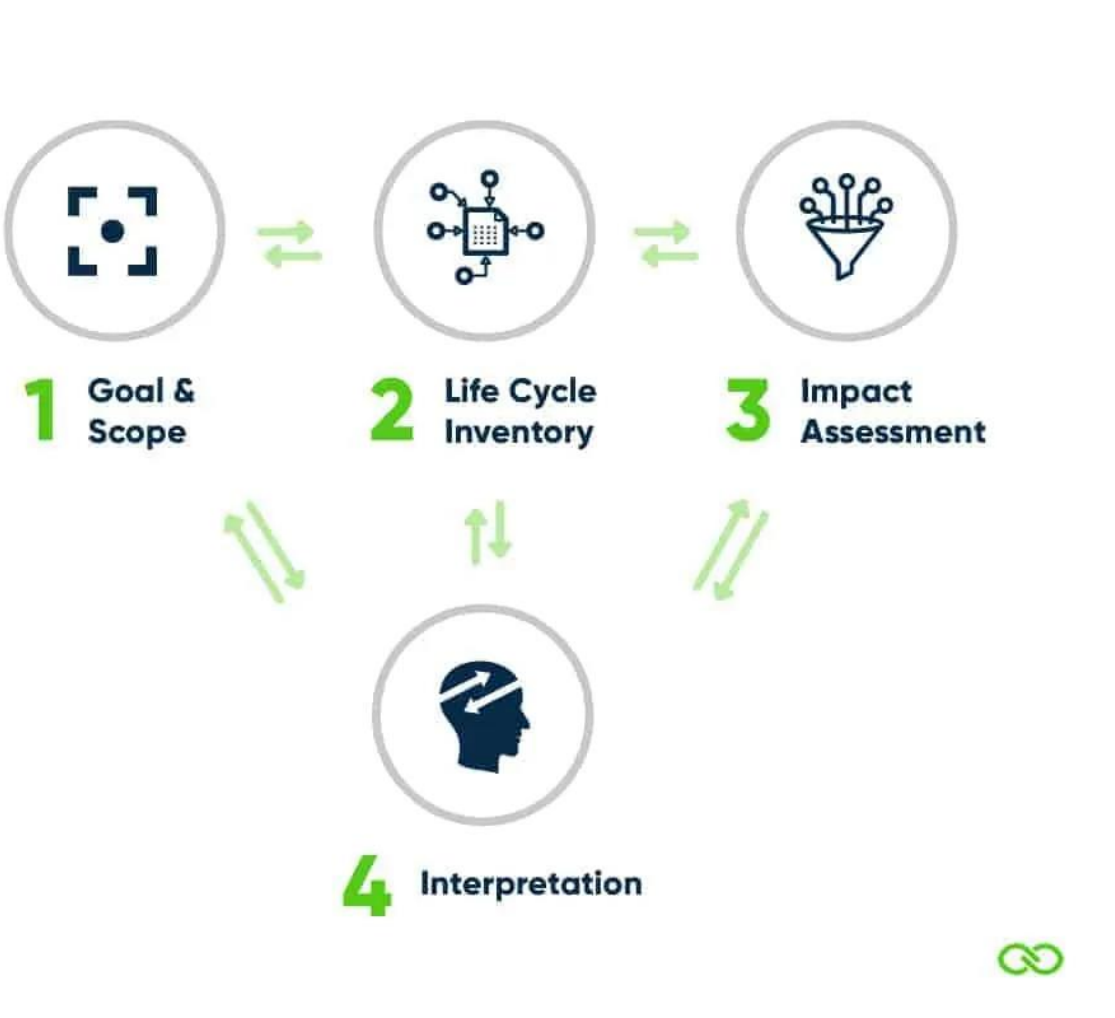
Project objectives:

1. Optimization of *Hermetia Illucens* diet
2. Valorization of agronomic potential of the frass
3. Finding out the optimal level of *Hermetia Illucens* larvae in chicken diet
4. Larval influence on the bird welfare status
5. The impact of larvae bioactive compounds on chicken gut
6. Larval influence on poultry meat quality
7. The environmental impact of the chicken meat

SOY OR INSECTS? CHICKEN OR EGGS?

- Protein of animal origin – high environmental costs
- Higher efficiency:
    1) less resources used and/or
    2) more protein
- Can we use insects to minimize the use of resources?
- How can we get the most protein from chicken production?

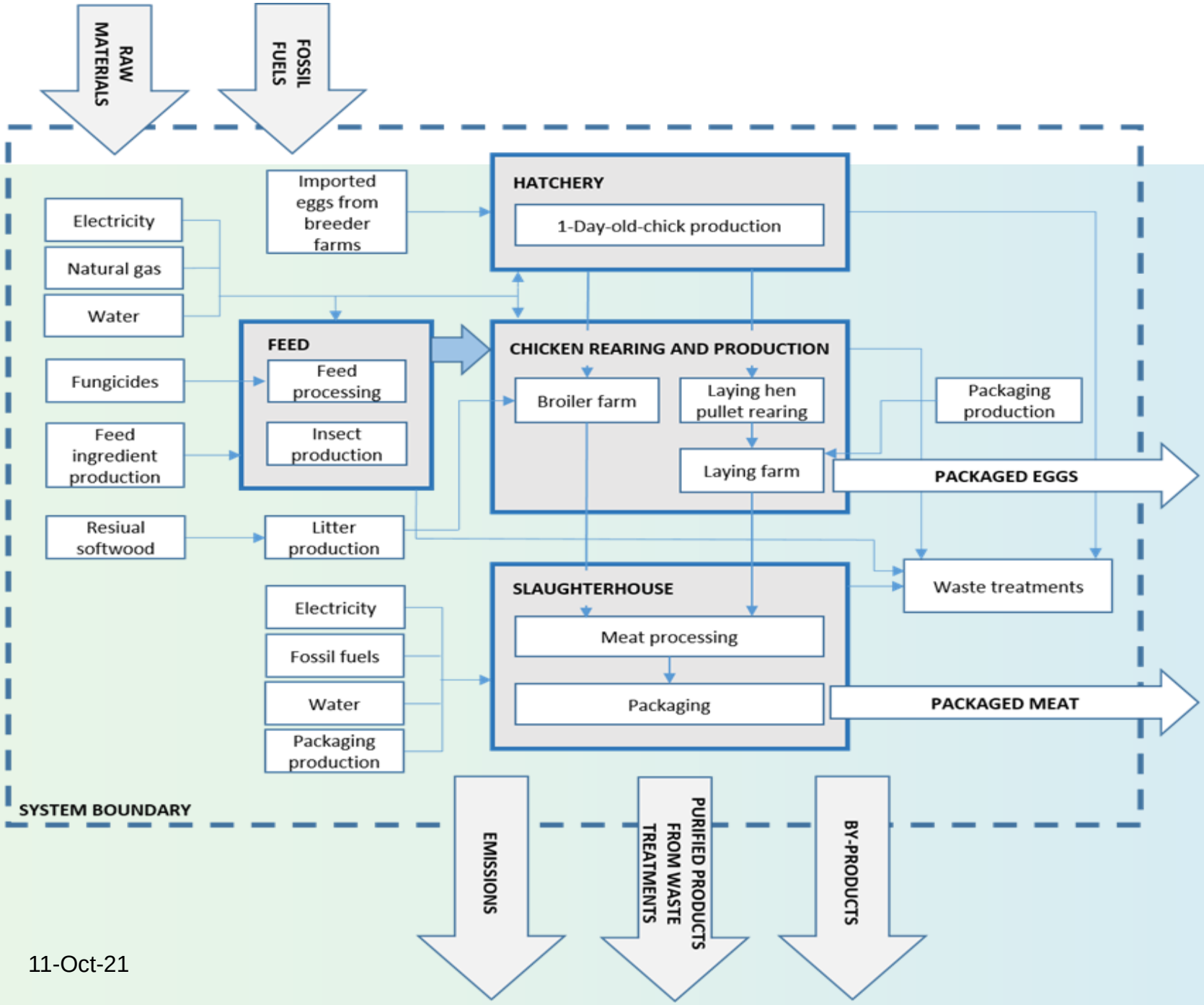
LCA STAGES



Picture source: https://ecochain.com/knowledge/life-cycle-assessment-lca-guide/

GOAL AND SCOPE

- Environmental impact and efficiency of 2 types of chicken protein production
- Estimate the amount of protein produced from feed providing 20t of protein
- Further, it was hypothetised that environmental footprint of protein production can be lowered by inclusion of insects into the commercial feed
- Insects were considered to be fed on 2 different diets


RAW MATERIALS
FOSSIL FUELS
Imported eggs from breeder farms
HATCHERY
1-Day-old-chick production
Electricity
Natural gas
Water
FEED
Feed processing
Insect production
Fungicides
Feed ingredient production
Resiual softwood
Litter production
CHICKEN REARING AND PRODUCTION
Broiler farm
Laying hen pullet rearing
Laying farm
Packaging production
PACKAGED EGGS
Waste treatments
SLAUGHTERHOUSE
Meat processing
Packaging
PACKAGED MEAT
Electricity
Fossil fuels
Water
Packaging production
SYSTEM BOUNDARY
EMISSIONS
PURIFIED PRODUCTS FROM WASTE TREATMENTS
BY-PRODUCTS

INVENTORY ANALYSIS

- The data were collected from the literature, mostly:

    1. Dekker et al. (2011) (Netherlands) for laying hen production and
    2. González-García et al. (2014) (Portugal) for broiler production)

- Calculations were done in SimaPro 8.5.2.0 (PRé Consultants, Netherlands)
- Background data were taken from the ecoinvent 3 (ecoinvent, Switzerland) and Agri-footprint (Agri-footprint, Netherlands) database.
- Adapted to the DIN EN ISO 14044:2006

INVENTORY ANALYSIS

- Methodology - IMPACT 2002+
- Two functional units:

    1. Protein conversion ratio, FU1 – amount of chicken protein that can be produced with 20t of feed protein.

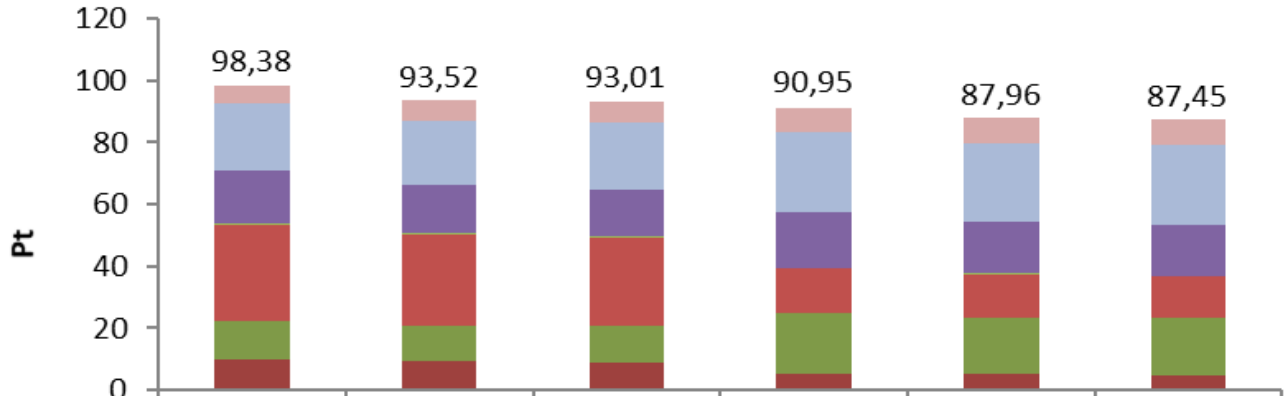
    2. Functional unit, FU2 – estimation of production of 1 kg of chicken protein.

PROTEIN PRODUCED

Scenarios		Commercial feed protein (t)	BSFL protein, fed with Gainesville diet (t)	BSFL protein, fed with fruit and vegetable waste (t)	Protein produced (kg)
A	Egg production	20			8,335.75
B	Egg production	18	2		
C	Egg production	18		2	
D	Broiler production	20			9,135.456
E	Broiler production	18	2		
F	Broiler production	18		2	

Protein conversion efficiency: 0.417 for laying hens and 0.446 for broilers.

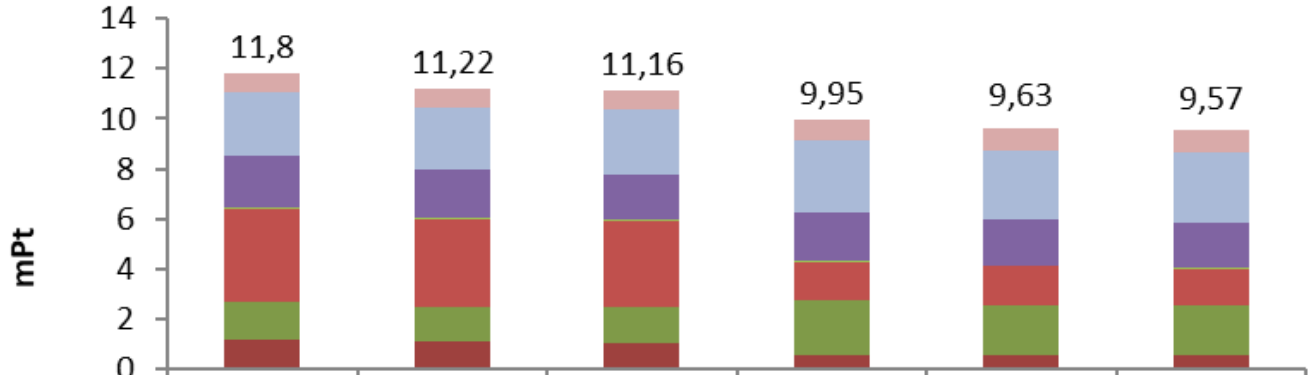
LCA RESULTS



	Scenario A	Scenario B	Scenario C	Scenario D	Scenario E	Scenario F
Non-renewable energy	5.9358	6.325	6.7158	7.6382	8.117	8.5077
Global warming	21.6267	21.022	21.5076	26.0406	25.248	25.7337
Land occupation	16.804	15.6618	15.1724	17.7097	16.7596	16.2703
Terrestrial acid/nutri	0.5376	0.5084	0.4934	0.4345	0.4221	0.4071
Terrestrial ecotoxicity	31.2559	29.2303	28.6297	14.26	14.0222	13.4216
Respiratory inorganics	12.4206	11.6928	11.5668	19.6196	18.3642	18.2382
Non-carcinogens	9.4004	8.7037	8.5412	4.5695	4.3874	4.2249
Carcinogens	0.3966	0.3762	0.3853	0.6763	0.6412	0.6502

Comparing processes; FU1: use of 20 t of feed protein
Method: IMPACT 2002+ V2.14 / IMPACT 2002+ / Single score

LCA RESULTS



	Scenario A	Scenario B	Scenario C	Scenario D	Scenario E	Scenario F
Non-renewable energy	0.712	0.7588	0.8057	0.8361	0.8885	0.9313
Global warming	2.5944	2.5219	2.5802	2.8505	2.7637	2.8169
Land occupation	2.0159	1.8789	1.8202	1.9386	1.8346	1.781
Terrestrial acid/nutri	0.0645	0.061	0.0592	0.0476	0.0462	0.0446
Terrestrial ecotoxicity	3.7496	3.5066	3.4346	1.5609	1.5349	1.4692
Respiratory inorganics	1.49	1.4027	1.3876	2.1476	2.0102	1.9964
Non-carcinogens	1.1277	1.0441	1.0246	0.5002	0.4803	0.4625
Carcinogens	0.0476	0.0451	0.0462	0.074	0.0702	0.0712

Comparing processes; FU2: 1 kg produced chicken protein
Method: IMPACT 2002+ V2.14 / IMPACT 2002+ / Single score

CONCLUSIONS

- Broiler production has slightly higher protein efficiency than egg production
- Laying hen production achieved higher single score results than broiler production
- The production of feed has by far the largest share of the environmental impact of the entire production
- Decrease of environmental impact due to introduction of larvae:

Decrease with introduction of *Hermetia Illucens* larvae into diet of	Larvae fed on Gainesville diet	Larvae fed on fruit and vegetable waste
Laying hens	-5%	-5,5%
Broilers	-3.3%	-3.8%

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Thank you for your attention!

Dusan Ristic

Research Associate | Food Data Group
DIL Deutsches Institut für Lebensmitteltechnik e.V.
d.ristic@dil-ev.de