

The environmental potential of the conversion of organic resources by black soldier fly larvae

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Planet Earth

10 Billion in 2050



BSF and the conversion of organic resources



Environment versus Growth



BSF as feed



Assess environmental potential of BSF larvae reared on different organic resources classified within the EU framework.



Bosch et al.

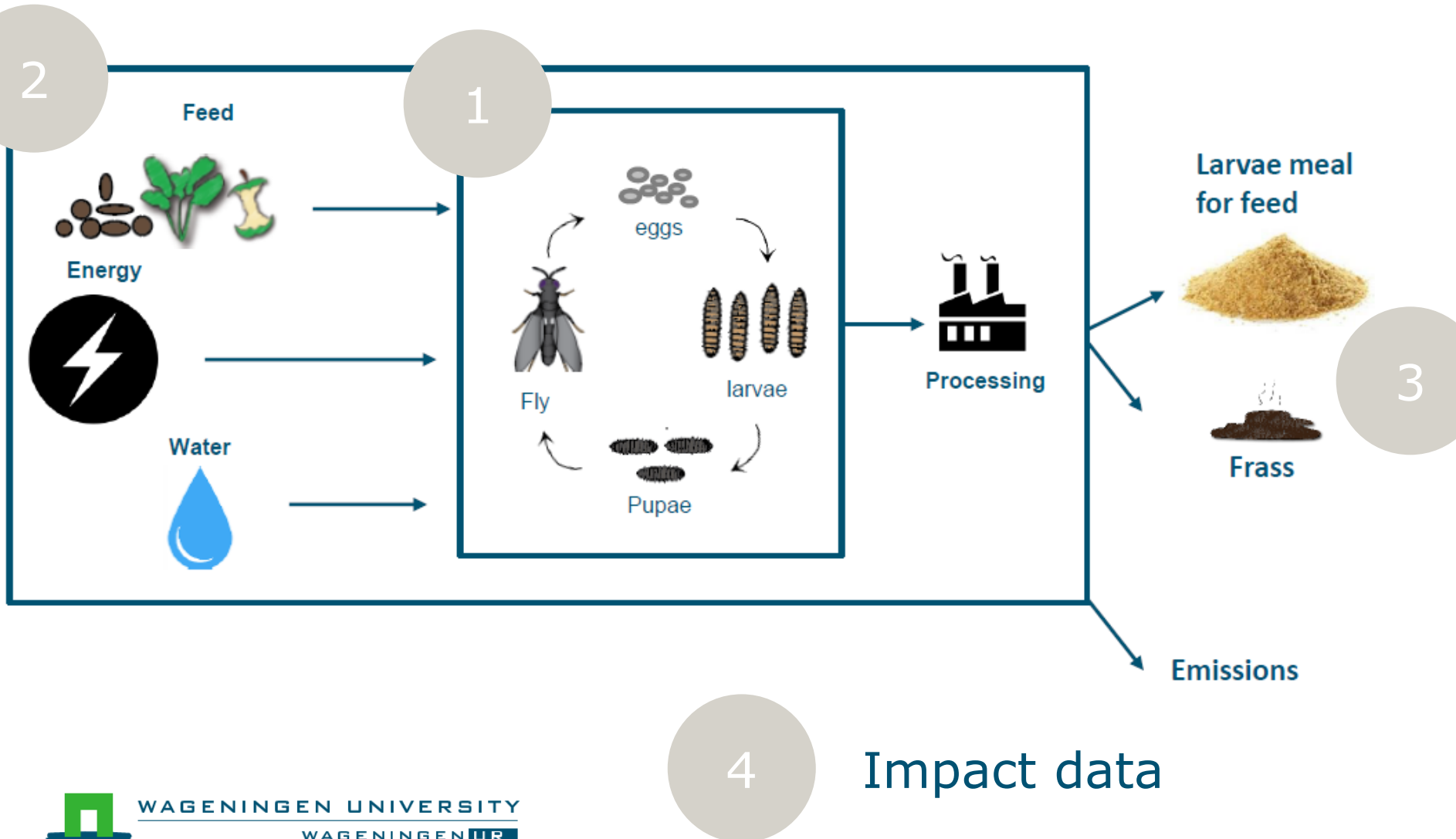
Conversion of organic resources by black soldier fly larvae:
legislation, efficiency and environmental impact
J. of Cleaner Production 2019

Method

1. Assess the environmental impact (LCA): Data based on a literature
2. Classify the various feed sources for rearing insects, within the current EU legislative framework



Method: Life Cycle Assessment

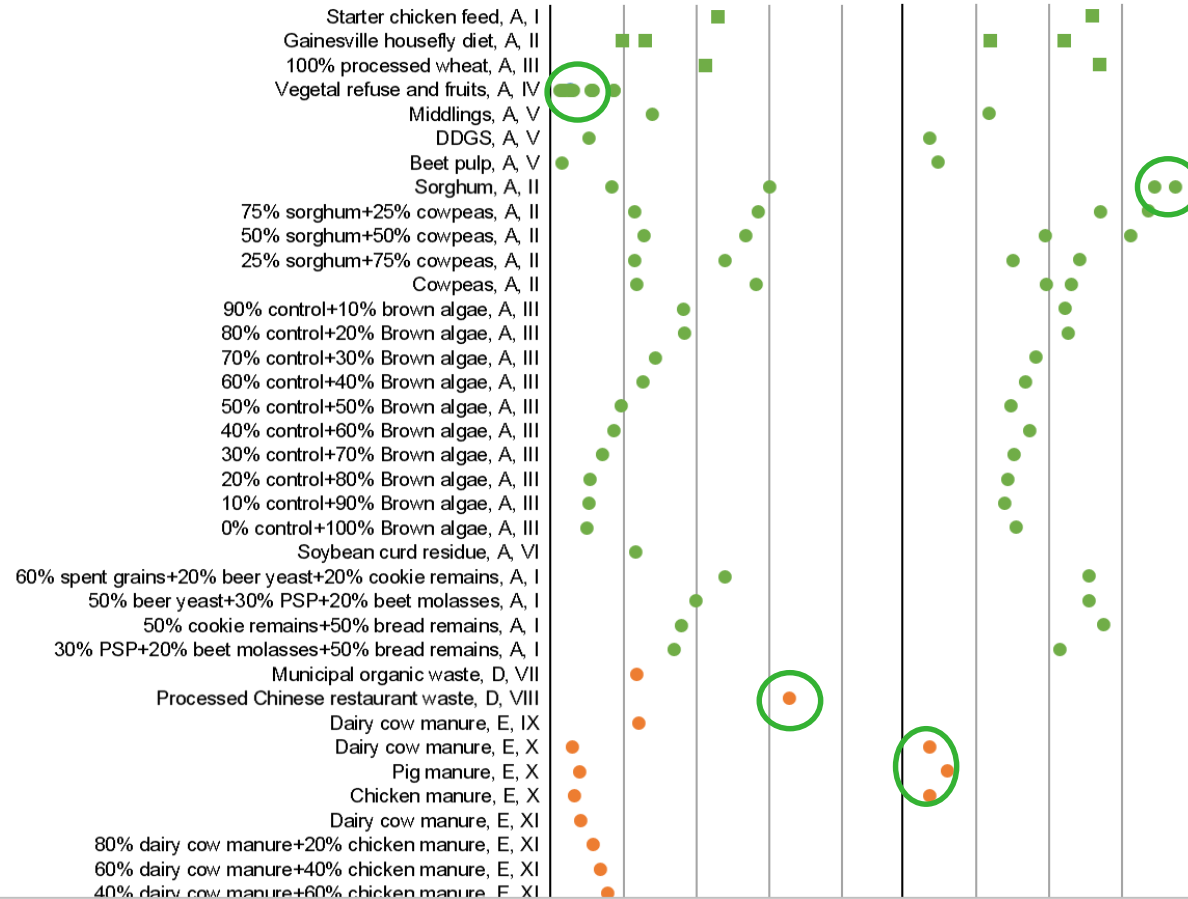


Literature overview

Rearing						Harvest	Conversion		Reference
Amount of feed	Larvae	Age	Temp.	Light	RH	Life stage	DM	N	
(g FM)	(#)	(d)	(°C)	(h)	(%)		(%)	(%)	
NR	NR	0	31.8	NR	NR	Prepupae	+	-	Diener et al. (2011)
1249	~1200	10	27	Env.	60-75	Prepupae	+	+	Li et al. (2011b)
1000	1000	8	26-29	NR	65-75	50% Prepupae	+	-	Zheng et al. (2012b)
13-19	100	0	28	12	70	1 st Prepupae	+	+	Oonincx et al. (2015a)
111-165	100	0	27	12	70	1 st Prepupae	+	+	Oonincx et al. (2015b)
96-1194	59-333	NR	26-28	NR	NR	50% Prepupae	+	-	Parra Paz et al. (2015)
19,200- 20,000	~16,000	8	NR	NR	NR	5-6 instar larvae	+	+	Tschirner and Simon (2015)
3000- 12,000	~15,000	8	30	0	65	16 d old larvae	+	-	Liland et al. (2017)
1000	1000	6	27	NR	60-70	1 st Prepupae	+	-	Rehman et al. (2017a)
1000	1000	6	27	NR	60-70	1 st Prepupae	+	-	Rehman et al. (2017b)

- 11 studies, 21 organic resources and 62 values for DM conversion efficiency
- 5 studies, 13 organic resources and 34 values for N conversion

Cases per study and related output



DM conversion efficiency: 1.3 – 32.8%

N conversion efficiency: 7.4 – 74.8%

27 values use for LCA

Category	Description	Legal status	Legal justification
A	Animal feed materials according to the EU catalogue of feed materials and authorized as feed for food producing animals.	✓	Regulation (EU) No 68/2013
B1	Food produced for human consumption, but which is no longer intended for human consumption for reasons such as expired use-by date or due to problems of manufacturing or packaging defects. Excluding meat and fish.	✓	Vegetable: <ul style="list-style-type: none"> Regulation (EU) No 68/2013 Animal: <ul style="list-style-type: none"> Regulation (EC) No 1069/2009 Regulation (EU) No 142/2011, Annex X, Chapter II, Section 10
B2	Meat and fish produced for human consumption, but which is no longer intended for human consumption for reasons such as expired use-by date or due to problems of manufacturing or packaging defects.	X	Regulation (EU) No 142/2011, Annex X, Chapter II, Section 10
C	By-products from slaughterhouses (hides, hair, feathers, bones etc.) that do not enter the food chain but originate from animals fit for human consumption.	X	<ul style="list-style-type: none"> Regulation (EC) No 999/2001, Article 7(2) See also: Regulation (EU) No 56/2013
D	Food waste from food for human consumption of both animal and non-animal origin from restaurants, catering and households.	X	<ul style="list-style-type: none"> Regulation (EC) No 1069/2009, Article 11(1)b
E	Animal manure and intestinal content.	X	<ul style="list-style-type: none"> Regulation (EC) No 1069/2009, Article 9(a)
F	Other types of organic waste of vegetable nature such as gardening and forest material.	?	<ul style="list-style-type: none"> Unclear
G	Human manure and sewage sludge.	X	<ul style="list-style-type: none"> Directive 86/278/EEC Regulation (EC) No 767/2009, Article 6

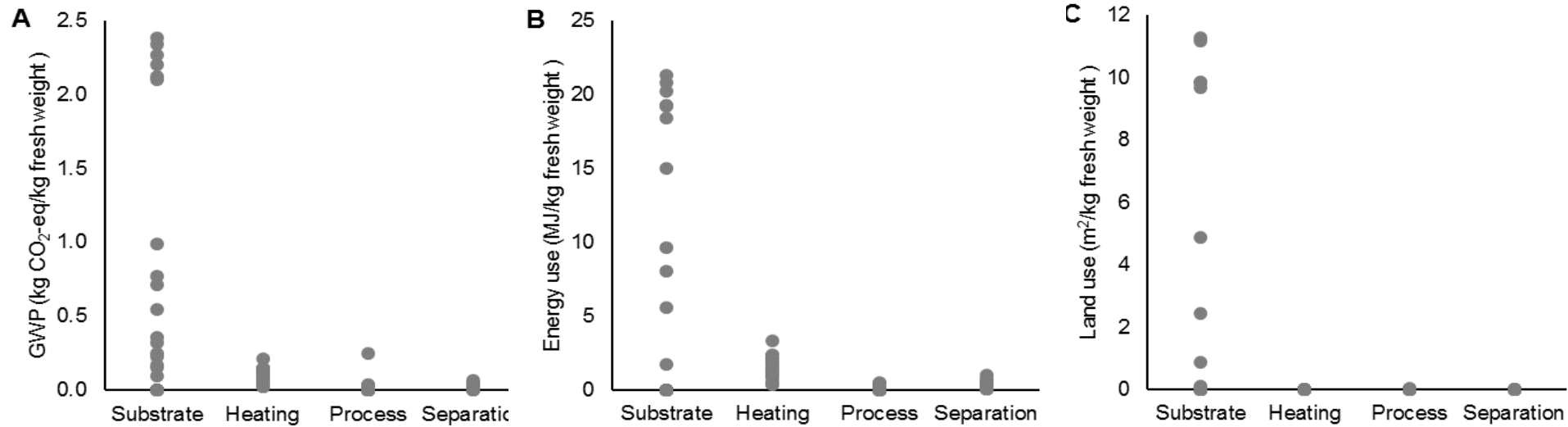
Environmental impact

per kg fresh larvae

Category	GWP, kg CO ₂ -e		Energy use, MJ		Land use, m ²	
	Average	Range	Average	Range	Average	Range
A (10 values)	1	0 – 3	17	1 – 24	5	0 – 11
B (4 values)	1	0 – 1	6	2 – 10	0	0 – 0
D (1 value)	0	-	1	-	0	-
E (12 values)	0	0 – 1	2	0 – 3	0	0 – 0
Total (27 values)	1	0 – 3	8	0 – 24	2	0 – 11



Environmental impact

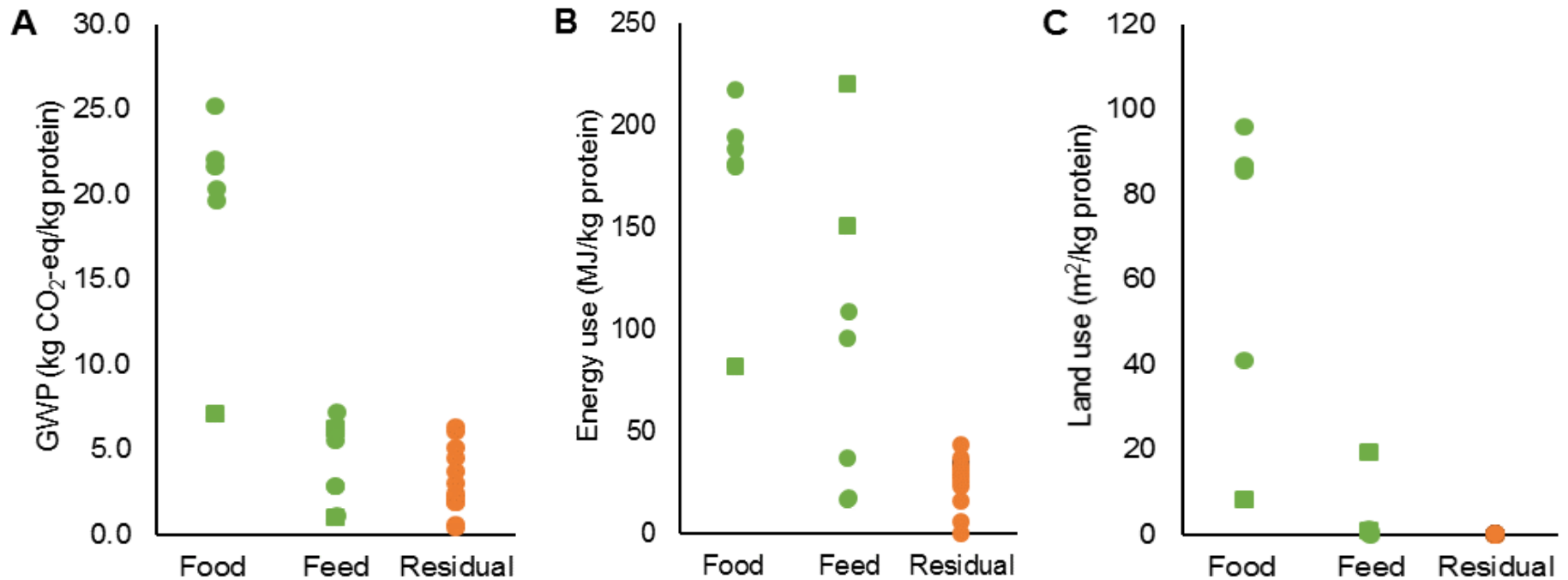


Substrate has a large impact



Environmental impact

per kg protein



Food is legal category A
Feed is A and B
Residual is the rest



Environmental impact

per kg protein

Parameter	Fishmeal	Soybean meal	BSF		
			Food	Feed	Residual
GWP, CO ₂ -eq	2.8	1.1	19	3	6
Energy use, MJ	44	9	174	84	26
Land use, m ²	0.0	3.4	67	3	0



Discussion/Conclusion

- Substrate determines the impact:
 - Conversion efficiency
 - Emissions of substrate
- Consequential LCA needed - substrates often used for bio-energy
- Data based on experiments



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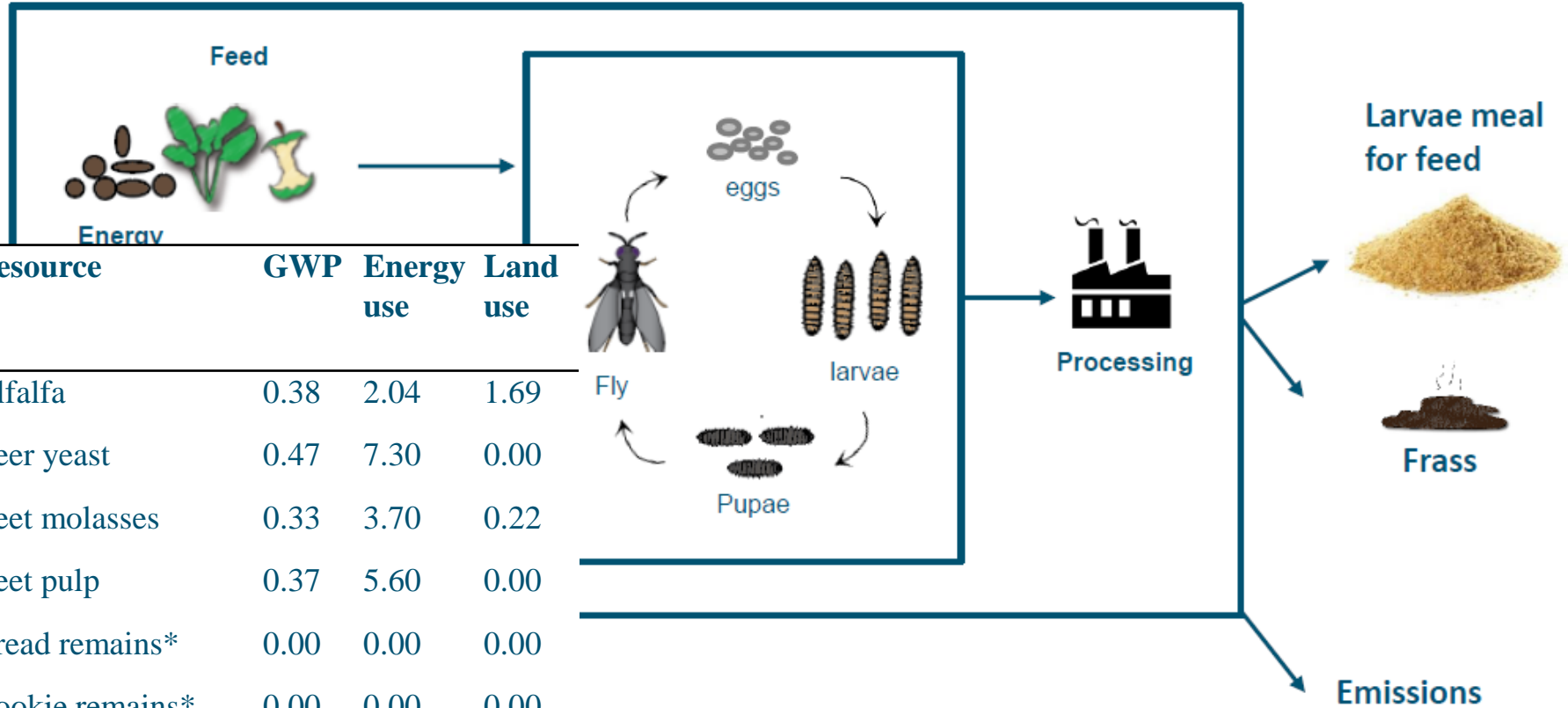
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Questions



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LCA impact data



Resource	GWP	Energy use	Land use
Alfalfa	0.38	2.04	1.69
Beer yeast	0.47	7.30	0.00
Beet molasses	0.33	3.70	0.22
Beet pulp	0.37	5.60	0.00
Bread remains*	0.00	0.00	0.00
Cookie remains*	0.00	0.00	0.00
Corn meal	0.64	6.50	1.20
Cowpea	0.67	5.51	3.20
Wheat bran	0.43	4.80	0.53
Wheat middlings	0.25	2.20	0.60