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Treatment of faecal matter – A product value comparison of four treatment strategies

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Circular sanitation

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Aim of study

Assess the economic value of products generated in different faecal matter treatment strategies in a Swedish context:

- Black soldier fly composting (BSF)
- Anaerobic digestion (AD)
- BSF + AD

Black soldier fly composting

- Conversion of organic matter:
  - Larval biomass (40% protein of dm)
  - Compost
- Efficient reduction in organic matter and water
- Reduction in bacteria and viruses (not parasites)*
- High degradation of pharmaceuticals and pesticides**

Photo: Anna Simonsson

*Lalander, C. H., Fidjeland, J., Diener, S., Eriksson, S. & Vinnerås, B. (2015). *Agronomy for Sustainable Development* **35**, 261-271.
Lalander, C., Senecal, J., Gros Calvo, M., Ahrens, L., Josefsson, S., Wiberg, K. & Vinnerås, B. (2016). *Science of the Total Environment* **565, 279-286.

Anaerobic digestion

- Conversion of organic matter:
  - Biogas (CH_4 + CO_2)
  - Digestate
- Efficient reduction of organic matter (not water)
- Low reduction in pathogens (mesophilic digestion)*
- Relatively low removal of pharmaceuticals**

Photo: Cavendish farms

*Smith, S. R., Lang, N. L., Cheung, K. H. M. & Spanoudaki, K. (2005). *Waste Management* **25**, 417-425.
Carballa, M., Omil, F., Ternes, T. & Lema, J. M. (2007). *Water Research* **41, 2139-2150.

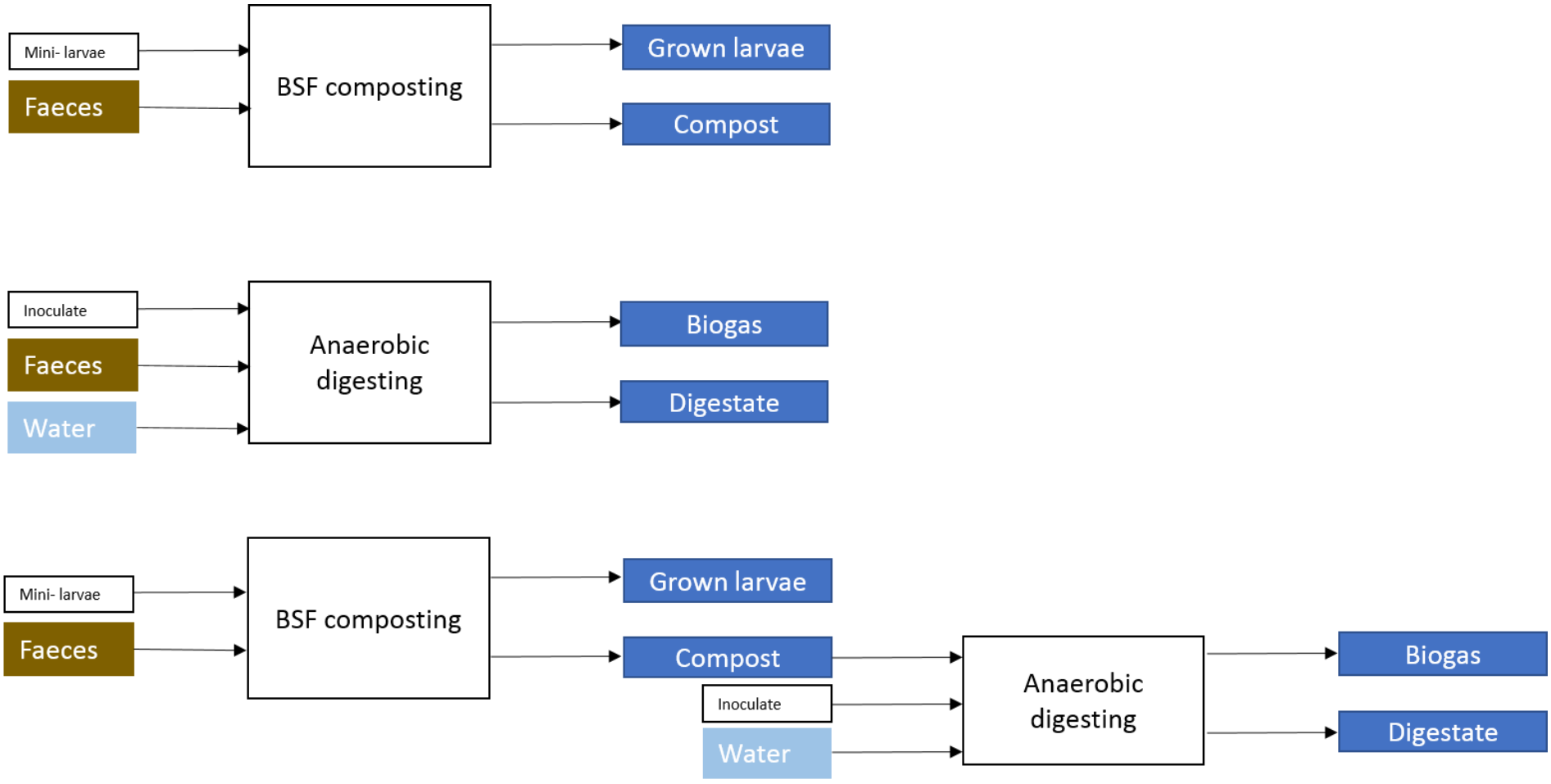
Treatment efficiencies

treating organic matter

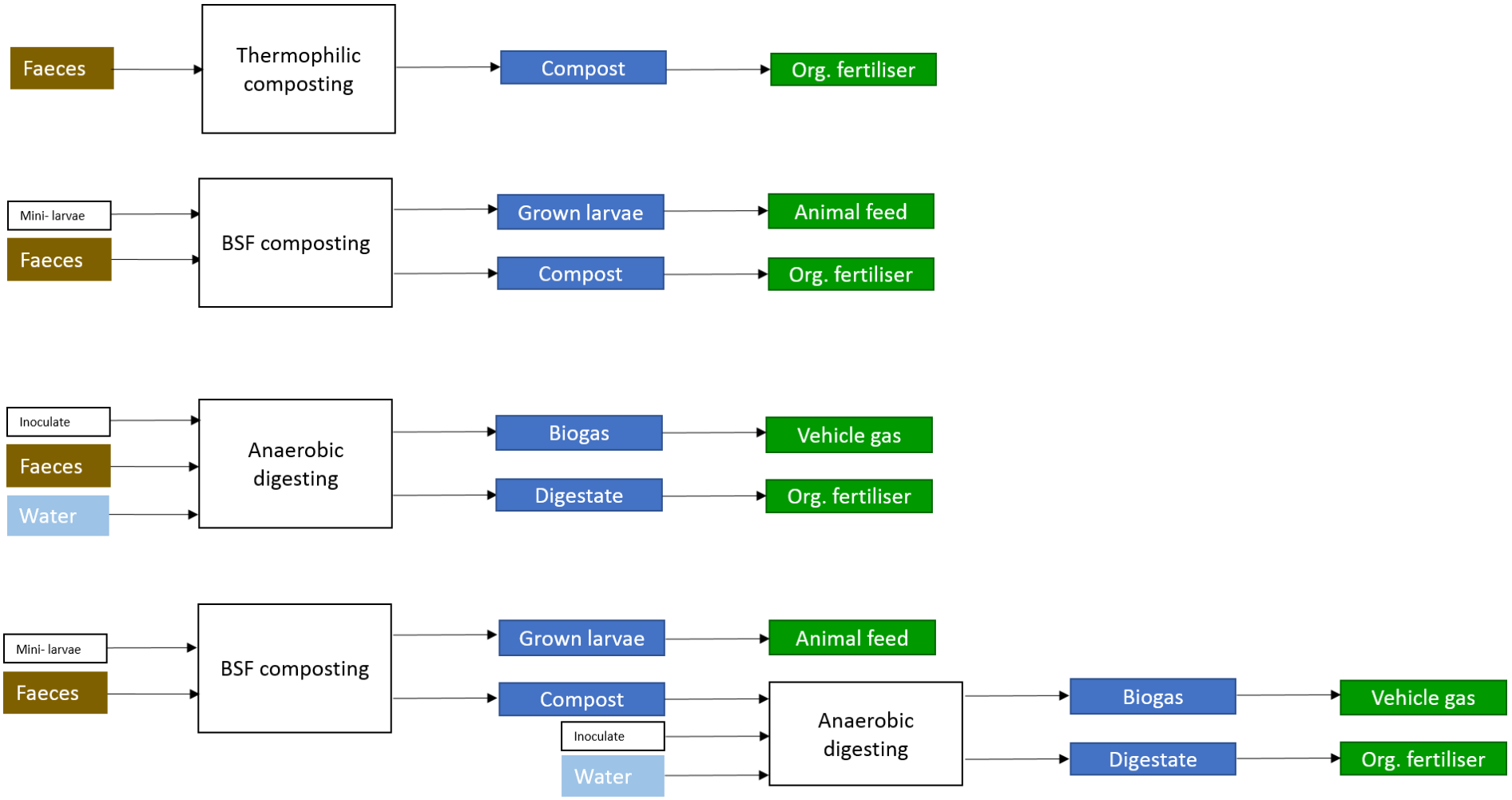
	Black soldier fly composting	Anaerobic digestion (mesophilic)
Reduction in organic matter	Up to 60%	Up to 75%
Reduction in volume	~90%	None
Inactivation of *Salmonella* spp.	7 $\log_{10}$[a)]	1.5-2 $\log_{10}$[b)]
Reduction in carbamezapine	1.1 $\log_{10}$[c)]	None[d)]

a) Lalander, C., Diener, S., Magri, M. E., Zurbrügg, C., Lindström, A. & Vinnerås, B. (2013). *Science of the Total Environment* **458–460**, 312-318
b) Smith, S. R., Lang, N. L., Cheung, K. H. M. & Spanoudaki, K. (2005). *Waste Management* **25**, 417-425.
c) Lalander, C., Senecal, J., Gros Calvo, M., Ahrens, L., Josefsson, S., Wiberg, K. & Vinnerås, B. (2016). *Science of the Total Environment* **565**, 279-286.
d) Carballa, M., Omil, F., Ternes, T. & Lema, J. M. (2007). *Water Research* **41**, 2139-2150.

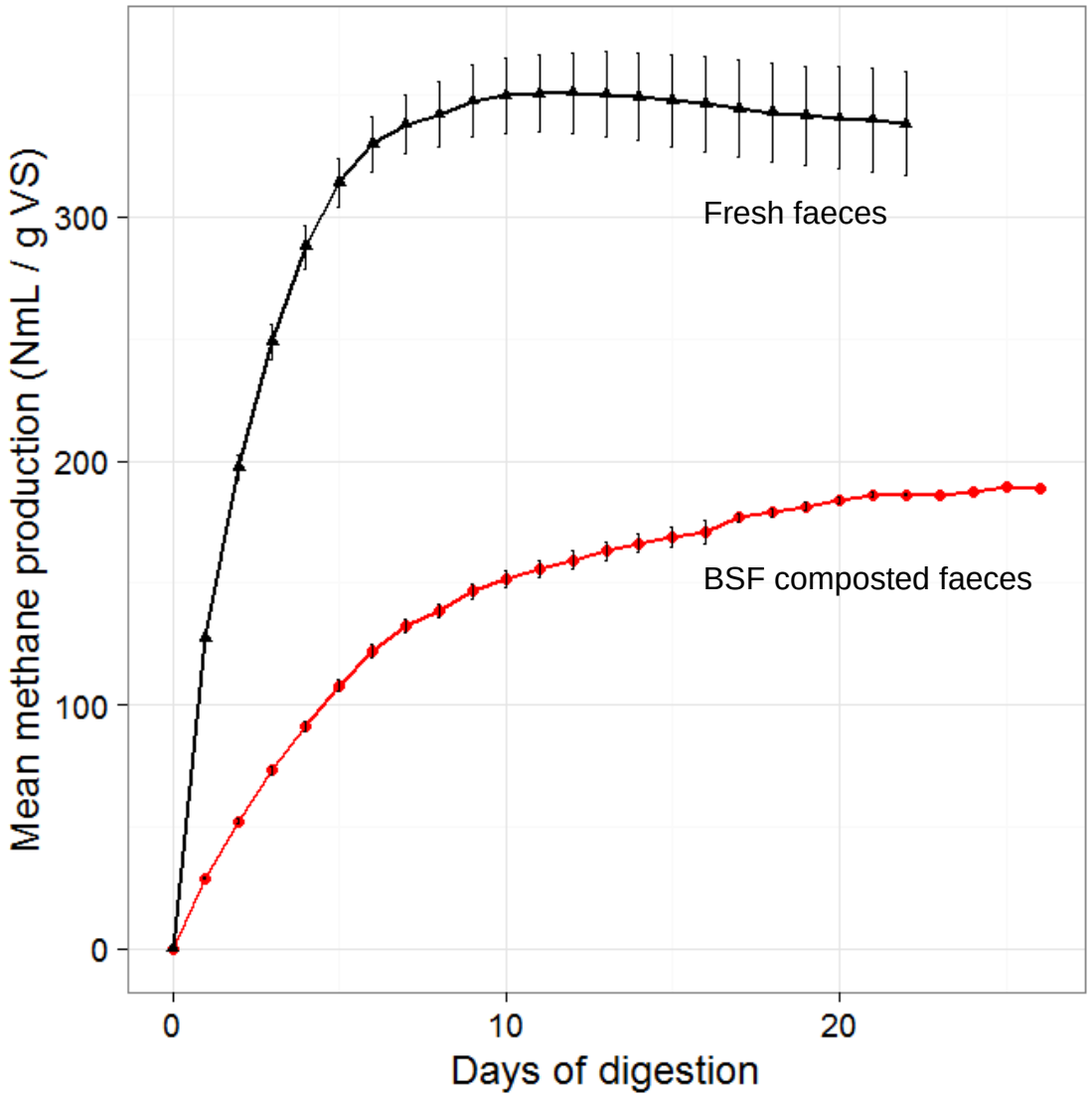
Experimental outline



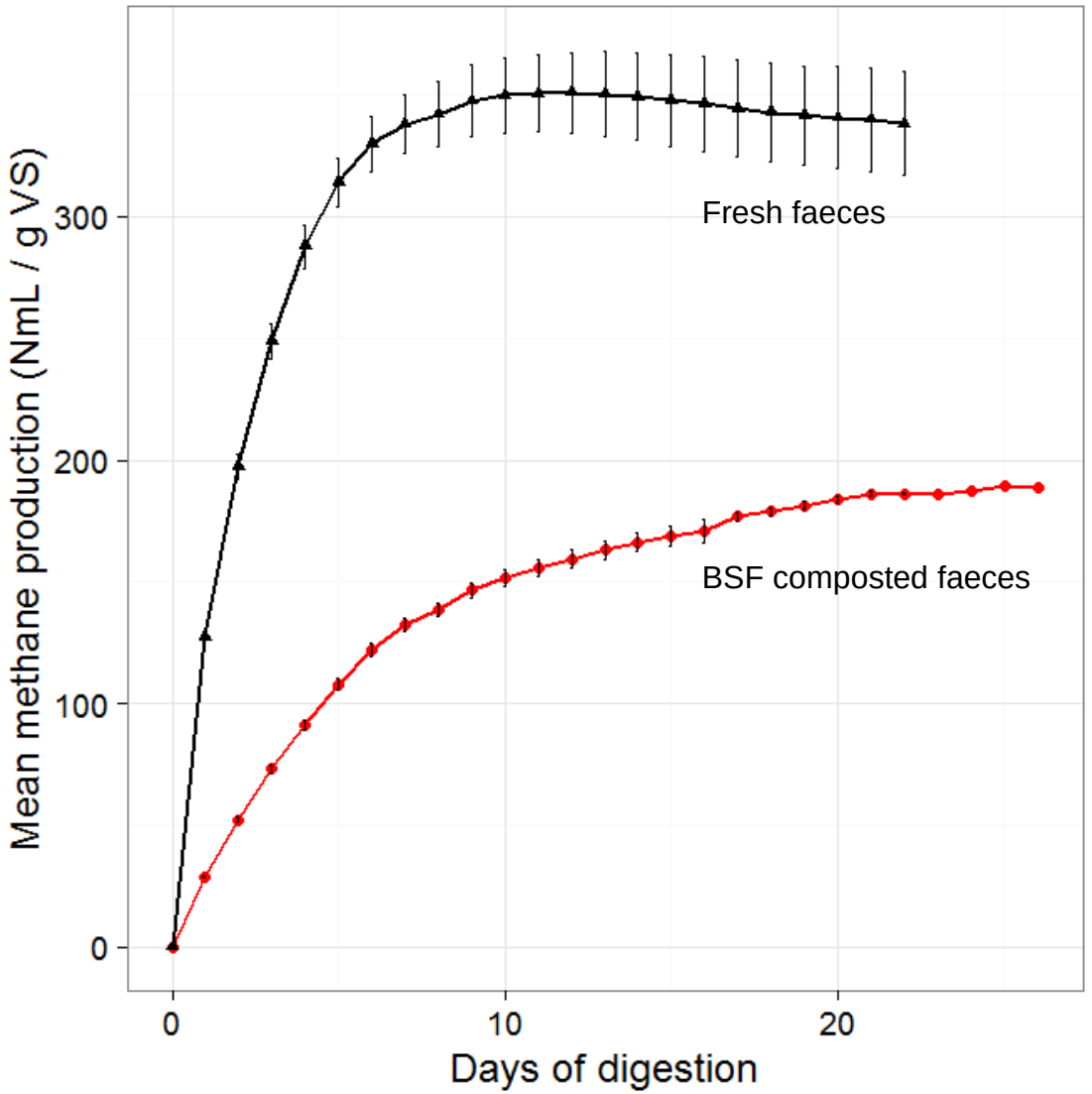
Economic assessment



Biomethane potential



Biomethane potential



60 % CH_4

55 % CH_4

Process efficiencies

Compost

Grown larvae

Biogas

	Thermophilic compost	BSF compost	Anerobic digestion	BSF + AD
Reduction in organic matter (%)	70*	57	75	80
Faeces-to-larval biomass conversion rate (% TS)		36		36
Methane yield (NmL / g organic matter)			350	190

*Bai F, Wang X. 2010. Nitrogen-retaining property of compost in an aerobic thermophilic composting reactor for the sanitary disposal of human feces. *Frontiers of Environmental Science & Engineering in China* 4: 228-34

Generated products

treating 1000 kg faeces

Org. fertiliser

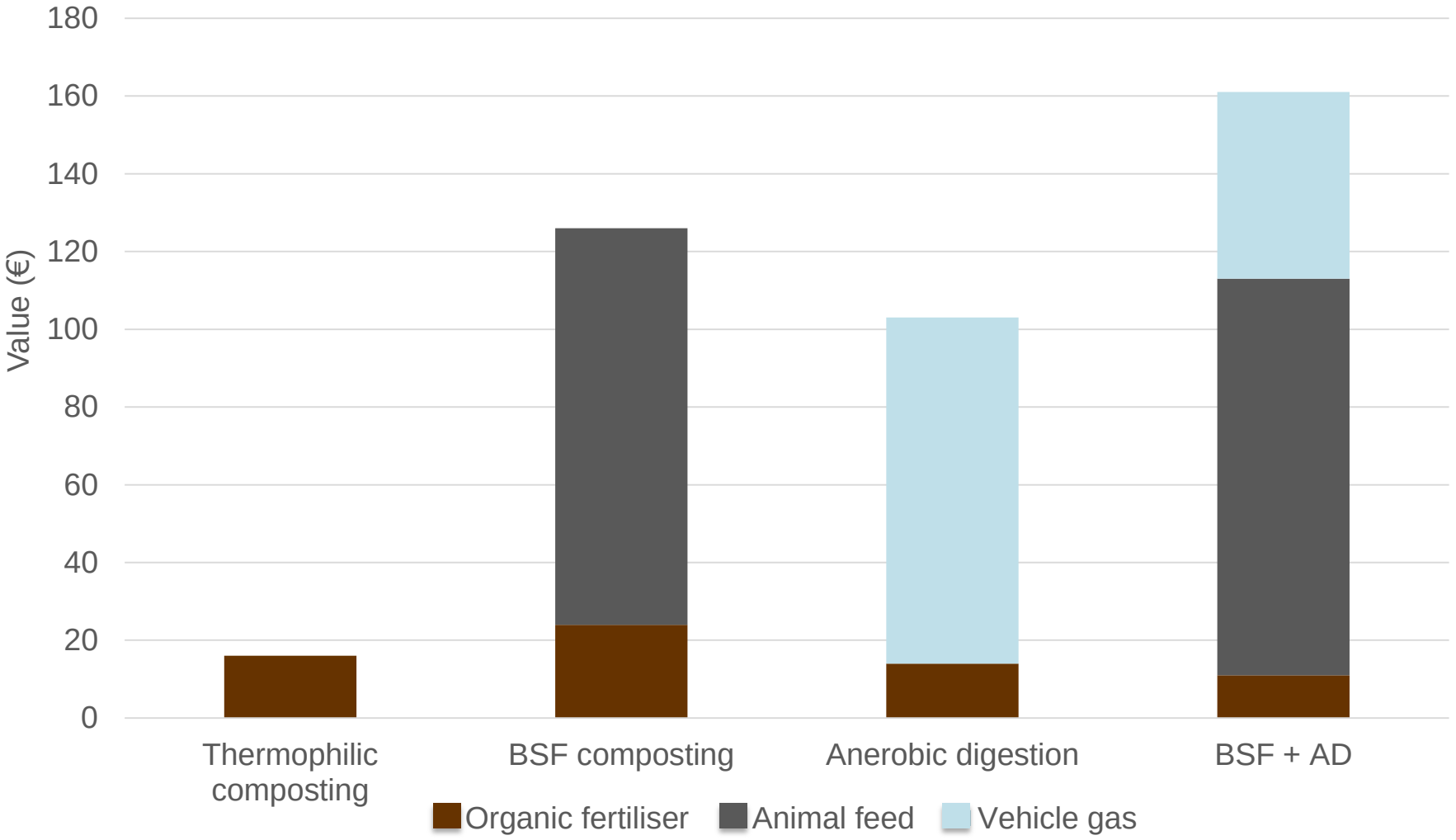
Animal feed

Vehicle gas

	Thermophilic compost	BSF compost	Anerobic digestion	BSF + AD
Larval biomass (kg dry matter)		80		80
Organic fertiliser (kg organic matter)	60	80	50	40
Methane (kg)			50	30

Total value products

treating 1000 kg faeces



Selection of treatment strategy

Product value provides an estimate of the total possible cost of the treatment

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Highly dependent on local context

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- Local demand of products

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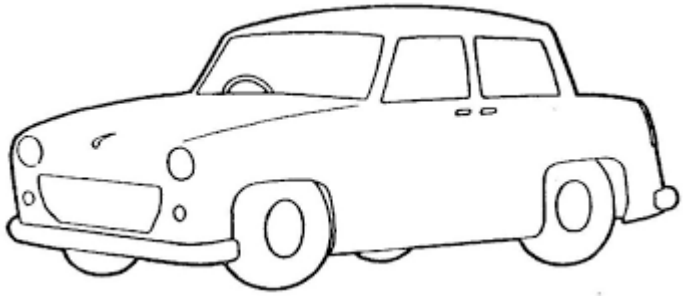
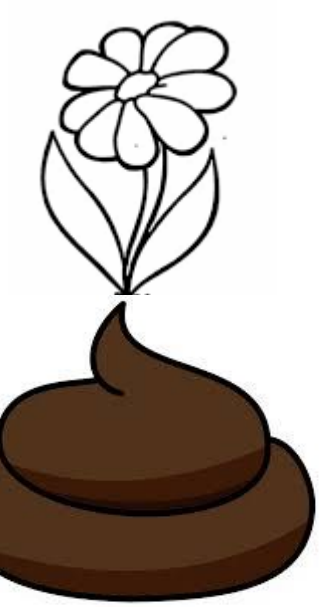
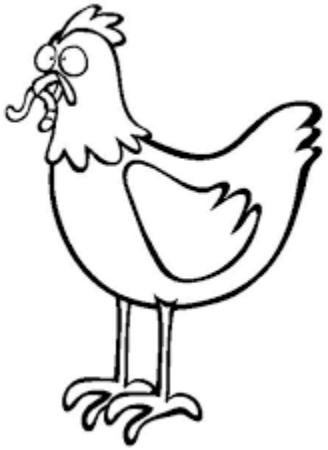
High value, if converted to products in demand

Thank you for your attention!







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