Economic feasibility of Eco-feed concepts in the Netherlands

PPS RENEW (LWV20147)

March 2022, Dr B. (Bob) Castelein (WFBR), Dr L. (Luuk) Vissers (WEcR)

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PO box 17, 6700 AA Wageningen, The Netherlands, T + 31 (0)317 48 00 84, E info.wfbr@wur.nl, www.wur.eu/wfbr.

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Summary

The PPP RENEW (side- and residual streams for Eco-feed application in the Netherlands, with specific attention for the design of circular food systems and consumer acceptance) was launched in February 2021. The project is a public-private partnership and its aim is to design and valorise Eco-feed concepts. Eco-feed is conceptualized as a circular feed product for non-ruminant animals, based on side- and residual streams collected from retail and foodservice outlets. In this project, we consider only Eco-feed for pigs and poultry (layers and broilers).

The research focuses on 3 main research questions (RQs):

RQ.1) Which conditions are necessary to create a positive business case for Eco-Feed in the Netherlands, from economic, environmental and animal welfare point of view?

RQ.2) Which conditions are necessary to create consumer and food value chain acceptance of Eco-feed products?

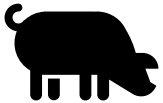
RQ.3) Which scenarios contribute to the development of Eco-feed concepts?

This report presents the findings on task 1.1 in RENEW (related to RQ.1) and addresses the analysis of economic conditions in the business case for eco-feed. In collaboration with the private partners, a set of options and selection criteria have been formulated and visualised in a process scheme from sourcing of suitable streams at catering level, towards collection & processing within feed production and delivery of feed at farm level. An estimation has been made of associated costs and benefits for the different steps in the process scheme, with the option to model outcomes for different scenarios of feed composition and targeted animals. A comparison has been made to conventional feed.

Summary

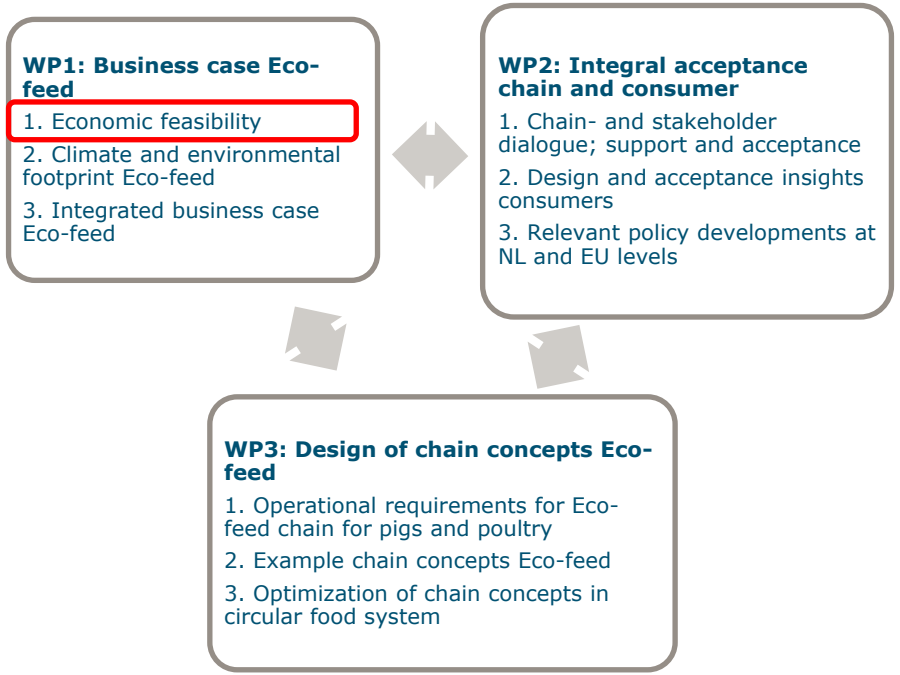
- Significant costs of Eco-feed (relative to conventional feed) are incurred upstream in the chain, specifically related to processing and collection costs (depending on the network structure)
- We show that it is possible to produce and market Eco-feed at a competitive price point, when a relatively small part of the total available volume of food waste from retail and foodservice outlets in the Netherlands (~14kton of the ~250kton theoretically available per year) are used to produce Eco-feed. As collection costs (related to distance/ton input) prove to be sensitive in this regard, collection distances are a limiting factor.
- In case it is not possible to produce Eco-feed at a competitive price at feed production level, additional value/profit needs to be gained by higher pricing post-farmgate, at trade and outlet levels.
- Future research could include the expansion of the economic feasibility model to include other target livestock species and their relevant feed products, and by quantifying the environmental footprint of Eco-feed in different scenarios compared to conventional feed.

1. Introduction RENEW and Task 1.1



1. Introduction – the RENEW project

RENEW aims to **generate insights on the use of side- and residual streams from retail and out-of-home sector as livestock feed, currently not allowed under EU-regulation**. Where other research focuses on nutritional and food/feed safety aspects of valorisation towards animal feed, RENEW focuses on the business case for Eco-feed, its acceptance by consumers & business stakeholders and how it contributes to a more circular food system. This report presents the findings on the Task 1.1 within the Business Case: establishing the economic feasibility of Eco-feed.



1. Introduction – Task 1.1 Economic Feasibility

The aim of Task 1.1 is to analyse the economic feasibility of Eco-feed concepts. To achieve this aim, the following activities were implemented:

- Identifying options and criteria that are relevant to Eco-feed concepts, and can be controlled or monitored, with the aim to establish conditions for a positive business case
- Identifying potential side- and residual streams and potential animals for feed products
- Create a Process Flow, that schematically indicates the valorisation routes, composition, volume and value from origin (foodservice and retail), to processing (feed production site[s]) and destination (farms)
- Calculating costs and benefits estimations for Eco-feed concepts compared to those associated with conventional feed. Various scenarios were developed, which differed from each other in terms of the number of outlets, the processing volume and the distance of the outlet to the processor.
- Quantifying added value for users
- Indicating the relevance of business models for Eco-feed in current market structure

1. Introduction – Method & data sources

Method:

- Regular working sessions with WUR-team and private partners were organized to define, compile and refine definitions, process flow elements and criteria. Furthermore, scenarios were established during these sessions for the first baseline modelling of economic feasibility
- Partial budgeting was applied to identify the costs and benefits of each actor in the Eco-feed chain.
- A simple deterministic model was developed to estimate the costs and benefits of liquid Eco-feed in the upstream part of the chain (collection until delivery of feed to farm).

Data sources:

- Scientific literature
- Findings and insights from relevant projects (e.g., H2020 REFRESH, PPS "Voeder- en Voedselveiligheid van Reststromen", PPS "Safe insects")
- Sharing of insights, best practices and data by private partners to the WUR team (including composition and volume information, process technology data, feed system information)

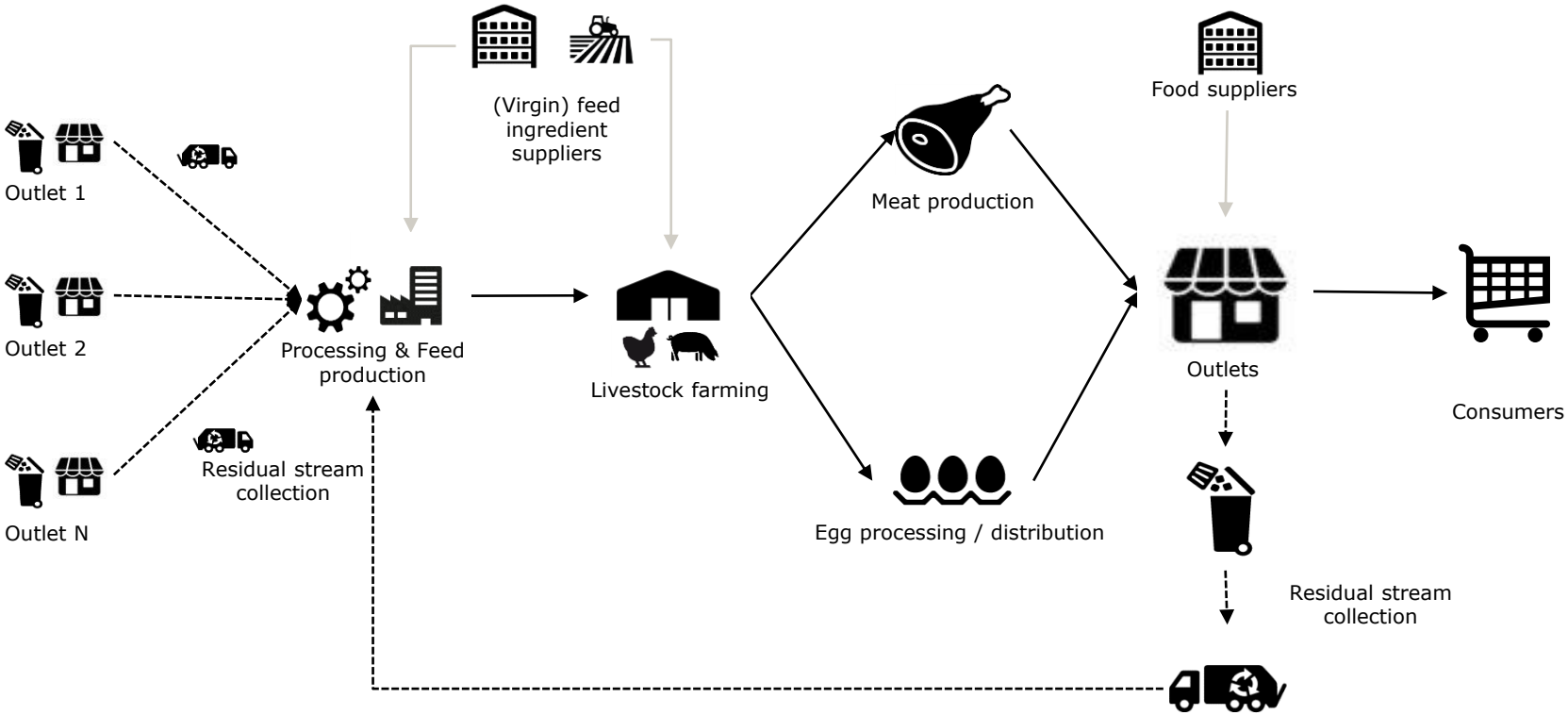
2. Characterizing Eco-feed concepts

2. Eco-feed chain design principles

Characterising Eco-feed concepts, explaining the underlying assumptions for the modelling of economic feasibility, compared to conventional feed products

- Circular design: Side- and residual streams from retail and foodservice outlets are valorised in Eco-feed for the production of food to be supplied to said outlets and consumers
- Adaptive: Based on side- and residual stream composition, processing requirements may change (e.g., to meet legal requirements for streams with animal by-products)
- Open system:
    - Other food products will enter the residual streams
    - Eco-feed is supplemented with other ingredients (virgin ingredients (agricultural products produced specifically for feed) or other co-products) either in feed production or at the farm
    - Outlets supplying side- and residual streams are not necessarily the same outlets offering Eco-feed based products (and vice versa)

2.1 Eco-feed chain design



2.2 250 kton of side- and residual streams potentially available for Eco-feed concepts

Eventually, the concept can be scaled to valorise all potentially available retail and foodservice side- and residual streams.

- Retail
    - ~6700 supermarkets in the Netherlands: 1.7% of food is wasted ~180 kton
    - Mix of unpackaged (potatoes, vegetables, fruit (34.5% of total waste)) and packaged (fresh meat and fish (7.5%), bread (31.5%), dairy, eggs, cooled ready meals (13.3%), and other fresh and preservable (13.2%)) products (*CBL, 2020*)
- Foodservice
    - 150-250g waste per cover (kitchen waste, unsold food, plate waste) (*CTC, 2020*)
    - Hospitality sector in the Netherlands: ~61kton of food waste (*Lachmeijer, 2020*) from ~55000 eateries and hotel-restaurants (*CBS, 2020*)
    - Catering in the Netherlands: ~5kton of food waste (*Soethoudt, 2012*) from ~14000 event caterers, ~1100 canteens and contract caterers
- Currently these are predominantly used for biogas, composting; a small part is recycled or valorised

2.3 Volume of side- and residual streams is relatively small compared to total market for animal feed

Eco-Feed is aimed to replace (part of) the virgin ingredients - often imported - currently used in animal feed, therefore we assess the replacement potential

- Market size: 11,750kton animal feed total (*NEVEDI, 2020*)
    - 16,700kton of raw materials for concentrate feed (*Vijn et al. 2019; NEVEDI 2019*)
        - 51.9% (virgin) base ingredients
        - 42.7% co-products from food industry (e.g. distiller and brewer grains, soy hulls, potato peel,)
        - 5.4% other (minerals, additives, oils, fats)
- Total volume of side- and residual streams from retail and out-of-home (estimated to be max. 250kton) is relatively small compared to total volume of animal feed (+/- 2.1%)

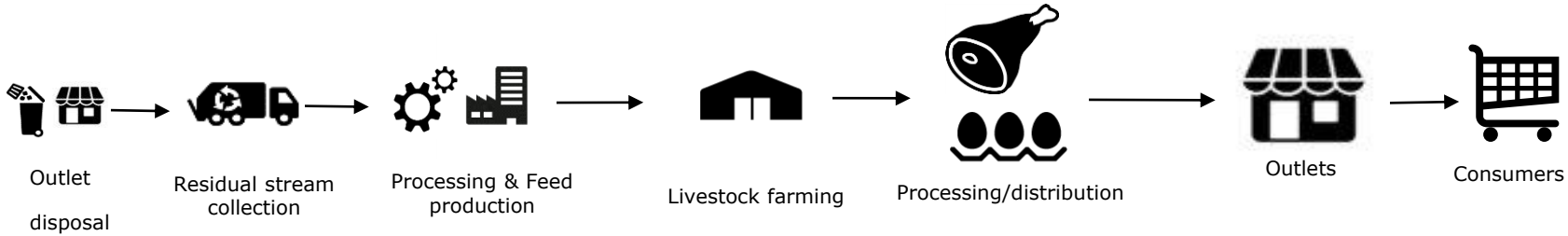
3. Criteria for developing Eco-feed concepts

3.1 Criteria for Eco-feed concepts

Levels and relevance of criteria:

- Product-related criteria
- Chain-related criteria
- Relevant for one stakeholder or multiple

3.2 Product and chain criteria



Acceptance

Product criteria

Feed production

Nutritional value Eco-Feed

Proposition relative to conventional feed

Volume and composition of side streams

Logistics

Costs / Benefits

Chain criteria

3.3 Criteria elaboration

Criteria for Eco-feed product development:

- Feed production – The side- and residual streams are processed into a suitable, high-quality feed product (full product or ingredient)
- Nutritional value – The Eco-feed product meets the animal's nutrient requirements (micro- and macronutrients, fibre and moisture content etc.) for acceptable performance and growth
- Proposition relative to conventional feed – The product is marketed as a distinct alternative to conventional feed, with a value-added proposition towards one or multiple chain actors or consumers
- Acceptance – The final product and associated proposition is accepted by consumers, ideally with a higher willingness-to-pay than for alternative (not Eco-feed based) products

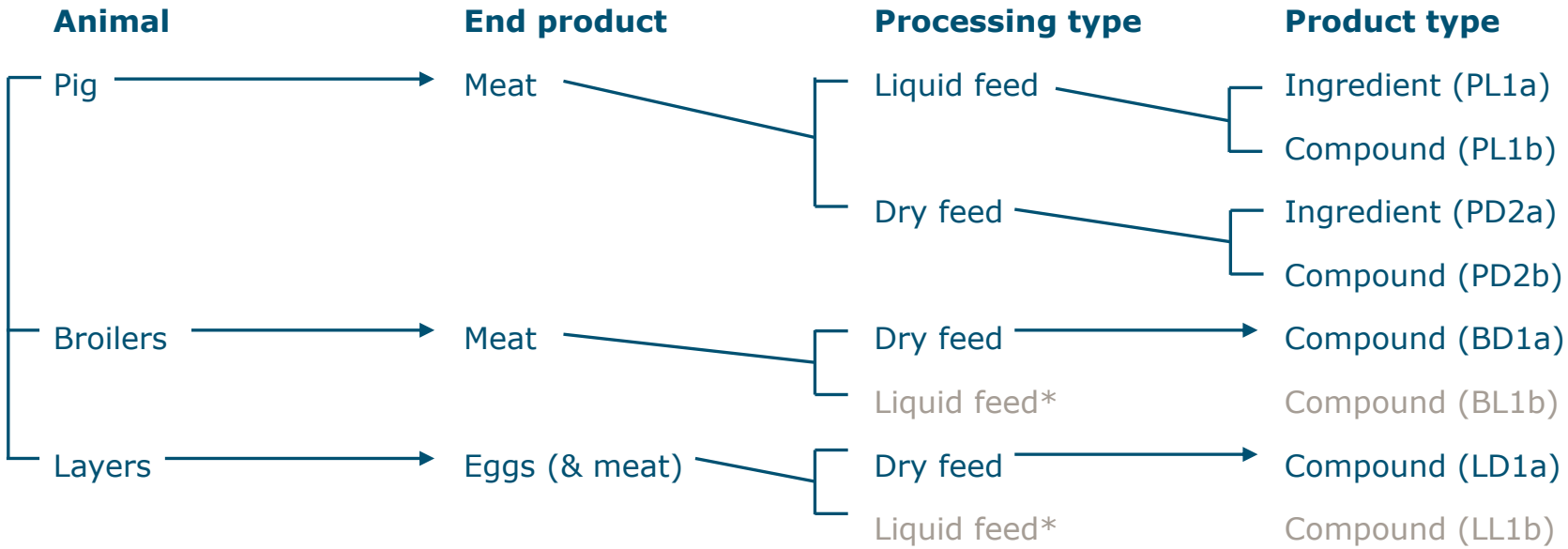
3.3 Criteria elaboration (2)

Criteria for Eco-feed chain design:

- Logistics – Decisions related to network design, transportation, storage, processing and distribution for making available the intended Eco-feed product
- Volume and composition of side- and residual streams – The Eco-feed chain and processes are adaptable to network size and stream composition. Insights in scale effects and (range of) side- and residual stream composition requirements
- Costs/benefits – Eco-feed concept (combination of product, proposition and chain characteristics) can be implemented in an economically feasible way by chain stakeholders by appropriate allocation of costs and benefits
    - Collection and transportation costs
    - Processing costs
    - Feed pricing and revenue
    - Product pricing and revenue downstream towards consumer

3.4 Potential eco-feed concepts

Eco-feed concepts can be applied to pigs and chickens, supplied as liquid feed or dry feed and supplied as an ingredient or as compound feed to the farmer.
Overview of potential Eco-feed concepts:



* Too far removed from conventional feed practices

4. Costs and benefits of actors in the Eco-feed chain

4.1 Outlets disposing of side– and residual streams

Relevant decisions for Eco-feed chain:

- Choice of disposal partner and contract
- Internal operations (e.g. waste segregation or not, storage)

Costs

- Container rental: No or nominal fee
- Collection fee: ~ €15 per 120 litre container (weekly frequency)

Benefits

- Sustainable waste disposal potential selling point towards customers

4.2 Collectors of side- and residual streams

Relevant decisions for Eco-feed chain:

- Participation in the eco-feed chain
- Network design (locations, distances, service frequency, fuel type)
- Equipment choice (truck capacity, cooling yes/no, fuel use)

Costs

- Transportation (€1.60-€2.15 per km, €48-€75 per hr total – including fuel, labor, and all costs for the truck) (*Panteia, 2018*)
- Storage (if relevant)
- Planning costs

Benefits

- Collection fee from client outlets
- Revenue from swill sales to processor (depending on composition, high-quality Cat. 3 side- and residual streams can net from a few euros to over €100 per ton)

4.3 Feed producers

Relevant decisions for Eco-feed chain:

- Vertical integration of collection yes/no
- Scale of processing
- Product and process type (see “Eco-feed concepts”)

Costs

- Processing costs
- Heat, plant-related, and financing costs (together >75% of costs of medium-sized plant)
- Labour, electricity, consumables and water costs

Benefits

- Feed revenue (liquid feed around €2 per % dm per ton; alternative co-products €2- €2.50 per %dm per ton), Eco-feed could also be marketed as a sustainable alternative with an ‘Eco-feed premium’

4.4 Livestock farmers

Relevant decisions for Eco-feed chain:

- Eco-feed product (ingredient/compound) and volume
- Sell animals to processor or contract processor and do product marketing

Costs*

- Possibly a higher feed price*
- Marketing and transaction costs
- Current feed prices (*Agrimatie, 2022*):

Pig feed: €23-€27 per 100 kg** (~56% of total costs are feed, per kg butchered weight, ~43% of costs are feed) (*Hoste, personal communication, 2021*)

Layer feed: €26-€31 per 100kg**

Broiler feed: €31-€38 per 100kg**

Benefits

- Possibly an 'Eco-feed premium'
- Current farm gate market prices (*Agrimatie, 2022*):

Pigs: €1.38-€1.70 per kg carcass weight**

Eggs: €7.65-€9.65 per 100 eggs**

Broilers: €0.75-€0.85 per kg live weight**

* It was assumed that the nutritional value of eco-feed does not differ from conventional feed. Therefore, it was also assumed that replacing conventional feed by eco-feed does not affect the technical performance of the animals.
** The ranges show the minimum and maximum price in the period 2017-2021 (*Agrimatie, 2022*)

4.5 Meat and eggs processors/distributors

Relevant decisions for Eco-feed chain:

- Contract services to client (livestock farmer) and deliver products back, or buy from livestock farmer and sell products directly
- End product of processing (meat, cold cuts, whole eggs or other)

Costs

- Operating costs
- If purchasing from farmer, potentially pay an 'Eco-feed' premium

Benefits

- Fee from client or revenue from products
- If marketing to outlets, potential 'Eco-feed premium' for products

4.6 Outlets buying products from animals fed with Eco-feed

Relevant decisions for Eco-feed chain:

- Carry Eco-feed products yes/no, if yes decide on product mix
- Price points (incl. margin), marketing
- Disposal of residual streams (partner and contract)

Costs

- Purchasing of (Eco-feed) products
- Purchasing of other products
- Disposal (collection) costs of side- and residual streams, possibly with 'Eco-feed premium'
- Marketing & operating costs

Benefits

- Potential 'Eco-feed premium' in product revenues
- Sustainable, circular supply chain as part of PR/advertising

4.7 Consumers

Relevant decisions for Eco-feed chain:

- Buy Eco-feed product or alternative (based on willingness-to-pay and price of products)

Costs

- Potentially higher price of product (for pig meat a €0.10 cost increase at the farm translates to a €0.30-€0.50 cost increase for the consumer) (*Hoste, personal communication, 2021*)

Benefits

- Perceived value of more sustainable product (reflected in willingness-to-pay)

5. Economic feasibility model

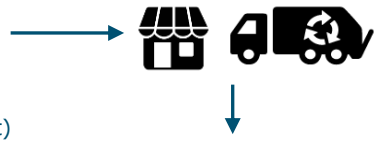
5.1 Model description

Example: production of liquid feed for pigs from catering waste (*Luykx et al. 2019*)

- Modelling the upstream part of the chain (collection until delivery of feed to farm)

Swill collection

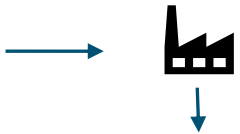
- # outlets
- Volume
- Distances
- Collection fee
- Frequency
- Transport (modality, cost)



- Collection revenue
- Collection cost

Feed production

- Composition residual streams
- Intended animal
- Process
- Inputs and energy mix
- Processing scale



- Volume Eco-feed
- Processing costs

Main questions to be addressed:

- What are the main (upstream) cost and revenue drivers?
- At what scale can liquid eco-feed be offered at a price that is competitive with the price of conventional feed (break-even)?
- How do costs increase (and need to be recouped downstream) when starting at a smaller scale or with a more dispersed network?

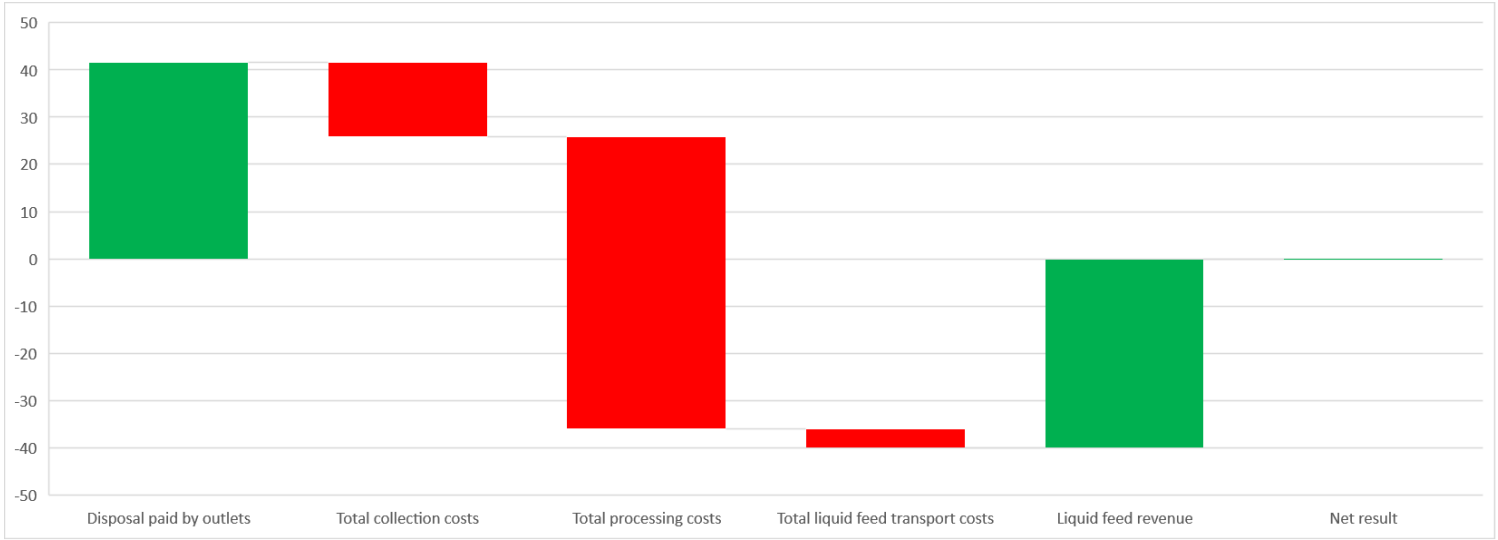
5.2 Model assumptions

- 120kg/day of side- and residual stream per location (rough average for example catering locations)
- Collection network: Trucks collect weekly from 7 locations on a 70km trip
- Economies of scale in processing
- End-product is 20% dm liquid feed for pigs, with a market price of €40 (€2 per % dm per ton)
- Average 25km transport to the farm

5.3 Production costs of eco-feed are primarily driven by processing costs

Scenario 1

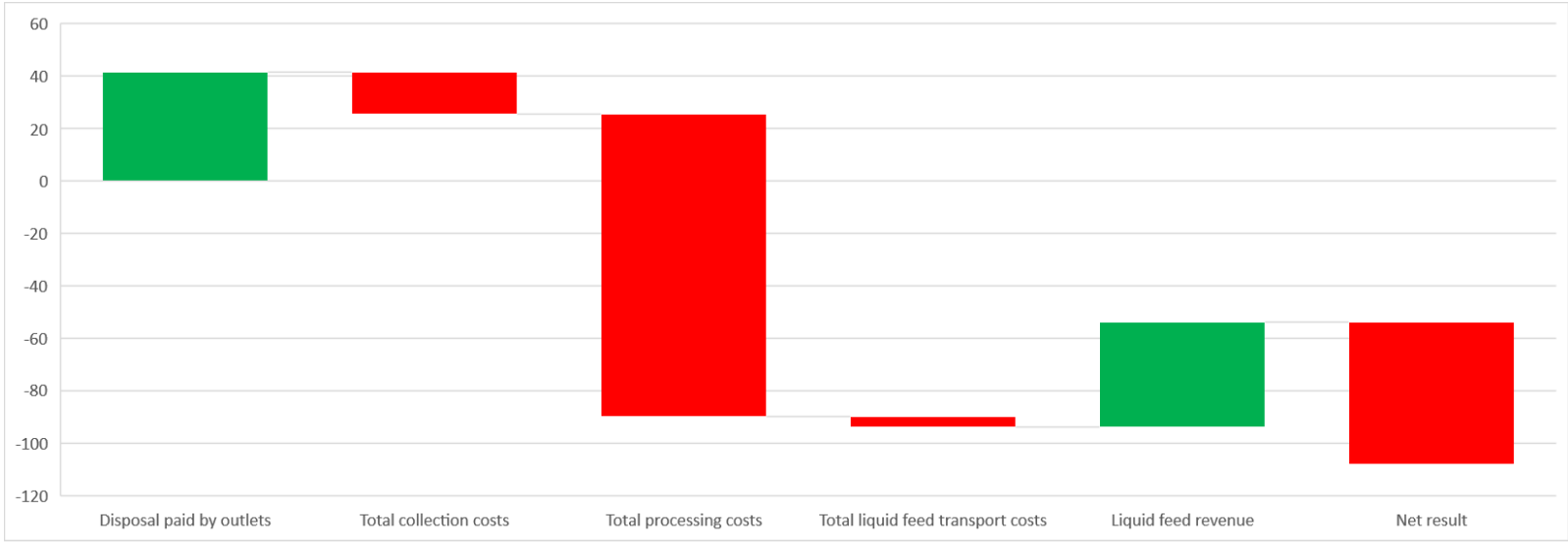
- Figure below shows the breakdown of costs at the scale at which market-competitive pricing of feed is enough to recoup upstream costs (331 locations, 14kton swill/year)
- Total costs strongly driven by processing costs
- When calculated per ton liquid feed, collection fees and feed revenue contribute equally



5.4 Processing costs strongly affected by economies of scale at processing plant

Scenario 2

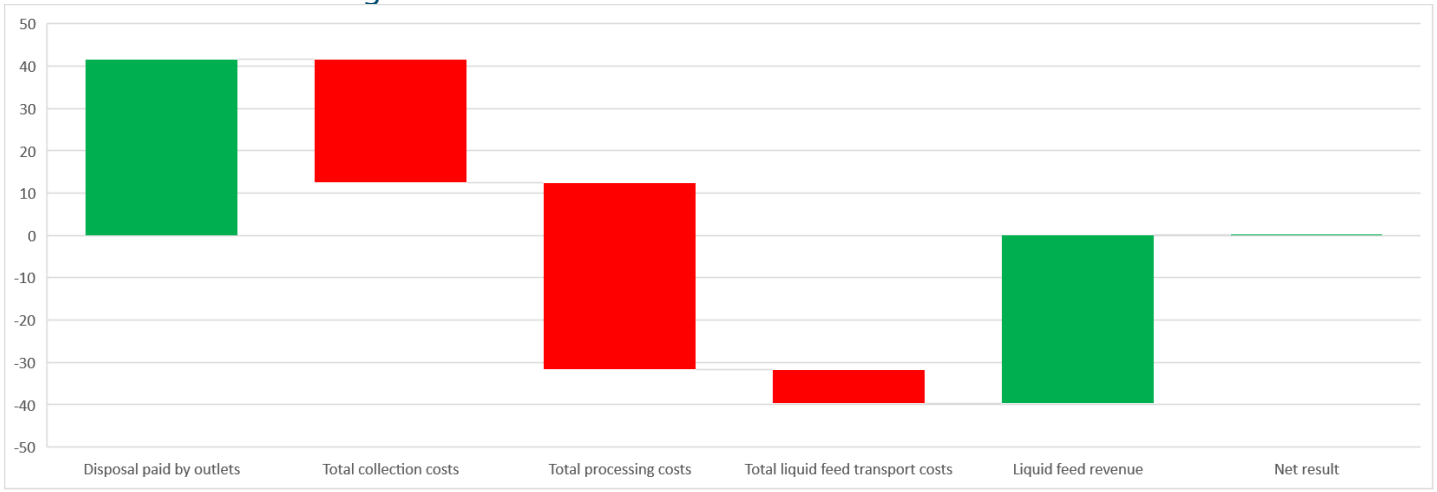
- **At half the scale used previously** (now 165 locations, 7kton swill/year) – all else equal – the liquid feed price per ton would have to be more than double the market price to recoup the costs
- Processing costs per ton increase significantly at small scale (economies of scale)
- Cost increase needs to be recouped downstream (need for an 'Eco-feed premium in pricing)



5.5 Collection and distribution costs strongly depend on distance to processing plant

Scenario 3

- Suppose we **double all distances** (collection rounds of an average 140km, an average 50km from feed production to the farm) and find the scale at which costs and revenues are balanced (break-even)
- The scale needed to recoup the increased collection and distribution costs (22kton swill/year from 494 locations) is considerably larger
- Total costs are still driven primarily by processing costs, but with a more dispersed network collection costs become a significant factor as well



5.6 Takeaways

- Feed processing costs make up the bulk of total production costs, but decrease with total annual volume
- In the break-even situation, the contribution of collection costs and transportation costs to total production costs is relatively small
- When distances become larger in the network, collection costs start to increase significantly and weigh heavier on the cost-benefit balance
- At a certain scale (and depending on characteristics of the network) Eco-feed can compete on price with conventional feed
- If costs are too high (either due to lack of scale or a too dispersed network) to compete on price, revenue needs to increase to make the concept possible

6. Eco-feed business models

6.1 Two options

1) Eco-feed can be competitively priced compared to other feed products (see previous examples)

2) Eco-feed cannot be competitively priced compared to other feed products due to high costs upstream (see next 3 slides)

    - For the business case to be feasible and the concept to work additional revenues should cover the additional costs
    - We propose different business models where an 'Eco-feed premium' allows actors to recoup higher upstream costs
    - Assume all else equal (e.g. other input prices, operating costs, regulation, taxation)

6.2 Higher collection costs

- Collecting the required volume of residual streams from outlets can only be done at such costs that it results in a more expensive ingredient (compared to other feed ingredients) at the factory gate
- Offset options for collector:
    - Higher collection fee paid by outlets for circular processing
    - Processor accounts for higher costs in feed price (costs passed down the chain to retailers and consumers)

6.3 Higher processing costs

- Processing the collected residual stream into a suitable feed (ingredient) product incurs more energy and input costs than can be recouped by pricing the Eco-feed competitively compared to alternatives
- Offset options for processor:
    - Vertically integrate residual stream collection to save on overhead and independent collector’s margin
    - Create economies of scale in processing
    - Higher product price to offset costs (costs passed down the chain to food outlets and consumers)

6.4 Higher costs of livestock farming

- Using Eco-feed results in a higher unit cost price (per kg of carcass weight (for pigs and broilers) or per egg) – either due to higher feed price or reduced performance
- Offset options for farmer
    - Higher product price to offset costs (costs passed down the chain to food outlets and consumers)
    - Market product more directly (e.g. direct to consumer, contracting processor), omit middlemen and increase margin

6.5 Further downstream

- After livestock farming, the final product is produced
    - Further cost increases for downstream actors stem from higher product cost price
    - Cost increases can be offset with higher price point for buyer (B2B) or consumer (B2C)
    - Acceptance and willingness-to-pay may be stimulated through PR/marketing communication for Eco-feed products

7. Discussion and conclusions

7.1 Conclusions

- Total (theoretically) available volume of side streams is relatively small compared to total market for animal feed; Eco-feed produced at full scale can easily be absorbed by market
- Production costs are primarily driven by processing costs and collection costs in the upstream part of the chain (collection until delivery of feed to farm)
- Importance of economies of scale in processing: to enhance the economically feasibility of eco-feed concepts, it needs to aim for a large scale
- Costs can be controlled upstream, or need to be recouped through higher final selling price – with an 'Eco-feed premium' downstream paid by buyers (B2B) and consumers (B2C)
- Next steps:
    - What are the sustainability gains? → Quantify environmental footprint
    - Elaborate business case for all scenarios specified

7.2 Discussion

- Marketing and communication can be utilized to increase acceptance and willingness-to-pay
- Feasible business case is facilitated if virgin feed ingredients are priced to reflect their footprint – if their price increases, Eco-feed is more competitive
- To prevent ‘green claims’: When using Eco-feed as an ingredient, it should constitute a minimum % of the total feed for the products (meat, eggs) to be marketed as ‘Eco-feed’

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