"Non-food Crops-to-Industry schemes in EU27"

WP4. Costs and socio-economic impacts

D4.1 Modelling framework for key stages of crops-to-products schemes

Lead beneficiary: Imperial College London/ Centre for Environmental Policy

Authors: Calliope Panoutsou

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Task 4.1 Modelling framework

The aim of the Task is to provide the modelling framework for the cost analyses. The following steps were undertaken so far:

- Literature review to determine the main cost categories related to each of the selected crops (available literature included in D4.2).
- The development of a modelling framework which includes representative stages of crop-to-product schemes.
- The modelling framework IS populated with crop production data for a number of the selected crops per country.

Future steps

- Populating the model with costs regarding logistics (wherever required) & conversion technologies for the selected crops.
- Perform cost analysis of crop to product & co- product schemes for the selected cases.
- Develop a module (linked with the cost analysis model) to assess the socio-economic impacts (income & jobs).
- Perform socio-economic analysis for the selected cases.

Model description

A model was designed in MS Excel with which the cost analyses will be made. This model essentially consists of three separate components, which are all interlinked as highlighted in Figure 1.

- **Input:** Data will be sourced from literature & through extensive consultations with partners. Information sourced through the data collection exercise will be stored in two separate worksheets: one containing data relating to each crop under study and chain section and a second one containing assumptions considered in the selected crop-to-product schemes. References will be provided.
- **Cost analysis:** A sheet is set-up for each section of the crop chain, the output of which is a cost in €/ t per feedstock. Cost data will be linked to the data review sheets and referenced to ensure full transparency.
- **Output:** A summary sheet which is set-up and linked to each of the data processing sheets. This provides crop chain costs in €/t segmented by sector, scale and crop type (for a given conversion technology).

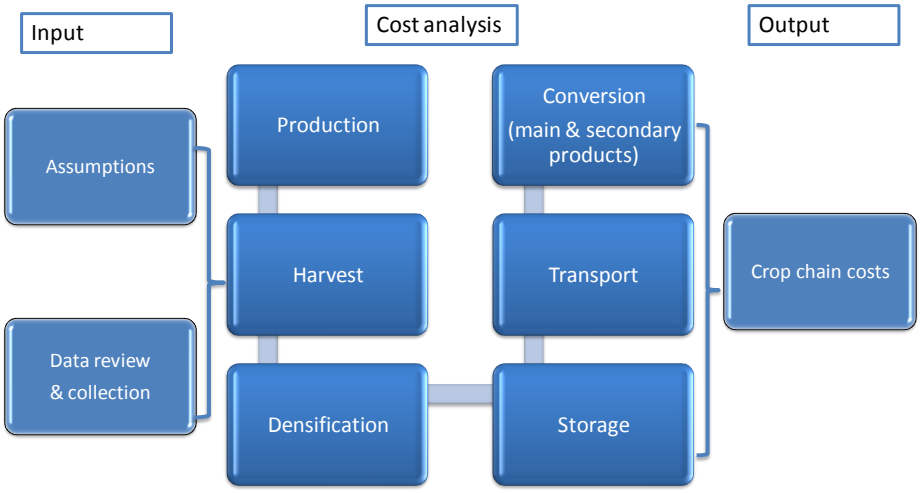

Figure 1: Cost analysis model layout.

As costs for many aspects of the crop chain exist across wide ranges (regional, temporal, scales, etc.) the model will account for these ranges by including a 'central' scenario, which will use data considered to be the most likely case; as well as cases that represented the 'low' and 'high'.

Figure 1 provides the model layout as well as the interactions between worksheets in the model while in the following sections details are provided for the inputs & outputs per crop chain stage. The assumptions and costs used in the model will be analysed in detail in the revised version following the economic analysis in the end of the project.

Crop Production

This stage includes all expenses per cultivation & management practice for the under study crops. The model will consider both annual & perennial crop options and will be modified accordingly for each case.

Table 1. Input & output from the crop production section

INPUT	
Crop establishment	
General assumptions	
Planting density	plants/ha
Yield - 2010	odt/ha
Yield - 2020	odt/ha
Yield - 2030	odt/ha
Harvest interval	yrs
Plantation lifetime	yrs
Establishment costs	
Ploughing	€/ha
Harrowing	€/ha
Herbiciding	€/ha
Initial fertilising	€/ha

Sowing/ Planting	€/ha
Irrigation	
Cost of fencing (optional)	€/ha
Cost of cut-back at end of first year	€/ha
Exit costs (Grubbing up)	€/ha
Recurring costs	
Land rent	€/ha
Irrigation	€/ha
Fertilisation	€/ha
Harvesting	€/ha
OUTPUT	
Annual equivalent of establishment costs	€/ha
Recurring costs	€/ha
Subsidy A	
Subsidy B	
Total cost	€/ha

Harvesting

In this stage of the chain information will be provided on the harvesting method, the time & interval as well as on the actual harvested yield.

Following detailed information on related costs will be provided per crop & region under study.

Table 2. Input & output from the harvesting section

INPUT	
Harvesting method	Type
Harvesting time	Month(s)
Harvesting interval	yrs
Yield	t/ha/yr
Variable Costs	
Harvesting and chipping	€/ha
Harvesting / cutting / mowing	€/ha
Baling	€/ha
Carting / stacking / loading to storage	€/ha
OUTPUT	
Harvesting cost	€/ha
Harvesting cost	€/t

Densification

This stage includes any operation that changes the state and/or reduces the volume of a given mass of feedstock. This size reduction can increase the unit density of the raw material, resulting in a smaller space required for storage and transportation.

Table 3. Input & output from the densification section

INPUT	
Processing type	
Variable Costs	
Processing cost	€/t
Handling and packaging cost	€/t
Handling cost	€/t
OUTPUT	
Densification cost	€/t

Storage

During ***storage***, and depending on the crop type, the end use requirements and storage conditions, biodegradation of raw material occurs, mainly due to microbial activity. Important parameters characterizing the degradation linked to the storage include humidity and the exact type of storage (e.g. indoor versus outdoor) which is site-specific. Current storage infrastructure has been developed to accommodate dry bulky material like agricultural bale system (for the supply of forage and bedding materials to small and medium scale livestock operations) and wood industry operations (sawmill, particle board industry, etc.). In the future, storage facilities will have to balance issues of low-cost, high-density, and multiple feedstocks harvested at different times throughout the year.

Table 4. Input & output from the storage section

General Assumptions	
Biomass composition	type
Storage method	type
Average storage duration	mths
Storage losses per month	%
Storage losses	%
Variable costs	
Losses due to decomposition / wetting	€/ha
Loading to storage / handling	€/ha
Storage costs	€/ha
Cost summary	
Storage cost	€/ha
Storage cost	€/t

Transport

Transport plays a key role in the economics of the crop to industry chains. In practice, existing transport infrastructure and means are used. Important parameters characterizing the transport stage include the type of transport (lorry, ship, rail), the feedstock load per km, the distance traveled, the fuel consumption, etc.

Table 5. Input & output from the transport section

INPUT	
Biomass composition	Type
Biomass density	kg/m3
Average travel distances by mode	
Road	
Road	Road
Rail	
Harvest site to rail depot 1	Road
Rail depot 1 to rail depot 2	Rail
Rail depot 2 to conversion facility	Road
Sea	
Harvest site to distribution centre	Road
Distribution centre to port 1	Road
Port 1 to port 2	Sea
Port 1 to conversion facility	Road
Variable costs	
Cost of lorry	€/t/km
Cost of rail	€/t/km
Cost of ship	€/t/km
Transport costs	
Road	
Loading to transport	€/t
Harvest site to conversion facility (round trip)	€/t
Total cost	€/t
Rail	
Harvest site to rail depot 1	€/t
Rail depot 1 to rail depot 2	€/t
Rail depot 2 to conversion facility	€/t
Total cost	€/t
Sea	
Harvest site to port 1	€/t
Distribution centre to port 1	€/t
Port 1 to port 2	€/t
Port 1 to conversion facility	€/t
Total cost	€/t

Conversion (main product/ by- product)

The conversion to product & by- product technologies will be grouped per feedstock type and per sector (industry & energy) and their key cost parameters will be analysed in relation to the production of the respective crop.

Table 6. Input & output from the conversion to product & co- product section

INPUT	
Capital cost	€
Annual production	tonnes
Capital cost - gross of capital grants	€/t product
O&M costs	€
O&M costs	€/t product
Variable costs	€
Variable costs	€/t product
OUTPUT	
Total costs	€
Total costs	€/t product

Table 7: Overview of the parameters used in the crop chain model.

	Options	Input	Output
Data review			
Crop Chains Review	Crop types, Crop chains	Cost information for selected crop chains, yield, harvest interval (all fully referenced).	Data used in the model (i.e. *Data input and processing* worksheets).
Conversion Technology Review	Technology types	Capex, Opex, capacity, conversion efficiency, load factor (all fully referenced).	Information used to populate 'Conversion Assumptions worksheet'.
Assumptions			
General Assumptions	General assumptions	Product values, yield, harvest interval, co-product co-efficients	Data used in the model.
	Financial assumptions	Farmers margin, discount rate, plantation and plant lifetime, inflation index.	
	Grants and policy incentives	European & national support schemes	
Conversion Assumptions	Technology types Scale type: Small, Medium and Large	Capex, Opex, conversion efficiency, load factor.	Data used in the 'Conversion' sheet.
Data input and processing			
Feedstock	Oil crops, sugar crops, carbohydrate crops, other speciality crops	Establishment costs, variable costs, fixed costs.	Feedstock cost (€ t^{-1})
Harvesting	Harvesting method, Additional processing (i.e. densification).	Costs for harvesting, loading to storage, additional processing and bagging.	Harvesting cost per feedstock (€ t^{-1})
Storage	Outdoors or indoors.	Storage costs, storage duration and losses.	Storage cost per feedstock (€ t^{-1})
Transport	Transport mode: Road, rail and sea.	Transport distance, loading to transport.	Transport cost per feedstock (€ t^{-1})
Conversion	Technology types Scale type: Small, Medium and Large.	Conversion data from the 'Technology review' sheet.	Feedstock cost per scale and technology type (€ t^{-1})
Data output			
Summary	Inclusion of grants and policy incentives, sensitivities (yield, conversion cost, conversion efficiency), conversion technology and transport type.	Output data from 'Feedstock', 'Harvesting', 'Storage', 'Transport' and 'Conversion' sheets.	Cost per chain (€ t^{-1})
Graphs	Graph type	Data from 'Summary' sheet.	Bar graph per feedstock, scale and sector.

2.2.2 Data collection

The data include costs but also parameters such as crop yields, time required for each cropping practice, labour rates, product values, etc. When necessary, data will be collected from selected stakeholders within the participating countries or selected industrial ones suggested by the partner responsible for each feedstock.

A database for the cost information has been structured (see D 4.2) for the under study crops. Data version from August 2011 is segmented by crop type.

In the final version an additional sheet will be included containing data relating to the conversion-to-main-product technologies and for co- products.

All data will be clearly referenced and any appropriate comments will be noted. This will facilitate the comparison between data sources and the review by external parties.

2.2.3 Model validation

Versions of the model are regularly circulated for validation to members of the project team, as well as the Steering Committee. Discussions with industrial representatives are at the moment of the update (August 2011) ongoing. This is considered to be an essential aspect of the research as it is expected to ensure that both the data and the modelling analysis accurately reflect commercial reality. Co-ordination of these activities is conducted through various channels; primarily through email correspondence, but also by telephone contact and in face-to-face discussions.