

# A TECHNO-ECONOMIC EVALUATION ON THE PRODUCTION OF HMF FROM SUCROSE

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## Problem Context

In recent years, there has been increasing demand to replace fossil-fuel based products with bio-based substitutes. To achieve this, bio-based platform chemicals, such as 5-hydroxymethylfurfural (HMF), should be used as intermediate products. The structure of HMF, and possible applications, are shown in Figure 1. The state of art technology is to produce HMF from fructose. However, this is not cost-efficient enough for an industrial process. An alternative feedstock is sucrose, and this integration project focusses on this production process.

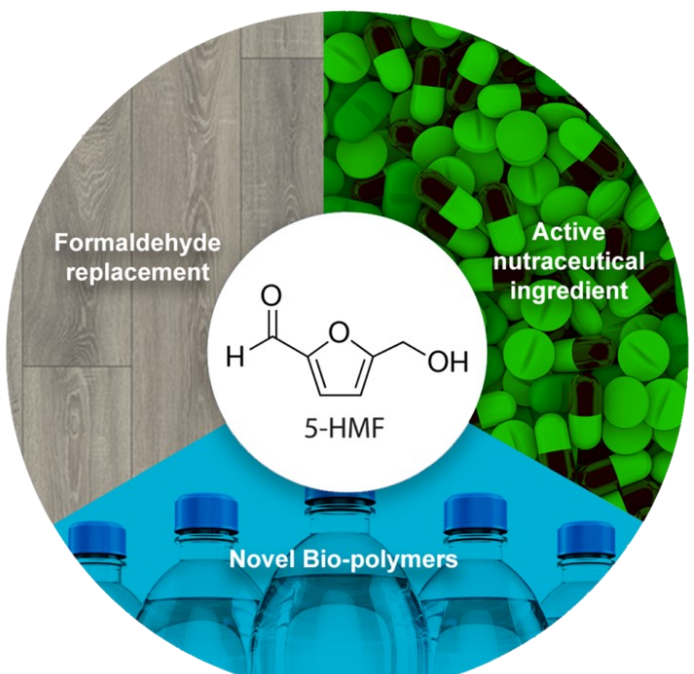


Figure 1: HMF structure and applications

## Methods

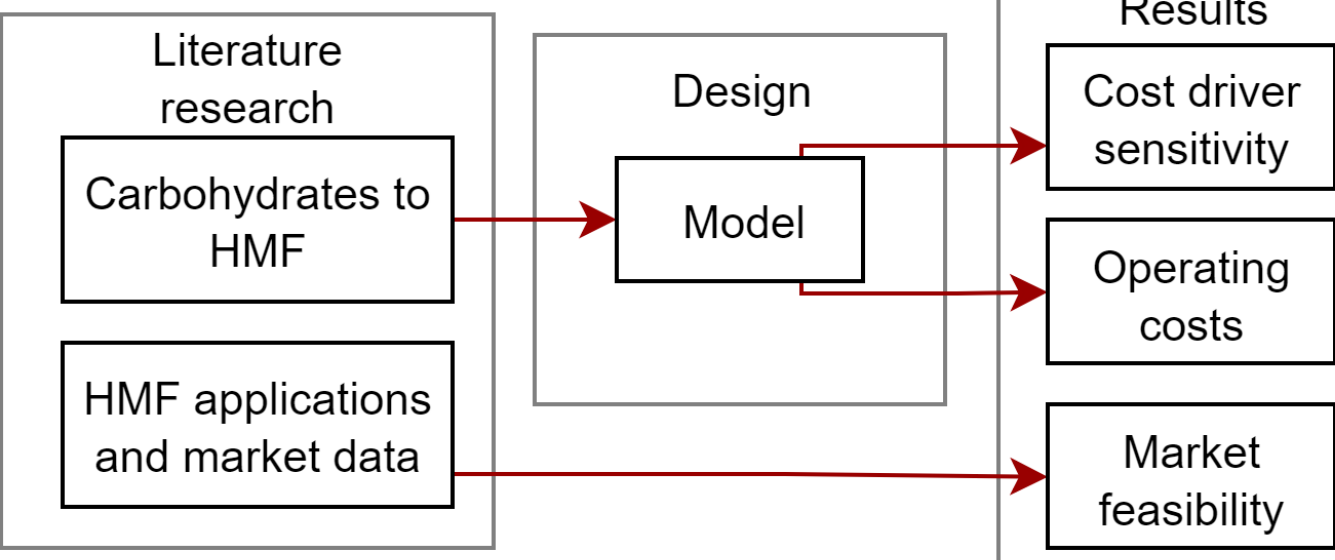


Figure 2: Research methodology

## Results 1a: fructose to HMF cost drivers

- HMF minimum selling price (MSP): \$1.25/L
- Most important cost driver: feedstock (Figure 3)
- \$1.25/L functions as benchmark for sucrose processes

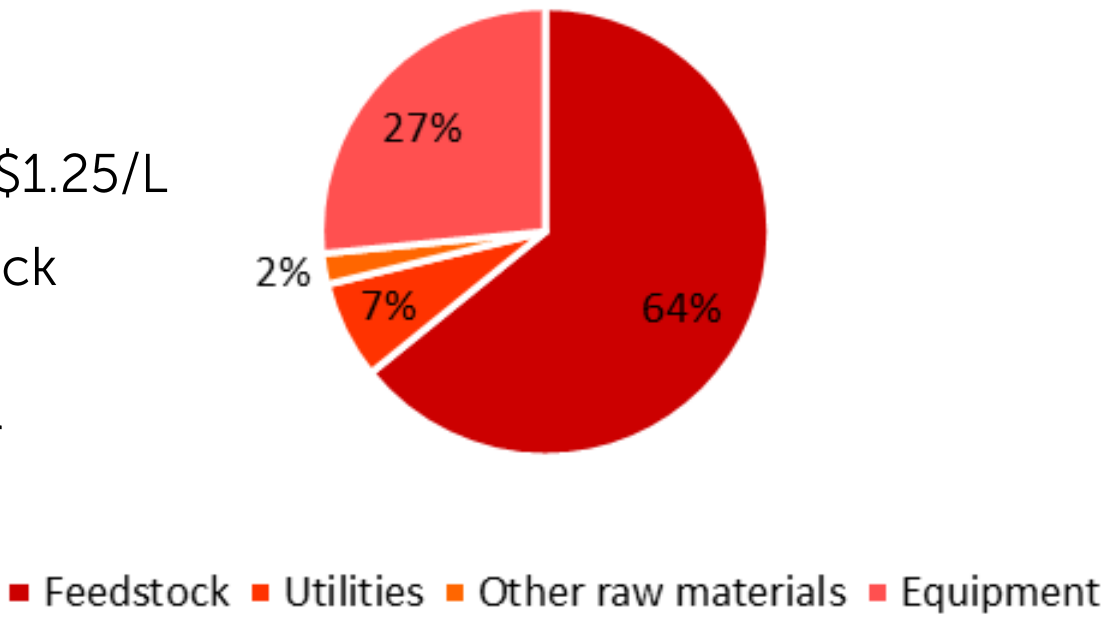


Figure 3: Cost drivers of the fructose of HMF process

## Results 2a: 'one-pot' sucrose to HMF cost drivers

- HMF MSP: \$1.29/L
- Most important cost driver: feedstock (Figure 5)
- Equipment and utility costs more expensive due to required purification equipment
- Other raw material costs higher due to additional catalyst

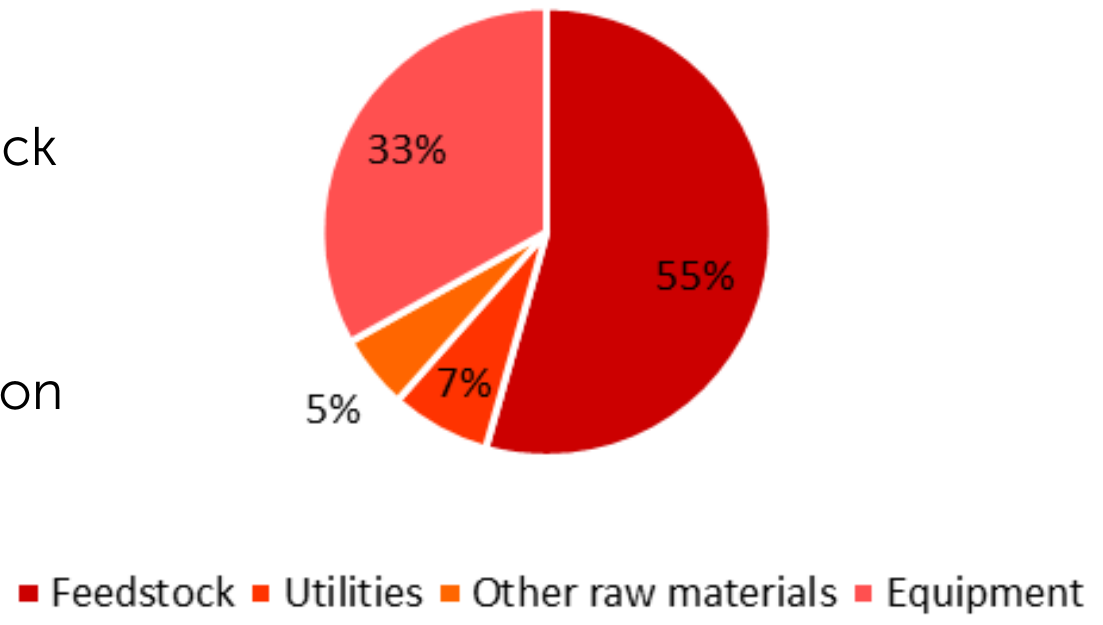


Figure 5: Cost drivers of the sucrose to HMF process

## Results 3a: sucrose thin juice to HMF cost drivers

- HMF MSP: \$1.06/L
- Most important cost driver: equipment (Figure 6)
- 40% price reduction in feedstock compared to pure sucrose as an intermediate sucrose extraction product is used
- Equipment costs higher due to impurities in the thin juice

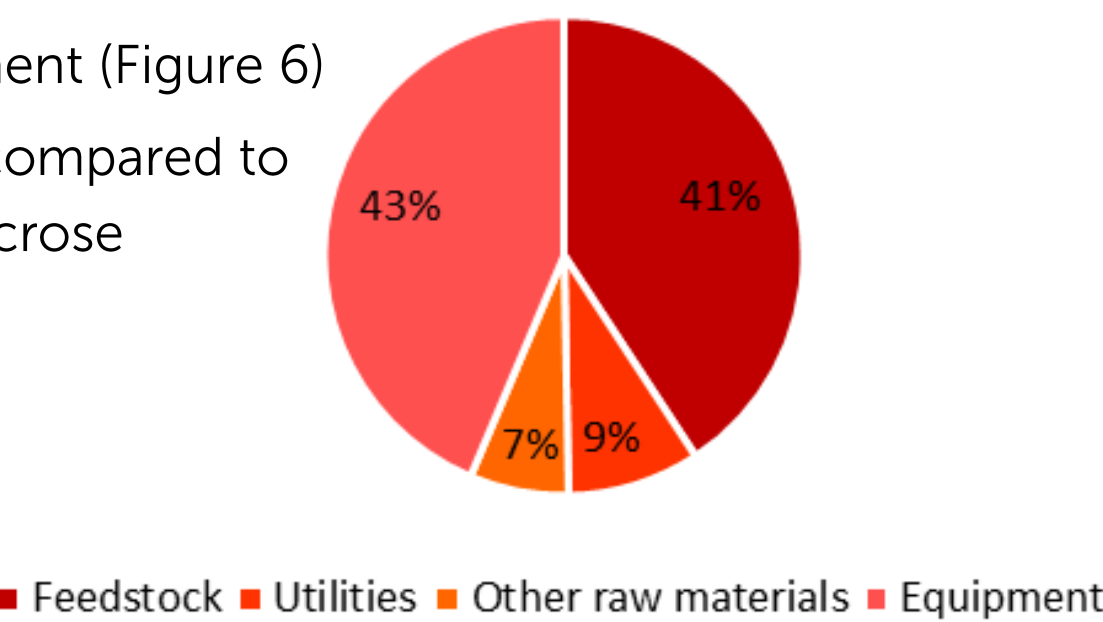


Figure 6: Cost drivers of the sucrose thin juice to HMF process

## Results 1b: fructose to HMF sensitivity

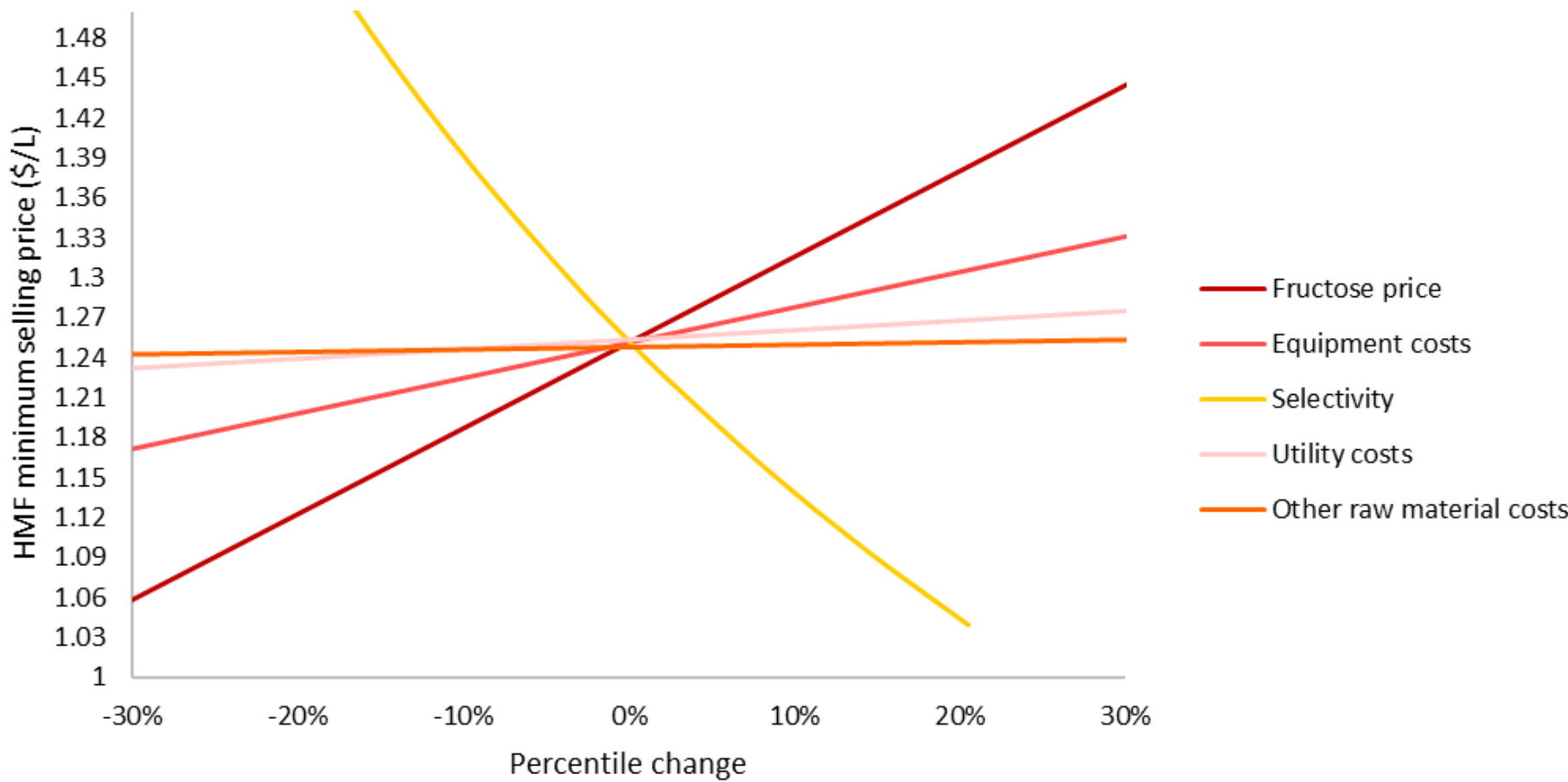


Figure 4: Sensitivity analysis for the fructose to HMF process

## Results 3b: sucrose thin juice to HMF sensitivity

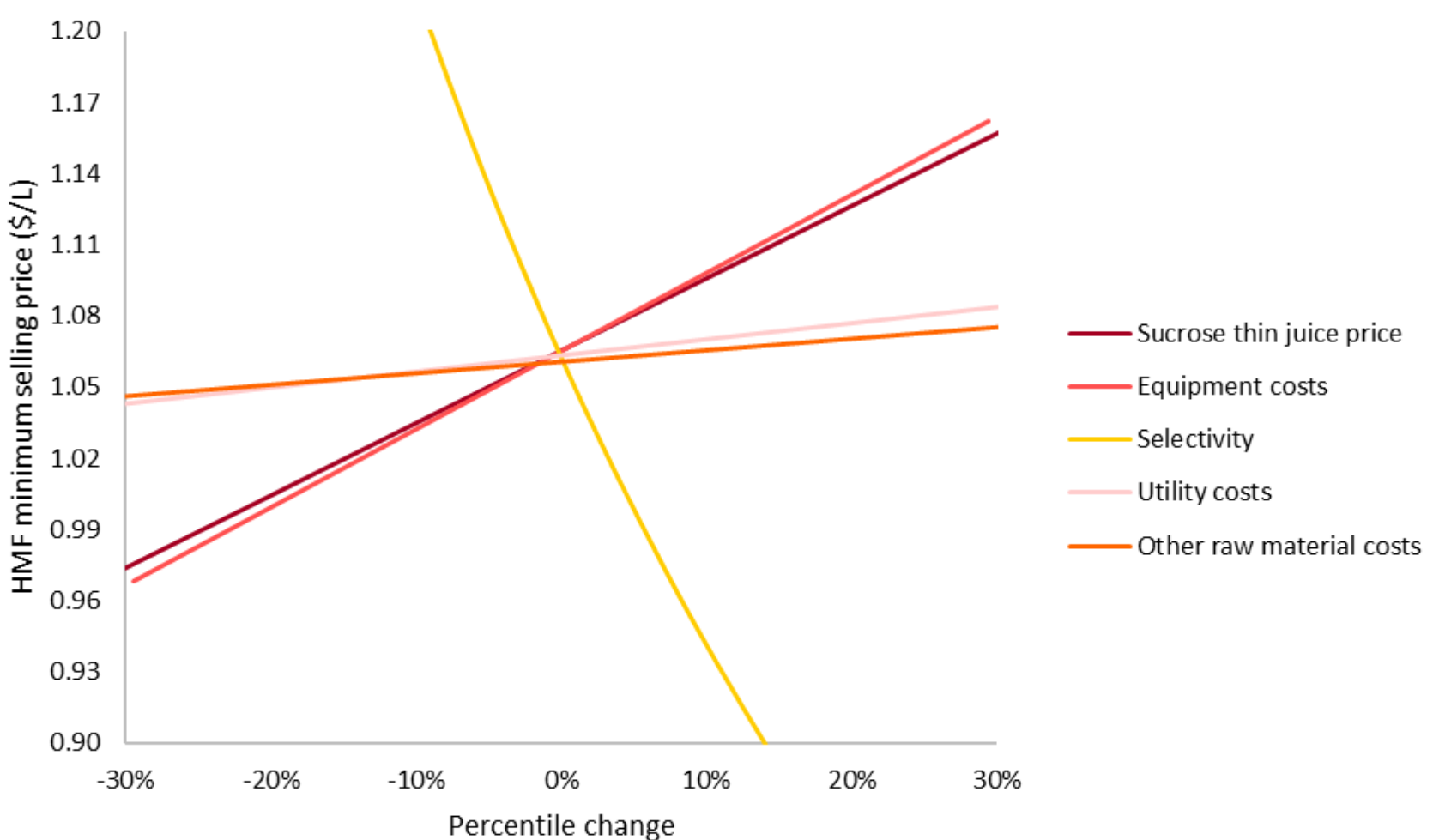


Figure 7: Sensitivity analysis for the sucrose thin juice to HMF process

## Conclusion: model results

- Processes in row 3 and 4 are least cost-efficient and were therefore not discussed
- Converting sucrose thin juice to HMF is more cost-efficient than benchmark process

Process	HMF MSP (\$/L)	Limiting factor
Fructose to HMF (1a)	1.25	Feedstock price
Sucrose: conversion of fructose to HMF and separation of glucose	2.77	Feedstock price
Sucrose: separate fructose and glucose conversion to HMF	1.72	Feedstock price
Sucrose: 'one-pot' conversion to HMF (2a)	1.29	Feedstock price
Sucrose thin juice to HMF (3a)	1.06	Equipment cost

## Conclusion: market analysis

Market	HMF Advantage	HMF price competitiveness	Market size
Bio-based Packaging	Better performance	+	++
Biofuels	Better performance	-	++
Adhesives	Environmentally preferred	-	+
Food Additives	Unclear	++	--

