

BIO-REFINING AGRICULTURAL CROP PRODUCTS INTO HIGH-VALUE MATERIALS

- ECONOMIC IMPACTS ON THE AGRICULTURAL SECTOR

Jørgen Dejgård Jensen
Department of Food and Resource Economics
jorgen@ifro.ku.dk

UNIVERSITY OF COPENHAGEN



Overview

- Agriculture in the bio-based economy
- The problem
- Methodology
- Scenarios
- Results
- Discussion

Agriculture in the biobased economy

- Increased focus on management, disposal and recycling of natural resources
- EU Strategy: Innovating for Sustainable Growth: A Bioeconomy for Europe (2012):
 - Economic growth and employment in rural areas
 - Reduce fossil fuel dependence
 - Improve economic and environmental sustainability of primary production and processing
 - Better utilization of bio-resources
- Search for new opportunities for agricultural value creation in non-food bio-products



Bio-refining

Biorefining: Transformation of biomass into products via biological, enzymatic or chemical processes.

Biorefinery systems are characterised by four features



Example:

Sugar cane

sugar

ethanol

What's in it for agriculture?

- Agriculture can supply feedstock
 - Biomass crops (grain, sugarcane, potatoes, grass, willow, ...)
 - Crop residues (e.g. straw)
 - Off-fall from other production
- Agriculture can use biorefined products
 - Refined protein feeds and other nutrients
 - Materials



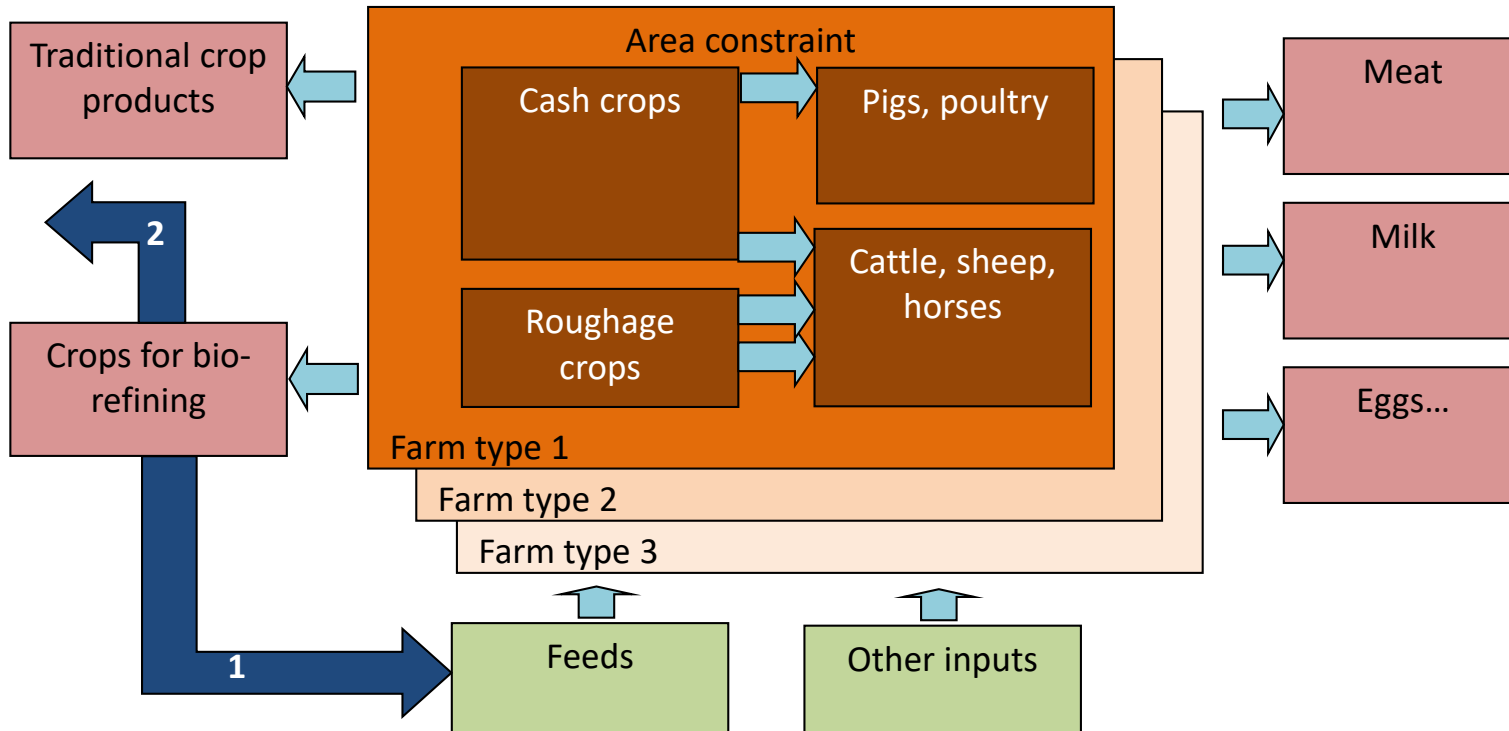
Objective of the study

- Examine agricultural economic consequences of scenarios, where bio-refining of agriculturally supplied biomass is successfully implemented
 - Refining green biomass (grass etc.) to extract high-value protein feed for pigs and poultry – to replace imported protein feeds, such as soya
 - Refining agricultural biomass to high-value industrial materials and products to be sold outside agriculture

Partial equilibrium agricultural sector economic model

- Effects of biomass production on allocation of agricultural land
- Effects of biomass production on domestic livestock production
- Effects of biomass production on the equilibrium price of biomass
- Effects of biomass production on the agricultural profitability at the sector level
- Effects of biomass production on production and profitability in different farm types
- Effects of biomass production on agricultural employment

ESMERALDA- partial equilibrium agricultural sector model



15 farm types

25 crop sectors

11 livestock sectors

Theoretical approach

- Cost minimization in individual lines of agricultural production
- Zero profit condition in individual lines of agricultural production
- Profit maximizing allocation of farm area on different crops
- Profit maximizing size of livestock and capital input
- Account of physical, technological and political restrictions – regulated by shadow prices

Farm typology: 15 farm types

Type	Approximate number, 2011	Area per farm (ha)
Small conventional crop full time farm, clay soil	1302	134
Large conventional crop full time farm, clay soil	153	377
Small organic crop full time farm, clay soil	7	141
Large organic crop full time farm, clay soil	6	433
Small conventional crop full time farm, sandy soil	5422	111
Large conventional crop full time farm, sandy soil	10	334
Small organic crop full time farm, sandy soil	6	134
Large organic crop full time farm, sandy soil	8	425
Conventional cattle full time farm	3252	117
Organic cattle full time farm	463	181
Small conventional pig (+other) full time farm	4772	85
Large conventional pig (+other) full time farm	10	317
Small organic pig (+other) full time farm	88	114
Conventional part time farm	23138	36
Organic part time farm	2022	38
Large farm: > 200 ha		

2 bio-refining scenarios

1. Extraction of high-value protein from green biomass (grass etc.) to be used for pig and poultry feeding and use of the residual component for cattle feeding
2. Extraction of high-value components of the biomass for non-food industrial processing, e.g. as a substitute for petrochemical raw materials – biomass area equal to that of scenario 1

Scenario 2 is more flexible than scenario 1 – and potential economic gains may be expected to be largest in scenario 2

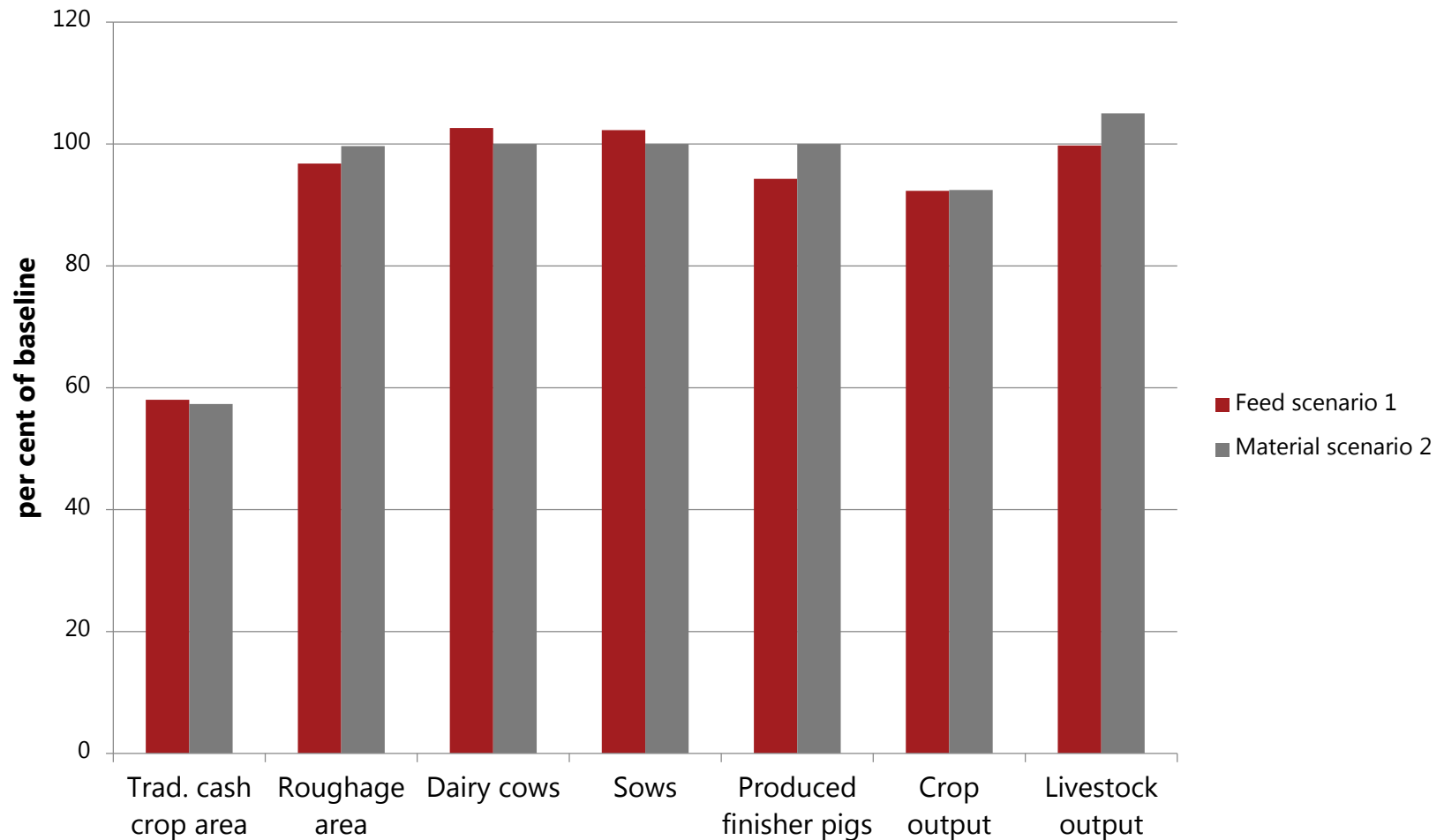
Scenario 1 – protein feed from green biomass

- Increase national self-sufficiency rate for protein feed by one third (compared with baseline) via production of green biomass (grass) for bio-refining
- Increased production of biomass -> increased biomass area -> increased opportunity cost of land -> increased unit cost of biomass production -> increased price of biomass (for all) -> increased unit cost of protein feed -> changed allocation of land -> changed livestock activity -> changed economic performance in agriculture -> changed agricultural employment

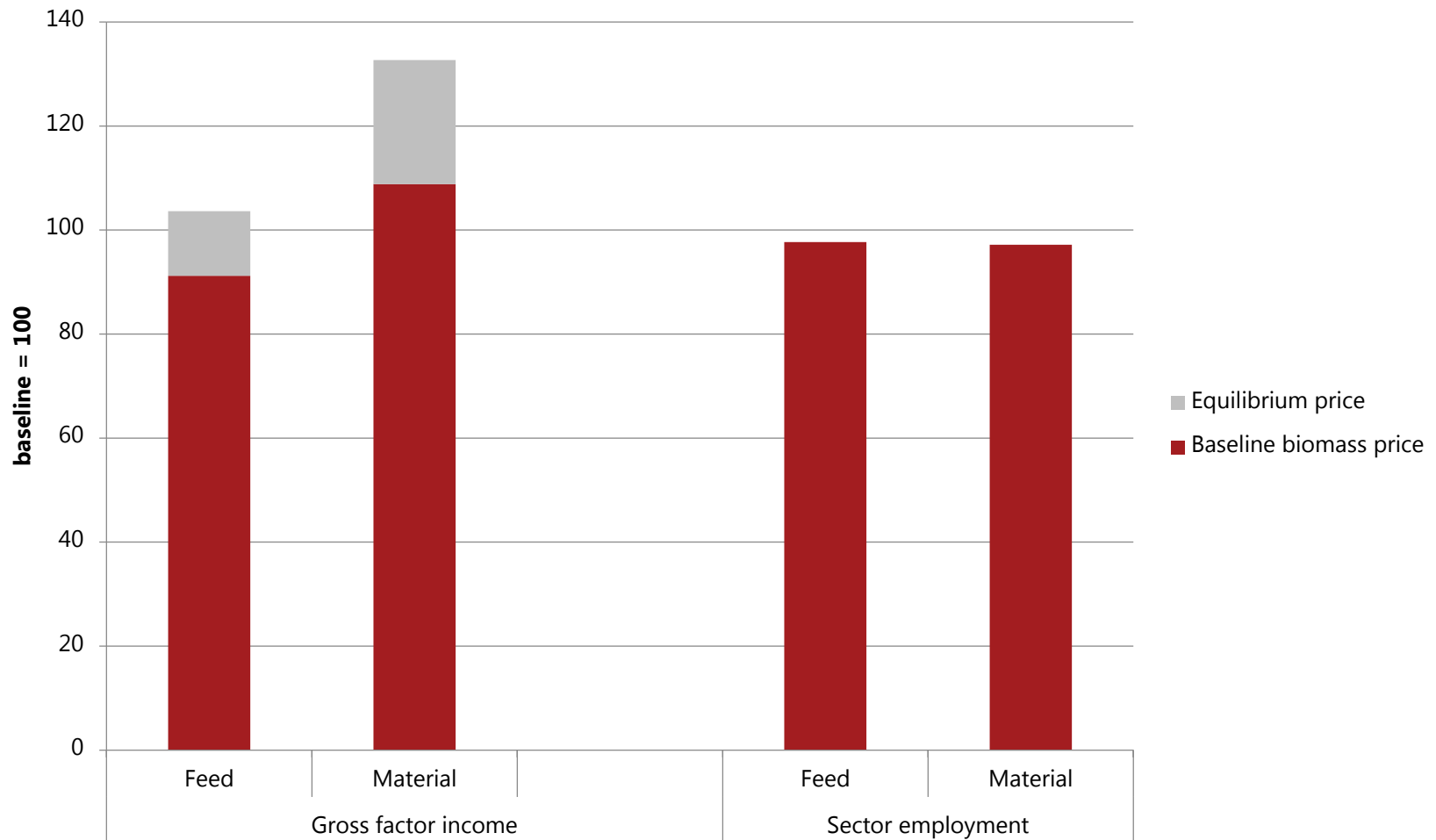
Scenario 2 – materials from biomass

- Total biomass area (sc. 2 - not necessarily "green") = Total biomass area (sc. 1) -> Increased opportunity cost of agricultural land
- > increased unit cost of biomass production -> ...

Results – sector level output changes



Results – sector level income and employment



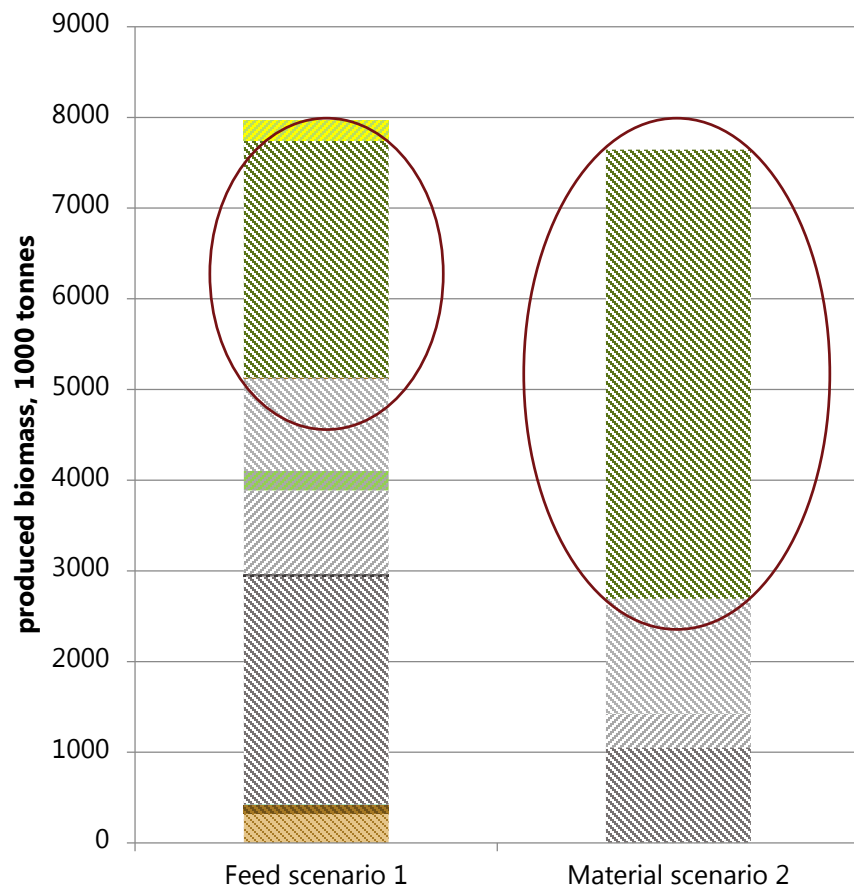
Results – sector level

- Unit cost of biomass increases
 - Does the price of biomass increase correspondingly?
 - Does feed price adjust to increased biomass price?
- Area for biomass production drawn from grain production
- Only small employment effect in agricultural sector

Distribution of effects on farm types

- Biomass production occurs on those farm types, where the opportunity cost of land is relatively low
- Derived impacts on feed prices affect livestock production – depending on the farm types' profitability in these livestock sectors

Distribution of biomass production between farm types



- Organic part time farm
- ▨ Conventional part time farm
- Small organic pig (+other) full time farm
- ▨ Large conventional pig (+other) full time farm
- ▨ Small conventional pig (+other) full time farm
- Organic cattle full time farm
- ▨ Conventional cattle full time farm
- Large organic crop full time farm, sandy soil
- ▨ Small organic crop full time farm, sandy soil
- ▨ Large conventional crop full time farm, sandy soil
- ▨ Small conventional crop full time farm, sandy soil
- ▨ Large organic crop full time farm, clay soil
- ▨ Small organic crop full time farm, clay soil
- Large conventional crop full time farm, clay soil
- ▨ Small conventional crop full time farm, clay soil

Distribution of farm-level economic effects



Note: +2: Above average, +1: Positive, but below average, -1: Negative

Discussion

- Scenarios assume that biomass can be sold at production costs – requires that price of products from bio-refining can remunerate the cost of biomass
- Influence from market shocks and various policy regulations on economy of biomass production
- Uncertainty – economics of biomass production only known at experimental/pilot level – but what about large-scale biomass production
- Work in progress – preliminary results – comments and suggestions welcome

Thanks for your attention



This study was funded by :

The BioValue SPIR, Strategic Platform for Innovation and Research on value added products from biomass, which is co-funded by The Innovation Fund Denmark, case no: 0603 – 00522B

•
ORGANOFINERY which is part of the Organic RDD2 programme coordinated by ICROFS and funded by the GUDP programme.