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Life Cycle Assessment Perspective for Sectoral Adaptation to Climate Change: Environmental Impact Assessment of Pig Production

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Mutua Kennedy Ndue

Outline

- Background
  - Policy environment and rationale for the application of LCA
  - Rationale for the pig sector
- Methodology
  - The rationale for Adopting LCA
  - Simplified Pig sector LCA
  - Steps in LCA for Pig Value Chain
- Results
- Conclusion and Perspectives

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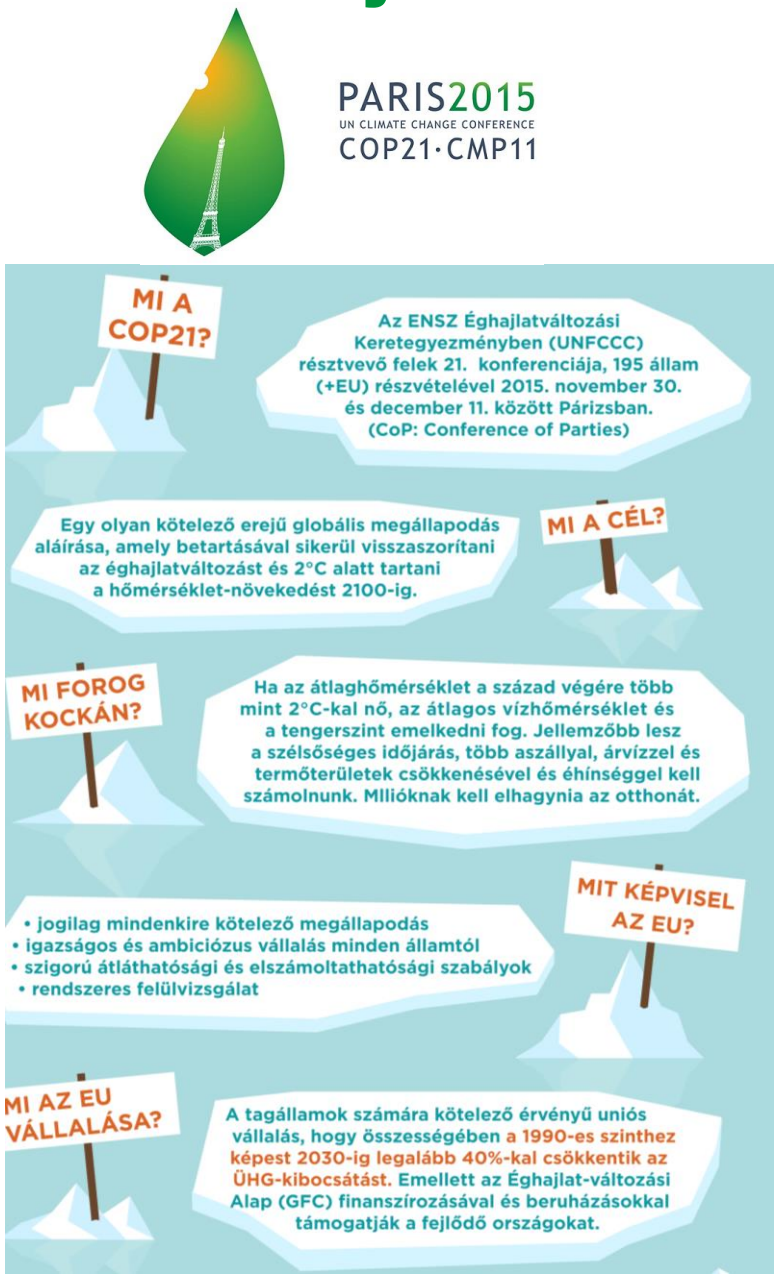
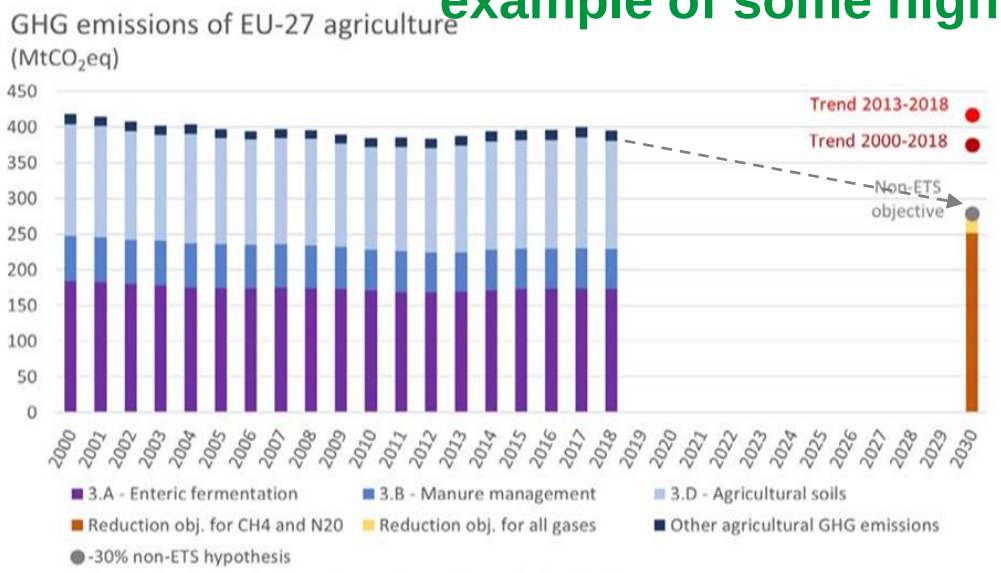
The policy background of the research

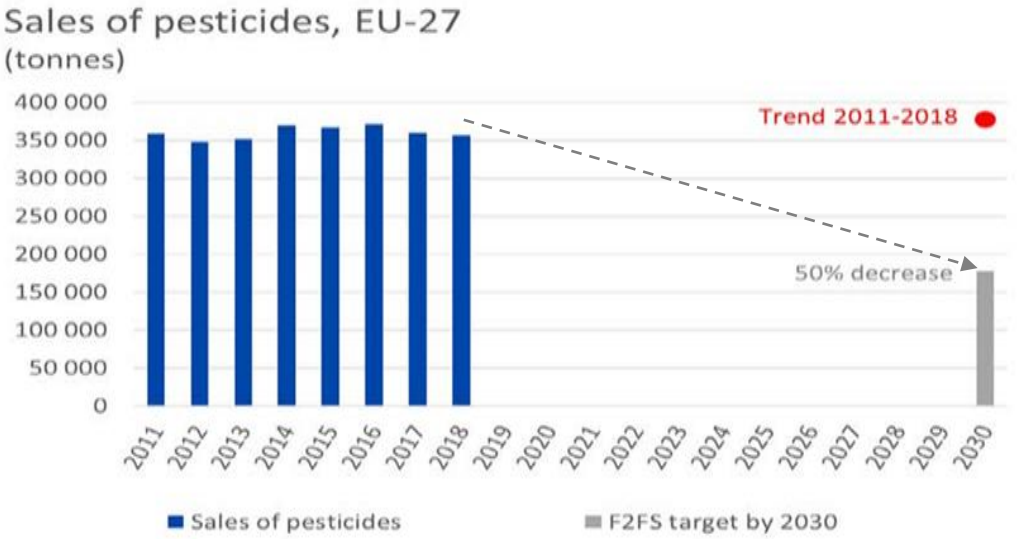
Objectives of the European Green Deal

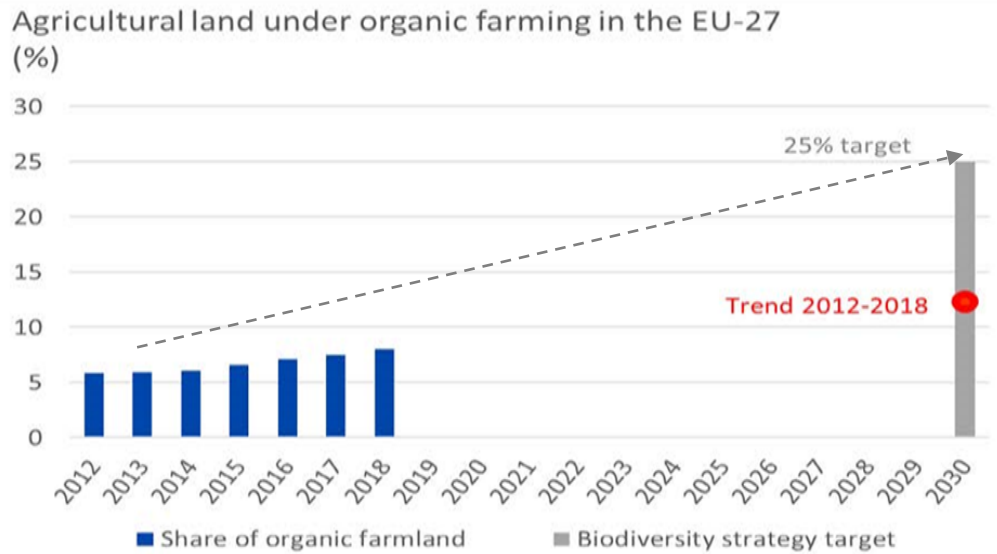


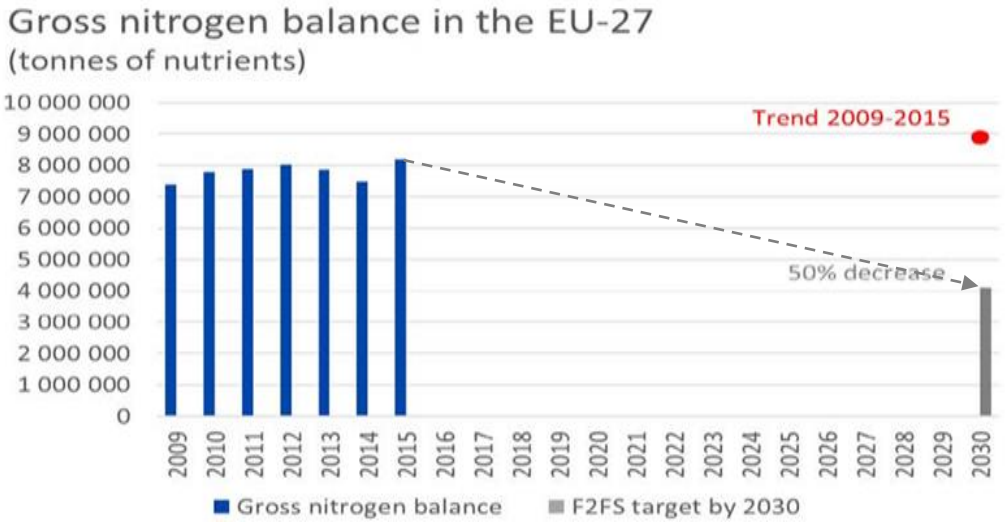
F2F and Biodiversity Strategy

example of some highlighted areas









Forrás: Eurostat-adatok alapján INRAE

Greenhouse Gases

GHGs accounted for in the national inventory

- CO_2
- CH_4
- N_2O
- F-gázok (HFC-k, SF_6, NF_3)

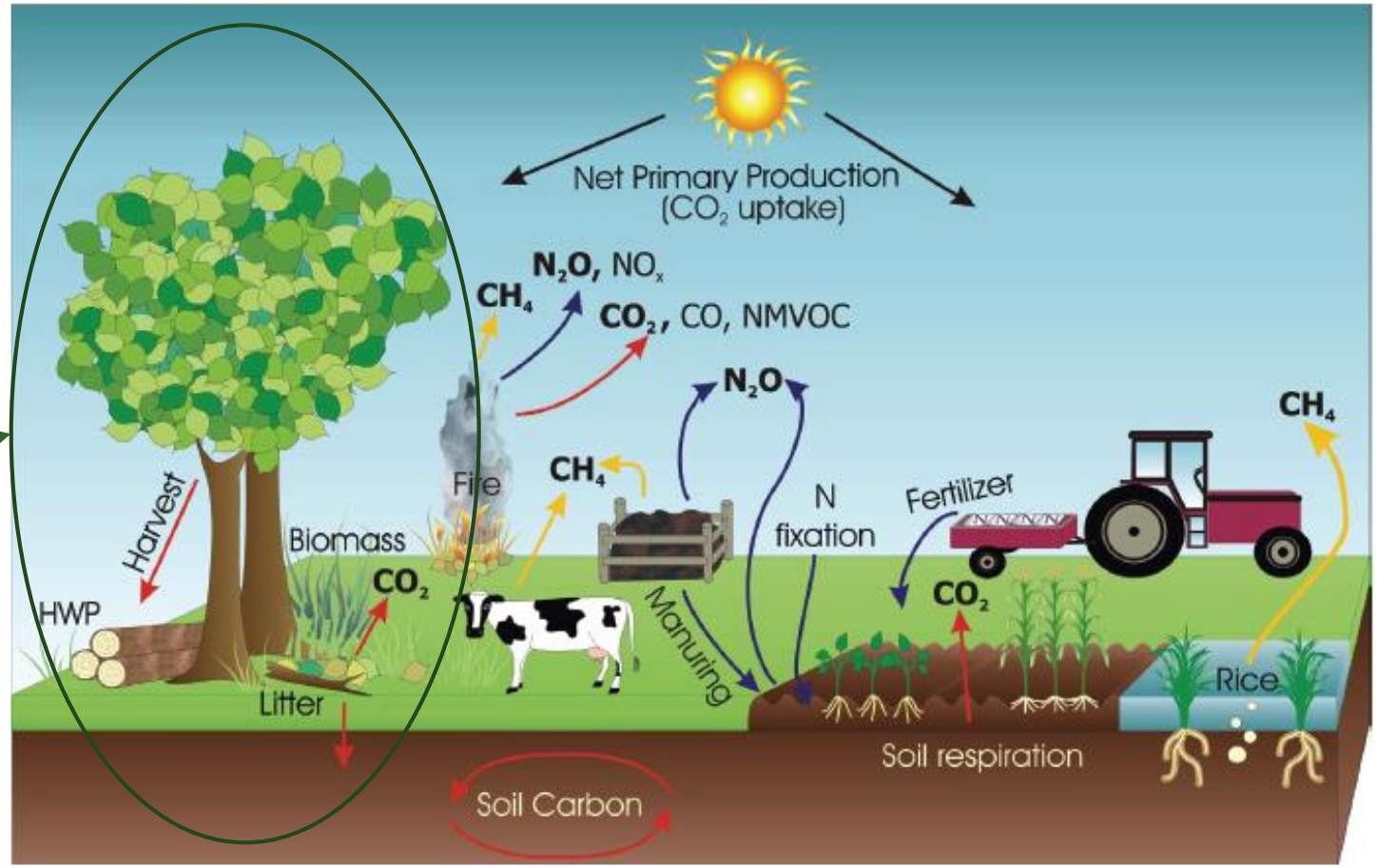
GHGs of agricultural origin

- CO_2
- CH_4
- N_2O

Summary: based on GWP (Global Warming Potential)

GHG sources of agricultural origin

LULUCF:
- Biomass;
- Dream;
- Soil;
- Wood products.



Forrás:2006 IPCC GIs.

Allocation of agricultural resources

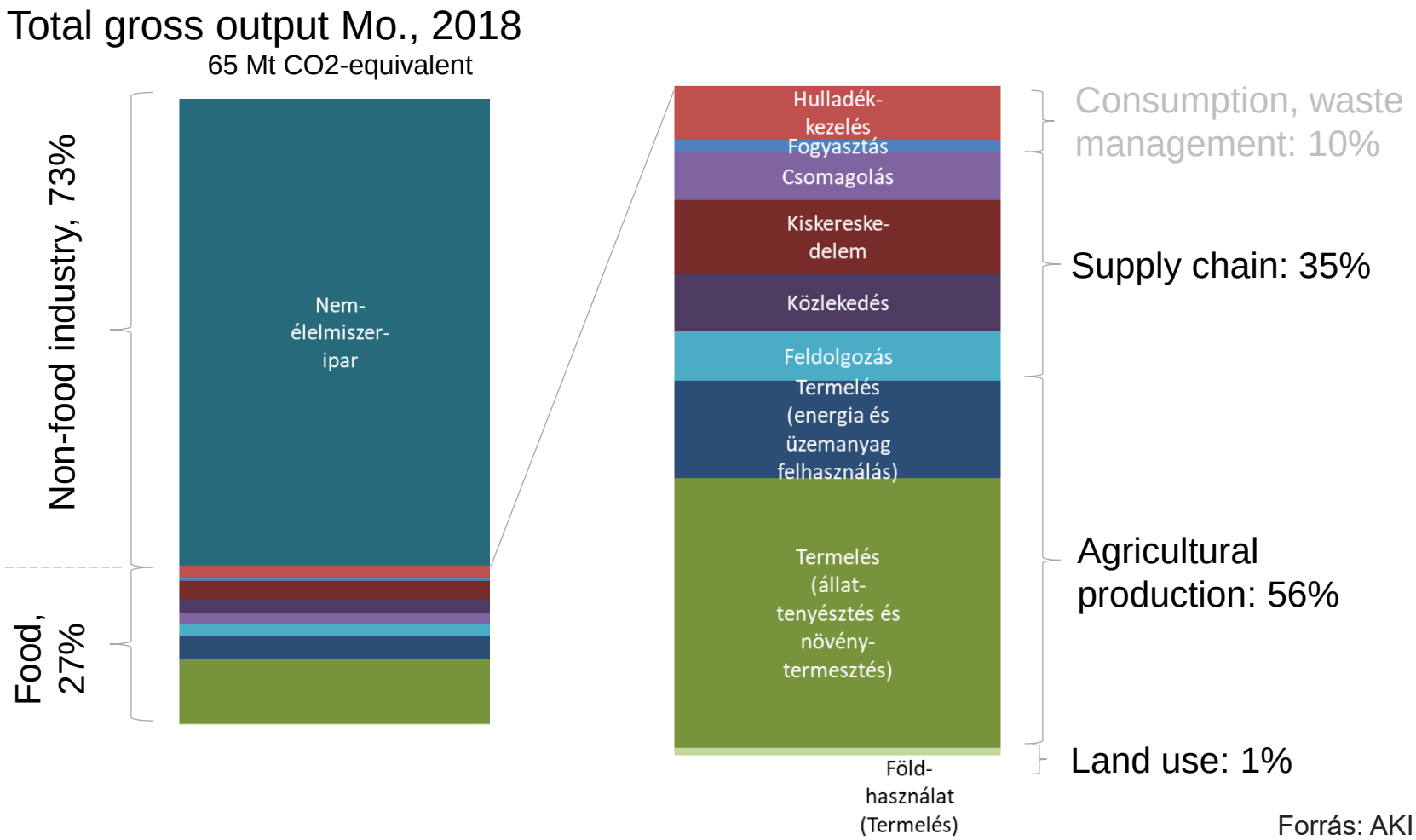
Agricultural sector - technological emissions

- Digestion (CH_4);
- Fertilizer treatment (CH_4, N_2O);
- Rice cultivation (CH_4);
- Agricultural soils (CH_4, N_2O);
- Stubble burning (CH_4, N_2O);
- Liming (CO_2);
- Use of urea and other C-containing fertilizers (CO_2).

Other emissions related to the agricultural sector

- **Energy: fuel and fuel consumption;**
- **Industrial processes: e.g. fertilizer production, food processing,**
- **LULUCF: sequestration/emission of CO_2 from mg. soils**
- **Waste: management of agricultural waste.**

Emissions related to the agricultural and food industry sector

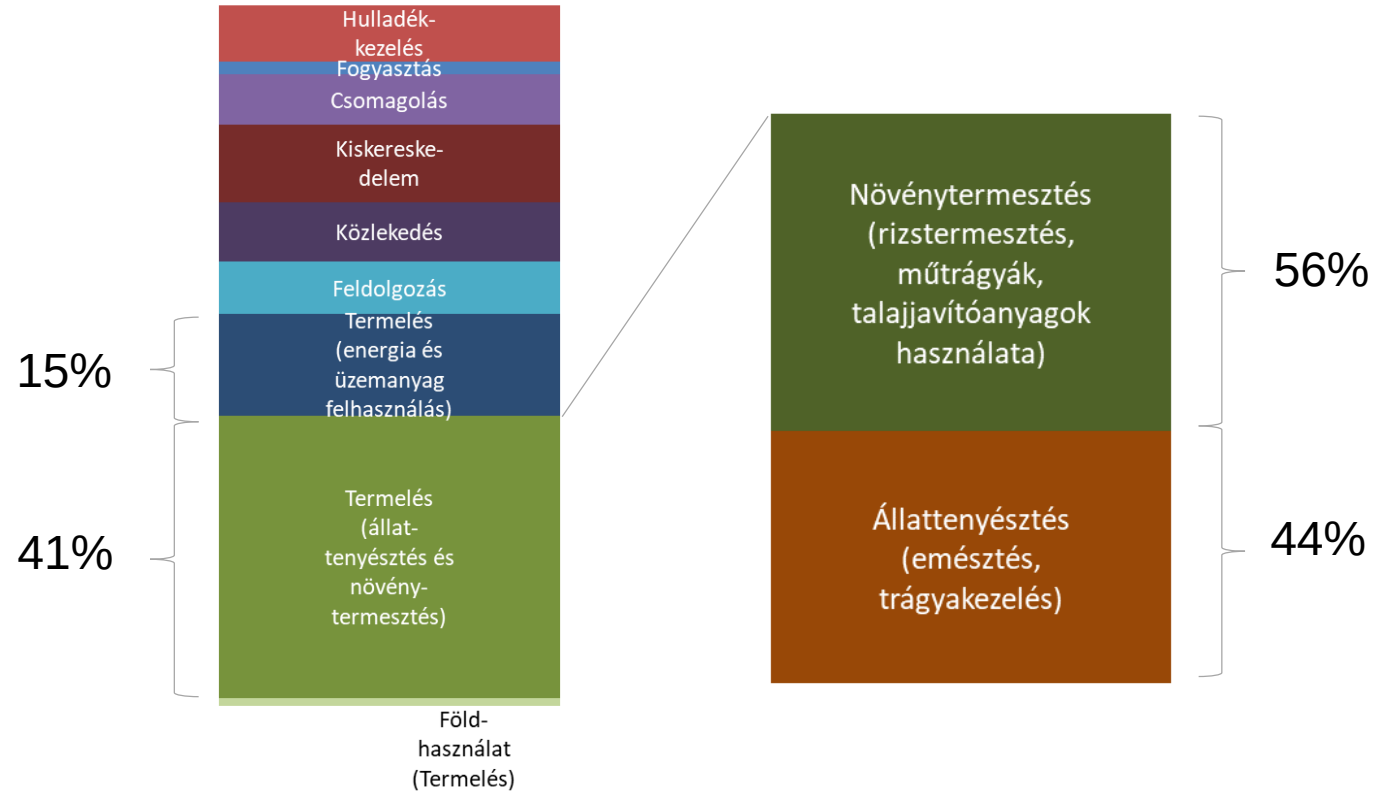


Forrás: AKI, 2022.

Emissions from agricultural production, at the macro level

Total agriculture and food industry net output Mo., 2018

17 Mt CO2-equivalent



Forrás: AKI, 2022.

Why do we also deal with LCA?

European Commission

EN English

Search

Home > ... > Law > Planning and proposing law > Better Regulation: why and how > Better regulation: guidelines and toolbox > Better regulation toolbox

Better regulation toolbox

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Related links

Chapter 1 – General principles of 'better regulation'

- TOOL #1. Principles, procedures & exceptions
- TOOL #2. The regulatory fitness programme (REFIT) and the Fit f
- TOOL #3. Role of the Regulatory Scrutiny Board

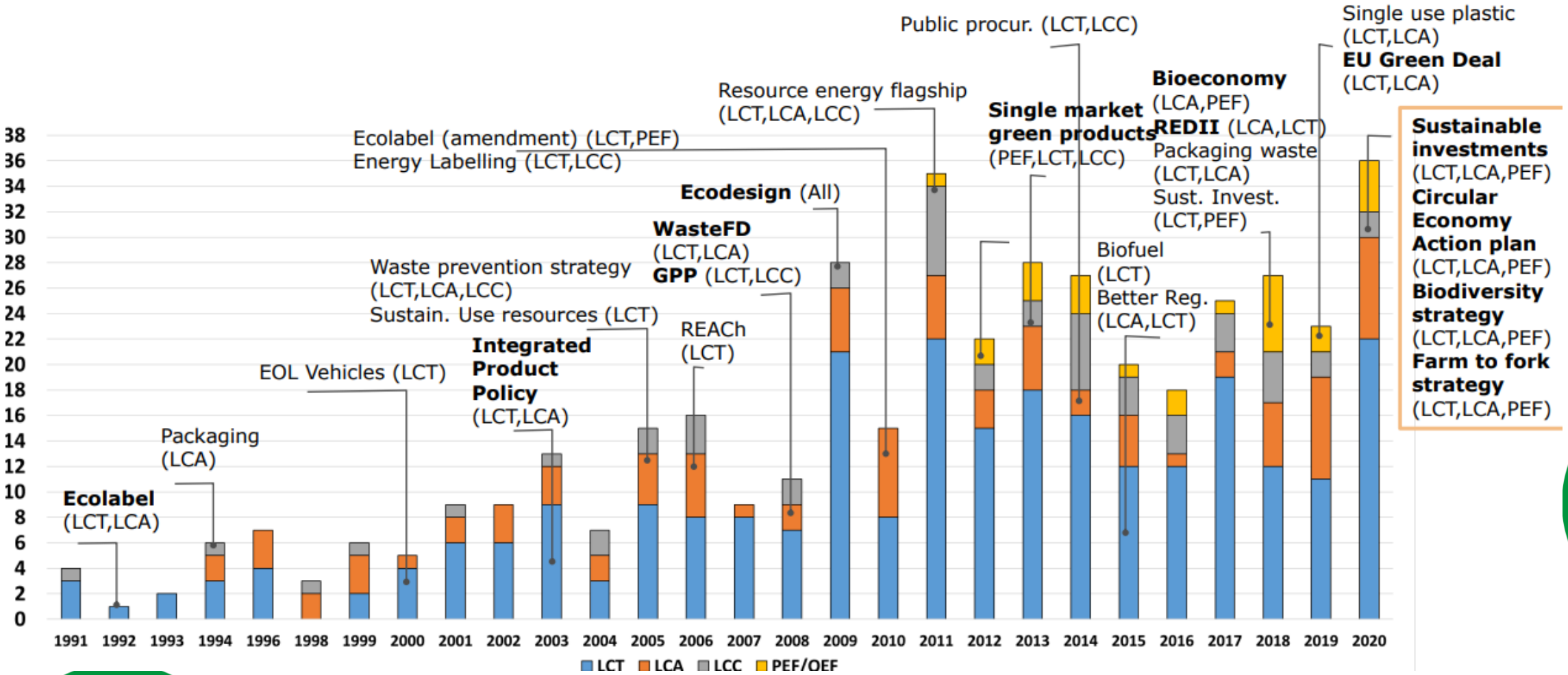
Impact assessment tools adopted by the European Commission

Chapter 8 – Methodologies for analysing impacts in impact assessments, evaluations and fitness checks

- TOOL #56. Typology of costs and benefits
- TOOL #57. Methods to assess costs and benefits
- TOOL #58. EU Standard Cost Model
- TOOL #59. Cost estimates and the 'one in, one out' approach
- TOOL #60. Baselines
- TOOL #61. Simulation models
- TOOL #62. Multi-criteria decision analysis
- TOOL #63. Cost-benefit analysis
- TOOL #64. Discount factors
- TOOL #65. Uncertainty and sensitivity analysis
- TOOL #66. Life cycle assessment

Forrás: COM(2015) 2021 update

LCA thinking in EU policy evaluations



Rationale for adopting LCA tool

Amongst European Commission Tool for Assessing Environmental Impacts of systems (Better Regulation toolbox)

Identification of the most important burdens and most relevant life cycle stages contributing to environmental and social impacts.

Identification of unintended burdens shifting between environmental (and/or socio-economic) impacts (reducing one impact while increasing another) and over life cycle stages

Policy development- Examples of LCT-based European environmental policies are the Communication on Sustainable Consumption and Production (CEC 2008a) and the Communication on Circular Economy (CEC 2015b).

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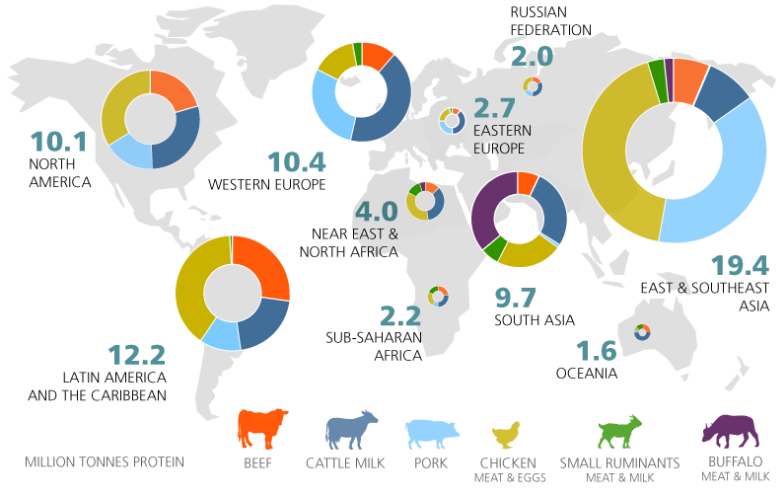
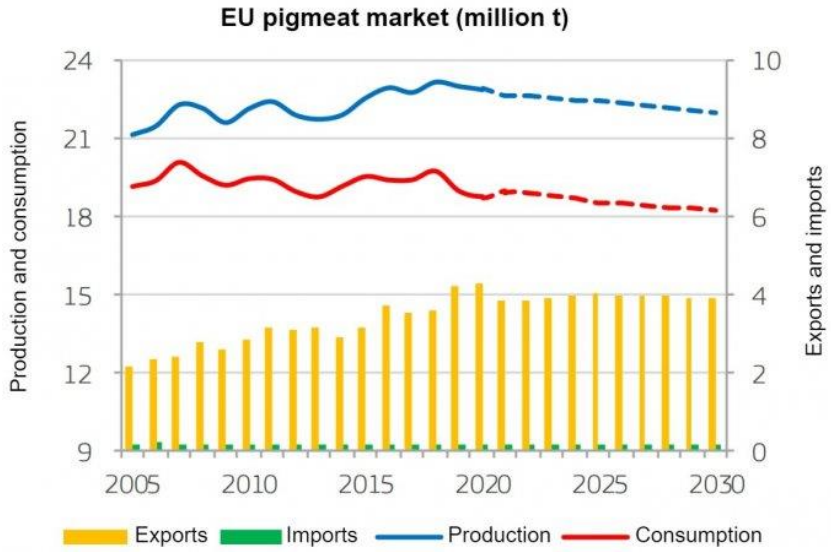
Rationale for the pig sector

Reasons

- Research on the effects of climate change on agriculture is expanding exponentially.
- Plant cultivation plays a greater role in CCI (climate change impacts) modeling compared to animal husbandry.
- Life cycle analyzes examining livestock sectors mainly deal with ruminants.
- Understanding the sector's vulnerability provides an opportunity to develop an adaptation framework that can be used to classify and characterize livestock technologies that are more resilient to climate change.
- Understanding the adaptation of the sector to climate change is necessary.
- It is necessary to find a balance between reducing environmental impacts and increasing animal welfare demands while maintaining the profitability of the sector.





Pork sector life cycle analysis

USA, 2019

Lower GHG emissions, energy and water consumption were observed in housing technology suitable for group placement of pregnant sows compared to individual housing, the use of alternative housing technology reduces the global warming potential (GWP):

- CH4 emissions decreased by 2.9 percent;
- N2O emissions decreased by 2.1 percent;
- feed consumption was 1.92 percent lower.
- At the same time, the space requirement of the barns is 65 percent larger, the additional space requirement increases the global warming potential, which partially offsets the lower GWP during production during the expected 10-year lifespan of the barns.

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METHODOLOGY

Applied tools

Model:

ReCiPe midpoint 2016 (H) V1.13

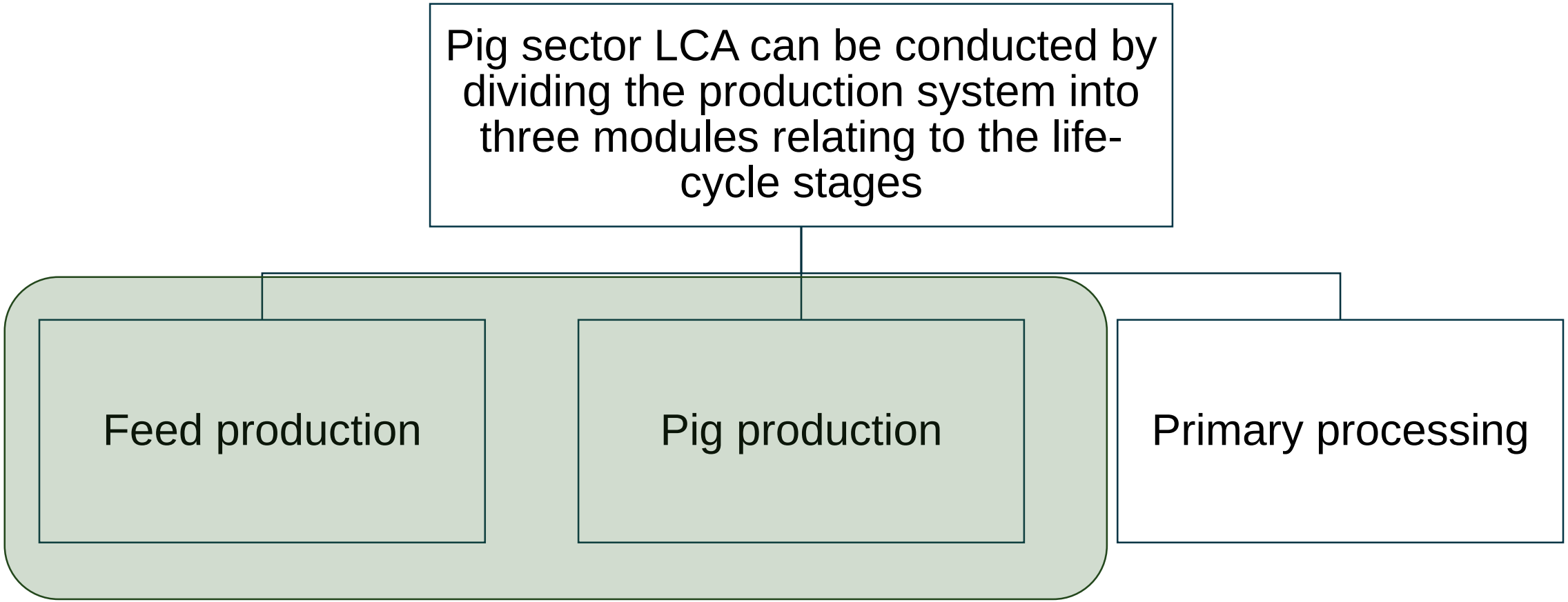
Softver:

OpenLCA 1.10.2

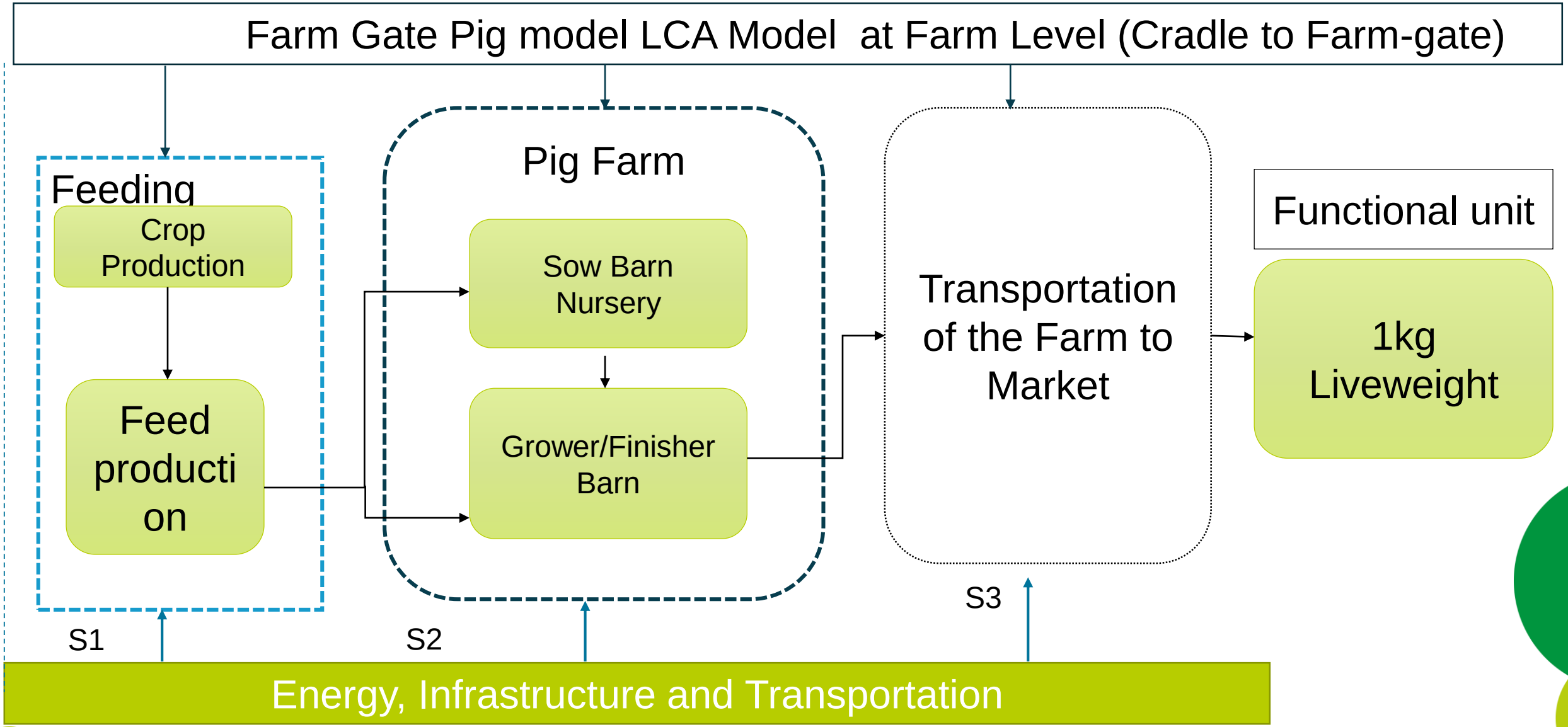
Database:

AGRIBALYSE® 3.0

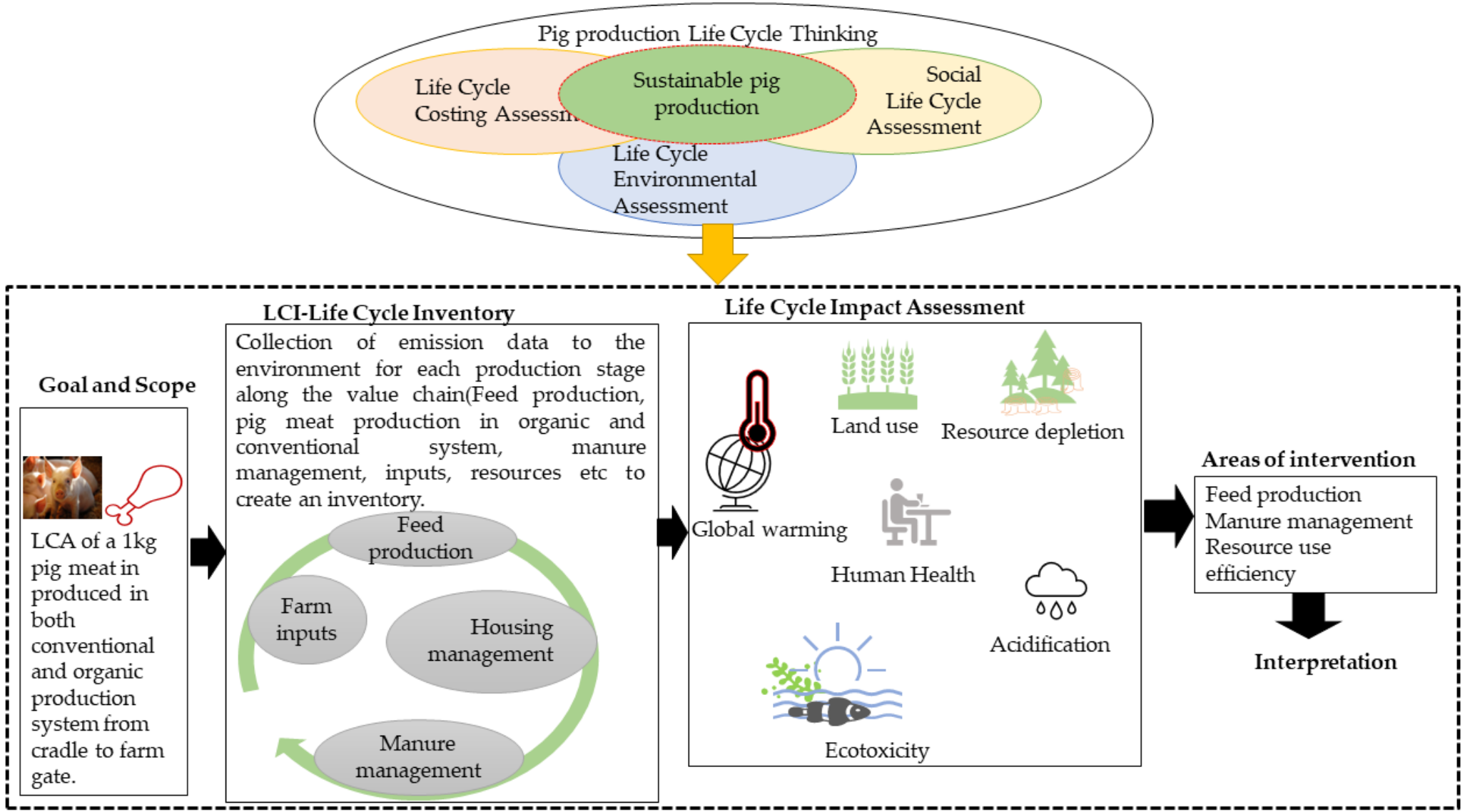
Pig sector LCA



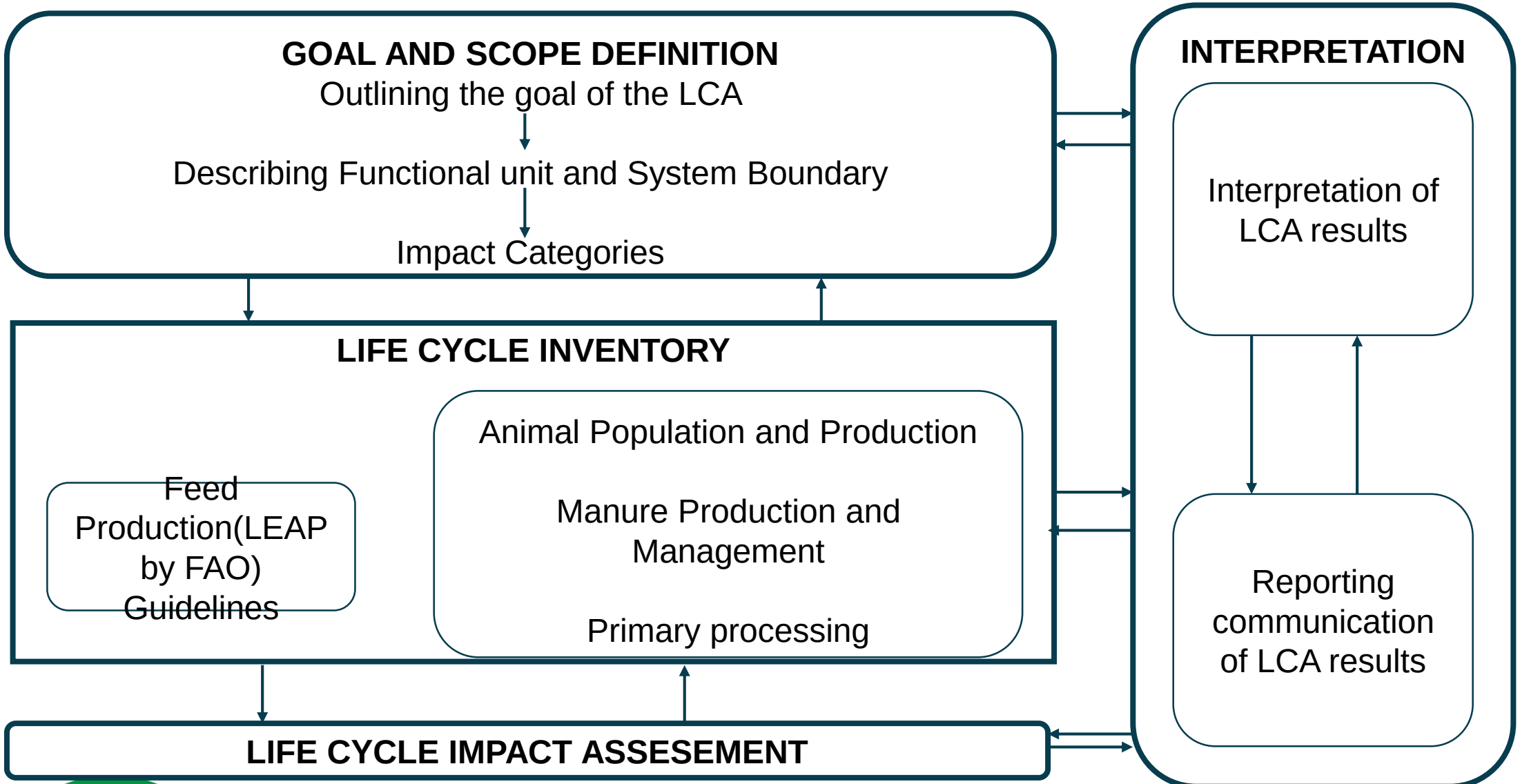
Life Cycle Analysis of Pig sector

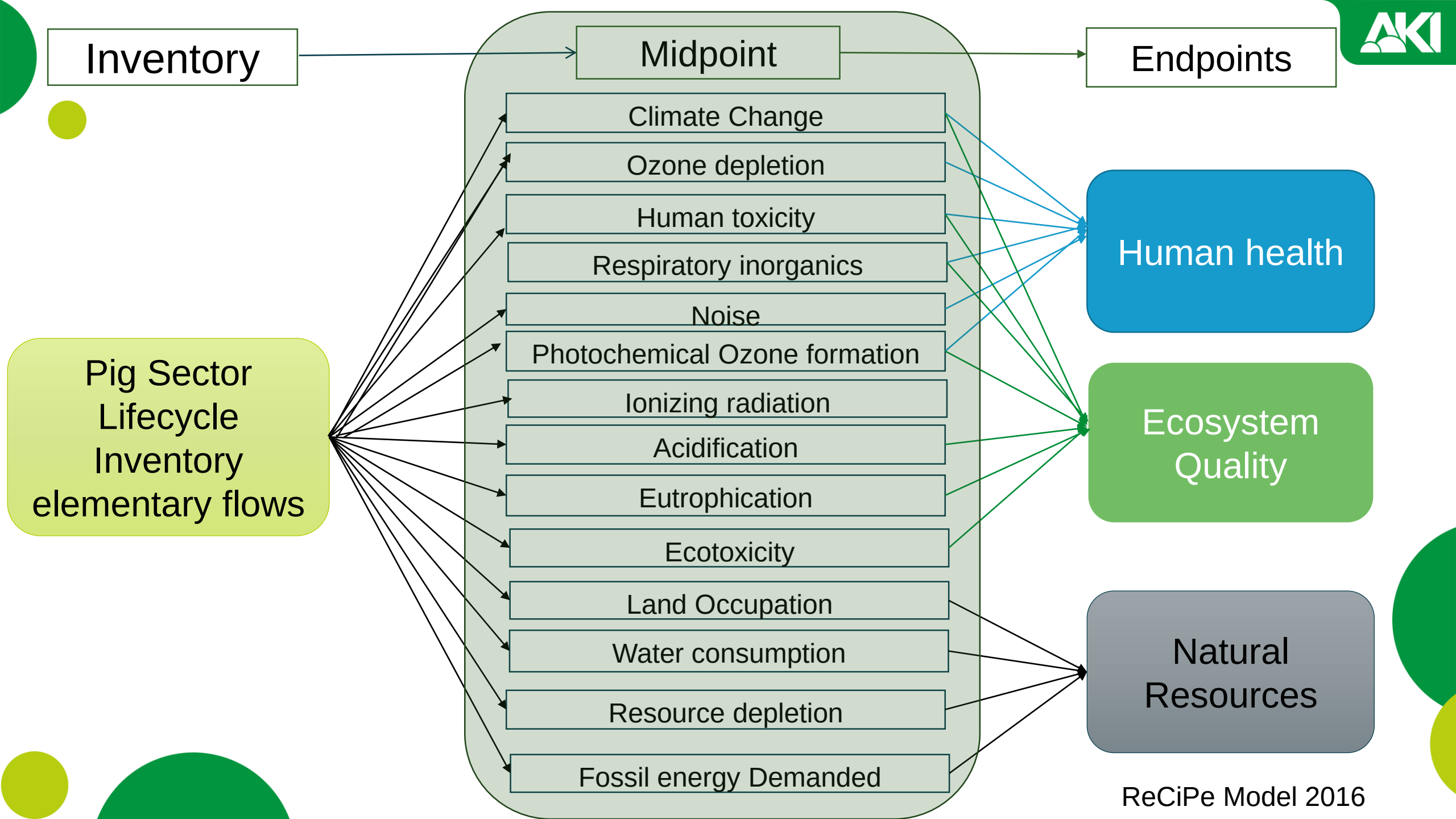


Steps to conduct LCA in pig production



Pig Supply Chain Environmental performance Assessment Guideline (ISO 14044)




Inventory
Midpoint
Endpoints
Climate Change
Ozone depletion
Human toxicity
Respiratory inorganics
Noise
Photochemical Ozone formation
Ionizing radiation
Acidification
Eutrophication
Ecotoxicity
Land Occupation
Water consumption
Resource depletion
Fossil energy Demanded
Pig Sector Lifecycle Inventory elementary flows
Human health
Ecosystem Quality
Natural Resources
ReCiPe Model 2016

A Simplified Farm Level LCA Calculation

Goal, Scope, System boundary, and Functional Units description (system Boundary)

Pig population- draw Pig flow diagram (inventory)

Manure management system (in house, outside house storage and treatment, manure utilization

Annual Pig production factsheet, (number/quantity, LW, sales dates)

Use animal date to calculate annual animal energy requirements and DM intake

Calculate actual amount of feed DM consumed annually from purchased and home- grown/grazed feeds

Define feed DM digestibility and calculate Volatile Solids excreted

From DM intake and feed %N, calculate feed-N intake by pigs

From product yield and product %N, calculate product -N output

Calculate $N_{excreted}$ from N_{intake}-$N_{products}$

Determine percentage of different manure management, usage (deep pit, lagoon compost, biogas digesters, land application)

For each feed, determine GHG/kg DM for production, processing, storage and use.

Define quantity of each Functional Unit(UF)

Calculate kg CO_2 eq /FU

Calculate enteric CH_4

Calculate dung/ manure/ bedding CH_4

Calculate direct and indirect N_2O from excreta on pasture (free range/organic)

Calculate direct and indirect N_2O from on-farm manure management

Calculate CO_2 eq from feeds used (including wastage)

Calculate GHGs and use GWP factors to calculate total CO_2

Vizsgálatba vont tartás technológiák

Conventional

intensive

Ecological

extensive

Conventional

Label Rouge

extensive

Convetional

Label Rouge

Semi-intensive

Assessed Pig Systems

Organic

Conventional

Semi Conventional -Label Rouge (with run systems)

Semi Conventional- Label Rouge (Outdoor)-

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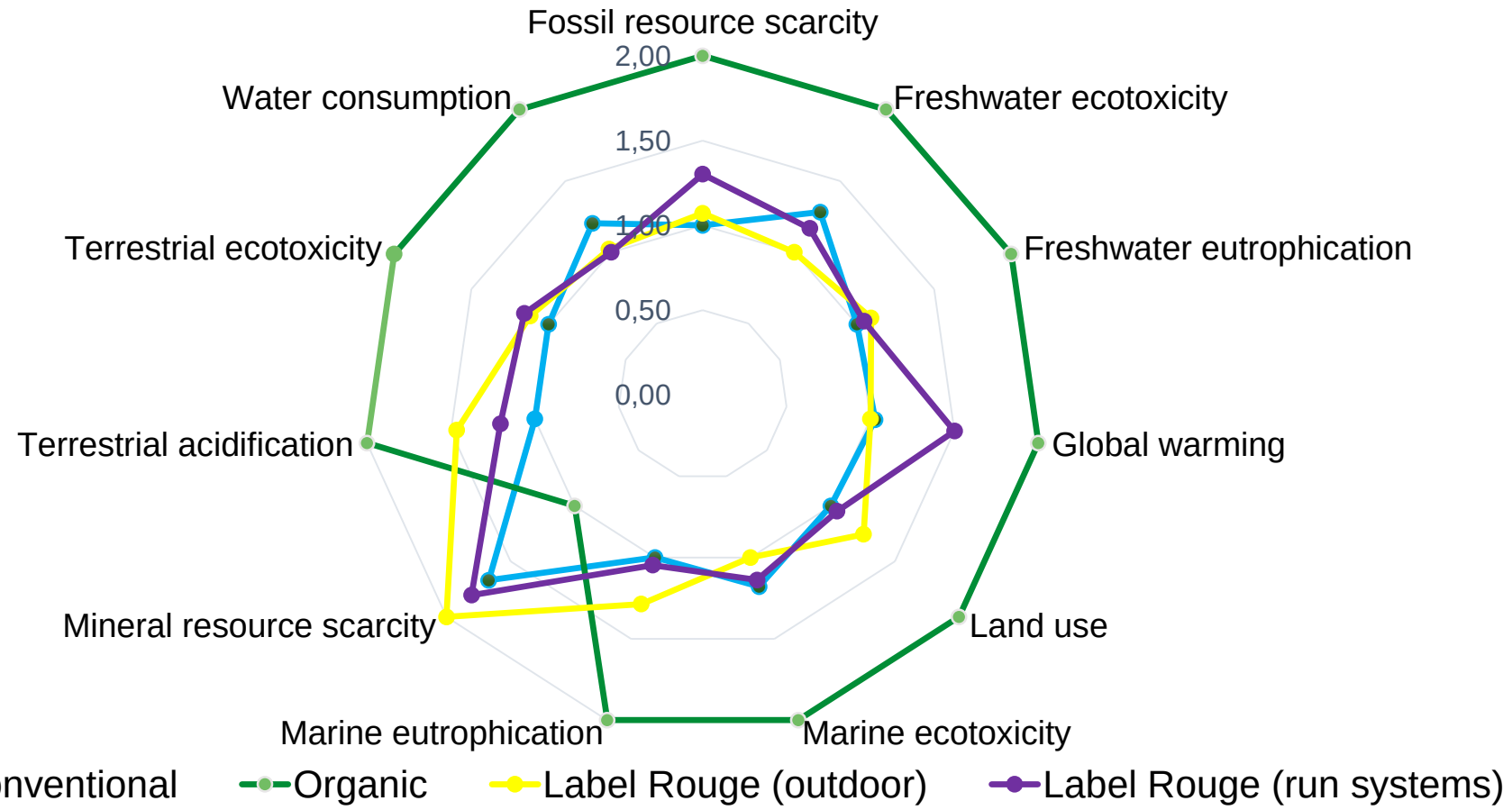
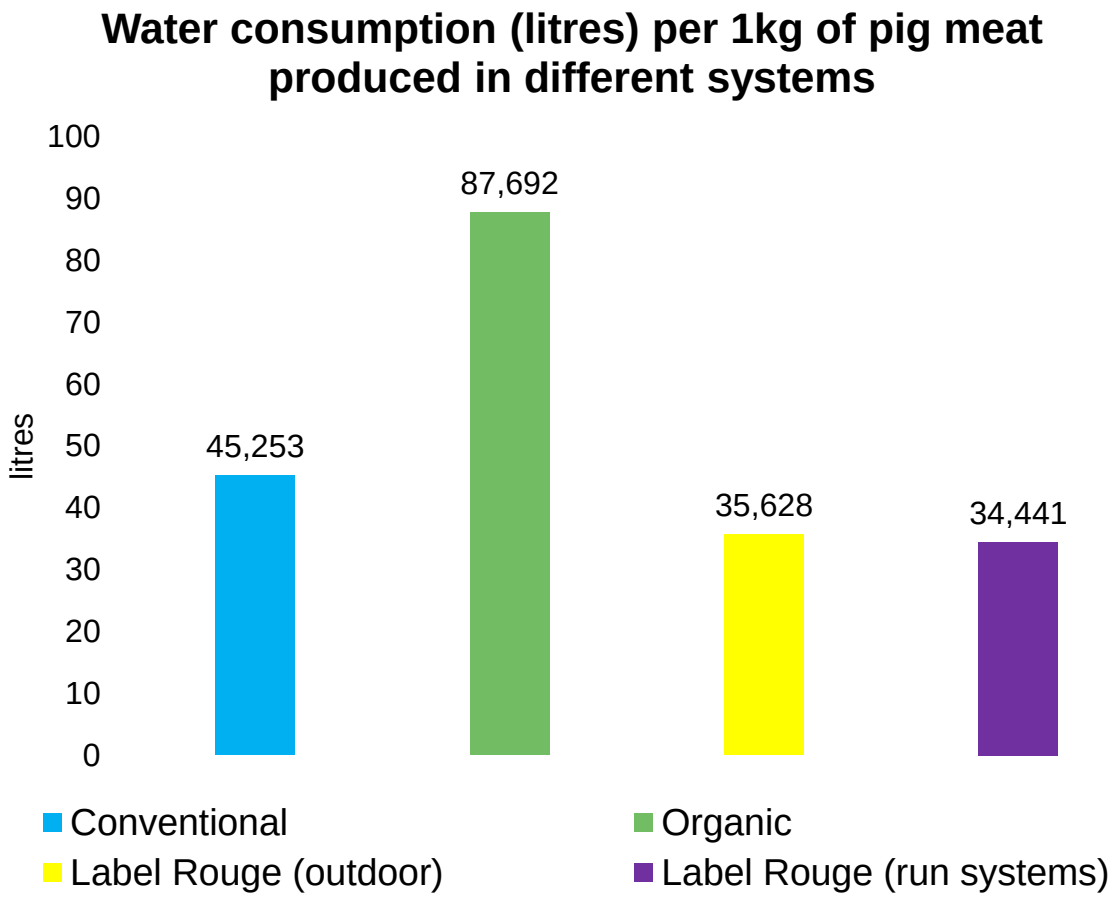
Results

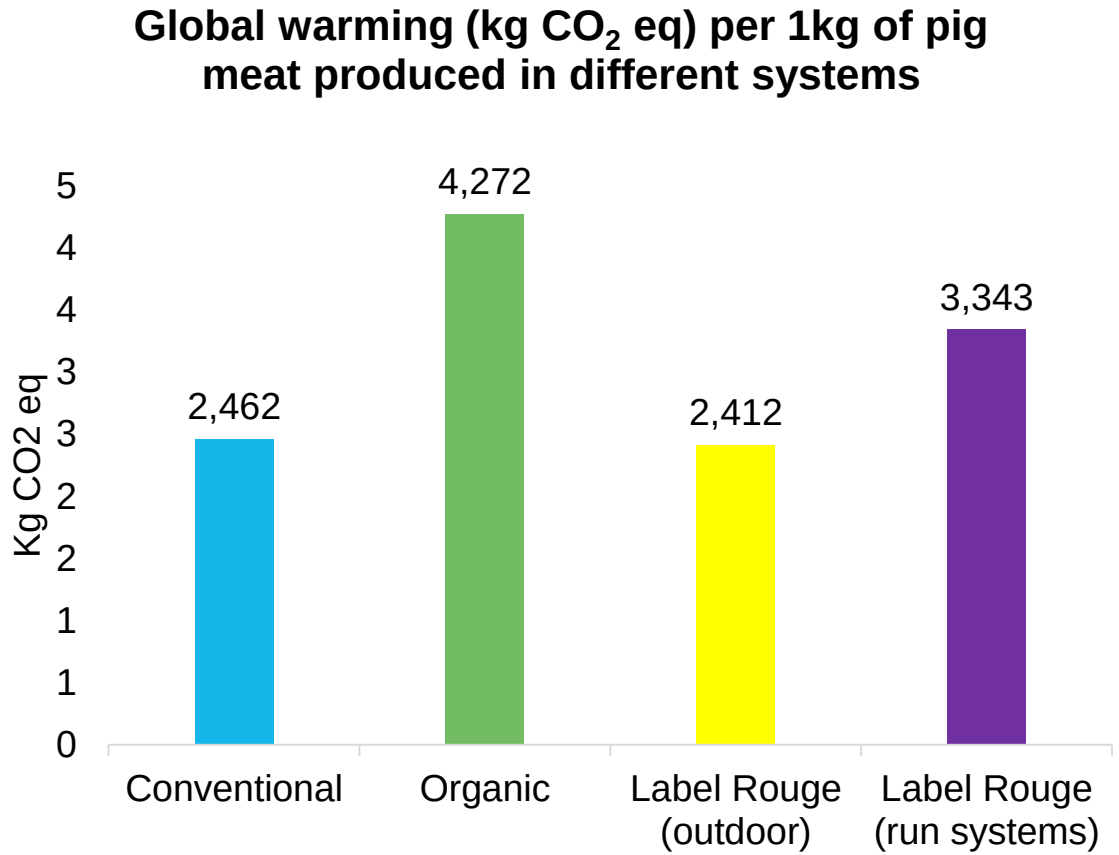
Environmental impacts of producing 1kg of pig meat under different systems

Relative environmental impacts per unit of production(1kg) under different systems



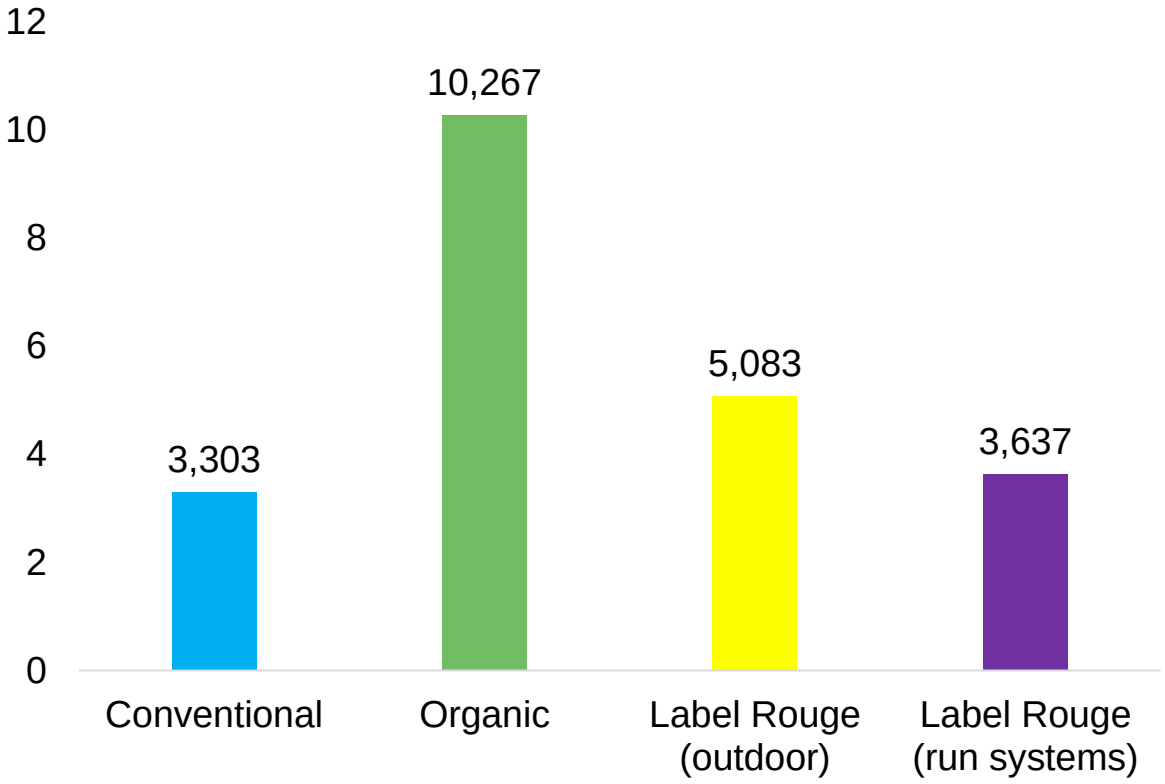
Environmental impacts of producing 1kg of pig meat under different systems



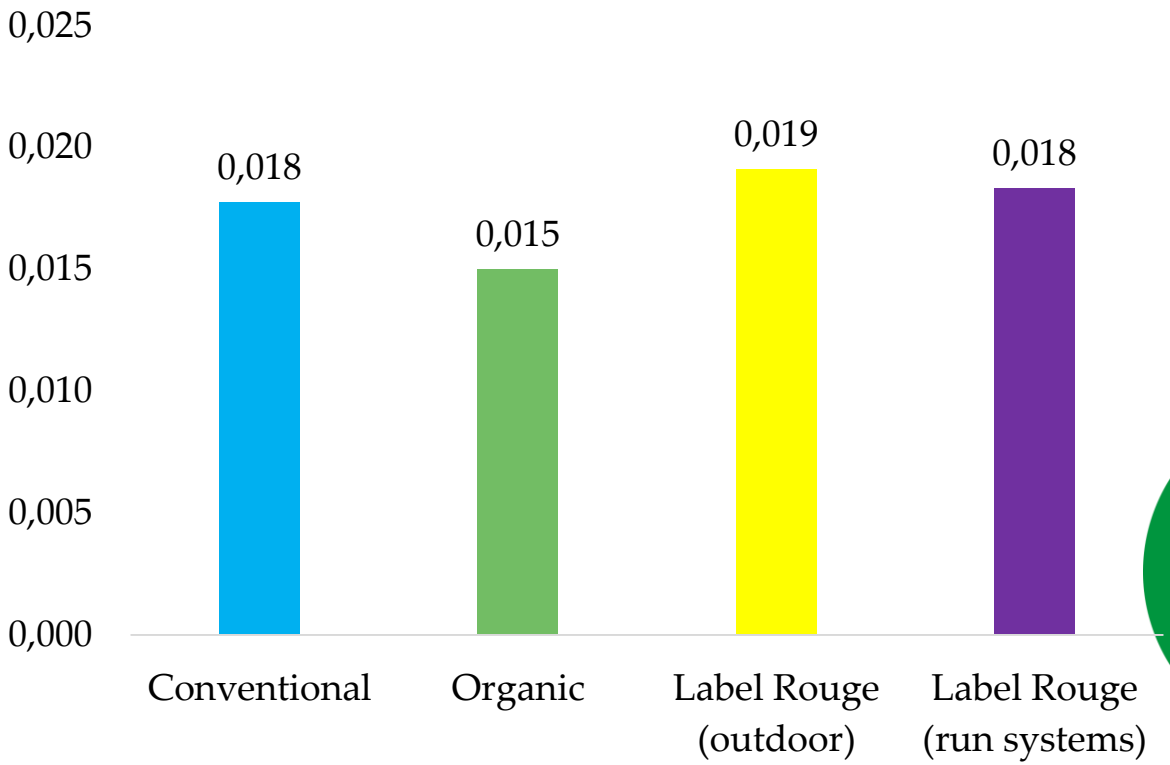


Environmental impacts of producing 1kg of pig meat under different systems

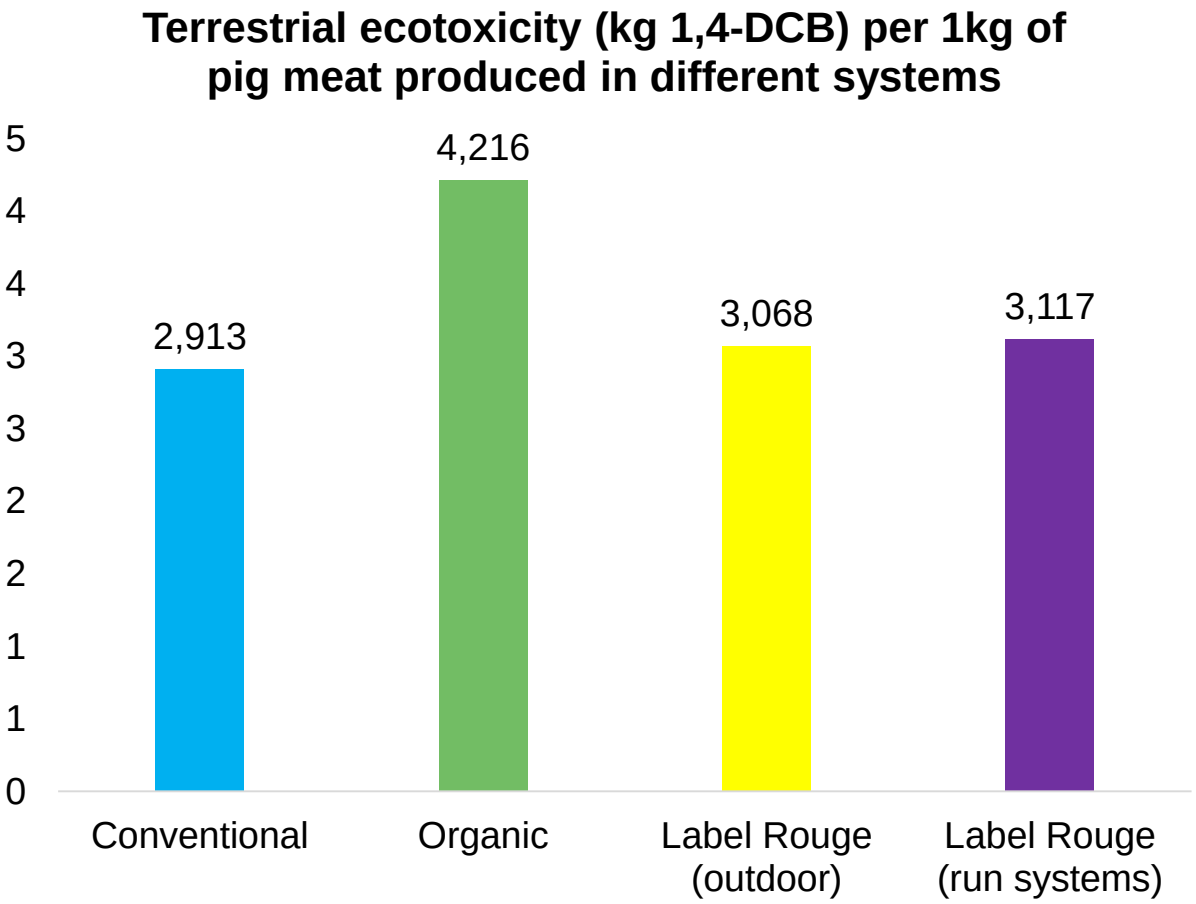
Land use (m^2a crop eq) per 1kg of pig meat produced in different systems

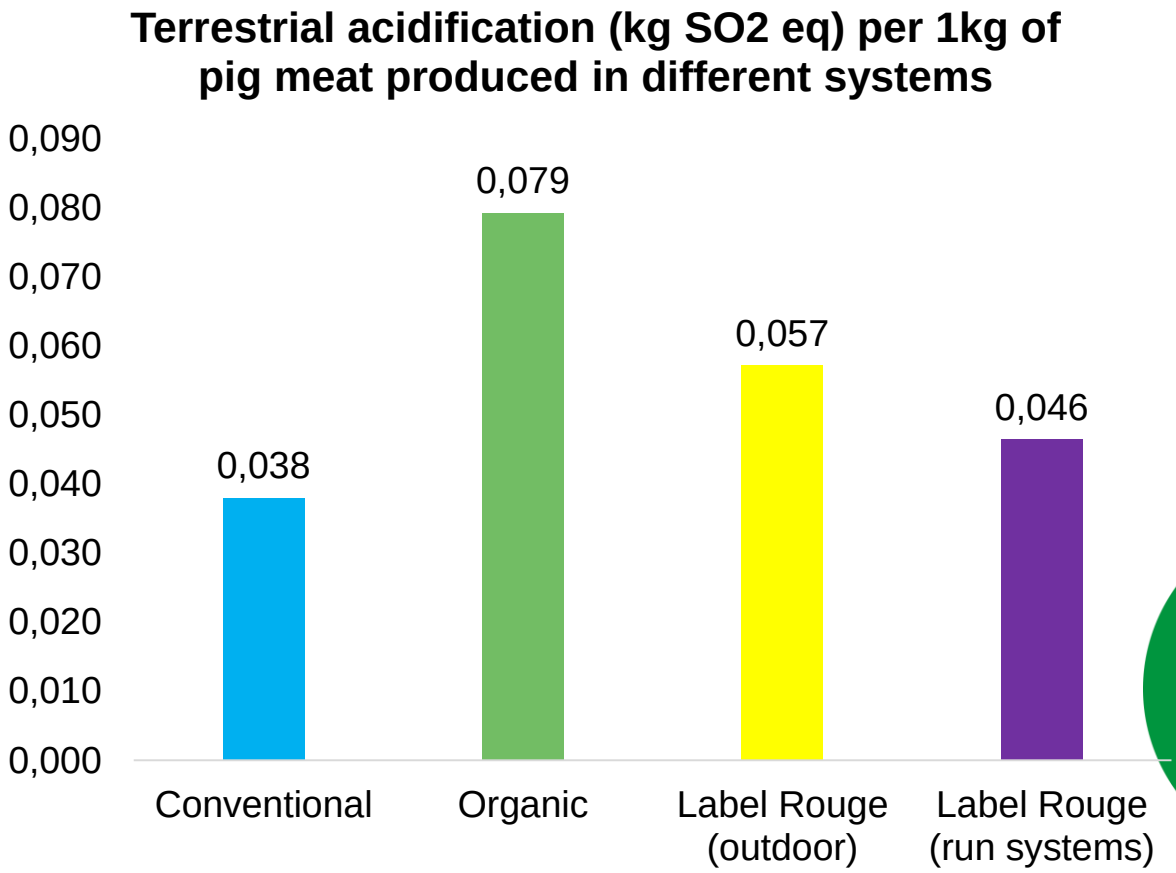


Mineral resource scarcity per 1kg of pig meat produced in different systems (kg Cu eq)



Environmental impacts of producing 1kg of pig meat under different systems





Conclusions and Perspectives

- Feed production and Manure management are the main hotspots in pig production LCA (Cradle to farmgate)
- Implementing the Best Available Techniques (BATs) and Good Agricultural Environmental Conditions in the Sector will play crucial role in decarbonising the pig sector.
- Organic is not always equivalent to lower Environmental Footprint
- Efficiency is Key in attaining lower Environmental footprint- This explains why the conventional system has lower footprint per unit of production compared to Organic ones.
- More funding for Farm LCA tool development is required to promote farm level Assessment.
- Joint approach and open data sharing by all actors across the value chain can promote.

Agrárközgazdasági Intézet

Thank you for your kind attention

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