A framework for exploring land use and GHG emissions in alternative food production scenarios

Ilkka Leinonen
Scotland's Rural College (SRUC)
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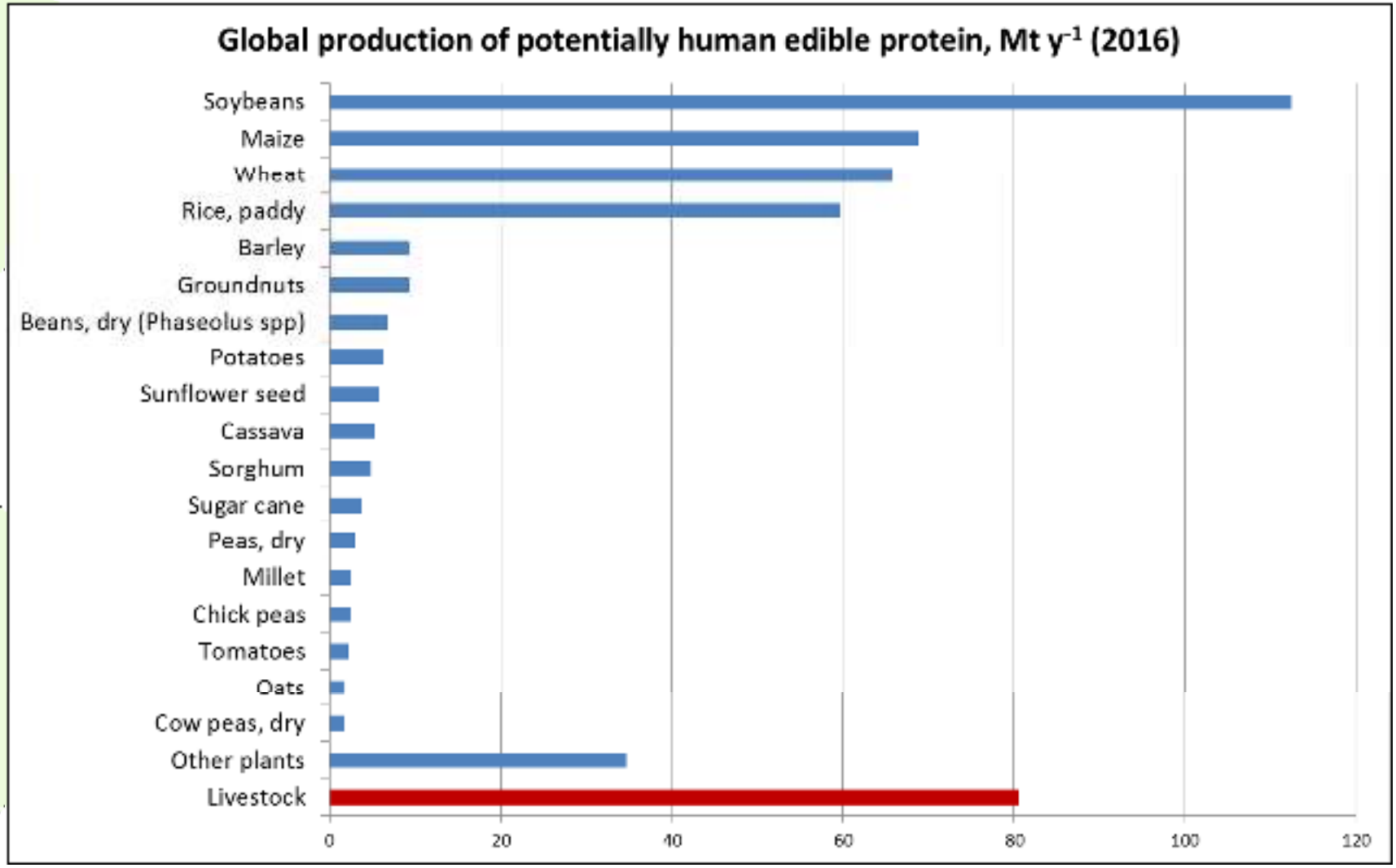
General principles

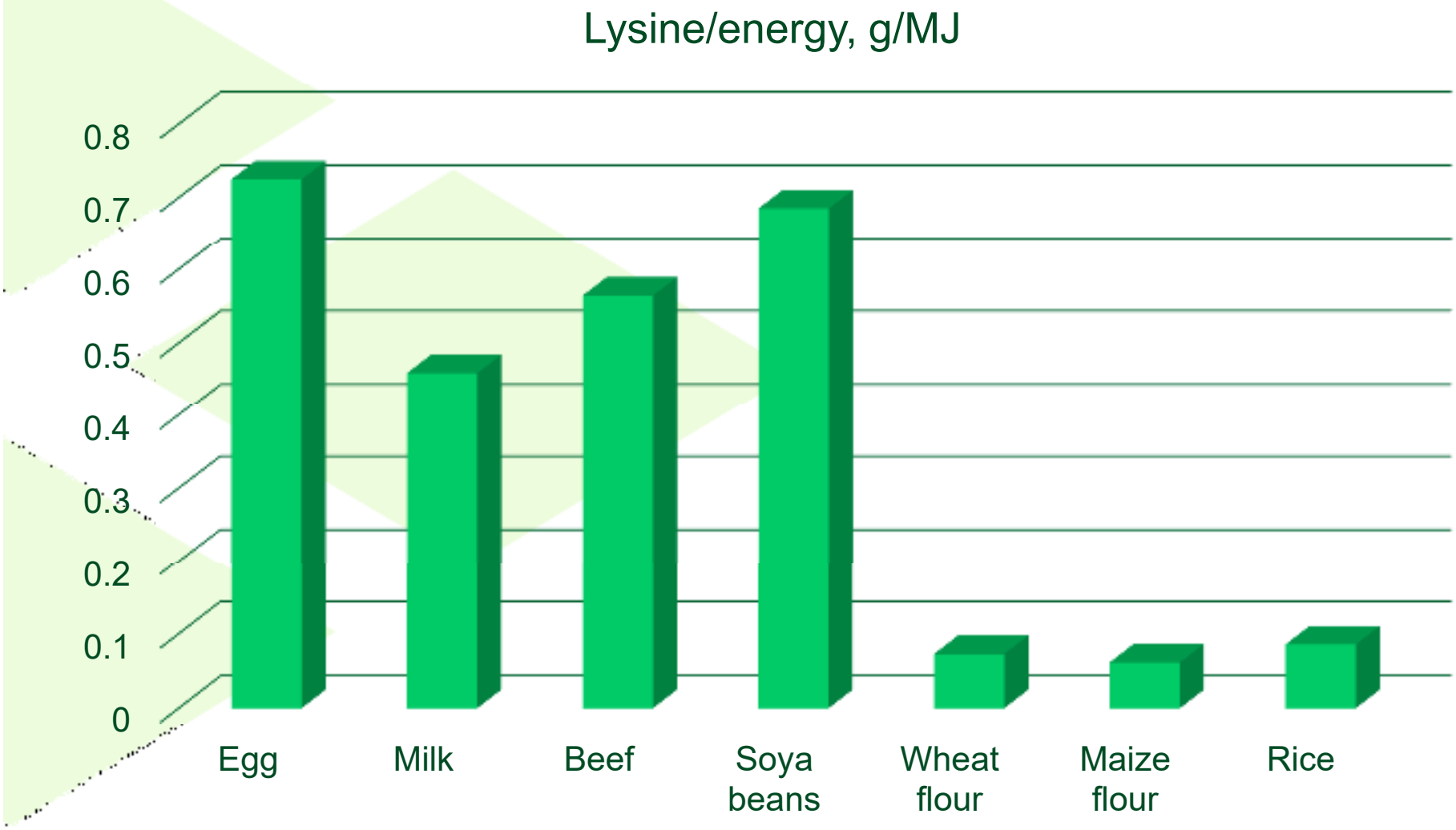
- Background: global food demand is expected to shift from animal-based products towards plant-based products, as a result of environmental concerns (GHG)
- However, at the same time, global population continues to grow and consumption of animal products is currently still increasing
- Food production driven by global demand
  - Overall demand continues to increase
  - Supply must meet demand
- Main components of demand for food:
  - **Food energy**
  - **High quality protein**

Global protein production: importance of livestock

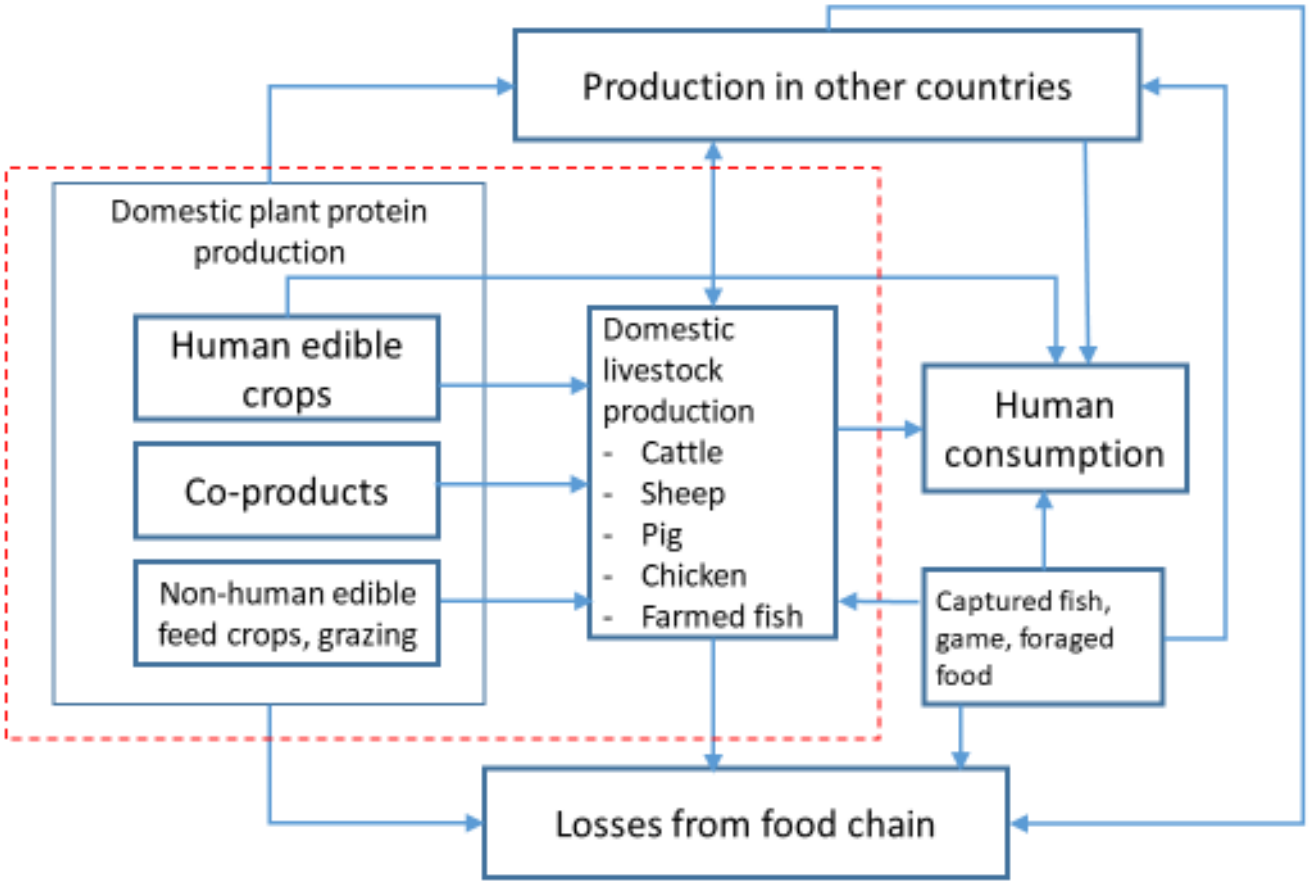


Sources: FAOSTAT, USDA etc.

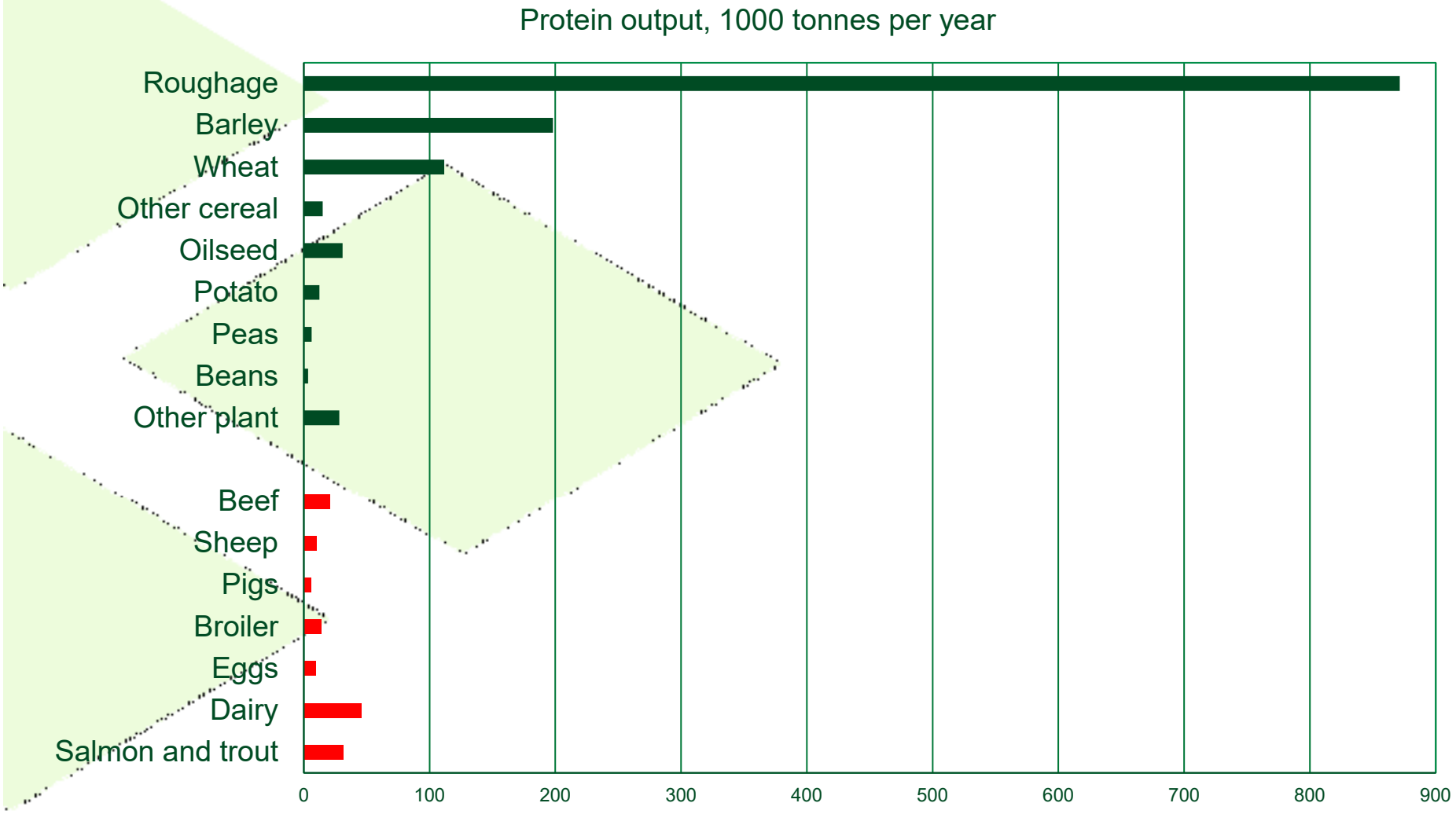
Need for high quality protein (balanced amino acid content)



Regional protein balance: Scotland

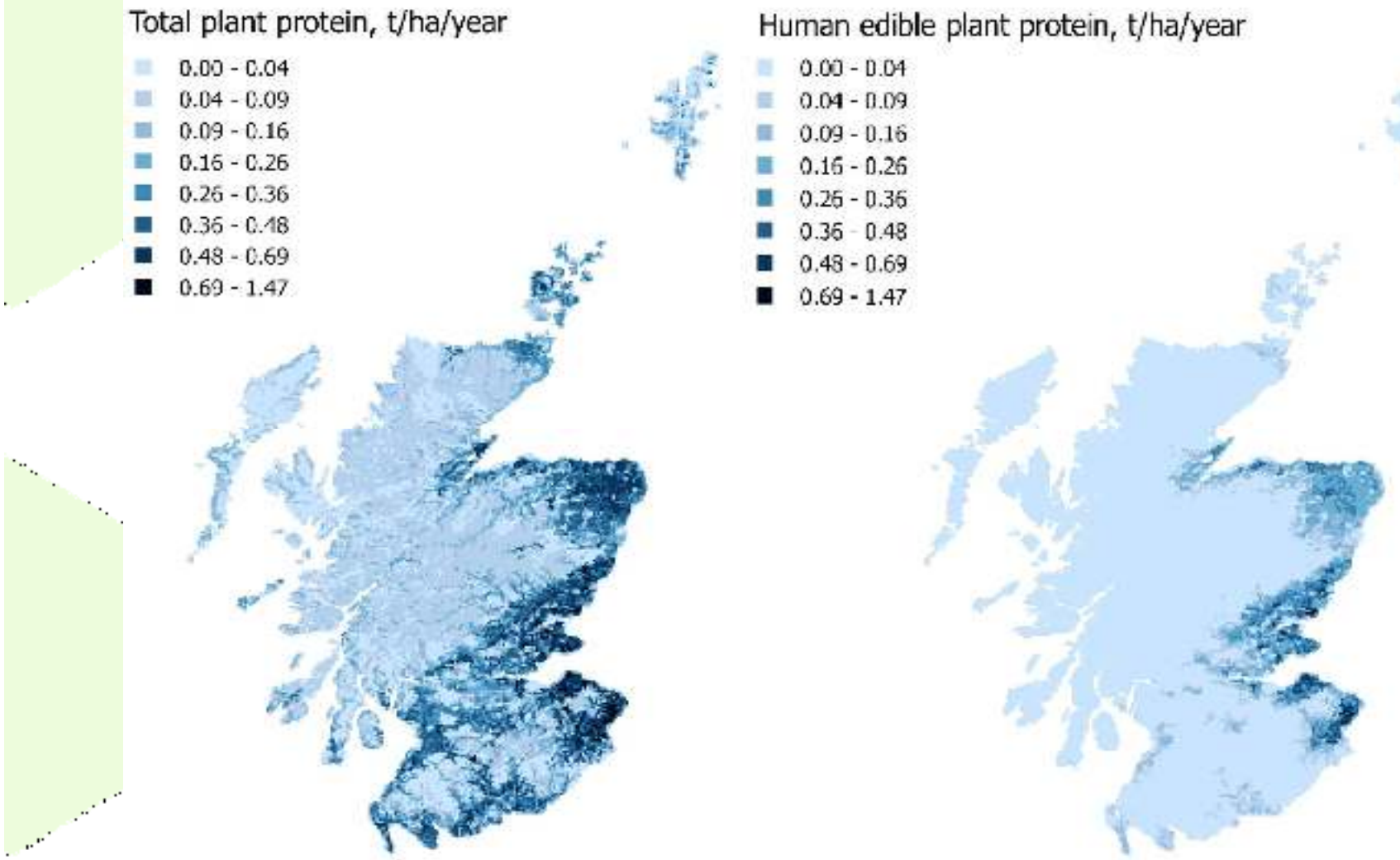


Protein production in Scotland (for humans and livestock)



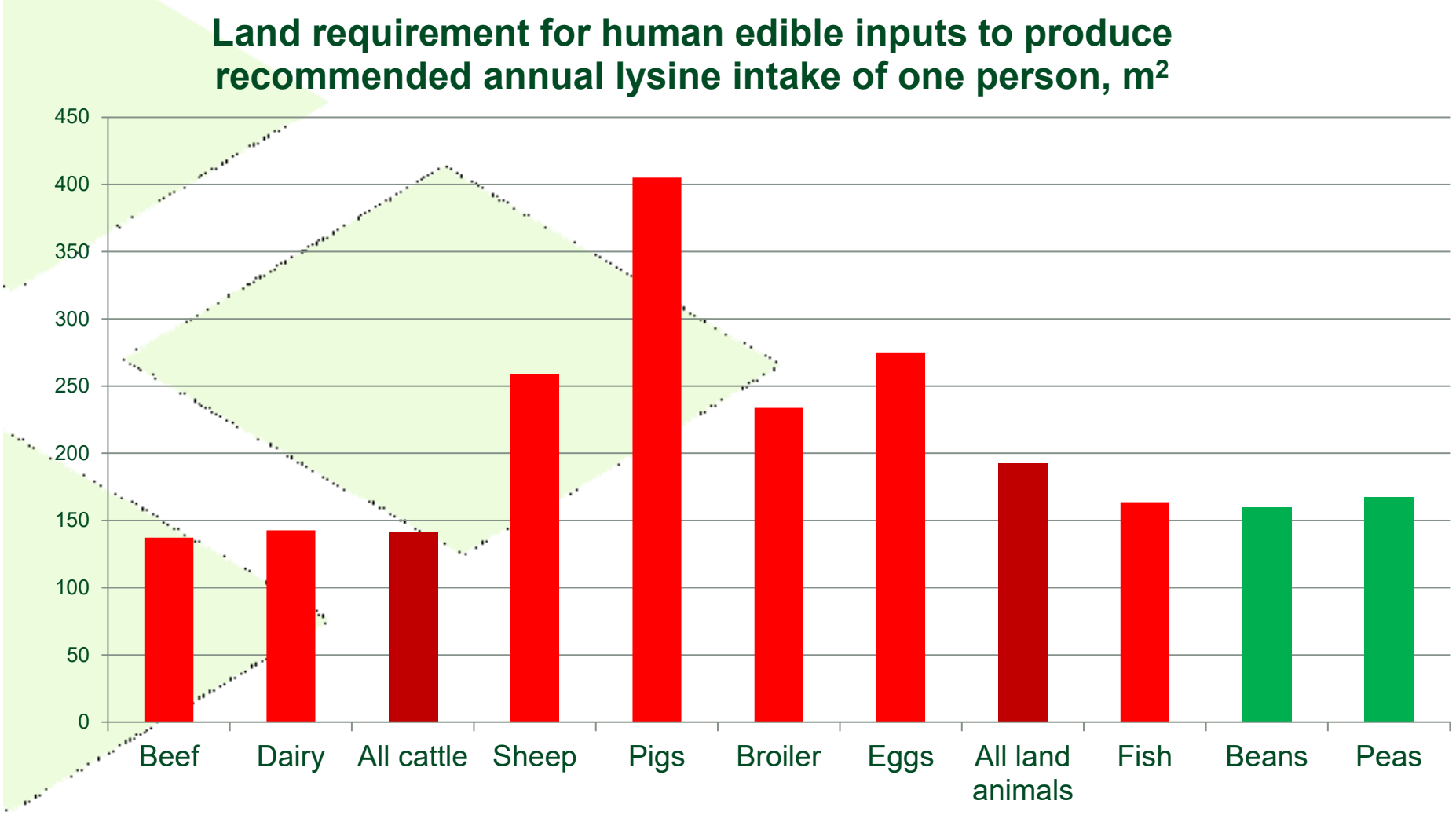
Sources: ERSA, EDINA agcensus etc.

Plant protein production in Scotland



(Source of spatial data: EDINA agcensus)

Arable land use efficiency of protein production



Alternative food production options

- Example: simplified scenarios to estimate the minimum land requirement for producing enough food **energy** and **high quality protein** for human consumption in Scotland

1. Meat-based option
   - Assume that beef is the main source of high-quality protein and wheat provides the additional food energy
2. Legume-based option
   - Assume that field beans are the main source of high-quality protein and wheat provides the additional food energy

Arable land requirement for different food scenarios

- Land needed (m^2) to produce food **energy** and **high-quality protein** that would meet the demand of one person during one year
- Potentially **human-edible** inputs (arable land only, grassland not included)

	Meat option	Legume option
Meat (beef)	53	
Beans		62
Wheat	259	259
Total	**312**	**320**
Total, by-products only in cattle feed	**259**	

Food production scenarios and GHG emissions

- A systematic framework needed to predict the effect of **changes** in food production
- Proposed approach: consequential LCA modelling
- Changes in global demand -> changes in production -> changes in land use -> links to global production systems through import/export -> overall effects on GHG emissions

Example: shift from animal protein to plant protein (changing demand)

- Reduced cattle production -> reduced methane emissions
- Changes in arable land use -> Land Use Change pressure -> CO_2 emissions
- Reduced demand for grassland -> carbon sequestration
- Changes in by-product demand -> material for renewable energy generation
- Changes in demand for soya bean meal -> reduced supply of soya oil -> increased demand for vegetable oil production -> increased land use change pressure -> CO_2 emissions