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Aspects on

Assessment methods of animal food systems

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Agenda

- Background
- LCA and the functional unit
- Soil sustainability more important than other factors
- Multidimensional assessments and – systemic modelling

Background (I)

- Animal food systems under scrutiny
- Agriculture/food sector substantial part of human activites causing GHG
- Need for reliable tools to be used for policy and decision making – even at this conference!
- Life cycle assessment widely used to compare environmental performances of multiple farming strategies at the systems level

Background (II)

- Several difficulties regarding food production systems:
  - Functional unit(s), one dimensional but used for complex systems
  - Multifuntional systems
  - Inventory snap shot – history, ”average performance”
  - Static/linear vs. dynamic
  - Predictions?

- Discuss some critical points in LCA for food systems
    - Functional unit, soil-C
    - Need to describe complexity with multifunctional assessment
  - Variability of production systems
  - The need for predictions by systemic modelling

Functional unit (FU)

- Definition FU (14044 standard by ISO (ISO, 2006))
  - is the quantified performance of a product system for use as a reference unit.
  - should define the performance characteristics of the product.
- Important: – should be meaningful, e.g. improve practices in farming systems in relation to output in services, sustainability or nutrient quality
- Results are used by policy makers in organizations and individuals

LCA and Functional Unit (FU)

- Environmental burden, e.g. CF/GWP
  - per mass unit
  - per 100 g protein
  - Nutrient based - based on human nutrient requirements RDI/NI
    - Selected nutrients
    - Formation of Nutrient Density Index (NDI)
    - Advanced selected nutrients as FU –omega3
  - Arable Land Use (ALU)

FU – per mass unit

- Present in numerous earlier papers
- One dimension
- Also in media ”food – climate lists” :Consequences for policy decisions by organizations
- Awkward comparisons

- Plant origin
  - Carrots 0,2 (0,1-0,9)
  - Beans 0,7 (0,2-1,4)
  - Potatoes 0,1 (0,1-1)
  - Grain (0,3-0,5)
  - Rice 0,6 (0,4-0,9)
- Animal origin
  - Milk 1 (0,8-2,5)
  - Beef 26 (10-40)
  - Lamb 21 (15-33)
  - Porc 6 (4-8)
  - Poultry 3 (1,7-4)
  - Eggs 1,5 (1-4,6)

FU – per 100 g protein

- Nutrient based but still one dimension,
- amino acid profile not considered
- Human edible protein in plants is generally 20 % less than in proteins of animal origin

- Plant origin
  - Carrots 0,2 (0,1-0,9)
- Animal origin
  - Beef 26 (10-40)

But still need to eat 3 kg carrots to get the same amount of protein as in 100 g beef

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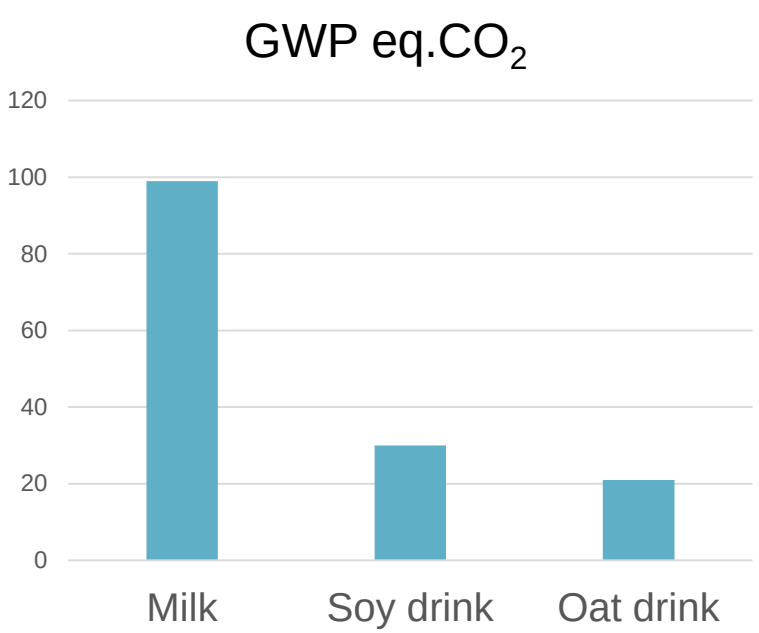
100 g

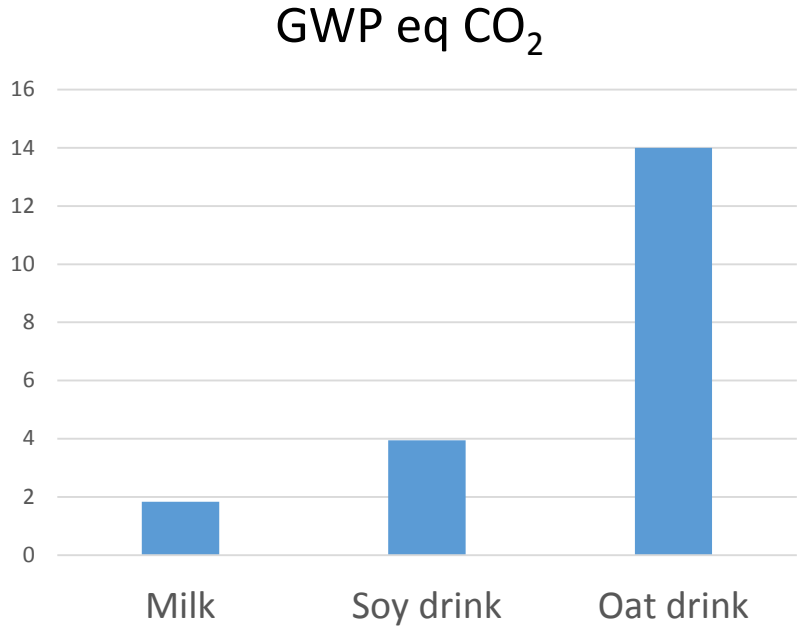
FU - Nutrient Density Index

- Human nutrient demands, RDI – 22 nutrients, daily recommended daily nutrient intake

Mass based



Nutrient Density



Adapted from Smedman et al. (2010)

Nutrient quality and arable land use (ALU) for different meats

- Fat composition: plus for omega-3, minus for satured fatty acids (SFA)
- Content differ between production methods (intensive/extensive)
- 10 nutrients in an index with Omega-3 in product minus (SFA and Na)
- Only small differences in GWP eq-CO_2 (poultry < pigs < cattle < sheep)

  McAuliffe et al (2018)
- Arable land use favored grass based systems (sheep < cattle < pigs < poultry).

  (Lee et al., 2018)

Importance of Soil-Carbon

- Soil-C is crucially important for the sustainability of agricultural land:
  - Soil fertility, soil structure, nutrient holding capacity
  - Water holding capacity, drought resistance
  - Resistance to soil erosion, loss of arable land
  - Fate of pollutants
  - Global carbon cycle
- Different food systems have different impact on soil-C!
- Loss of soil carbon in soils with only crop production compared to crop rotations with temporary grasslands
- Suggests a separate handling of C-sequestration as a FU and not only included in the total sum!

Beef production contribution to soil-C (some studies)

- Intensive systems
  - Veal, young bulls 9-11.5 kg eq CO_2 per kg bonefree meat,
  - little contribution to soil C
- Grass based system
  - steers, suckler cows 16.6-29.7 kg eq CO_2
  - Soil carbon balance offset this by 3-7 kg

Mogensen et al. 2014

- Adaptive multi-paddock (AMP) grazing improve animal and forage productivity from 9.62 to -6.65 kg eq-CO_2 per kg carcass weight -
  - AMP could be a net C sink! (finishing phase)

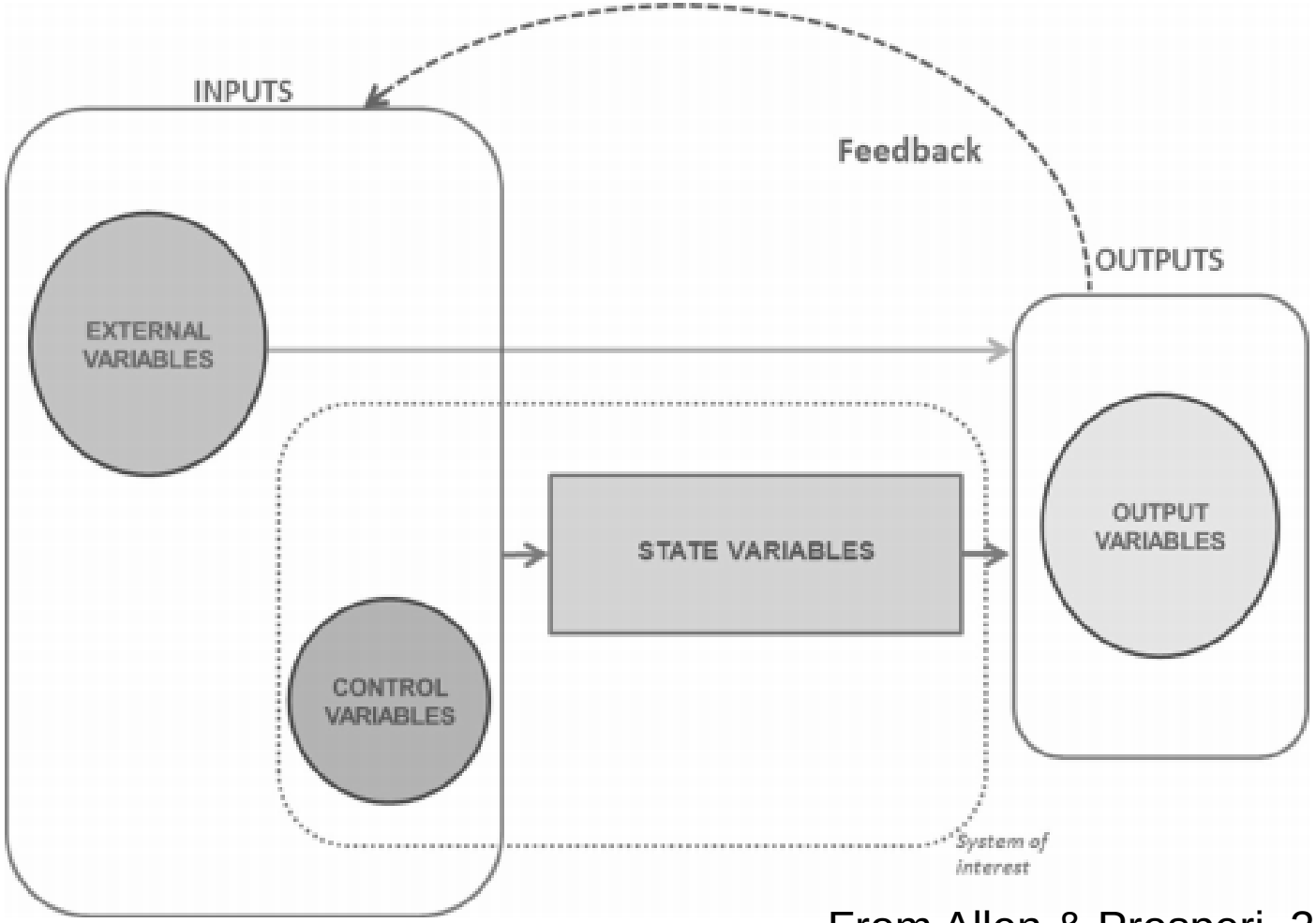
Stanley et al. (2018)

Systems modelling

- Holistic approach
- Complex relationships
- Casual pathways
- Dynamic processes
- Multidimensional out-come
- Simulate future scenarios

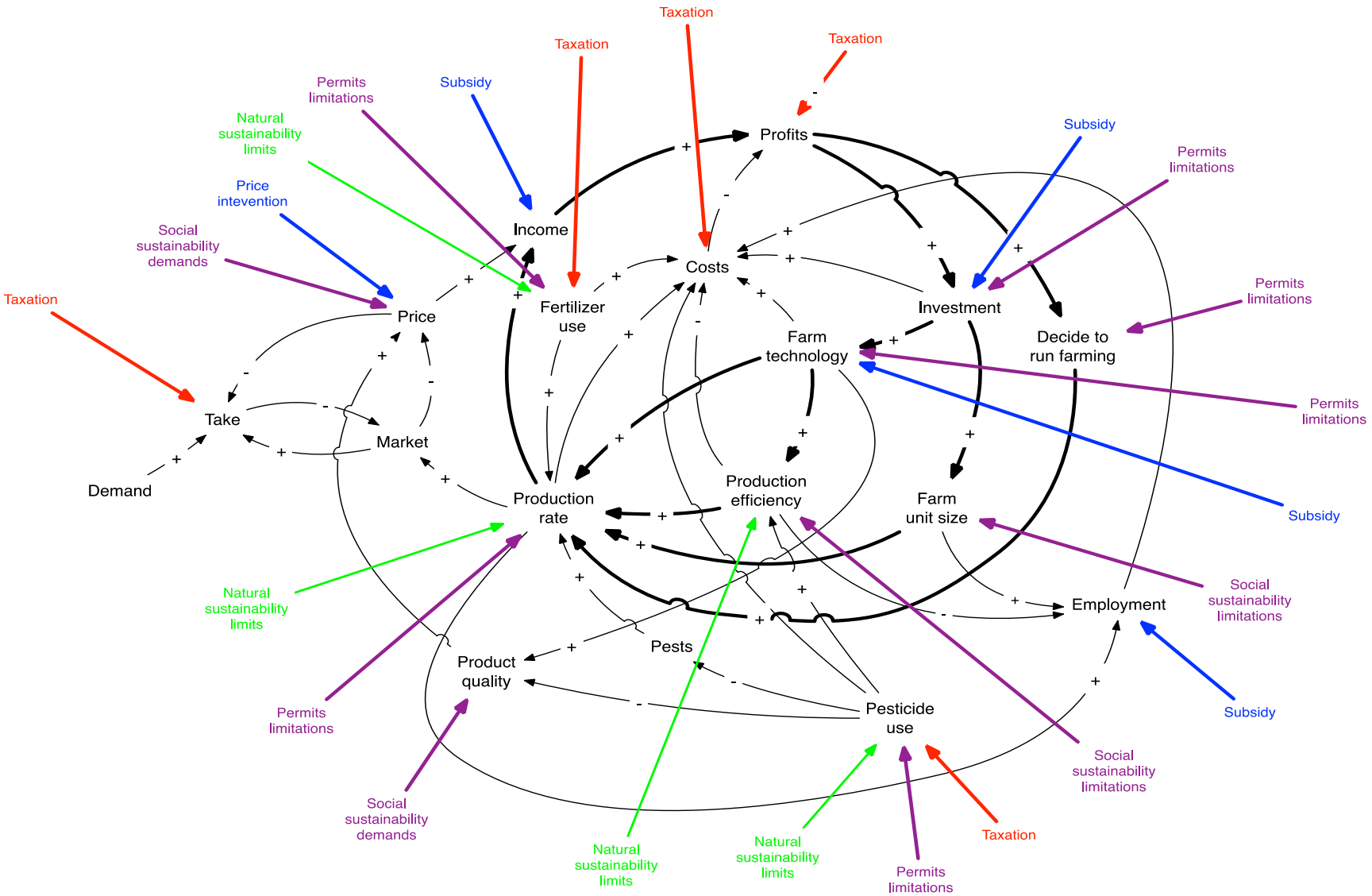
Basic model – multiples of these build systemic models

Basic representation of a dynamic system



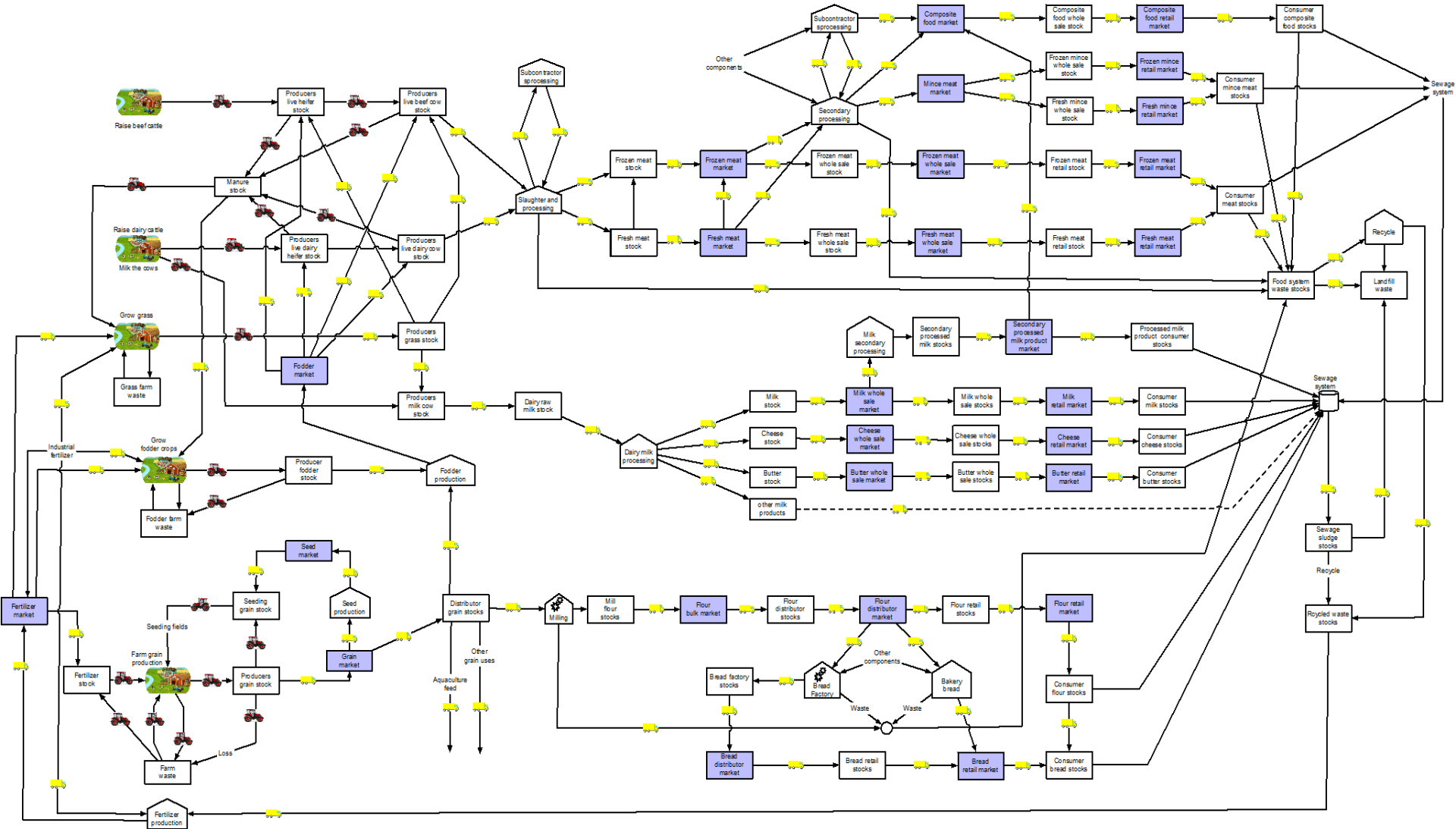
From Allen & Prosperi, 2016

First: «Finding out how it works!»
Secondly: «Finding out what to do!»
Allow multiple dimensions to be assessed



Cattle – Dairy – Grain – Grass

A complex system asking for dynamic models



Take home message

- Improve communication of assessments of food systems!
- Single dimensional functional units are not useful, feedbacks are missing
- Food systems deliver several integrated services and therefore needs multidimensional assessments
- Need to allocate services correctly
- Soil-C should be assessed and valued separately!
- Traditional LCA needs substantial improvement or
- have to be replaced by System dynamics modelling which is more suitable for predictions of dynamic relationships and multidimensional assessments


Thank you for your attention