Berkeley Faculty Roundtable on Environmental Services in Rangeland Production Systems

Presentation and Discussion Notes from the Fourth Roundtable: September 25, 2009

AVERY COHN

DEVELOPING A DECISION SUPPORT TOOL FOR LIVESTOCK CLIMATE POLICY ANALYSIS

Berkeley Faculty Roundtable on Environmental Services in Rangeland Production Systems

Part I:
Powerpoint Presentation by Avery Cohn

Developing a Decision Support Tool for Livestock Climate Policy Analysis

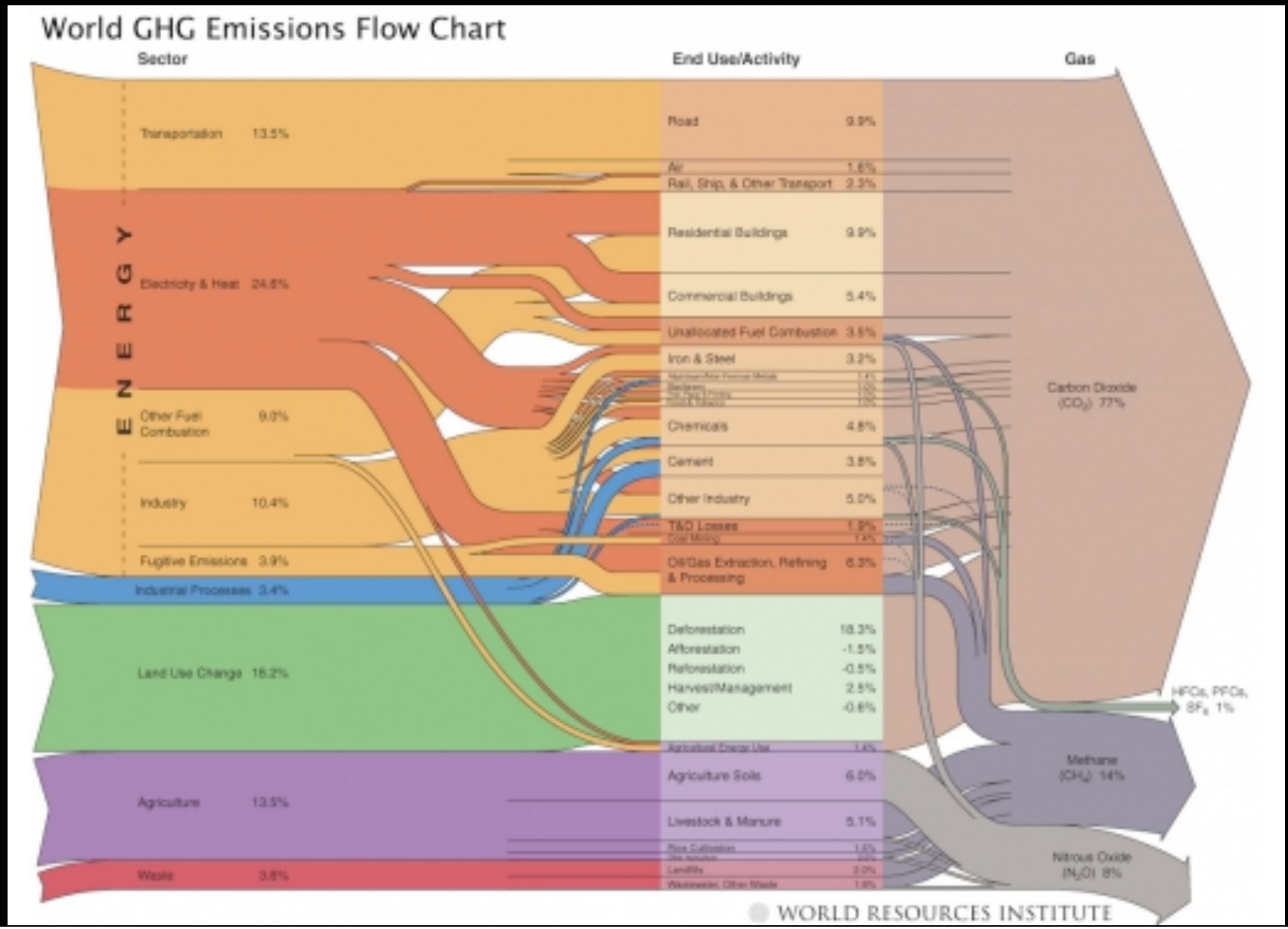
Avery Cohn

Rangelands Roundtable

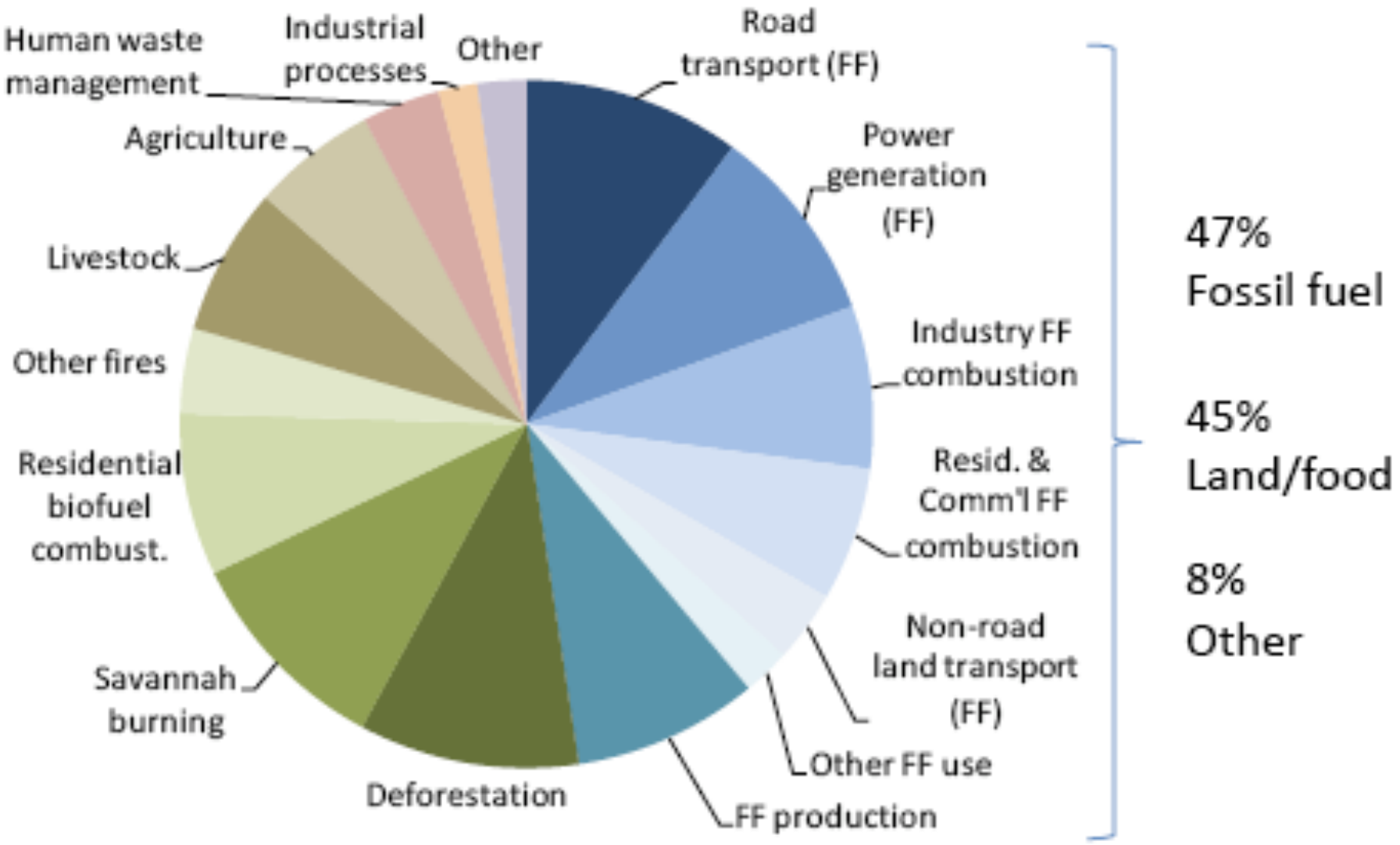
September 25th 2009

Livestock in the Chico Mendes Extractive Reserve, Acre, Brazil | Photo: Christian Palmer

Role of LULUCF

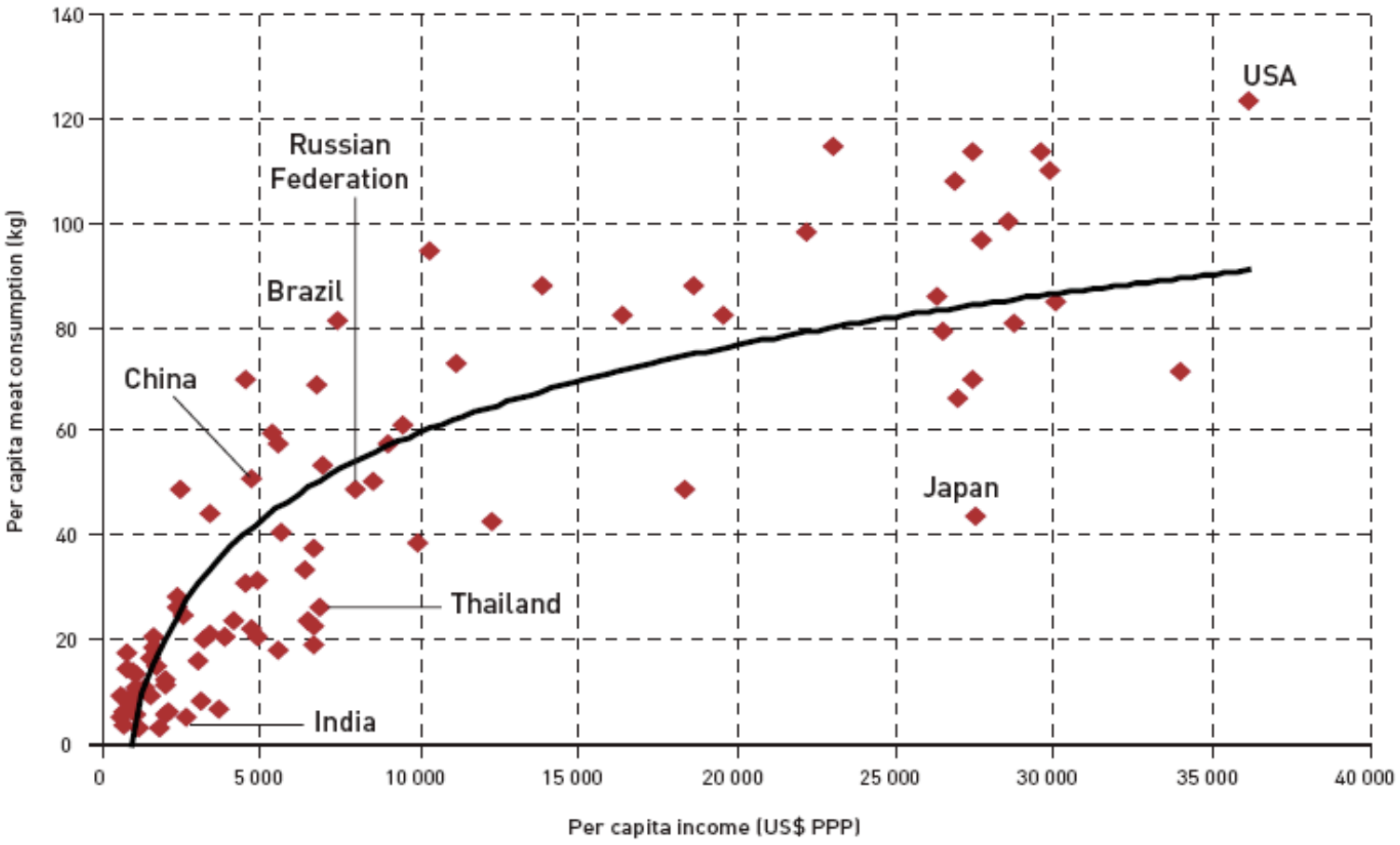


Contributions of Future Emissions to Year 20 Forcing
(as % of gross positive forcing)



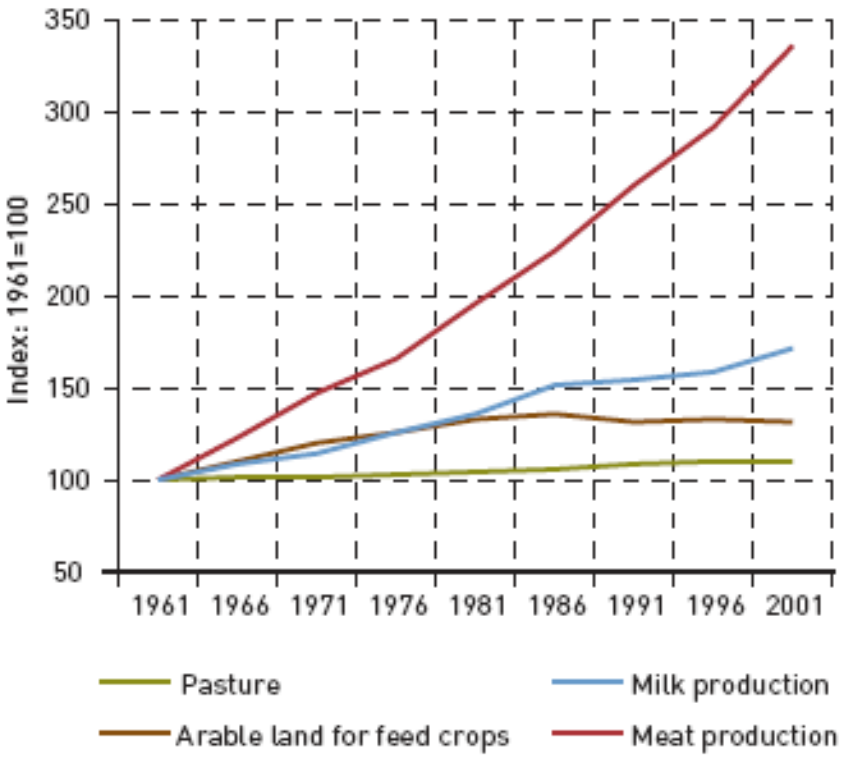
Source: Jackson, 2009

Figure 1.4 The relationship between meat consumption and per capita income in 2002



Note: National per capita based on purchasing power parity (PPP).
Source: World Bank (2006) and FAO (2006b).

Figure 2.18 Global trends in land-use area for livestock production and total production of meat and milk



Source: FAO (2006b).

Stefest et al. 2009: Model structure and key assumptions

- BAU demand forecast
- Productivity gains
- Gradual shift from pasture to mixed/ landless

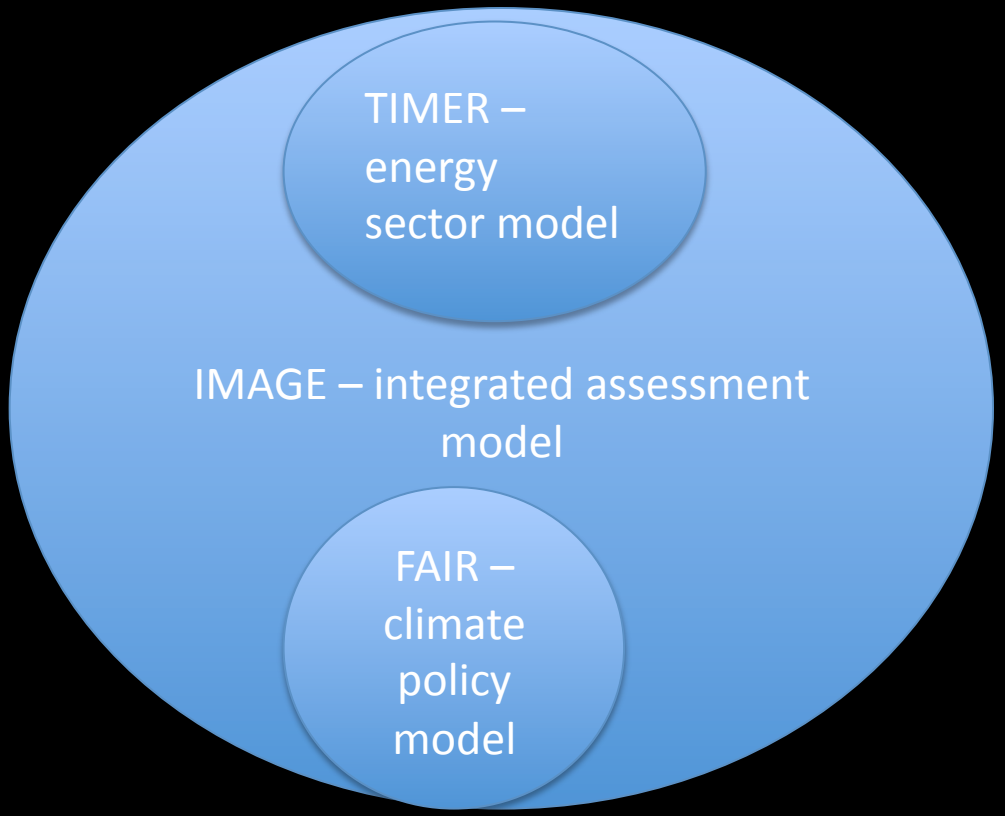


Table 5 Land-use emissions in 2000 and 2050 for the reference scenario and four dietary variants

	GtC eq.
2000	3.0
2050-Reference	3.3
2050-NoRM	1.7
2050-NoM	1.5
2050-NoAP	1.1
2050-HDiet	2.1

Stehfest et al. 2009

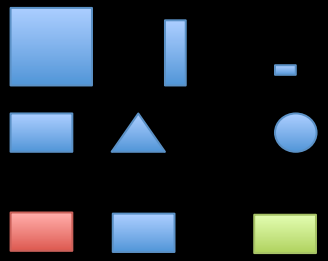
Research questions raised

- Policy mechanisms?
- How heterogeneous is:
  - the GHG intensity of livestock production?
  - the change in production function of livestock systems under GHG mitigation policies?
- What would the impacts of more realistic changes in demand?
  - i.e. smaller and more heterogeneously distributed

Mitigation Source (Efficiency vs. reduced production)

Key Questions:

1) For each of a 5-10 generalized production pathways, how does GHG intensity of beef production in Brazil vary according to edaphic condiitions and management practices?
2) For each of 5-10 generalized production pathways, how does the cost function of beef production relate to the GHG intensity?
3) What policy interventions can be used to reduce quantity of beef produced and or increase production efficiency? What would the GHG impacts be?
4) How might these policies interact with other policies targeting GHG mitigation from land use (i.e. biofuels standards, REDD, etc)?



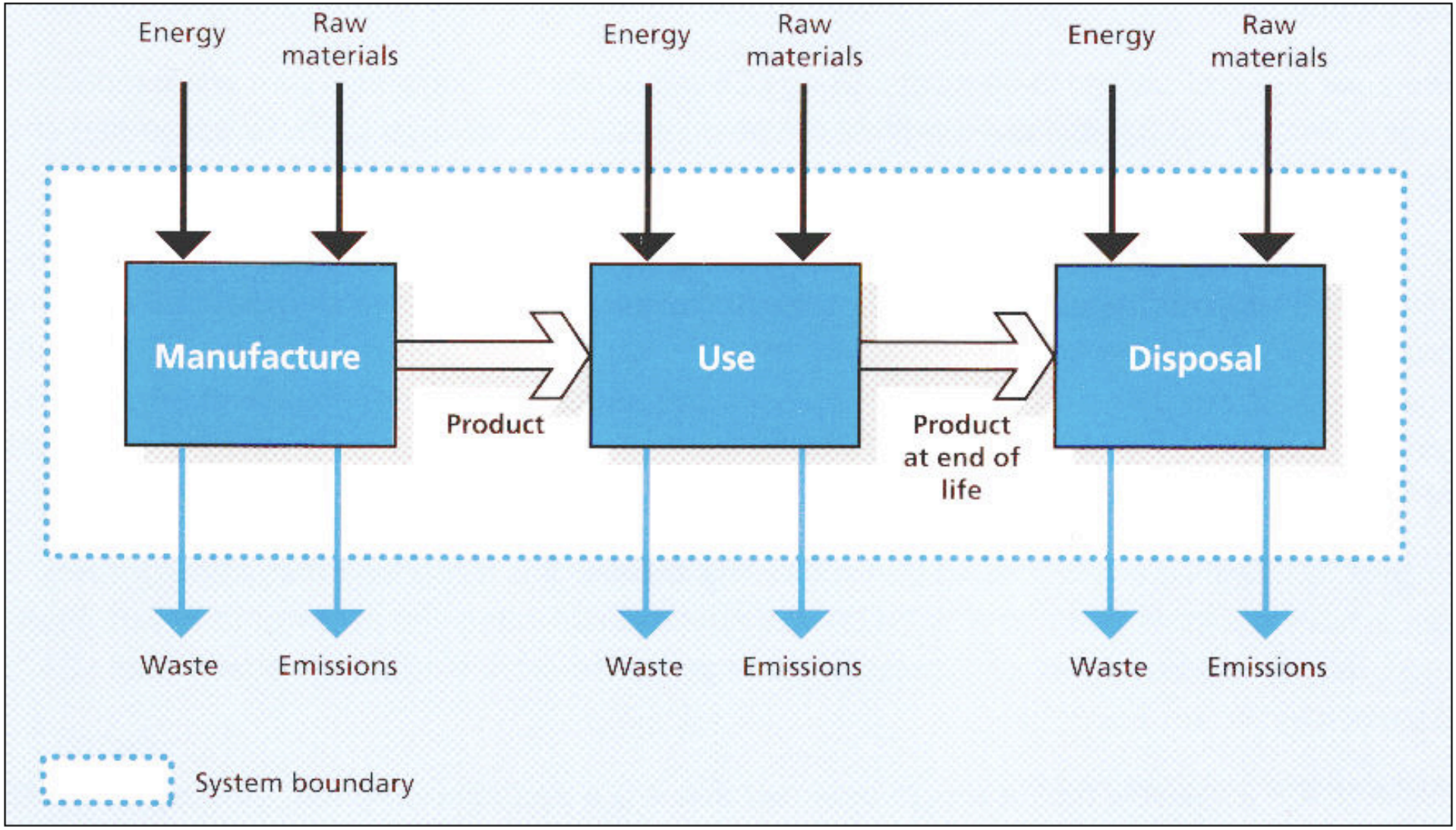
GHG intensity

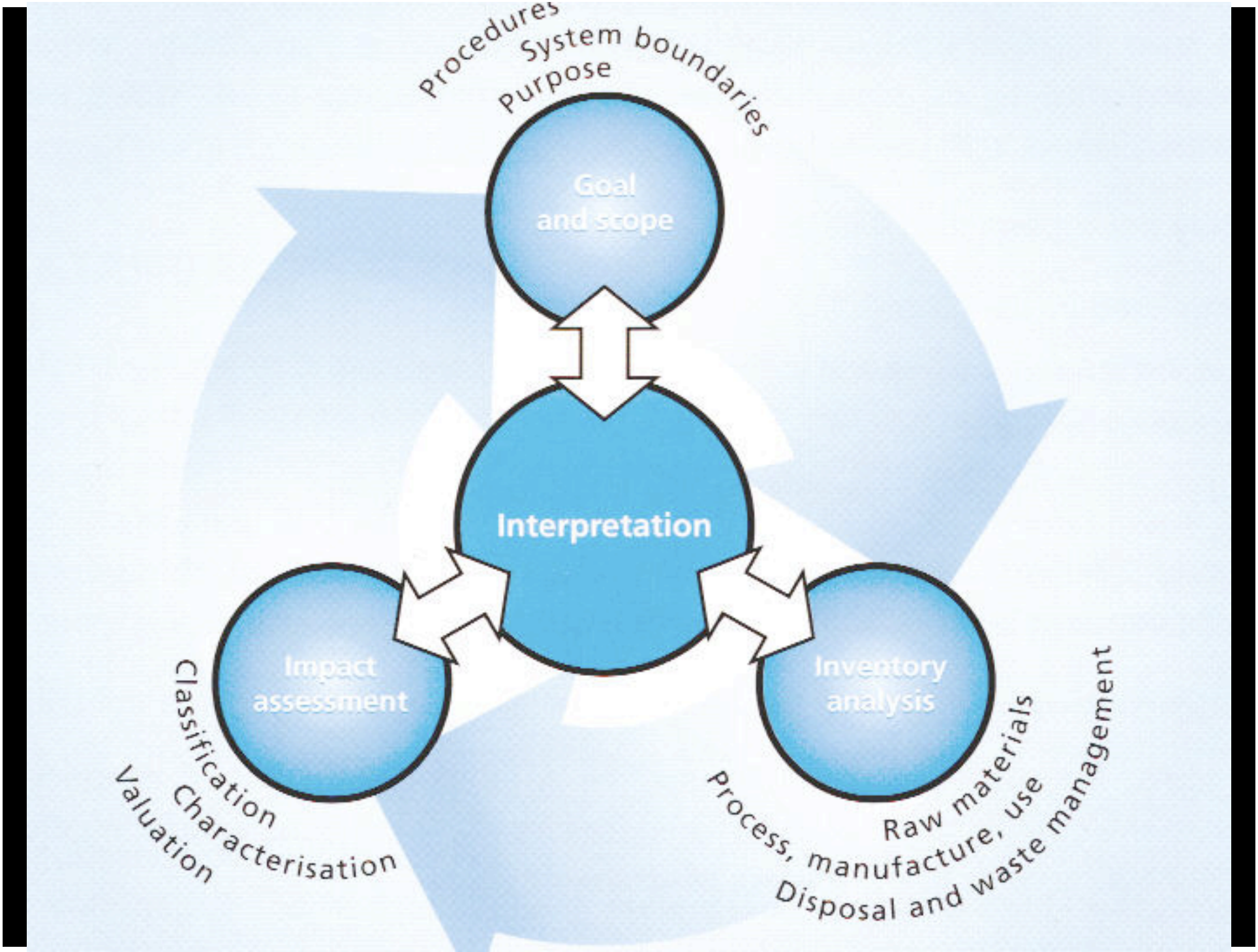
Production type

Edaphic region

Mitigation

LCA


Energy
Raw materials
Energy
Raw materials
Energy
Raw materials
Manufacture
Product
Use
Product at end of life
Disposal
Waste
Emissions
Waste
Emissions
Waste
Emissions
System boundary


Procedures
System boundaries
Purpose
Goal and scope
Interpretation
Impact assessment
Inventory analysis
Classification
Characterisation
Valuation
Raw materials
Process, manufacture, use
Disposal and waste management

INTERNATIONAL STANDARD

ISO 14040

Second edition
2006-07-01

Environmental management — Life cycle assessment — Principles and framework

Management environnemental — Analyse du cycle de vie — Principes et cadre

Reference number
ISO 14040:2006(E)

ISO standards

- ISO 14040 & 14044 define international standards for life cycle assessment
  - More guideline & principles than precise recipe
  - Naturally behind the leading edge of research
- Standards explicitly allow for methodological improvements
  - Claims that iLUC modeling doesn't meet the standard are irrelevant

GHG LCA Basics

- Define a functional unit (1 kg beef, 400g protein, 1 satisfying meal?)
- Determine the quantity of inputs used (activity level)
- Determine the environmental impact per unit of input (emissions factor)
- Sum

GHG Accounting

- Well-mixed GHGs are global pollutants, so it makes sense to add them, wherever they occur
- Most models consider CO_2, CH_4, N_2O
  - Aggregated based on IPCC 100-year GWPs
- All combustion of energy sources is tracked to estimate GHGs (mostly CO_2)
- Efficiency losses
  - transmission & distribution
  - leakage
- Other GHG-emitting processes are tracked
  - Soil N_2O emissions

Major issues in LCA

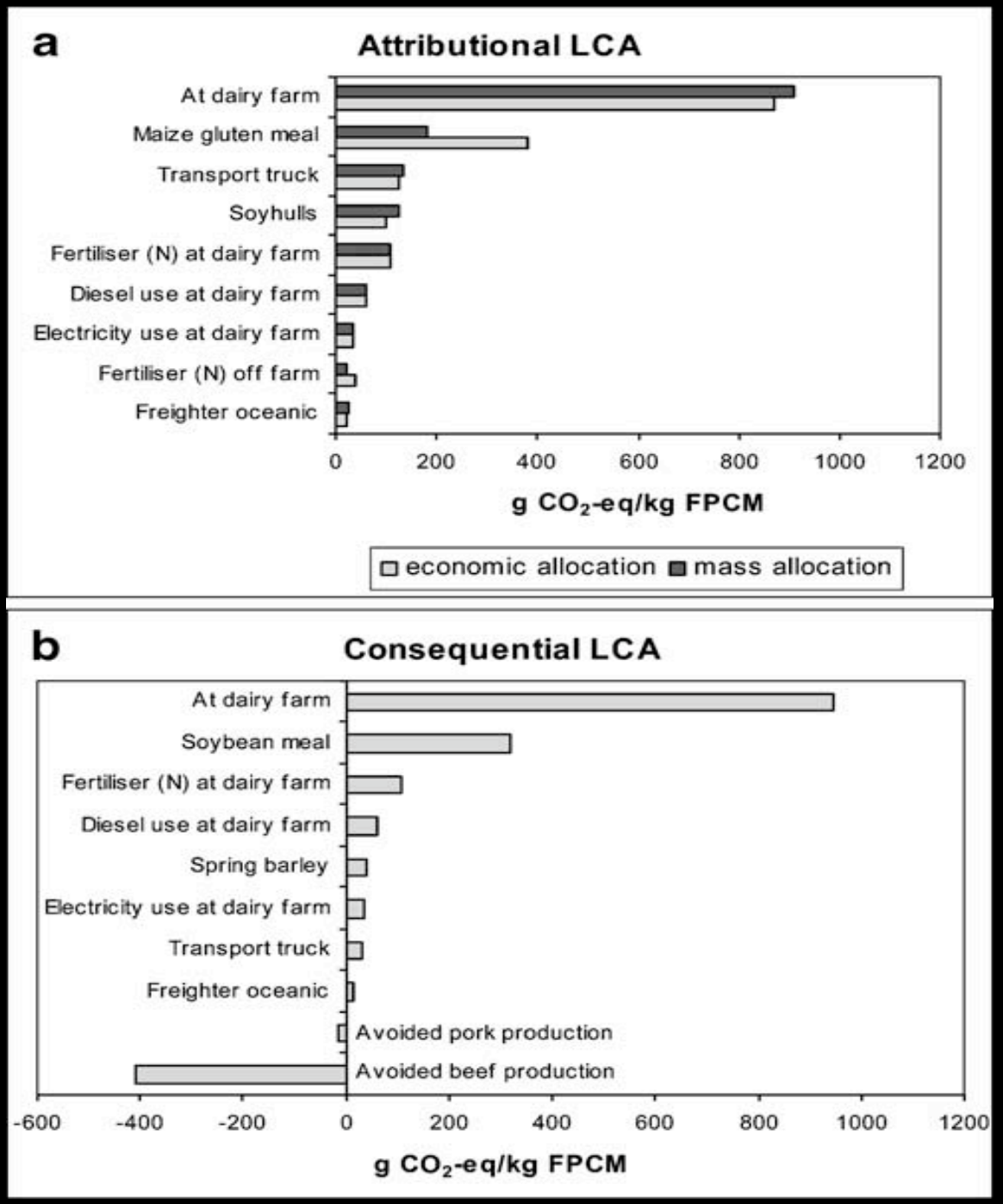
- Data gaps, data vintage, use of averages
- System boundary / truncation
  - Often arbitrary "cut-off" criteria
- Joint production processes
  - Allocating effects among co-products
- Aggregation of impacts into categories (e.g. GHGs)
- Uncertainty
  - It can be difficult to distinguish between choices

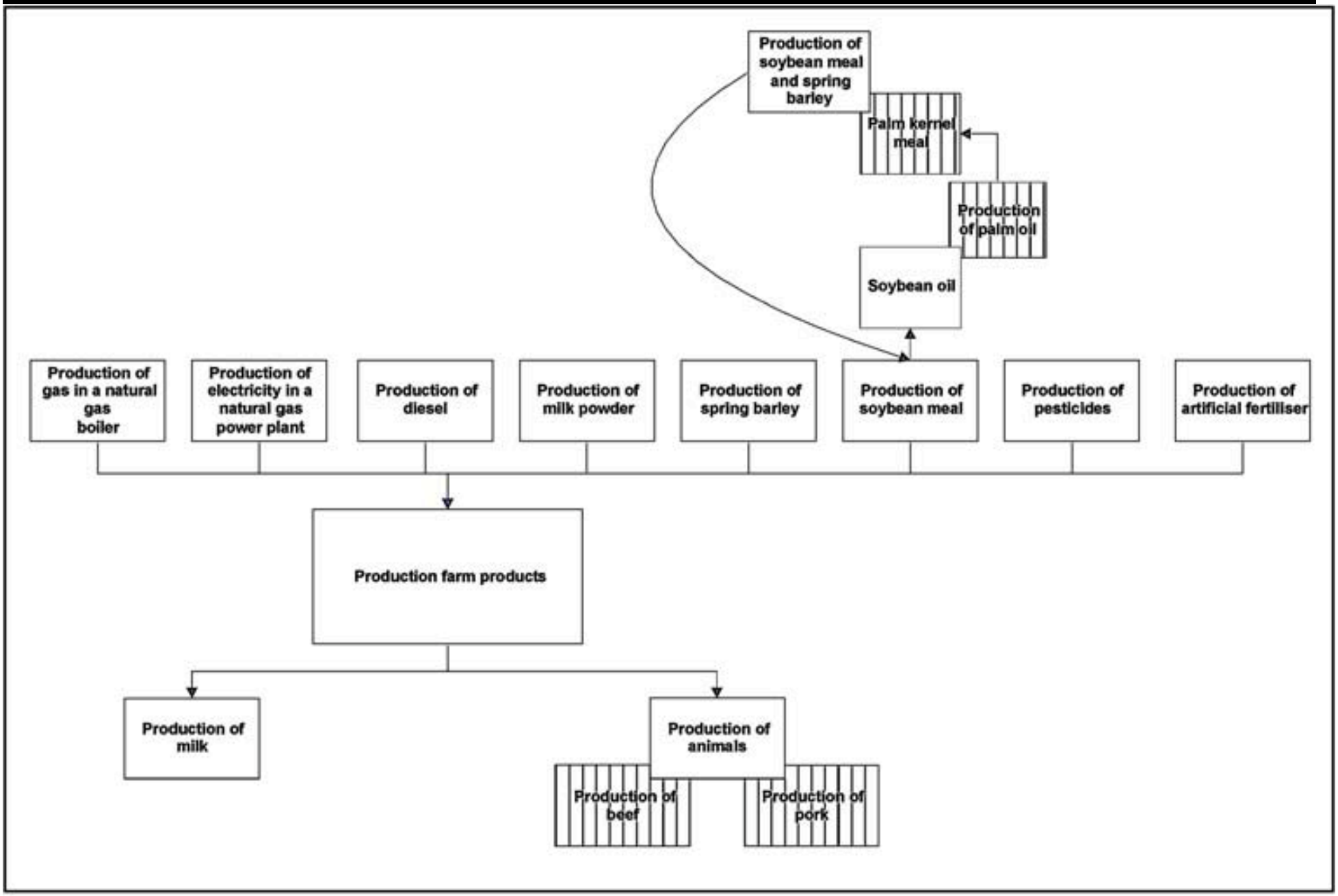
Joint production processes

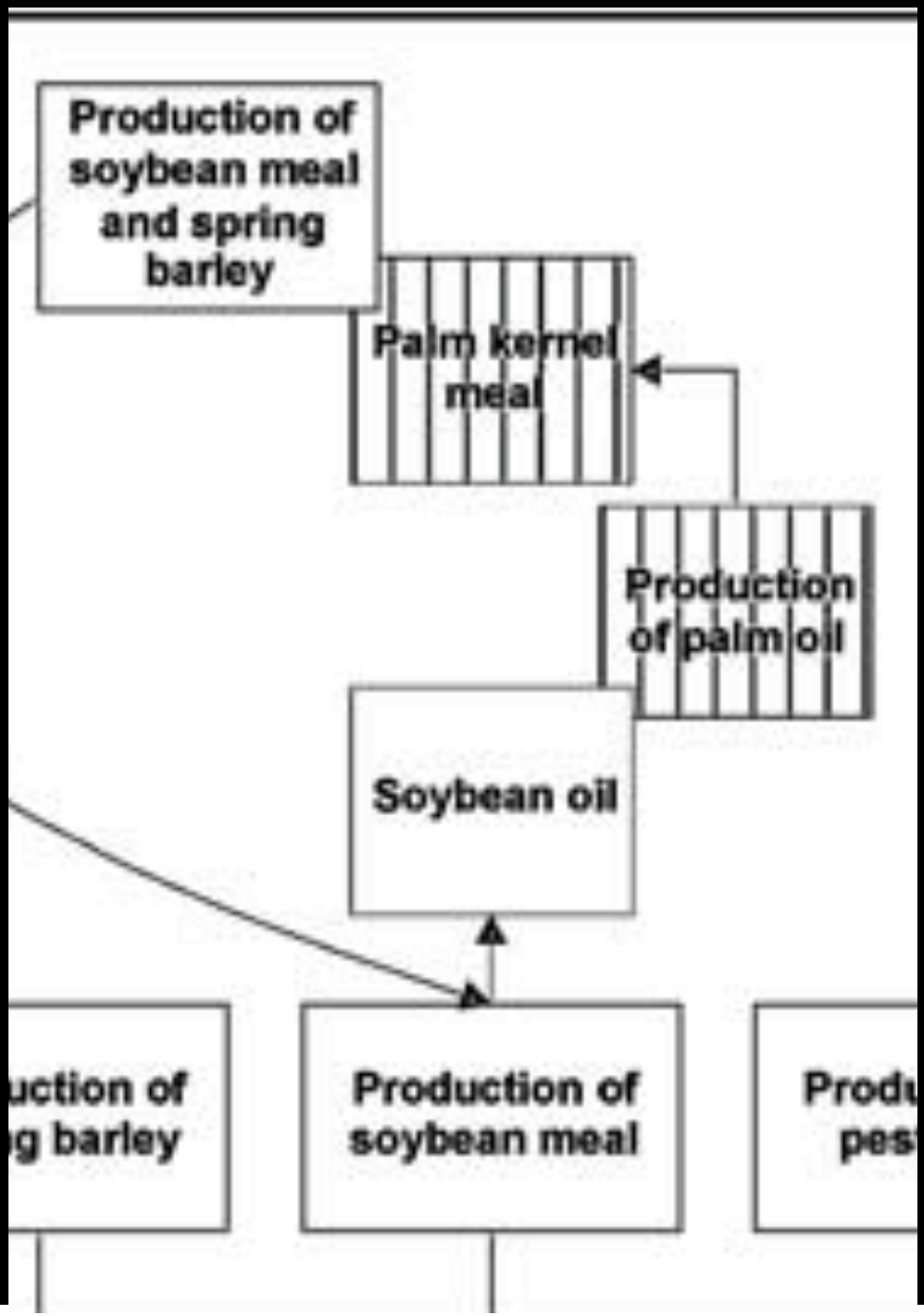
- Many agricultural products yield co-products
  - Corn ethanol and distillers grains
  - Meat, leather and dairy
  - Soybean biodiesel, soybean meal, glycerine
- LCA emissions are shared, but how should they be divided?

Co-product handling

- Allocation
  - By mass, market value, or energy content
  - Germans propose using energy content because it's easy, though it's a lousy proxy for GHG effect
  - None is correct and they yield differing results
- System Expansion
  - Expand the system boundary to include affected products
  - Considers what other process is *displaced* by the existence of the co-product
  - Brings economic modeling into ALCA


a
Attributional LCA
At dairy farm
Maize gluten meal
Transport truck
Soyhulls
Fertiliser (N) at dairy farm
Diesel use at dairy farm
Electricity use at dairy farm
Fertiliser (N) off farm
Freighter oceanic
0
200
400
600
800
1000
1200
g CO2-eq/kg FPCM
economic allocation
mass allocation
b
Consequential LCA
At dairy farm
Soybean meal
Fertiliser (N) at dairy farm
Diesel use at dairy farm
Spring barley
Electricity use at dairy farm
Transport truck
Freighter oceanic
Avoided pork production
Avoided beef production
-600
-400
-200
0
200
400
600
800
1000
1200
g CO2-eq/kg FPCM


Production of soybean meal and spring barley
Palm kernel meal
Production of palm oil
Soybean oil
Production of gas in a natural gas boiler
Production of electricity in a natural gas power plant
Production of diesel
Production of milk powder
Production of spring barley
Production of soybean meal
Production of pesticides
Production of artificial fertiliser
Production farm products
Production of milk
Production of animals
Production of beef
Production of pork
Avoided process


Production of soybean meal and spring barley
Palm kernel meal
Production of palm oil
Soybean oil
uction of
g barley
Production of soybean meal
Produ
pes

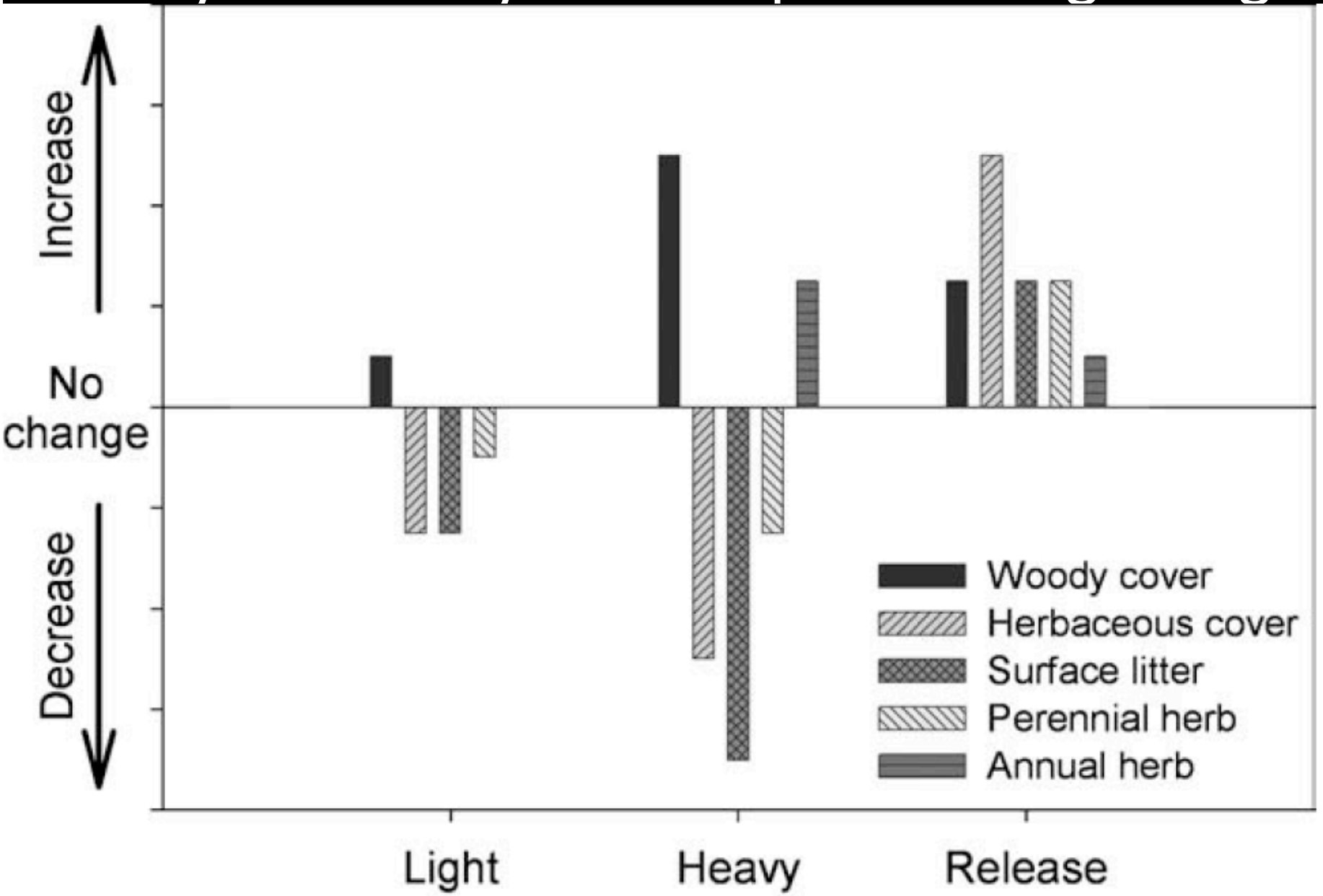
My model approach

- I'm modeling impact of policies that evaluate products based on their GHG intensity
- My modeling will need to be dynamic (i.e. multiple periods)
- I will use CLCA methods to calculate part of the lifecycle emissions
  - Co-products
  - LUC
  - Etc.
- I'll focus on production in Brazil for world market

Some Key Questions (LCA)

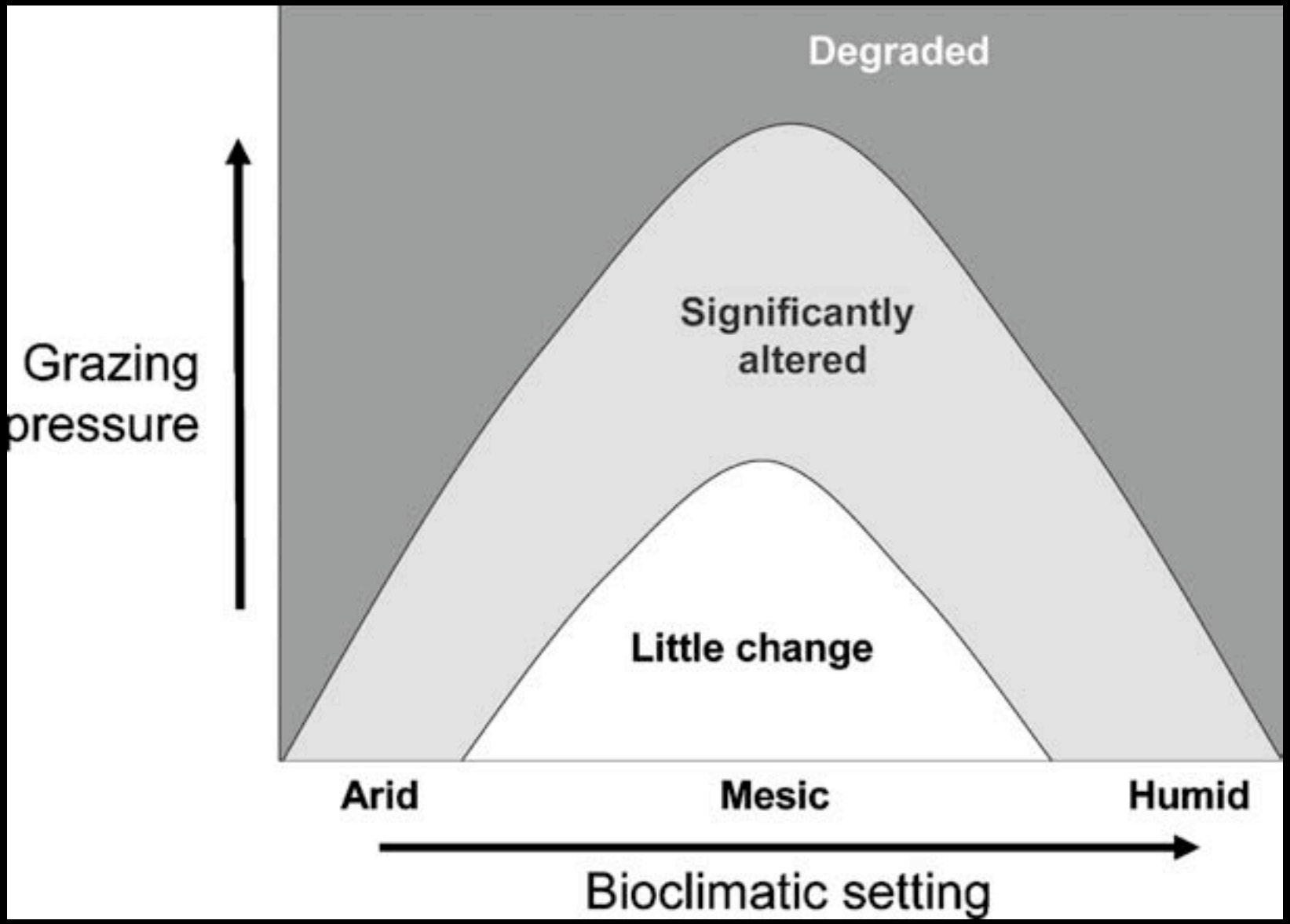
- What are the categories?
- GHG implications of land/labor horizon
- Enteric fermentation/unit beef in tropics
- Appropriate resolution to parameterize edaphic conditions
  - AEZ's are very coarse and don't capture soil variabilty
- Land degradation/propensity to abandon
  - Present value of GHG intensity based on expected duration of ranching operation?
- Deforestation
  - Proximate vs. ultimate causes of deforestation
    - Is it accurate to attributed all clearing occupied by livestock to livestock?

Dryland ecosystem responses to grazing



Source: Asner et al., 2004

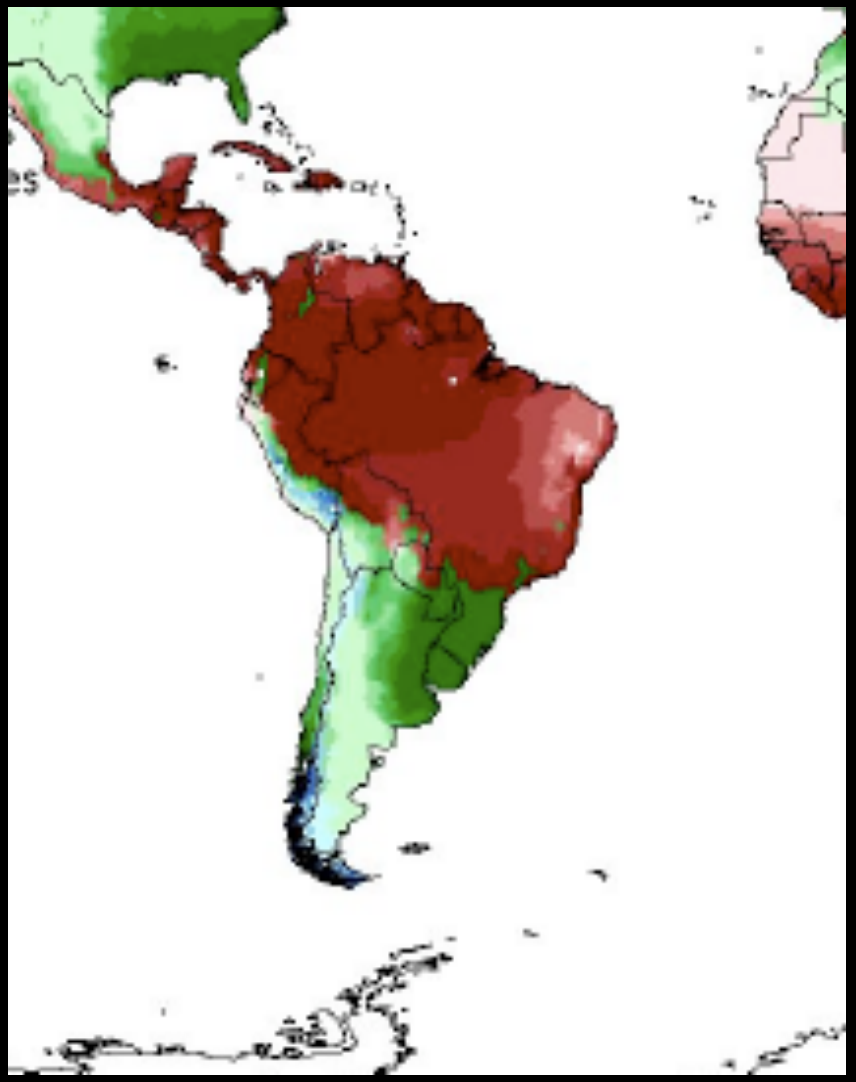
Influence of Edaphic Condition on Significance of Grazing Intensity

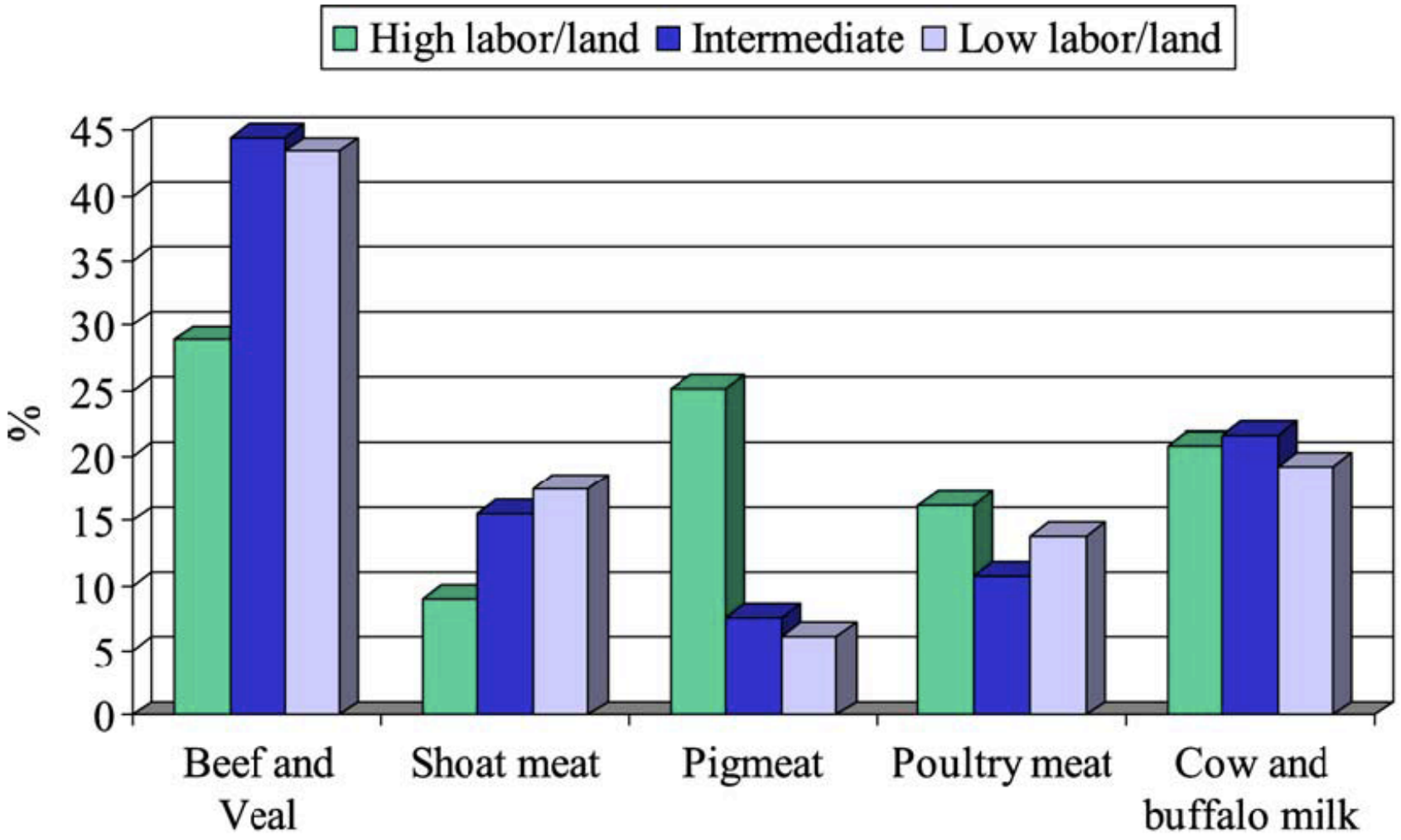


Source: Asner et al., 2004

Change from Grazing	Indicator (s)	Edaphic conditions	Direct GHG effect	Indirect GHG effect	Region of Brazil
desertification	Lower NPP	arid	Lost sequestration, increased trace GHG gas emissions?	Avoided ag. production?	Northeast, cerrado
Woody encroachment	Higher NDVI	Semi-arid	?, increased trace GHG gas emissions?	Avoided ag. production, foregone ag. production?	Northeast, cerrado?
Deforestation	Lower NDVI	humid	Emission from forest soils and vegetation	Avoided ag. production, foregone ag. production?	North (Amazon), Atlantic Rainforest?

AEZs in Brazil




High labor/land
Intermediate
Low labor/land
%
45
40
35
30
25
20
15
10
5
0
Beef and Veal
Shoat meat
Pigmeat
Poultry meat
Cow and buffalo milk

Some Key questions (Economic)

- Land Counterfactual:
  - On which pasture land is cultivation possible?
    - Asserted that cane expansion is occurring on pasture (Goldemberg et al. 2008)
  - What is foregone productivity of food, feed and fiber?
    - Elasticities with regional beef markets
- Technology adoption
- Parameterization of land speculation
- Efficiency potentials

Next steps

- Livestock LCA meta-model
- Synthesis report on trends in Brazilian livestock sector
- Research design for empirical research
  - Just socioeconomic or some biophysical data collection possible/necessary

Berkeley Faculty Roundtable on Environmental Services in Rangeland Production Systems

Part II: Discussion

Notes and Synthesis by Kayje Booker

Berkeley Faculty Roundtable on Environmental Services in Rangeland Production Systems

I. Issues and questions in response to Avery's presenation:

A. Role of Land Use, Land Use Change, and Forestry in climate change:
   - Agriculture contribution to climate change is substantial over a 100 year time horizon
   - It is even more important over a 20 year time horizon – about 45% of climate forcing can be attributed to land use change and food production
   - Agriculture has many shorter lived, more intense gases
     - Political conundrum – most of these emissions are from developing countries that do not have caps under the Kyoto protocol
     - Next two decades are seen to be critical for in avoiding the worst effects of climate change

B. Response to the Stehfest paper:
   - Stehfest compared reductions of agricultural GHGs to GHGs from transportation and energy and found that lowering GHGs from agriculture would be a cheaper way to reduce emissions than focusing on energy and transportation.
   - But the paper raises some questions:
     - What are policy mechanisms for changing diet?
     - How heterogeneous is the GHG intensity of livestock systems?
     - How do you calculate the impacts of a more realistic change in demand?
   - In a way, the Stehfest paper looks at the beef and climate issue from the reverse angle of the roundtable. Stehfest poses the question of how global GHG emissions change if people changed their meat consumption in these various ways. The roundtable wants to know how beef consumption would change if various climate policies were put in place. In both cases, a key to the question is characterizing different beef production pathways in terms of their GHG emissions, which is the focus of Avery's research.

Berkeley Faculty Roundtable on Environmental Services in Rangeland Production Systems

II. Broader discussion

Due to the many questions during the presentation, time for discussion afterwards was less than past roundtables. A theme to which the conversation returned repeatedly was the implication of greenhouse gas life cycle analysis for rangeland beef production. Roundtable participants wanted to know if the results of this kind of analysis would give rangeland beef an advantage over feedlot beef. The speaker, Avery Cohn, is too early in his research to provide results, but his work will seek to characterize multiple beef production pathways and their environmental impacts. This characterization is the first step in determining if rangeland beef is better from a GHG perspective than feedlot beef and, if so, what might the be the effects of various climate policies on beef production.

A. Non-competitive sources

- One key point of comparison seems to be whether the beef is produced on lands that could be used for agriculture. If you are looking at indirect effects of land use change for raising beef cattle, those effects are very different if the land is not arable in the first place – you are not changing other commodity prices in the same way that you would if you displaced crops.
    - A major question for this roundtable is whether or not there is a way, through climate policies such as a carbon tax, to shift beef production to "non-competitive" sources (i.e. rangelands). We would like to know the GHG effect of raising cattle on non-competitive land sources and if that effect is significant in the lifecycle analysis of beef.
    - Right now, there is a perverse market incentive to raise beef cattle on grain that displaces other crops. Maybe carbon policies could even the playing field so that grass fed beef, raised on non-competitive lands, could compete on price with grain fed beef.

B. Beef production and ecological shifts

- The presentation suggests that ecological shifts caused by grazing are taken into account when calculating lifetime GHG emissions from beef. Are there stable beef production systems in Brazil that are not causing these shifts?
    - Yes – in the south of Brazil, where soils are more durable, cattle grazing has not caused ecological shifts. However, these lands are suited for agriculture, so they are competing with row crops, and the fastest growing region of Brazil for cattle production is in the Amazon, where cattle grazing leads to ecological shifts.
        - Amazon beef production is very profitable because the land is cheap and the infrastructure is improving rapidly. These infrastructure improvements are really changing the nature of the beef industry in Brazil.

C. Sources of emissions from grazing

- There is an interesting problem in characterizing the life cycle emissions of beef in that there are some changes that are caused directly by the cattle, but there are

some changes caused by humans in their management of cattle. Fore example, in the Amazon, people are cutting down trees to create pasture. Although those emissions are the result of cattle grazing, they are not really caused by the cattle. Is it necessary to keep them separate?

- Those should be kept separate in the analysis because one is more avoidable or more amenable to policy than the other. People may be able to avoid some of their management activities (such as deforestation) that emit GHGs if there was a policy that regulated that activity or incentives to do things differently. It is much harder to avoid most of the direct effects of grazing (e.g. methane emissions).

D. Sustainability with rising demand

- This presentation began with the assertion that rising wealth leads to higher meat consumption, but you finished with talking about how to make meat more sustainable. If demand is rising, how would this work?
  - A good analogy is China and global warming. Their emissions are rising astronomically with their economic growth, and most of the discussion is around how to reduce that trajectory and allow them to grow without such huge increases in emissions. Reducing the trajectory matters, but it won't solve the problem. So, in beef, we need to consider how to produce meat more efficiently, with fewer greenhouse gas emissions per pound of beef, but we'll also likely need to limit beef consumption in places that are overconsuming, like the United States. To limit beef consumption in developing countries, where consumption is growing but still much, much lower than in the US, is not really an option, politically.

E. Effect of carbon tax on beef production

- One of the main roundtable questions: if you put a carbon tax on different kinds of beef production, would beef production change? Are there sustainable and stable grazing systems, and, if so, would a carbon tax make those systems more relatively affordable.
  - First step is characterizing the GHG intensity of different beef production, which is the research that Avery is pursuing. This question gets at the next step which is to then analyze how different policies might encourage or discourage the different pathways.
  - The key question is can you define different kinds of beef and, if so, what are the consequences for climate change and other environmental metrics?