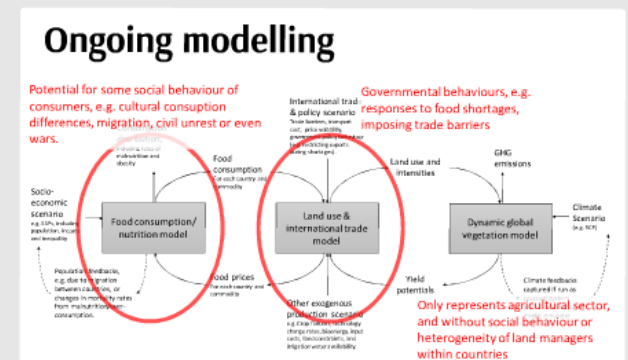
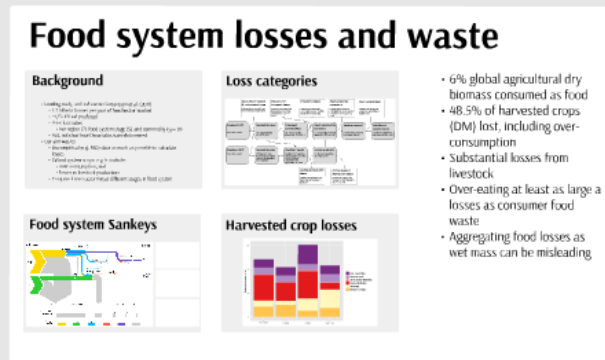
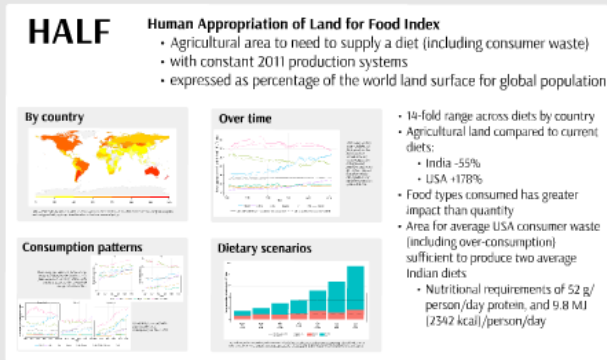
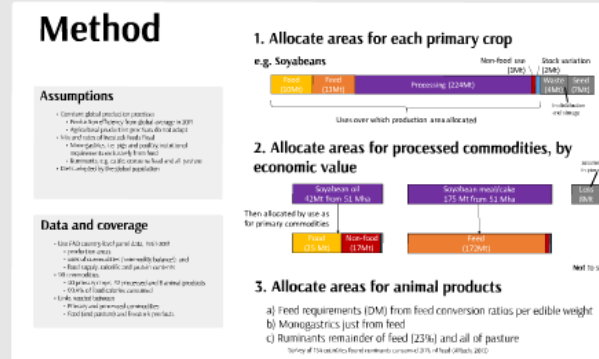
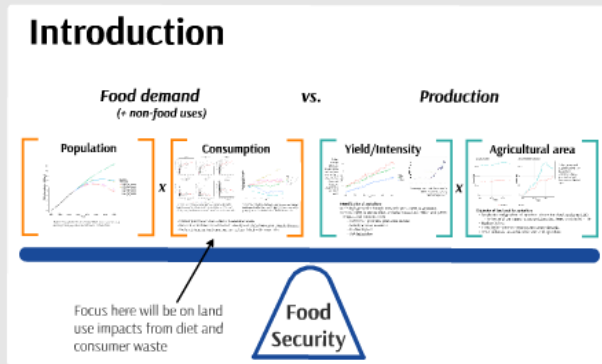


Global scale agricultural systems: the role of diet and food waste

Peter Alexander
University of Edinburgh

23rd May 2016



References

Alexander, P., Brown, C., Arneith, A., Finnigan, J., Moran, D. & Rounsevell, M. D. A. 2016 Losses and waste in the global food system. Agric. Syst. In review.

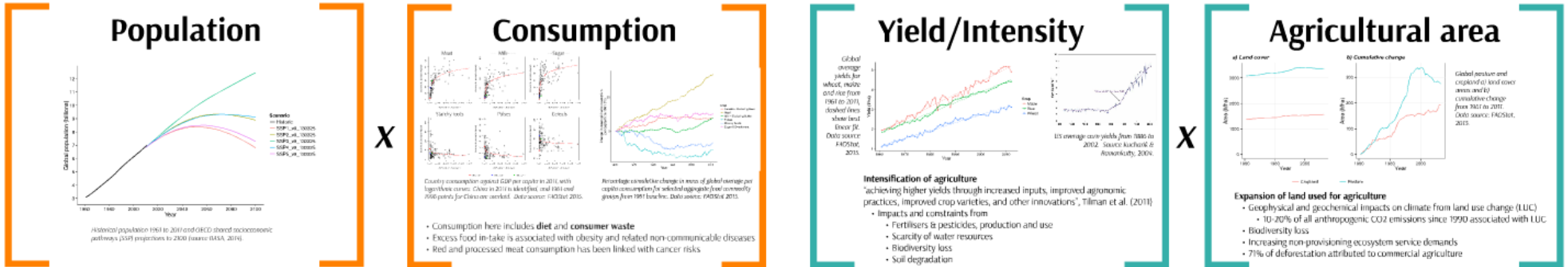
Alexander, P., Brown, C., Rounsevell, M., Finnigan, J. & Arneith, A. 2016 Human appropriation of land for food: the role of diet. J. R. Soc. Interface In review.

Introduction

Food demand
(+ non-food uses)

vs.

Production



Focus here will be on land use impacts from diet and consumer waste



Method

Assumptions

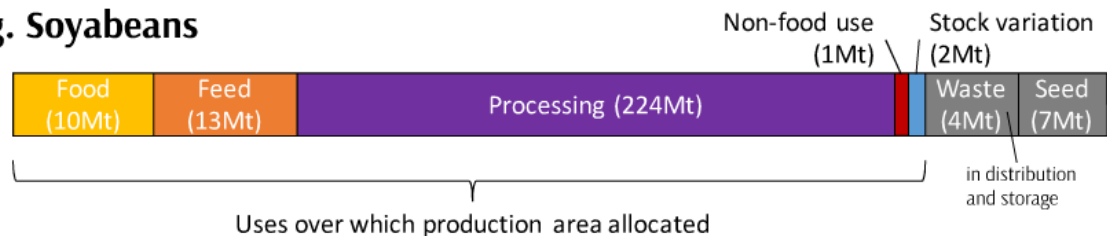
- Constant global production practices
 - Production efficiency from global average in 2011
 - Agricultural production practices do not adapt
- Mix and rates of livestock feeds fixed
 - Monogastrics, i.e. pigs and poultry, nutritional requirements exclusively from feed
 - Ruminants, e.g. cattle, consume feed and all pasture
- Diets adopted by the global population

Data and coverage

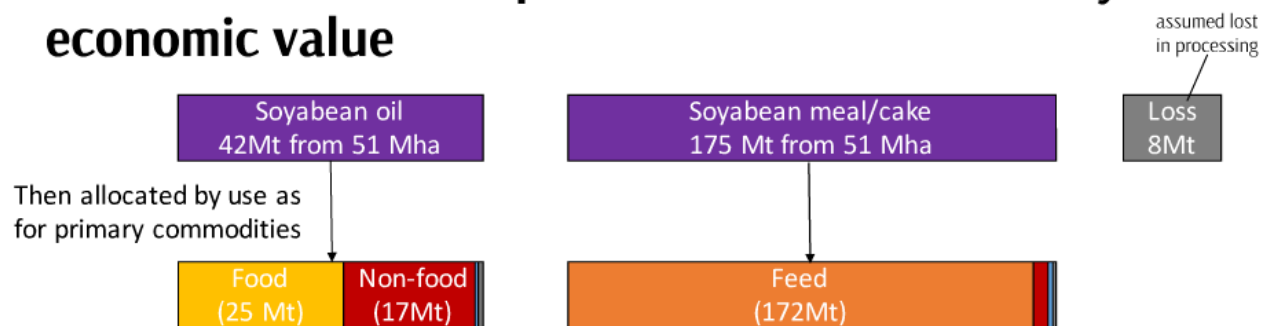
- Use FAO country-level panel data, 1961-2011
 - production areas
 - uses of commodities ('commodity balance'), and
 - food supply, calorific and protein contents
- 90 commodities
 - 50 primary crops, 32 processed and 8 animal products
 - 99.4% of food calories consumed
- Links needed between
 - Primary and processed commodities
 - Feed (and pasture) and livestock products

1. Allocate areas for each primary crop

e.g. Soyabeans



2. Allocate areas for processed commodities, by economic value



Not to scale

3. Allocate areas for animal products

- Feed requirements (DM) from feed conversion ratios per edible weight
- Monogastrics just from feed
- Ruminants remainder of feed (23%) and all of pasture

Survey of 134 countries found ruminants consumed 26% of feed (Alltech, 2013)

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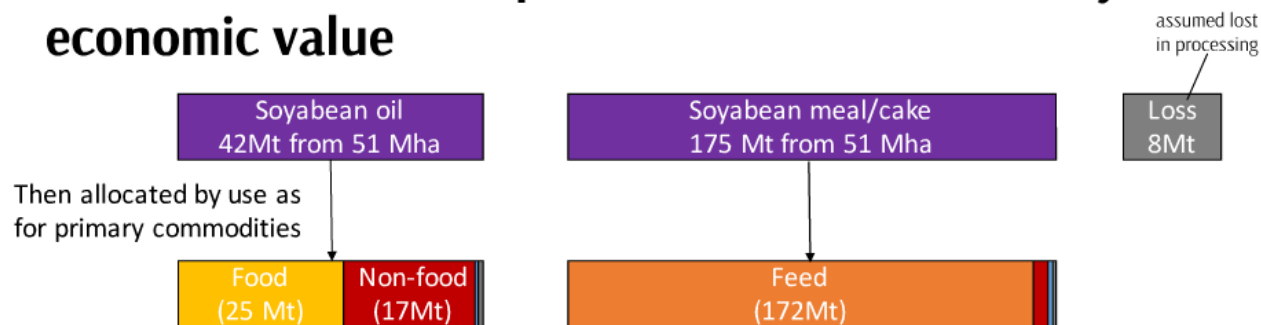
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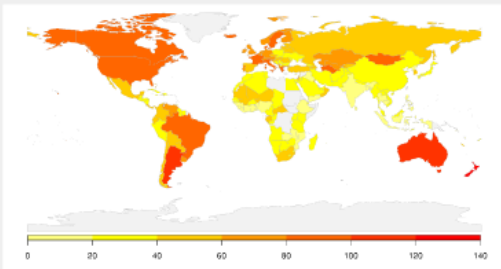
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HALF

Human Appropriation of Land for Food Index

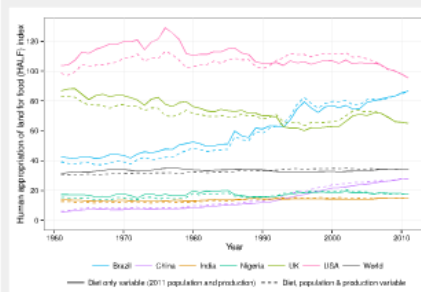
- Agricultural area to need to supply a diet (including consumer waste)
- with constant 2011 production systems
- expressed as percentage of the world land surface for global population

By country



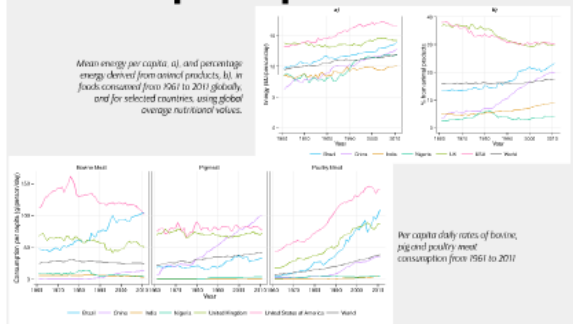
Map of HALF index by country in 2011. Countries where the index could not be calculated due to no commodity consumption data being available, e.g. Libya, Somalia and Greenland, are shown in light grey.

Over time

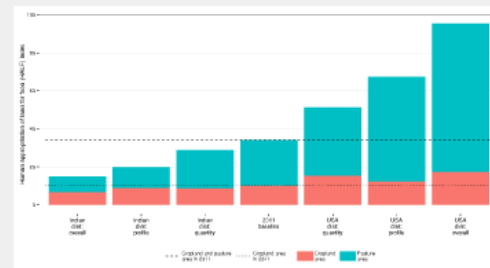


HALF index from 1961 to 2011, globally and for selected countries. Solid lines show variable diets, but constant population and agricultural production systems (for 2011 values). Dashed lines show variable diet, population and agricultural production systems over time.

Consumption patterns



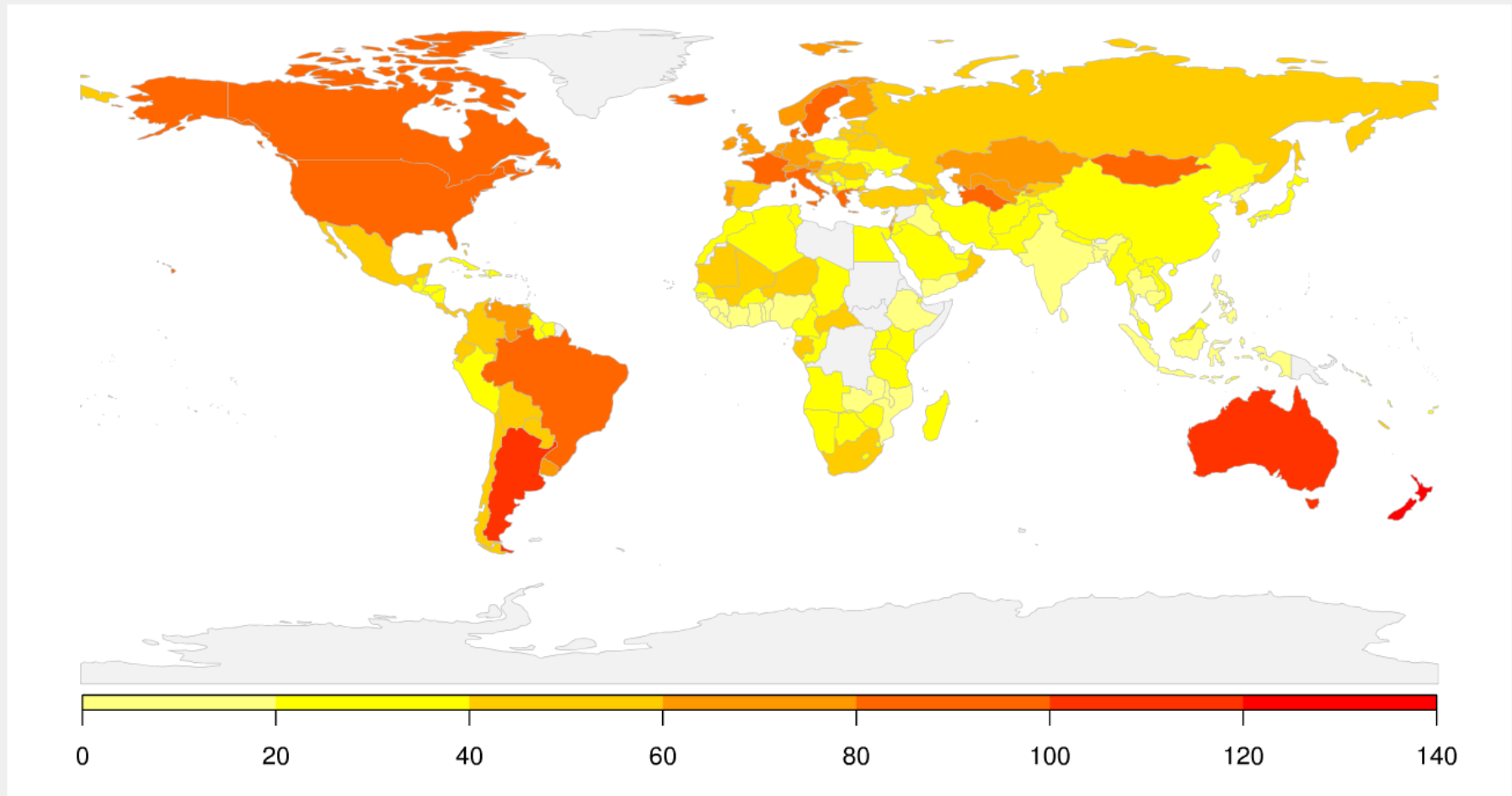
Dietary scenarios



Cropland and pasture to produce food under alternative dietary scenarios, expressed as required percentage of world land, or HALF index, using global 2011 population and production systems. Results possible at least required amounts of both energy and protein.

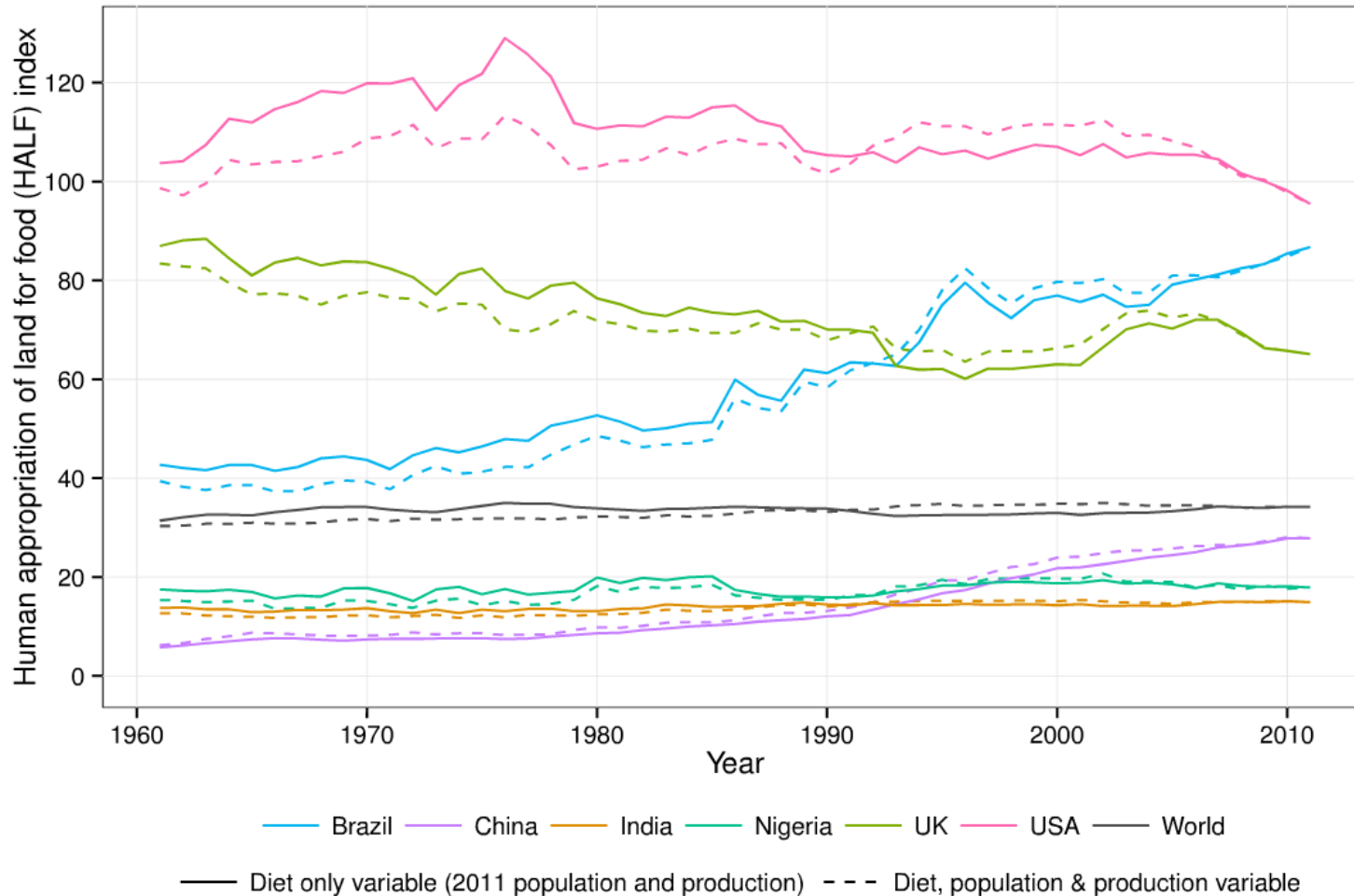
- 14-fold range across diets by country
- Agricultural land compared to current diets:
 - India -55%
 - USA +178%
- Food types consumed has greater impact than quantity
- Area for average USA consumer waste (including over-consumption) sufficient to produce two average Indian diets
 - Nutritional requirements of 52 g/person/day protein, and 9.8 MJ (2342 kcal)/person/day

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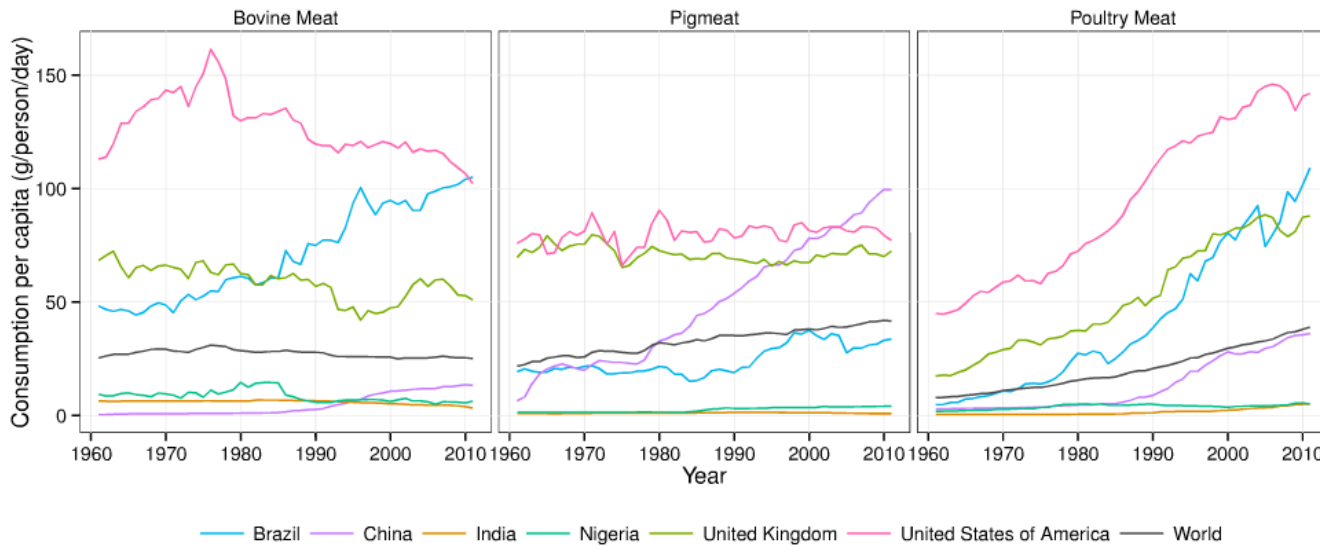
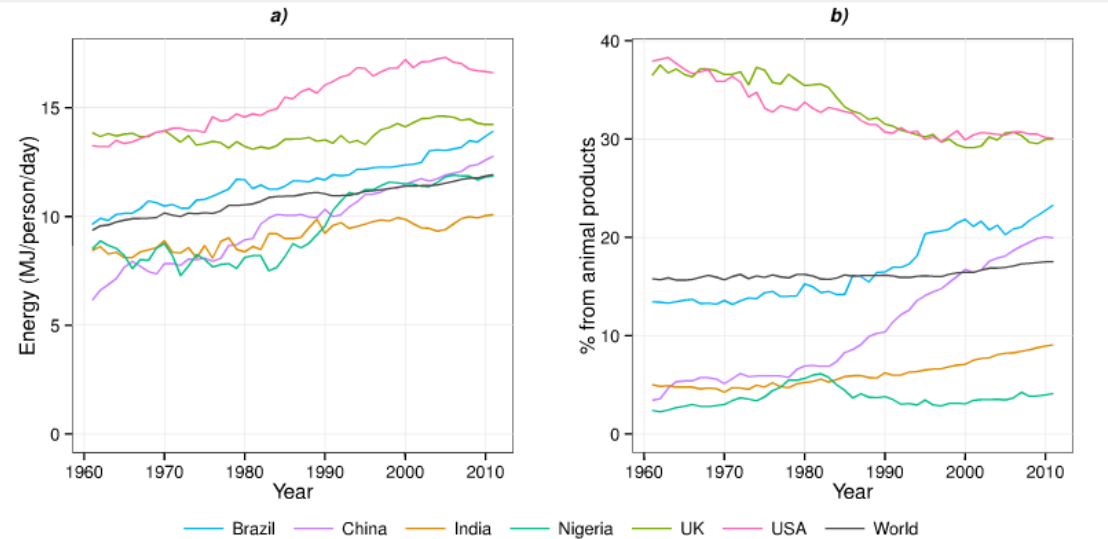
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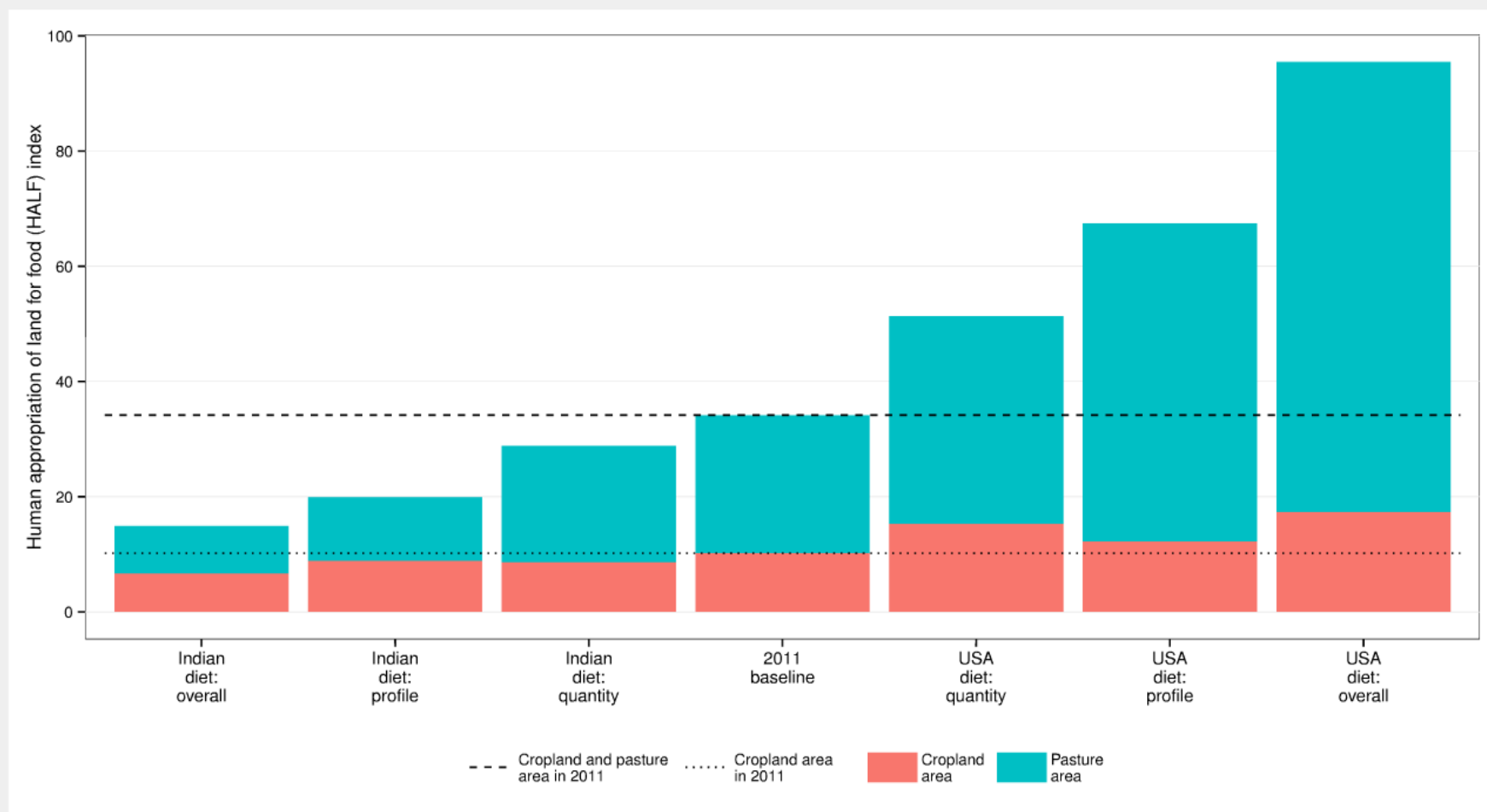
Consumption patterns

Mean energy per capita, a), and percentage energy derived from animal products, b), in foods consumed from 1961 to 2011 globally, and for selected countries, using global average nutritional values.



Per capita daily rates of bovine, pig and poultry meat consumption from 1961 to 2011

Dietary scenarios



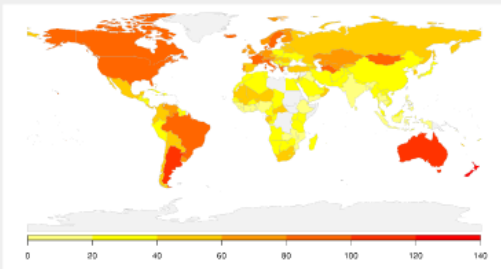
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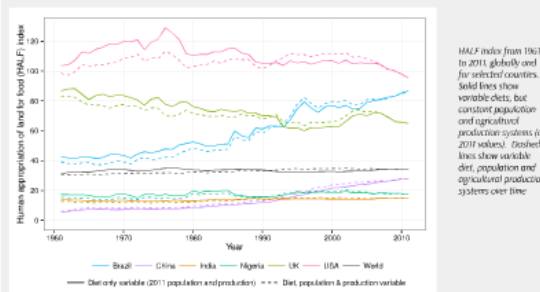
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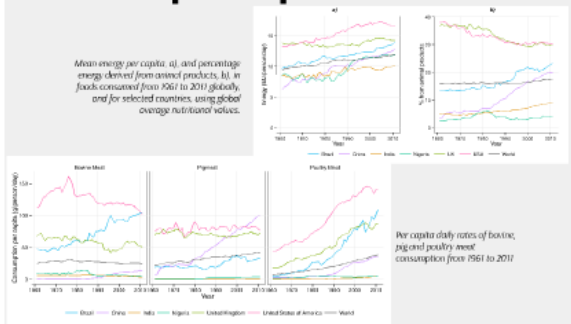
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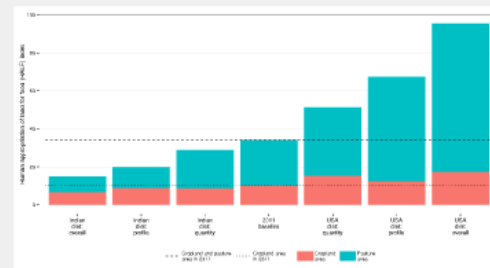


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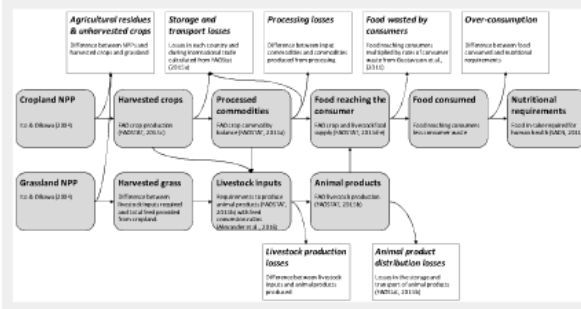
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Food system losses and waste

Background

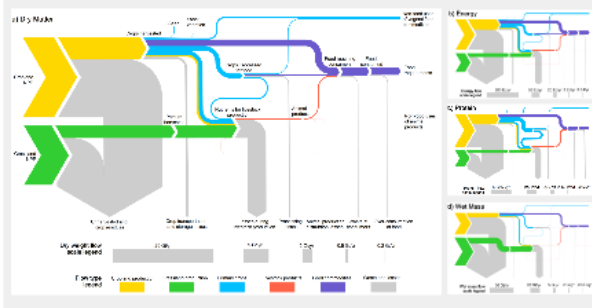
- Leading study on food waste Gustavsson et al. (2011)
 - 1.3 billions tonnes per year of food lost or wasted
 - ~1/3 of food produced
 - Uses loss rates
 - Per region (7), food system stage (5), and commodity type (7)
 - But, not clear how these rates were determined
- Our aim was to:
 - Use empirical (e.g. FAO) data as much as possible to calculate losses
 - Extend system scope, e.g. to include:
 - over-consumption, and
 - losses in livestock production
 - Compare losses occurring at different stages in food system

Loss categories

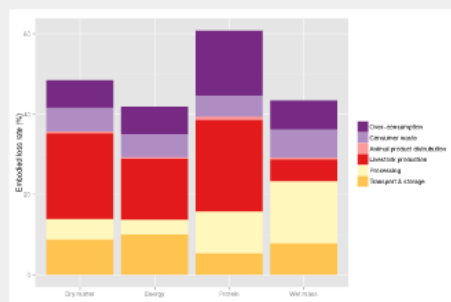


- 6% global agricultural dry biomass consumed as food
- 48.5% of harvested crops (DM) lost, including over-consumption
- Substantial losses from livestock
- Over-eating at least as large a losses as consumer food waste
- Aggregating food losses as wet mass can be misleading

Food system Sankeys



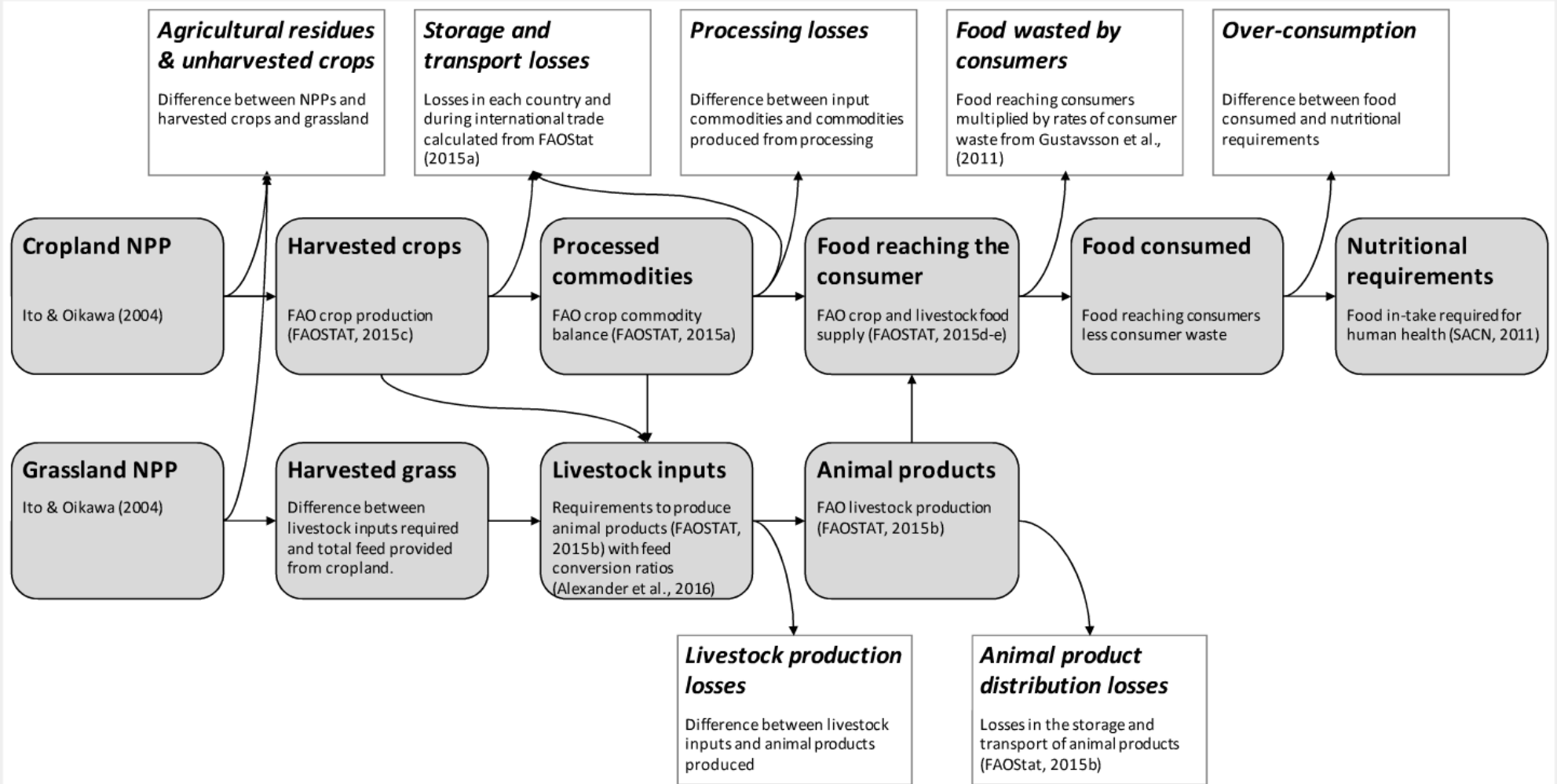
Harvested crop losses



Background

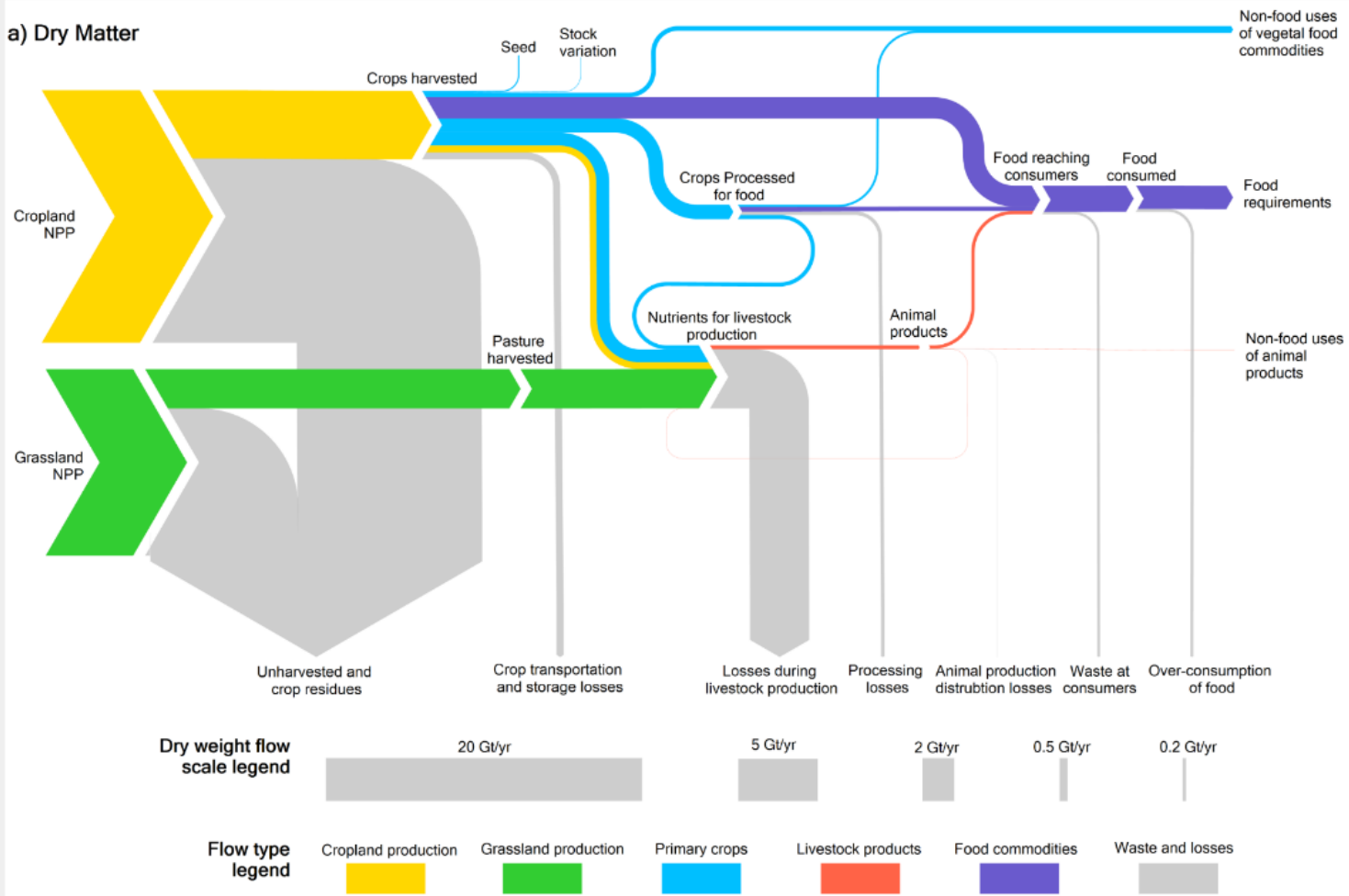
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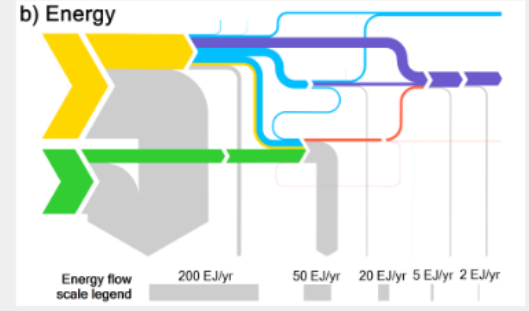


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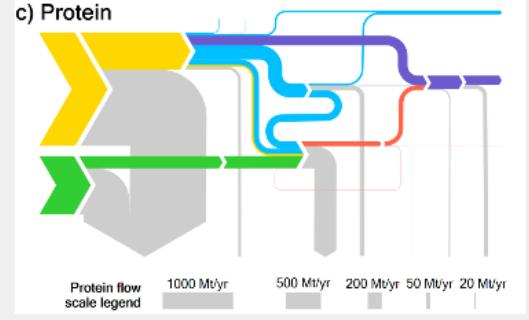
a) Dry Matter



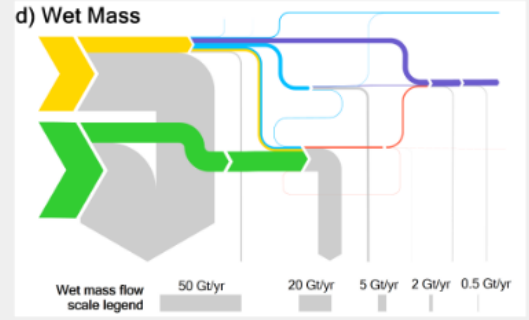
b) Energy



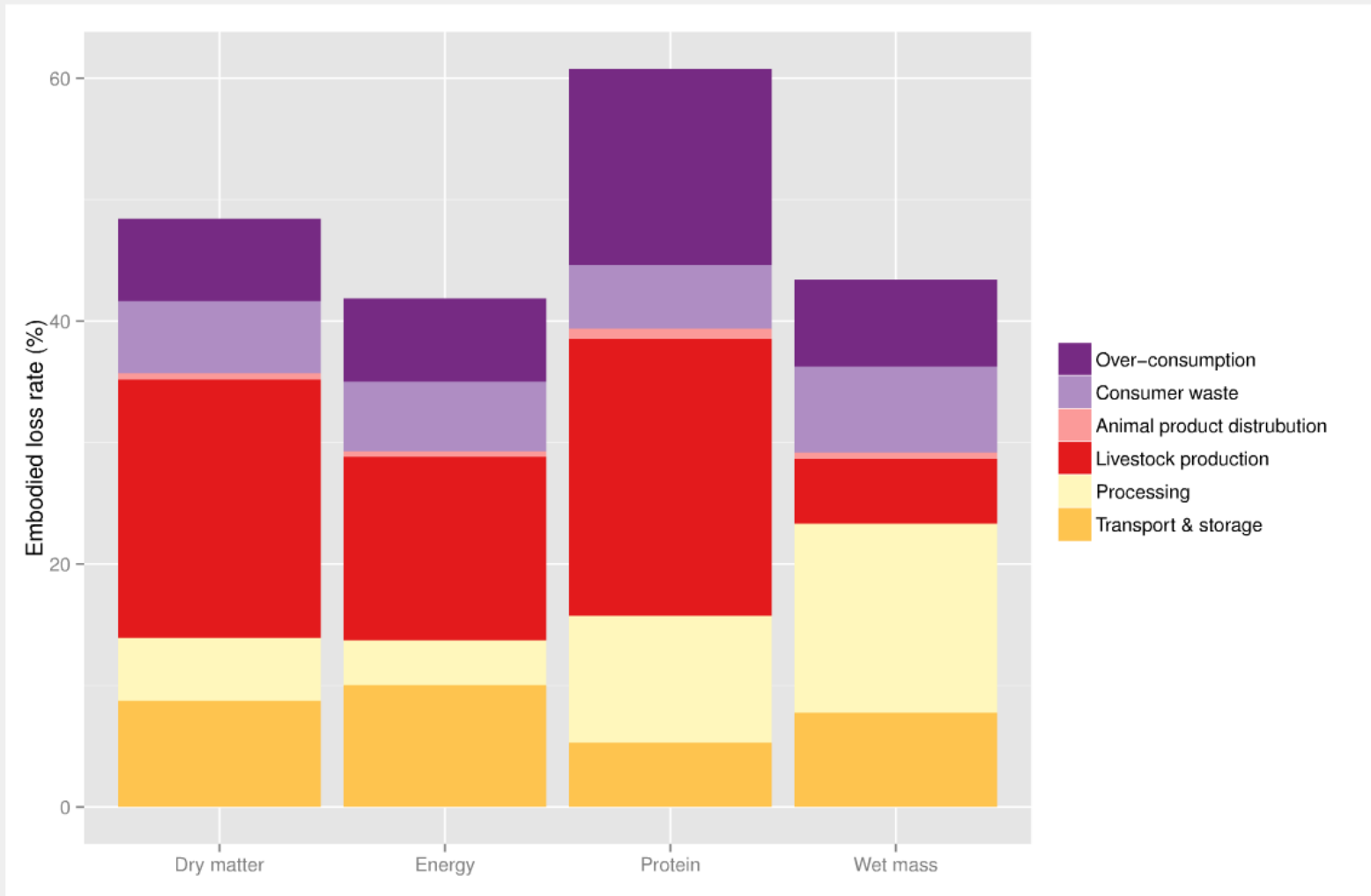
c) Protein



d) Wet Mass



Harvested crop losses

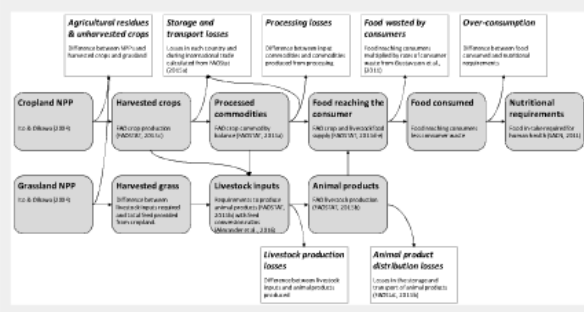


Food system losses and waste

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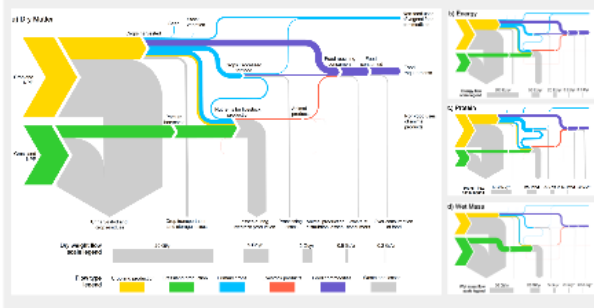
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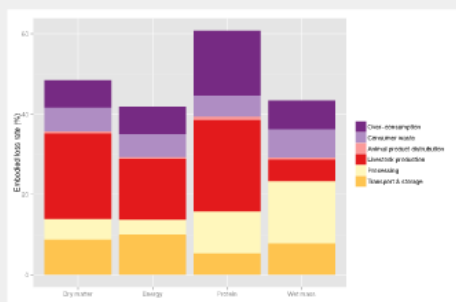


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Harvested crop losses



Ongoing modelling

Potential for some social behaviour of consumers, e.g. cultural consumption differences, migration, civil unrest or even wars.

Governmental behaviours, e.g. responses to food shortages, imposing trade barriers

