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Modelling nitrogen use efficiency by world pig production systems in 2050 under contrasting production and dietary scenarios

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MELBOURNE CRICKET GROUND | VICTORIA | AUSTRALIA

Introduction

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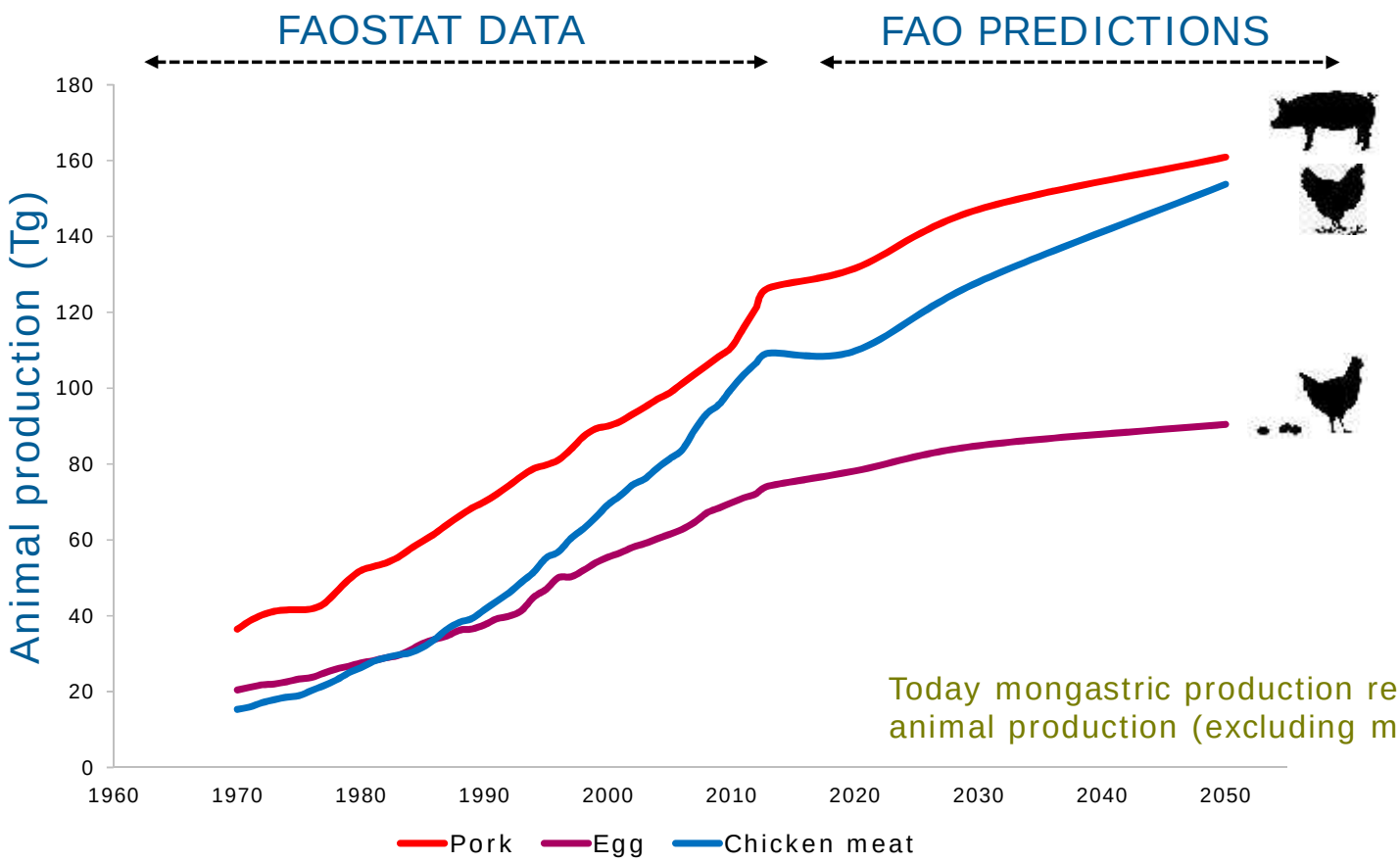
Monogastric production worldwide



Today mongastric production represents 74% of animal production (excluding milk)

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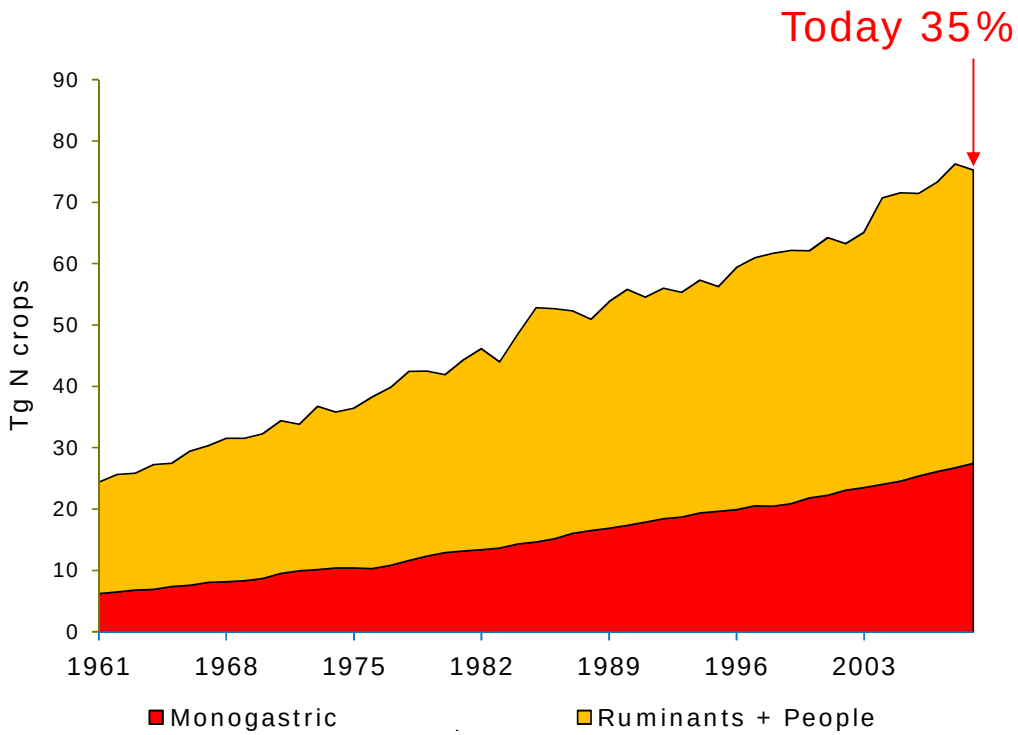
Crop protein allocated to monogastric systems globally



Lassaletta et al. 2016 (Env. Res. Lett.)

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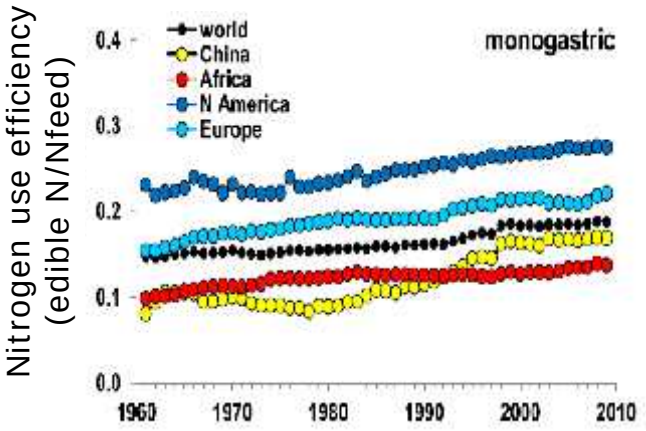
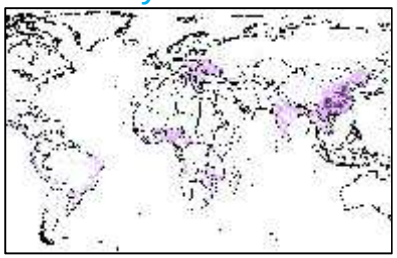
Lassaletta et al. 2014 (Biogeochemistry)

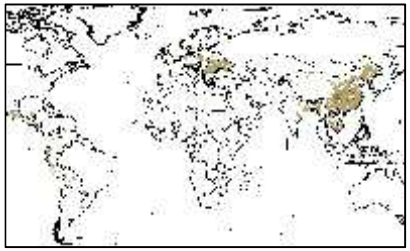


Lassaletta et al. 2016 (Env. Res. Lett.)

Backyard



Intermediate



Intensive

Robinson et al. 2014 (PLOS One)

Diverse feed rations

Aims

We have developed a new **pigs module** for the integrated assessment model framework **IMAGE**:

- to explore the animal and environmental performance of pig production systems under **different scenarios (SSPs) for 2050** with contrasting **pork demand**, **production performance** and **feed rations**.

- to study the effect of different situations on the **global N cycle**

Methods: IMAGE

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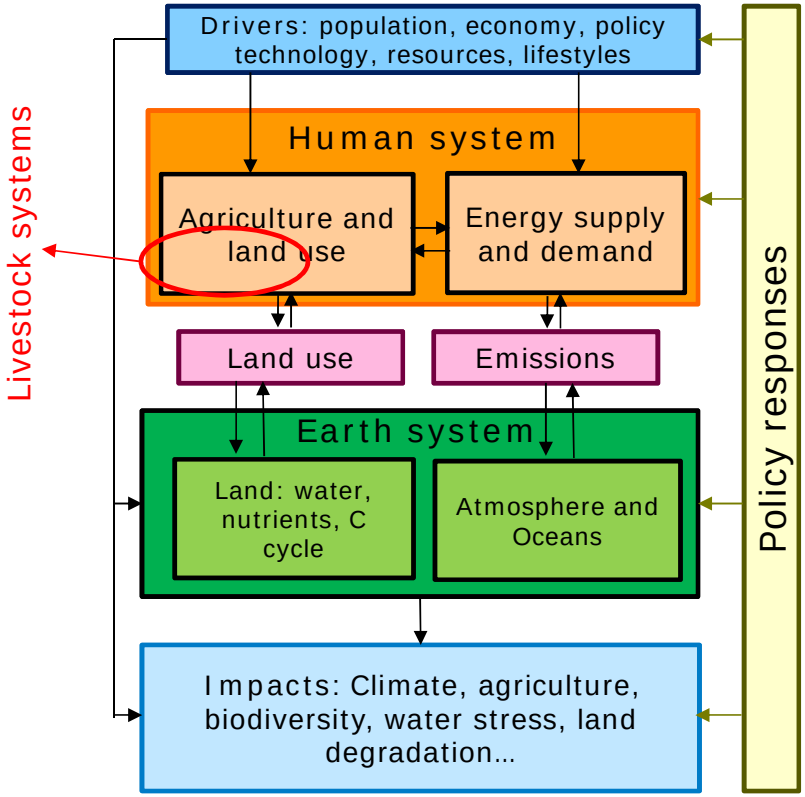
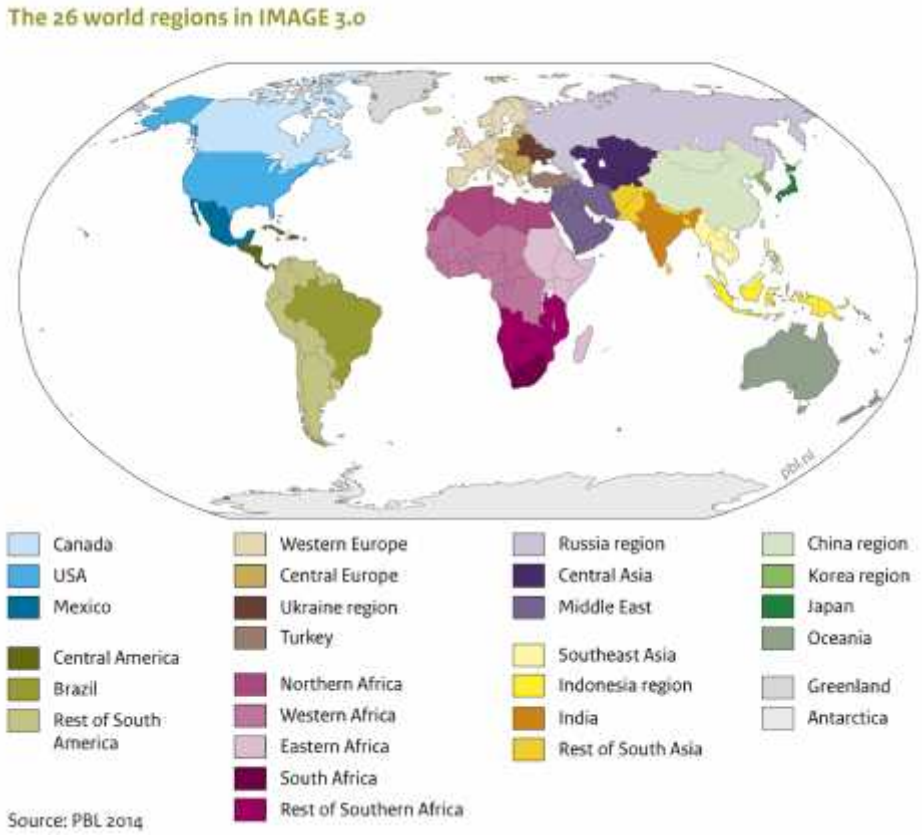
IMAGE model 3.0 Framework





Stehfest et al. 2014 (PBL)

The pigs module in IMAGE 3.0

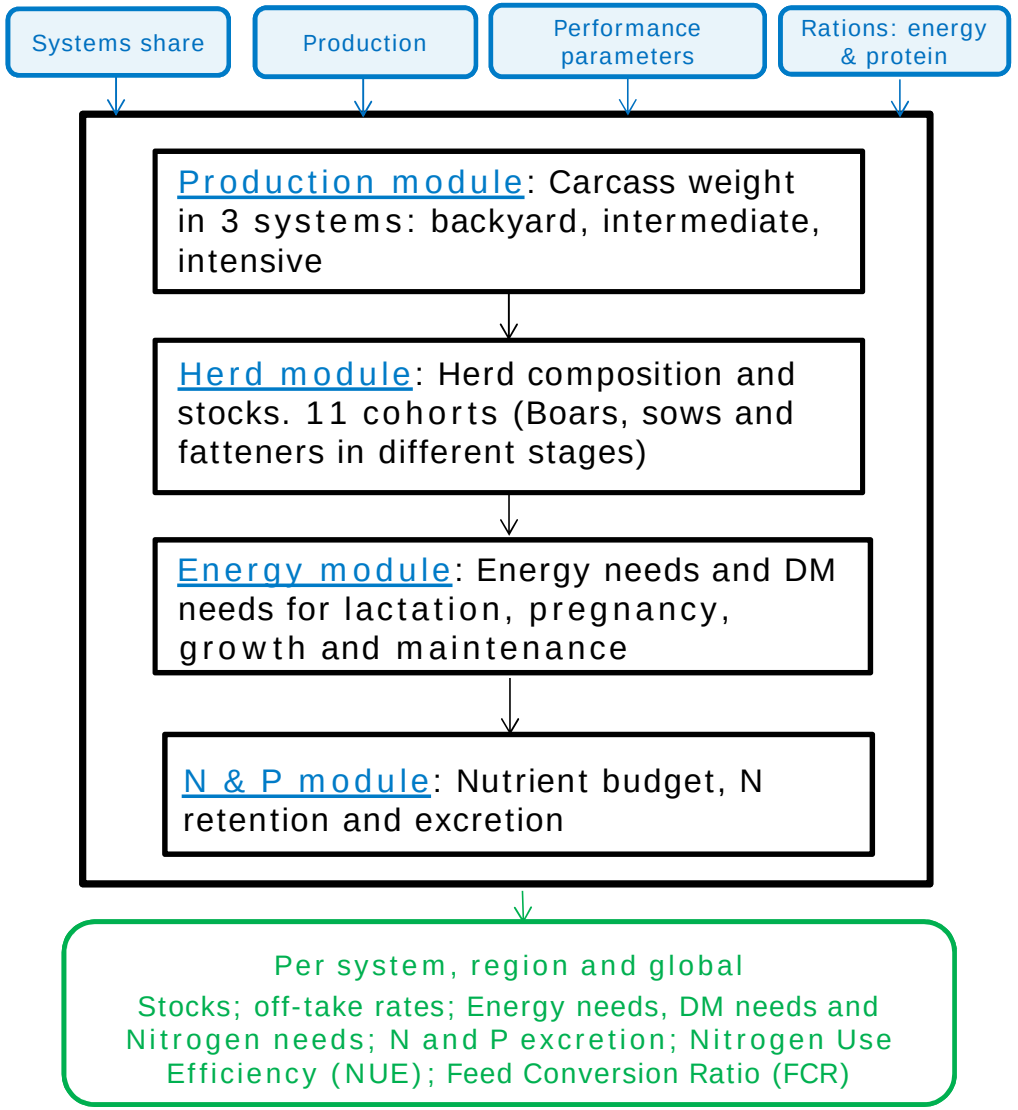
Key parameters scenarios construction

1. Fraction systems (backyard/inter/intens)
2. Production meat (kg)
3. Carcass weight
4. Daily growth (kg/d)
5. Litter size (piglets born alive)
6. Litters/sow/year
7. Metab. Ener. ration (Mj/kg DM)
8. Crude protein (CP) ration (%)

Other 13 auxiliary parameters

- 26 regions
- 3 systems: backyard, intermediate, intensive
- Calibration year: 2005
- Past trends: 1970-2010
- Scenarios: 2010-2050

NUE (Herd level) = N output (carcass) / N feed



Methods: Scenarios

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Shared Socieconomic Pathways (SSPs): Van Vuuren et al. 2014 (Clim. Change)

	SSP1 Sustainability	SSP2 Bussines as usual BAU	SSP3 Fragmentation	SSP4 Inequality	SSP5 Fossil fuelled developed
Population (2100; billion)	7 Lowest	9.1	12.8 Highest	9.5	7.4
GDP	↑↑	↑↑	|	Unequal	↑↑↑
Environmental concern	↑↑↑	↑↑	|	Unequal	↑↑
Crop productivity	↑↑↑	↑↑	|	Unequal	↑↑↑
Livestock efficiency	↑↑↑	↑↑	|	Unequal	↑↑↑
Meat consumption	↓↓↓	|	↑↑	|	↑↑↑

Methods: Parametrization

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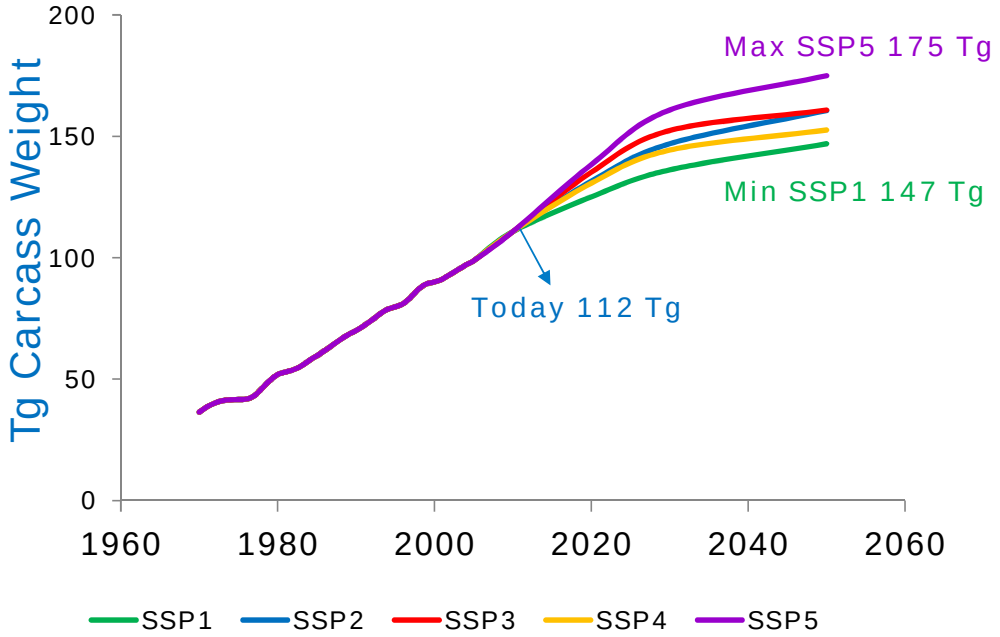
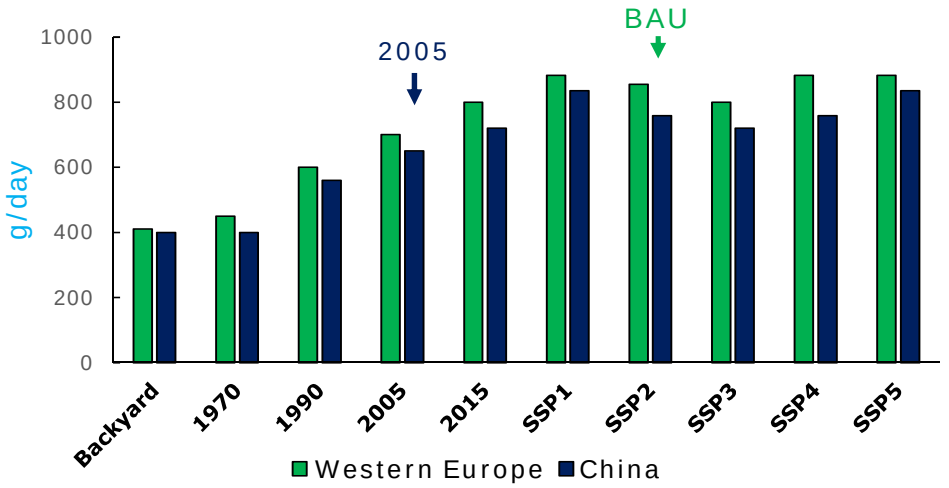
Pig production worldwide 1970-2050



Average Daily Weight Gain Fatteners Intensive



Several sources: FAOSTAT; Alexandratos & Bruinsma 2012 (FAO); Macleod et al. 2013 (FAO); Bai et al. 2014 (Env. Sci. Tech); Robinson et al 2014 (PLoS ONE); Hou et al. 2016 (AGEE), among others…

Methods: Parametrization

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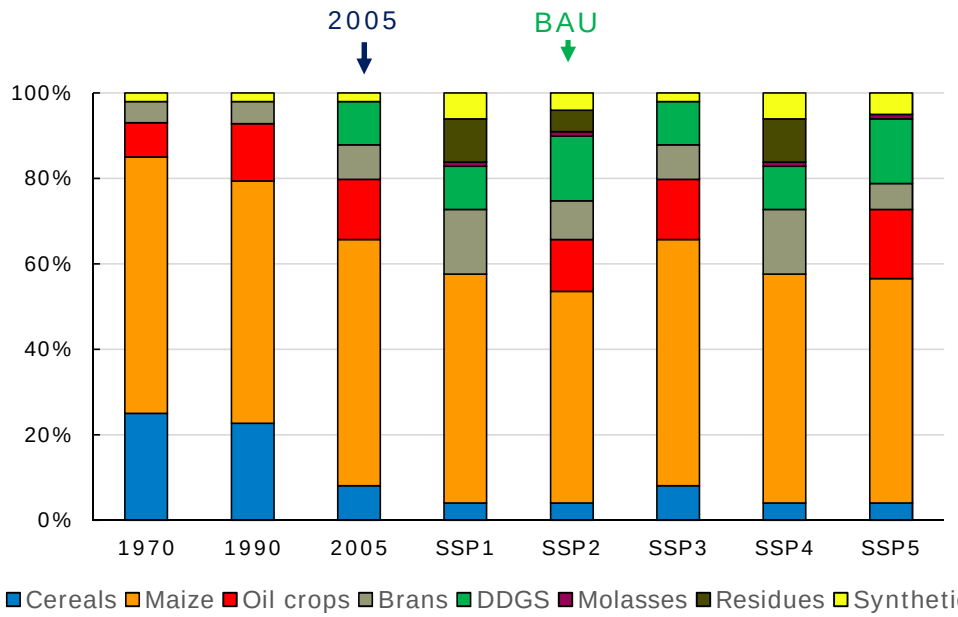
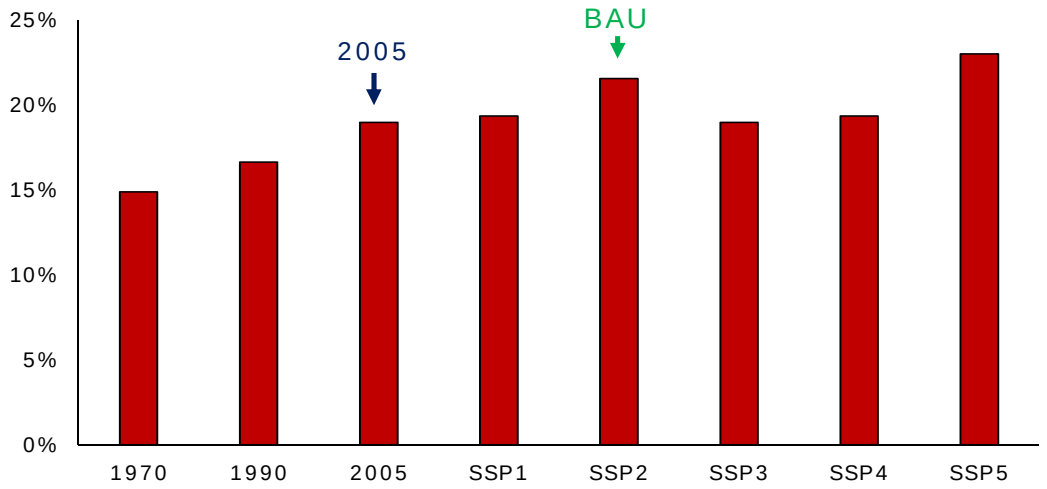
Feed rations e.g. USA Intensive



Crude protein content (%) USA intensive



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Results: feed demand

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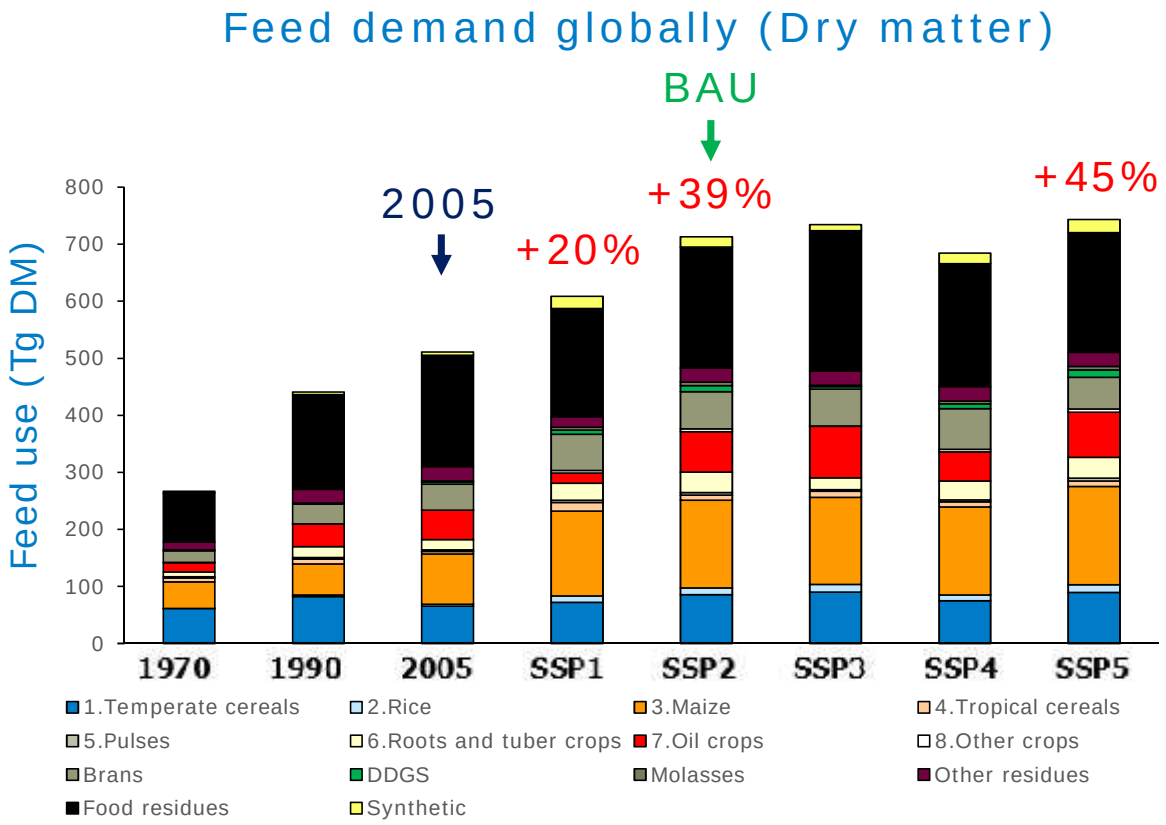

75% of food industry and household residues are used in China

Results: Feed conversion rate

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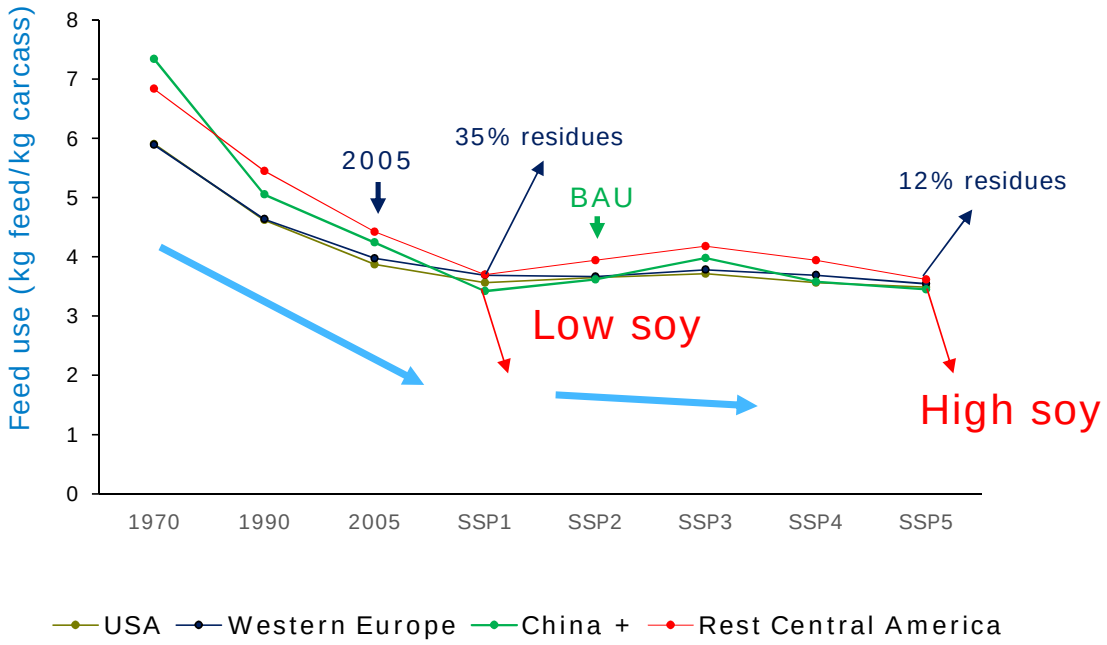
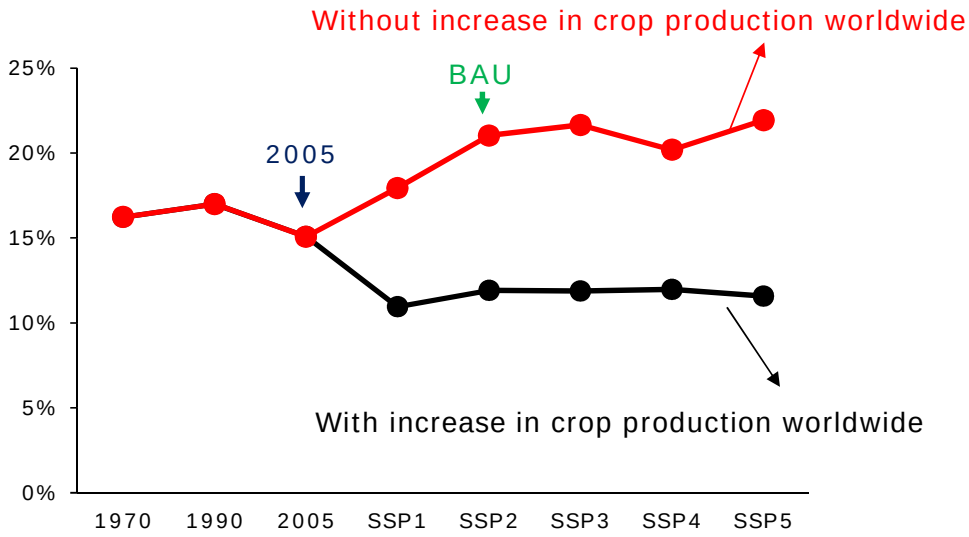
Feed conversion rate: kg feed (DM) / kg carcass

Intensive SSPs: Min 3.2, Average 3.9, Max 5.2; Backyard 8.9 (FCR average)



% of global crop production (In DM)



Results: NUE (herd level)

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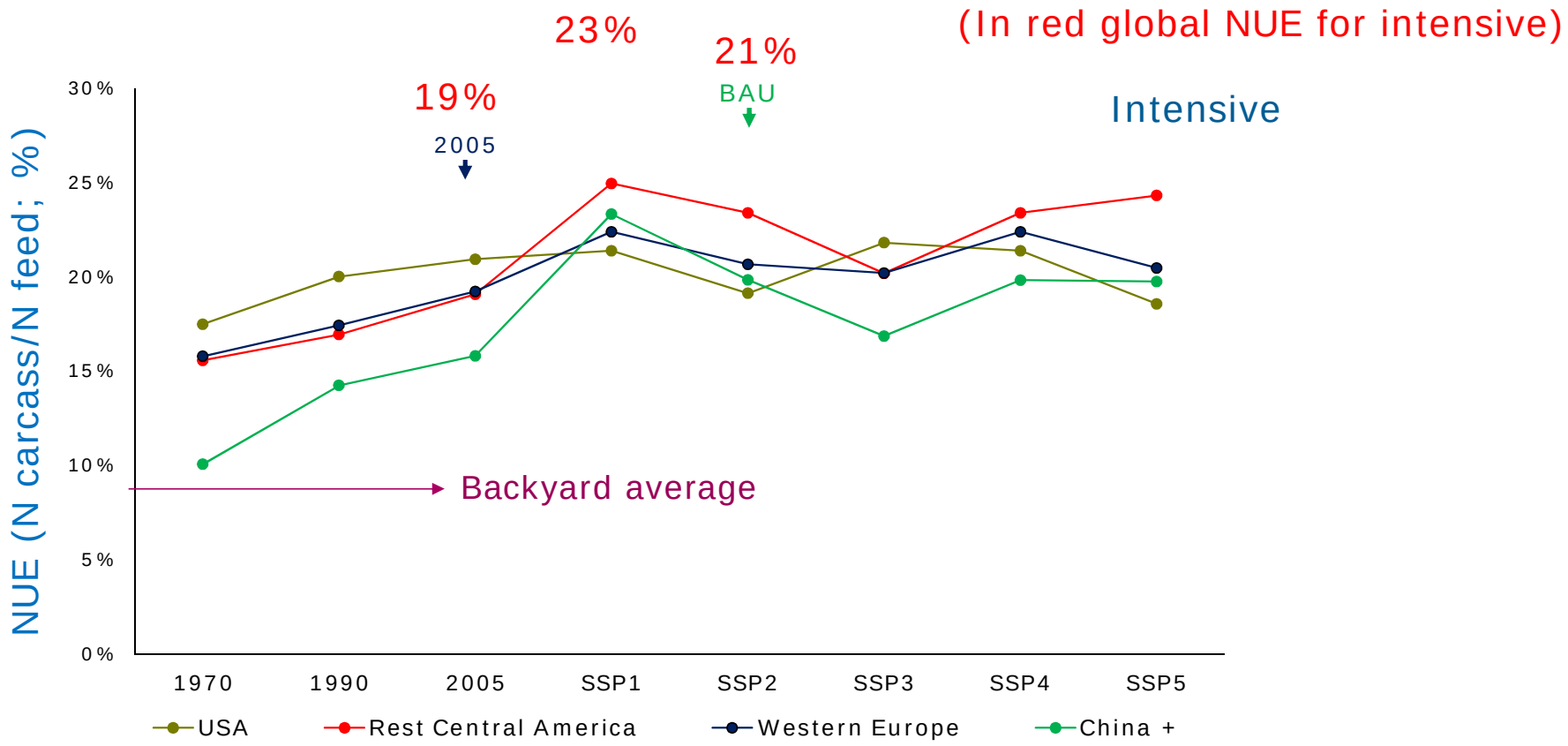
Nitrogen use efficiency: N carcass / N feed * 100



Results: Demand + excretion

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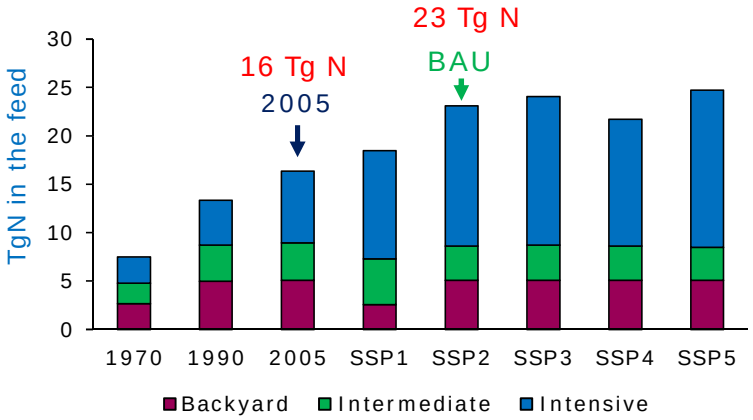
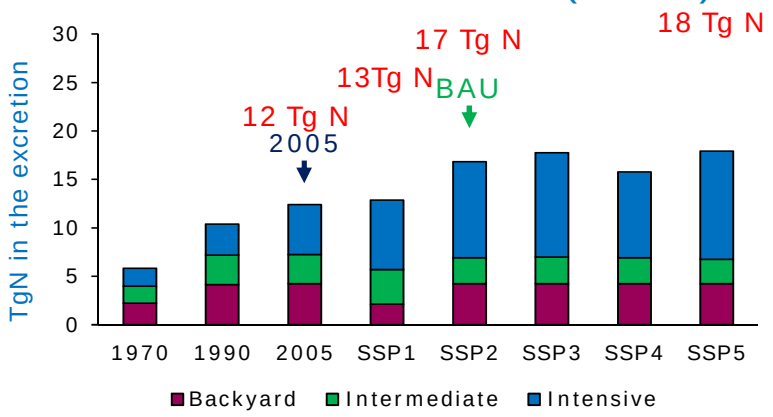
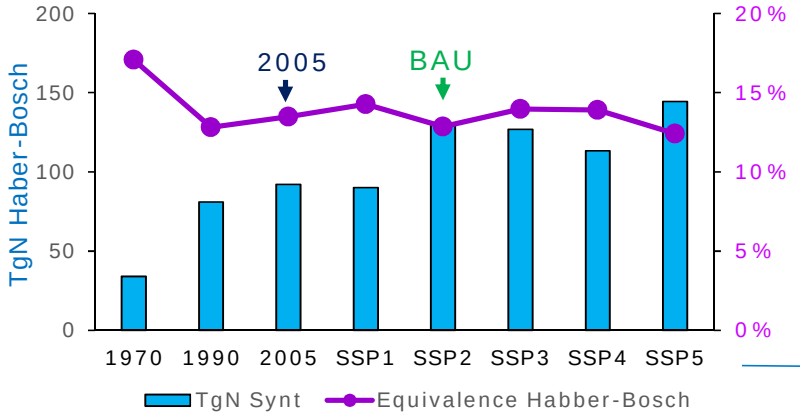
Nitrogen demand globally (Feed)



Total N excretion (Feed)

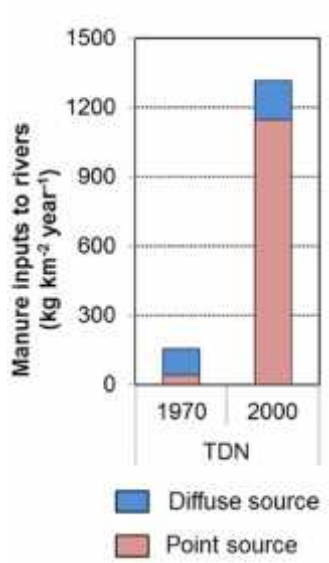


Equivalence Haber-Bosch



H-B estimation for SSPs in IMAGEby Mogollón et al (In prep.)

China manure wasted



Strokal et al. 2016 (Env. Res. Lett.)

Conclusions

- Global increase in efficiency (at the herd level) since 1970 in parallel to global increase in demand
- Even assuming efficiency improvements (that are arriving to biological limits), the amount of crops used as feed for pigs is expected to increase 40% in 2050 (SSP2), thus putting additional pressure on the global agro-food system
- The role of food residues recovered from the food industry can be very high for sustainable development
- Huge influence on global N cycle, huge amount of N in manure, huge challenge to return it to the crops avoiding a severe environmental problem

Thank you

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