University of BRISTOL

ROTHAMSTED RESEARCH

Global Challenges Symposium
13th April 2018

Steps to Sustainable Ruminant Livestock Production

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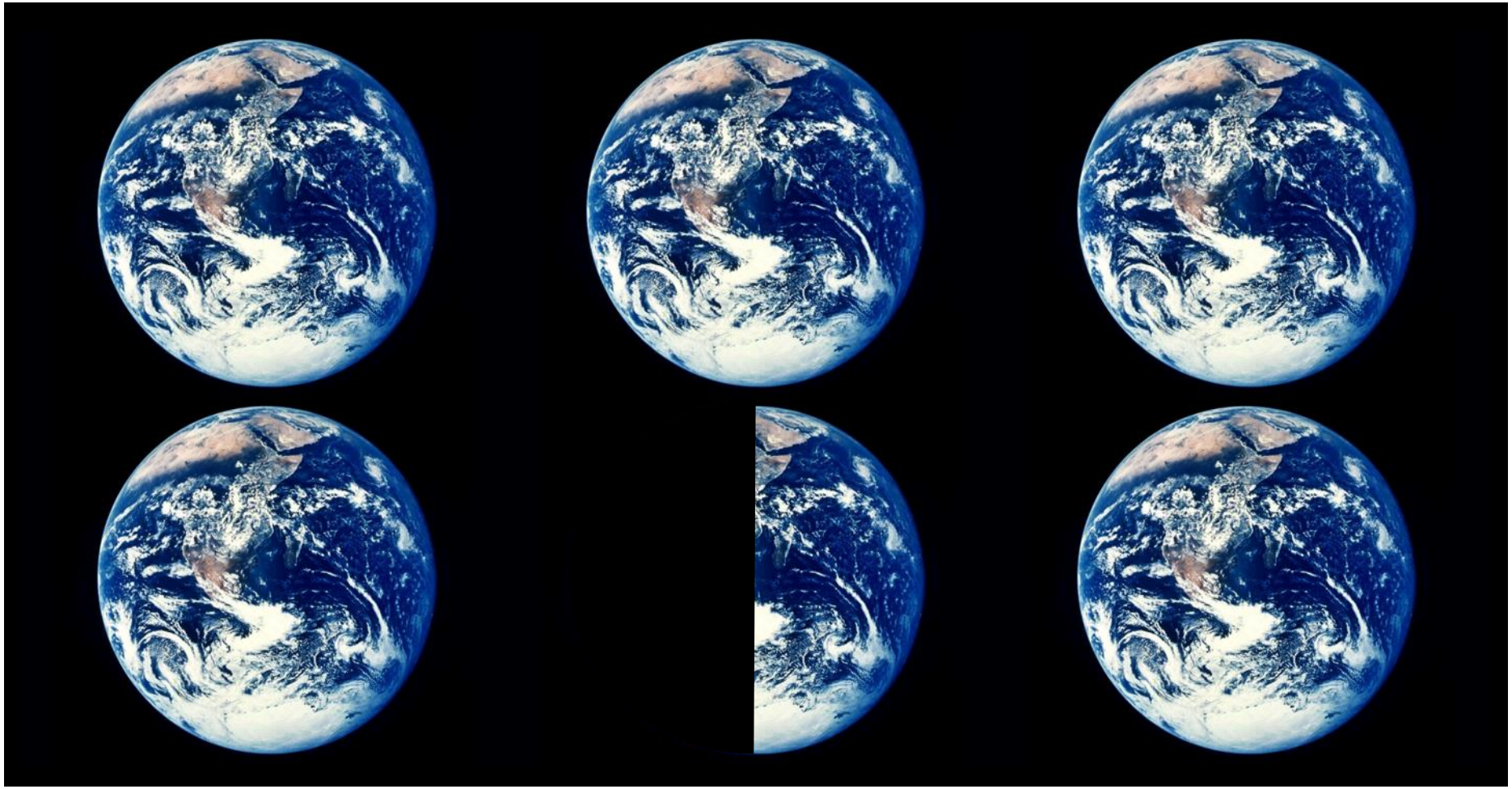
GLOBAL FARM PLATFORM
Towards Sustainable Ruminant Production

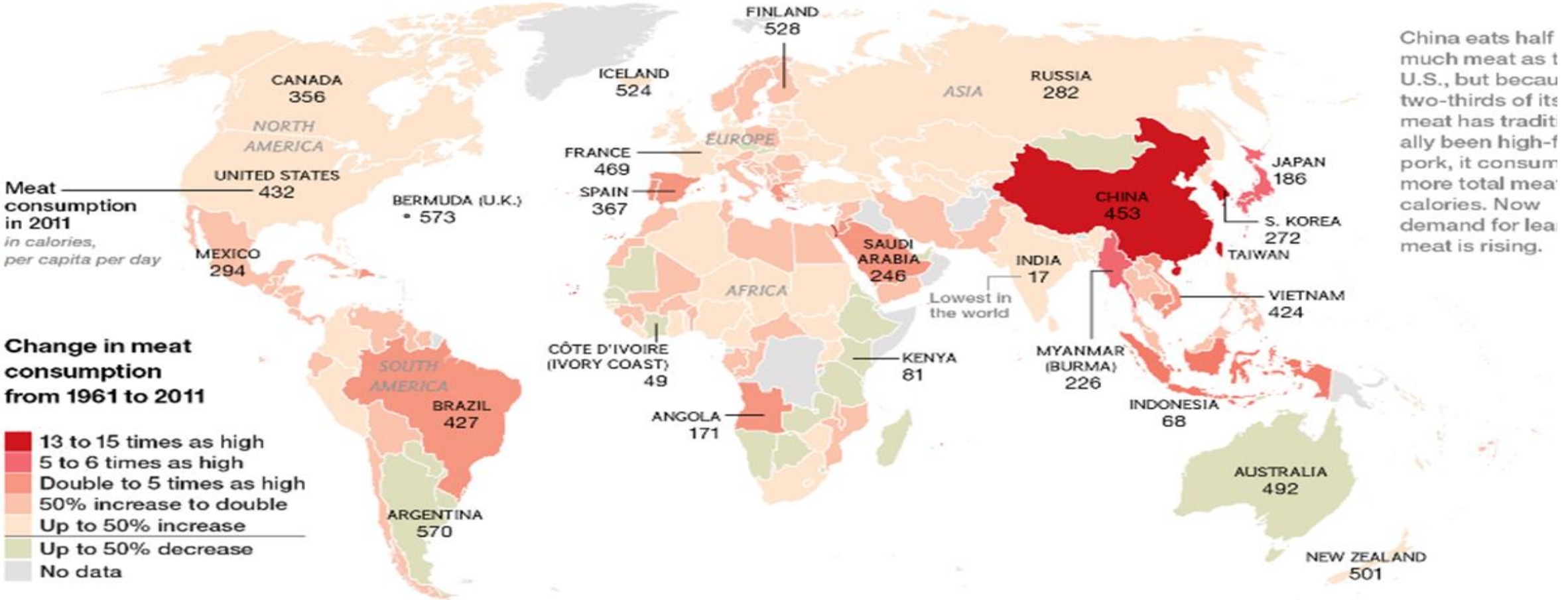
Global Challenges for Food Security

- Increasing population
- Increasing urbanisation
- Climate change
- Demand for animal protein

Extra Planets?



Increasing Demand for Meat



China eats half
much meat as t
U.S., but becau
two-thirds of its
meat has traditi
ally been high-f
pork, it consum
more total meat
calories. Now
demand for lea
meat is rising.

BBSRC bioscience for the future

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Role of Ruminants

- Global food demand predicted to increase up to 70% by 2050 (FAO, 2009)
- Requirement for increased efficient production from less land and resources

Food Conversion Ratios (input per unit of output)		
	Total energy (MJ/MJ edible energy in product)	Total protein (kg/kg edible protein in product)
Upland lamb	62.5	35.7
Lowland suckler beef	37.0	23.8
Cereal beef	13.2	8.3
Pig meat	9.3	4.3
Poultry meat	4.5	3.0

(Wilkinson, 2011)

- 26% of earth's ice free land mass is pasture (Steinfeld *et al.*, 2006)

➔ ruminant livestock offer a valuable contribution to food production

Six Steps to Sustainable Livestock

- 1. Competition with human edible feed
- **2. Poor animal health and welfare**
- **3. Genotype matching the environment**
- **4. Environmental Impact**
- **5. Quality and Waste**
- 6. Husbandry and Management

Steps to sustainable livestock

With improved breeding and cultivation, ruminant animals can yield food that is better for people and the planet, say **Mark C. Eisler**, **Michael R. F. Lee** and colleagues.

The need for efficient food production has never been greater. One in seven humans is undernourished[1]. Urbanization and biofuel production are reducing land availability, and climate change, lack of water and soil degradation are decreasing harvests. Over the past decade, cereal yields per hectare have fallen in one-quarter of countries. Meanwhile, developing nations and the growing world population are farming has thundered ahead with little regard for sustainability and overall efficiency (the net amount of food produced in terms of inputs such as land and water). With animal protein set to remain part of the food supply, we must pursue sustainable intensification and figure out how to keep livestock in ways that work best for individuals, communities and the planet.

Almost all of the world's milk and much of and humans, ruminants have a series of forestomachs leading to the true stomach. In the forestomachs, the largest of which is the rumen, microbes break down fibrous plant material into usable calories and also provide high-quality microbial protein. Ruminants can graze in marginal areas, such as mountainsides or low-lying wet grasslands. This helps to reserve agricultural fields for growing human food.

2. Poor animal health and welfare

Problem 1 Zoonoses: diseases shared by animals and humans

Low- and middle-income nations:

- 13 major livestock diseases infecting humans
- 2.2 million human deaths *per annum*

Solution

One Health: manage human and livestock disease together

Problem 2: Production loss

Disease kills young animals before they reach slaughter weight, reproduce, lactate…or delays these production goals

Result: higher environmental impact, reduced productivity, slow genetic gain

Solution

Management: hygiene, quarantine, preventive medicine, surveillance, reduced stocking densities

3. Environmental Footprint

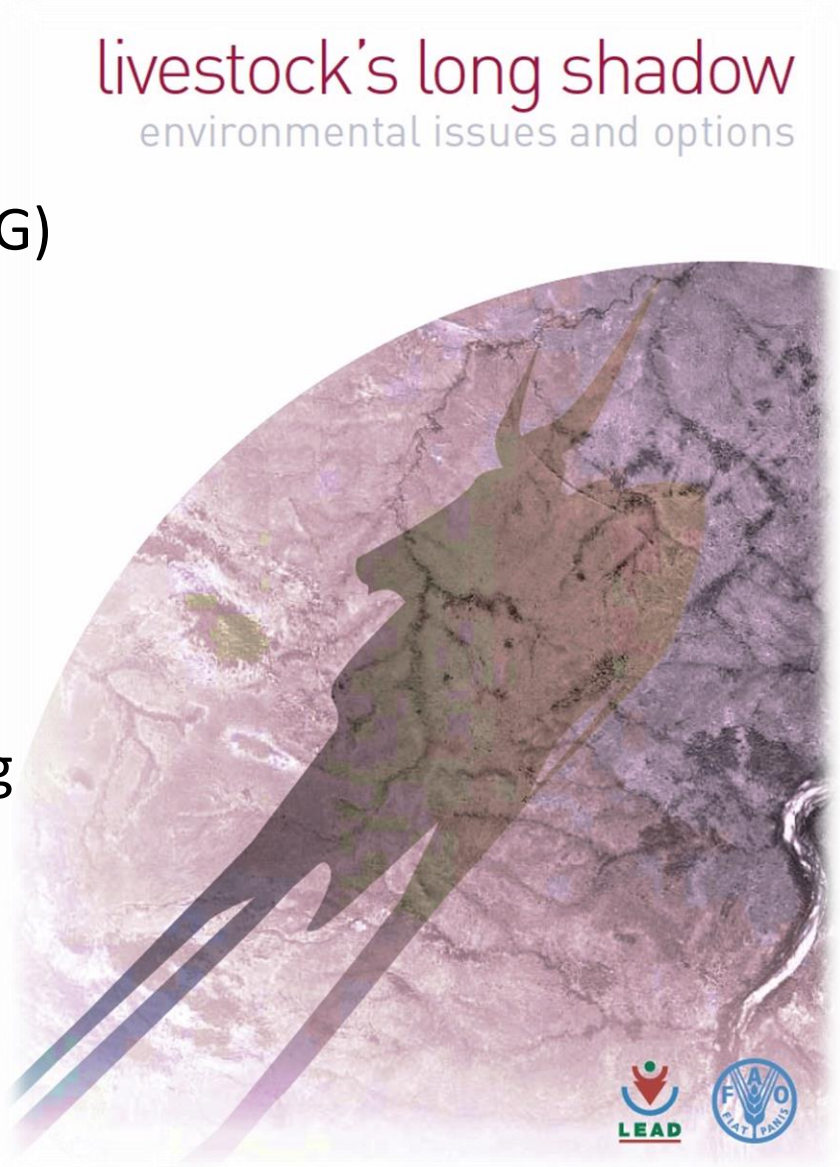
Problem Livestock considere

14.5% of human-induced em GHG)

Solutions: Life-Cycle Assessr s

Balanced, include positive co

- All products: hides, wool, t re)
- Biodiversity, ecosystem ser
- Carbon capture: manure v el)
- GHG from mechanized arab sing
- Nutritional strategies
- Integrated management (c



4. Species/genotypes not suited to the environment

Example: Holstein
30+ litres milk per day
Bred for intensive management
Bred for temperate climate

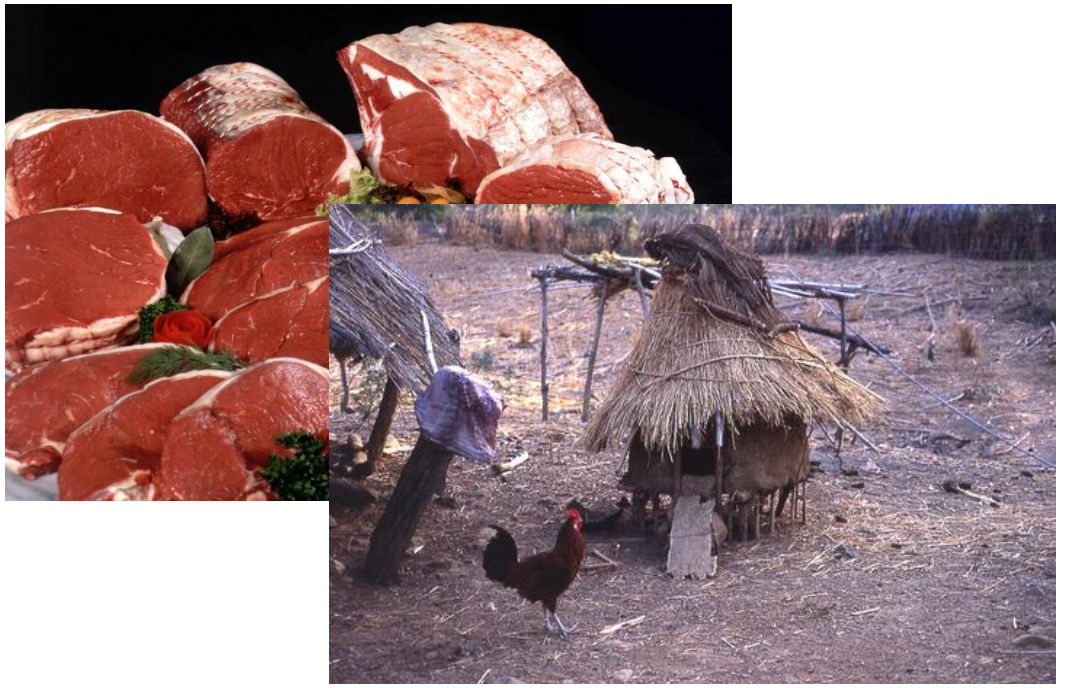
Imported into Africa, Asia, but …
Poor resistance to heat, humidity
Poor resistance to tropical diseases, parasites
Extra costs: Disease-free environment; extra drugs
Not pasture-fed: cut-and-carry fodder; buy expensive feed
Production 30% lower than expected
Expenses outweigh extra income

Solution
1) Native local breeds
   Resistant to climate
   Resistant to local diseases
2) Modern genomics:
   production, climate adaptation, disease resistance

5. Focus on healthy food plate and waste

- **Foods to improve the health of the nation**
  - Lipids (P:S; omega-3:omega-6)
  - Protein (amino acid balance)
  - Micro-nutrients (Minerals and vitamins)
  - Social science – what we eat
  - Malnutrition vs. Obesity

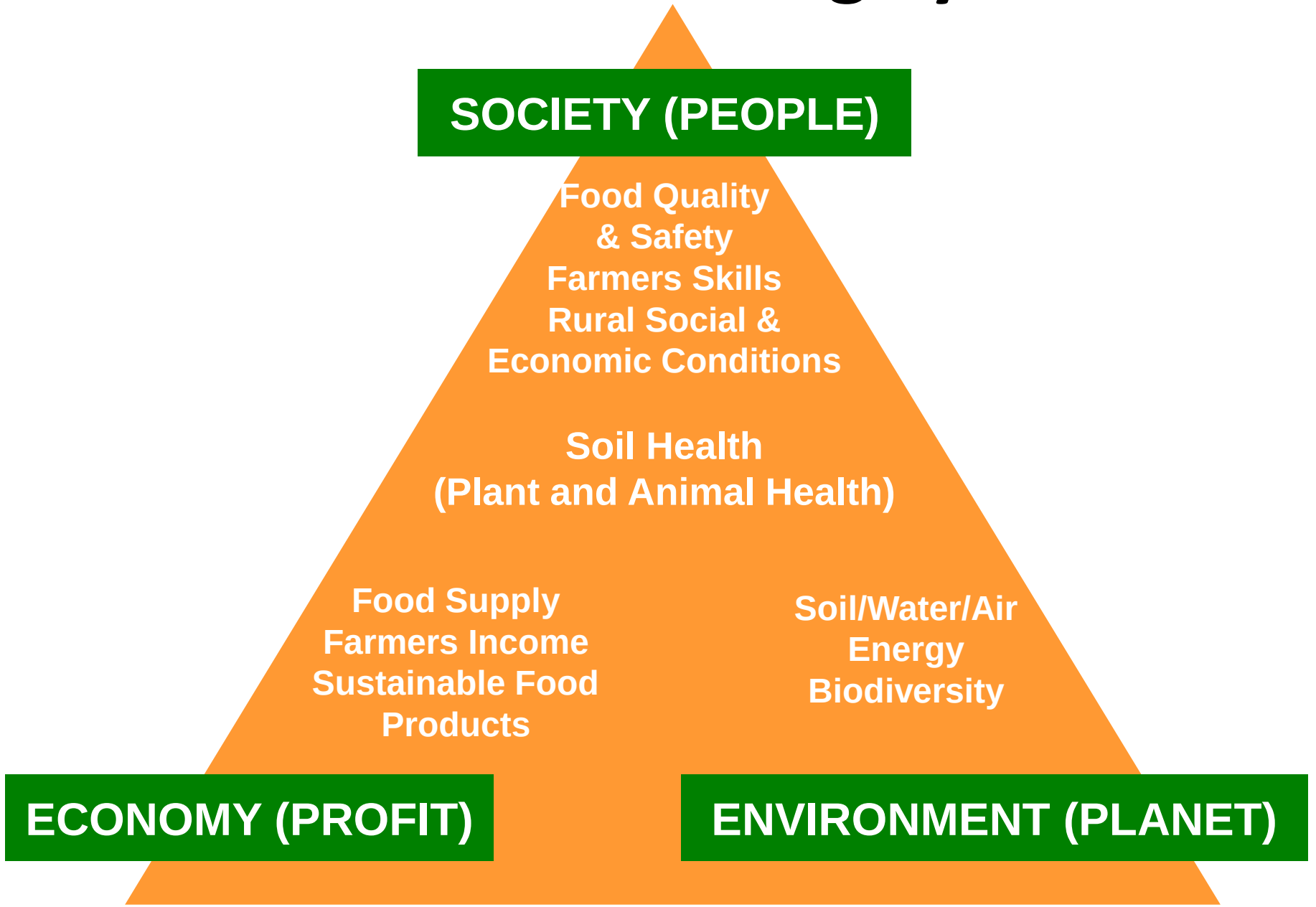
- **Solutions**
  - Eat less of a higher quality
  - Importance of high quality livestock products in the diets of the poor



Waste UK example

- 1.3 Billion tonnes wasted each year
- 1.3 Million tonnes in the UK
- Food is no longer valued
- Milk – Cheaper than bottled water in the UK!

Sustainable Farming Systems



Trade – offs (e.g. Beef)

Criteria	Measure	Units
Animal performance	Daily weight gain	Kg weight gain/day
Carrying capacity	Animals per hectare	Kg weight/ha
Nutritional quality	Nutrients per hectare (e.g. calories, protein, minerals)	Kg nutrient/ha
Nutrient and soil loss to water	Losses per hectare per day	Kg/ha/day
Greenhouse gas emissions Sulphonation Eutrophication	CO_2 (or equivalent) per unit of animal product (S and P equivalents)	Kg CO_2eq/kg product (S and P equivalents)
Animal health	Costs of preventive veterinary care and treatment of diseases	Veterinary costs (£)
Animal Welfare	Negative and Positive assessment	Disease/EU Behaviour /time
Biodiversity	Range of wildlife and plant species	Species/ha
Inputs (fertiliser, machinery, labour)	Purchase cost	£
Outputs (beef cattle)	Sales value	£

Contrasting Livestock Production Systems

- Nomadic herding e.g. Africa
- Intensive production e.g. USA/UK
- Grass-fed production e.g. Uruguay/UK
- Cut and carry systems e.g. India

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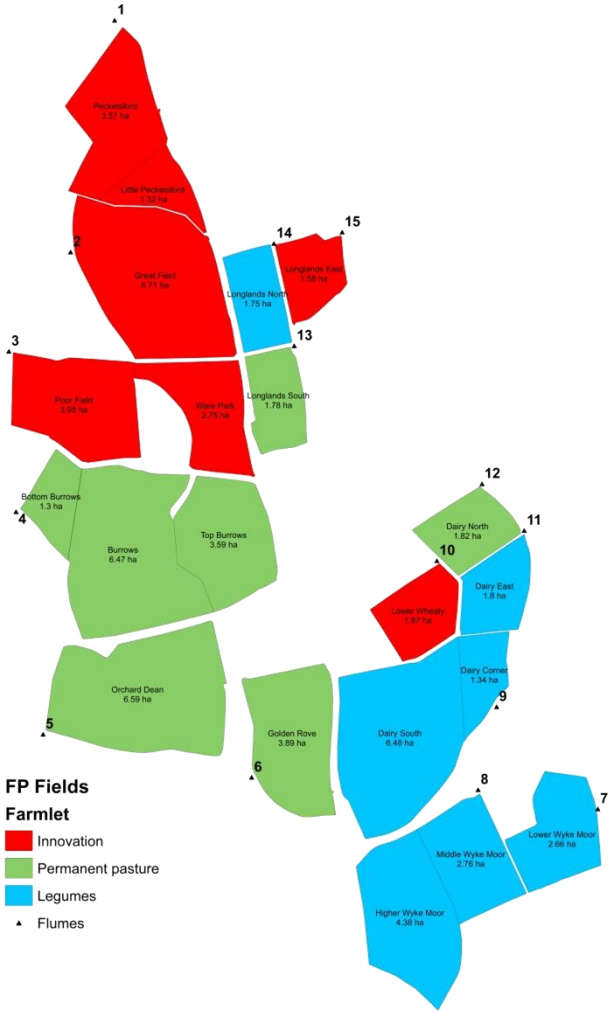
Strengthening global research through multilateral partnerships

GLOBAL FARM PLATFORM

Towards Sustainable Ruminant Production

North Wyke Farm Platform

- A globally unique facility covering 68ha addressing the issues of sustainable intensification
- Collects key data at the field-scale to enable farm relevant research



Sustainable metrics development – Base line data

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Platform design until July 2013

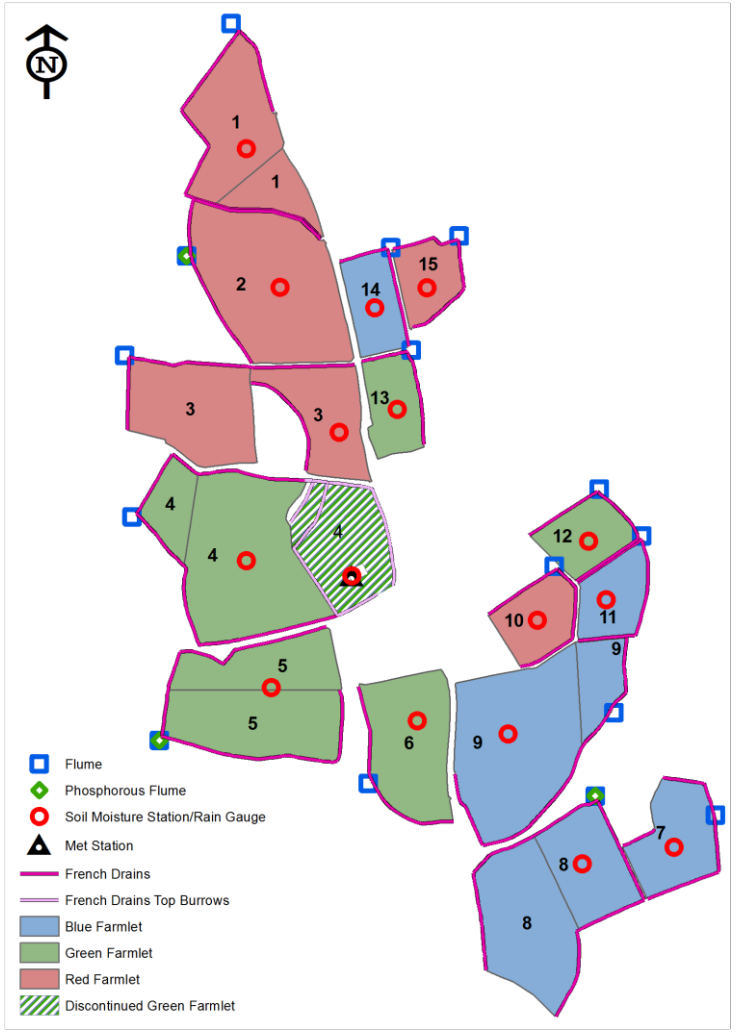
GREEN Permanent pasture

BLUE Permanent pasture

RED Permanent pasture

Catchment-by-catchment data on

- soil properties (survey)
- biodiversity (survey)
- emissions and leaching (modelling)
- animal performance



Takahashi *et al*. (submitted)

Environmental/ecological indicators

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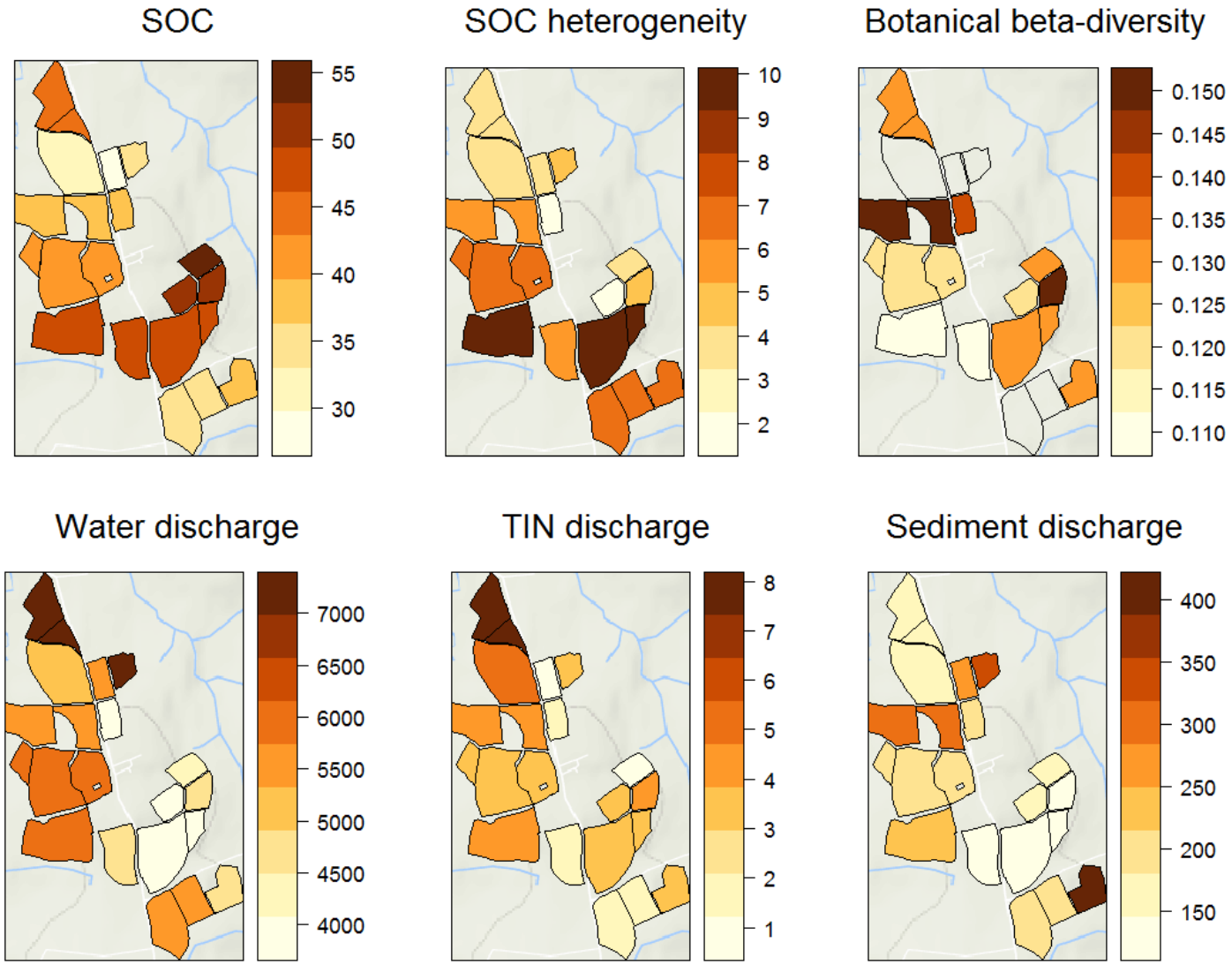

All values are per hectare. Based on pre-2013 data from 15 catchments.

Management variables

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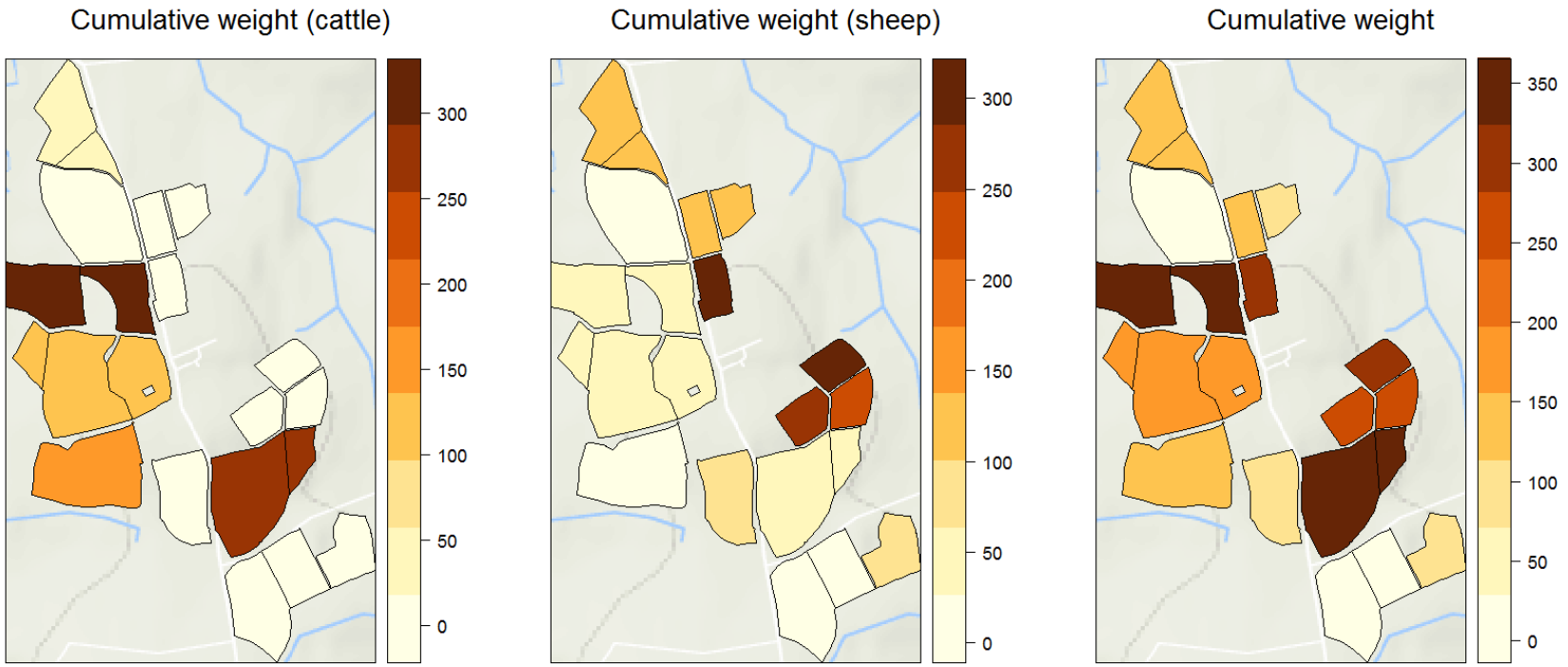

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Animal performance variables

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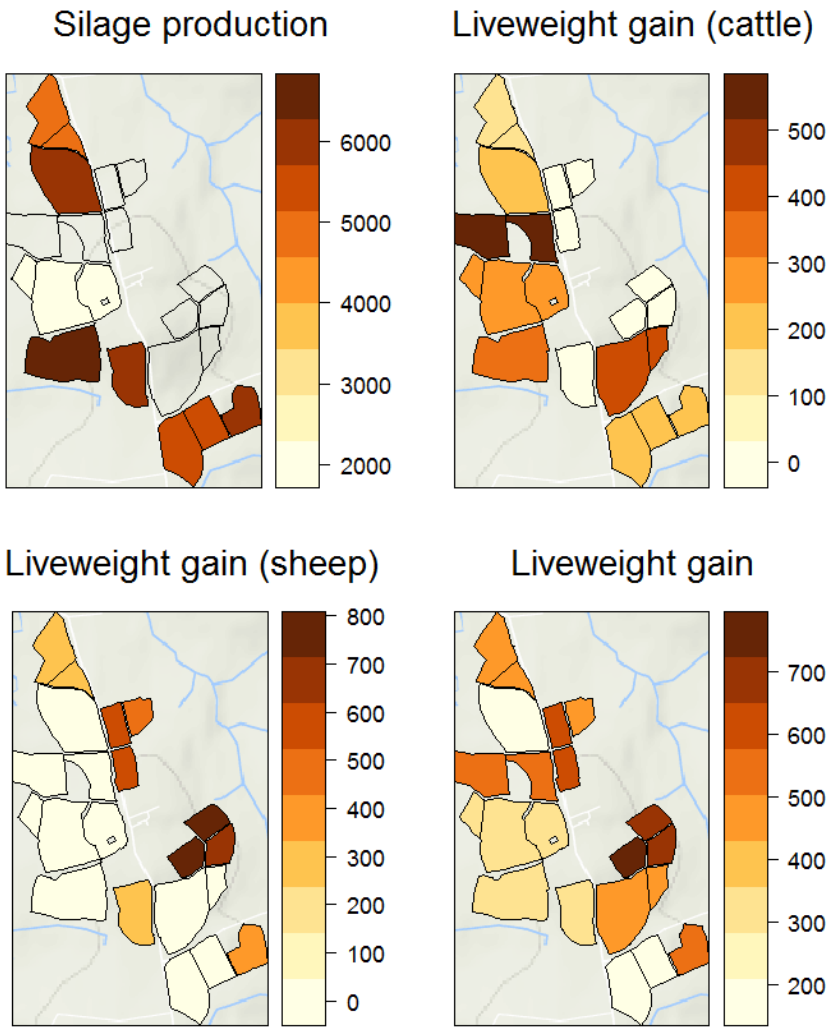

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Correlations between soils, environment and production

	SOC	HET	BOT	WAT	STO	LIV
SOC (t/ha)	1					
SOC heterogeneity	0.131	1				
Botanical β-diversity	0.306	0.342	1			
Water discharge (L/ha)	– 0.383	0.097	– 0.111	1		
Stocking rate (kg day/ha)	0.476	– 0.048	0.603	– 0.427	1	
Liveweight gain (kg/ha)	0.376	– 0.469	0.558	– 0.387	0.697	1

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Possible causal relationship:

SOC → pasture productivity → animal productivity → SOC → …
with additional long-term benefits on ENU (through less discharge) and biodiversity

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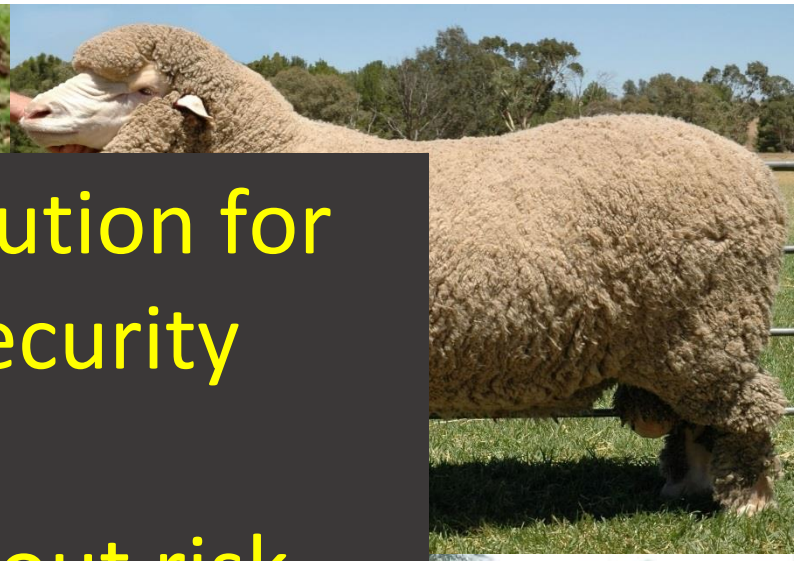
Livestock of course are more than food



Livestock are part of the solution for sustainable global food security

But they do not come without risk

and there is still lots to do……