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Resilient farming systems: global challenges & potential contributions from agricultural science

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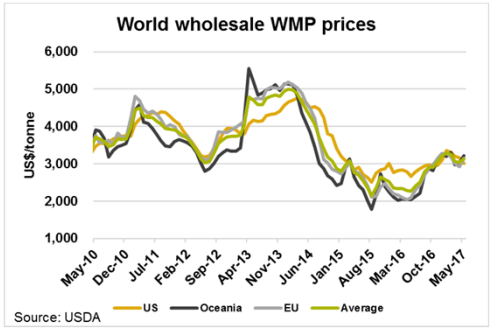
Resilience

- *Concept: mechanics – ecology – psychology*

- *OED: The capacity to recover quickly from difficulties; toughness*
- Moran: *Systems that can withstand shocks using various forms of available capitals, are resource use efficient and so minimise external costs*

Challenges / shocks

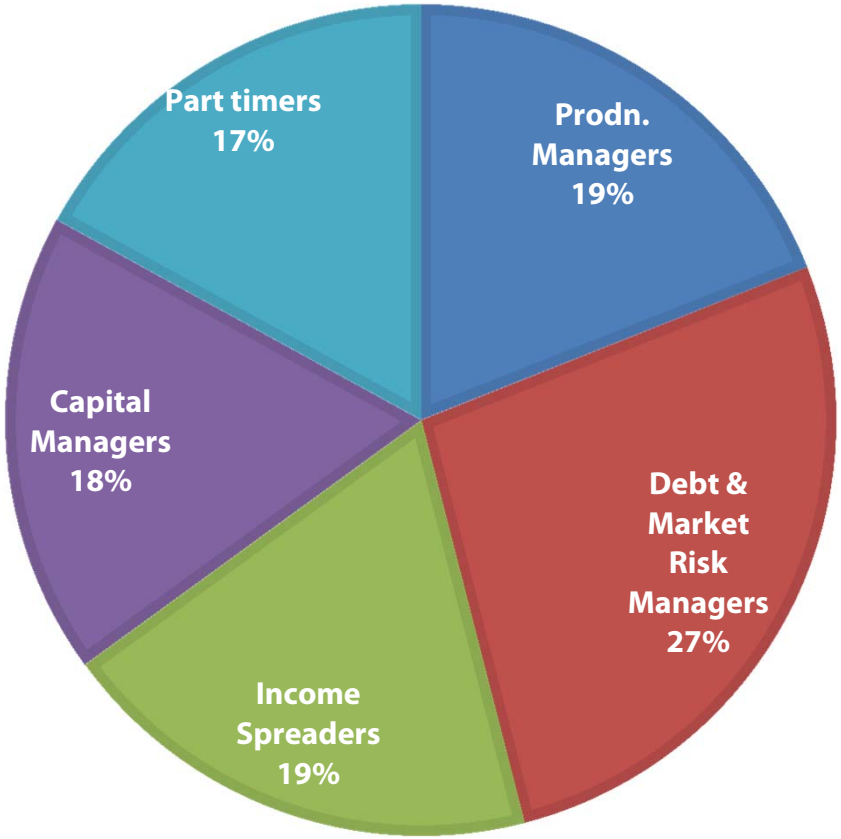
- Economic
  - local & global cycles in demand & supply
  - price/cost volatility
  - value chain relationships/power
- Political
  - changes in policy framework
- **Environmental**
- **Societal**



Sources: AHDB; Bankenverband;
https://www.flickr.com/photos/africaprogresspanel/15626635860/

NZ beef & sheep farmers response to policy & economic challenges

Risk reduction



Martin & McLeay, 1998

Resilience

- Lower inputs
- Increasing farm size
- Adopting technology
- Off farm income
- …

Paronson-Ensor & Saunders, 2011

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Disease prevention - risk reduction

Bovine Viral Diaorrhea, Scotland (Stott et al, 2003)

- Disease prevention measures can increase whole farm income & reduce variability (risk)

Zoonotic disease (TB, brucellosis), Malawi (Tebug et al, 2014)

- General awareness among farmers high, but risk behaviours practised

https://www.flickr.com/photos/ilri/5859564963/in/album-72157622888681191/

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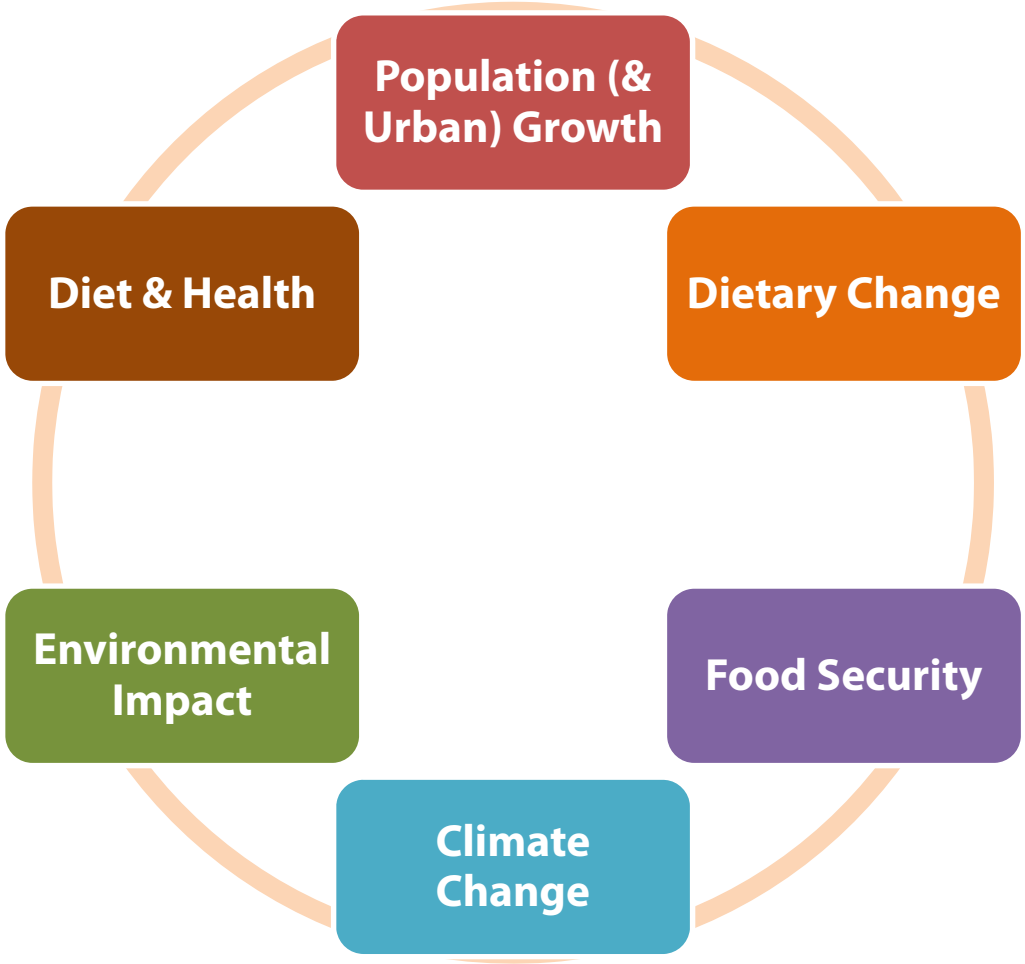
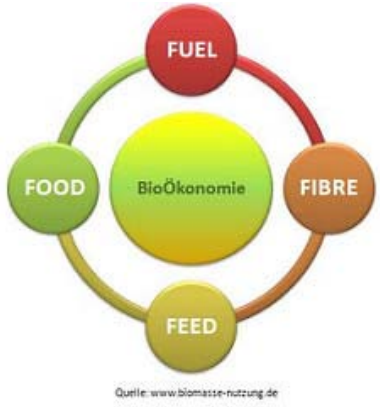
Global Challenges



Guiding frameworks/concepts

For example:

- Sustainable Development Goals
- Ecosystem Services
- Sustainability
- Farming Systems in Circular Bioeconomy
- …



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http://i0.wp.com/www.un.org/sustainabledevelopment/wp-content/uploads/2015/12/english_SDG_17goals_poster_all_languages_with_UN_emblem_1.png?resize=728%2C451; https://www.flickr.com/photos/greenron/5339540724/

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Potential solutions

Production

- Sustainable intensification (more production, less environmental impact)
- Food vs feed
- Long term, value chain-wide innovation
- Commercialization ('Global S')

Consumption

- Less ('Global N'), healthier, diverse, novel
- Waste less

Technological…

EU Waste Framework Directive (EC, 2008); *zu Ermgassen et al, 2016;* © IWM (Art.IWM PST 14743)

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Food, Land Use, GHG nexus

- ↑ no. modelling studies
  - livestock role in GHG, health
- Min land use ~12% animal protein in diet (grassland, co-products) *(Schader et al, 2015; Van Kernebeek et al., 2016)*
- Meeting WHO nutritional recommendations in UK[3]
  - Less dramatic dietary change
    - ↓ red meat, dairy products, eggs …, ↑ cereals, fruit and vegetables
  - 17% reduction in GHG; save ~7m life years lost *(Milner et al, 2015)*
- Modelling studies can miss complexity/nonlinearity
  - E.g. ↓beef in Brazilian *Cerrado* (decoupled from deforestation) could ↑GHG (de Oliveira Silva et al, 2015)

K State Research & Extension; https://www.flickr.com/photos/nancydregan/5023325968/
Kate Evans / Center for International Forestry Research

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Impact of science in livestock sector…

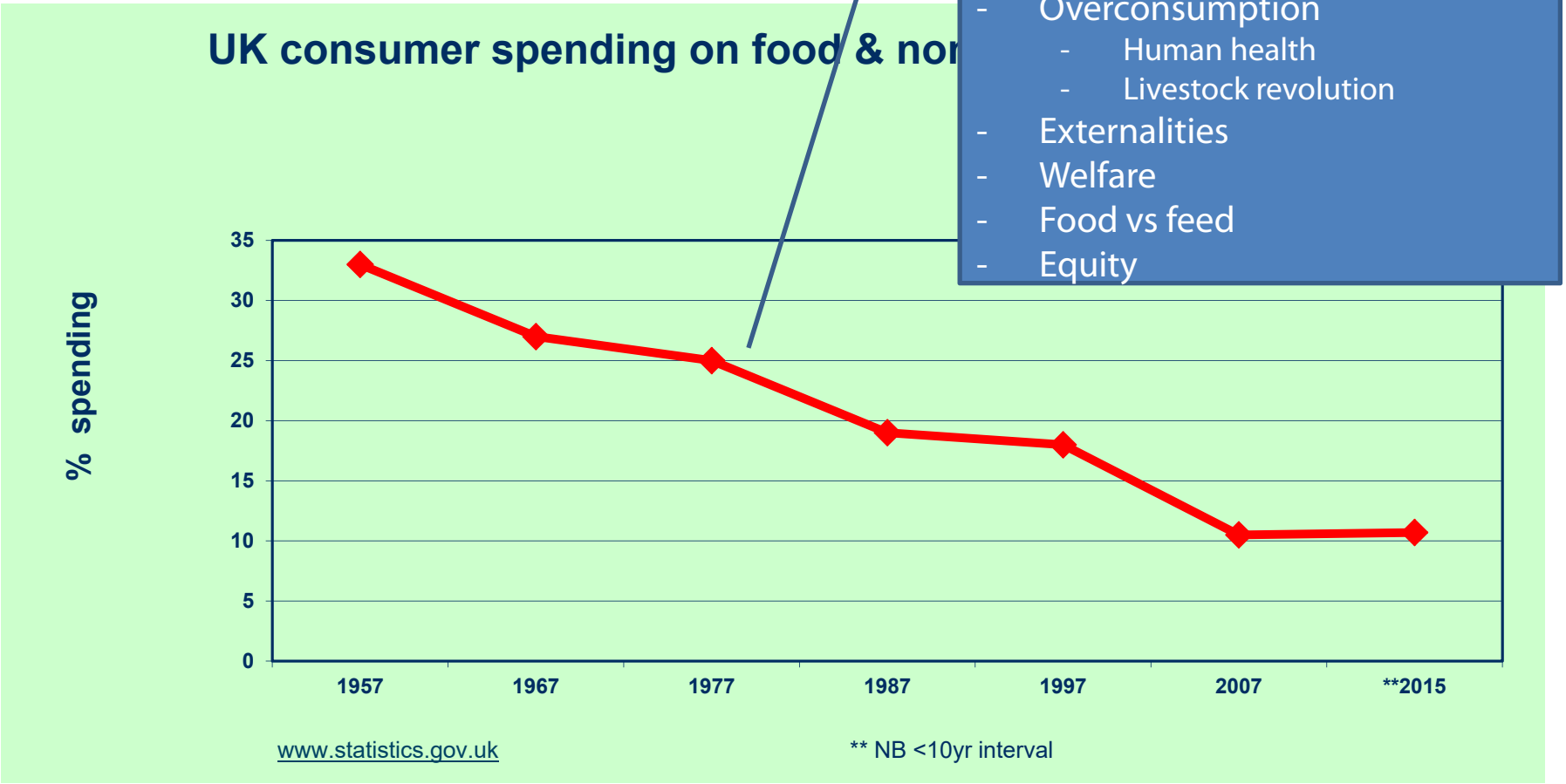
ACRBC 1957 Males – 2001 Feed

Ross 2001 Males – 2001 Feed

Day 43 **Day 57** **Day 71** **Day 85**

Havenstein, et al 2003

Food is relatively more affordable:



Success story?

- Overconsumption
  - Human health
  - Livestock revolution
- Externalities
- Welfare
- Food vs feed
- Equity

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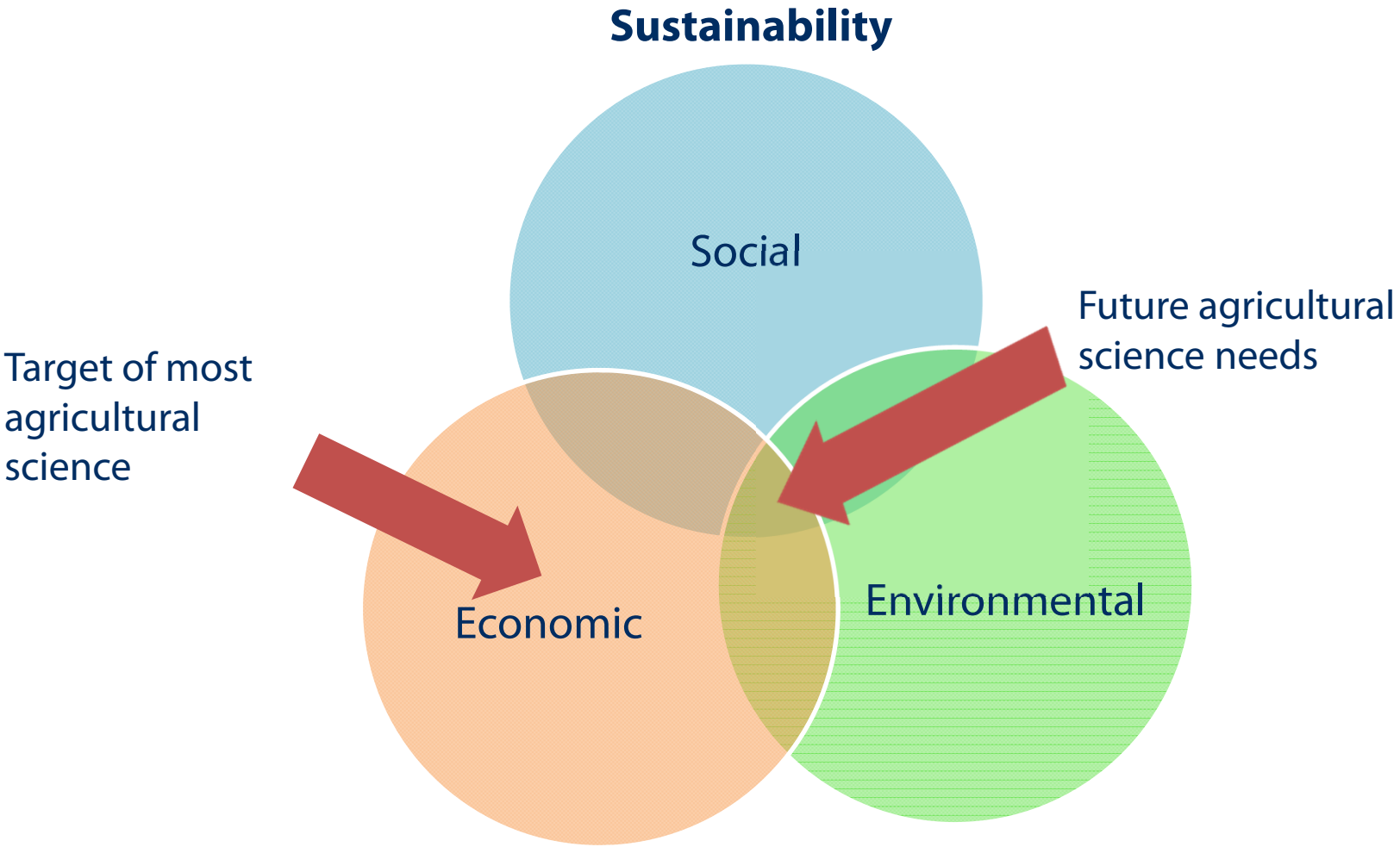
Guiding frameworks/concepts



Research priorities

Targets

- Innovative, dynamic, resilient, systems, with lower losses / externalities → long term, equitable societal benefit
- Healthy, quality products
- New feed sources
  - algae, insects, 'designer crops' …
- 'New' farmed species
  - aquaculture, (insects, cultured meat)…
- Efficient, robust, healthy crops & animals
- Positive welfare
- Better matching of genetic & system resources

Technologies

- Molecular biology / genetics / genomics / gene editing
- Informatics / data science
- Remote sensing
- Precision farming

Scottish Aquaculture Innovation Centre

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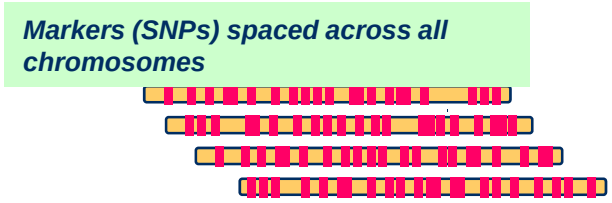
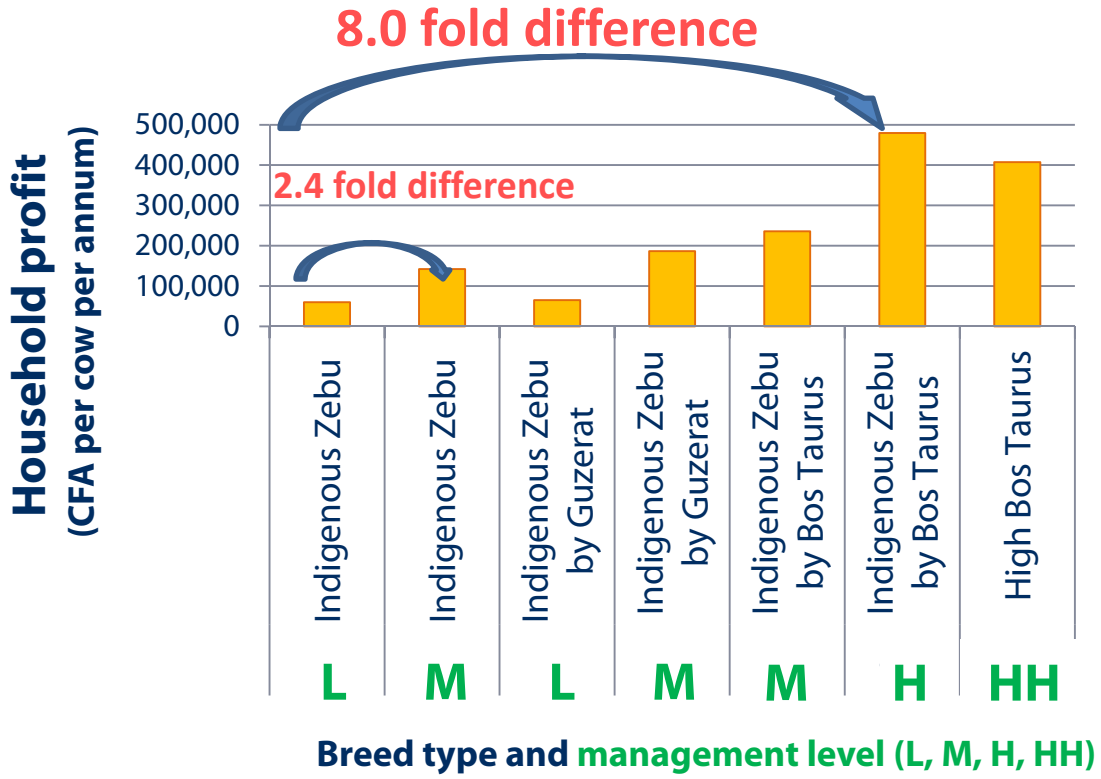
New breeding technologies

- GM widely used in crops globally (outside EU) – soybean, cotton, maize, rice, canola
- GM not widely used in animals
- New technology of 'gene editing'
- Genomic selection major impact & livestock & potential in some crops
- Opportunity to address:
  - micronutrient deficiencies: iron, Vitamin A, iodine, zinc
  - climate smart traits - heat, drought, flooding tolerance
  - disease & robustness/resilience



Better matching of genetics & systems

Household income from keeping different breeds in W Africa



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Marshall, ILRI

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Resilience capabilities

After Darnhofer, 2014

Contribution of new technologies?

Waste reduction / re-use
Resource use efficiency
Sustainable intensification
Drought /disease /nutritional challenge tolerance
Optimising genetic resource use
Precision farming
Data science / informatics
New breeding technologies

Translation of science to practice

Less…

https://www.flickr.com/photos/woodhead/6825087338/

More…

https://www.flickr.com/photos/andreas_klodt/27151819871/

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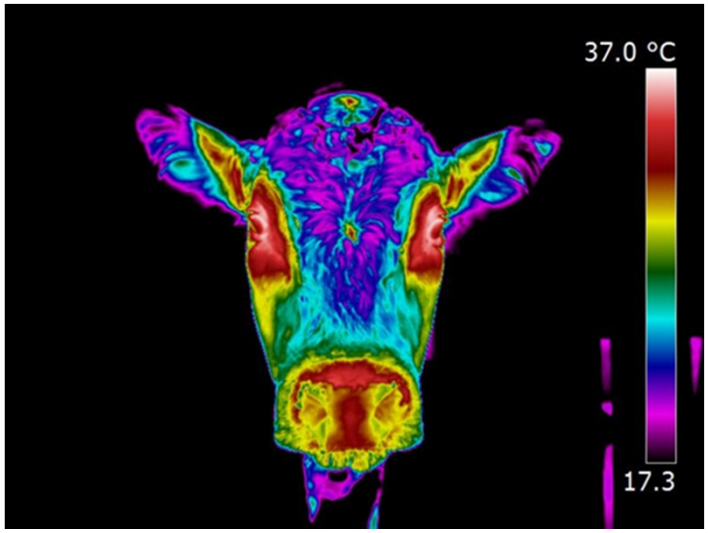
Conclusions

- Economic, political, environmental, societal shocks well documented
- Frontiers
  - Food vs livestock feed (competition, bioeconomy)
  - Agri-food systems to improve diet & health (N & S)
- Technical opportunities to
  ↑ resource use efficiency,
  ↓ waste, GHG emission intensity
- Better evaluation of contribution to resilience

- More info including new courses: http://www.ed.ac.uk/global-agriculture-food-security
- Thanks for listening



Mitchell / Farrish

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