Valuation of livestock eco-agri-food systems: poultry, beef and dairy

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Acknowledgement

- Study has been executed in cooperation between:

- Trucost
- True Price
- Wageningen Livestock Research
- Wageningen Economic Research
- Wageningen Environmental Research

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Background and goal of study

Background

- **Livestock production uses natural capital** and **generates positive and negative externalities** for humans, ecosystems and biodiversity.
- **TEEB developed a scheme to gain insight** into these relationships.

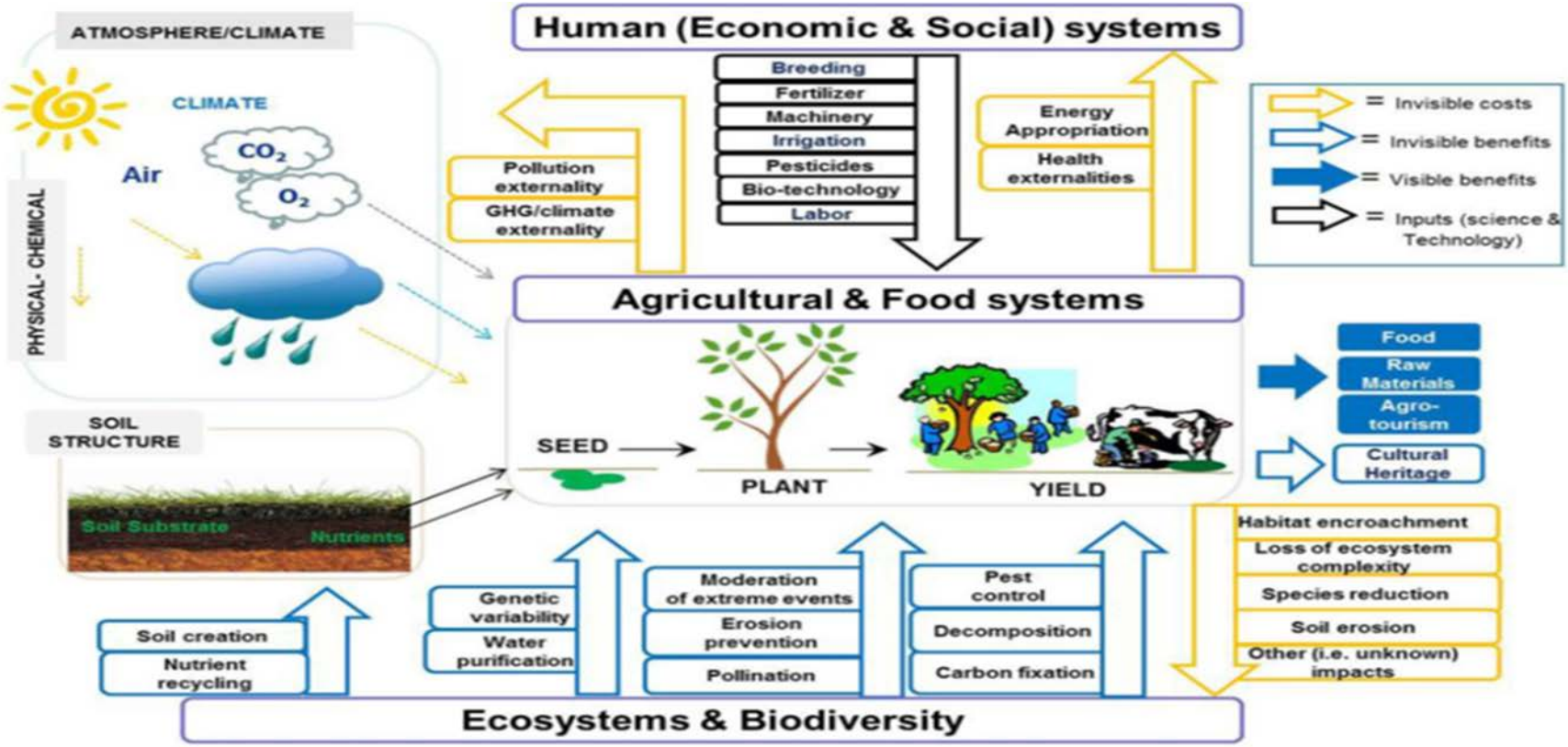
Goal

- The goal is **to give insight into the use of natural capital inputs** and **to assess the negative and positive externalities of livestock production systems**, on a global level and for several specific production systems in specific countries.
  Recommendations on how to ensure food security through sustainable livestock practices are also provided.

Research questions:

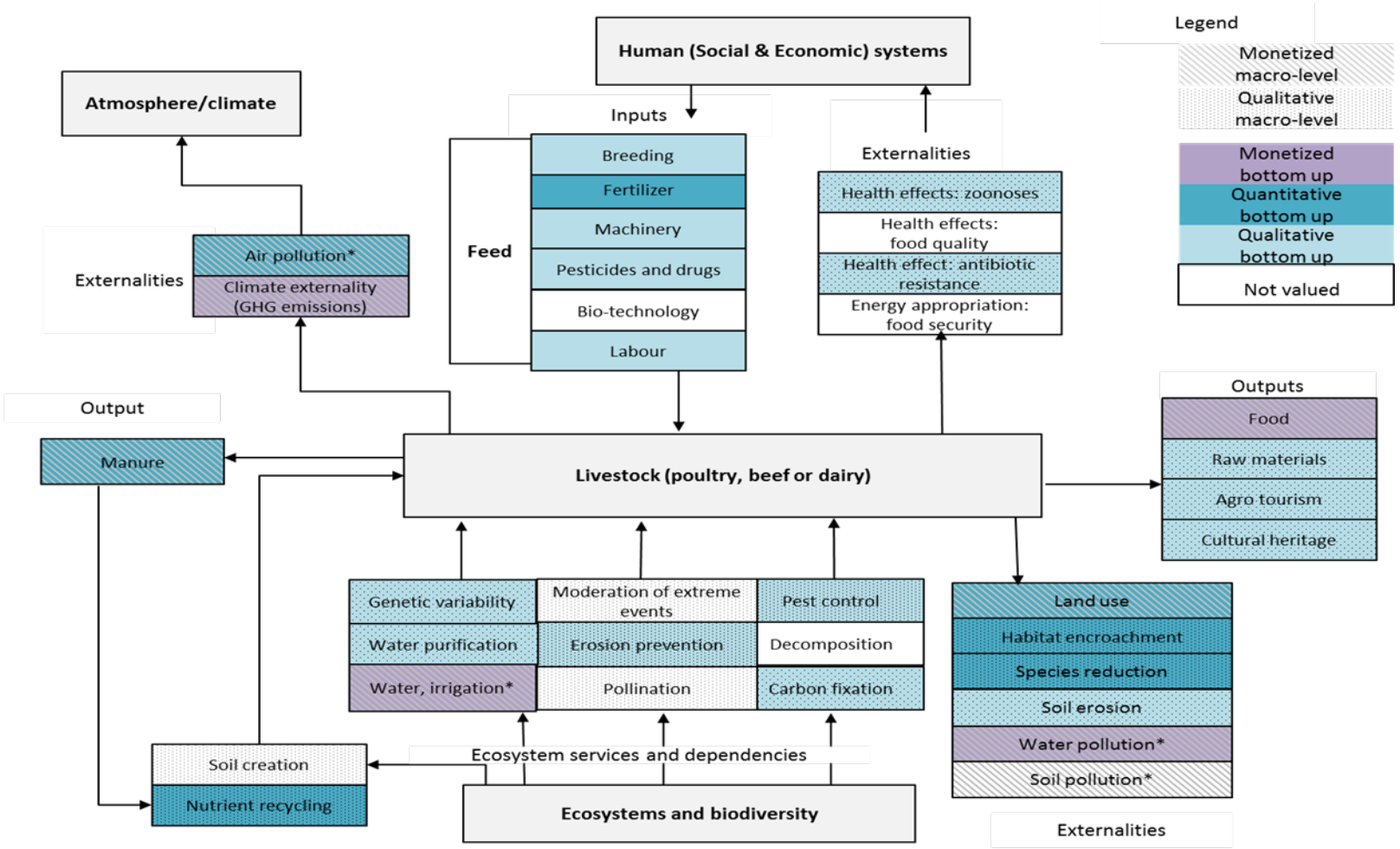
- To assess **the visible and invisible values of biodiversity and ecosystems to the various types of agriculture systems** (inputs) and evaluate the scale, range and degree of both positive and negative impacts of livestock production systems on ecosystems, health and livelihoods (outputs)
- To assess **the role of smallholder farming** and **large-scale systems**
- A **differentiated approach by major segments of society** such as rural and urban population, developed and developing countries, as well as gender;
- **Study sites should include Tanzania** for the pastoralist system evaluation.

Methods and data: TEEB Framework: overview of eco-agri-food system



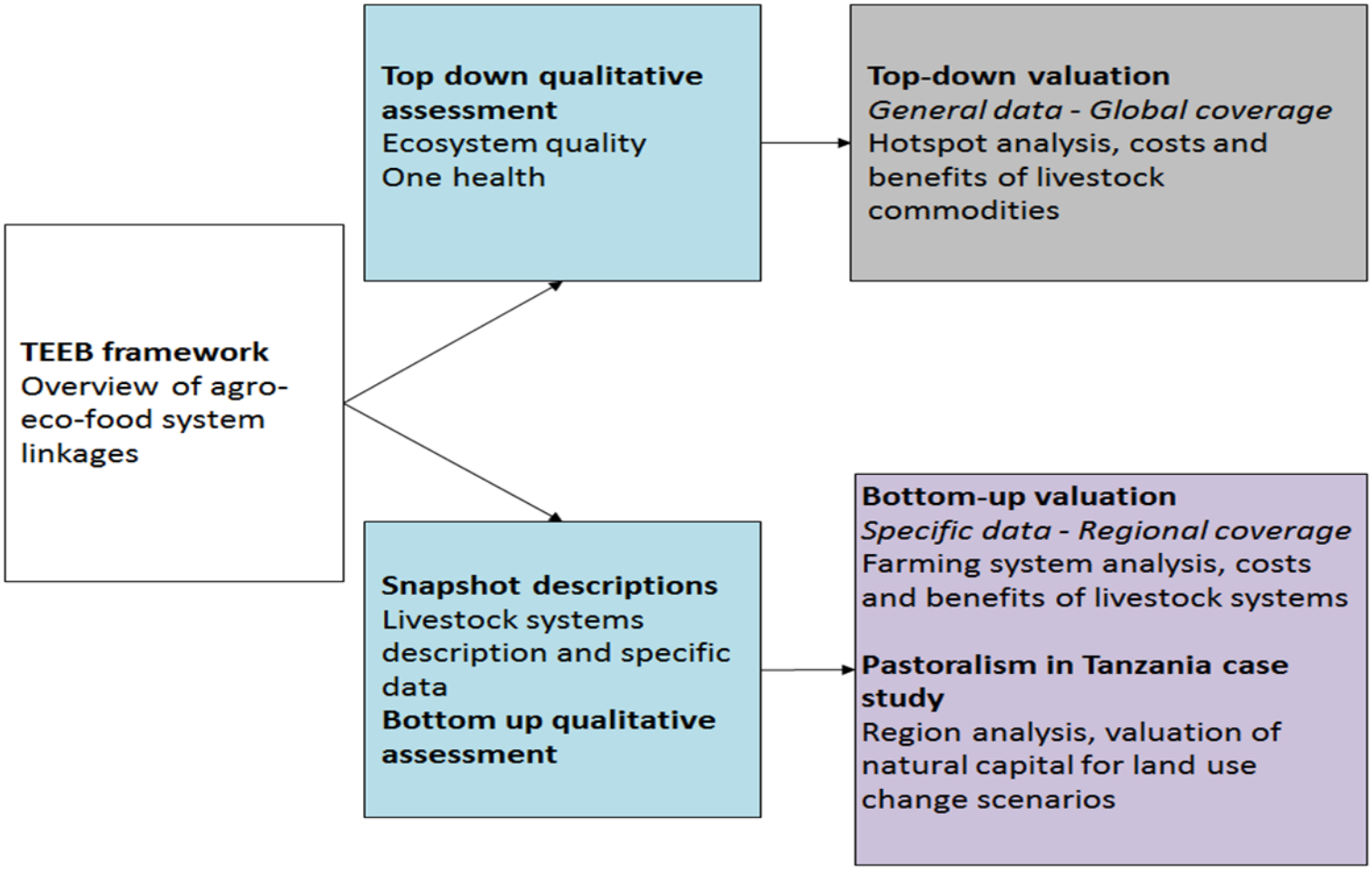
http://img.teebweb.org/wp-content/uploads/2013/08/TEEBAgFood_BrochureFinal.pdf

Scope of the assessment



* Negative externalities valuation includes monetization of Health effects in the top down assessment

Overview of methodologies used



Top-down approach

- **Qualitatively reviews the benefits** provided by livestock through a **literature review**. It **also values a selection of benefits derived from livestock**: food and manure provisioning.

- For all poultry, beef and milk producing countries (over 190 countries), it **values the natural capital costs from**:

    1. GHG emissions
    2. Air pollutants
    3. Water consumption
    4. Water pollutants
    5. Soil pollutants
    6. Land use change

- Through a **literature review**, it qualitatively assesses:

    - the interaction of livestock systems and biodiversity
    - the interaction between animal health and human health

Top-down valuation

- **System boundaries for most aspects**: Livestock farming and production of inputs (upstream supply chain).
- **Quantification**: Trucost's Environmentally Extended Input-Output model
- **Valuation**: integrated biophysical and economic model, which follows the methodology proposed by Keeler et al. (2012). Value transfer is used (Brander et al., 2013).
- **The quantification and valuation of farming operations is country specific when possible**; otherwise is global. **The quantification and valuation of the upstream supply chain uses global average factors**.
- **Valuation coefficients are used for each natural capital impact**. For example, EPA Social Cost of Carbon (128 $ per tonne) is used to value the impact from GHG emissions.

Limitations of top-down valuation

- **Aggregation of data**: In some cases, components of valuations which represent impacts on different receptors (i.e. humans) are aggregated and use different valuation techniques.
- **Exclusions**: Positive externalities are only briefly and mainly qualitatively assessed. In the case of negative externalities, soil and water pollution due to farming operations are not included.
- **Static**: Valuations are adjusted using inflation rates applied at a specific point in time.
- **Value transfer is used and implies a degree of uncertainty** compared to primary valuation techniques.
- **The top-down approach does not capture intra-national differences in impacts or differences between specific livestock production systems**. These results are strengthened by the bottom-up analysis and the use of primary data.

Bottom-up approach

- **Snapshot description** of **ten livestock production systems** in **five countries** on all issues.
- **System boundaries**: livestock farming and production of feed.
- **Valuation per snapshot** of :
  - GHG emissions
  - Water pollutions
  - Blue water dependency
- **Quantification** of land occupation
- **Land-use impacts** on biodiversity
- **In-depth case study of Pastoralism** in the Maasai Steppe in Tanzania
- **Main data sources**: FAOSTAT and GLEAM (Opio et al., 2013; McLeod et al., 2013).

Snapshots selected

Species	Extensive <----------> Intensive		
Poultry	1. Tanzania (backyard)	2. Indonesia commercial family farm	3. Netherlands industrial broilers
Grassland based beef	4. Tanzania (pastoralist)	5. India (pastoralist)	6. Brazil (grassland based with 3 months in feedlots for fattening)
Dairy, mixed systems	7. Tanzania	8. India	9. Netherlands 10.Indonesia

Limitations of bottom-up approach

- **Scope is partial**: other aspects can be important as well, for example human health risk, soil degradation.
- **Focus is on one type of benefit**: food provision
- **Comparability is limited**: livestock systems need to be assessed given their context
- **System boundaries differ per natural capital cost in the valuation approach**: for example
    - feed production is excluded for water pollution
    - GHG emission also include post farm transport and processing.

In-depth case study of pastoralism in the Maasai Steppe in Tanzania

- **Value of pastoralism** for landscape conservation
- **Proposes new framework for quantifying internal value** of natural capital assets in a region with a **dynamic model**
- **Comparison of land conversion scenarios and impacts** on natural capital value
- **Quantification** of livestock, crops, tourism, wood, wild foods, and other **final ecosystem services**
- **Valuation of carbon stocks changes**: impact for global community
- **Key limitation**: data-intensive approach, limit to the amount of scenarios that could be investigated

Key findings of top-down approach (1)

- **Natural capital costs**

Indicator	Beef	Milk	Poultry meat
Total natural capital costs (trillion US$)	1.5	0.5	0.3
Contribution of farming operations (%)	78%	65%	29%
Cost share for the top 5 countries Cost share for the EU-28 (not in top 5)	50% 8%	39% 19%	43% 10%

- **Natural capital intensities** (in $ per kg of protein)
  - **Average for all producing countries**: **Beef>milk>poultry meat**. The main reason is high impact of the GHG emissions and land-use change for beef production compared to milk and poultry production.
  - **EU countries have a lower natural capital intensity than the global average** due to higher efficiencies for livestock production.

Key findings of top-down approach (2)

Natural capital aspect	Beef	Milk	Poultry
GHG emissions	21%	22%	40%
Land use	72%	62%	38%
Air pollutants	6%	14%	19%
water consumption, water pollutants and soil pollutants	< 1%	< 2%	< 4%

Key findings of top-down approach (3)

- **Benefits**: diverse cultural (i.e. tourism), regulating (i.e. soil carbon sequestration), supporting (i.e. connexion of habitats) and provisioning services (i.e. provision of food, which is a key benefit).
- **Biodiversity impact**: Livestock production impacts biodiversity in different ways. Depending on local conditions impact differ in type and magnitude.
- **Animal and human health**: huge direct and indirect impact; positive and negative externalities are possible. Elements are food, zoonoses, use of antibiotics. Diseases from poultry have other impact on human health than diseases from cattle.

Main characteristics of poultry snapshots

Characteristic	Backyard chicken Tanzania	Medium commercial Indonesia	Large scale Netherlands
Flock size (heads)	100	5,000	90,000
Output meat (kg LW)	70	40,375	1,210,000
Productivity (kg LW /head)	0.7	8	13
CO_2 eq. per kg carcass	4.75	5.20	5.20

Main characteristics of beef snapshots

Characteristic	Tanzania Pastoral	India Pastoral	Brazil Beef and feedlot
Herd size	300	100	300
Output meat kg LW	12,677	3,665	31,547
Productivity (meat per head)	42	37	105
CO_2 eq. per kg of carcass weight	38	46	41
NH_3 emissions per ha	5	6	15
N surplus per ha	-0.1	-0.4	8

Main characteristics of dairy snapshots

Characteristic	Tanzania dairy mixed	India dairy Mixed	NL dairy	Indonesia dairy mixed
Herd size	8	8	160	8
Output milk (kg)	7,500	5,000	698,445	7,000
Output meat (kg LW)	646	547	15,804	815
CO_2 eq. per kg of milk	3.3	4.7	1.4	3.5
NH_3 emissions per ha	194	75	79	28
N surplus per ha	136	221	163	88

Key findings bottom-up analysis (1)

	Beef	Milk	Poultry
Carbon externality as % of average retail price	114%	57%	26%
Natural capital costs of GHG in USD per kg of protein	35-41	5-18	4-5
Land occupation in m^2 per kg of protein	1,131-10,913	23-1,231	0-58

Key findings of bottom-up analysis (2)

- **Snapshot specific findings**
  - **Natural capital costs of dairy farms** in NL with milk and **meat and poultry meat** in NL are **of same order**.

    But

    a. **meat quality of milk dairy cows** and their offspring **is different from pure beef production**;

    b. **nutrient load per ha is high** in dairy due to high stocking density.
  - **Improvements** within livestock production system **can decrease natural capital costs** up to **20%**.
  - In backyard systems the **environmental profile of feed is low, while feed conversion rate is poor**, in intensive systems **environmental profile of feed is high, but feed conversion rate is very good**.
  - **Pastoralist systems have a low natural capital efficiency however this system does not affect biodiversity and natural capital negatively** (see the in depth study of Maasai Steppe in Tanzania)

Key findings of bottom-up analysis (3)

Biodiversity

- **Livestock impacts biodiversity directly and indirectly**. The impact on biodiversity per ha of production system is smallest for the pastoralist systems and is higher for the more intensive and feed based production systems.
- **For poultry the relation is more obscure**. Systems are called ‘land-less’ but in reality poultry production and feed production are spatially disconnected.
- **In extensive conditions, sustainable intensification is a solution to reduce the environmental impact per unit of product**. Further intensification of intensive systems has little effect.

Animal and human health

- **Large variation in use of antibiotics** within and between species.
- **Zoonoses exist in all regions** and livestock production systems.
- **Impact of food-born diseases is more or less unknown**, but can play an important role.

Key findings of bottom-up analysis (4)

In-depth study Maasai Steppe

- **Internal value** of natural capital **2.7 – 4.0 billion USD**.
- **Low speed of land conversion increases internal natural capital value** of the Maasai Steppe
- **Carbon emissions** are **also an important negative externality of conversion** to arable cropping.
- **Livestock production contributes to ecosystem quality and provide food**. Some farming systems are a threat to the ecosystem quality. Tourism is stimulated by the way Maasai manage their land.

Discussion (1)

Findings in perspective

- **In line with** the **literature**
- **The present assessment is still partial**; an integral assessment can change the order of commodities regarding natural capital costs (for example the impact of zoonoses).
- **Findings are based on environmental impacts**. Ruminants utilise human inedible products, where poultry competes with human edible food. This should be considered as well.

Discussion (2)

Individual dietary preferences

- **Diets have a big impact on natural capital costs** by total amounts and type of products consumed per head.
- **Especially developments in diets in the non-industrialised world are decisive** regarding the global demand of animal proteins.

To meet the future global demand of animal protein:

- Livestock production systems **need to become more efficient**.
- Existing livestock production systems can be **replaced by more efficient systems**.
- Animal protein can be **produced with species which are more efficient**.

Discussion (3)

Scenarios with increased production and consumption of animal protein without increasing natural capital costs are feasible.

- **Poultry**
  - **Increase in commercial and industrialised systems** including supplying feed industry, services and slaughterhouses and processing industry for urban areas.
  - **Backyard systems will survive in rural areas** but **relative importance will decline**.
  - **Impact on natural capital costs is limited** because both type of systems have more or less same impact. **Higher production will increase natural capital costs**.

Discussion (4)

Dairy systems

- **Especially smallholders can increase efficiency by increasing production per cow**, which will lead to decreasing natural capital costs per kilogram of protein
- **Western production system can also increase production per cow** but **with only a small decrease in natural capital costs** per kg of protein.
- **Scale of farms will increase** because of economies of scale.

Discussion (5)

Beef systems

- **Beef production in Brazil is expected to increase**. By using feedlots efficiency can be increased. Impact of efficiency improvement on natural capital costs is modest.
- **The transhumance pastoralist systems in Africa and Asia will decrease**. Due to population increase mixed cropping systems will increase. For the maintenance of the landscape transhumance pastoralist system should be safeguarded.

Conclusions (1)

- **Overall**: **Livestock sector presents many risks for natural capital but much can be done to face these risks.** Future needs of proteins can be fulfilled without increasing natural capital costs.
- **Livestock production results in an ecological footprint.**
- **Production of animal protein is expected to grow.**
- **Implications of systems with high productivity levels and high levels of inputs** like feed, capital and medicines **are clear and have relative low natural capital costs**. These systems have potential to feed urban regions all over the world.
- **Natural capital costs increase from poultry, milk to beef in average terms**. However **within every species there may be room to decrease natural capital costs per kg of protein**. For ruminants there are double wins especially for smallholders in Asia and Africa.
- **Subsistence systems have low inputs and outputs per kg of protein**. These systems supply food to the most vulnerable populations, are well adapted to local constraints and have a low or even positive impact on biodiversity.

Conclusions (2)

- **Sustainable intensification pathways are possible for each species** but these pathways **depend on the local context**.
- Methodology: **top-down and bottom-up are complementary approaches** that allow:
  - Determining the impact of livestock sectors worldwide and identifying hotspots;
  - Gaining deeper insight into particular locations with specific types of production systems.
- **Part of the impacts are hard to quantify**, but important factors to consider are: one health, biodiversity, edibility of products.

Policy recommendations

Pay full price without affecting food security

Negative externalities need to be priced and positive should be rewarded.

Consolidate the valuation of natural capital

An international standardised valuation framework for identifying hidden costs and benefits of systems will allow informed decision making to achieve sustainable livestock production.

Improve livestock production systems

Examples are: implement good agriculture practice; increase production per animal (efficiency improvement), contexts are important how efficiency can be improved; promoting knowledge exchange and sharing among countries.

Healthy diet: role of consumers

Consumer awareness should be raised by governments.

Agenda for future research

To an integral assessment

Present study is still partial, with limited snapshots and themes valued. Besides costs also benefits need to be valued.

The next right questions

Look at substitutability of production systems; combined arable-livestock systems; attention to smallholders

Agriculture for landscape management and the value of ecosystems

Livestock systems produce food but also manage landscape. For other regions than the Maasai Steppe in Tanzania insight into the relation of agriculture systems with semi-natural ecosystem can support sustainability.

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Thanks for the attention

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