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Towards a modular and coherent approach to sustainability assessment of food value chains

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Sustainability Assessment of Agrifood Systems,
Center for Sustainable Food Systems, Justus Liebig University, Giessen, 20-21 November 2025

Outline

1. Why do we need a coherent and a modular approach to sustainability assessment?
2. What can we do about it?

Sustainability Assessments in the private sector



Food

In France, McDonald's is the #1 restaurant where children eat fruit.



100 MILLION

In the U.S., we anticipate introducing 100 million cups of fruit into children through the Happy Meal®.

95%

of McDonald's restaurants offer a fruit, vegetable or low-fat dairy option.

Planet



Infos, Gewinnspiel und Rezepte unter www.superwurst.info



Netto
Marken-Discount

E
EDEKA

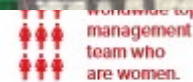
LIDL

People

We strengthened alignment around the important role of our **EMPLOYEE VALUE PROPOSITION**, which emphasizes friends and family, flexibility and future.



8 of our top nine markets report to supports their professional development.



Worldwide top management team who are women.

Increase in **LOCAL ECONOMIC INVESTMENTS** in eight of our top nine markets.



Types of product environmental footprints on food products

working with
the Carbon Trust



per product

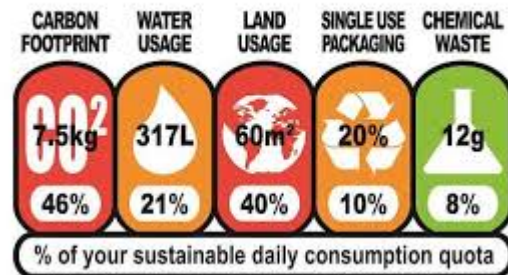
NACHHALTIG \uparrow 14,3% weniger CO₂
 \downarrow 14,8% weniger Wasser
BESSER \uparrow 26,0% mehr Naturvielfalt
 ist mehr Biodiversität
 als herkömmliche Milch

Ihre frische Muraue Bergbaue Milch wurde nachhaltig
 umweltschonend hergestellt: mit geringerem CO₂-Ausstoß
 und Wasserverbrauch, fördernd für die regionale
 Tier- und Pflanzenwelt.

Prüfen Sie nach, wie weit unser Bio geht – von der Herkunft
 bis zur Milch – mit Chargencode oder Mindesthaltbarkeits-
 datum auf der Packung unter:

www.zurueckzumursprung.at

Environmental impact of this product



Planet SCORE **B** **D E**

PESTIZIDE \circ \bullet \bullet \bullet \bullet

BIODIVERSITÄT \bullet \bullet \bullet \bullet \bullet

KLIMA \bullet \bullet \bullet \bullet \bullet

ECO-SCORE



ENVIRONMENT

TOTAL **+52%**

WORSE AVERAGE BETTER

MOST RELEVANT IMPACTS ARE...

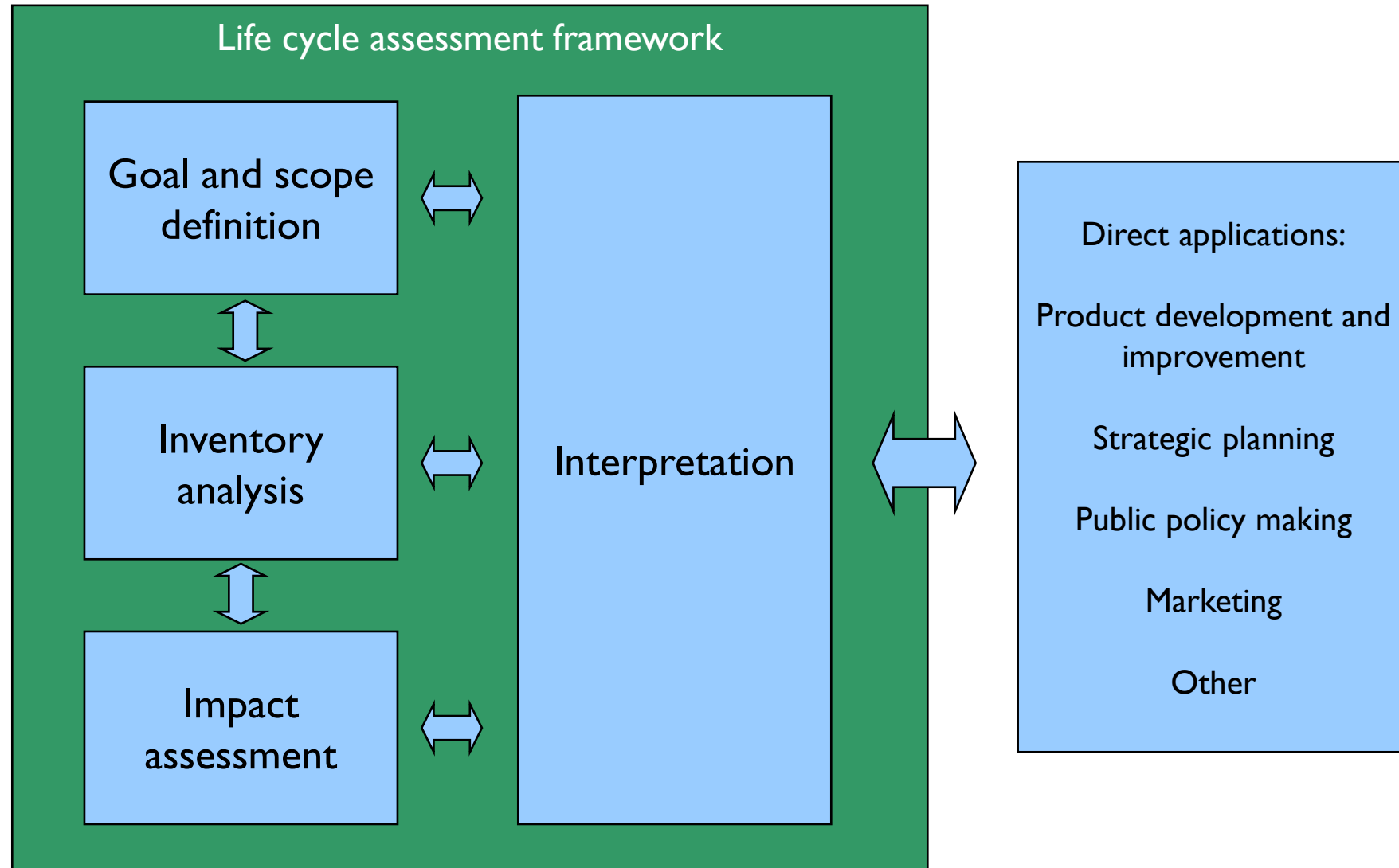
| | | |
|----------------|-----------------------|-----------------------------------|
| BETTER | BETTER | AVERAGE |
| Climate change | Resource use, fossils | Resource use, minerals and metals |

You can combat global warming by choosing wisely: this wine leads to less emission of greenhouse gases.

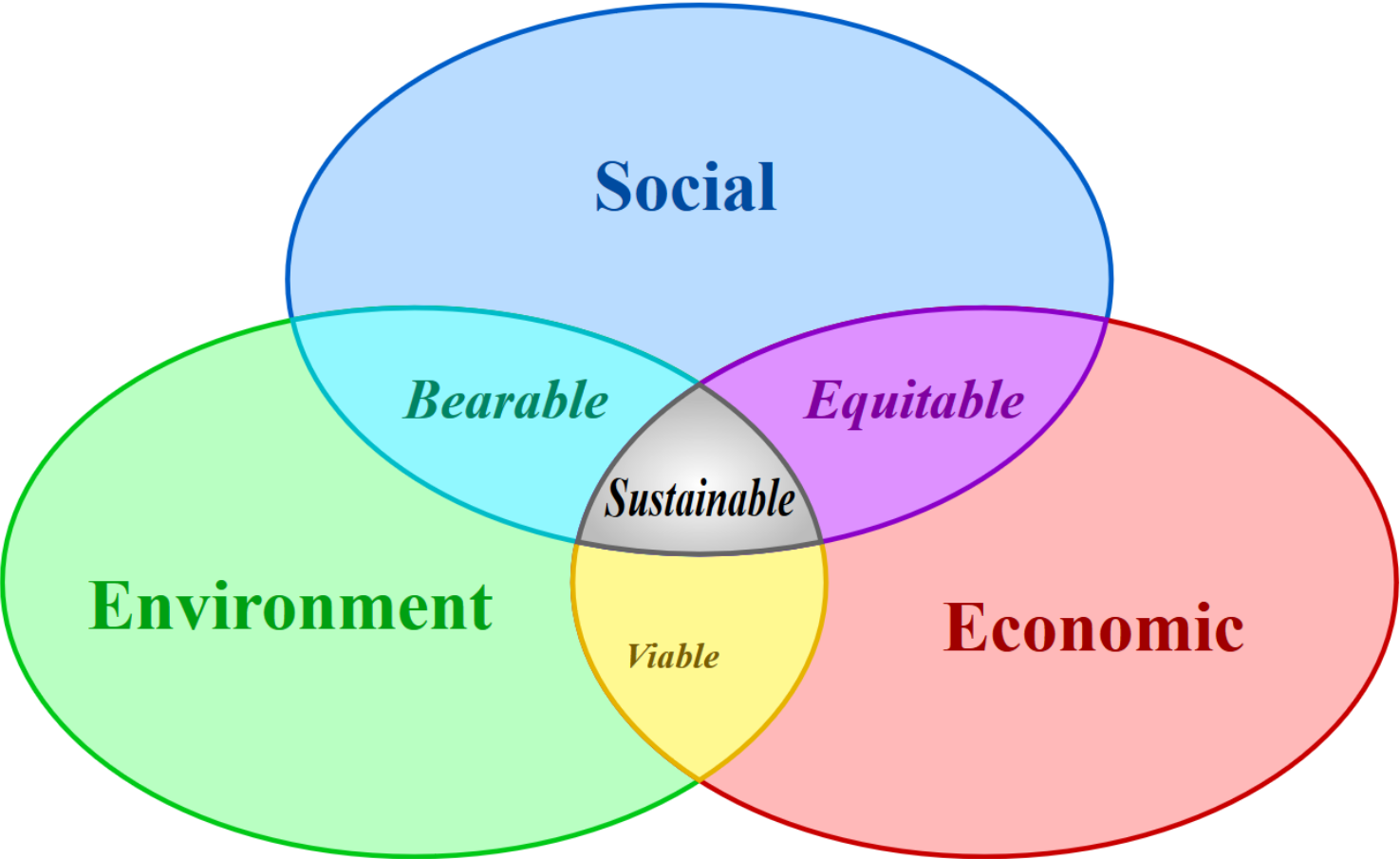
Results relative to the average wine*, based on the EU PEF method
 Verified by EFHA



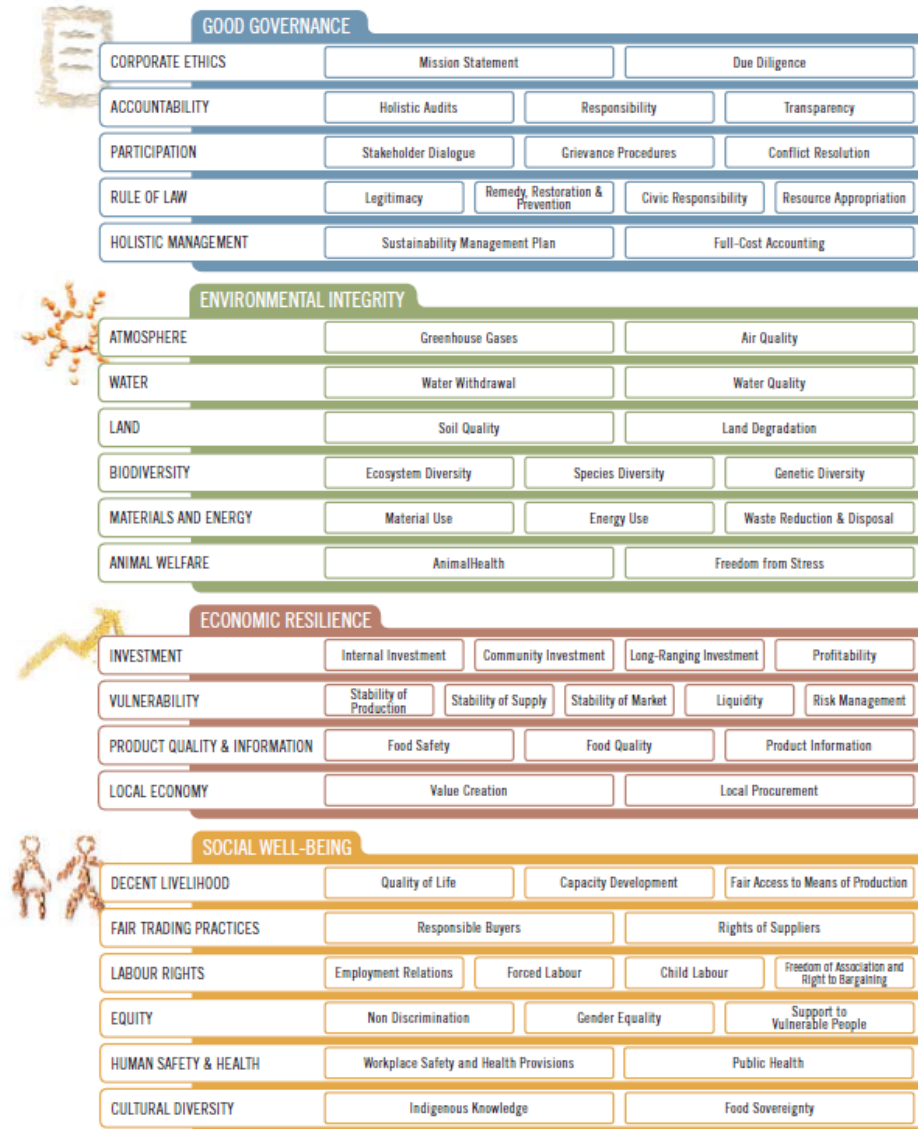
Life cycle assessments (ISO 14040-14044)



Three pillars of sustainability



Guidelines for sustainability assessment of agriculture and food systems (SAFA)

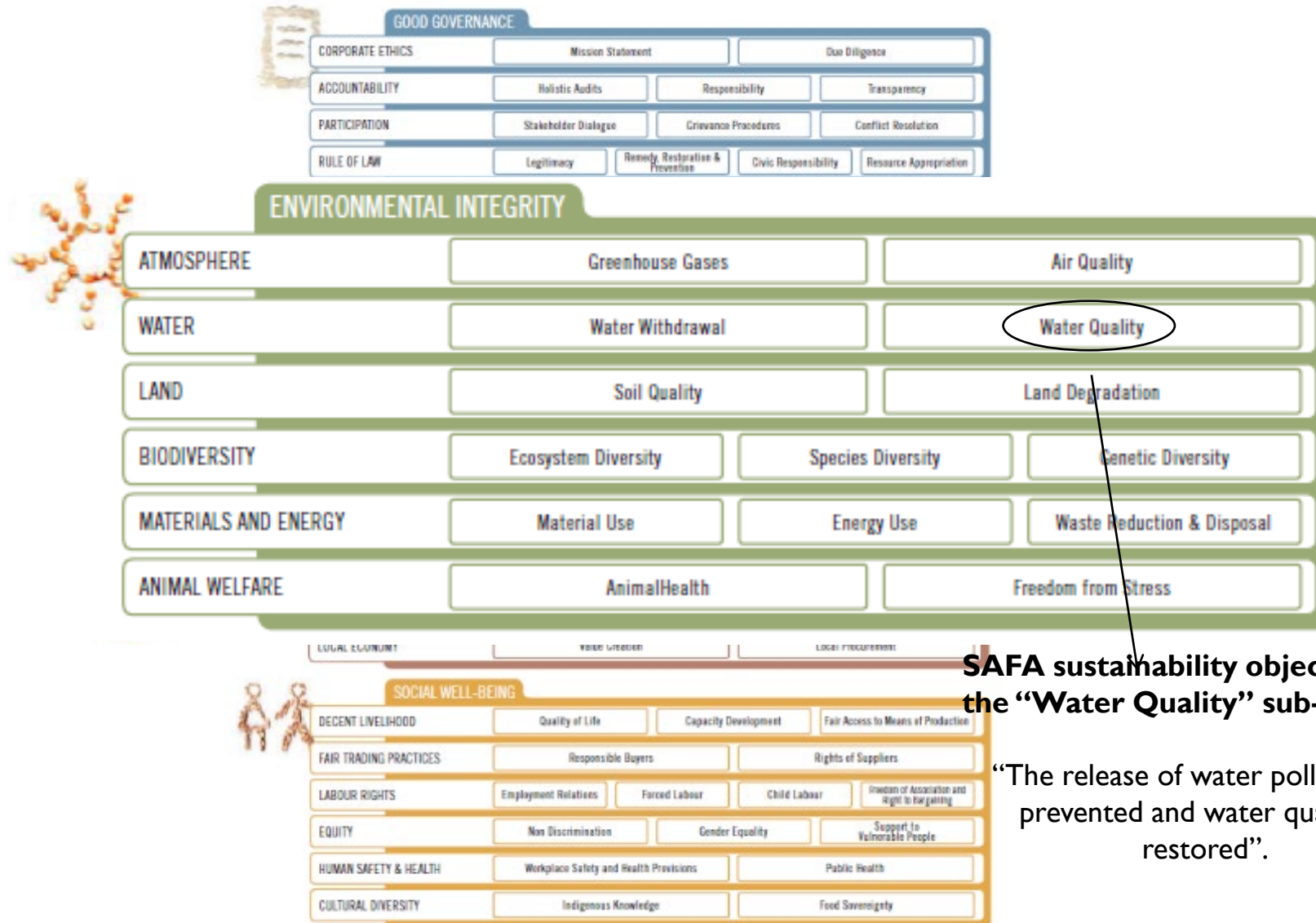


- 4 Dimensions
- 21 Themes
- 58 Sub-themes with sustainability objectives



Food and Agriculture Organization of the United Nations

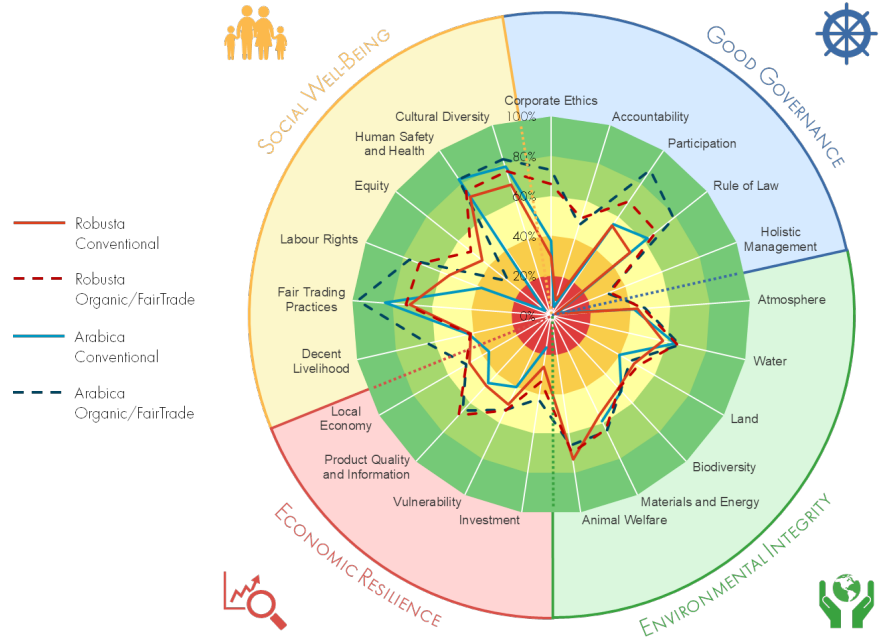
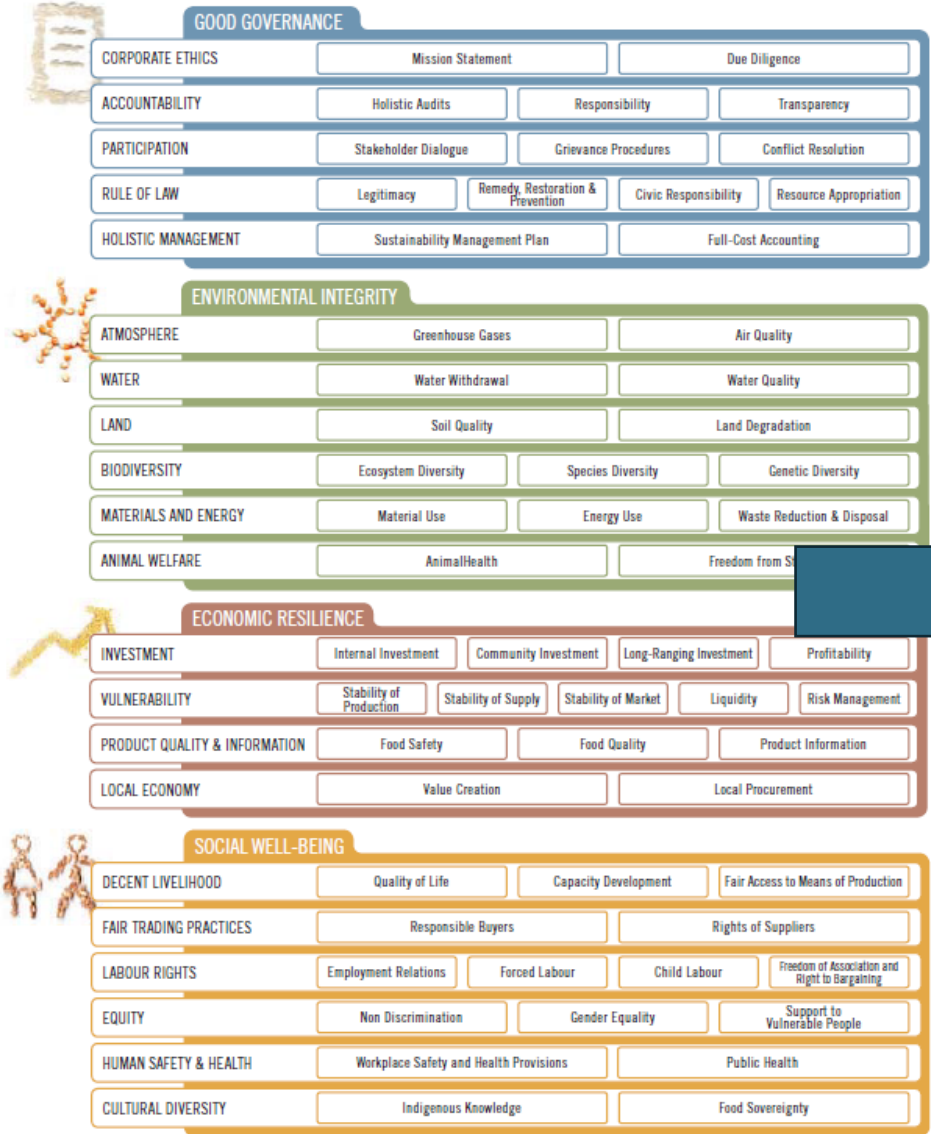
SAFA Guidelines



SAFA sustainability objective for the “Water Quality” sub-theme:

“The release of water pollutants is prevented and water quality is restored”.

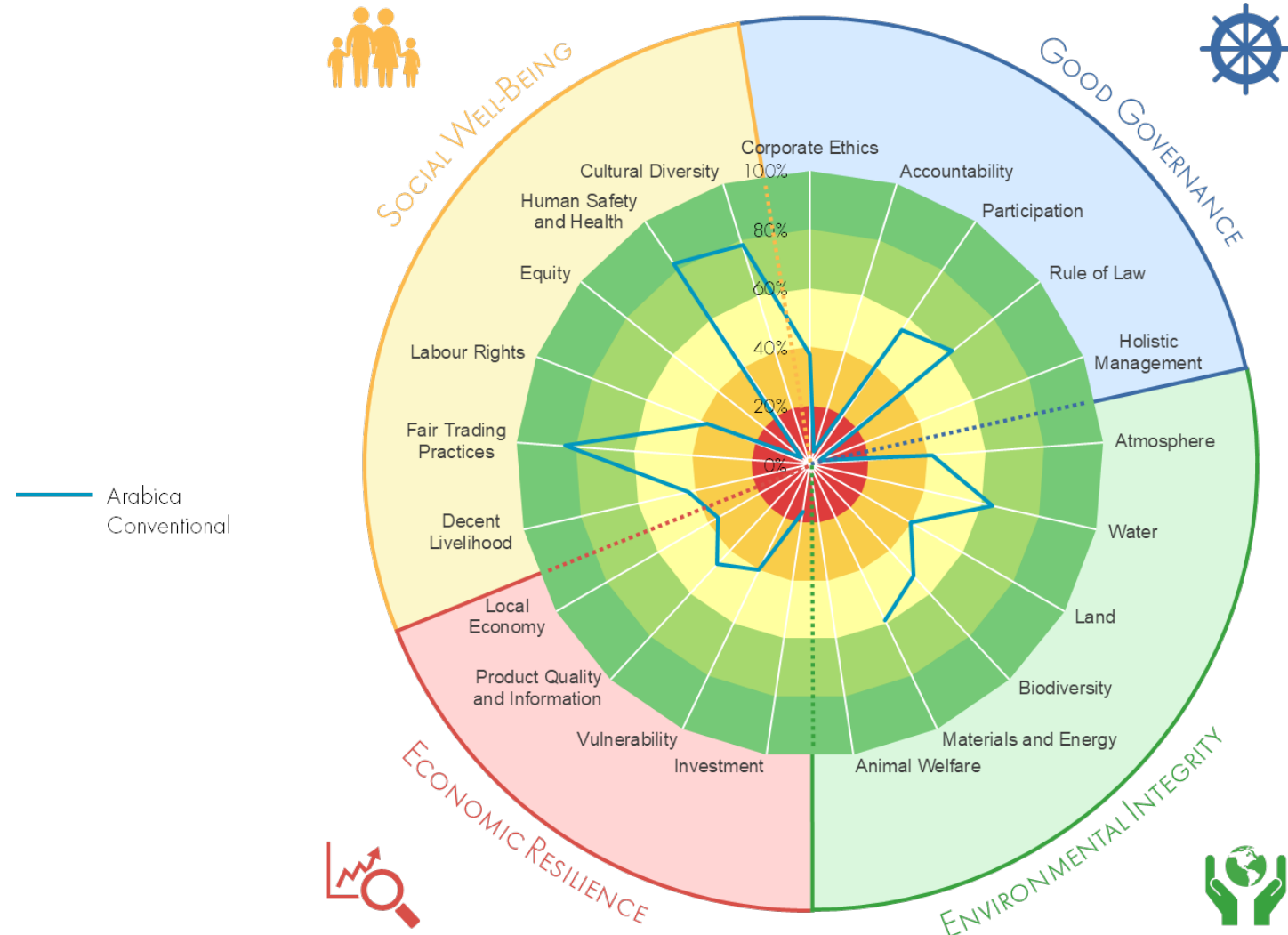
Tools for implementing the frameworks



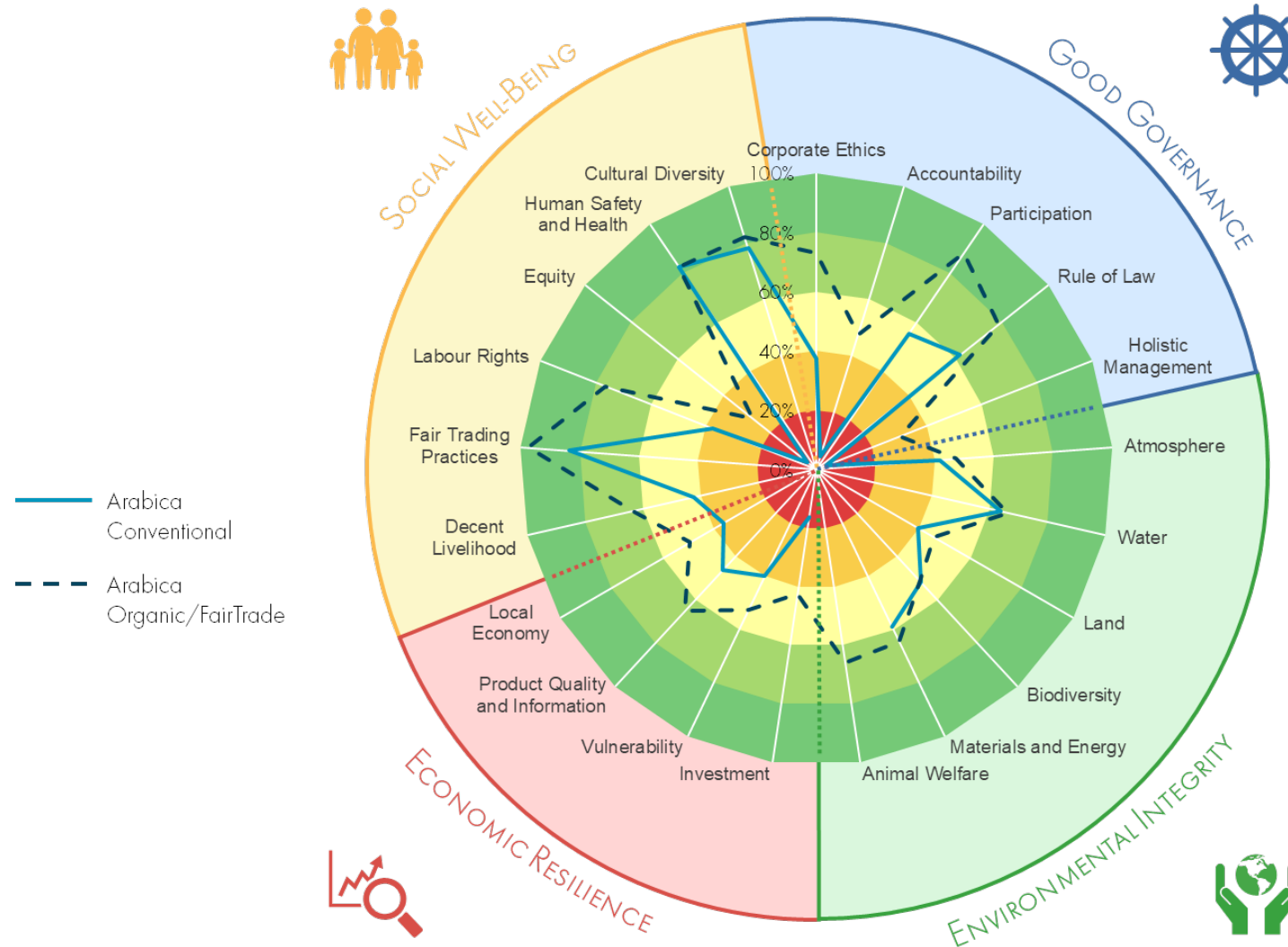
On-farm data collection



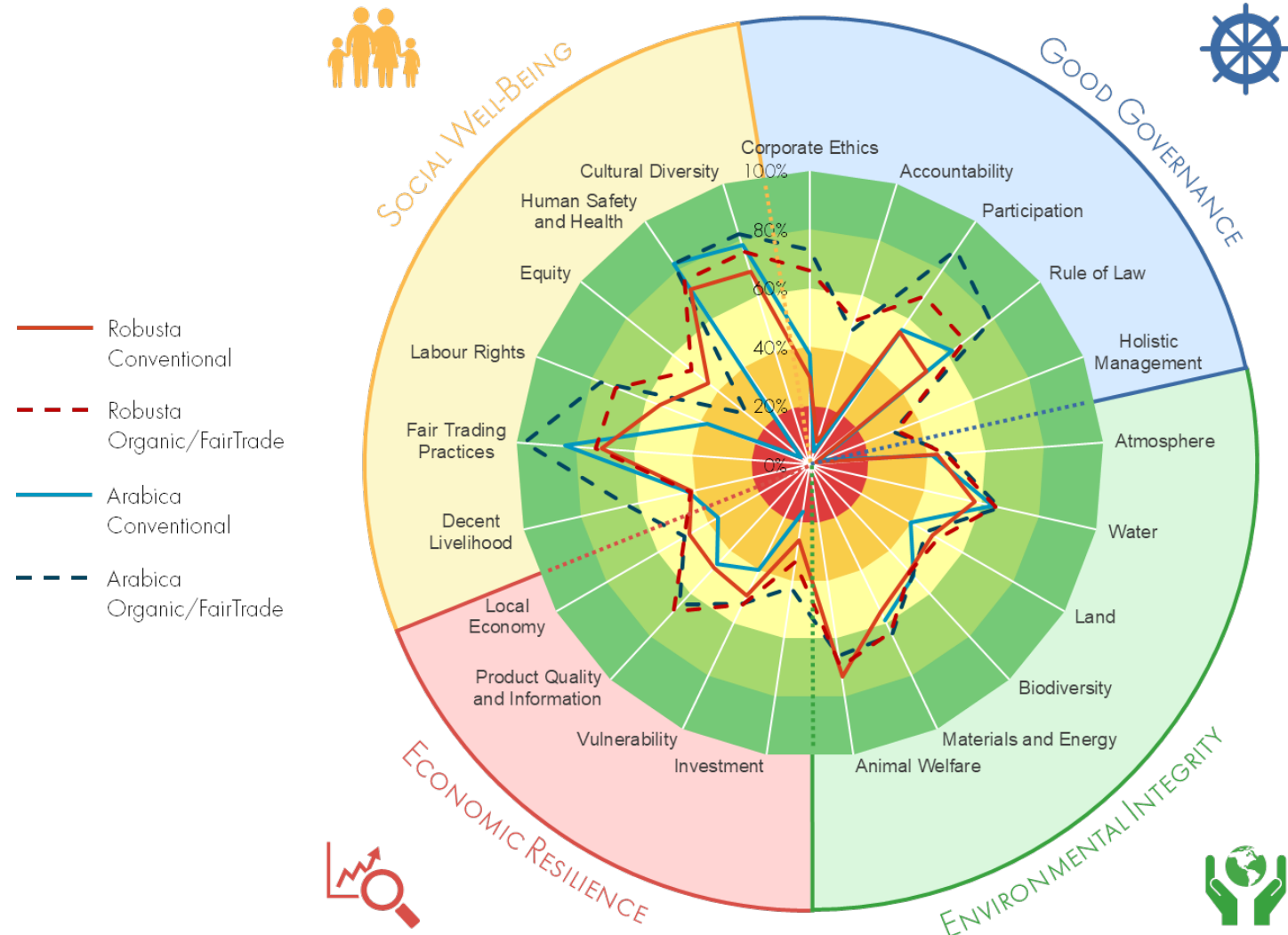
Sustainability Assessment of Coffee Production in Uganda

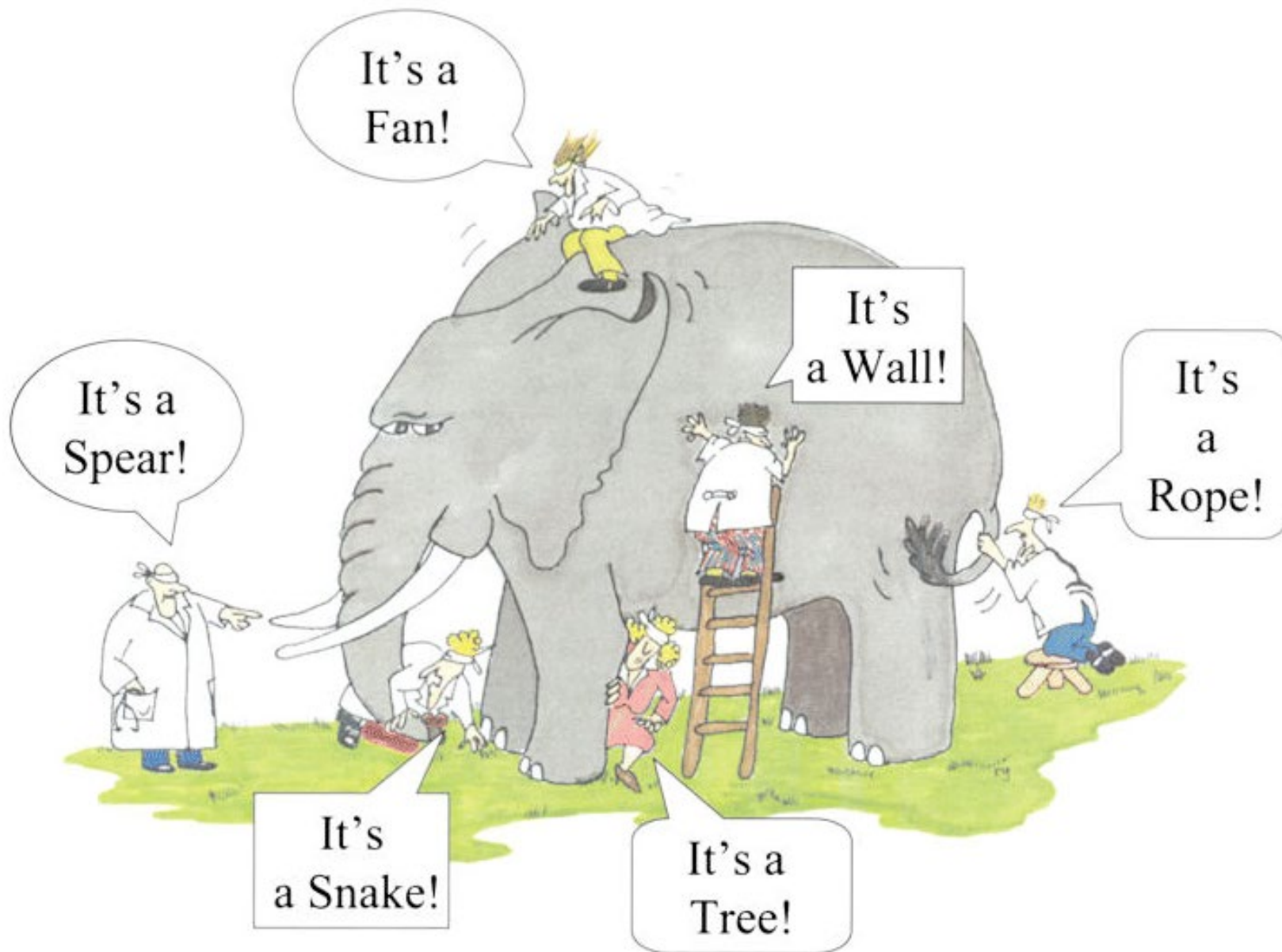


Sustainability Assessment of Coffee Production in Uganda

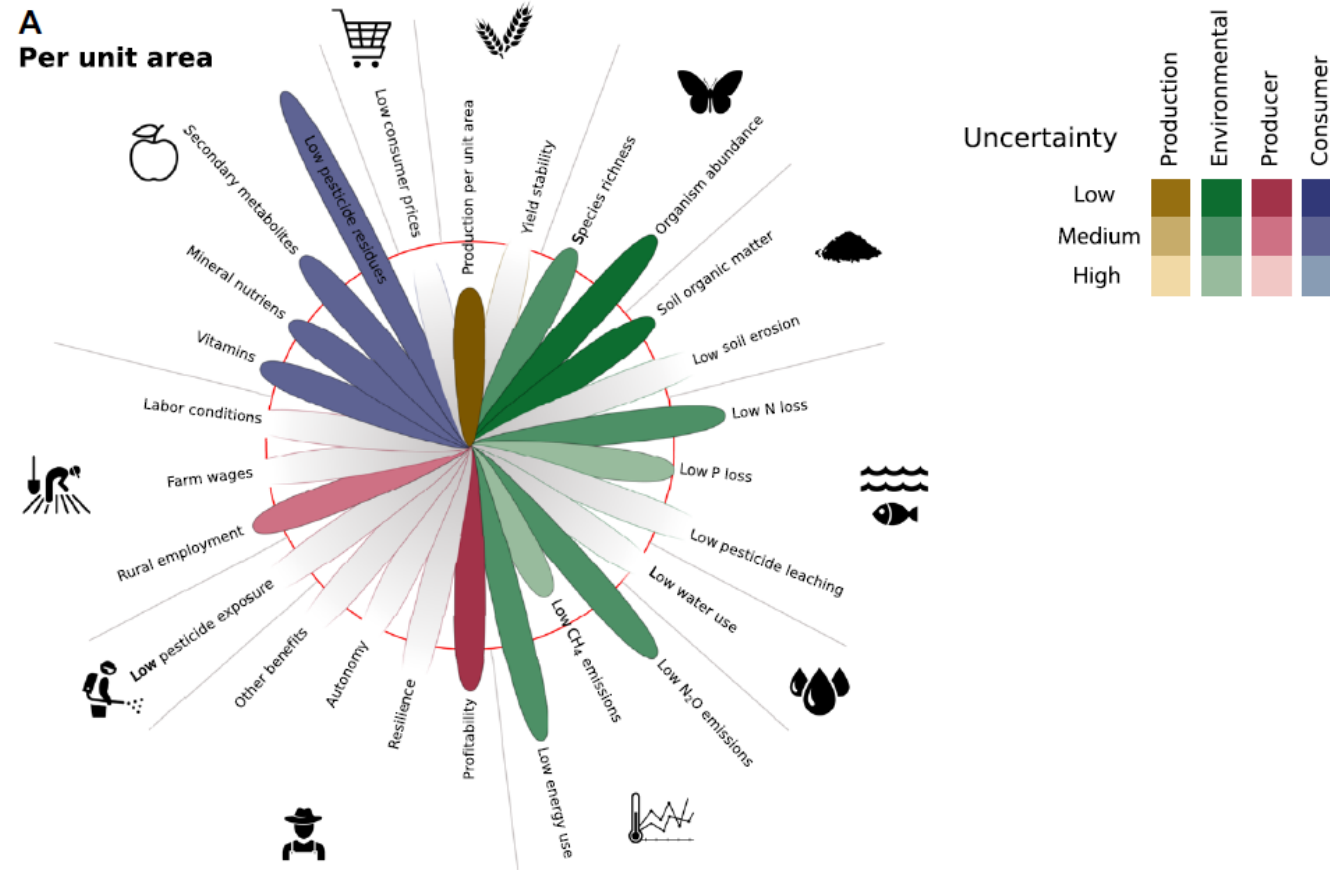


Sustainability Assessment of Coffee Production in Uganda

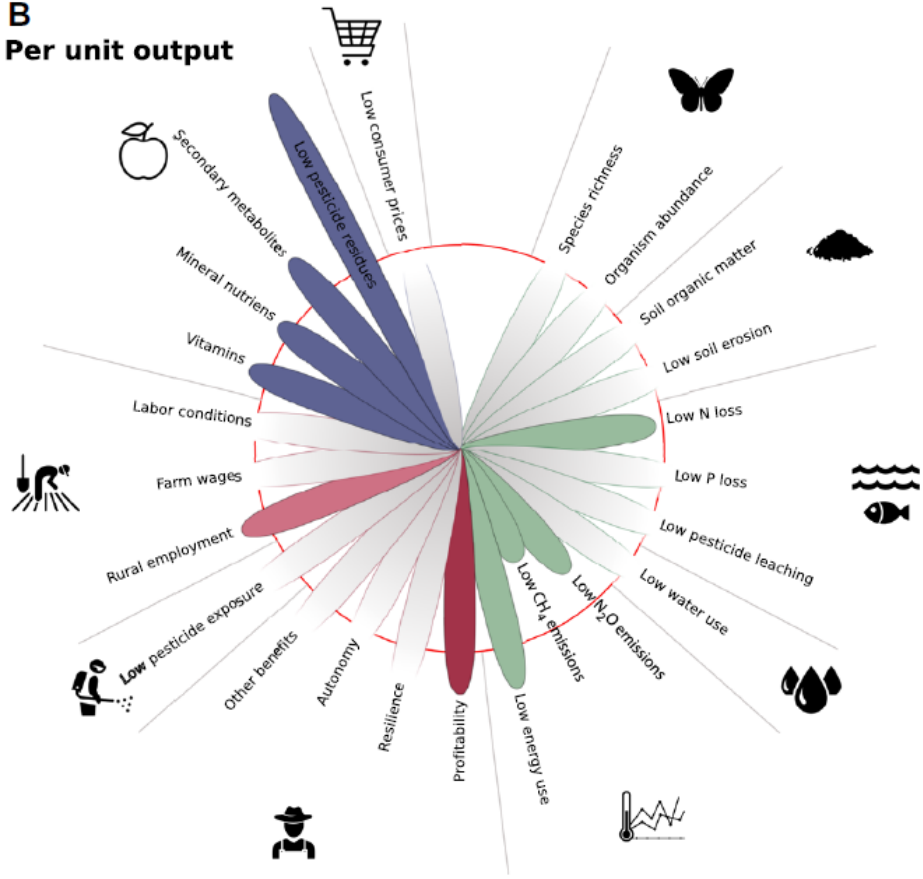




Sustainability performance of organic farming per ha



Sustainability performance of organic farming per kg of output



Land use

Billion hectares

Land occupation:

■ Current situation: Base year
 ■ 2050: Reference scenario
 ■ 2050: Food - not feed



Diets

Energy intake

Kcal/cap/day

● livestock products
 ● plant products

total: 2,763

total: 3,028

total: 3,028



Current situation:
Base year

2050:
Reference Scenario

2050:
Food - not feed

Protein intake

G Protein/cap/day

● livestock products
 ● plant products

total: 77

total: 82

total: 78



Current situation:
Base year

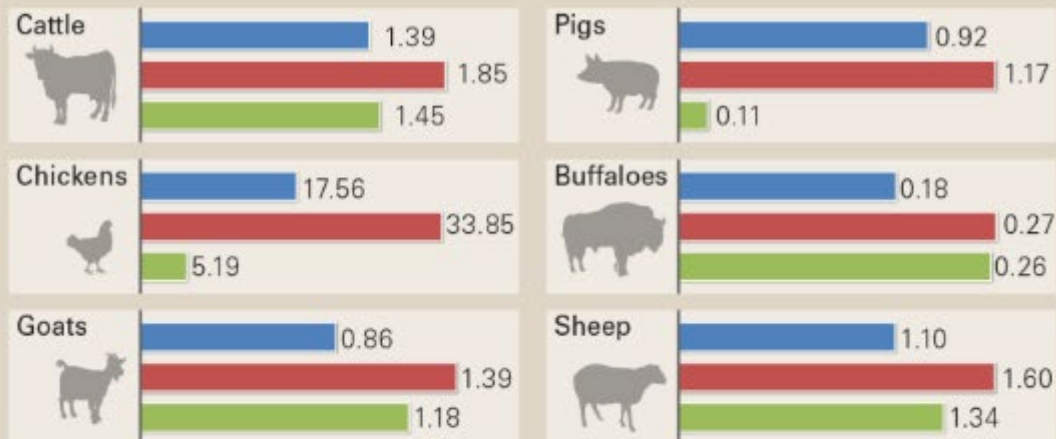
2050:
Reference Scenario

2050:
Food - not feed

Livestock

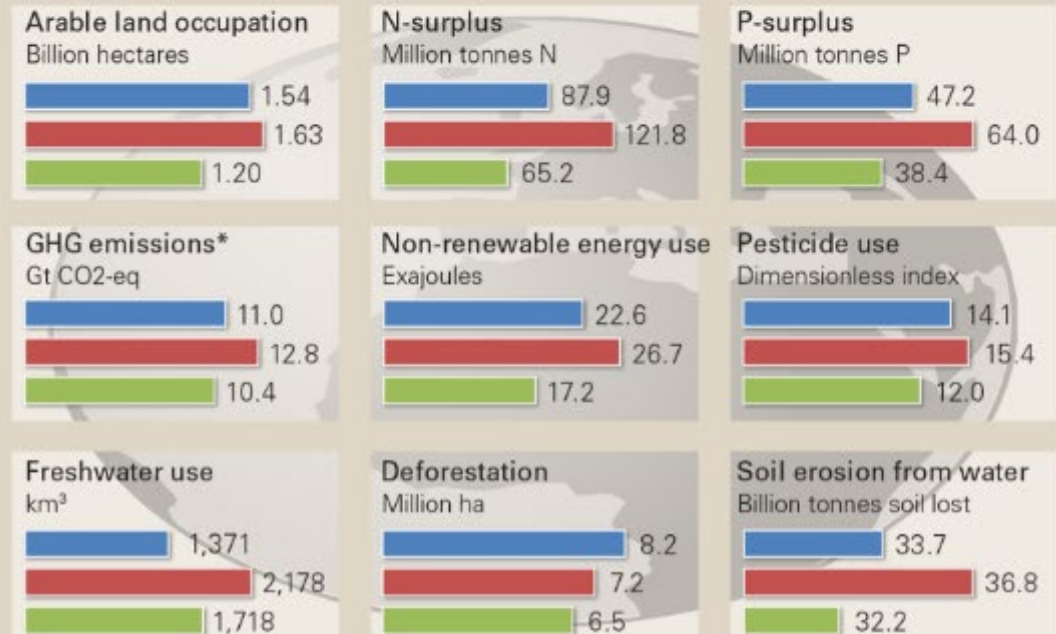
Billion animals

■ Current situation: Base year ■ 2050: Reference Scenario ■ 2050: Food - not feed



Environment

■ Current situation: Base year ■ 2050: Reference Scenario ■ 2050: Food - not feed
















* GHG emissions include emissions from input provision, deforestation and organic soils.

Schader et al. 2015,
Journal of the Royal Society
Interface

What can we do about it?

- Common framework for sustainability assessment
- Guidance on what tools are needed for which use cases and for how to deal with contradicting results
- Harmonisation of methods and assumptions for specific use cases
- Improvement of data availability and quality for sustainability assessments

| Dimension | Theme | 2.4.1 Sub-indicator | PROSA | Data Source | |
|-----------------------------------------------|---------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|--------------------------------------------------------------------------------|-----------------------------------------------|--------------------|
| Economic |  1. Land productivity | Farm output value per hectare | Gross production value per agriculture area (1000 ha) | FAOSTAT | |
| |  2. Farm profitability | Net farm income | Net production value per rural population | FAOSTAT, FishStatJ | |
| |  3. Resilience | Access to credit & insurance; farm diversification (value of production) | Credit to agriculture per rural population | | FAOSTAT |
| Production Value diversification index (Gjnl) | | | | FAOSTAT | |
| Environmental |  4. Soil health | Prevalence of soil degradation | Soil nutrient Budgets | FAOSTAT | |
| | | Nitrogen Balance | kg N per ha of Agricultural Land | FAOSTAT | |
| |  5. Water use | Variation in water availability | Economic water use efficiency: Gross production value per Volume of water used | FAOSTAT, FishStatJ, AQUASTAT | |
| |  6. Fertilizer risk | Organic source of soil nutrients (manure or composting residues) | | NA | FAOSTAT |
| | | | Synthetic or mineral fertilizer | Synthetic fertilizer use per area of cropland | FAOSTAT FAOSTAT |
| |  7. Pesticide risk | Use one pesticide no more than two times or in mixture in a season | | Pesticide use per area of cropland | FAOSTAT |
| |  8. Biodiversity | Use of synthetic pesticides | | Pesticide use per area of cropland | FAOSTAT |
| | | | area under a single continuous commodity | Crop and livestock index (gini) | FAOSTAT, FishStatJ |
| Social |  9. employment | Wage rate in agriculture | Value added per worker | FAOSTAT | |
| |  10. Food security | Food Insecurity Experience Scale (FIES) | PoU | FAOSTAT | |
| |  11. Land tenure | Secure rights to land | NA | | |
| Additional |  GHG emissions | NA | GHG emissions and intensity | FAOSTAT | |
| Additional |  Land use change | NA | Agricultural and forest land use change | FAOSTAT | |

IGs)

SAFE AND NUTRITIOUS FOOD

Ensure access by all people, and people in vulnerable situations, to safe, nutritious and sound.



TARGET 2.2 END ALL FORMS OF MALNUTRITION

By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons.

PRODUCTIVITY AND INCOMES OF SMALL-SCALE FARMERS

Enhance agricultural productivity and incomes of small-scale food producers, in particular women, family farmers, indigenous peoples, including through secure and equal access to productive resources and financial services, markets and value addition and non-farm income.



TARGET 2.4 SUSTAINABLE FOOD PRODUCTION AND RESILIENT AGRICULTURAL PRACTICES

By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.

AGRICULTURAL BIODIVERSITY IN FOOD

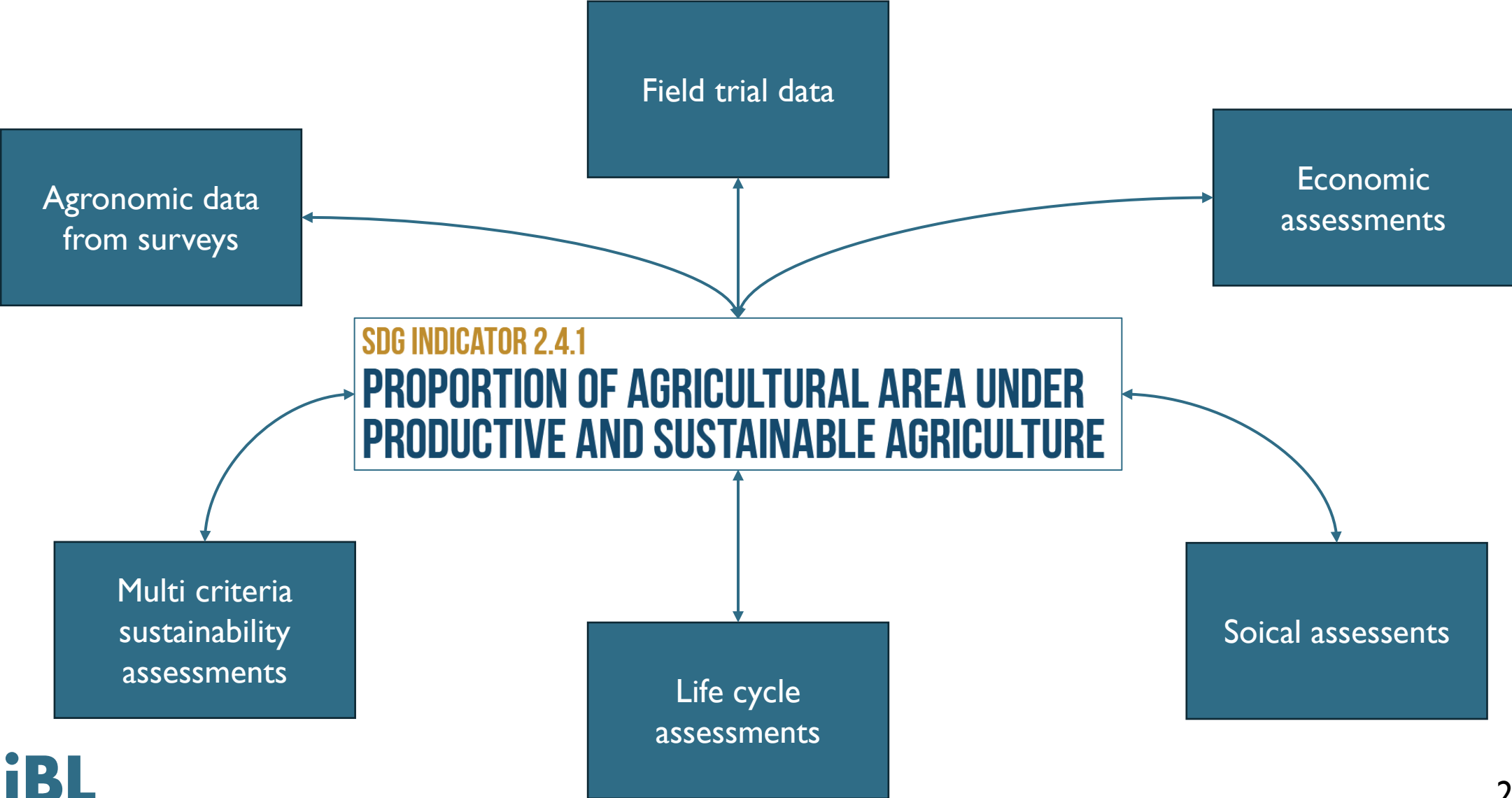
Enhance agricultural biodiversity of seeds, plants, and domesticated animals, and wild species, including through enhanced national, regional and international systems to protect and promote agrobiodiversity and to ensure fair and equitable access to and fair and equitable benefit from the utilization of agrobiodiversity, including associated traditional knowledge, nationally agreed.



TARGET 2.6 INVEST IN RURAL INFRASTRUCTURE, AGRICULTURAL RESEARCH, TECHNOLOGY AND GENE BANKS

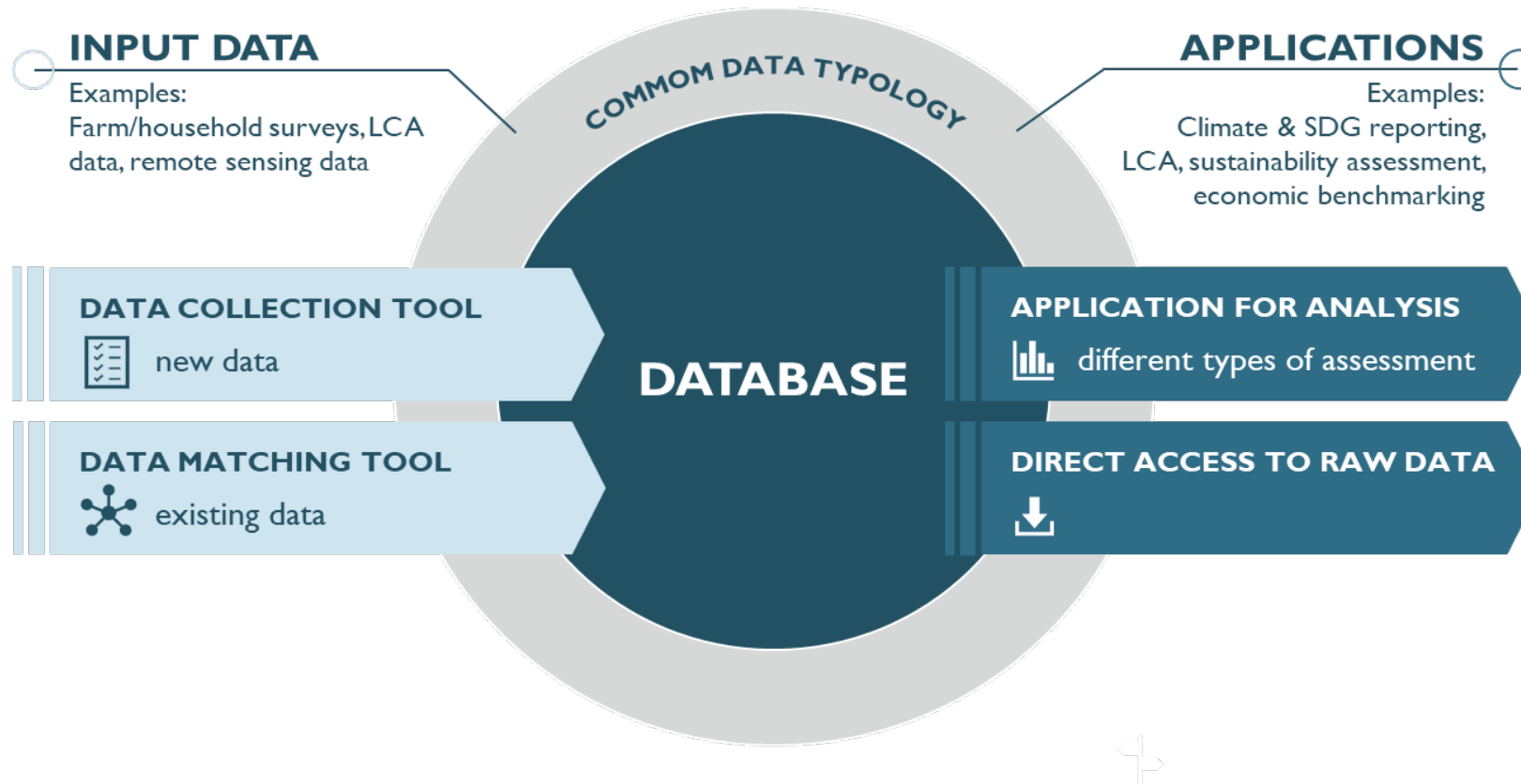
Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries.

Compiling data from existing assessments



Project objective

- Improving the availability, quality, depth and compatibility of data on agriculture.



Expert and stakeholder interviews

SELECTION CRITERIA

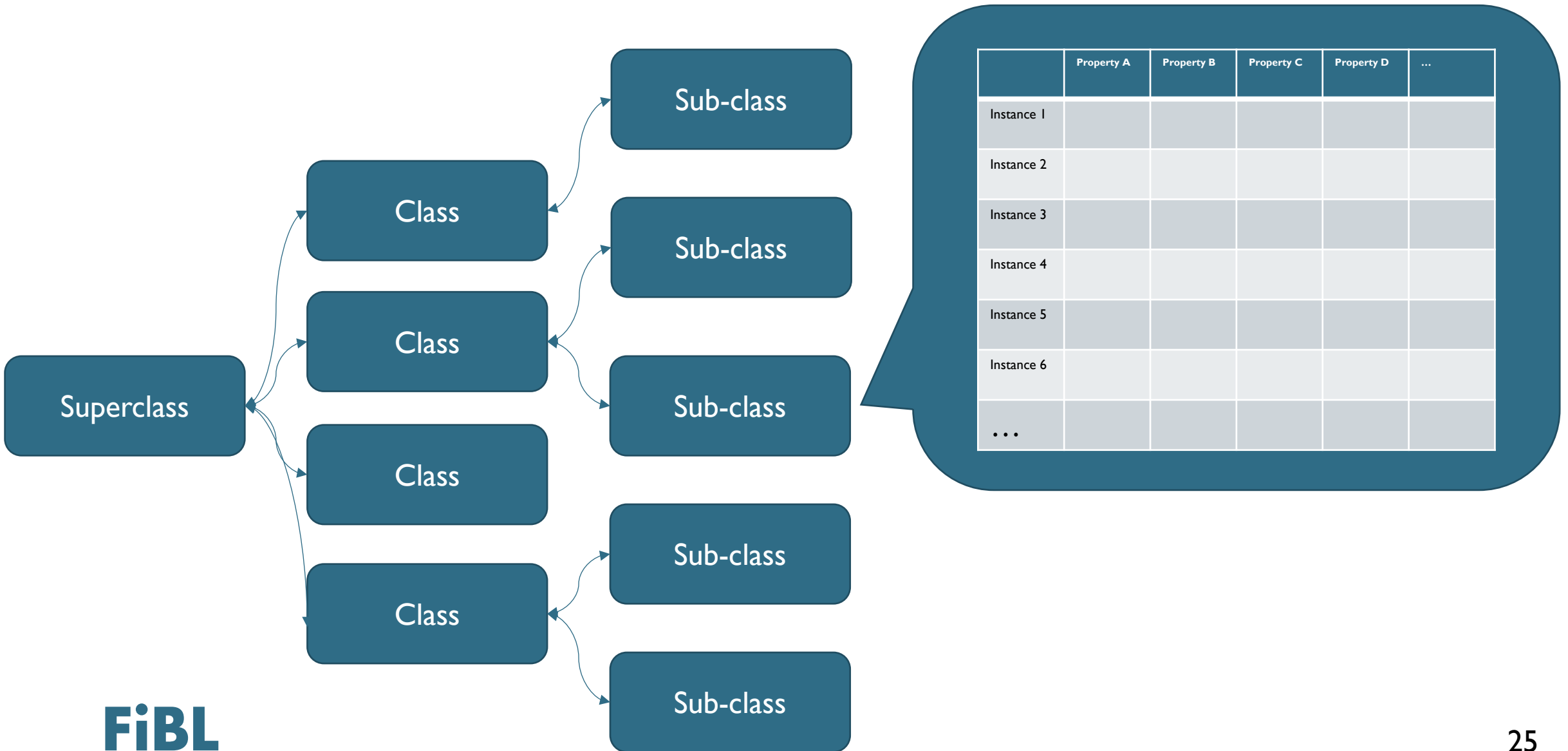
- Potential end-users and stakeholders of the ontology
- Experience with monitoring and assessment of sustainable agriculture
- At least 4 persons from research, policy/NGOs and business each
- Ideally a global scope of work (at least 2 persons from each continent)

| RESEARCH | POLICY/NGOs | BUSINESS |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none">• Wageningen University• INRAE• Oxford University• Cornell University• George Washington University• HAFL• FiBL• World Resources Institute | <ul style="list-style-type: none">• FAO• OECD• Roundtable on Sustainable Palm Oil (RSPO)• World Benchmarking Alliance | <ul style="list-style-type: none">• Bio Inspecta• Rainforest Alliance• Sustainable Food Systems GmbH• OLAM International• Nestlé Nespresso S.A. |

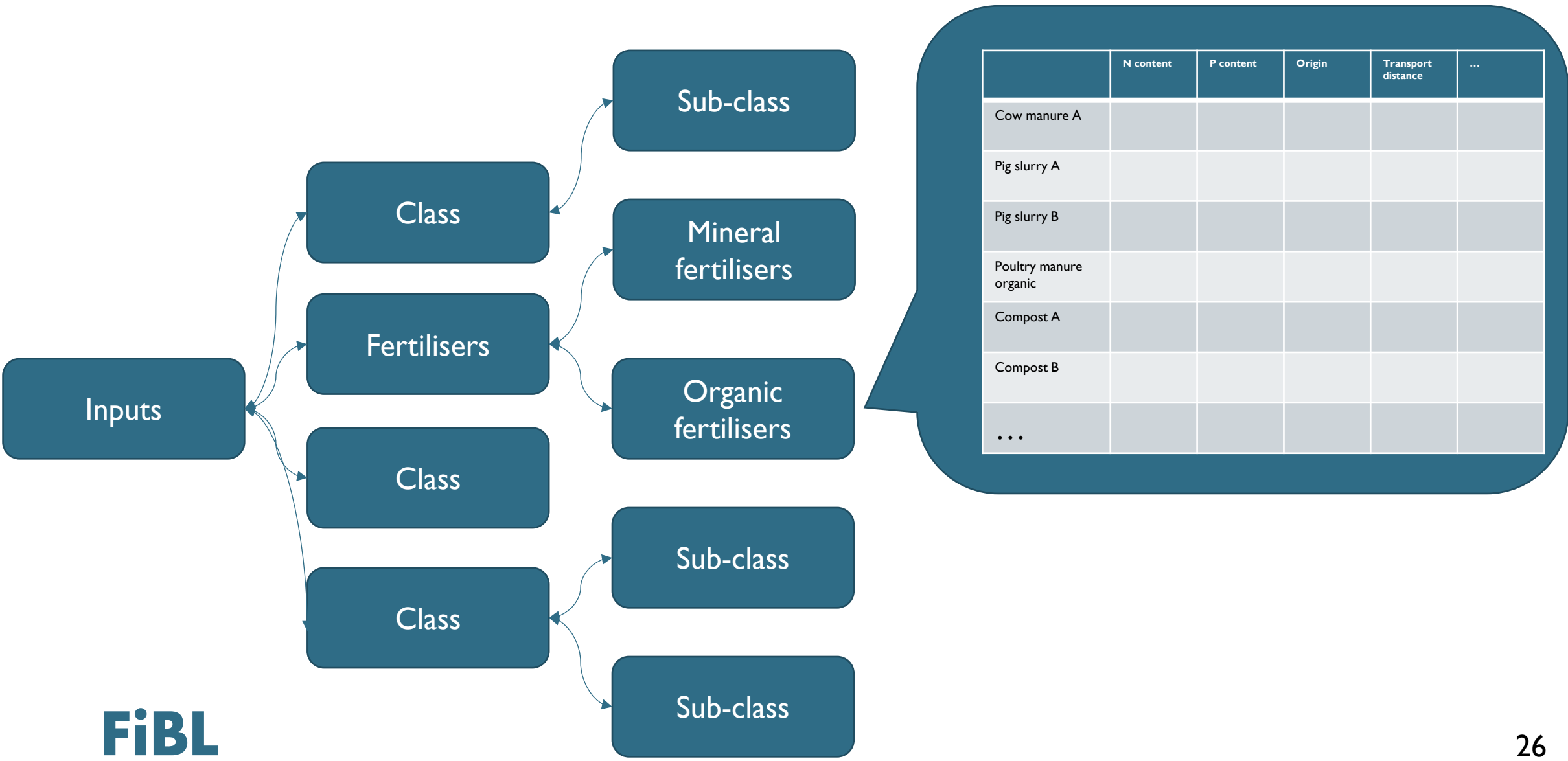
Choice sustainability assessment approaches piloting

| General approach to sustainability assessment | Specific methods/tools |
|------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| Multi Criteria Assessment | SDG24I and PROSA (Tubiello et al. 2022) |
| | SMART-Farm Tool (Schader et al. 2022) |
| | TAPE (Mottet et al. 2020) |
| Life Cycle Assessment | HESTIA (Poore and Nemecek 2018) |
| | Cool Farm Tool (Hillier 2012) |
| Profitability Analysis / Efficiency analysis | Gross Margin calculations and environmental economic efficiency analysis (Schader et al. 2022, Heidenreich et al. 2022) |
| Environmentally Extended Cost Benefit Analysis | True Cost Accounting (Michalke et al. 2022) |
| Mass flow modelling | SOL-m based sustainability impact assessment (Schader et al. 2015, Muller et al. 2017) |
| Agronomic data / field trial data | Field trial data (Krause et al. 2024) |

Structure of the ontology



Structure of the ontology



Overview of superclasses



Metadata

- covers all data points that describe the dataset itself.



Production Units

- covers all data points that describe which activities are conducted.



Context

- covers all data points that describe an influence on the production system but are not influenced by the production system itself.



Inputs

- covers all data points that describe goods or services that are bought, leased, or produced within the production system for farming activities or use within the system.



Outputs

- covers all data points that describe the products and services that are intentionally produced within the production system.



Practices

- covers all data points that describe the ways of production, namely how activities are conducted.



Sustainability Performance

- covers all data points that describe the impacts and the performance of the production system and its components excluding datapoints covered under "Other mass flows".



Other mass flows

- covers all data points that describe mass flows that have their origin and/or destination within the system and are not inputs or outputs.

Conclusions

- There is currently **no common framework for sustainability assessment**
 - **Lack of comparability** of results
 - All approaches have strengths and limitations => **no one-size-fits all solution**
- Full and high-quality sustainability assessment are **too costly**
 - Primary **data collection time consuming** and reason for poor data quality
 - Data requirements are often very similar (LCA, MCA, economic assessments, etc)
 - No common classification for data available
- **Generic framework for sustainability assessments**
 - **Modularity** to allow to focus on specific aspects of relevance
 - **Coherence** to allow to fit results into a bigger picture and reuse data
- **Impacts of the framework**
 - Increase data **availability and quality**
 - Reduce **cost** of sustainability assessments
 - Improve **comparability**